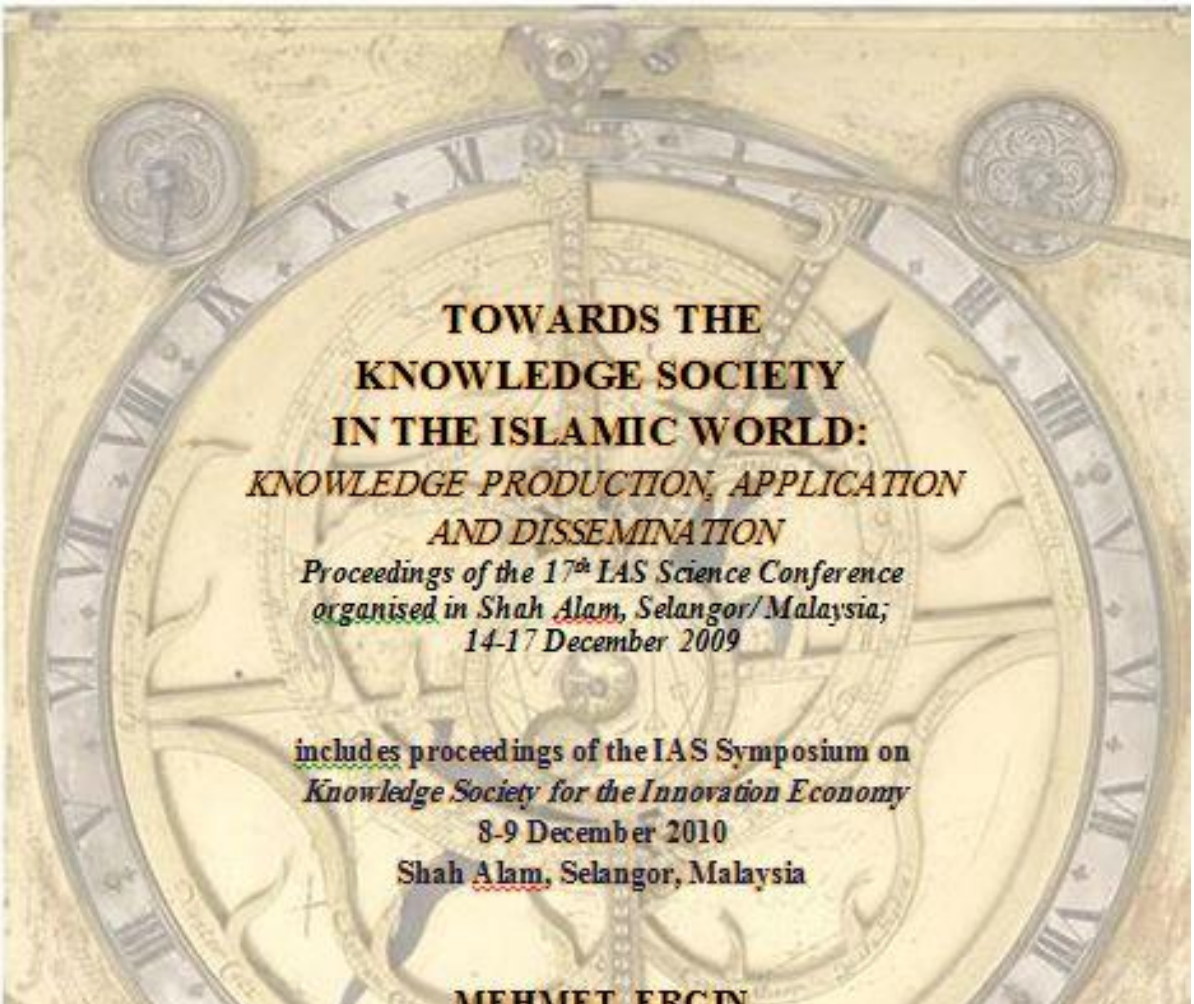

TOWARDS THE KNOWLEDGE SOCIETY IN THE ISLAMIC WORLD:

KNOWLEDGE PRODUCTION, APPLICATION AND DISSEMINATION

Proceedings of the 17th IAS Science Conference organised in Shah Alam, Selangor/Malaysia; 14-17 December 2009

includes proceedings of the IAS Symposium on *Knowledge Society for the Innovation Economy* 8-9 December 2010 Shah Alam, Selangor, Malaysia

MEHMET ERGIN
MONEEF R. ZOU'BI
EDITORS

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بسم الله الرحمن الرحيم

TOWARDS THE KNOWLEDGE SOCIETY IN THE ISLAMIC WORLD: KNOWLEDGE PRODUCTION, APPLICATION AND DISSEMINATION

Proceedings of the 17th IAS Science Conference on
Towards the Knowledge Society in the Islamic World: Knowledge Production, Application and Dissemination
organised in Shah Alam, Selangor/ Malaysia;
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Edited by

Mehmet Ergin
and
Moneef R. Zou'bi

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Some of the participants in the 17th IAS Science Conference;
Shah Alam, Selangor/ Malaysia; 14-17 December 2009.

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For a note on the editors, see below.

Editors:

Prof. Mehmet Ergin was for many years a professor of Chemical Engineering at Hacettepe University in Ankara (Turkey). He is a Founding Fellow (1986) and current Vice-President of the Islamic World Academy of Sciences. He is a former President of the Turkish Scientific and Technical Research Council (TUBITAK) and a former President of the Turkish Atomic Energy Authority. He received his PhD in Physical Chemistry from Glasgow University in the UK, back in 1969.

Dr Moneef R. Zou'bi is the Director General of the IAS. Formerly, he occupied the positions of Technical Affairs Director and Deputy Executive Director of the IAS. He studied at the University of Brighton, Loughborough University and the University of Malaya, to acquire his degrees in engineering and Science and Technology Studies, respectively. His academic interests include information technology, the environment as well as science and technology policy studies. He has developed an interest in the history of Islamic science since joining the IAS in 1990.

PREFACE

The Organization of Islamic Co-operation (OIC), formerly known as the Organization of the Islamic Conference (OIC), was founded in 1969 as a political organization grouping Islamic countries. In 1981, the heads of state of the OIC decided to establish a number of specialized organs to enhance co-operation between the OIC-Member countries in the fields of culture, trade and science and technology. The science and technology role was assigned to the Islamabad-based COMSTECH; the Standing Committee on Scientific and Technological Co-operation.

In 1984, the heads of state of the OIC approved a proposal by COMSTECH to launch the Islamic World Academy of Sciences (IAS) as an independent autonomous S&T Think Tank of the OIC to be based in Amman, Jordan. Of the issues that the IAS has been concerned with since its launch has been bridging the divide that has historically existed between the science community and the decision-making community in OIC-Member countries, as well as science advocacy in general.

Today, knowledge is a major component in production processes. A new economic and productive paradigm is emerging in which the most important factor is not the availability of capital, labour, raw materials or energy, but the intensive use of knowledge and information. Comparative advantage is increasingly determined by the use of knowledge and of technological innovations. This centrality makes knowledge a pillar of the wealth and power of nations.

In 2003, the European Commission defined the *knowledge society* as a society that is characterised by a number of interrelated trends, including major advances in diffusing and using information and communications technologies (ICTs), increased emphasis on innovation in the corporate and national context, the development of knowledge-intensive business service economies and knowledge management.

The 2003 Arab Human Development Report stated that the knowledge society is one in which knowledge diffusion; production and application become the organizing forces of people's activities: culture, society, the economy, politics…

OIC countries have been striving to achieve steady socioeconomic development. With the diffusion of ICTs as a prerequisite, actions are needed to invigorate; (a) knowledge production, (b) knowledge application and (c) knowledge dissemination; to help OIC countries build knowledge societies and achieve rapid socioeconomic development.

This book includes the majority of the papers that were presented at the 17th IAS Conference, which was held in Shah Alam, Selangor, Malaysia, during December 2009. A conference in which over 200 participants including IAS Fellows and invited speakers from outside Malaysia, academics, decision-makers, scientists, researchers as well as presidents/representatives of academies of sciences from all over the world, took part.

It is divided into ten parts.

Part One includes the statements of the two patrons of the IAS, the statements of IAS President as well as the statements of the officials of the host country during the inaugural session of the conference.

Part Two embraces a keynote address by Wolfgang Schürer, Chairman of the Foundation Lindau Nobel Prize Winners Meetings and Vice-President of the Council for Lindau Nobel Laureates Meetings, who presented a policy paper entitled 'Educate, Inspire and Connect the Lindau Nobel Laureates Meetings as a Cross-fertilising Platform;' and a keynote by IAS Fellow Prof. Atta-ur-Rahman, Coordinator General of COMSTECH, who presented an overview paper on 'Building a Knowledge Society: Challenges and Opportunities.'

Part Three is dedicated to the papers presented in the session on the 'The Human Factor and Symposium on Women and Science,' in which five papers were presented mostly by scientists from Malaysia; speakers from the University of Putra Malaysia and Univirsiti Kebangsaan Malaysia, in addition to a speaker from the Imperial College in the UK.

Part Four includes a presentation by Mehmet Fatih Serenli from the Statistical, Economic and Social Research and Training Centre for OIC Member Countries (SESRIC),Ankara, Turkey on 'The Atlas of Islamic World Innovation (AIWA),' and a presentation by Ehsan Masood, Nature Magazine, UK, on 'The Landscape of Science in the Islamic World: Historically and Contemporaneously.'

Part Five addresses the topic of Knowledge Society and the Business Sector and includes papers by Prof. Mohd Azzman Shariffadeen on 'Addressing the Challenges of the Knowledge Society: Charting the Way Forward for OIC Countries,' a presentation by Qusai Sarraf on 'Opportunities and Challenges in Creating a Knowledge-Based Economy: A Viewpoint from the International Private Sector,' a presentation by Michael Grimes, President of EnvironTeq, Thailand, on 'Knowledge Workers in a Globalised World: From America to South East Asia' and a presentation by Prof. Rosti Bin Suruwono, President/Vice Chancellor, Universiti Industri Selangor, Malaysia, on 'Academic Industry Partnership Towards the Innovation Economy: A Proposed Best Practice.'

Part Six includes the papers which were presented in the session entitled 'Knowledge Society: Policy Aspects,' including a broad policy paper by IAS Fellow Prof. Adnan Badran on 'Science and Technology Landscape of the OIC: The Arab Countries in Focus,' a presentation by Mehmet Fatih Serenli on 'R&D and KE Performance in OIC Member Countries,' a paper on 'Science and the Information Society' by Dr El-Tayeb Mustafa, former Director, Science Policy Division of UNESCO and a paper by Prof. Hussam Salama from the University of Southern California entitled 'Hubs of Knowledge and Information Flows in Islamic Countries: Challenges and Potentials.'

Part Seven consists of eleven papers in the session entitled 'Knowledge Dissemination Forum. Prof. Mazhar Qurashi presented a paper on 'Renaissance of Science and its Integration with Islamic Thought,' the Prof. Kamal Batanouny presented a paper entitled 'A Vehicle for Dissemination of Knowledge: Doha Quranic Garden,' Prof. Mehdi Golshani talked about 'Some Neglected Factors in Science Planning in the Islamic World,' and Prof. Noor Butt on 'Nanotechnology: The Urgent Necessity for OIC;' Iqbal Parker on 'Health and Human Well-being: An Extrapolation into the Future;' Syed Qaim presented a paper on 'Enhancement of Nuclear Knowledge for Application in Medicine, Particularly in Positron Emission Tomography;' Qurashi Ali on 'Quality of Medical Education: How to Assess Customer Satisfaction?' Prof. Mohammad Jairajpuri presented a paper on 'The Living Dead;' Prof. Karim Lahlaidi on 'Islamic World Through the Societies of Knowledge: Vision of Morocco;' Prof. Mostefa Khiati on 'The Challenge to Access a Knowledge-Based Economy: The Case of Algeria' and a paper by Prof. Anuar Ahmad on 'Design, Simulation and Fabrication of Polysilicon-based Piezoresistive Microcantilever Biosensor for Human Stress Measurement.'

Part Eight consists of two presentations; one by Prof. Maqsudul Alam on 'Genome-based Discovery Platform Uncovers Biotechnology Potential of Papaya and Rubber Genomes,' and one by Prof. Muhammadu Kah from the University of Gambia entitled 'Towards the Knowledge Society: The Gambia as an OIC Country Starting-up.'

Part **Nine** is the last part of presentations and consists of papers by Dr Hammadi Ayadi, Tunisia; Dr Arif Ergin from the Gebze Institute of Technology, Turkey; and finally a presentation by Prof. Mohammad Abdollahi, Tehran University of Medical Sciences, Iran.

Part Ten includes papers that were presented at the follow-up international symposium which was held in Shah Alam, Selangor, Malaysia, during 8-9 December 2010, under the title 'Knowledge Society for the Innovation Economy.' The symposium was organised by the International Islamic Academy for Life Sciences and Biotechnology (IAB) and the Islamic World Academy of Sciences (IAS).

The part includes a presentation by Prof. Raymond Boot-Handford from the University of Manchester, UK, entitled 'Innovations in Post Graduate Research Training within Life Sciences at the University of Manchester;' a presentation by Prof. David Leak from Imperial College, London, UK, on 'Capturing Innovation – the Imperial College Model;' a presentation by Prof. Tony Cass, also from Imperial College, London, UK, entitled 'From Research to Innovation: Routes to Exploiting the Intellectual Capital in Universities;' a presentation by Dr Moneef Zou'bi, Director General of the IAS entitled ‘S&T Landscape in the OIC: Role of the Islamic World Academy of Sciences (IAS); a presentation by Prof. Abdallah Daar FIAS from the University of Toronto, Canada, which was entitled ‘Building Scientific Capacity and Increasing Innovation in Developing Countries.’

Prof. Ameenah Gurib-Fakim FIAS also presented a paper within the symposium entitled ‘Innovation in Traditional Milieus – Medicinal Plants of Mauritius: From Academic Research to Business Model.’ There was a presentation also by Prof. Munir Nayfeh FIAS from the University of Illinois, Urbana-Champaign, USA, entitled ‘Nano Innovation: Innovation in Nanotechnology, where is it taking us?;’ and a presentation by Prof. Alison Gurney from Manchester University, UK, which was entitled ‘Women in Life Sciences at the University of Manchester.’ Another presentation within the symposium was by Prof. Jim Platts from the University of Cambridge, UK, under the title ‘Developing genuinely innovative people’ and last but not least, a presentation by Prof. Sharifah Shahrul Rabia Syed Alwee from FELDA Biotechnology Center, Malaysia, which was entitled ‘Managing a Commercial Oil Palm Tissue Culture Laboratory: Past Reminders and Future Challenges.’

Part Eleven of the book is the appendix that includes the list of participants in the conference, the conference scientific and organising committees, the names of IAS Fellows and Council members, as well as other details about the Islamic World Academy of Sciences (IAS).

Mehmet Ergin
Moneef R. Zou’bi

ACKNOWLEDGEMENTS

The Islamic World Academy of Sciences (IAS) is indebted to His Royal Highness Sharafuddin Idris Shah, the Sultan of the State of Selangor, Malaysia; for his patronage of the 17^{th} IAS Conference and the outstanding speech he delivered during the opening session. The support and encouragement of His Excellency the President of the Islamic Republic of Pakistan, IAS Patron; and His Royal Highness Prince El-Hassan bin Talal of Jordan, Founding Patron of the IAS, are also thankfully acknowledged. The IAS is also grateful to the Hon. Tan Sri Dato` Abdul Khalid Ibrahim, Chief Minister of Selangor, Malaysia; and Dr Halimah Ali, Selangor State Minister of Education and Higher Education, Selangor, Malaysia; for their interest and support.

The IAS extends its appreciation to all the organisations that sponsored the conference, foremost among which is the International Islamic Academy of Life Sciences and Biotechnology (IIALSB), Shah Alam, Malaysia, headed by Prof. Abdul Latif Ibrahim FIAS; to the University of Industry Selangor (UNISEL), Shah Alam, Malaysia; the OPEC Fund for International Development (OFID), Vienna, Austria; Islamic Development Bank (IDB), Jeddah, Saudi Arabia; OIC Ministerial Committee on Scientific and Technological Co-operation (COMSTECH), Islamabad, Pakistan; Jordan Phosphate Mines Company, Jordan; Arab Potash Company, Jordan; United Nations Educational, Scientific and Cultural Organisation (UNESCO), Paris, France and last but not least the Perdana Leadership Foundation in Malaysia.

The preliminary work done by the IAS Council, and the efforts volunteered by IAS Fellows from Malaysia: Tan Sri Prof. Omar bin Abdul Rahman FIAS; Prof. Datin Paduka Aini Ideris FIAS; Prof. Khatijah Yusoff FIAS together with Dr Moneef R. Zou'bi, IAS Director General, during the meetings of the scientific committee and the conference itself are gratefully accredited.

The dedicated staff of the IAS Secretariat in Amman including Ms Lina Jalal, who was responsible for the unenviable task of preparing the manuscript, Ms Taghreed Saqer, Mr Abdel Hamid Shamseddin, Ms Najwa Daghestani and Mr Hamza Daghestani, all deserve our thanks and appreciation.

Last but not least, we thank Mr George Anz and Ms Amal Mizher for patiently designing and producing the manuscript of the book and supervising the printing thereof.

Mehmet Ergin
Moneef R. Zou'bi

IAS 2009 Shah Alam Conference
on
Towards the Knowledge Society in the Islamic World: Knowledge Production, Application and Dissemination

Conference Sponsors

(1) Islamic World Academy of Sciences (IAS), Amman, Jordan;
(2) University of Industry, Selangor (UNISEL);
(3) International Islamic Academy of Life Sciences and Biotechnology (IIALSB), Shah Alam, Malaysia;
(4) OPEC Fund for International Development (OFID), Vienna, Austria;
(5) Islamic Development Bank (IDB), Jeddah, Saudi Arabia;
(6) OIC Ministerial Committee on Scientific and Technological Co-operation (COMSTECH), Islamabad, Pakistan;
(7) Jordan Phosphate Mines Company, Amman, Jordan;
(8) Arab Potash Company, Jordan;
(9) United Nations Educational, Scientific and Cultural Organisation (UNESCO), Paris, France; and
(10) Perdana Leadership Foundation, Putrajaya, Malaysia.

ISLAMIC ACADEMY OF SCIENCES 2009 SHAH ALAM DECLARATION

TOWARDS THE KNOWLEDGE SOCIETY
IN THE ISLAMIC WORLD:
KNOWLEDGE PRODUCTION, APPLICATION AND DISSEMINATION

adopted at Shah Alam/Selangor, Malaysia
on
30 Dhul-Hijja 1430
17 December 2009

PREAMBLE

1. Worldwide, a new economic paradigm is emerging in which the most important asset is not capital, labour, raw materials or energy, but also the intensive use of knowledge. Comparative advantage is increasingly determined by the competitive use of knowledge and technological innovation. This centrality makes knowledge a pillar of the wealth and influence of nations;

2. Science, Technology and Innovation (STI) represent still the primary force behind the advancement of human civilisation. Productivity gains and achievements of humankind have been derived chiefly from innovation based on scientific exploration, technological and engineering innovations as well as extensive application of S&T in the social life of humankind;

3. Organisation of Islamic Conference (OIC) countries have been striving to achieve steady socioeconomic development. With the diffusion of ICTs as a prerequisite, actions are needed to invigorate; (a) knowledge production, (b) knowledge application and (c) knowledge dissemination, to help OIC countries build knowledge societies and achieve rapid socioeconomic development; and
4. Because the quest for knowledge is a pillar of the Islamic Code of Belief قل هل يستوي (الذين يعلمون و الذين لا يعلمون), and knowledge and its pursuit have assumed augmented importance in an increasingly knowledge driven world economy, countries of the Organisation of the Islamic Conference (OIC) must commit themselves to becoming a community that values knowledge, one that is competent in utilizing Science, Technology and innovation (STI) to enhance its socioeconomic well-being.

THE PARTICIPANTS IN THE 17TH IAS CONFERENCE NOTE THAT:

a) In responding to the growing demands of the Knowledge-based or K-economy, a fresh-look is needed to re-examine the infrastructure and delivery of higher education in OIC and developing countries in terms of quality and relevance. Also an attempt should be made to evaluate the scientific development and acquisition capacity as well as technology application in the productive sectors of the economy; and

b) There exist significant obstacles to science and technology in OIC-Countries, including, *inter alia*, lack of comprehensive Science, Technology and Innovation

(STI) policies, and strategies emanating therefrom. The objective of such policies should to realise some level of national prosperity, food, water and energy security and national self-fulfilment. The dearth or inadequacy of resources, infrastructure and institutions, gender imbalance in Science and Technology, shortage of trained personnel, prohibitive costs of acquiring knowledge and technology, and barriers to the transfer of knowledge, personnel and technologies from developed to developing countries are also obstacles of significant impact.

AND APPEAL TO THE DECISION-MAKERS IN OIC COUNTRIES TO:

1. Implement specific actions at the national and international levels including *inter alia*, engender commitment at the highest level to STI; sizeably increase R&D expenditure, and promote the central role of the university as originator of scientific output. Investment in science and technology education has been a critical source of economic transformation. Such investment should be part of a larger framework to build capacities in STI worldwide. Improvements in higher education needs to be accompanied by growth in economic opportunities so that graduates can apply their acquired capabilities;

2. Promote and enhance scientific and technological cooperation among developing and OIC countries. The IAS also calls for the exchange of scientific experiences and of technologies with a view to intensifying cooperation and delivering real benefits among developing countries, especially involving countries that have developed significant expertise in S&T policy development, S&T infrastructure, biotechnology, nanotechnology and information technology;

3. Create links between knowledge generation and enterprise development as this is one of the greatest challenges facing OIC and developing countries. To further promote the development of local technology, OIC countries need to improve their incentive regimes including taxation and must try to promote technological innovation and generate markets for new products and services within their societies;

4. Recognize that future generations of scientists are today's IT and knowledge savvy students, and that prompt action is required to ensure that these young scientists cultivate a sense of hope and purpose so that they may contribute to shaping a sustainable future. Future generations in OIC countries must be **educated and not indoctrinated, they must learn – and not be taught** – to work hard, to identify role models in science and life that they can emulate, and learn to work together as teams rather than as individuals. A thorough review of our higher education system in the OIC is required to ensure that the generations of tomorrow are equipped with the tools that enable them to face the challenges of tomorrow. Moreover, our community leaders are invited to support and mentor the youth and early career scientists;

5. Engage more female scientists in raising the right questions and searching for sound answers if the sizeable women science community of the OIC is to contribute to the development of the *Ummah*. Even in developed countries today, the upper levels of

the occupational ladder in science and technology women are under-represented. Women graduates in science and technology count for only one fifth of full professors in research institutions. This phenomenon has been aptly called the leaky pipeline or the glass ceiling. What is needed is an integrated approach that includes mentoring, science education, recognition and the promulgation of best practices;

6. Recognise that a salient feature of modern science is its greater autonomy from the public. This has resulted in the codification and institutionalization of the scientists' professional role and the emergence of a divide between scientists on the one hand, the polity and the media on the other. The media has a considerable role in promoting science and technology and scientists need to communicate with the general public, policy-makers, and the media. Scientific institutes need to open lines of communication with, and engage more with the outside world; and

7. Appreciate that advice on science, technology, and innovation needs to reach policymakers. For this to happen an institutional framework needs to be created and commitment needs to be garnered to support it. At the university level, we must **integrate rather than segregate** students especially from the science and literary streams so that all future leaders appreciate the value of science as a means of socioeconomic advancement. Advisory structures differ across countries. In many countries science advisors report to the president or prime minister and national science academies provide political leaders with advice. The advisory processes should be able to gauge public opinion about science, technology, and innovation. At the level of the OIC, appropriate mechanisms should be worked out by the IAS to provide advice to OIC heads of state, parliamentarians and other decision-makers.

FURTHERMORE, THE ISLAMIC WORLD ACADEMY OF SCIENCES (IAS):

a) Expresses its deep concern for the safety and well-being of all Iraqi scientists, academics and educationalists both inside and outside Iraq; and

b) Extends its appreciation to the His Royal Highness the Sultan of Selangor and the State of Selangor for hosting the conference; to the University of Industry of Selangor (UNISEL) and the International Islamic Academy of Life Sciences and Biotechnology (IIALSB) for coordinating local arrangements; the Islamic Development Bank; COMSTECH; OPEC Fund for International Development (OFID); Perdana Leadership Foundation; United Nations Educational, Scientific and Cultural Organisation (UNESCO); Arab Potash Company; and the Jordan Phosphate Mines Company for generously sponsoring this international scientific congregation.

IAS 2009 SHAH ALAM CONFERENCE
on

Towards the Knowledge Society in the Islamic World: Knowledge Production, Application and Dissemination

Adopted at Shah Alam/ Selangor, Malaysia
on
30 Dhul-Hijja 1430
17 December 2009

CONFERENCE REPORT

General

Under the patronage of His Royal Highness Sharafuddin Idris Shah, the Sultan of the State of Selangor, Malaysia; the Islamic World Academy of Sciences convened its 17^{th} IAS Conference in Shah Alam, the capital of Selangor, from 14 to 17 December 2009.

The conference was under the title; *Towards the Knowledge Society in the Islamic World: Knowledge Production, Application and Dissemination*.

Held mainly at the Concorde Hotel in Shah Alam, the conference was preceded by a 'Science Youth Forum,' which was held at the University of Industry of Selangor (UNISEL), Shah Alam.

Over 150 participants representing over 25 countries participated in the conference including the representatives of no less than 15 academies of sciences; IAS, TWAS, Arab Academy of Sciences, Pakistan Academy of Sciences, Bangladesh Academy of Sciences, Bosnian Academy of Sciences, Academy of Sciences of South Africa, American Academy of Sciences, Academy of Sciences Malaysia, Egyptian Academy of Sciences, Tatarstan Academy of Sciences, Iranian Academy of Sciences, Sudan National Academy of Sciences, Indian National Science Academy and the Indonesian Academy of Sciences.

Alongside the conference, meetings of the IAS Council, IAS General Assembly, and the General Assembly of the Network of Academies of Sciences in Islamic Countries (NASIC) were also convened.

The conference was organised and sponsored by the following organisations:

- Islamic World Academy of Sciences (IAS), Amman, Jordan;

- International Islamic Academy of Life Sciences and Biotechnology (IIALSB), Shah Alam, Malaysia;
- University of Industry of Selangor (UNISEL), Shah Alam, Malaysia;
- OPEC Fund for International Development (OFID), Vienna, Austria;
- Islamic Development Bank (IDB), Jeddah, Saudi Arabia;
- OIC Ministerial Committee on Scientific and Technological Co-operation (COMSTECH), Islamabad, Pakistan;
- Jordan Phosphate Mines Company, Amman, Jordan;
- Arab Potash Company, Jordan;
- United Nations Educational, Scientific and Cultural Organisation (UNESCO), Paris, France; and
- Perdana Leadership Foundation, Putrajaya, Malaysia.

The aim of the conference was to promote the watchword that knowledge was becoming a major component in production processes, and that a new economic paradigm was emerging in which the most important factor was not the availability of capital, labour, raw materials or energy, but the intensive use of knowledge and information.

The conference also aimed to highlight that knowledge has become a pillar of the wealth and power of nations.

At the OIC level, the conference re-examined the actions that were required to invigorate; (a) Knowledge production, (b) Knowledge application and (c) Knowledge dissemination; in order to help OIC countries build knowledge societies and achieve rapid socioeconomic development.

The 17th IAS Conference of 2009 was organised around the above three themes, and aimed to achieve the following main objectives:

a) To engender the awareness of the public and decision makers of the concept of knowledge society;
b) To assess the role of women as knowledge producers in science and the scientific enterprise in OIC and developing countries;
c) To highlight the hurdles facing R&D in OIC countries (knowledge workers' views);
d) To strengthen private sector science linkages (knowledge application);
e) To strengthen the linkages between science and the scientific community and the media (knowledge dissemination); and
f) To engage the youth of OIC countries in science, technology and innovation (STI) (knowledge for the future).

Prior to the conference, the IAS and UNISEL organised a special session for the youth at UNISEL, which was called the 'Science Youth Forum.' Over 150 young science students were invited to what turned out to be an interactive session during which students listened to informal talks by some of the young scientists participating in the conference as well as other senior Fellows of the

IAS on the value of science and why some of them had taken up careers in science.

Presentations

In the first session, and in addition to a memorable invited address entitled; *The Leadership and Policy Components for the Knowledge Society: A Proposed Best Practice for OIC Countries,* by the former Prime Minister of Malaysia Tun Dr Mahathir Mohamad Hon. FIAS; Professor Wolfgang Schürer (Switzerland), Vice-President of the Council for Lindau Nobel Laureate Meetings, presented a keynote address entitled; *Educate, Inspire and Connect: The Lindau Nobel Laureates Meetings as a Cross-fertilising Platform.* This was followed by a presentation by Prof. Atta-ur-Rahman FIAS, Co-ordinator General COMSTECH on; *Building a Knowledge Society in the Islamic World: Challenges and Opportunities.*

The afternoon session of the first day was devoted to the subject of 'Women and Science.'

The IAS has long realised that women scientists form an important constituent of the knowledge production community, a constituent that is undervalued and underutilised. It is for this purpose that this session was organised. The fact that the session included a keynote by Tan Sri Prof. Omar Ibn Abdul Rahman FIAS; Former Science Advisor to the Prime Minister of Malaysia; and Founding President, Academy of Sciences; on *Human Capital Development for the Knowledge (Innovation) Economy,* represented a rare opportunity for the participants to appreciate the role of women scientists in the context national human capital that societies have/need to build in order to bring about the innovation economy.

The OIC Secretariat is collaborating with *Demos* and *Nature* to produce a study of science and technology-based innovation across the Islamic world. This project will gauge the changing landscape of science and innovation across many OIC countries with help and support of partner organisations in each country. An overview of this project was presented in a special session that was organised on the morning of the second day. That was followed by an exciting session in which two private-sector entrepreneurs participated; Mr Qusai Sarraf, Chief Executive Officer, IVIS Group, UK; who presented a paper entitled; *Opportunities and Challenges in Creating a Knowledge-Based Economy: A Viewpoint from the International Private Sector,* and Michael Grimes, of EnvironTeq in Thailand, who presented a paper entitled; *Knowledge Workers in a Globalised World: From America to South East Asia.* This session concluded with a talk by the Chief Minister of Selangor who outlined his plans to turn the state of Selangor into high-tech and education hub.

Knowledge Society: The Policy Aspects, was the title of a major session on the second day in which Prof. Adnan Badran FIAS, Former Prime Minister of Jordan presented a quantitative overview paper on; *Science and Technology Landscape of the OIC: The Arab States in Focus.* In the same session, Mr

Mehmet Fatih Serenli of the Statistical Economic and Social Research and Training Centre for Islamic Countries in Turkey presented a paper on: *R&D and KE Performance of OIC Member Countries.* That was followed by presentations by Dr El-Tayeb Mustafa of UNESCO on *Science and the Information Society*; Dr John Boright of the US National Academy of Sciences on the *Role of Academies of Sciences in Building the Knowledge Society: The Approach of the US National Academy of Sciences*; and the youngest speaker in the 17th IAS, Dr Hussam Salama who talked about; *Hubs of Knowledge and Information Flows in Islamic Countries: Challenges and Potentials.*

After a one-day break, the conference resumed on the morning of Thursday 17 December 2009 with two 'Open Science Fora.' These were sessions in which IAS Fellows and other participants presented papers on general science topics or research findings. A total of twelve papers were presented in two parallel sessions.

A lot of interest was shown in the session that followed which was dedicated to 'Science and the Media.' It started with an exciting presentation by Prof. Maqsudul Alam, Chief Executive Director, Centre for Chemical Biology, Universiti Sains Malaysia on; *Genome-based Discovery Platform Uncovers Biotechnology Potential of Papaya and Rubber Genomes*. That was followed by a number of statements by IAS Fellows on the importance of developing an OIC stance on Genetically Modified Organisms (GMOs).

The Least Developed Countries (LDCs) of the OIC were represented in this session by Prof. Muhammadou M. O. Kah, Professor of Information Technology and Communications, Vice Chancellor of University of the Gambia; who presented a comprehensive paper entitled; *Towards the Knowledge Society: The Gambia as an OIC Country Starting–up.*

The aim of this session was to highlight to the media in the OIC some science-related success stories as well stories of LDCs that are just starting up on the long road of development through S&T.

The ultimate session of the conference which was entitled; *Knowledge Production for Development*, was devoted to a number of top research scientists in the OIC who were eager to share their ideas on scientific publishing.

Declaration

At the conclusion of the four-day conference, which also included a number of specialised meetings and site visits, the IAS adopted the IAS 2009 Selangor Declaration on *Towards the Knowledge Society in the Islamic World: Knowledge Production, Application and Dissemination*.

The declaration emphasized that the quest for knowledge is a pillar of the Islamic Code of Belief and that knowledge and its pursuit have assumed augmented importance in an increasingly knowledge driven world economy. It reiterated that Science, Technology and Innovation (STI) represented the primary force behind the advancement of human civilisation and that productivity gains and achievements of humankind have been derived chiefly from innovation based on scientific exploration as well as extensive application of S&T in the social life of humankind.

In responding to the growing demands of the knowledge-based or K-economy, the declaration suggested that a fresh-look is needed to re-examine the infrastructure and delivery of higher education in OIC and developing countries in terms of quality and relevance.

Furthermore, the obstacles to science and technology in OIC-Countries, including, *inter alia*, lack of comprehensive Science, Technology and Innovation (STI) policies should be addressed.

The declaration appealed to OIC decision makers to implement specific actions such as sizeably increasing R&D expenditure, promoting the central role of the university as originator of scientific output, and promoting scientific and technological cooperation among developing countries. Moreover, it called for the creation of links between knowledge generation and enterprise development and for prompt action to ensure that young scientists cultivate a sense of hope and purpose so that they may contribute to shaping a sustainable future. It added that "future generations in OIC countries must be educated and not indoctrinated, they must learn – and not be taught – to work hard and learn to work together as teams rather than as individuals."

The IAS also called for measures to help the sizeable women science community of the OIC to contribute to the development of the *Ummah*.

At the university level, the IAS reiterated, attempts should be made to integrate rather than segregate students especially from the science and literary streams so that all future leaders appreciate the value of science as a means of socioeconomic advancement.

The Declaration also addressed the question of science advisory structures in the various countries and stated that the advisory processes should be able to gauge public opinion about science, technology, and innovation and that appropriate mechanisms should be worked out by the IAS to provide advice to OIC heads of state, parliamentarians and other decision-makers with sound science-based advice.

The Declaration concluded by expressing its concern for the safety and well-being of all Iraqi scientists, academics and educationalists both inside and outside Iraq.

The IAS moreover extended its appreciation to the His Royal Highness the Sultan of the State of Selangor and the State of Selangor for hosting the conference; to the University of Industry of Selangor (UNISEL) and the International Islamic Academy of Life Sciences and Biotechnology (IIALSB) for the local arrangements; the Islamic Development Bank, COMSTECH, OPEC Fund for International Development (OFID), Perdana Leadership Foundation, United Nations Educational, Scientific and Cultural Organisation (UNESCO), Arab Potash Company, and the Jordan Phosphate Mines Company for generously sponsoring this international scientific congregation.

As part of the follow-up action to the conference, the Academy will circulate the IAS 2009 Shah Alam Declaration to concerned individuals and relevant agencies throughout OIC and developing countries, so that measures are taken to put into action the ideas proposed at the conference.

The IAS will also publish the complete proceedings of the conference in a quality volume that will be distributed internationally.

PART ONE

STATEMENTS AT THE INAUGURAL SESSION

Address of Hon. Dr Halimah Ali
Chairman of National Organizing Committee
Selangor State Minister of Education and Higher Education

Bismillahirahmanirahim

Your Royal Highness Sultan Sharafuddin Idris Shah, Sultan of Selangor, Patron of the 17th IAS Science Conference
Rt. Hon. Tan Sri Dato' Khalid Ibrahim, Chief Minister of Selangor and Advisor to the NOC
Your Excellency Prof. Abdel Salem Majali, President of Islamic World Academy of Sciences
Tan Sri Tan Sri, Puan Sri Puan Sri, Dato' Dato', Datin Paduka Datin Paduka, Invited Speakers
Honoured Guests
Ladies and Gentlemen

Assalamu 'alaikum, and a very good morning

I am honoured to welcome His Royal Highness Sultan Sharafuddin Idris Shah to the opening ceremony of the 17th IAS Conference. I am also delighted to welcome the eminent scientists from the IAS, invited speakers and guests. On behalf of the organizing committee, I would like to thank His Royal Highness, the Sultan of Selangor for consenting to officiate this morning.

Your Royal Highness
Ladies and Gentlemen

The idea of organizing the 17th IAS Conference in Shah Alam, Selangor, came from Prof. Emeritus Abdul Latif Ibrahim from UNISEL 15 months ago when he invited me to join him to participate in the 16th IAS Conference which was held in Kazan, Republic of Tatarstan, Russia. There he presented a paper on 'Selangor as an Islamic Centre of Indigenous and Scientific Biological Knowledge for Sustainable Development.' After listening to his presentation, I was convinced that Selangor can play a bigger role as an Islamic centre. Later, he told me that he will propose to the IAS General Assembly that Shah Alam hosts the 17th IAS Conference. I brought this idea to the Chief Minister Tan Sri Abdul Khalid Ibrahim who then gave me his blessings to pursue the matter. So, Prof Latif and I together with Puan Nadzirah from UNISEL embarked on a 24 hour-trip to Kazan. And with his diplomacy and charm, Prof. Latif secured the approval of the General Assembly for Selangor to organize and host this conference.

Your Royal Highness
Ladies and Gentlemen

One of the distinctive features of Islam is its emphasis on knowledge, with the Book of Allah and His messenger's practical example, referred to as the Holy Qur'an and Sunnah, respectively, as the main sources of information. The Holy Qur'an calls upon all Muslims to study the whole universe and everything between the heavens and the Earth, and to unravel the various natural phenomena and their activities, for this can lead to the discovery of the majesty of the creation of Allah (SWT).

As stated in Surah Al Baqarah, Verse 164, which means:

> *"Behold! In the creation of the heavens and the earth; in the alternation of the night and day; in the sailing of the ships through the ocean for the benefit of mankind; in the rain which Allah Send down from the skies, and the life which He gives therewith to an earth that is dead; in the beasts of all kinds that He scatters through the earth; in the change of the winds, and the clouds which they trail like their slaves between the sky and the earth—(Here) indeed are Signs for a people that are wise."*

It is reported that the Messenger of Allah (SWT) peace be upon him to have once said, 'Learning comprises treasure houses whose keys are queries.' Prophet Muhammad (PBUH) encouraged the spirit of investigation and analysis of facts. One of the most inspiring Ayat (verses) in the Holy Qur'an is the following:

> *"And He has subjected to you, as from Him, all that is in the heavens and on earth: behold, in that are signs indeed for those who reflect." (Surah Al-Jathiyah, Verse 13)*

Reflection is a scientific spirit which leads to understanding and discoveries about the creation of Allah (SWT) who guides the efforts of the scientists to meaningful purposes. Rational thinking is emphasized throughout the Holy Qur'an. Repeatedly, the Qur'an calls the believer to do *tadabbur* (deliberate), to do *tafakkur* (tafkir or think), and *ta'qqul* (reason).

Islam has, from its inception, placed a high priority on education and enjoyed a long and rich intellectual tradition. The importance of education is repeatedly emphasized in the Holy Qur'an with frequent injunctions, such as 'God will exalt those of you who believe and those who have knowledge to high degrees' (58:11), 'O my Lord! Increase me in knowledge' (20:114), and 'As God has taught him, so let him write' (2:282). Such verses provide a forceful stimulus for the Islamic community to strive for education and learning.

Your Royal Highness
Ladies and Gentlemen

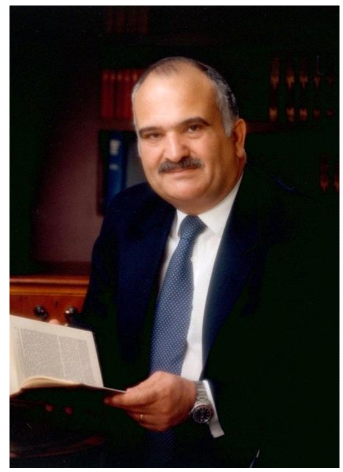
The theme of this conference is 'Towards the Knowledge Society in the Islamic World: Knowledge Production, Application and Dissemination.' Looking at the list of papers to be presented, I believe that this conference will provide an opportunity for a meaningful and fruitful exchange of ideas.

Many people have been involved in organizing this conference and a lot of effort, energy and sacrifice have been put to make the occasion a memorable and far-reaching experience that will benefit the *Ummah*. To all of them, especially Prof. Abdul Latif Ibrahim, I express my sincere appreciation and thanks. Before I end, I would like to remind us of the quotes by Ibnu Sina, the inspiring Muslim physician, philosopher, astronomer, chemist, Hafiz, logician, mathematician, physicist, scientist and statesman who once said, 'The knowledge of anything, since all things have causes, is not acquired or complete unless it is known by its causes.'

Again, I would like to thank HRH the Sultan of Selangor for his support and his interest in the conference.

AMPUN TUANKU

Message[1] of
His Royal Highness Prince El Hassan bin Talal of Jordan, Founding Parton of the Islamic World Academy of Sciences



At the World Summit on Food Security held in Rome on 16th-18th November this year, Dr Jacques Diouf said in his opening statement:

'One billion hungry people, that is one out of every group of six persons in the world, 105 million more than in 2008, five children dying every 30 seconds. Beyond the numbers, this means suffering for each of these human beings who is a loved child, mother, father, brother, sister, family relative, friend or neighbour.'

Dr Diouf goes on to say, '*This is our tragic achievement in these modern days when our technology allows us to travel to the moon and to space stations.'*

At the Thematic Debate on Human Security at the United Nations General Assembly on 22nd May, 2008 entitled *Dignity and Justice for All of Us: Human Security on the Global Commons*, I emphasised that as the world grows more populous, many nations are also becoming more prosperous overall. Some two dozen states from the *emerging* South have enjoyed economic growth and become more dependent on each other's growth; but the poorer states of the *developing* South are just as dependent on demand from the North as they were thirty years ago. One billion people still live in extreme poverty, 70% of whom are in Africa. Unbearable poverty continues to afflict major regions of Asia and Latin America. Three-quarters of the world's poor live in rural areas, where food accounts for more than half of a family's spending.

As demand soars, supplies are unable to keep pace. Food aid, health services, and medicinal supplies also decline as the price of food goes up, pushing hundreds of millions into hunger and malnutrition, economic depression, and social unrest. It should be clear by now that water and food, which are essential to life, are human rights reflecting the personal dignity, common needs and well-being of humanity.

Dr Ahmad Zewail, at the 2009 World Science Forum held in Budapest last month spoke of a lack of knowledge; a lack of resources and the need for the scientific community to be engaged with the rest of society and that an example of trustworthiness should be shown by the scientific community. I personally believe in the third sphere, of an *ad hominem* participation of public figures in government, private sector and civil society, in developing a comprehension of national, regional and global commons.

In the Arabian Peninsula, Muslims inherited from the Holy Prophet in their first generation, the injunction of 'Seek knowledge, even unto China' which is why I regret that the Arab Ministries of Education abandoned the name *Wazarat al Ma'aref* – Ministries of Knowledge. I propose a *Ministry for Epistemology*. Likewise, the Qur'an also postulates a kind of 'proof

[1] Delivered by Prof. Adnan Badran FIAS.

theory' if you will, commanding, 'Bring your proof – *if* – you are telling the truth.' Thus Muslim students by religious mandate are instructed to adopt heuristic methods of 'learning – to prove' what they know and indeed what they think they know.

The first words of the Qur'an and I am speaking of revealed script in the Muslim tradition, is 'Read, in the name of your Lord, who created' and the concept of reading and learning and the instrument of the pen are repeated in the first two lines of the same *sura*. Just as God orders people to read, in the Qur'an, God orders them to think and to think *critically*, making this a religious obligation. I emphasise reference to the Qur'an because I think we have to accept that through the ages there is a complementarity between Qur'anic knowledge and Muslim knowledge, neither of which an injunction to learn by rote is. On the contrary, the Qur'an condemns those who base their opinions and beliefs on blind imitation of what have been handed down to them from their forefathers (43:23-4). It also condemns those who base their beliefs or opinions on guesswork, for 'guesswork is of no value against the truth' (53:28). It commands, 'Bring your proof if you are telling the truth' (2:111).

Our selective memory and our inability, despite the world of computers inter-working and 'inter-netting', reminds us that 'individual memory came to matter less than words on the page a long time ago; a new interest in the totality of human knowledge evinced in the sum of theology of Thomas Aquinas, separated it from the contents of the individual human mind while making it more attainable. The art of memory also found a new outlet in the medieval theory of illumination by miniatures. Pictures as illustrations, an art immemorially old, achieved a new function as a guide to devotion through memory of its signification.'[2]

Our time is characterised variously as the age of knowledge, the age of energy and the age of globalisation. A solid education should address the common human weakness and vulnerability and the predicaments to which human life is prone. It must offer much more knowledge of the world: the major world religions, economic conditions, the deprivations with which a large proportion of the world's people live from day to day. This would teach us at a young age to decipher the suffering of the 'other' anywhere in the world.

One could ask what role creativity in knowledge production has and also what are the grounds, presuppostions and global commons of scientific practice? The global commons of scientific practice include ethics (scientific values), scientific practice, the scientist as a socio-educational type, epistemology (scientific reason and tools of scientific rationality) and ontology (ontological presuppositions of scientific rationality).

By creating a system of education for employment, the brain drain and the outflow of technical capabilities can be prevented. Islamic countries have immeasurable innovative energy, wasted due to the lack of a suitable climate ensuring research and academic freedom and the weakness of institutionalisation in the fields of knowledge generation and dissemination, impelling the best of our academics to emigrate. The brain drain is one of the most dangerous indicators; this waste of resources and capacity is clearly manifest in widening the knowledge gap between Islamic countries and the advanced world. A system of education for employment and education for citizenship would also create a sense of ownership in terms of the general public, a feeling that glitzy projects are not only for the rich or for the foreigner, but for them. We can learn by analogical processes of education such as the Erasmus Mundi programme: the European Union's cooperation and mobility programme in higher education. Students from our Princess Sumaya University of Technology (PSUT) in Jordan have participated in a number of European educational projects such as Medforist as well as several Tempus and Erasmus Mundi projects.

The history of human endeavour is full of hopeful parallelisms; events and periods of human enlightenment that find their counterpart in other cultures and at other times. Europe's 17th Century, the Age of Reason and of discovery, had its comparison in the Arab-Islamic world of the

[2] Stockholm Short, Mr. Nicholas Barker, UK

10th Century. But I must emphasise that to believe in one's own self, history and community does not necessarily imply a misunderstanding, disdain or degradation of the other. Learning about our shared human history reminds us that synthesis of thought has proved vital to mankind's progress through history. Further, it informs us that we must not fall victim to a purely scientific mindset. I have long sought to place a *humanitarian vision* at the centre of our drive to achieve greatness in the scientific and economic fields. I believe that knowledge of our respective achievements can help to promote this and remind us that we have far more in common than we often realise.

'The revelation of the Qur'an did not begin with the imperative of faith, but with the imperative of knowledge. God Almighty did not ask Muhammad, (peace be upon him) to believe, but He asked him to read and learn what and how to believe. This is so because humanity is born with faith. There is no need; therefore, to ask humanity to believe if that is already in the soul. But there is a need to remind humanity to read and learn what is in the soul. Humanity needs knowledge with faith as well as faith with knowledge.'[3]

The coming together of knowledge and enquiry from India, from Ancient Greece and from the Levant represents a true *alliance of cultures* and a confluence of civilized achievement. The Age of Enlightenment, which has benefited the entire *family of cultures* that comprise our great human civilization, drew from the knowledge and achievements of the past and from present innovations – I might mention Nicomachus of Gerasa, that ancient city just 40 minutes drive from modern Amman, whose Greek multiplication table was the first to use what we now call *Arabic numerals*.

Isaac Newton said of his work: 'If I saw further than other men, it was because I stood on the shoulders of giants.' Thus, the historical process that culminated in this great development of the 17th Century, stretches back thousands of years and covers a vast geographical area with contributions from many great minds. Via the calculus, which he invented, Newton turned the laws of nature into immensely powerful tools of knowledge production – tools of world creation. Such is the power of the integro – differential equations that express the laws of nature.

In terms of belonging to a more physical science than philosophy, we might consider the idea of a *Genetics of Knowledge*. Just as our human genome teaches us so much about our past and introduces manifold opportunities for a better future, so an appreciation of the evolution of man's search for knowledge across centuries can open a path to a *universal consciousness* that crosses cultures and creeds. Whereas historic modes of production were needs – oriented and geared towards satisfying basic existing needs, the Capitalist Mode of Production (CMP) is profit – oriented and thus geared towards creating new needs, illusory needs included. What greater creator of needs is there than the knowledge enterprise – the knowledge industry.

Modern science is central, unlimited in scope with millions of practitioners including an enormous size in numbers of producers and in investment. It has a crucial economic impact and an industrial, corporate form of organisation. Science is the largest modern industry.

It was in the Arabian Peninsula where God addressed mankind in the Qur'an more than fourteen centuries ago: '*We created you all from one male and one female, made you into nations and tribes so that you may get to know each other*.' (49:13)

Knowledge is what we discover through the inquisitive mind at the lab bench in our laboratories or in the field. The product of scientific practice has two peculiarities that set it worlds apart from conventional industrial products. First, there is the process of evaluation which is an integral part of the production process. The immediate product is a mere potentiality which acquires its actuality from the intricate process of evaluation. Secondly, the knowledge product is intrinsically unenvisageable before its actual production, unlike other conventional industrial products. This means that the knowledge production process can never be just a routine assembly line process with priori defined steps of production. To disseminate knowledge is to empower the minds of men so that they can apply it to peaceful use. This is the secret formula for human

[3] *A Declaration of European Muslims*, February, 2006.

development and eventually the secret formula of the agenda of peace and development for the future of humanity. It is essential to develop the endogenous capacity of the South so as to overcome disparity and conflicts between those 'who know' and those 'who know not.' With knowledge, poverty will be mitigated, because stability or security cannot be achieved without overcoming the issue of disparity and poverty.

This is the reason why it is important to address science literacy so that knowledge will empower all the people (include the excluded and reach the unreached), to release their individual potential in building democracy and contributing to solving problems confronting us: population growth, poverty, migrations and degradation. The world is suffering from around 850 million illiterates – a large percentage of them women. It has been said by a wise man 'In educating a woman, you educate a nation.'

Only creative scientists can ultimately survive in the scientific enterprise. This leads us to the concept of collective creativity, as opposed to individual creativity. Collective creativity is an accurate reflection of the size and efficacy of a knowledge industry. Individual creativity, which is the phenomenal form of creativity, is rooted in collective creativity.

There is an opportunity and a challenge for Islamic countries to link what should be done now and what should be done in the future, particularly in the area of food security. This depends on how we invest our energies and our ability to benefit from the experience of others – the process of collective knowledge and wisdom and to avoid what Ghandi termed, 'knowledge without character.'

Thank you.

Message[1] of
His Excellency Mr Asif Ali Zardari
President of the Islamic Republic of Pakistan
Patron of the Islamic World Academy of Sciences

I am pleased to learn that the Islamic World Academy of Sciences is holding its seventeenth annual conference in Selangor, Malaysia. I wish to greet all distinguished delegates and renowned scientists who have come from far and wide to participate in this conference and wish them a productive discourse in the most hospitable environs of Malaysia.

The survival and progress of humankind depends on knowledge and its application. The body of human knowledge is constantly growing and it is a great challenge of our times to keep pace with the phenomenal growth of knowledge and technology.

Unfortunately, for a variety of reasons, the Muslim world is lagging behind in the acquisition, assimilation and application of knowledge. The OIC member states spend a mere 3.8% of their GDP on education. Less than one fifth of its citizens have access to mobile phones and less than 7% of its citizens have access to the internet, the highway of modern information and knowledge.

There was a time when Muslims led the world in knowledge and education. Today, it has not only lost its pre-eminent position, it is also lagging far behind other nations in the acquisition and application of modern knowledge.

The eminent scientists and the Fellows of the Islamic World Academy of Sciences who have gathered in Selangor need to put their heads together to reflect on these issues and make recommendations on how to overcome the problems and regain, at least in part, the lost glory in science and learning. Some of the key issues facing the Muslim world today are low agricultural yield, lack of quality institutions of higher learning, dearth of qualified scientific and technical manpower and inadequate facilities of R&D.

I urge the scientists, technologists and educationists who have gathered for the conference to make concrete recommendations to address these issues for the consideration of the governments of OIC. One area that may be specially considered is the public-private partnership in promoting science, technology and R&D in the Muslim world. Given proper incentives, the private sector can play a greater role in the promotion of science, technology and higher education.

I hope the recommendations this assembly makes will enable the OIC to address its problems and put its people on the path of progress and prosperity.

I wish you great success in your deliberations.

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[1] Delivered by Dr M. A. Mahesar, (at the time) Assistant Co-ordinator General, COMSTECH, Islamabad, Pakistan.

Address of
His Excellency Prof. Abdel Salam Majali FIAS
President of the
Islamic World Academy of Sciences (IAS)

Your Royal Highness
Tun Mahathir, Honorary Fellow of the IAS
Excellencies
Distinguished Guests and Fellows of the IAS
Ladies and Gentlemen

السلام عليكم و رحمة الله و بركاته

- I am happy to greet you all here in the capital of the Malaysian State of Selangor. We are here at the invitation of His Royal Highness the Sultan of Selangor, the patronage of whom we cherish. Allow me also to greet His Majesty the King and His Excellency the Prime Minister of Malaysia for their support of the IAS and the OIC.
- The title of today's conference clearly states our goal: to develop an understanding of the 'knowledge society.' We all believe in the power of science and research. We believe in knowledge creation and dissemination for the advancement of our societies. I have looked into some of the abstracts of the presentations to this conference and was pleased to see that they made a strong case in that direction.
- Although this conference will address the three independent yet interconnected aspects of knowledge production or generation, knowledge application and knowledge dissemination, it aims to do so by focusing on issues pertaining on knowledge workers including women and the youth. This is vital for our countries. For the moment however, I hope to add some pointers in the interdisciplinary fashion for which the IAS has become famous.

Excellencies
Dear Colleagues

- Do we live in an era of change or in a changing era? How can one characterize the deep transformations that come with the accelerated assimilation of Information and Communication Technologies (ICTs) in our present society?
- 'Information society,' 'information age,' 'knowledge society' and 'innovation economy' are just a few of the terms that have been coined to identify current trends. The debate continues. Reality races ahead leaving us trying to figure out how to deal with these knowledge phenomena. How to ride the wave to achieve meaningful progress for humanity?
- The current spread of new technologies and the emergence of the internet as a public network seem to be carving out fresh opportunities to widen this public knowledge forum. Do we now have the means to achieve equal and universal access to knowledge? This should be the cornerstone of true knowledge societies.
- In other words, is the spread of knowledge synonymous with more equity for us humans? I pose this question to politicians.

- Knowledge of how to do things, how to communicate and how to work with others is the most precious wealth of humankind. The dramatic advances in information and communication technologies (ICTs) in the last twenty years, particularly the rapid emergence of the internet and the web as a global public network, have provided the ideal conditions for widening and globalizing the public forum for knowledge. Have we been able to ride the wave? This is the question I pose to the civil society.
- Our ability to access information and transform information into meaningful and useful knowledge is a key driver of sustainable social and economic development. This is where we have to have capacity and vision. A capacity to leverage knowledge tools to help realise our visions of socioeconomic advancement and solve our human problems. Have we managed to succeed in this endeavour? This is my question to scientists, technologists and entrepreneurs!

Your Royal Highness
Ladies and Gentlemen

- Almost all countries aspire to become 'knowledge economies' or 'knowledge societies.' The terms are frequently used interchangeably by politicians. Being the educationist, masquerading as a politician, I will look at this issue from the higher education viewpoint.
- For two decades now, universities have been expanding access to higher education. The knowledge society needs more graduates. The knowledge society moreover, fuelled by the expansion in the higher education sector, will in turn generate more knowledge industries producing additional competitive pressures for traditional institutions of higher education.
- Those involved in university education in this digital age must appreciate that knowledge industries are creating the means by which individuals can acquire the immediate skills and knowledge those industries need.
- Universities wishing to respond to these new demands need to answer the following difficult question: How should the curriculum balance expert knowledge and practitioner knowledge? Universities are comfortable teaching specialist knowledge produced by experts, but practitioner knowledge and the skill to develop it, which is what the knowledge industry needs, is not a natural part of university curricula.
- In other words, the divide between higher education and the corporate world must be bridged.
- In OIC countries in particular, we are feeling the proverbial pinch. Our higher education system is in a state of turmoil and our universities are not sure which way to turn. No longer are they the excellent teaching establishments they once were. Nor have they become the internationally ranked leading research universities that many developing countries have.

Excellencies
Ladies and Gentlemen

- In her now famous book "*Catching the Knowledge Wave?*" Jane Gilbert questions many long-held ideas about knowledge and education. She says that knowledge is now a verb, not a noun—something we do rather than something we have—and explores the ways our schools need to change to prepare people to participate in the knowledge-based societies of the future.
- The knowledge society is an idea that is widely discussed, but not well understood. Knowledge is developing a new meaning, one that is quite different to the one our schools were built on. Because of this, knowledge society developments are a major challenge for our schools. We need a completely new framework—one that takes account of knowledge's new meaning, but also gives everyone an equal opportunity to succeed.
- In our attempt to create the knowledge community of the future, school education has to be fun again; for both teacher and student. Needless to say efforts such 'La main a la pate' of the French Academy of Sciences must be commended and emulated.

- Yesterday morning I was happy to be involved in a very special experience. Hundreds of young local university students were involved in a lively dialogue with some of the IAS's younger scientists in an energetic focused debate on how exciting science can be. This 'Youth Science Forum' is what we need to rekindle young inquisitive minds.
- In OIC countries, we need a thorough overhaul of our educational system as a prerequisite for riding the knowledge wave.
- Indoctrination can no longer be the way.

Your Royal Highness
Excellencies
Dear Colleagues

- The knowledge economy is a particular knowledge driven stage of capitalist development, based on knowledge, succeeding a phase marked by the accumulation of physical capital. Knowledge replaces the workforce. The wealth created is measured on the general level of science and the progress of technology.
- One thing is certain: certain "intangible" activities linked to research, education and services, tend to assume increasing importance in the global economy. In quantitative terms, the share of these activities in the gross national product (GNP) of countries is continually growing. The proportion of research and development (R&D) expenditure in GNP has been increasing since the start of the 1950s (even before the information revolution).
- Other intangible investments (education, health, etc.) are also increasing sharply in relation to tangible investments (physical capital, material resources, etc.), and statistics show that this tendency is also marked in the South. But, the importance of knowledge in economic activity is not confined to the high-tech sectors: modes of organization of production in apparently low-tech sectors have also been transformed, or are in the course of transformation, with the new use of knowledge bases.
- Sadly, in our OIC countries, we do not score high on any of these measures. I have recently had a look at the soon to be published UNESCO Science Report of 2010, in particular, the chapter pertaining to Arab states, and the picture is not rosy at all. The majority of Arab states spend less than one-half of one percent on research and development. The numbers for human resources active in science are low, and apart from this country; Malaysia, most OIC countries hardly export any high technology products.
- The Report shows that only seven Arab countries or territories out of 22 have a national academy of sciences or play host to a supranational academy. This is an astounding fact, as academies of sciences, being strong advocates of science and impartial advisory bodies, have been at the vanguard of the scientific endeavour in advanced countries such as the USA, the United Kingdom and France for centuries. They are also part of the landscape in economically emerging economies such as Brazil, China, India, Malaysia and Mexico.
- As the academy of sciences of the OIC, it is the intention of the IAS to be a champion for stimulating and engaging the basic sciences in support of development, especially through capacity-building, knowledge-sharing and promotion of international and regional cooperation.
- As one of a number of academies promoting interest in basic sciences on a regular basis, the IAS has a unique role to play in this area, not only by identifying and disseminating best practices but also by fostering synergies between modern science and local knowledge systems.
- Academies of sciences realize that they have a serious role to play in raising the awareness of the decision-maker and the public, and in helping people understand the importance of development and scientific advancement, and indeed helping in achieving socio-economic progress.

- In a similar vein and in 2008, the IAS addressed the issue of science and the media. It specifically made the following recommendations for improving scientific understanding among the public:
- *Newspapers and broadcasters should employ more science graduates*
- *Scientists and science graduates should be encouraged to undertake media training*
- *Universities should offer multidisciplinary science degrees which include issues of ethics*
- Dare I say that the bottom line is that we should try hard to bridge this divide between scientists and the media.

Fellow Scientists
Dear Friends

- It is my strong hope that our gathering today is a timely one and that the sprout will grow up and succeed in making a significant contribution towards generating changes that are both necessary and desirable for the future of developing countries.
- The idea of the information society is based on technological breakthroughs. The concept of knowledge societies encompasses much broader social, ethical and political dimensions. There is a multitude of such dimensions which rules out the idea of any single, ready-made model; for such a model would not take sufficient account of cultural and linguistic diversity, and that is vital if individuals are to feel at home in a changing world.
- I am confident that our meeting here will give our stand on this subject a considerable boost. I am confident that each of us as scientists, in his/her own way, can help in promoting understanding and tolerance.
- Let me conclude by again thanking you all, by thanking the Chief Minster and the Government of the State of Selangor and our eminent host Professor Abdel Latif Ibrahim, our local IAS Fellows and my colleagues form the IAS who travelled from various places to be with us.

Thank you for joining the IAS in its efforts in a spirit of open-mindedness.

PART TWO
THE KEYNOTES

Educate, Inspire and Connect:
The Lindau Nobel Laureates Meetings as a Cross-Fertilising Platform

WOLFGANG SCHUERER
Chairman of the Foundation Lindau Nobel Prize Winners Meetings
and
Vice-President of the Council for Lindau Nobel Laureate Meetings
Switzerland

1 EDUCATE, INSPIRE AND CONNECT – THE LINDAU NOBEL LAUREATE MEETINGS AS A CROSS-FERTILISATION PLATFORM

Let me thank the patron, His Highness, the Sultan of Selangor and congratulate the organizers, the Islamic World Academy of Sciences (IAS) on this initiative. Looking at the crucial importance of the theme of the conference - knowledge, its production, application and dissemination in the Islamic community and indeed throughout the world, it is a privilege to join such a special gathering. It is also a particular pleasure to address this conference and to see here a number of friends who already work closely with us on behalf of their academies and who are real partners in the Lindau Dialogue. Such links are crucial to the success of the Mission Education and to the knowledge society as such. It is my hope and expectation that this conference will help to extend the circle of those partnerships even further.

> *I am glad to learn that this meeting will cover the issue of science education and the responsibility of scientists on sustainable development of our world, which I think are very important in the age of globalization.*
>
> *HRH Princess Maha Chakri Sirindhorn, Thailand.*

2 THE NEED TO EDUCATE, TO INSPIRE AND TO CONNECT: THE NOBEL LAUREATE MEETINGS IN LINDAU

The IAS has set out key objectives for this conference: raising public awareness of the knowledge society and of science for policy formation; the role of women; the serious obstacles facing R&D in some countries; linking science with the private sector (knowledge application) and with the media (knowledge dissemination). Not least, we have to acknowledge the importance of engaging the youth of our countries in science, technology and innovation (knowledge for the future). These are vitally important issues for all countries and indeed for the world. They are also a fundamental part of the inspiration for our annual meetings of Nobel Laureates at Lindau in Germany. Our aim there is ‘to educate, to inspire and to connect.’

> *While it may not be apparent what such interactions yield in the short term, each interaction has the potential of lighting a match to a candle, of igniting young minds in ways that can change the face of the earth.*
>
> *Shri Kapil Sibal, Indian Minister for Human Resources.*

I shall highlight in particular the positive experience of the Lindau Meetings as a platform for cross-fertilisation across generations, and across boundaries of geography, culture and scientific discipline. The Lindau Meetings are a model in this respect. It is the ambition - of more and more of the very best among the world’s young scientists - to participate, including many from Islamic countries.

3 THE CONTEXT: SCIENTIFIC KNOWLEDGE IN A CHANGING WORLD

As we all know, science – in the broad sense including the humanities – cannot operate in an ivory tower especially as it is often publicly funded. Science has a responsibility to society and the wider world reaching across borders. Today, the world is both highly differentiated and strongly inter-dependent. It is marked by social and political tensions, gross economic inequalities and huge challenges related to climate and health, as well as access to information and resources. Human development in many countries is lagging. The world's population is growing and ageing. It is a rapidly changing world and economic power especially is shifting. Success in meeting these challenges depends on many factors – on responsible political, academic and not least civil society leadership. It requires open-mindedness and mutual understanding. It also requires cooperation – at the national, regional as well as international levels. In the end, much comes down to the initiative, determination and above all the knowledge of individuals and scientific understanding. In science especially, teamwork and fruitful international cooperation are often pre-requisites to both personal fulfilment and professional achievement.

4 THE KEY ROLE OF SCIENTIFIC UNDERSTANDING

None of us will be protected against challenges such as climate change and future pandemic infections unless we cooperate and apply the tools of science, technology and innovation (STI). However, science itself is changing. There is increased specialisation and sophistication in science, as well as in economics and in finance – recently to its detriment. At the same time, there is a greater need for interdisciplinary approaches. Science cannot stop at borders whether of disciplines, countries, cultures, religions, ethnicities, gender or age, as information flows do not stop at borders. On the contrary, crossing such borders can stimulate the cross-fertilisation which we need. The bottom line remains – it is people who make the difference.

It is important to reach out to and inspire young people, including women, and encourage them to pursue a scientific career. Science has a set of principles which are universal. It is often the scientists coming together to speak their common language who are the first to build bridges between countries. Yet, we are aware that science follows a different rationale than religion or politics. While science is open-ended in itself, clashes with religious dogma or public values cannot be resolved. Mutual respect serves as the only way to overcome these divergences.

> *The number of young scientists, their enthusiasm, seem greater and even stronger than I remember from before. The meetings help in sparking some interest in science, particularly in developing countries, where the prospect for travel cannot compete in priority with other needs for resources.*
>
> *John Hall, Physics 2005.*

Referring to the Islamic world, it was Laureate Prof. Ahmed Zewail, who mentioned in his acceptance speech in Stockholm the long tradition of science in the Islamic world. Let me emphasize just one example with the Bibliotheca Alexandrina that has been inspiring the world of science ever since. Indeed, success in bringing scientists together depends on a number of pre-requisites. It cannot just be left to transpire.

5 CROSS-FERTILISATION OF SCIENTIFIC IDEAS: THE PARAMETERS OF SUCCESS

What are the parameters which ensure successful international scientific dialogue?

- *History*: knowing where "We" and "They" came from. There have been periods when dogmatism in one part of the world has concurred with openness in another part. Subsequently, the roles have reversed and with it the place of scientific leadership;
- *Curiosity*: not just for scientific explanations but also for each other's circumstances and backgrounds; at all times, a desire to learn;

- *Open-mindedness*: at minimum tolerance and mutual respect; at best understanding;
- *Ambition*: determination in the face of obstacles or of lack of understanding;
- *Hard work*: even for no remuneration (cf. *pro bono* work for Lindau);
- *Cooperation*: on practical things on a day to day basis, amounting to total commitment when demanded;
- *Excellence*: insistence on the rigour of the scientific method and on selection through peer review; and
- *Out-reach*: enrich society and the economy through readiness to seek applications for scientific discoveries and explain them in a way which can generally be understood. This applies to the humanities - in their contribution to the understanding of our societies - just as much as to natural sciences.

In bringing scientists from different countries and different disciplines together, the role of scientific academies, such as the Islamic World Academy of Sciences (IAS), either working alone or in collaboration with other agencies is particularly fruitful.

Now I would like to address the example of the Lindau Nobel Laureates meetings

> *The Lindau Meetings transcend the boundaries between cultures, disciplines and generations and encourage networks of scientific excellence.*
>
> *Annette Schavan, Federal Minister for Education and Research*

Launched almost 60 years ago, the Lindau Meetings have become ever more successful in recent years. What are the ingredients of that success?

The parameters I have set out guide us. They were embodied in the philosophy of our first guiding spirit, Count Lennart Bernadotte, whose grandfather, the Swedish King Gustaf V presented the very first Nobel Prizes. His vision was that science would be a catalyst firstly for post-war European reconciliation. Secondly, as a means of outreach to the world.

Then, as now, the problems facing mankind are pressing. It is the intelligent application of the best science which will help humanity to meet them. Above all, the key idea remains to bring together Nobel Laureates – role models – with young scientists to inspire and inform them. This will bring hope for future generations and the possibility of a better world. Only the best scientists attend: chosen either by the Nobel Committees, and, for the young scientists, through their nomination by their national academies of sciences through a rigorous selection process, anchored by the Council's peer review panel. Today, we assemble the best talents worldwide in the three Natural Sciences disciplines; physics, chemistry and medicine/physiology as well as Economics. This allows us to establish a relaxed atmosphere and an informal programme. It is one hallmark of our success as it is in sharp contrast with today's remorseless drive to image profiling.

> *The most important part of the meeting, for me, was the chance to meet and talk with the student participants. I was impressed by their intelligence and enthusiasm. By their selection as participants, the Lindau Foundation gives the students early recognition of their importance and promise.*
>
> *Martin Chalfie, Chemistry 2008.*

The encounters that take place in Lindau and the lasting friendships which are formed make the experience special. But, it is above all the candid and exclusive dialogue which takes place between the two groups, the Laureates and the outstanding young scientists from around the world, and among the best talents themselves, which makes the Lindau Meetings truly unique. They speak about scientific problems as well as their careers and share experiences. The young scientists learn from the Laureates' candid comments regarding their own failures and understand how important it is to overcome disappointments – they recognise the need for stamina when conducting research and indeed in life!

The Lindau Meeting was an outstanding experience. Besides the scientific lectures, the Laureates gave us a taste of the way science is done. Surely there is lot of hard work and perseverance, but there is also much love. I noted that most of them give their best not only for research, but for all other aspects of life. When talking about their research, they were always excited in a way that made them look like youngers. They gave us a lesson for life.

Young Scientist José A. Hoyos, Physics, Brazil.

'Mission Education' thus gives the Lindau meetings a unique position on the global science map that is not only endorsed but actively supported by many Laureates. It is this philosophy which enables us to realise the potential of the meetings and to ensure that they render service far and wide.

Even after the award of a Nobel Prize, the Laureates continue to learn. The sparkle of the young scientists' enthusiasms is something that the Laureates enormously value.

The Lindau Nobel Laureates meetings with students bring two extremes together: The past including the most experienced scientists that have contributed significantly to the understanding of basic life and universal processes - but that may not be the freshest minds anymore - and the future, namely the least experienced young generations, with the most brilliant, fresh, unconventional and daring way of thinking. I was challenged by a youngster to address philosophical and scientific problems that I have not thought of, and together, we were forced to take a deep dive into the ocean of our minds, to fly to high skies in order to carve our ways out.

Aaron Ciechanover, Chemistry 2004.

A striking example of how the visit in Lindau can provide a boost to a young scientist is Prof. Bert Sakmann, who attended as a student and came back later after having been awarded the Nobel Prize. Another example is Garima Ghale from Nepal:

Held in the beautiful island of Lindau, the Meeting of Noble laureates for me was a once in a lifetime experience. As such, it made my dream come true to meet and discuss with people who have made huge contributions to science and society, further driving my interest towards scientific research and development. It also provided me with a platform to communicate ideas and works with a wider community of fellow researchers and distinguished scientist, which otherwise might not have been possible!

Garima Ghale, Nepal.

6 THE LINDAU MEETINGS ARE FLOURISHING

The Lindau Meetings are now supported by almost all living Nobel Laureates who are members of the Lindau Foundation. No less than 69 Laureates will attend the next meeting in 2010. We continuously enable the participation from all continents: 67 countries were represented in 2009. The standard of the young scientists is getting better and better. Best talents from Egypt, Iran, Jordan, Malaysia, Pakistan, Saudi-Arabia and Turkey took part in 2009. Participation from Islamic countries has more than threefold since 2005. International agreements – MOUs – have been signed covering all continents, where about 200 academies of sciences and institutions in the realm of science and research are our academic partners.

We have established a promising partnership with COMSTECH and UNESCO as well as innovative fellowship programme with the OPEC Fund for International Development (OFID) – which also sponsors today's conference – provide initial funding.

The meetings themselves are exclusive, but the lectures and the platform discussions are increasingly accessible via the web to worldwide audiences.

7 KEY THEMES FOR THE FUTURE

In conclusion, I should like to suggest some key themes for your discussions, based on our experience at Lindau:

- First, threats to our future are more present than ever before;
- Second, faced with this reality, it is ever more important that good science and good scientists are listened to;
- Third, the fundamental and universal principles of science provide fertile ground for cooperation, in the interest of science but also for wider understanding; and
- Fourth, in almost all countries, too few young people, especially young women, are pursuing scientific careers. We need them and we need to encourage them.

Many more should follow in the footsteps of Sridhar Arulmani from India:

> *The Meeting of Nobel Laureates 2009: This is the best opportunity that I got at the correct time because now I am going to start my research career. This gave me a chance to interact with Nobel Laureates, scientists and young researchers from other countries. I got more information about current research and I also found my research area of interest. Also, I enjoyed a lot the get-togethers and I am proud to be one of the participants.*
>
> *Sridhar Arulmani, India.*

It is ever more important, now and in the future, that *good science and good scientists are listened to.* This is precisely the nature of the Lindau Meetings and why so many Laureates support them.

> *People come to listen. People come to debate. It's about the people – not the papers.*
>
> *Countess Bettina Bernadotte.*

Last but by no means least, pursuing these goals and fostering cross-fertilisation and dialogue requires hard work and active support from dedicated people and committed institutions, public and private. I am confident that we can count on the support of delegates at this conference.

Thank you for your attention.

Building a Knowledge Society in the Islamic World: Challenges and Opportunities

ATTA-UR-RAHMAN, FRS, FIAS
Coordinator General COMSTECH

ABSTRACT

We live in a world in which natural resources have diminishing importance. It is the ability of nations to innovate through unleashing the creative potential of their human resources which today, determines the process of socio-economic development. Nations which have realized this paradigm shift that has taken place over the last few decades and have invested massively in strengthening science, technology and innovation, have progressed rapidly, leaving others behind.

There are about 1900 universities in the Islamic world but only 39 of them are included among 3788 highly cited universities of the world. There are only between 50 - 300 scientists per million population in the OIC member states whereas in the west there are 2000 - 3000 scientists per million population. Only 4.18 percent of total world research papers and 0.05% of world's patents are contributed by the OIC member states. The RAND has categorized countries into 4 categories: (a) Scientifically advanced, (b) Scientifically proficient, (c) Scientifically developing and (d) Scientifically lagging.

There are no OIC member countries in the first two categories while there are 9 OIC member states in category 'C', and there are 48 OIC member states in the last category.

Finland, a small country which comprises only of 4 million people, may be taken as an example of how education and entrepreneurship can transform a nation. Just one Finnish company, Nokia, has exports of over 35 billion US Dollars annually!

While Turkey and Iran have made some progress in science and technology, and Malaysia has a good number of patents annually, the majority of the remaining OIC member states still live in darkness. They need to invest massively in developing a critical mass (at least 2000 PhDs per million population) of highly creative scientists in order to make real progress. They need to promote entrepreneurship and innovation, establish technology parks and offer incentives to the private sector for investment in research and development. Pakistan has made rapid strides in higher education, science and technology in recent years. A large number of exciting programs were initiated which include the establishment of a digital library which provides university students free access to 45,000 text books and 25,000 international journals, the launching of a national Network of Video-Conferencing facilities in universities so that lectures can be delivered from technologically advanced countries and attended by students in various universities of Pakistan with real time interactivity, the raising of salaries of productive faculty members so that these are now 4 to 5 times the salaries of Federal Ministers in the government under a new "tenure track" system of appointments, and the introduction of strong quality control measures. The enrolment in universities has tripled in the last five years.

The OIC member states should embark on such initiatives as jointly setting up universities and Centres of Excellence, sharing knowledge through international delivery of courses through video-conferencing, access to digital libraries, joint initiatives in developing cures for diseases or increasing agricultural productivity, strengthening of science academies and science networks and developing strong university - industry relationships.

Figure 1. Truth Stranger than Fiction!

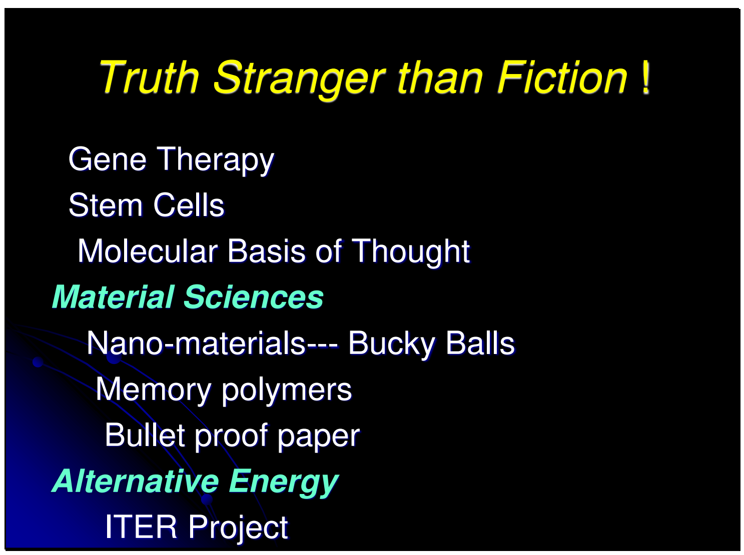

Figure 2. Truth Stranger than Fiction!

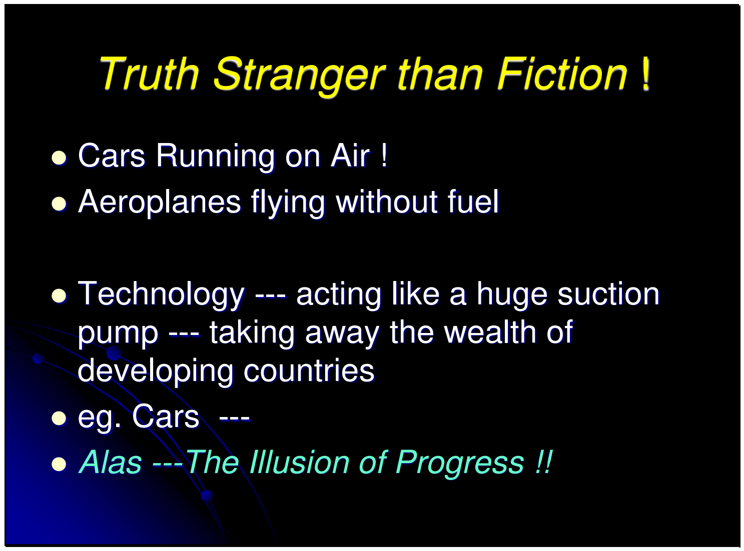

Figure 3. Truth Stranger than Fiction!

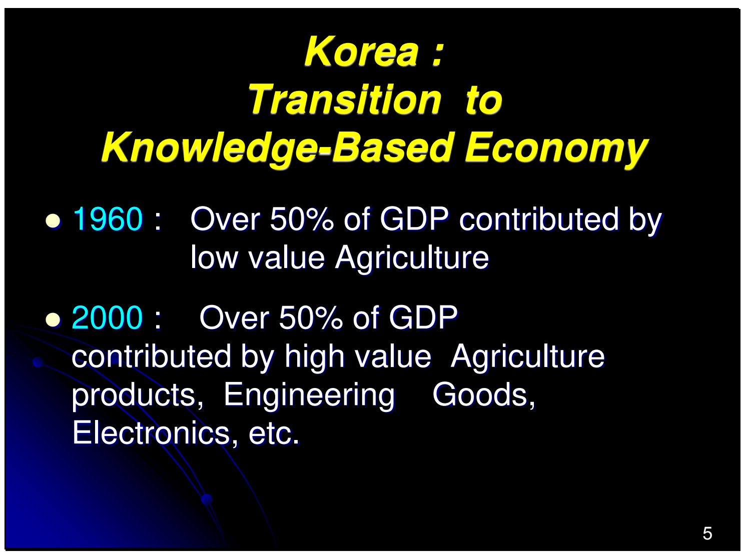

Figure 4. Korea: Transition to knowledge-Based Economy.

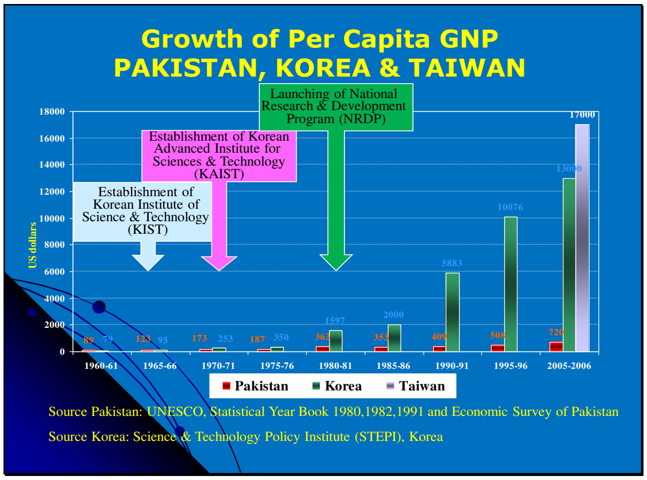

Figure 5. Growth of Per Capita GNP Pakistan, Korea & Taiwan.

Korea: Direct Correlation Between Technical Manpower and Exports

	1960	1970	1980	1990	2008
Higher Education Enrollment	5%	8.7%	16%	37.7%	82% *(4.6%)
Exports US$ (Million)	32	660	17,214	63,2124	150,439 *18,000

* Statistics for Pakistan

Figure 6. Korea: Direct Correlation Between Technical Manpower and Exports.

Figure 7. Singapore/ Finland (4 million).

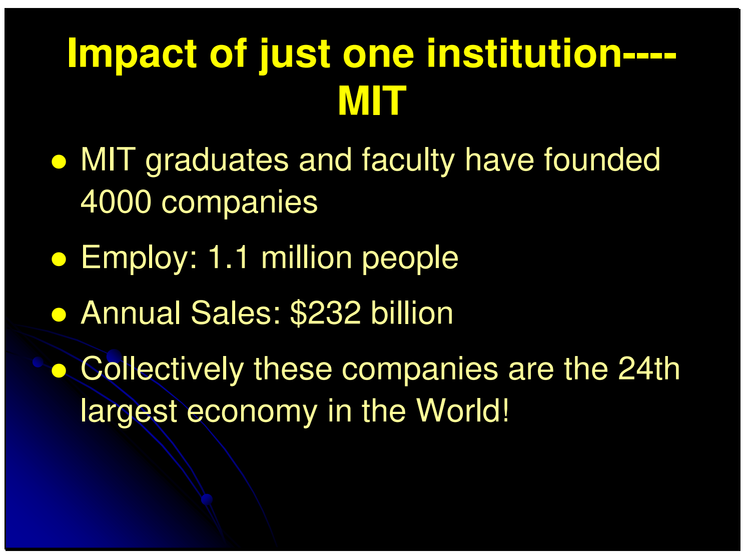

Figure 8. Impact of just one institution –MIT.

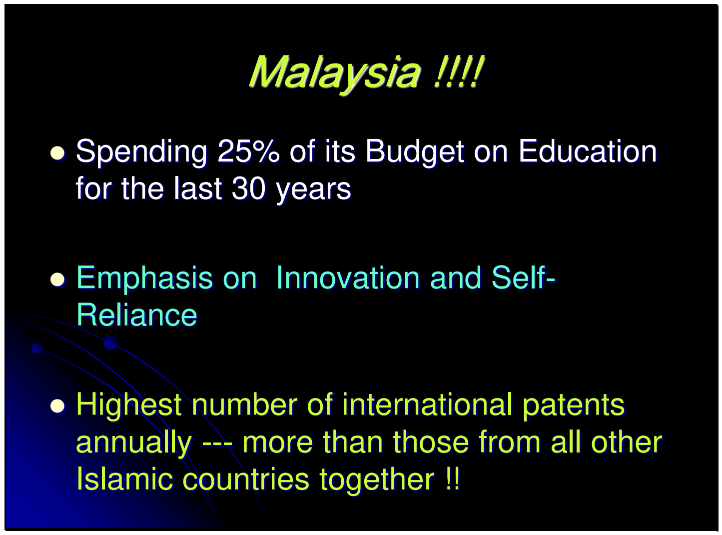

Figure 9. Malaysia!!!

Figure 10. Avoid "Sri Lanka Syndrome".

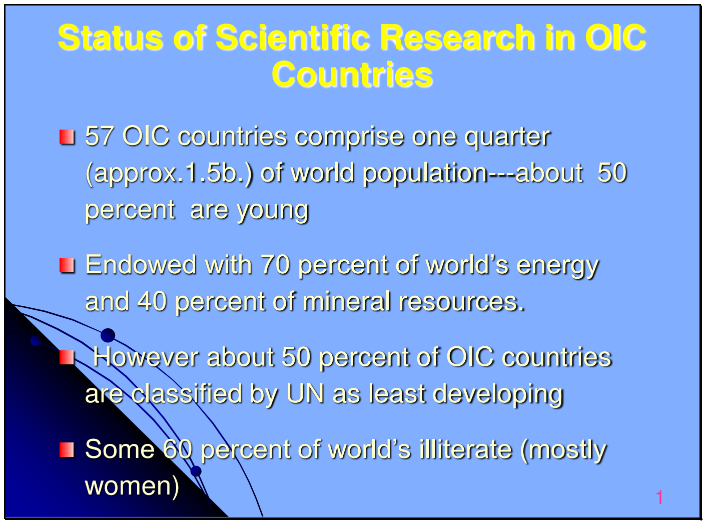

Figure 11. Status of Scientific Research in OIC Countries.

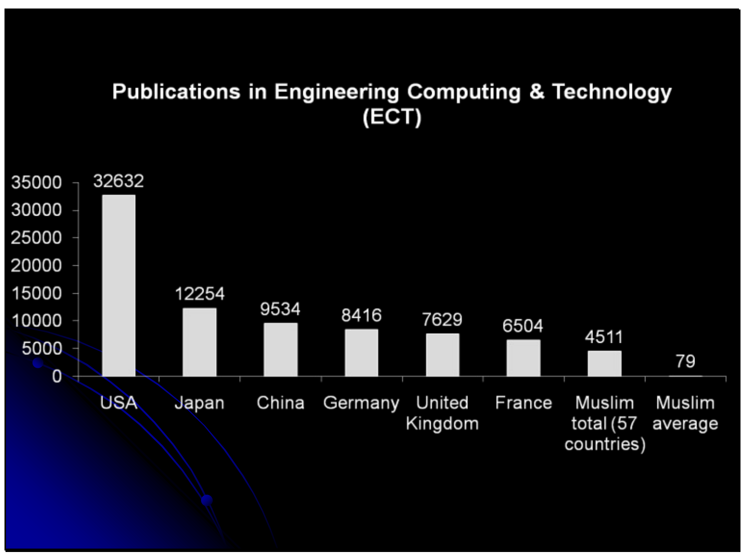

Figure 12. Publications in Engineering Computing & Technology (ECT).

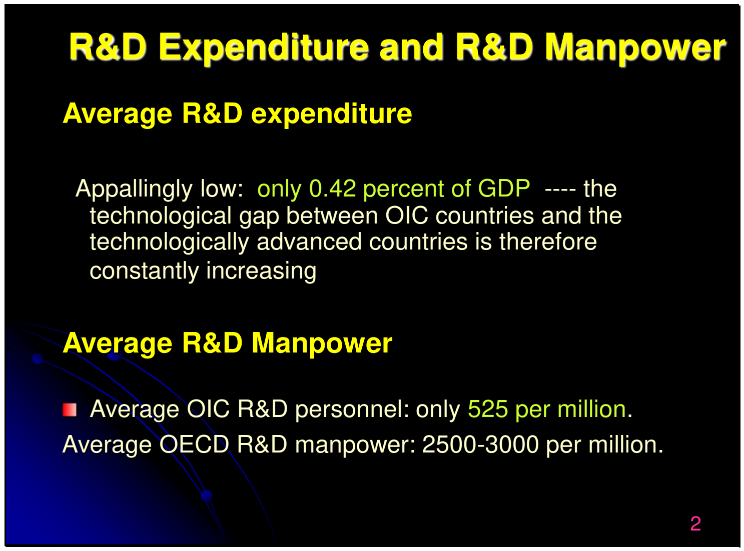

Figure 13. R & D Expenditure and R & D Manpower.

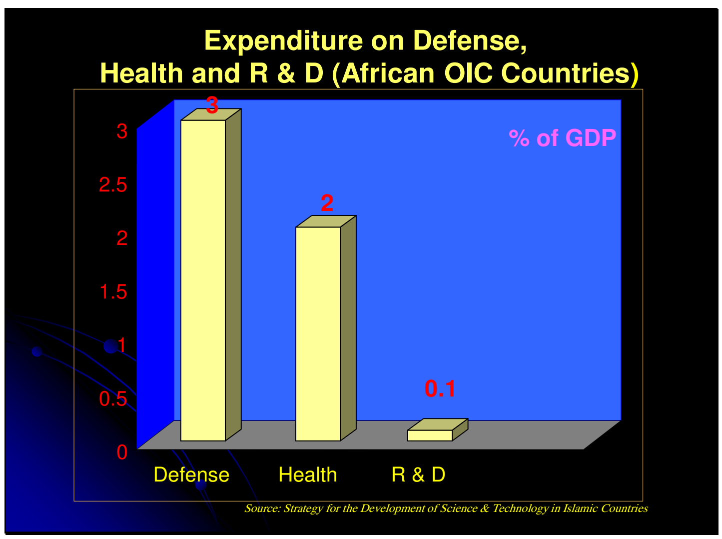

Figure 14. Expenditure on Defense, Health and R&D (African OIC Countries).

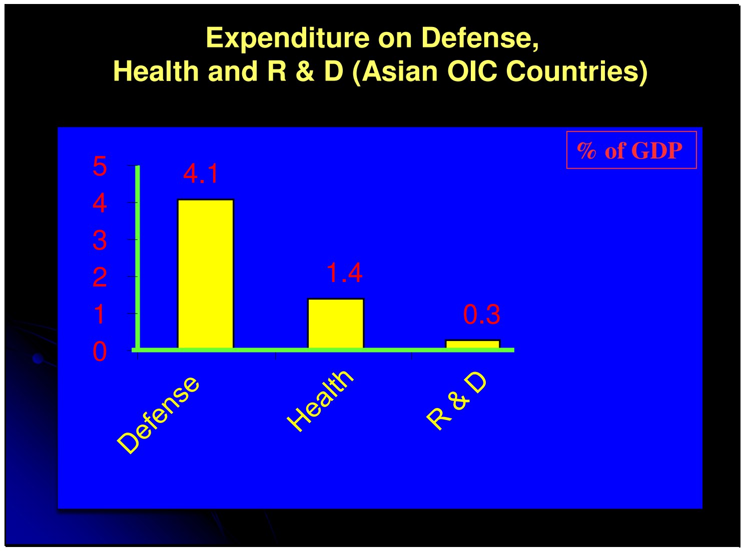

Figure 15. Expenditure on Defense, Health and R&D (African OIC Countries).

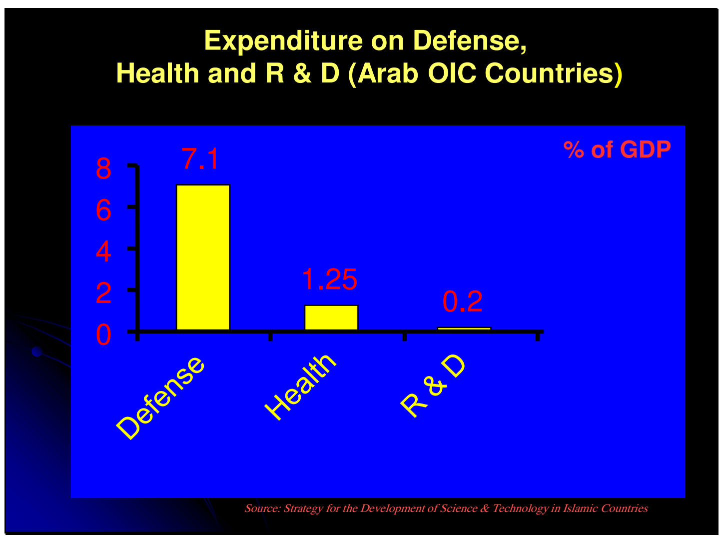

Figure 16. Expenditure on Defense, Health and R&D (African OIC Countries).

Figure 17. Challenges.

Figure 18. Key Investments.

Figure 19. Some Promising New Initiatives.

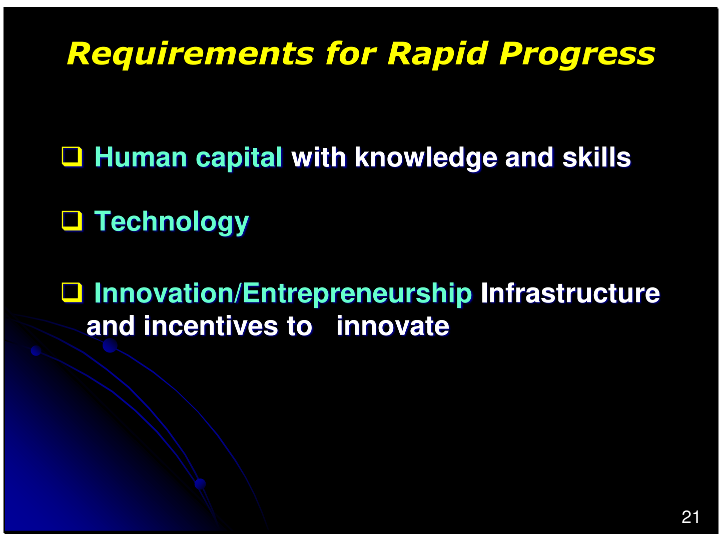

Figure 20. Requirements for Rapid Progress.

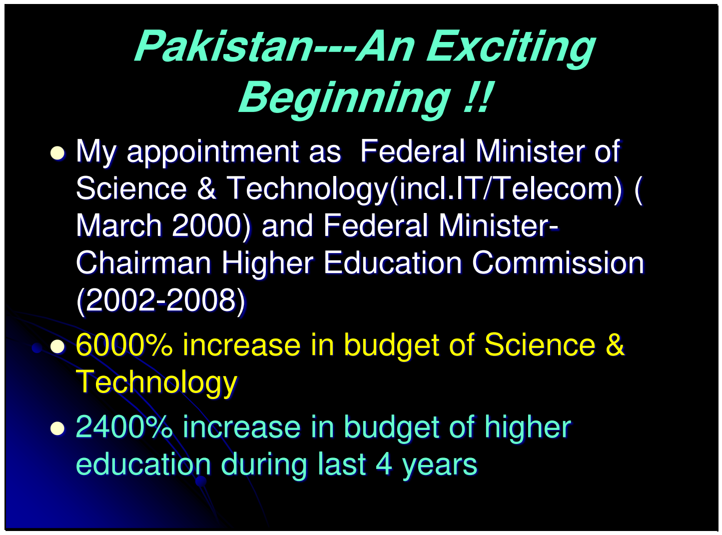

Figure 21. Pakistan – An Exciting Beginning!!

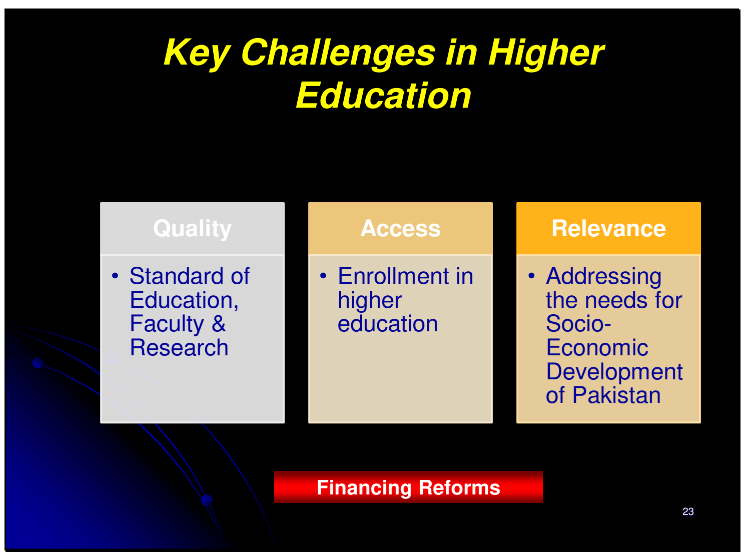

Figure 22. Key Challenges in Higher Education.

Figure 23. Plan of Action.

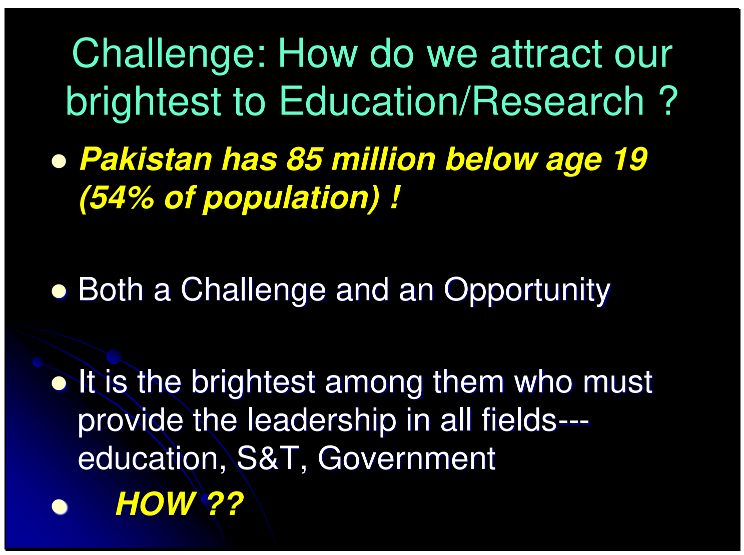

Figure 24. Challenge: How do we attract our Brightest to Education/Research?

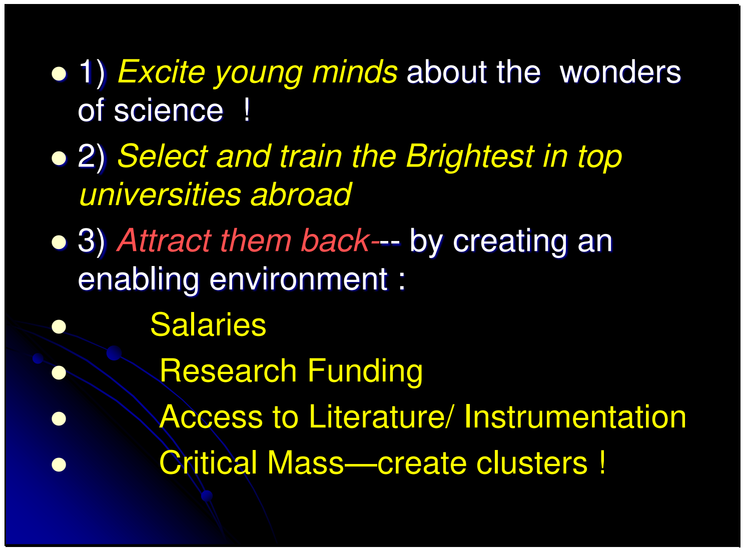

Figure 25. Challenge: How do we attract our Brightest to Education/Research?

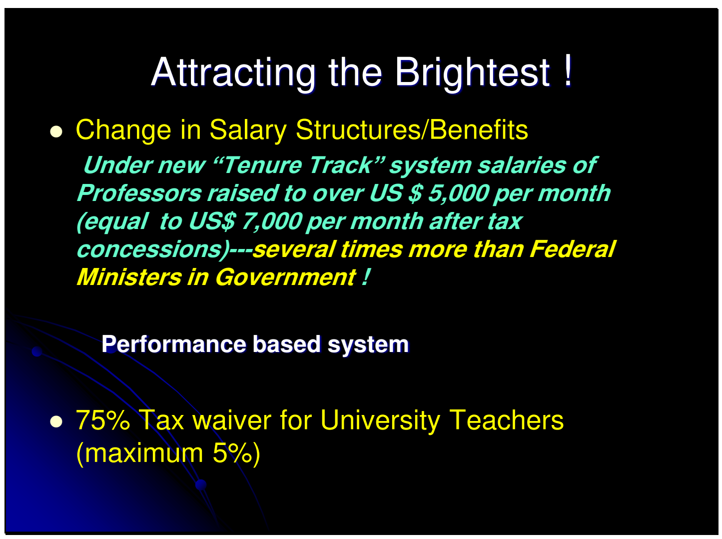

Figure 26. Attracting the Brightest!

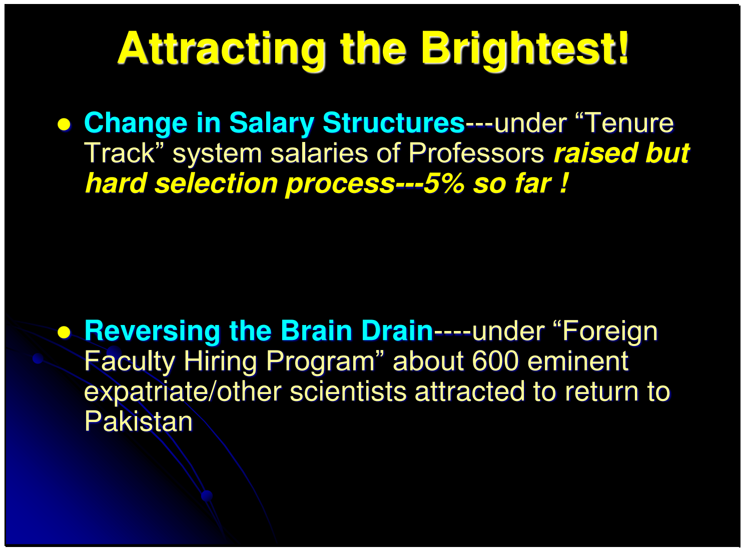

Figure 27. Attracting the Brightest!

Figure 28. Attracting the Brightest!

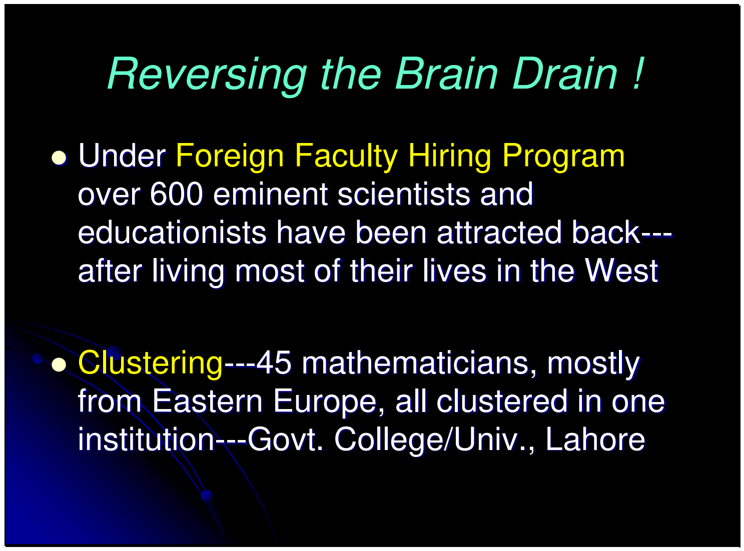

Figure 29. Reversing the Brain Drain!

Figure 30. Training the Brightest!

Figure 31. Training the Brightest!

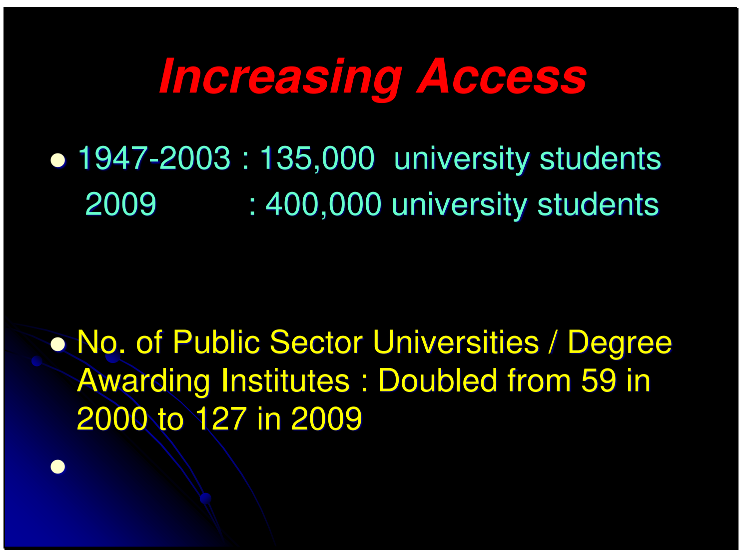

Figure 32. Increasing Access.

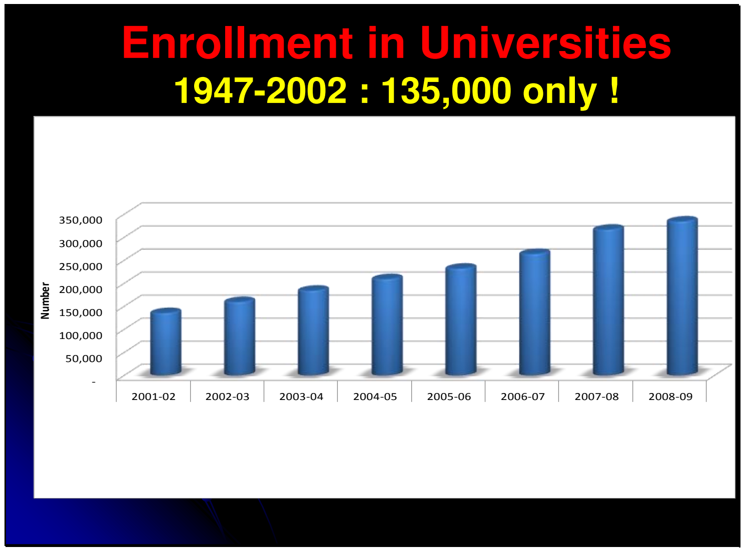

Figure 33. Enrollment in Universities.

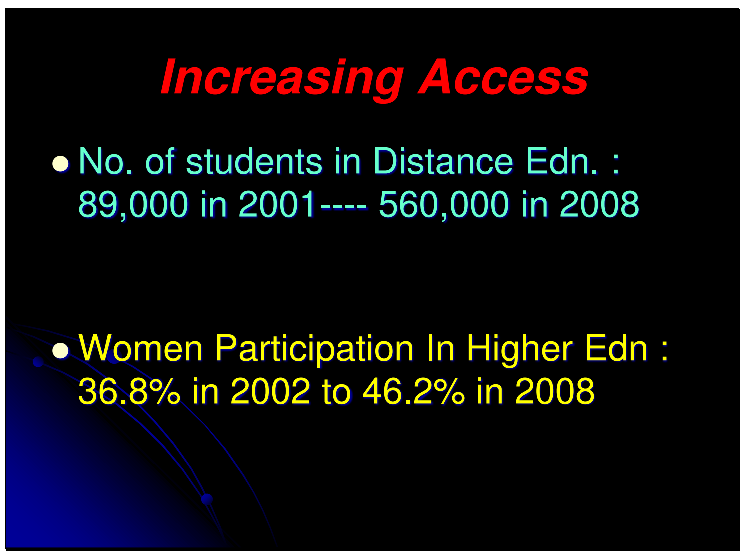

Figure 34. Increasing Access.

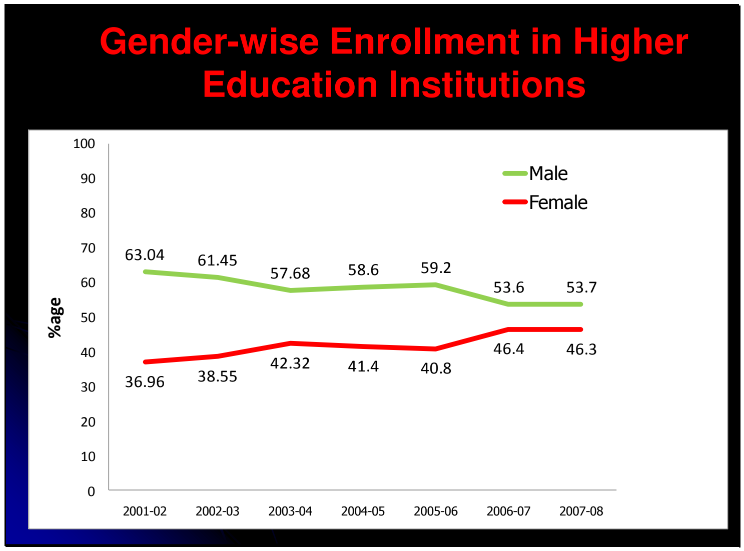

Figure 35. Gender-wise Enrollment in Higher Education Institutions.

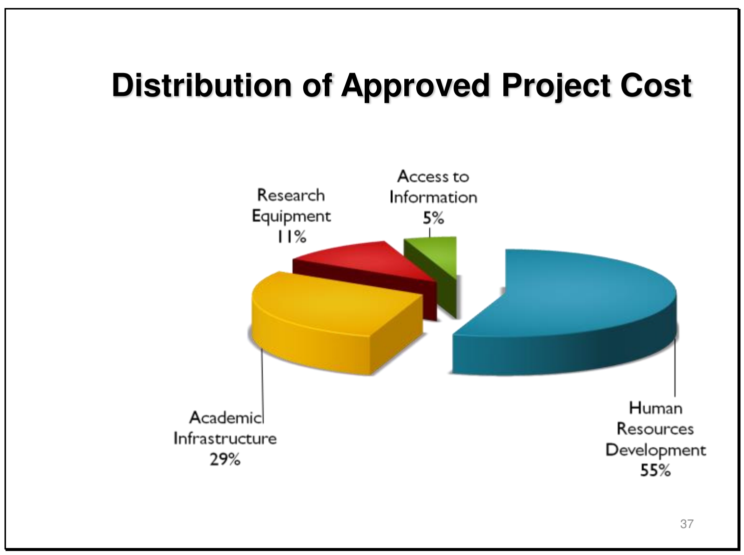

Figure 36. Distribution of Approved Project Cost.

Figure 37. A Focus on Quality Assurance.

Figure 38. Grants & Scholarships for Private Sector Universities.

Figure 39. Using Technology to Leap-Frog!

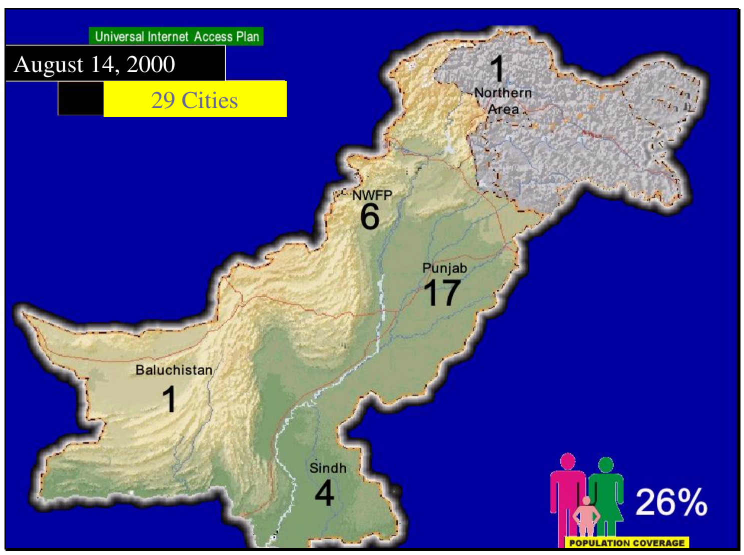

Figure 40.

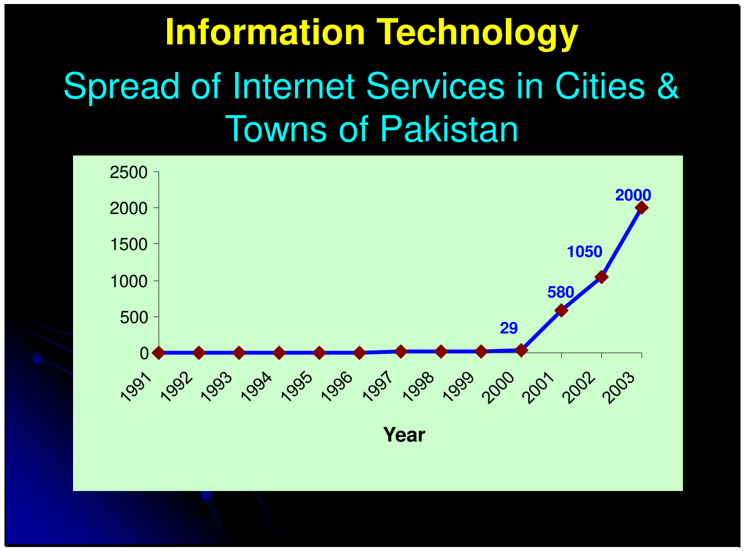

Figure 41. Information Technology.

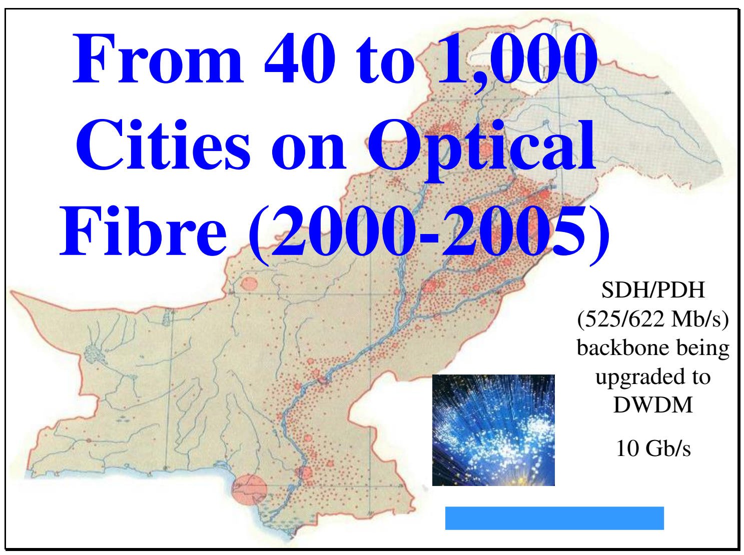

Figure 42. From 40 to 1,000 Cities on Optical Fibre (2000-2005).

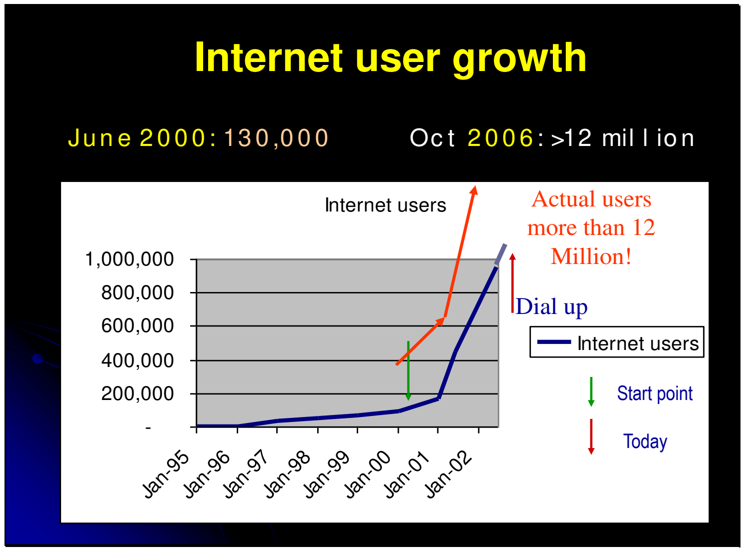

Figure 42. Internet user Growth.

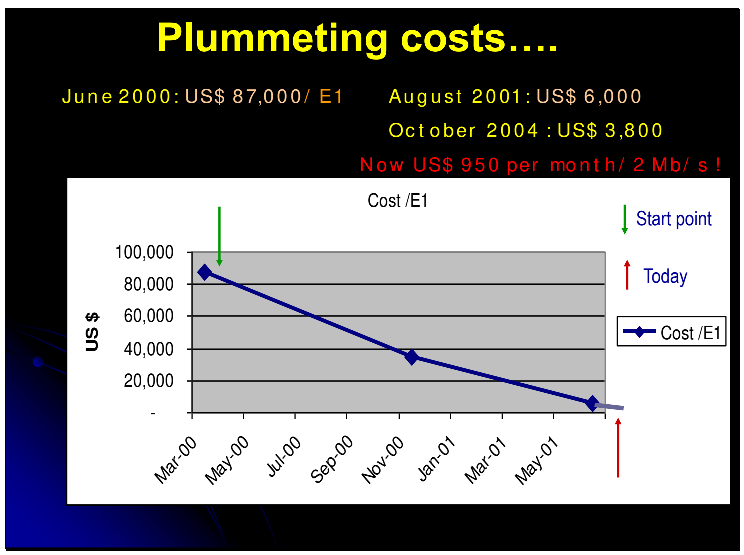

Figure 43. Plummeting Costs.

Figure 44. Communications Network – the Effect of One Good Decision.

Pakistan Education & Research Network

Details	PERN – I (2003 – 08)	PERN – 2 (2009 – 13)
Universities/ Institutes	80	250+
Core Bandwidth	155 Mbps	10 Gbps
Last Mile Bandwidth	4-24 Mbps	1 Gbps
International Bandwidth	350 Mbps	2.5 Gbps
International Leased Circuit	155 Mbps	622 Mbps

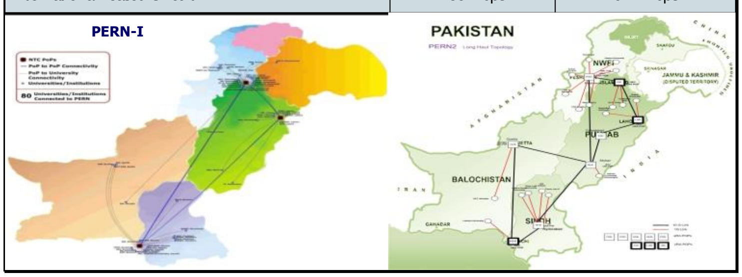

Figure 45. Pakistan Education & Research Network.

Figure 46. Digital Library.

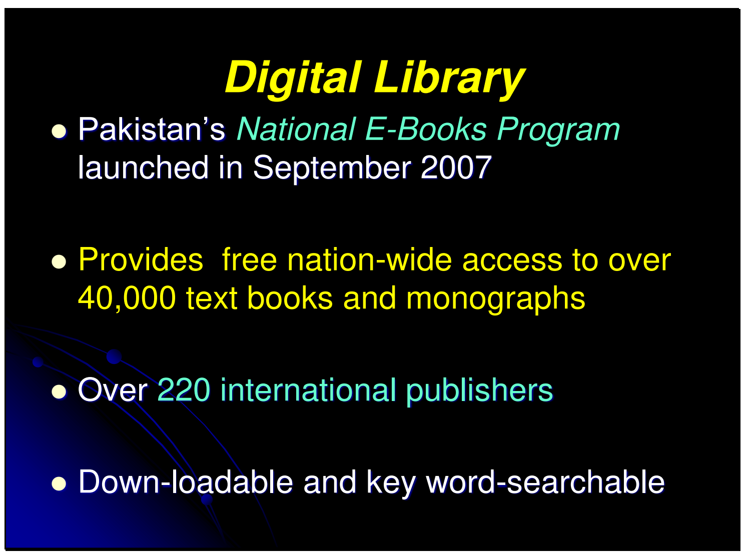

Figure 47. Digital Library.

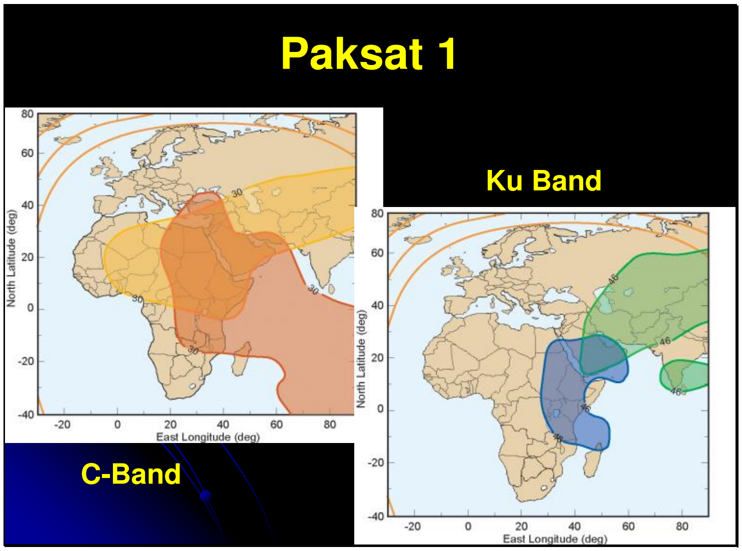

Figure 48. Paksat 1.

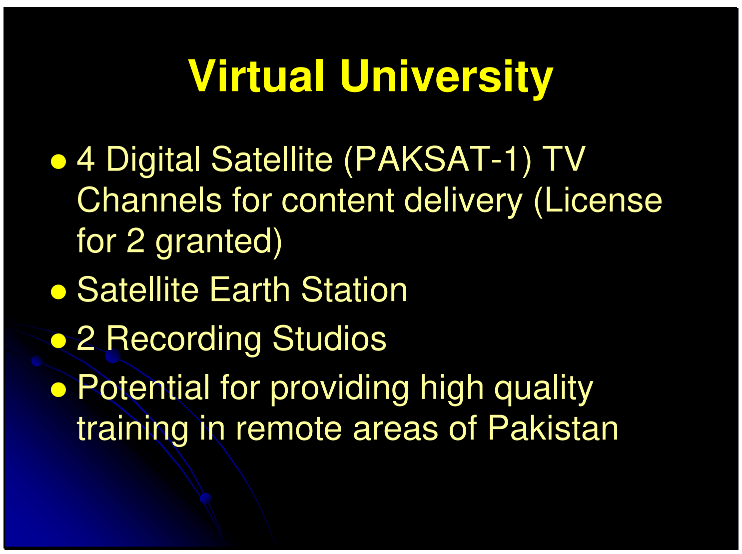

Figure 49. Virtual University.

Figure 50. International Video-Lecturing Program/Distance Learning.

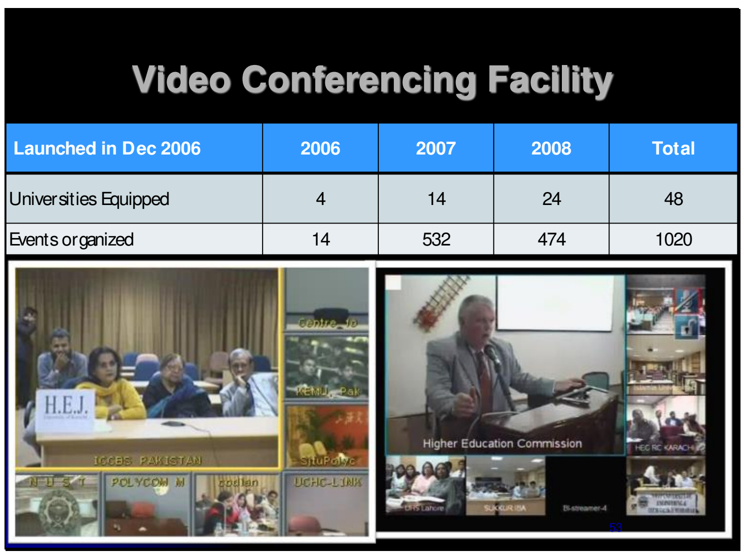

Figure 51. Video Conferencing Facility.

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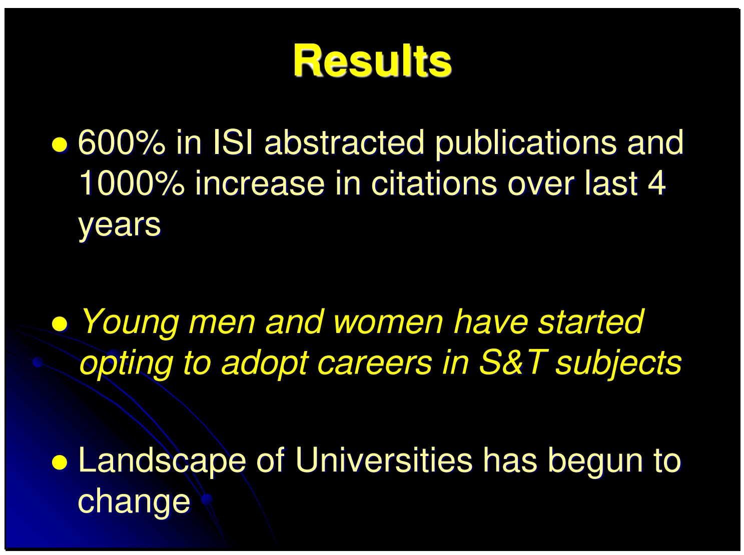

Figure 53. Results.

Figure 54. Pakistan: Rising Star Publications in the World's Best Journals.

Figure 55. Pakistan: Rising Star.

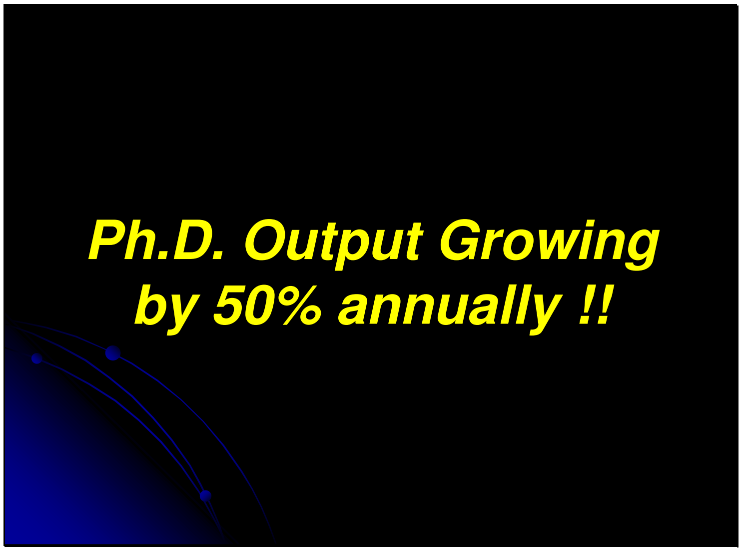

Figure 56.Ph.D. Output

Figure 57. Investment in HRD Pays Back a Million fold!

Figure 58.

Figure 59. COMSTECH Institute of Advanced Training.

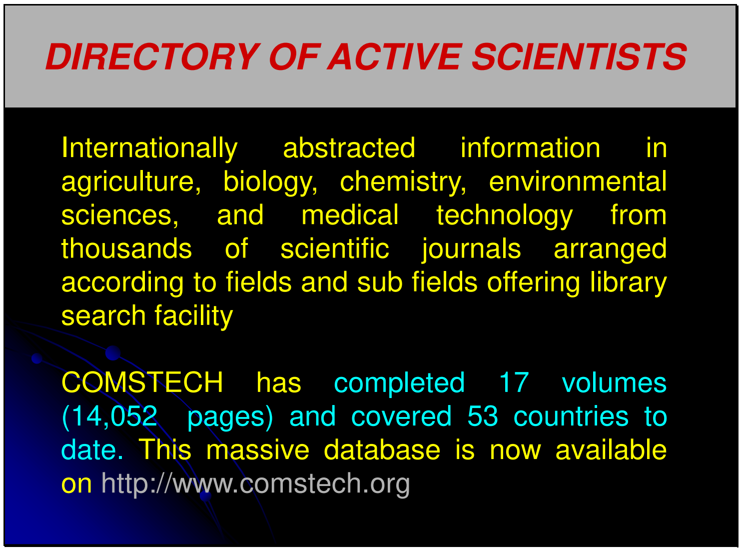

Figure 60. Directory of Active Scientist.

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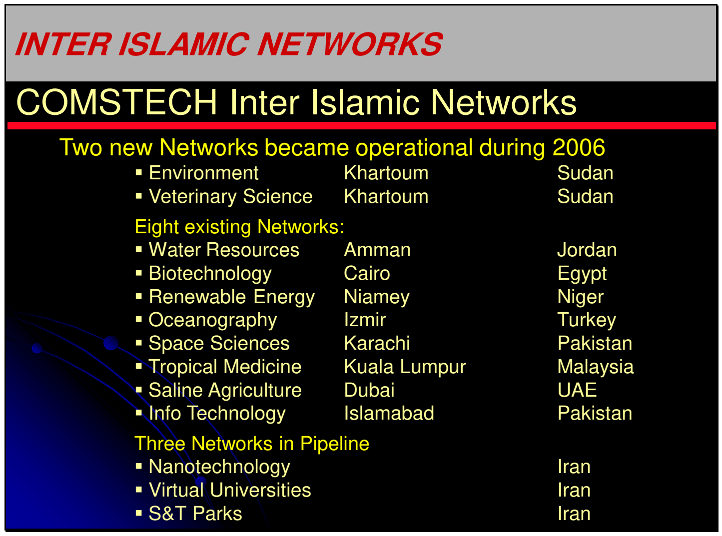

Figure 66. Inter Islamic Networks.

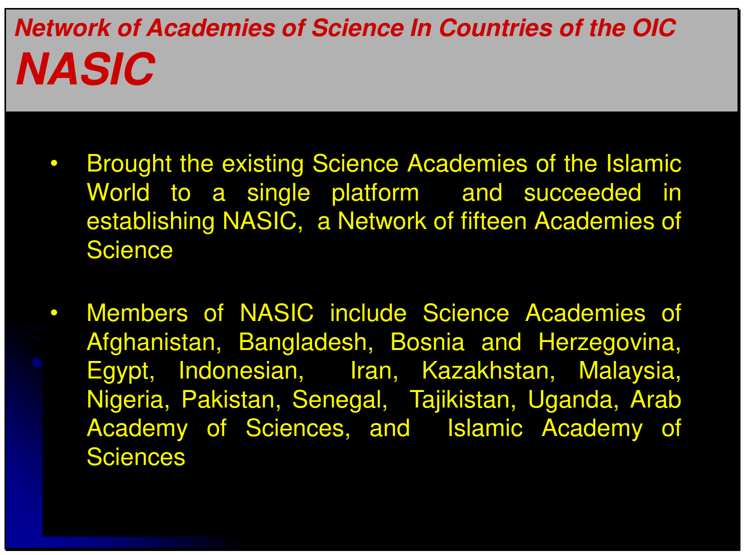

Figure 67. Network of Academies of Science in Countries of the OIC NASIC.

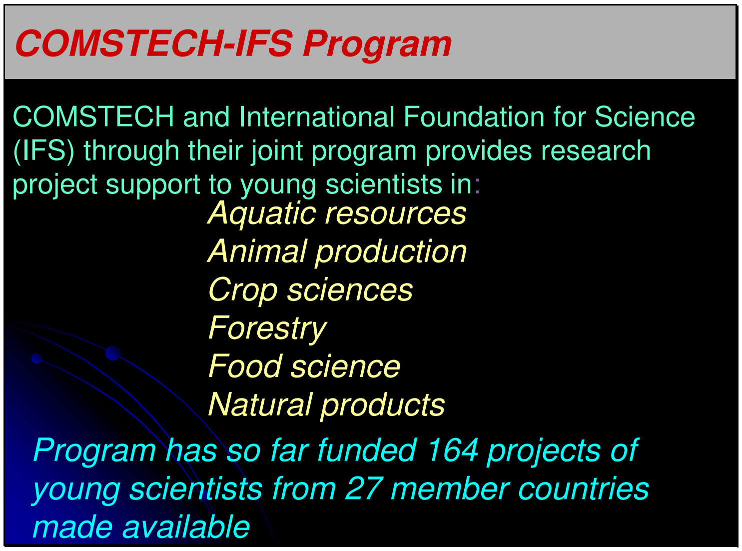

Figure 68. COMSTECH-IFS Program.

Figure 69. COMSTECH-IFS Research Projects.

Figure 70. COMSTECH-IFS Research Projects.

Figure 71. Centre for Technology and Innovation Policy established in COMSTECH.

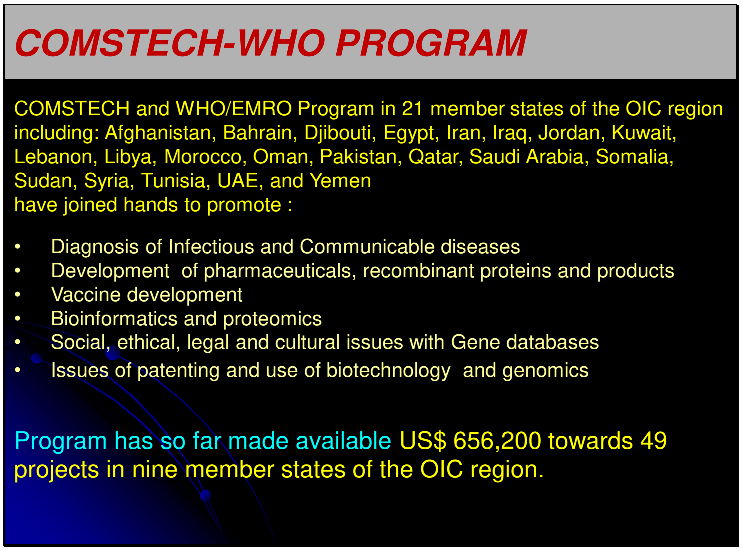

Figure 72. COMSTECH-WHO Program.

Figure 73. COMSTECH-ISESCO Joint Program.

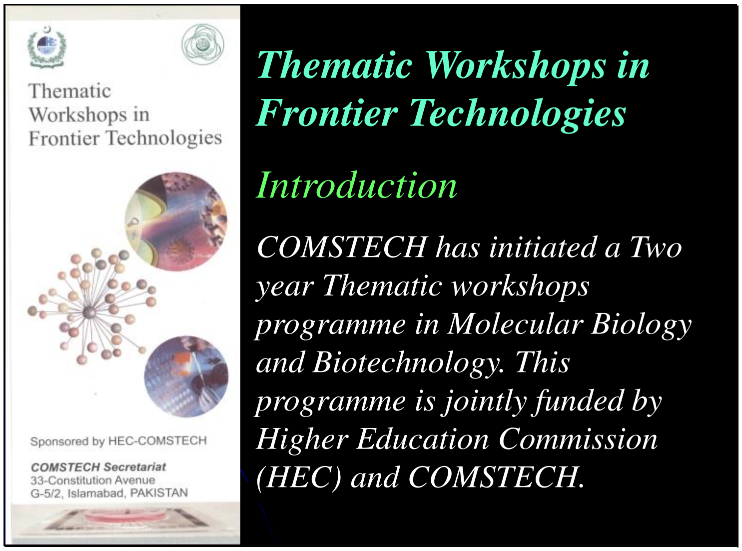

Figure 74. Thematic Workshops in Frontier Technologies.

Figure 75. Higher Education Science & Technology Innovation.

THANK YOU

Part Three

The Human Factor & Symposium on Women and Science

Human Capital Development for the Knowledge (Innovation) Economy

OMAR ABDUL RAHMAN

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Formerly Science Advisor to the Prime Minister of Malaysia

ABSTRACT

This presentation concentrates on one aspect of the Knowledge Society – namely the development of a workforce for the knowledge – based or innovation economy. This workforce comprises the Knowledge workers and the knowledge managers.

A knowledge worker is more than just an ICT literate. A knowledge worker is characterized by:

- The ability to provide solutions, working alone or in a team;
- Possession of a core competency which is enhanced by mastery of ICT;
- Being creative, innovative and entrepreneurial;
- High motivation; adaptable and open to learning, including self-learning and re-learning and be prepared to master new skills;
- Being a risk taker, able to work boundary less and borderless; and
- Work ethics based on Smart Partnership values (respect, trust, tolerance and transparency) and science ethics (professional, social, environmental, moral and ethical obligations).

This presentation will recapitulate the essence of the knowledge or innovation economy, the ecosystem necessary for the innovation economy and the basic concept for human capital development for the innovation economy.

Examples from Malaysia of an inclusive human capital development approach at the university level and an entrepreneurship nurturing programme are presented.

GROWTH DRIVERS OF DEVELOPING ECONOMIES

1. Driven by **Foreign Borrowings.**
2. Resulting from **Commodity Booms.**
3. Led by **Economic Restructuring** and **Diversification** into **New Products** and **Services.**

No. 1 – not sustainable; No. 2 – boom and bust cycles
No. 3 – most sustainable and based on production of **manufactured goods** and other **modern goods** and **services**.

Source: Dani Rodrik
- A de-globalised world?
STARBIZ, 14 May 2009
© Project Syndicate

Figure 1. Growth Drivers of Developing Economies.

MANUFACTURING, THE BACKBONE OF DEVELOPED ECONOMIES

Example: EUROPE

- Manufacturing employs more than 34 million people in 2.2 million enterprises in 23 industrial sectors; another 60 million people in related service areas for manufacturing.
- Manufacturing : 55% of European GDP

New Initiative

European Technology Platform for High-Adding-Value (HAV), Knowledge-based Competitive Sustainable Manufacturing (CSM); **Lisbon Agenda for Growth and Sustainability in the Knowledge Community** - **MANUFUTURE.**

Source : *F.Jovane, E.Westkamper and D.Williams - 2009, editors – The Manufuture Road. Springer – Verlag Berlin*

Figure 2. Manufacturing, the Backbone of Developed Economies.

ESSENCE OF INNOVATION ECONOMY

The production of manufactured goods and other modern goods and services Is the **essence** of the **Knowledge-driven** or the **Innovation Economy** and dependent on the **Total National Capacity (TNC) in Science, Technology and Innovation (STI)**

Figure 3. Essence of Innovation Economy.

TOTAL NATIONAL CAPACITY (TNC) IN STI IN THE INNOVATION ECONOMY

- A **scientific community** able to contribute to and draw from the global pool of scientific and technological knowledge.
- A **government** committed to providing a comprehensive **STI infrastructure** (soft and hard: institutions, funds, processes, etc)
- A **private sector** capable of **creating** wealth through application of **technology** and **innovation** in all sectors of the economy.
- A **society** that provides and supports the social and ethical framework necessary for the all the above to operate.

TNC is a Hallmark of the Knowledge Society.

Figure 4. Total National Capacity (TNC) in STI in the Innovation Economy.

THE ECOSYSTEM OF INNOVATION ECONOMY

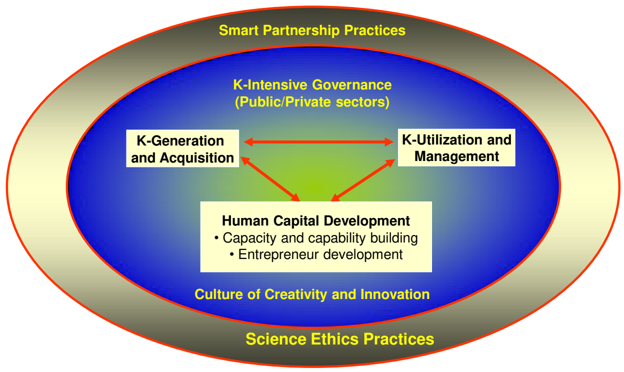

Figure 5. The Ecosystem of Innovation Economy.

HUMAN CAPITAL DEVELOPMENT

Is the holistic approach to the development of the full human potential. The objective is to create human capital i.e. “productive assets in the form of human competencies” or “a portfolio of different skills and assets” required by both industry and government to create a nation of high competitiveness in the knowledge society.

Figure 6. Human Capital Development.

HUMAN CAPITAL DEVELOPMENT

Human Capital development encompasses the practices and the environment to develop: intellectual capital, skills capital, social capital, entrepreneurial capital, psychological capital and spiritual capital within individuals.

Figure 7. Human Capital Development.

HUMAN CAPITAL DEVELOPMENT

- Intellectual Capital – Nurtured through formal and informal education – logical, strategic thought processes.
- Skills Capital – Codified and tacit knowledge; technical skills from training or acquired through experience.
- Social Capital – Social skills, communication, cooperativeness, networking, smart partnership principles enhances social capital.
- Entrepreneurial Capital – Creativity, innovativeness and entrepreneurship.
- Psychological Capital – Commitment, passion, dedication, confidence, belief in self (Malaysia Boleh).
- Spiritual Capital –
  - Ethical values and principles.
  - Right and wrong.
  - Smart partnership ethos.

BY DESIGN AND/OR BY DIFFUSION

Figure 8. Human Capital Development.

HUMAN CAPITAL DEVELOPMENT

The product of human capital development is a knowledge-worker or knowledge manager par excellence.

Figure 9. Human Capital Development.

HUMAN CAPITAL DEVELOPMENT

A knowledge worker is more than just ICT literate. A knowledge worker is characterized by:

- Ability to provide solutions, working alone or in a team
- Possession of a core competency which is enhanced by mastery of ICT
- Being creative, innovative and entrepreneurial
- High motivation; adaptable and open to learning, including self-learning and re-learning and prepared to master new skills
- Being a risk taker, able to work boundaryless and borderless
- Work ethics based on Smart Partnership values (respect, trust, tolerance and transparency) and science ethics (professional, social, environmental, moral and ethical obligations)

Figure 10. Human Capital Development.

HUMAN CAPITAL DEVELOPMENT

A knowledge-manager possesses or is capable of developing the following assets:

- General management human capital
- Strategic human capital
- Domain-specific human capital (industry or public sector specific expertise)
- Relationship human capital
- Company/institution-specific human capital

Figure 11. Human Capital Development.

PROCESS OF HUMAN CAPITAL DEVELOPMENT

Home: The environment at home must be conducive to the learning process at an early age, encourage inquisitiveness and creativity

School: New approach to learning process, teacher-pupil relationship, new subjects that promote creativity , innovativeness and entrepreneurship, assessment system that encourages 'thinking out of the box'.

Development of social skills, racial mix as an asset, communication skills: debate, negotiations, consultation; smart partnership ethos.

University: As above plus:-

Fostering a culture of life-long learning, unlearning and relearning; commitment to R&D.

Workplace: Open, flexible system that encourages team work, rewards creativity and entrepreneurship; wellness culture

Figure 12. Process of Human Capital Development.

SMART PARTNERSHIP

- Partnering based on **respect, trust, transparency** and **tolerance.**
- Long-term, with evolving common objectives; goes beyond strategic alliance.
- Cooperation to succeed vs. cooperation to compete.
- **Outcome:** prosper thy neighbor; win-win, equitable; balance between business and social benefits.

(Promoted by CPTM)

Smart Partnership framework - applicable in the specific context of Total National STI capacity for the Innovation Economy.

Smart Partnership - preferred framework for the conduct of business and Government nationally and internationally.

Figure 13. Smart Partnership.

SCIENCE ETHICS PRACTICES

"Principles according to which scientific activity should be conducted and the mechanisms by which conformity to such principles is promoted, fostered and ensured"

COMEST, May 09

UNESCO

- 1974 Recommendations on Status of Scientific Research:
  - ✓ Integration of science ethics in science policy
- 1999 Declaration on Science and the Uses of Scientific Knowledge
  - ✓ Ethics to be included in all Science teaching at universities

Figure 14. Science Ethics Practices.

ENTREPRENEUR - ENTREPRENEURSHIP

Entrepreneur – “ Anybody who starts a business, be it a corner shop or a high-tech startup.”

- Innovative entrepreneur or replicate entrepreneur
- Entrepreneurial business or lifestyle business.

Entrepreneurship – Ability to start business by offering an innovative solution to a problem.

- “ Innovation is the specific instrument of innovative entrepreneurship.”

- Entrepreneurship can be developed through **education, nurturing, mentoring and networking**.

Figure 15. Entrepreneur-Entrepreneurship.

INTEGRATION OF ENTREPRENEURSHIP & MANAGEMENT INTO UNDERGRADUATE PROGRAMMES –
Malaysia University of Science and Technology - MUST

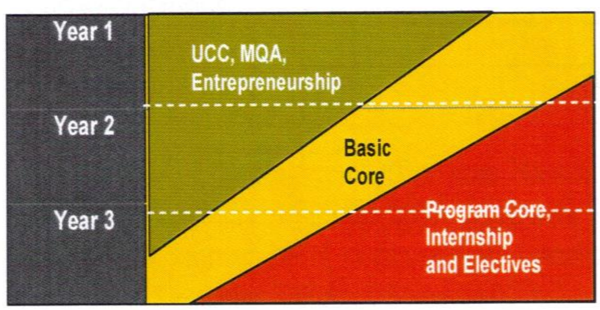

Figure 16. Integration of Entrepreneurship & management Into Undergraduate Programmes – Malaysia University of Science and Technology-MUST.

EXPECTED OUTPUT

Graduates who are not just seeking employment but also capable of creating employment – skill to commercialize ideas or technology innovations.

Figure 17. Expected Output.

BIOTECHNOLOGY ENTREPRENEURSHIP SPECIAL TRAINING (BeST) PROGRAMME

BeST is a six-month intensive and structured retooling programme for graduates from all disciplines wishing to enter the biotechnology industry and other related industries in general.
BeST combines classroom-based instruction, laboratory work and industry internship. The programme is aimed at equipping the graduates with essential skills and knowledge for entry-level positions within biotechnology companies or biotechnology-related companies.
This Programme aims :

- To enhance the knowledge and skills of graduates in technical, communication/ language and business/ entrepreneurship areas.
- To match the knowledge and skills of graduates with the competencies required by biotechnology industry.
- To give unemployed graduates relevant "real world" skills as well as industry experience and exposure.
- This programme is fully funded by BiotechCorp. In addition, the programme participants will also be receiving a monthly training allowance of RM1,000.00 for the duration of the programme including the industry internship placement. Training will be conducted in the following locations: Pulau Pinang, Kuantan, Marang, Kuala Lumpur, Pasir Gudang, Kota Kinabalu, Kuching.

The BeST Programme is supported by excellent industry collaborations and has a successful and proven track record in providing internship and job placement assistance to all BeST Programme's graduates.
Application form can be downloaded via our website at http://www.biotechcorp.com.my. Please submit your application form together with a complete CV and passport size photograph to:

BIOTECHNOLOGY ENTREPRENEURSHIP SPECIAL TRAINING (BeST) PROGRAMME
Human Capital Development Department, Strategy & Planning Division
Malaysian Biotechnology Corporation Sdn Bhd
Level 20, Menara Atlan, 161, Jalan Ampang, 50450 Kuala Lumpur

Closing Date: 14th December 2009 | Only short listed candidates will be called for an interview

Figure 18. Biotechnology Entrepreneurship Special Training (BeST) Programme.

ESSENTIALS FOR ENTREPRENEURIALISM

ESSENTIALS FOR ENTREPRENEURIALISM

Mindset Change – Entrepreneurial Culture
- High motivation, failure not a stigma

Funds
- Angels – Friends, Family and Fools.
- Venture Capital, pre-seed funds, (ideas funds) – e.g. Cradle

Access to Market
- New technologies especially personal computers, mobile phones and the internet.

Regulatory Environment
- Ease of doing business (Top 10:- Singapore, New Zealand, U.S., Hong Kong, Denmark, U.K., Ireland, Canada, Australia, Norway) Malaysia?

Business Environment
- Job mobility
- Support from big companies, other established institutions – e.g. universities – Cambridge, Oxford, Stanford, MIT

Figure 19. Essentials for Entrepreneurialism.

NEW ROLE FOR UNIVERSITIES

ACADEMIC FACING

Teaching
- Promote curiosity
- Develop intellect

Research
- New knowledge
  - Better understanding
  - Problem solving
- Publications/ thesis
- Patents

INDUSTRY FACING

Teaching/ Training
- Skill/ expertise
- Entrepreneurship
- Industry specific

Research
- Customer-driven
  - Problem solving
  - New possibilities
- Commercialization-driven
  - From new knowledge
  - From “idea”

Figure 20. New Role for Universities.

UNIVERSITY – INDUSTRY INTERACTION – INDUSTRY FACING

Industry Facing

- Teaching/ training for industry relevance.
- Strong university – Industry Linkage

Research

- Customer-driven
- Entrepreneurial skill to market and sell university research service.
- Commercialization-driven
- Entrepreneurial skill needed to evaluate and to " package " commercially viable projects.

Figure 21. University – Industry Interaction – Industry Facing

CONCLUSIONS

- Knowledge worker an important component of knowledge society
- Has attributes beyond ICT
- Crucial workforce for the knowledge or innovation economy
- Inclusive human capital development strategy necessary for knowledge workers with emphasis on entrepreneurship
- New role for universities – industry - facing
- Comprehensive learning and working environment necessary for entrepreneurialism

- No gender bias in the knowledge society
- No gender bias in entrepreneurship

- What role for IAS beyond "Declarations" and "Conference Report"?

Figure 22. Conclusion.

THANK YOU

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Knowledge Society and the Status of Women in Science in Malaysia

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1 ABSTRACT

Knowledge has always been recognized as strength in any progress or success, especially in this information age. It is also an important factor of production in a `new economy' (Evers, 2002), and in Science and Technology (S&T). The Malaysian government has outlined the strategies on how and when to reach the stage of a fully developed industrialized nation with knowledge based society. The former Malaysian Prime Minister, Tun Mahathir Mohamad, mentioned that the challenge for Malaysia is to develop this knowledge amongst her citizens, so that Malaysia's success will be due to the contributions of Malaysian talents and knowledge workers. Therefore, S & T has been clearly placed as an important factor for sustainable development in a country. Thus, the greater challenge for Malaysia is to identify the best, brightest and most innovative S&T talents, as prime movers of the nation, with equal access of women and man. The Advisory Panel for the Inter-Academy Council (2008) stated that greater participation of women in all aspects of science, engineering and medicine, will strengthen the science, technology and innovation (STI) capacities of all nations.

In Malaysia, though males out-number females out of over 26 million population, the enrolments in universities indicate higher percentages of females compared to males, even in many professional programmes. The life expectancy is also higher in females than males. However, there is an uneven female participation across occupational categories. Female participation in science professions, such as doctors and engineers, remain low in percentages, despite the increase in absolute figures. The low percentage of women in the workforce for S&T requires proper analysis of the available data.

2 INTRODUCTION

The Malaysian government has developed a vision on when and how to reach the stage of a fully developed industrialized nation with knowledge based society. Following through the action plans under Vision 2020, Malaysia is progressively on her way to developing the knowledge society. There are many definitions of a 'Knowledge Society' given by politicians, policy makers, and academicians. According to Abdul Waheed Khan (General Sub-Director of UNESCO for Communication and Information), knowledge society is an information society, whereby;

> *Information society is the building block for knowledge societies. Whereas I see the concept of 'information society' as linked to the idea of 'technological innovation', the concept of 'knowledge societies' includes a dimension of social, cultural, economical, political and institutional transformation, and a more pluralistic and developmental perspective. In my view, the concept of a 'knowledge society' is preferable to that of the 'information society' because it better captures the complexity and dynamism of the changes taking place. (……) the knowledge in question is important not only for*

economic growth but also for empowering and developing all sectors of society. (Evers, 2003).

We can summarize that a knowledge society creates, shares and uses knowledge for the prosperity and well-being of its people. Knowledge becomes a major creative force and a component in any human activity, and it creates an atmosphere in which societies can blossom competitively.

Undoubtedly, the knowledge society is based on a paradigm that focuses on intellectual capital as a prime mover (Mustapha and Abdullah, 2004). In order to acquire the best human capital, smart investment has to be made. This includes formal and informal education and training. The former Malaysian Prime Minister, Tun Mahathir Mohamad, mentioned that the challenge for Malaysia is to develop this knowledge amongst her citizens, so that Malaysia's success will be due to the contributions of Malaysian talents and knowledge workers. In order to sustain the development of a country, S&T has been clearly placed as an important aspect. Thus, the participation of the workforce in S&T has shown that there is a big gap between women and men.

3 SCIENCE AND TECHNOLOGY IN MALAYSIA

Malaysia's Vision 2020 has placed S&T and Information and Communication Technology (ICT) as a critical pathway towards achieving the status of a developed nation (Shuib, 2008). Streaming into arts or science begins early in the secondary school, when the students enter Form Four. This clearly reflects how important S&T is to the government in terms of producing human capital. Malaysia's Five Year Development Plan has also placed S&T as an important component.

Science and Technology is the pedestal in sustaining the development of a nation. According to Shuib, (2008), in the 8th Malaysia Plan (2001-2005), the government has identified that an increased supply of quality human resources and the enhancement of Research and Development (R&D) as priority areas towards the creation of a knowledge-based economy. With that in mind, emphasis on human resource development in S&T continues into the 9th Malaysia Plan (2006-2010), during which premier universities are expected to focus more on R & D, with the creation of centers of excellence for research. The Ministry of Science, Technology and Innovation (MOSTI) is the lead ministry that formulates policies in the area of science, technology and innovation.

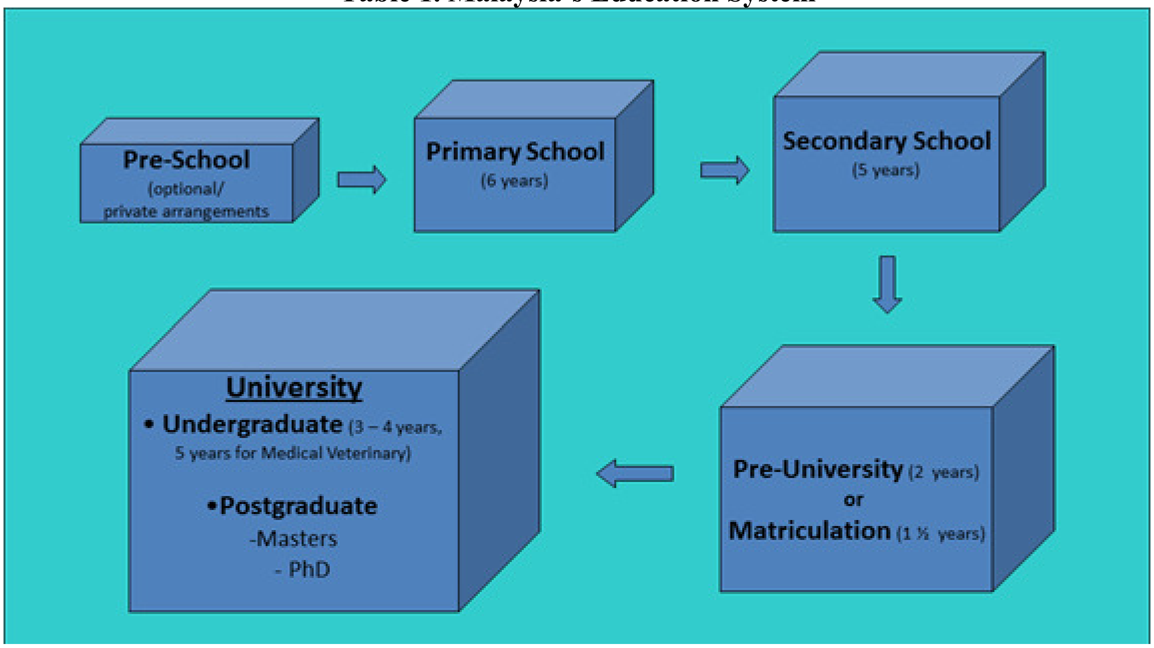
In the recent announcement on 2010 Budget for Malaysia, the Prime Minister, Y.A.B. Dato' Seri Mohd Najib bin Tun Haji Abdul Razak, emphasized on S&T as an important phenomenon towards nation building (Malaysia Budget 2010 Speech, Ministry of Finance's website). This includes intensifying research, development and commercialization (R, D & C), developing green technology, and enhancing highly skilled human capital (develop intellectuals in Science & Technology).

4 WOMEN IN SCIENCE AND TECHNOLOGY (MALAYSIA'S SCENARIO)

The current global phenomenon shows that lower numbers of women participate in scientific and technological careers compared to men. This trend is even more distinct in professional, managerial and leadership positions. Malaysia is not excluded, as the overall female labor participation rate has not increased much in comparison to the number of enrolment in higher education. This trend definitely needs serious intervention, as human capital depends on a larger pool of intellectual to include both women and men. Table 1 shows Malaysia's Education System and the time a student spends at each particular level.

4.1 The Education Scenario

Table 1. Malaysia's Education System



Based on the statistics provided by the Ministry of Women, Family and Community Development (2008), we discover that a higher proportion of boys were enrolled in primary and lower secondary schools compared to girls. The situation changes at the higher secondary, matriculation and pre-university, Diploma, First Degree and Masters, where there are more girls/women than boys/men. However, at the PhD level, the proportion of female decreases compared to male (Figure 1 and Figure 2). Taking the example of the percentage of students' enrolment in one of Malaysia's premier universities; Universiti Putra Malaysia (Table 2), a similar trend is also observed.

This trend, beyond doubt, needs critical efforts in order to examine and analyse the gender imbalance at various levels in Malaysian education system.

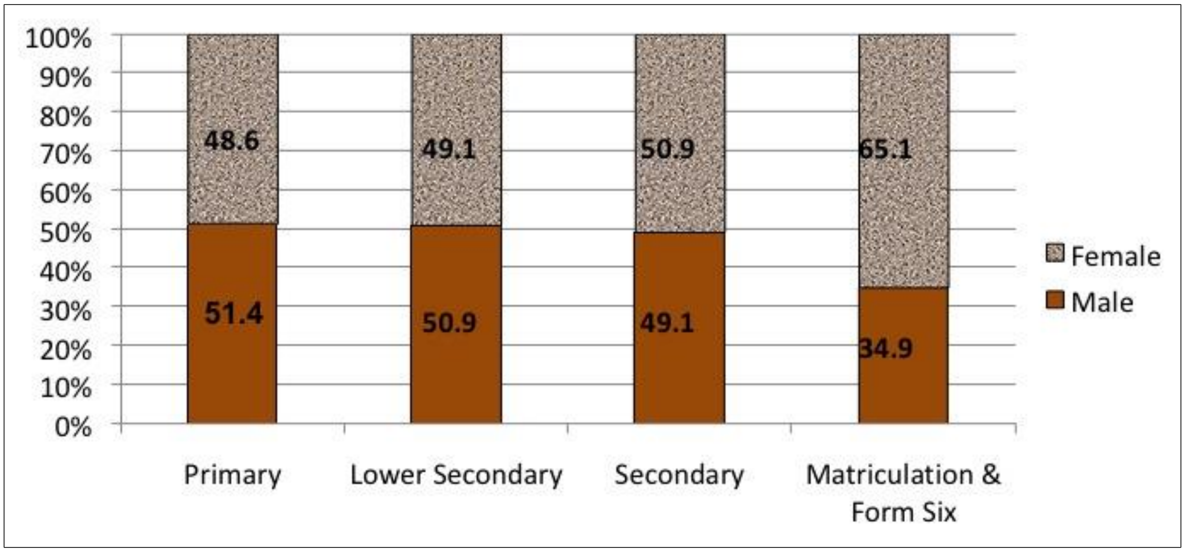


Figure 1. Student Enrolment in Government Assisted Schools by Level of Education and Sex, Year 2007.

(Ministry of Women, Family & Community Development, http://www.kpwkm.gov.my/new_index.php?page=statistic_content&year=2008&lang=eng)

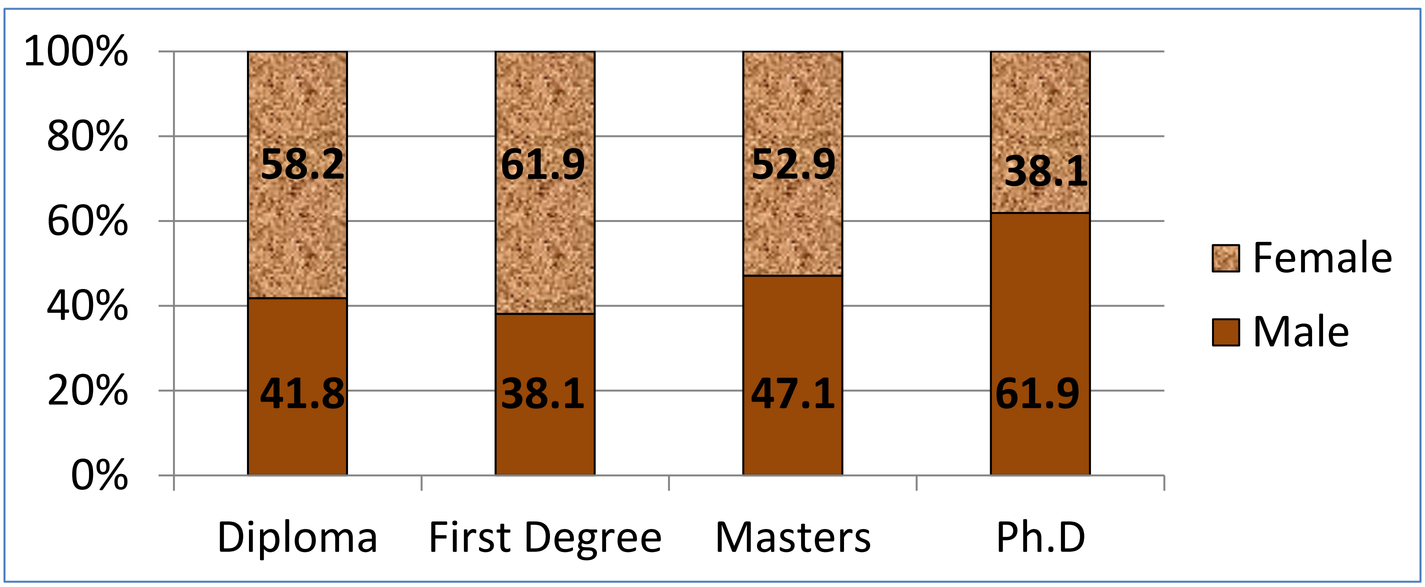


Figure 2. Student Enrolment in Public Higher Learning Institutions by Level of Study and Sex, Year 2007/2008.

(Ministry of Women, Family & Community Development, http://www.kpwkm.gov.my/new_index.php?page=statistic_content&year=2008&lang=eng)

Table 2. Percentage of Students Enrolment in Universiti Putra Malaysia by Cluster (1st Semester 2009/2010)

Cluster	Diploma		Bachelor		Masters		Ph.D	
	Male	Female	Male	Female	Male	Female	Male	Female
Agriculture, Forest, Environment & Food	42.7%	57.3%	32.5%	67.5%	38.1%	61.9%	60.7%	39.3%
Veterinary	-	-	33.9%	66.1%	49.5%	50.5%	63%	37%
Health	-	-	28.4%	71.6%	27.5%	72.5%	45.5%	54.5%
Engineering	-	-	54%	46%	62%	38%	77.1%	22.9%
S&T	-	-	31.2%	68.8%	37%	63%	55%	45%
Social Sciences	-	-	25%	75%	38.2%	61.8%	38.9%	61.1%

(Source: Academic Division, School of Graduate Studies and Graduate School of Management of Universiti Putra Malaysia, 30 November 2009)

4.2 The Workforce Scenario

Women have the drive and capability to succeed in S&T. However, there seems to be a phenomenon whereby the percentages of female begin to wane at the working level (and sometimes at the postgraduate level). It seems that the percentages of women in the sciences decrease as the qualification increases. Figure 3 indicates that overall female labour participation rate in Malaysia has not increased much, though the number of enrolment of females in higher education has out-numbered males. This shows that the life span of women workforce is shorter than men, though biological life span is higher than men.

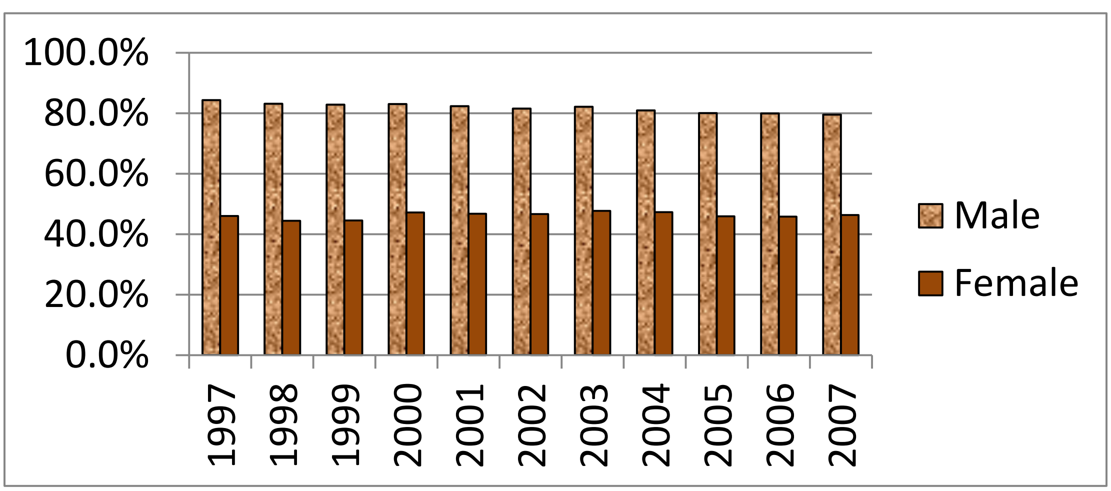


Figure 3. Labour Force Participation Rate by Sex, 1997-2007.

(Ministry of Women, Family & Community Development, http://www.kpwkm.gov.my/new_index.php?page=statistic_content&year=2008&lang=eng)

4.3 Malaysian Women in S&T

The end of World War II marked the beginning of Malaysians' (then Malayans') inspiration to start a new life, inspired by their will and belief, and realization in pursuing progress for the betterment of the country. Women and men together have researched and solved each emerging need since then! But, current phenomenon shows that higher proportions of men are involved in scientific and technological careers compared to women (Figure 4). Figure 5 also shows that there are more men than women as Fellows of Academy Sciences Malaysia.

However, we cannot deny the fact that the Malaysian Government has never put a barrier for women to be involved in S&T. There has been an increasing number of renowned women scientists spearheading cutting edge research programmes, such as in the fields of biotechnology, astronomy, vaccine development, diagnostics and many more.

Malaysia needs more researchers, scientists and engineers in order to sustain its development, regardless of the same being women or men.

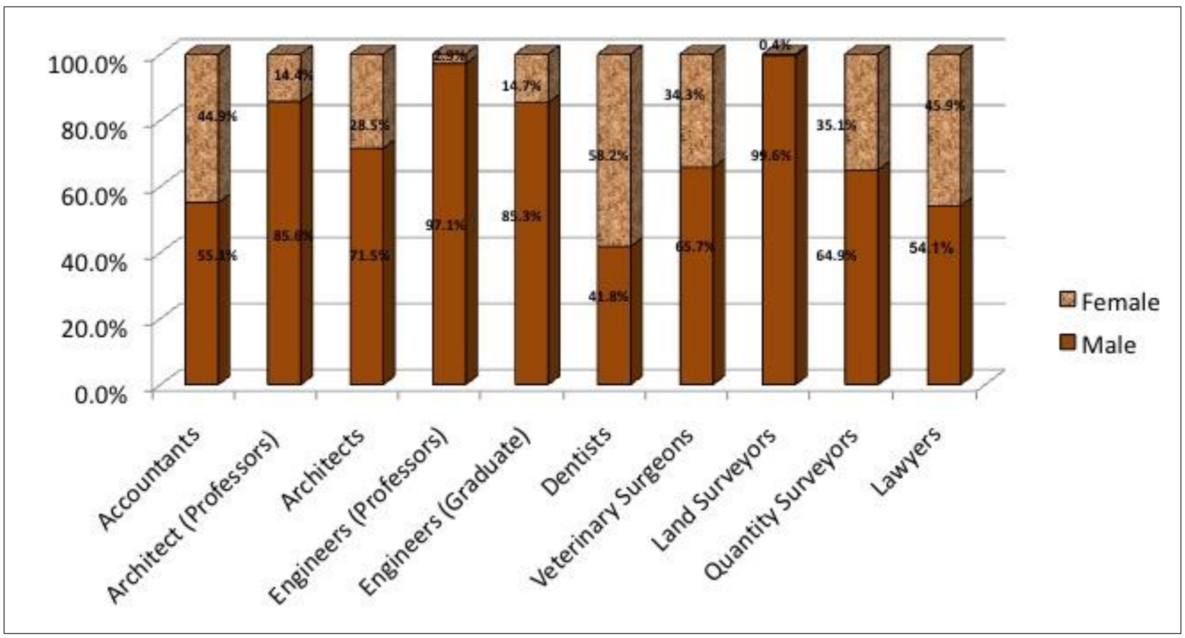


Figure 4. Number of Registered Professionals by Sex, Year 2007.

(Ministry of Women, Family & Community Development, http://www.kpwkm.gov.my/new_index.php?page=statistic_content&year=2008&lang=eng).

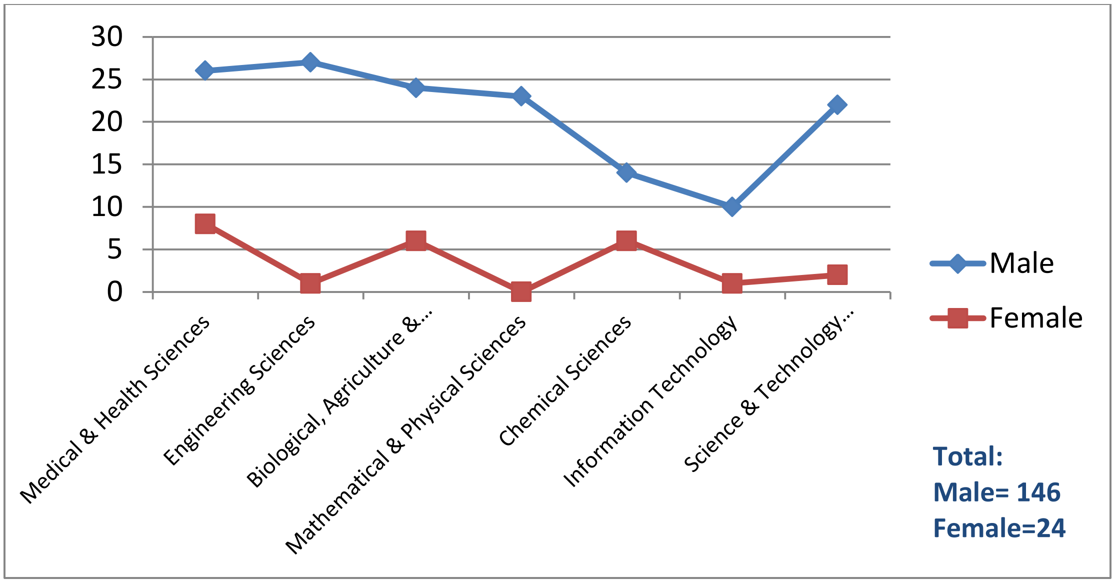


Figure 5. Statistics of Women vs. Men as Fellow Academy Sciences, Malaysia, Year 2009.

(Academy of Sciences Malaysia, http://www.akademisains.gov.my)

5 WAY FORWARD: ACTIONS TO INCREASE THE VISIBILITY OF `WOMEN IN SCIENCES'

According to UNESCO's website, the average percentage of presence of 'Women in Sciences' in the world is 27%, while in Asia it is 15%, West Europe 27%, East Europe 42% and Latin America 47%. The low percentages indicate that the government needs to take gender challenges in S&T seriously. In Malaysia, currently, there is no policy that addresses gender proportion in S&T workforce, thus the gender gap may remain status quo. Therefore, an action plan has to be firmed up with 'political will' playing an important role.

To move forward, women need to be included in all spheres, in particular decision-making levels. Extensive amount of support activities need to be carried out by the government and private institutions. This includes the establishment of more recognition and prizes for women in sciences, financial support to develop projects and programs on promoting women in science, and structural changes need to be implemented. According to Londa Schiebinger, the John L. Hinds Professor of History of Science at Stanford University and Director or Stanford's Clayman Institute for Gender Research:

> *Programmes aimed at increasing numbers of women in science generally attempt to fix the women… to make them competitive…But that is not enough…you also have to fix the administration …"*

There seems to be a phenomenon of gender-tracking or gender-streaming by female students into subject areas which are seen to be easier or perceived to be more feminine (Shuib, 2008). Consequently, corrective actions need to be done to eliminate these biases. It is therefore important for female students to realize their potential in S&T during their school days. At that stage, students should be given as much exposure in order to excel in S&T and to continue further on in their working life.

Higher Education Institutions (HEI) play an important role in promoting greater participation of women in sciences. HEI should therefore also act as incubator facilities for students who wish to try out innovative proposals while they are still in undergraduate programmes.

6 CONCLUSION

It is unquestionable that S&T is an indispensable tool for sustainable development in the quest for the 'knowledge society' of a country. Identifying the best, brightest, and most innovative science and technology talent will be crucial if the nation's industries and the nation itself are to maintain their competitive edge. Thus, S&T require more attention and support, including the participation of women (equal access).

In Malaysia, the gender issue has not been a barrier for women to be involved in S&T. It is manifested by the increasing number of renowned women scientists spearheading cutting edge programmes, such as in the fields of biotechnology, astronomy and vaccine development. Countries would not be able to aspire for development if women are not given the equal access in S&T, especially at decision making level. However, available data shows that the participation of women in S&T at the higher level is less than men. The low percentage of women in the workforce for S&T requires proper analysis of the available data.

7 ACKNOWLEDGEMENT

The author would like to acknowledge Ms Norhasliza Hassan for her technical assistance.

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Women and Science in the Public Sector: Future Outlook

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and
KHALID YUSOFF[2]

1 ABSTRACT

The increasing role of women in various levels of the community commensurates with and is a measure of the enlightenment of the society. Education which has previously been restricted for women has now been opened to them, and they are showing great enthusiasm and achieving much success, even up to the tertiary level. Science which has been foreign to women is now being much taken up by them. What has ushered in this transformation? What can be expected of this new awakening? These and other questions will be deliberated in this paper.

2 INTRODUCTION

Islam was revealed through proclaiming the importance of Knowledge; the first revelation was "Iqra" or "Read". Whilst the immediate recipient of the edict was the Prophet Muhammad S.A.W. himself, the order was gender neutral in that it applies to both males and females, regardless of who or where they are. Nonetheless, moving away from the Golden Age of Islam, local practices and customs, tended to shroud the true Islamic teaching such that various restrictions including education were imposed on the women folk, as was common in those *other* cultures. This however, tends to give rise to misconceptions about Islam, and of late feeds, much fuel to Islamophobia. Yet Islam came to liberate women and held them up in high esteem. Not only were they given the right to property but they also had the right to inheritance. That was a far departure from the prevailing practice in those days, 15 centuries ago where often *they* were the properties and *they* were the subjects of inheritance. In public life, Siti Khadijah R.A. was a prominent and prosperous merchant whilst the views and pronouncements of Siti Aishah R.A. were much sought after and awaited for (thus she was in practice, a jurist). A woman even dared in public to differ with the opinion of the khalifah who was none other than the fearful and forthright Omar al–Khattab R.A., who even the Prophet S.A.W. commented that even the *Shaitan* would prefer to avoid him. And what was the response of Omar R.A. to that woman? He said “Today, the Khalifah is wrong and the woman is right”. And lest we forget, the Prophet S.A.W. reminded us that ‘Heaven lies under the soles of mothers''. Truly Islam has not only elevated the stature of women but provided avenues for them to significantly contribute to the society in the home and in public. For those among us who aspire to bring back the glory of Islam, we need to bring back that glory and civilisation in all its totality, women included.

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3 WOMEN IN HIGHER EDUCATION

With the society's enlightenment, women are getting more involved in everything, including education, public service and inevitably science. The historian, Naomi Oreskes observed recently, “The question is not why haven’t there been more women in science? The question is rather why have we not heard more about them?” That remark was despite phenomenal contributions to science by women. Marie Curie made significant contributions to the understanding of radiation and became the first woman to win the Nobel Prize in 1903 (which she shared with her husband Pierre). Barbara McClintock won the Nobel Prize in Physiology/Medicine in 1983 through her discovery of the process of transposition and used it to demonstrate how genes are associated with the presence or absence of certain physical characteristics in human beings. She is one of the world's most famous cytogeneticists. So far though, only 40 women have won the Nobel Prize out of the 802 individuals and 20 organisations over the past 60 years.

Yet, 2009 saw a record of five women out of 13 winners: Herta Mueller for literature, Elinor Ostrom won the Nobel Memorial Prize for analysis of economic governance to help scientists make better use of their scientific discoveries; Elizabeth H. Blackburn and Carol W. Greider shared the prize for Medicine/Physiology with Jack W. Szostak on how chromosomes protect themselves from degrading while cells divide through their work on telomeres and telomerases and Ada E. Yonath for work on the ribosome structure and functions.

Interestingly the performance of women in the Nobel Prize seems to reflect on their performance at institutions of higher learning (Figure 1). In 1999, men were getting progressively better in postgraduate studies, which became translated into academic careers such as professors in universities. On the other hand, during that same year, although women tended to perform better at undergraduate studies, they progressively performed less well at postgraduate studies and this was reflected in their academic careers. Four years later (in 2003) there was no change in the performance of men and women in higher education.

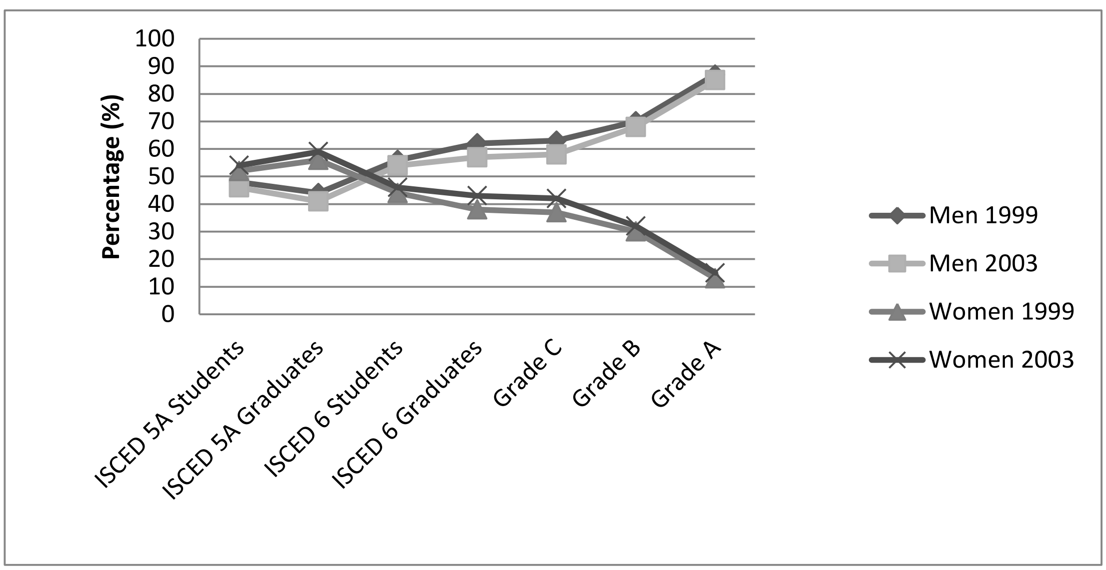

Figure 1. Percentages of male and female in higher education in the European Union countries (in all disciplines) in 1999 and 2003

(She Figures 2006, EC pp 55)

In science, engineering and technology (SET), a similar trend is seen. Of note, more men than women take up SET in the universities. The disparity between men and women may be worse off in the industry. Almost 70% of the undergraduate intake in SET is men. More men take up SET and more women take up the humanities and the social sciences. Moreover, at the first stage of their career (up to grade C), the participation levels remain almost constant where men predominate. Further, at the more senior levels, the divergence between men and women is progressively enlarging (Figure 2). Worse still there does not seem to be a change in the profile between 1999 and 2003.

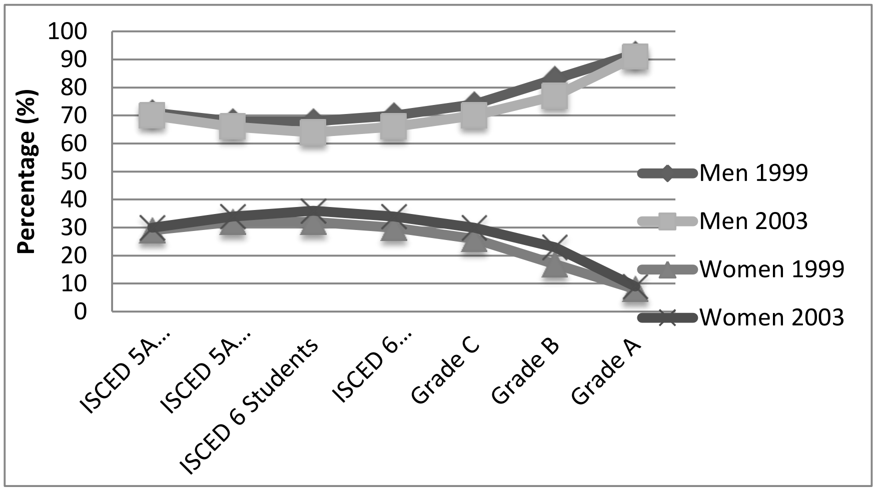

Figure 2. Percentages of male and female in Science, Engineering and Technology across the European Union in 1999 and 2003.

(She Figures 2006, EC pp 56)

Additionally, there is a preferential difference in the various sectors between the genders. Males tend to take up physical sciences while females tend to take up life sciences (Table 1). It is interesting to note that in this year's Nobel Prize, three women compared to one man won prizes in the life sciences. The next revolution in sciences is thought to be in the life sciences. If women are more adapt to the life sciences perhaps more women should be encouraged to take up life sciences.

Table 1. Proportions of female PhD (ISCED 6) graduates in 2003

	Science, Maths & Computing	**Engineering, Manufacturing & Computing**	**Agriculture & Veterinary**	**Health & Welfare**
EU-25	40.0	21.9	49.6	51.1
United Kingdom	41.9	19.6	45.2	52.4
Japan	19.9	9.2	24.7	25.7
USA	35.5	18.0	36.8	68.5
Turkey	34.8	28.9	39.8	62.6

(She Figures 2006, EC, pp 39)

5 WOMEN IN THE PUBLIC SECTOR

Women's participation in the workforce especially in the public sector is much to be desired. In recent years though, they have made significant advances in higher positions. For example the involvement of women in senior management in the public sector in Australia (Figure 3) shows a gradual improvement for women in the higher management from 2003 to 2007. Yet each of the three tiers of women's involvement is consistently below 50% and the higher tiers have much lower women representation than the lower ones.

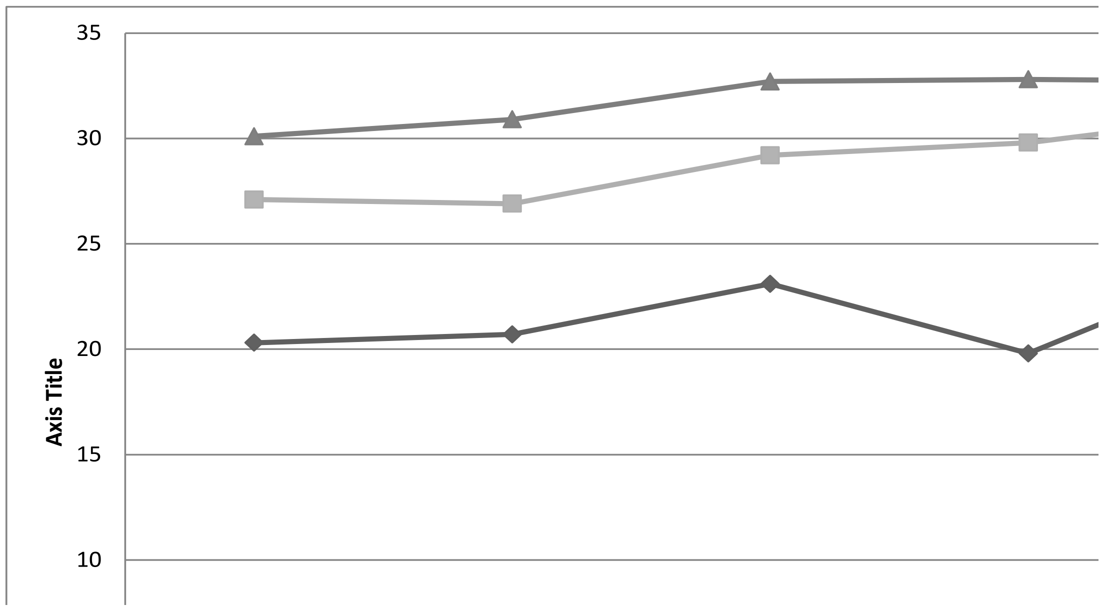

Figure 3. Women in Senior Management in Public Sectors in Australia in 2007.

(DFCSIA, 2007)

The question that needs to be answered is, "Why is this so?" and it can't be just for raising families! Figure 4 illustrates the situation in the private sector in a German company, Schlumberger (Gould. 2003). The representation of women in senior management improves from 1980 over the next 3 years. Yet women still trail behind men in higher senior management. Interestingly, at least in this company non-Western women tend to do better than Western women. The question that needs to be asked is "What are the underlying explanations for this trend?'

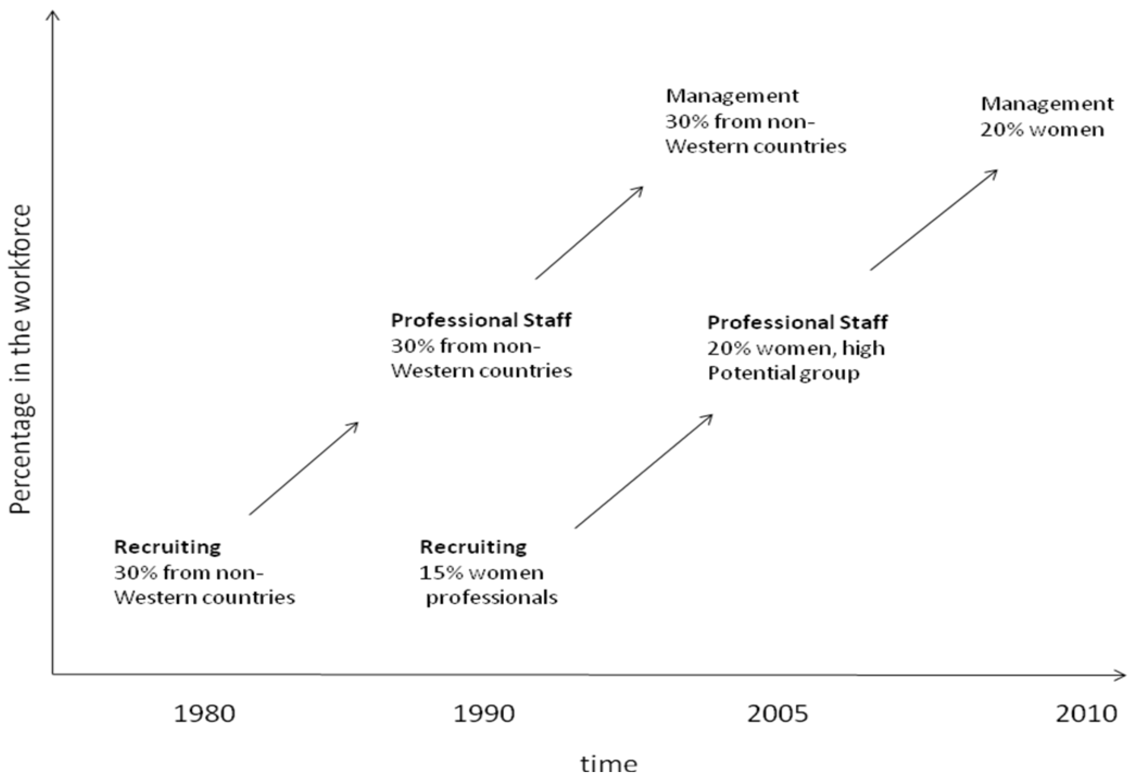

Figure 4. The percentage of women in the workforce in the industry.

(Gould, 2003)

There is an accelerated loss of women with talents from our science system in mid-career when they are most productive; this represents an abundance of wasted talent. Taking leave to start a family might be an obvious reason. The question is, “Is that all that there is to it?” We need to find out more to overcome this unremitting waste of human talents. Further, are these trends seen in the West operative in the developing world and for the wider Muslim world?

Even in politics, the number of women elected to parliaments is low even though there is a large variation between countries (Figure 5). There are a number of explanations for this overall performance profile of women in public service, which includes stereotyping, changing roles in the family, glass ceiling and first pass effect.

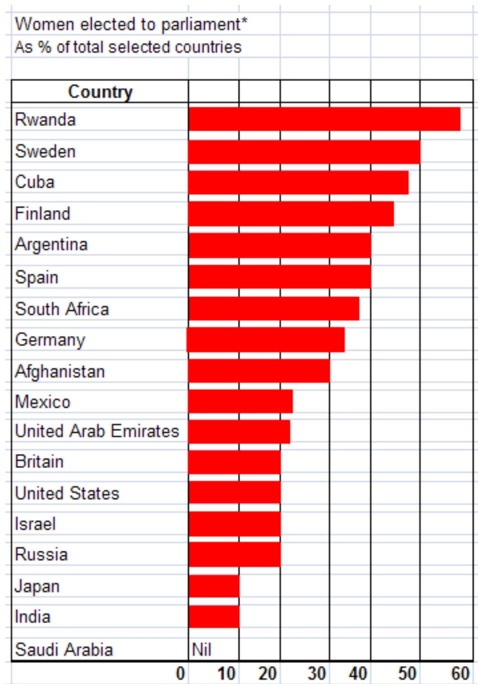

Figure 5. The number of women members of parliaments in 2008.

(Inter-Parliamentary Union, 2008)

5.1 Stereotyping

Stereotyping between the genders has been a powerful albeit insidious influence on career choices. The conventional wisdom that 'Males tend to take charge while females tend to take care' is often reflected in the career structure for men and women (Faulkner, 2000). One assumption is that the stereotype of engineers as being logical, rational, machine-oriented people does not fit with the self image of women as "people-oriented". It was assumed therefore that women are less attracted to S&T. Wachter (2005) showed that women are more attracted to inter-disciplinary engineering curricula as opposed to the standard curricula where there is a stronger social and environmental emphasis on technology. However, in seven European countries, one third of engineering students preferred non-technical subjects and contrary to expectations there was only a slight gender difference. At the same time, there were substantial differences between countries: French and Finnish students were satisfied with the existing curricula whilst Austrian and Greek students preferred more non-technical subjects.

5.2 Changing Roles in the Family

In industrialized societies, men were breadwinners and women were care providers, just like their forefathers from time immemorial. However, in the globalised ICT and high speed broad-band connected world of today, the interface between breadwinner and care-provider roles becomes blurred and even inter-changeable. More women now are working and they are working longer hours and working further afield from home, while others are working more from home. Companies are now confronted with women and men who are dedicating their lives less to their careers and more to their families. Flexibility and time sovereignty are critically important for modern workers. In this context, the workers need to feel supported and able to manage the quantity, quality and conditions of their work. Their share of family responsibilities is such that employers cannot now expect an unlimited presence at work. This provided new challengers and result in new issues for the management. Modern management structure needs to address this new social reality.

5.3 Glass Ceiling

There is still the invisible barrier to advancement that prevents women from attaining the higher levels in management both in public and the private sectors. This is called the Glass Ceiling. Women tend to be more cautious about taking career risks than men and are more conscious of the perception of quota compliance or making the numbers rather than a promotion truly based on merit. Thus women tend to be less assertive and less likely to demand for promotion than men.

5.4 First Pass Effect

Men have the advantage of the "first pass effect' where they tend to occupy the seats of power or senior management earlier and in greater numbers than women. Birds of the same feather tend to flock together; it is natural that men tend to promote men over women. Therefore, there are considerable serious roadblocks, especially for those women with the higher creative ability and the best leadership potential. To effect a change we need firstly to acknowledge these unequal and unjustifiable scenarios. Effective measures should then be crafted and implemented because this is a massive loss of talents which we cannot afford if our future is to be based on knowledge, innovation and technological advancement. We can change, if we want to!

In Malaysia, only two out of the 28 ministers are women; that is less than 10%. The number of women at the decision-making level in the public sector is less than 20% and in the private sector, the situation gets much worse. However, at the Ministry of Science, Technology and Innovation, the picture is rather different. It is a highly creative ministry well suited to address the challenges of the 21st Century. It has undergone considerable systematic and fundamental changes in structure and function to enable it to be the engine which promotes science, technology and innovation in the country. Whilst the Minister and the Deputy Minister are both men, the top management at the Ministry of Science, Technology and Innovation of Malaysia (MOSTI) is being handled mostly by women. Among the second tier management, more than 50% are made up of women (Figure 6). This Ministry has been given considerable tasks in enhancing science, technology and innovation in this country and even to support the vision of the Prime Ministry for a transformation of the economy into an innovation-led high-income economy. Thus, if a Ministry can have such a structure and such a make up of its top management in Malaysia which is a Muslim country, it is a wonder why other Muslim countries should not reconfigure their management profile. In the current highly competitive and interconnected world pushed forward by the ubiquitous ICT, being innovative and creative are essential. John Adair reminds us that 'innovation is more than having new ideas; it turns ideas into useful, practicable and commercial products and services'. Einstein once remarked that madness is doing the same thing over and over again, and expecting a different result. Women have shown their ability for S&T. It is incumbent on management to recognise this and provide avenues for women to further accomplish in this field, thus gaining on their potentially huge contribution to the community.

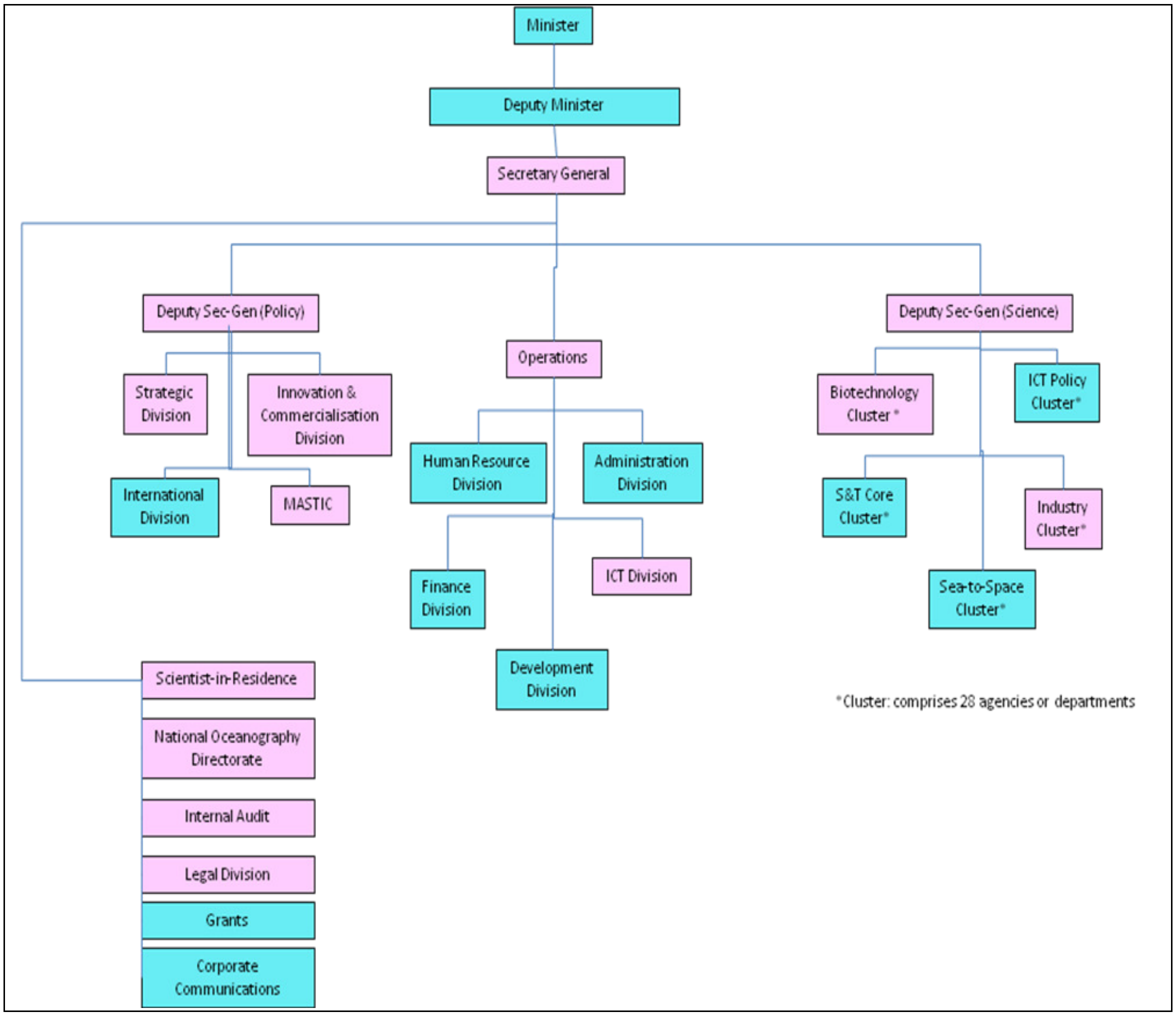

Figure 6. The number of women senior officers at the Ministry of Science, Technology and Innovation Malaysia. The blue boxes are headed by males and the pink boxes are headed by females. The Ministry comprises 28 agencies and departments which are under specific clusters.

6 DEVELOPING TALENTS – EQUALITY OF OPPORTUNITY

Talent is central to the current socio-economic potential, regardless whether it resides in women or men. We need to address these questions in order to explain the scenario and help provide the means to improve the picture: i) how to allow talents of everyone, women included, to flourish?, ii) how to discover such talents?, iii) what is required to nurture and cultivate such talent?, iv) what are the expected outcomes?, v) what long-held views need be adjusted or even discarded to ensure the revival of the Islamic Civilization?

6.1 Framework and mind set

Talent is a big word. For instance, infrastructure and tax have been used to be the main attractions for Foreign Direct Investment (FDI). However, in the new globalised world powered by innovation, it is the talent that foremost attracts FDI. Therefore, central to developing and nurturing talents, is equality of opportunity and to realize that the community has to provide a framework and adopt a mindset to make it happen. For instance, talents cannot be identified with particular sectors of the society: the urban vs the rural, the rich vs the poor, one ethnic group vs another, women vs men etc. The society needs to accept talent where it is, as it is, regardless of where it emanates from and moves to.

6.2 Awareness for transformation

Thus, preconceived ideas, bigotry or even conventional wisdom may need to be re-examined afresh. If the society is not willing to question itself, its own history and its long-held practices and firmly held beliefs, the society is really not ready for the new evolving and challenging world where talents count most, where science, technology and innovation will have more influence. Nonetheless, if a society is not ready for the new world, it does not mean that other societies are not shaping up and readying themselves for the new world. The need for transformation of the society's awareness and readiness is thus self-evident.

But the awareness for transformation should trickle down from the society as a body to individual members of the society, particularly so among the next generation. Issues such as how to engage the young generation, school children and students in institutions of higher learning to be aware of the need for transformation, must be addressed in order to instill a culture of open-mindedness, an eagerness and a curiosity to learn something new and something more about the world, and be comfortable with communication of ideas and needs. Creation of a generation of inquisitive and innovative minds is essentially important unless the wish is to have next generation as mere followers of the current practices or even follies.

6.3 Family support and supportive family

The family is of course the fundamental unit of the society. As such, it is the interest of the society to ensure that families are adequately supported in housing, hygiene, health, food, education, finances, entertainment, leisure and recreation. Here the woman has her traditional role to ensure the stability and success of her family.

6.4 Dare to risk

Dare to risk failure is necessary for success. Not all scientific experiments will turn out to be successful or as expected. Nonetheless, each failure is a lesson in itself. The Wright brothers did not fly off the ground on their first attempt or even on their tenth. Nurturing the ability to manage failures and to pick up from a fall is a necessary prerequisite for a successful scientist. In nurturing the family, there is a substantial role for women to instill such a character.

6.5 Infrastructure–education, finance and institutions

Infrastructure, is the mechanics required to get everything done. The community should be prepared to invest in education right from the very beginning and not just focus on developing top university. In addition, adequate quality schools, teachers, curriculum and finance are essential components for good science. A system of recognition, awards and rewards based on merits and potentials would be a strong motivator.

7 CONCLUSION

There are undoubtedly various issues to be addressed to facilitate the participation of women in science in the public sector in the future. Much needs to be done and much can be achieved. As a responsible driver of science, technology and innovation in the Islamic world, members and fellows of the IAS and the IAS itself should move forward to ensure women's active contribution to the world of science. The following, which can be done seamlessly and almost effortlessly, will start the ball rolling:

- Placement of women scientists in laboratories headed by IAS fellows;
- Creation of a network of IAS laboratories to support young scientists especially women;
- Lobbying for scholarships for women in science and management of science in the respective countries;
- Negotiate places in established world renowned centres of excellence; and
- Creation of Reaching-out and Reaching-in programmes.

8 ACKNOWLEDGEMENTS

Special thanks to our colleagues, Nik Ahmad Faizul Abd Malek, Nurazizah Tamsi, Johan Iskandar Poole-Johnson, and others who have helped in this manuscript.

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Malaysia-Imperial College Proteomics Research and Training Programme for Young Scientists in the Islamic World

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ABSTRACT

Proteomics is the characterization of complex protein mixtures by combining the skills and techniques of protein chemistry, mass spectrometry and bioinformatics. Proteomics has become the most powerful tool for large-scale analysis of heterogeneous protein mixtures. Realising the importance of proteomics in research and education Prof. Abdul Latif Ibrahim, International Islamic Academy for Life Sciences and Biotechnology, Malaysia and Dr. Judit Nagy, Imperial College London developed the above training and research programme. Proteomics research conducted in Malaysia is carried out in collaboration with the proteomics facility within the Institute of Biomedical Engineering, across-faculty centre at Imperial College London, UK.

The objectives of the programme are:

- To acquire capability and develop expertise in the application of proteomics research and upscaling production of enzymes of industrial importance through strategic alliance with Imperial College;
- Transfer knowledge and skills from Imperial College to be utilized to solve problems in Malaysia and to benefit the Malaysian national biotechnology industry and environmental bioremedation; and
- Partnership with Imperial College on human resource development programmes through specialized training programmes and joint PhD programmes.

This programme can serve as a model for countries in the Islamic world to develop educational and research programmes through partnership and networking with countries in the North, This was emphasised in the IAS-Malaysia 2005, Kuala Lumpur Declaration. We will be happy to share with the IAS our experience in planning and implementation of the programme

Figure 1. Imperial at a Glance.

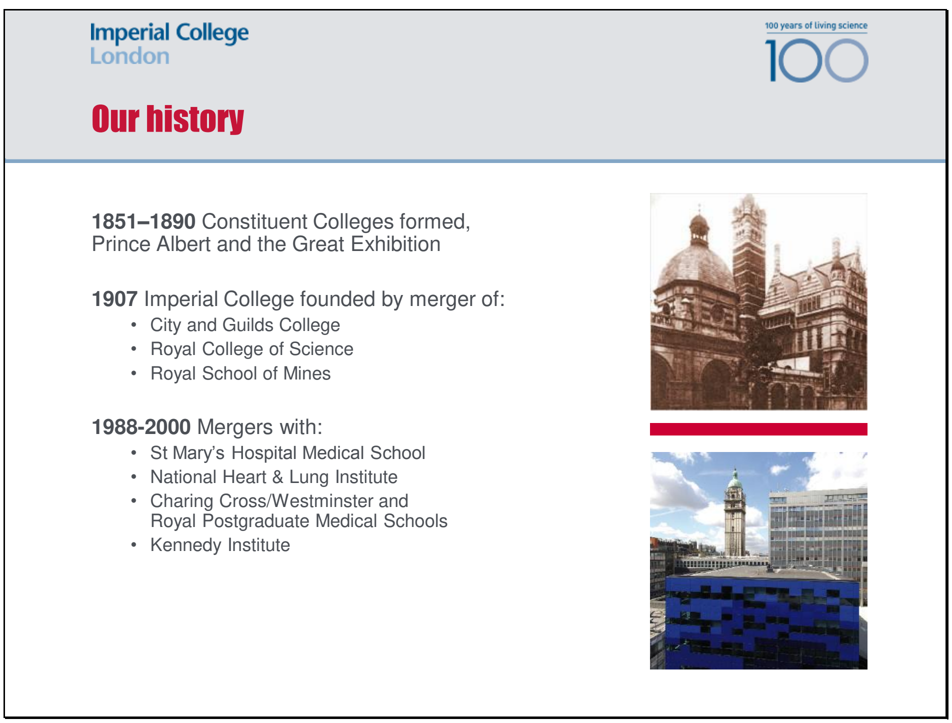

Figure 2. Our History.

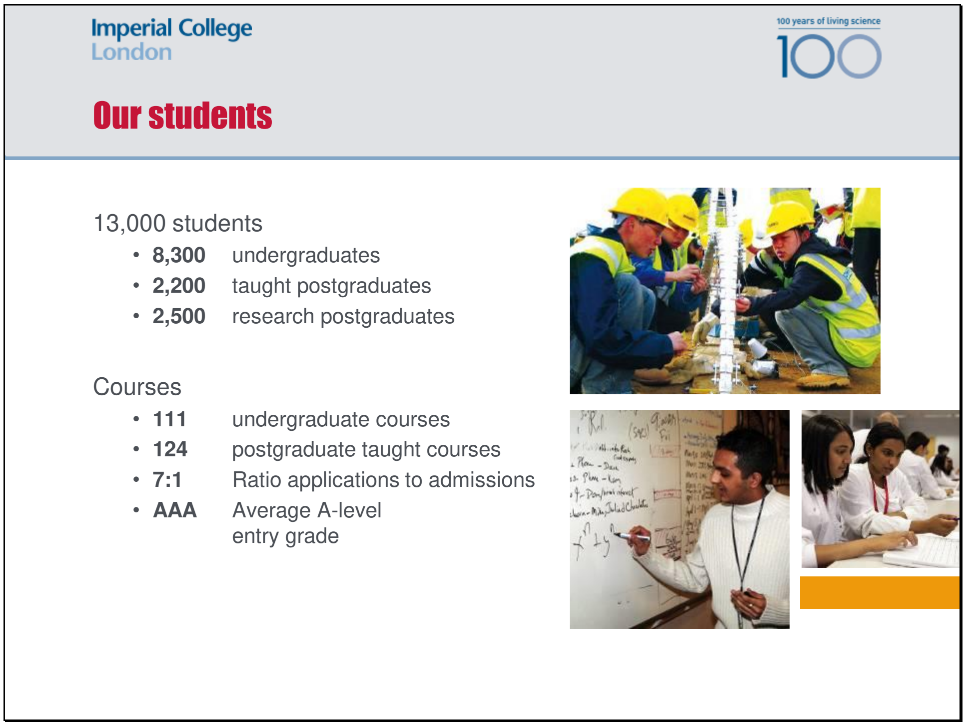

Figure 3. Our Students.

Figure 4. An International Institution.

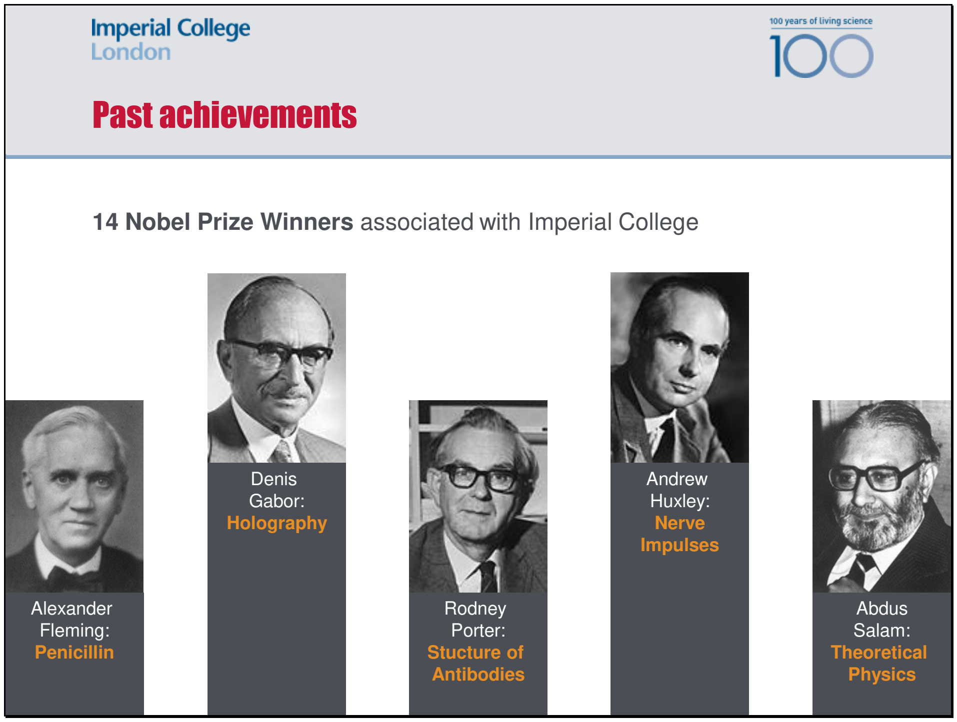

Figure 5. Past Achievements.

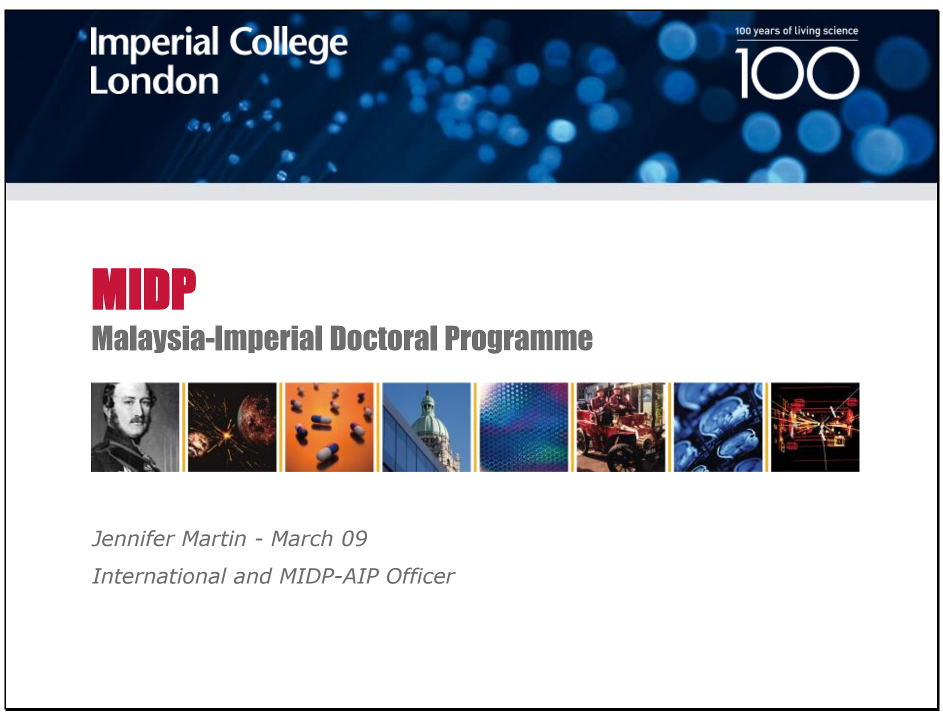

Figure 6. Malaysia- Imperial Doctoral Programme (MIDP).

Imperial College London

100 years of living science 100

MIDP - based on the Spit PhD model

- Imperial PhD

- Collaborative programme between Imperial & Malaysia (UM, UKM, UPM, UTM, USM)

- Joint supervision
  - Main supervisor - Imperial
  - Co-supervisor - Malaysian university
  - Supervisor exchange visits

- 3-4 years' study

-12 months minimum at Imperial
  - Remainder of time based in Malaysian university

- Capacity of programme 25 students per year

Figure 7. MIDP – based on the Spit PhD Model.

Imperial College London

100 years of living science 100

MIDP Programme currently

- 2006/2007 2 students (USM and UKM)

- 2007/2008 2 students (UPM, UM)

- 2008/2009 4 students (UPM, UKM, UM
  - 13 applicants

- 2009/2010 12 current applicants (UTM, USM, UM, UPM, UKM)

- Other students (3) started but transferred to full programme

Figure 8. MIDP Programme Currently.

Figure 9. Postgraduate Studies at Imperial: Training.

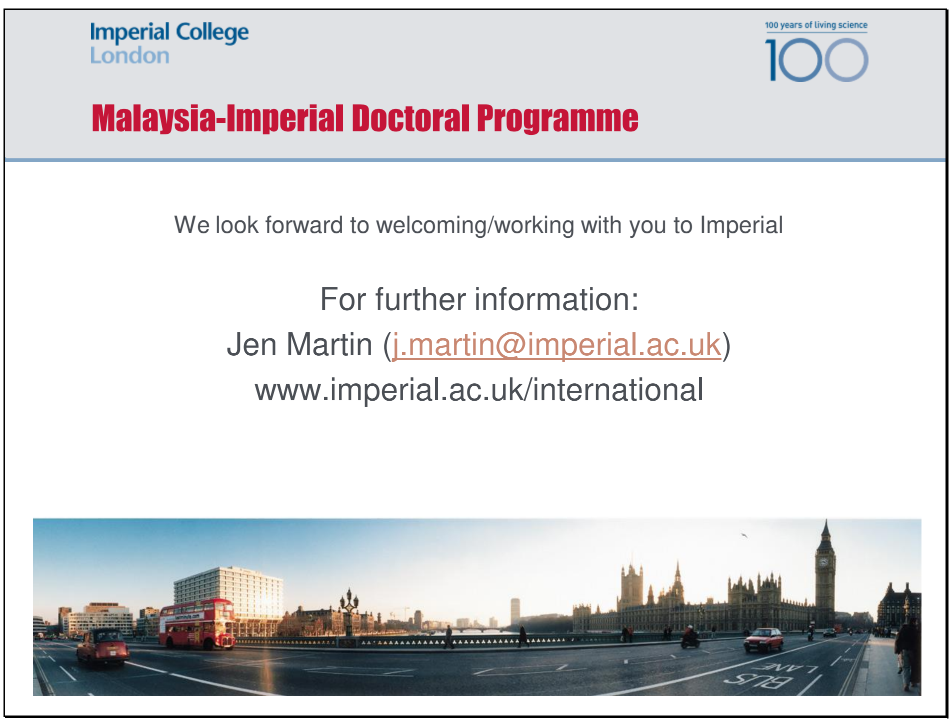

Figure 10. Malaysia-Imperial Doctoral Programme.

Figure 11. Additional Opportunities.

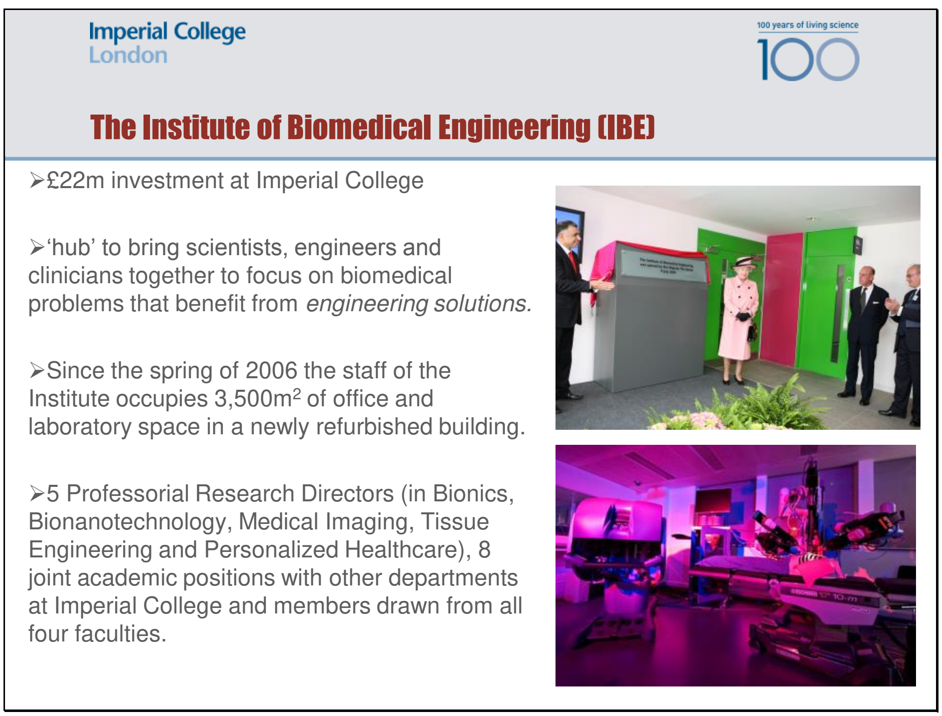

Figure 12. The Institute of Biomedical Engineering (IBD).

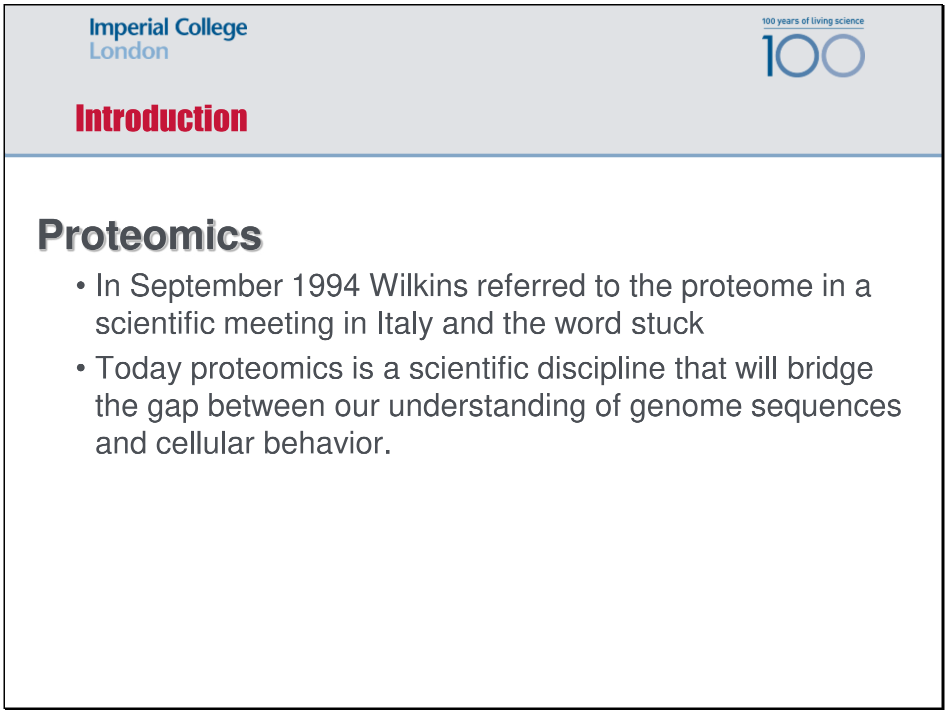

Figure 13. Introduction.

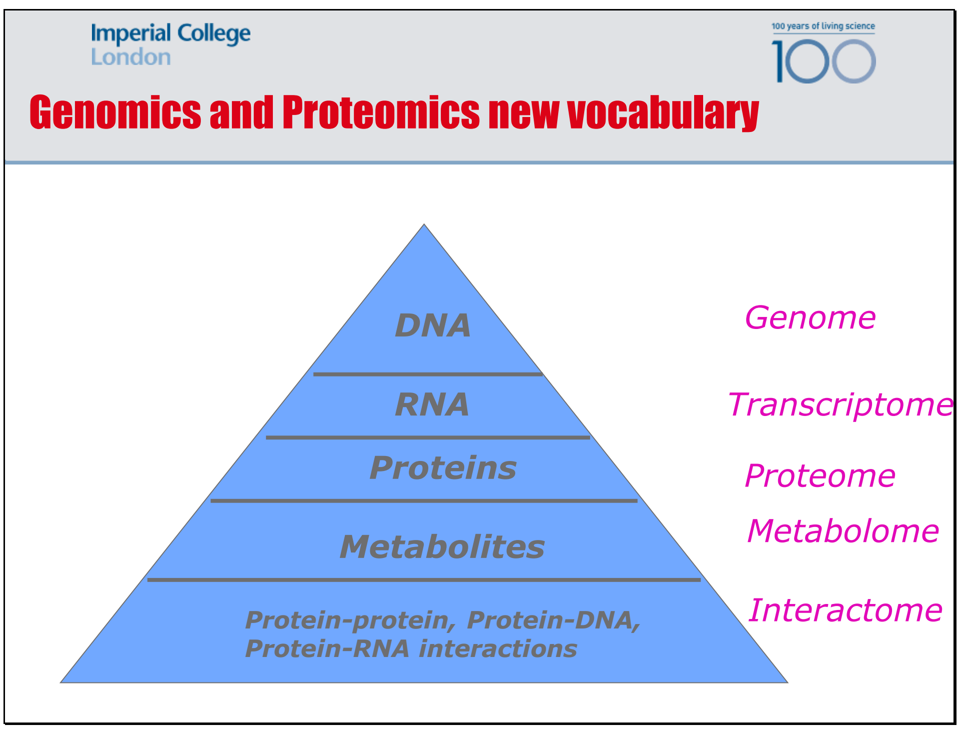

Figure 14. Genomics and Proteomics New Vocabulary.

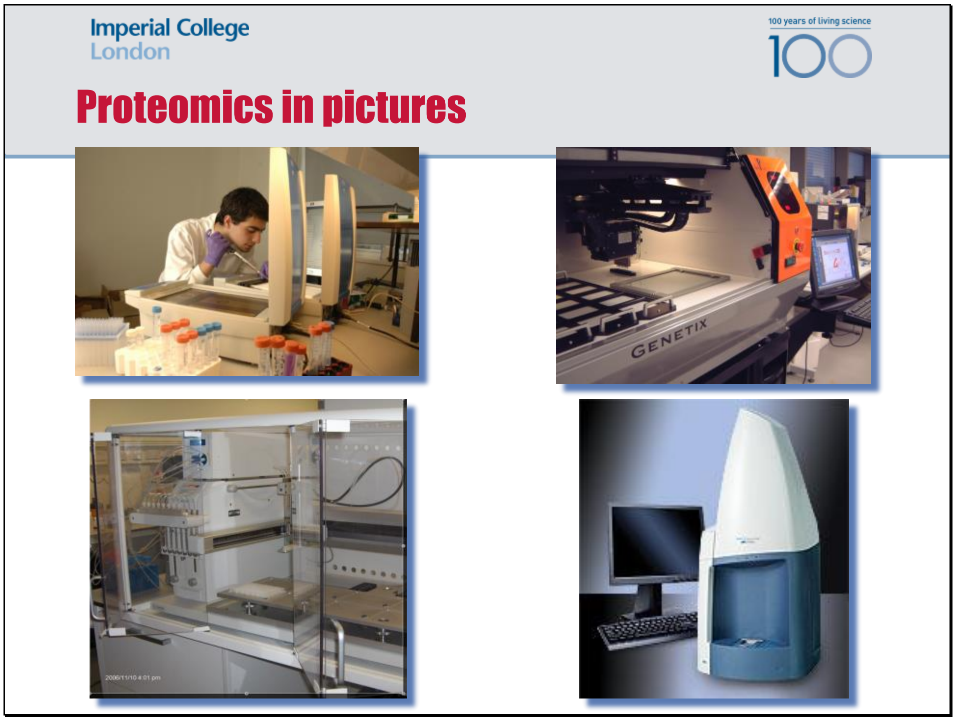

Figure 15. Proteomics in Pictures.

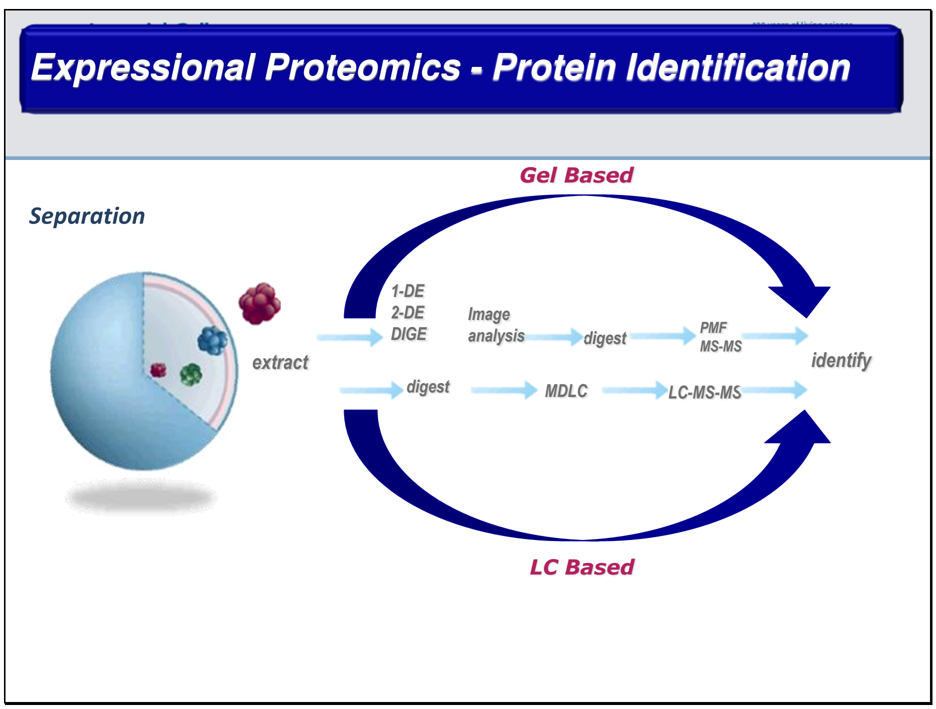

Figure 16. Expressional Proteomics – Protein Identification.

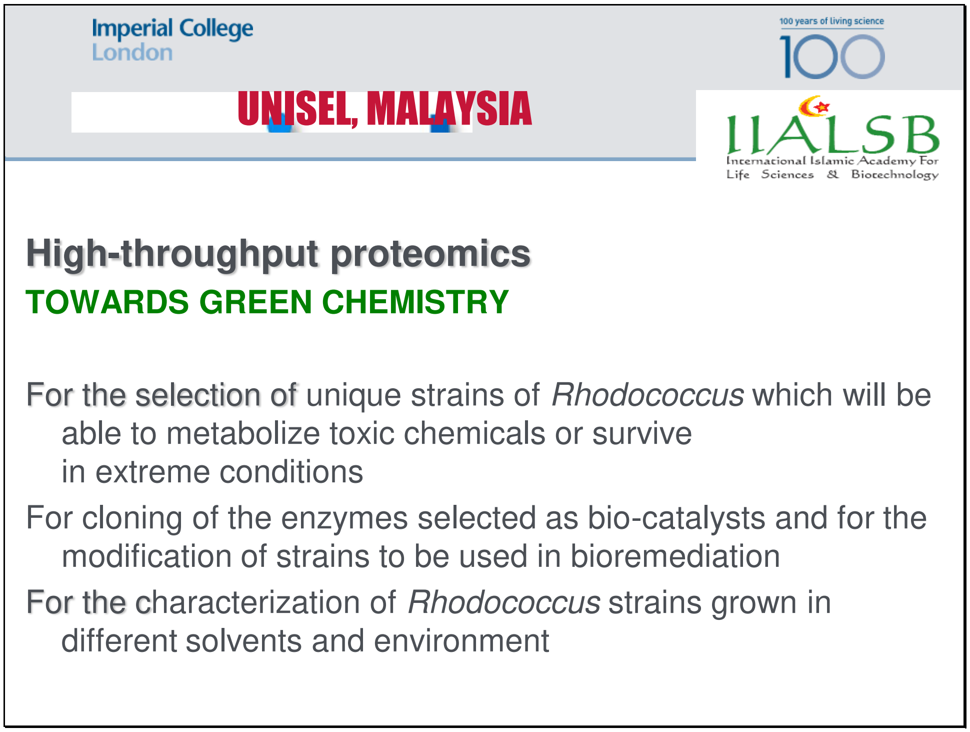

Figure 17. UNISEL, Malaysia.

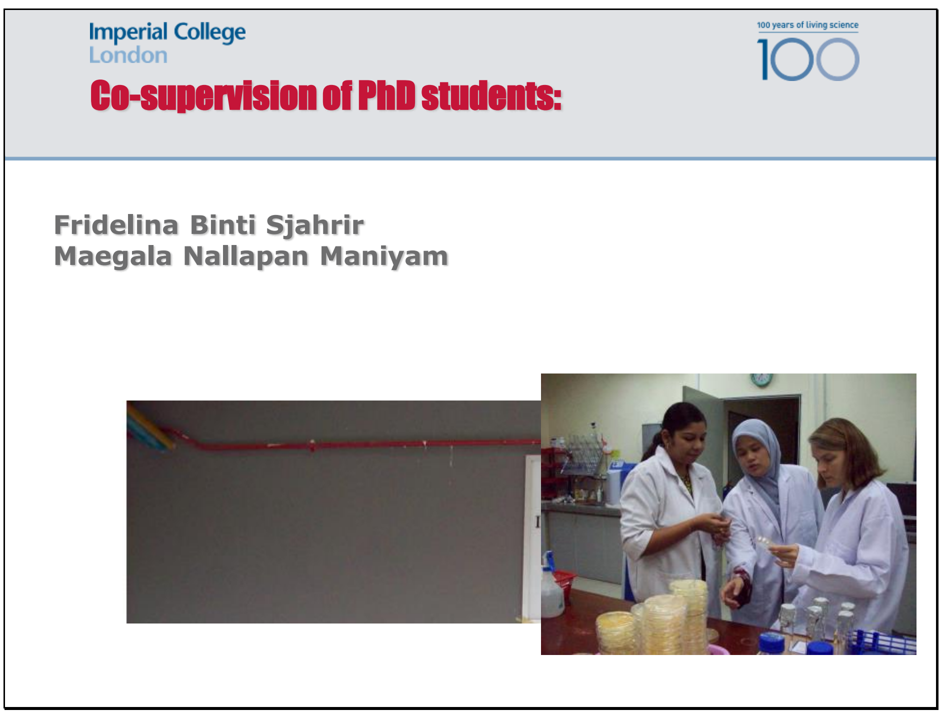

Figure 18. Co-Supervision of PhD Students.

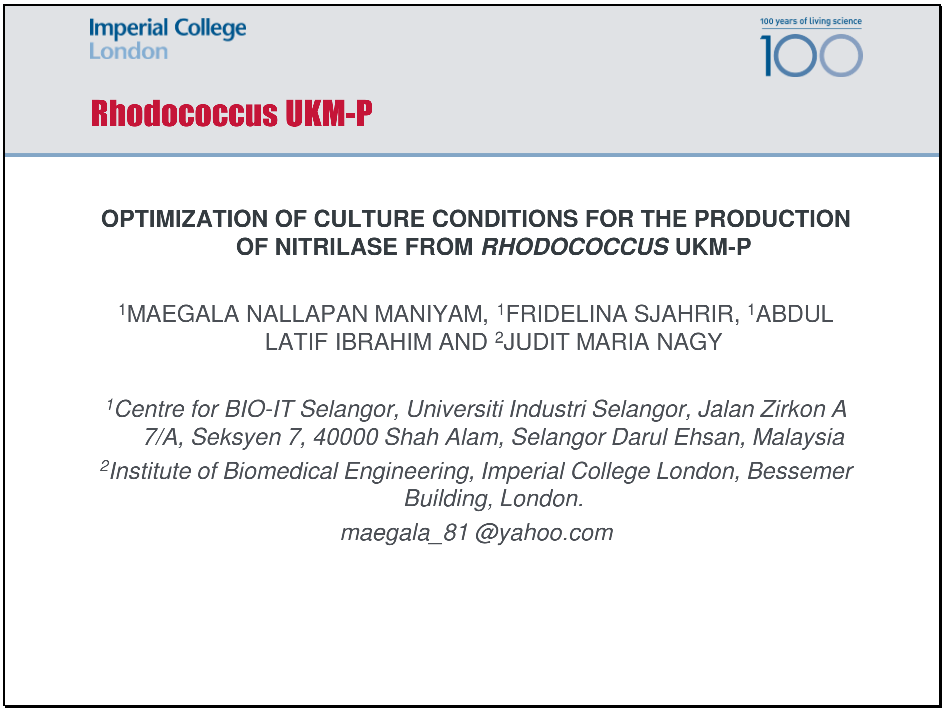

Figure 19. Rhodococcus UKM-P

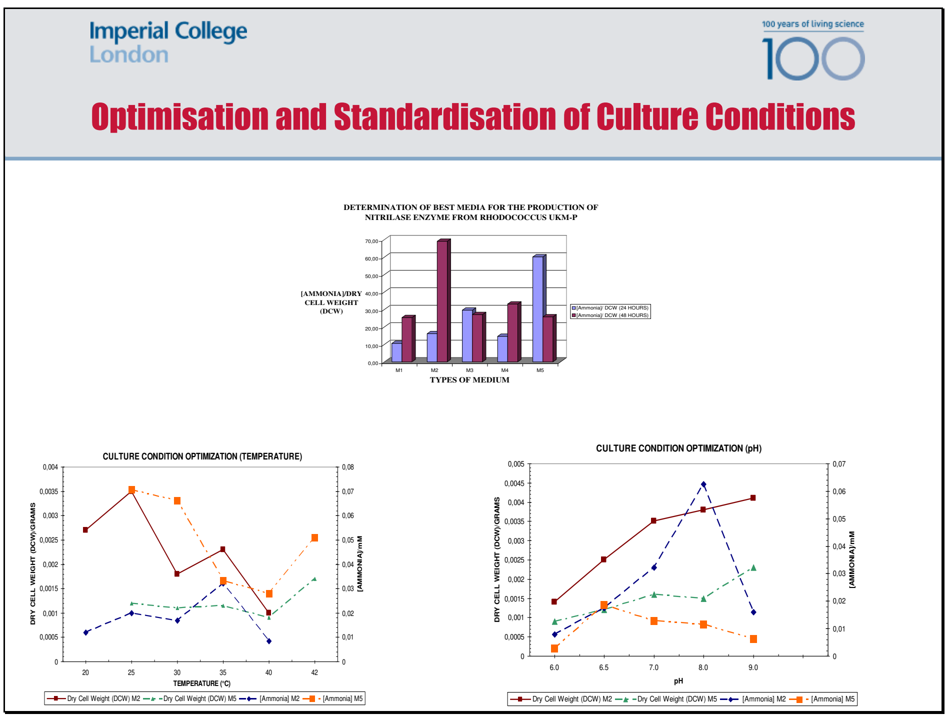

Figure 20. Optimisation and Standardisation of Culture Conditions.

Figure 21. Proteomics Facility in QSTP, Doha, Qatar.

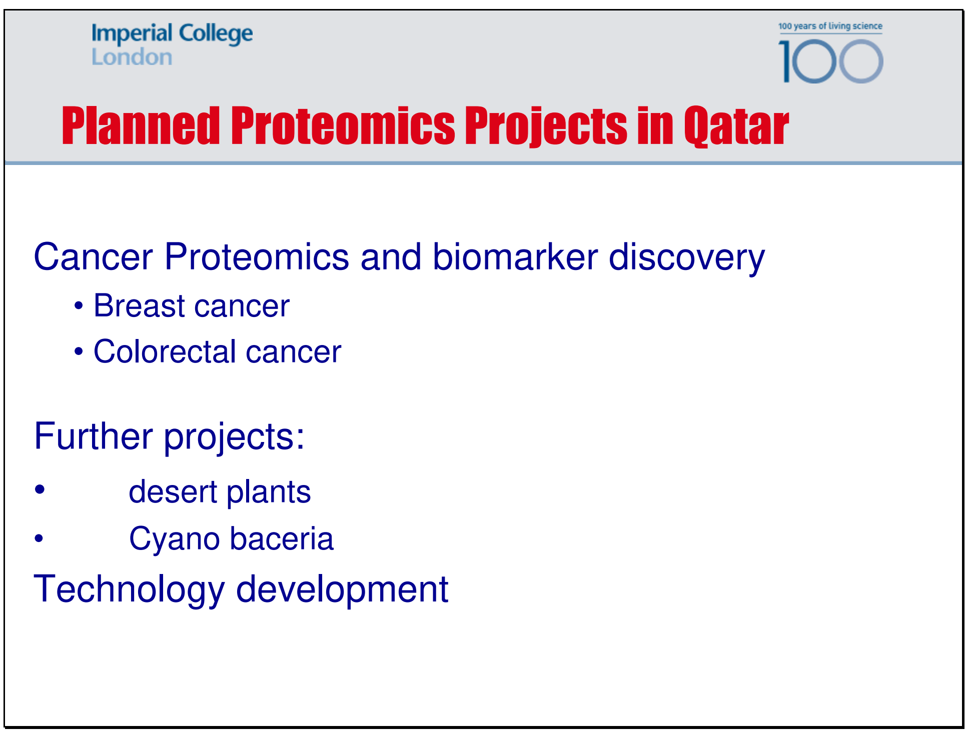

Figure 22. Planned Proteomics Projects in Qatar.

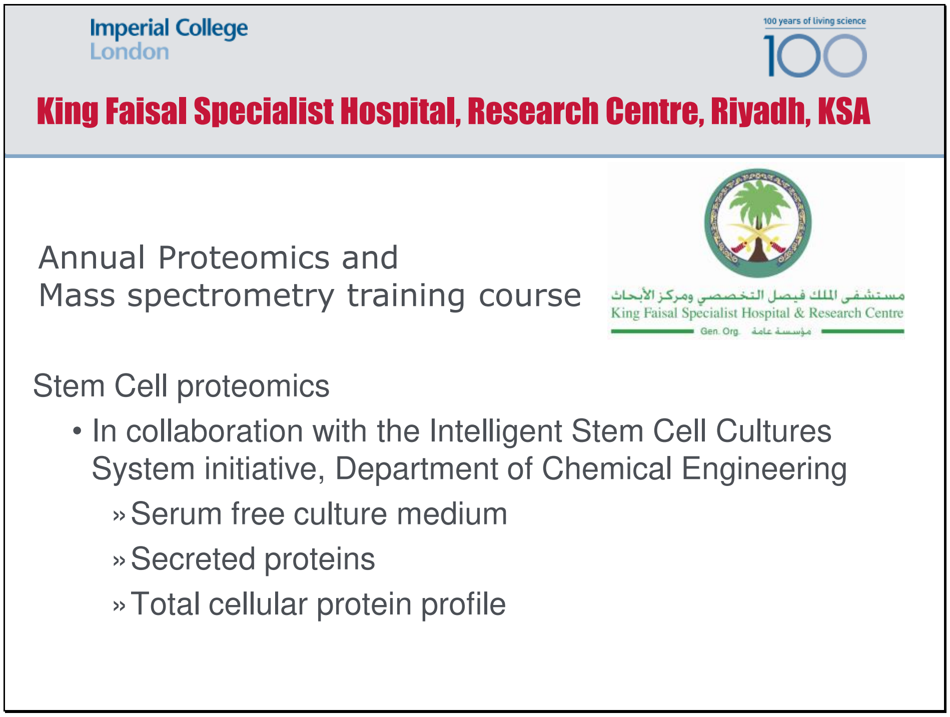

Figure 23. King Faisal Specialist Hospital, Research Centre, Riyadh, KSA.

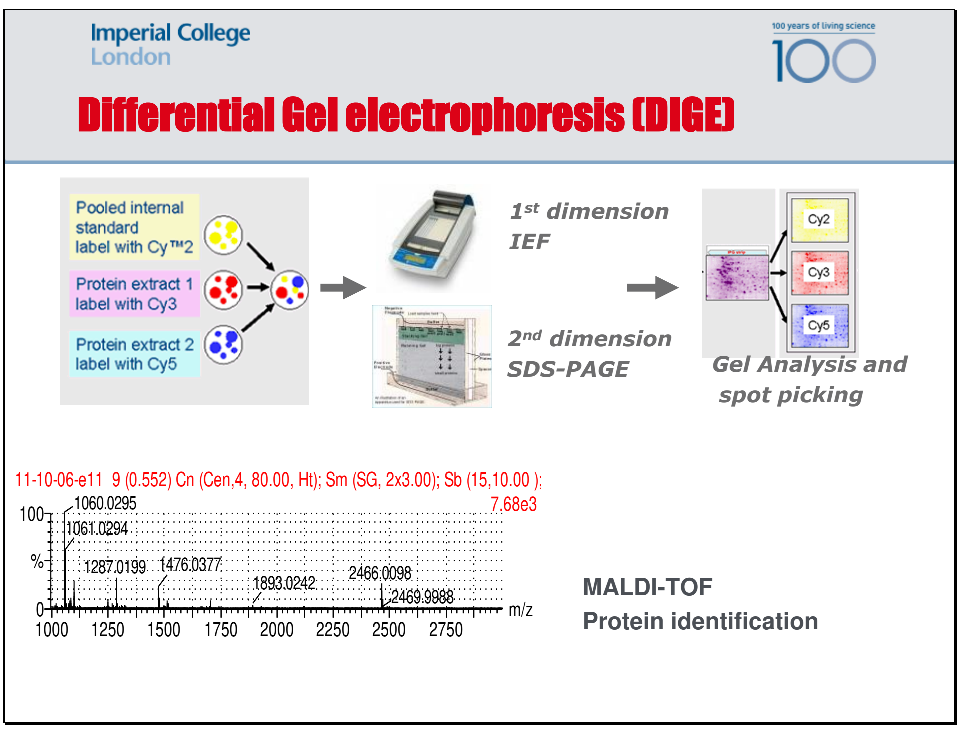

Figure 24. Differential Gel Electrophoresis (DIGE)

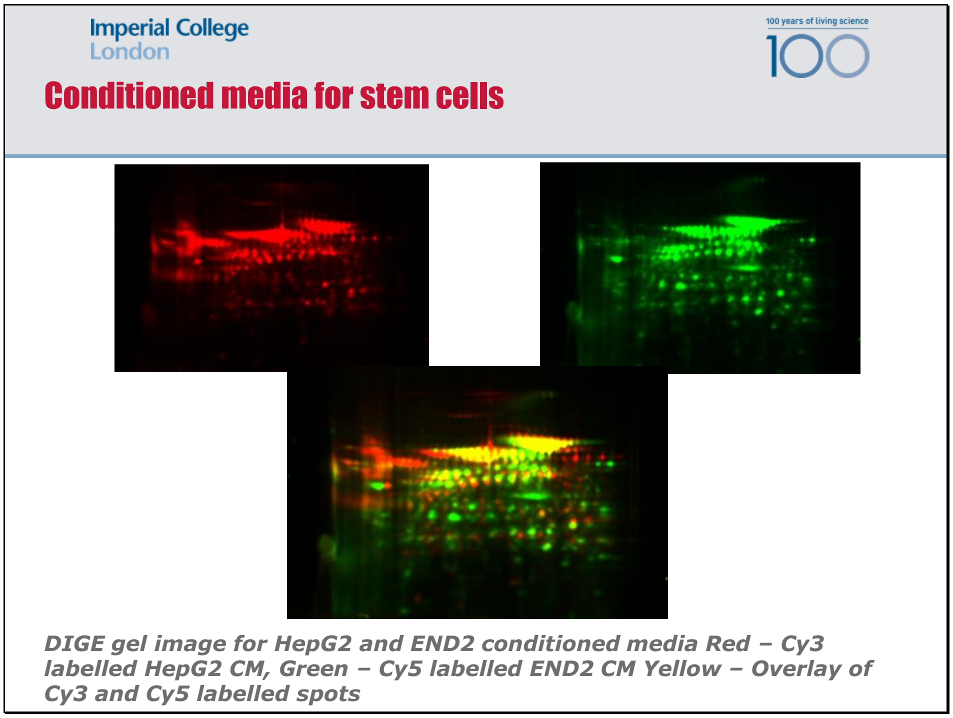

Figure 25. Conditioned Media for Stem Cells.

Figure 26. Acknowledgements.

EuPA

Eupa european proteomics association

Journal of Proteomics is ready for submission

Engendering the Knowledge Society in Malaysia: Indicators of Islamic Women Participation

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ABSTRACT

The idea of knowledge societies gained currency with the advent of information and communications technology (ICT) about four decades ago. ICT made global knowledge more accessible to local communities and local knowledge more accessible globally, leading to profound social and economic transformation in many countries. Rapid and affordable access to knowledge opened up new opportunities but also widened the "digital divide" between information "haves" and "have nots". In many instances the "have nots" are women. Many countries initiated specific strategies to ensure that women are not left out of the potential benefits of using ICT by assuring access to knowledge that can be tapped using these technologies, by identifying strategies and tools to empower women to improve their lives at every level; economic, social, cultural, religious and political, and by providing ways ICT can enable more efficient, transparent and participatory forms of governance at the local, national, regional and global levels. Women in many countries have gained tremendously from the information revolution, but questions remain whether they have fully participated and benefitted from the transformation process. For Muslim women in particular, their ability to use knowledge, ICT-mediated or otherwise, to attain and enjoy equality and justice, with control over their own lives remains elusive, although Islam is unequivocal in encouraging the education of women and their active participation in society. The indicators of Islamic women's participation in the knowledge society lie in the way we recognize the lived realities of women and men in the Muslim world today, and empower them as agents of change through our practices and in the way we construct and implement Muslim laws to ensure equality and justice within the Islamic tradition, within international human rights and constitutional frameworks.

Figure 1. Knowledge Society.

Figure 2. Innovation Society.

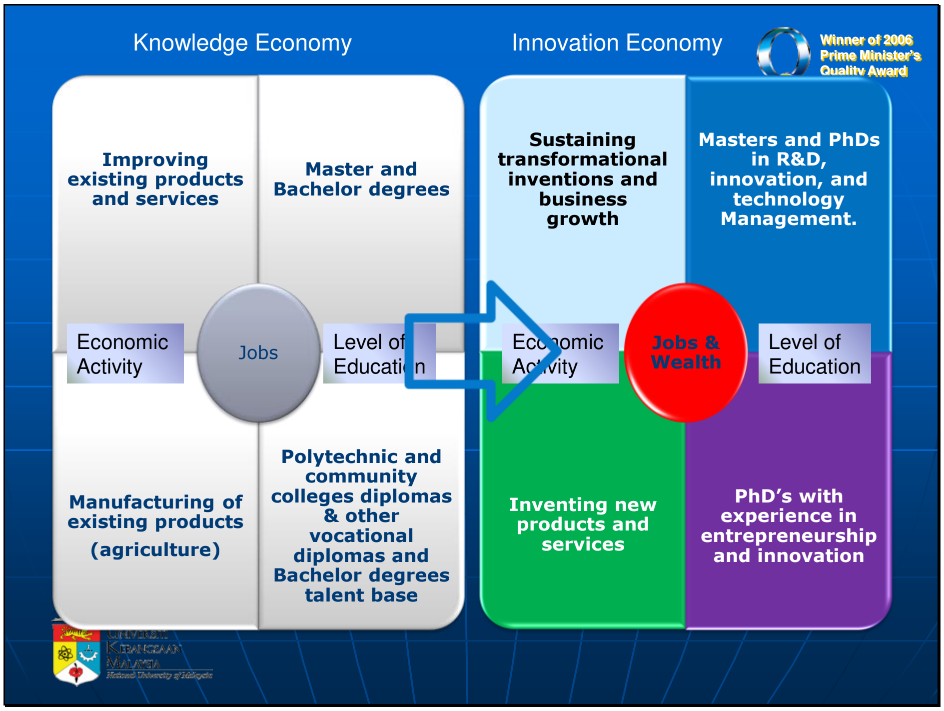

Figure 3.

Figure 4. Type of People Required.

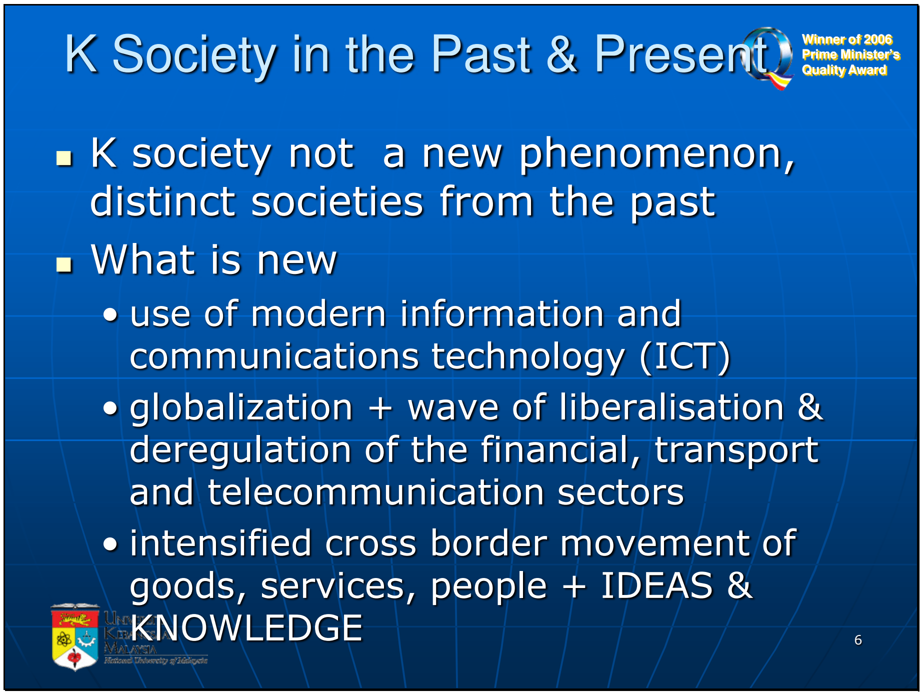

Figure 5. K Society in the Past & Present.

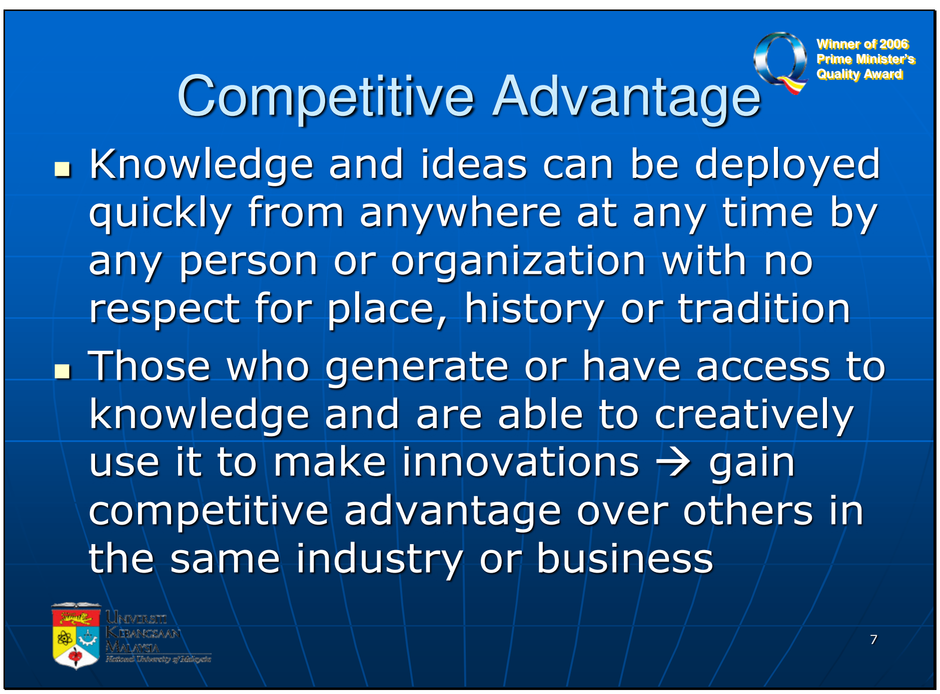

Figure 6. Competitive Advantage.

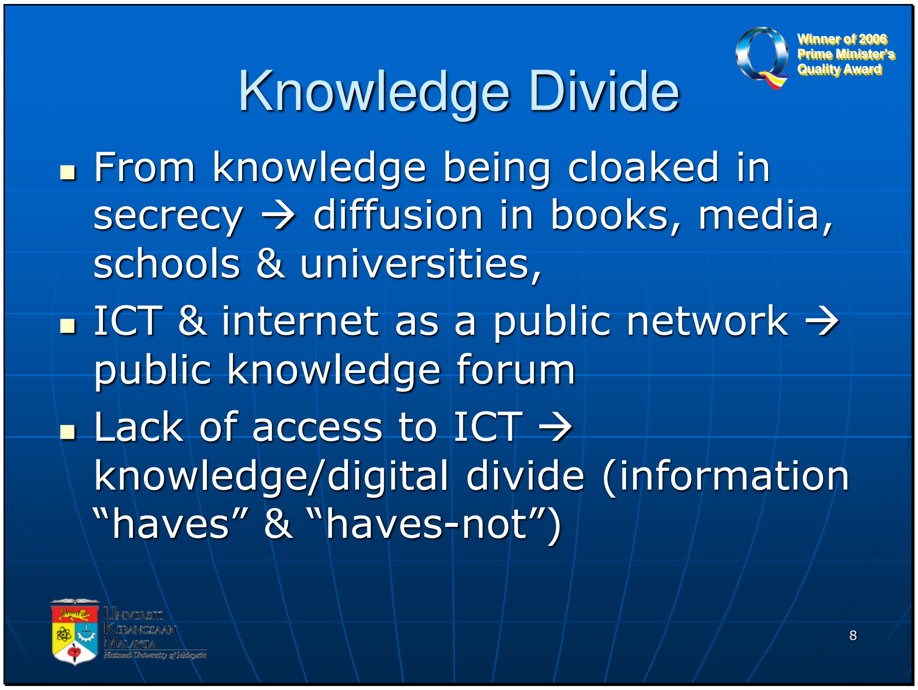

Figure 7. Knowledge Divide.

Figure 8. Reasons for Knowledge Divide.

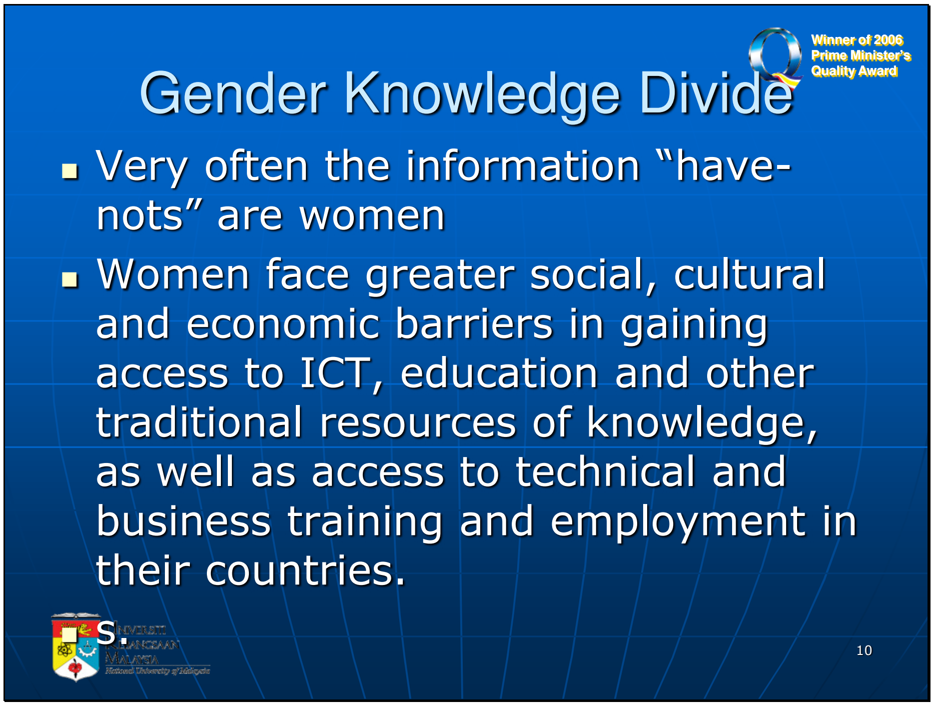

Figure 9. Gender Knowledge Divide.

Figure 10. Reasons for Gender Divide.

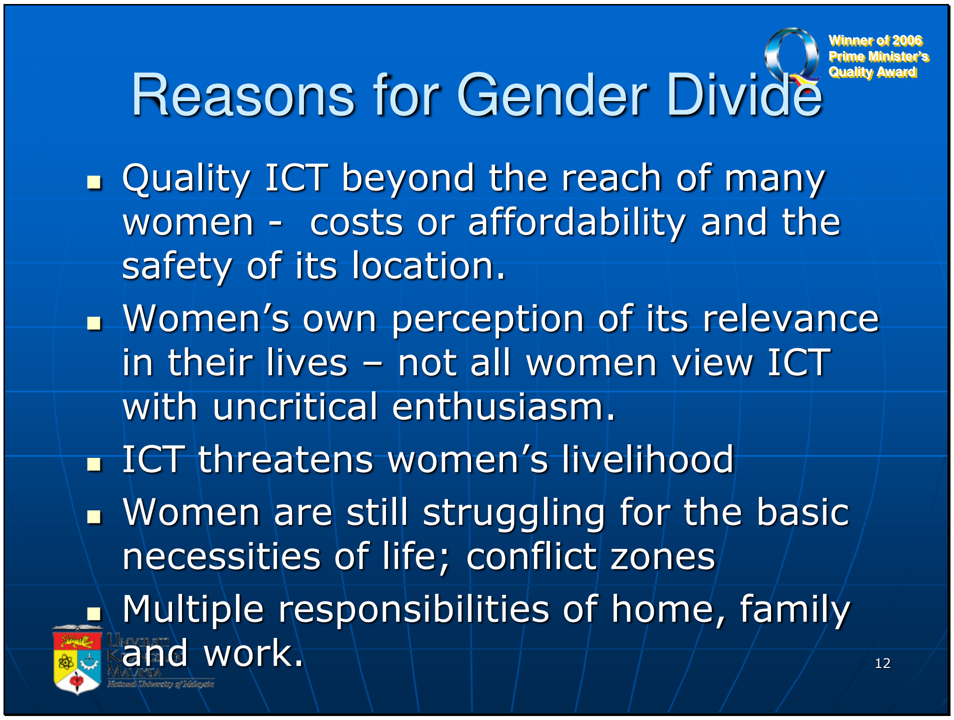

Figure 11. Reasons for Gender Divide.

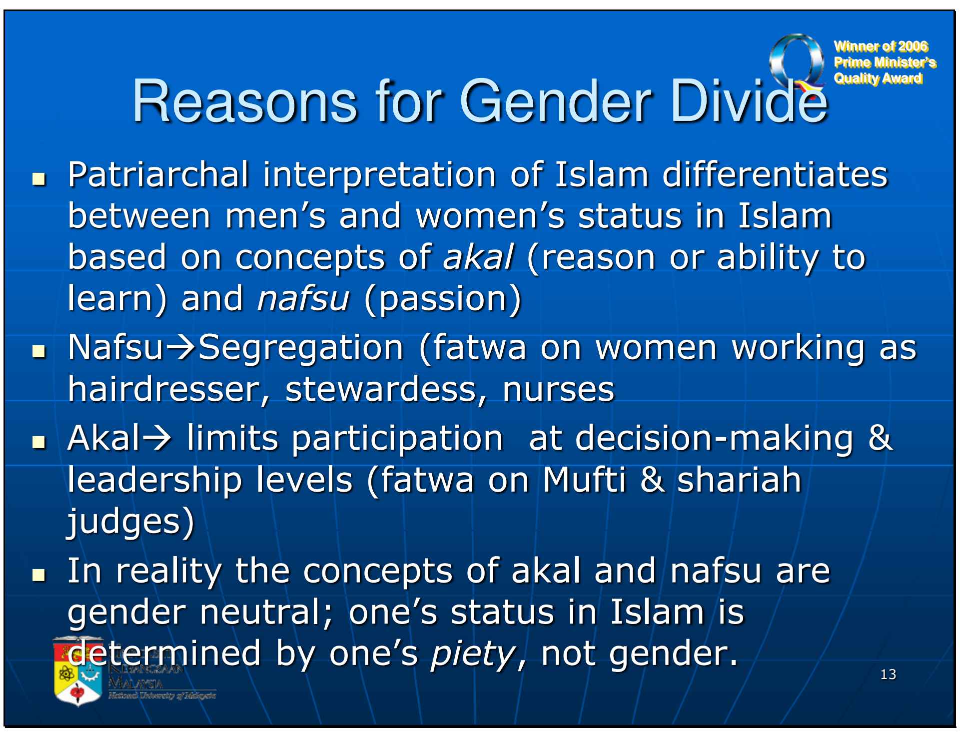

Figure 12. Reasons for Gender Divide.

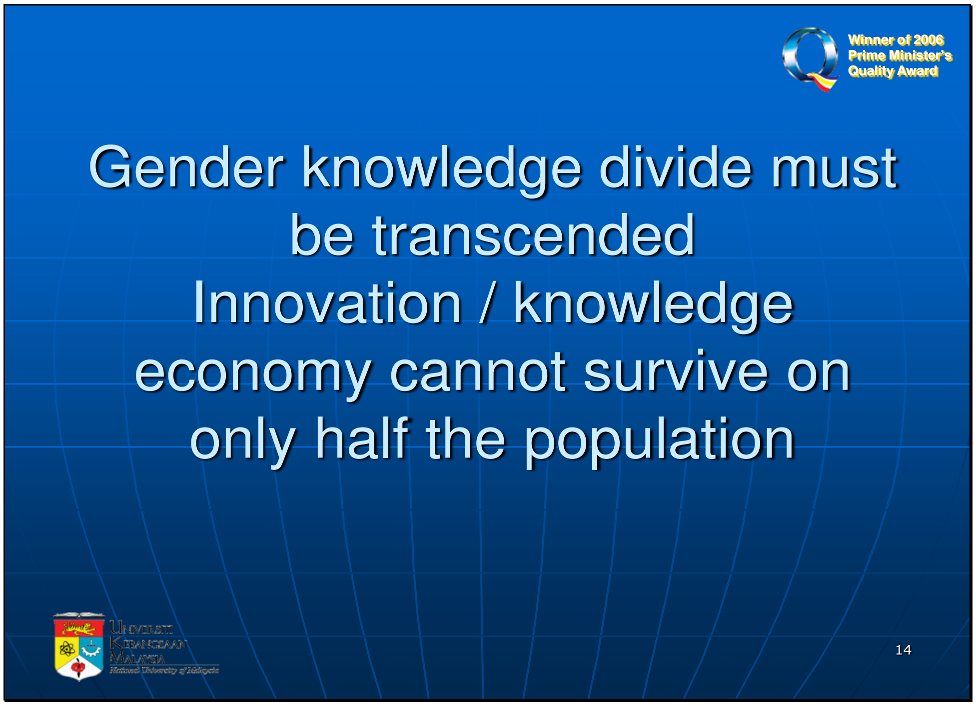

Figure 13.

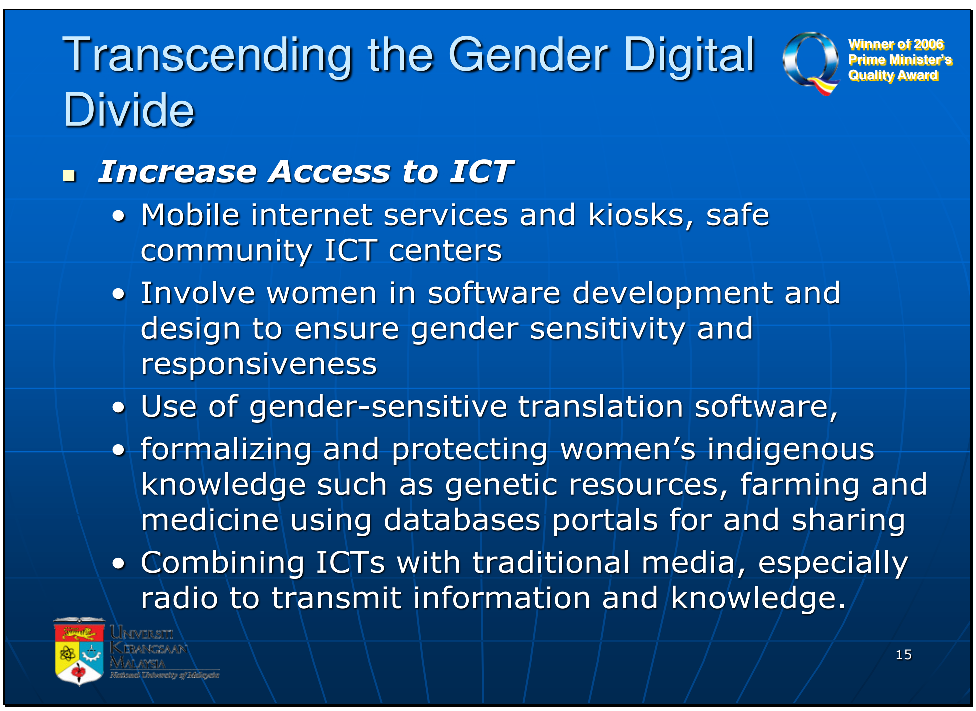

Figure 14. Transcending the Gender Digital Divide.

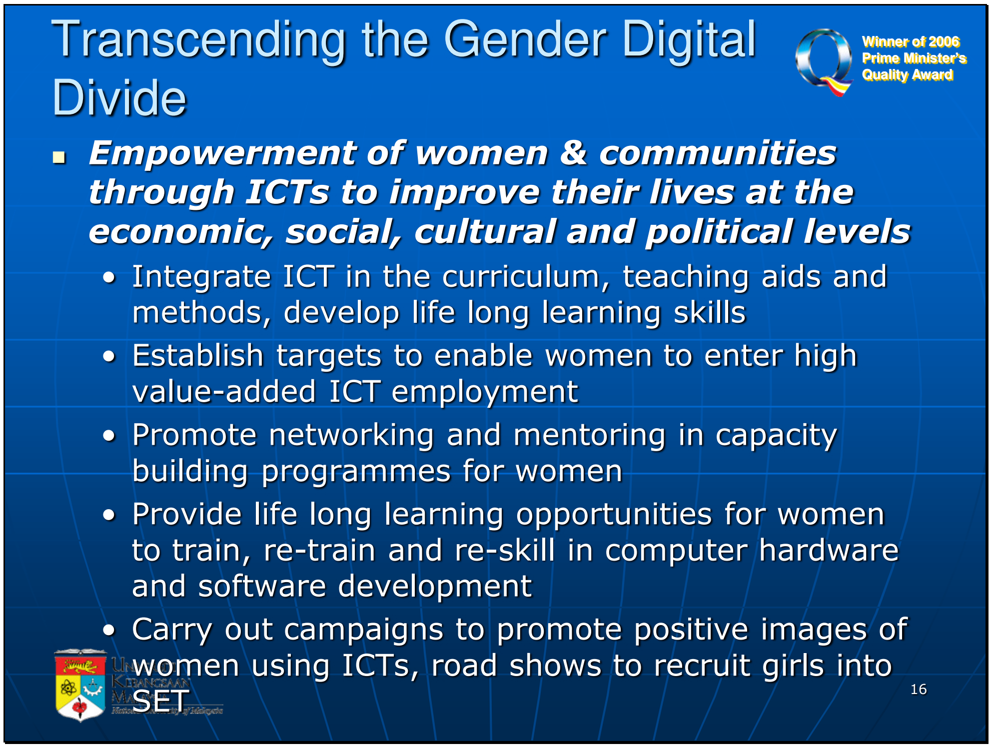

Figure 15. Transcending the Gender Digital Divide.

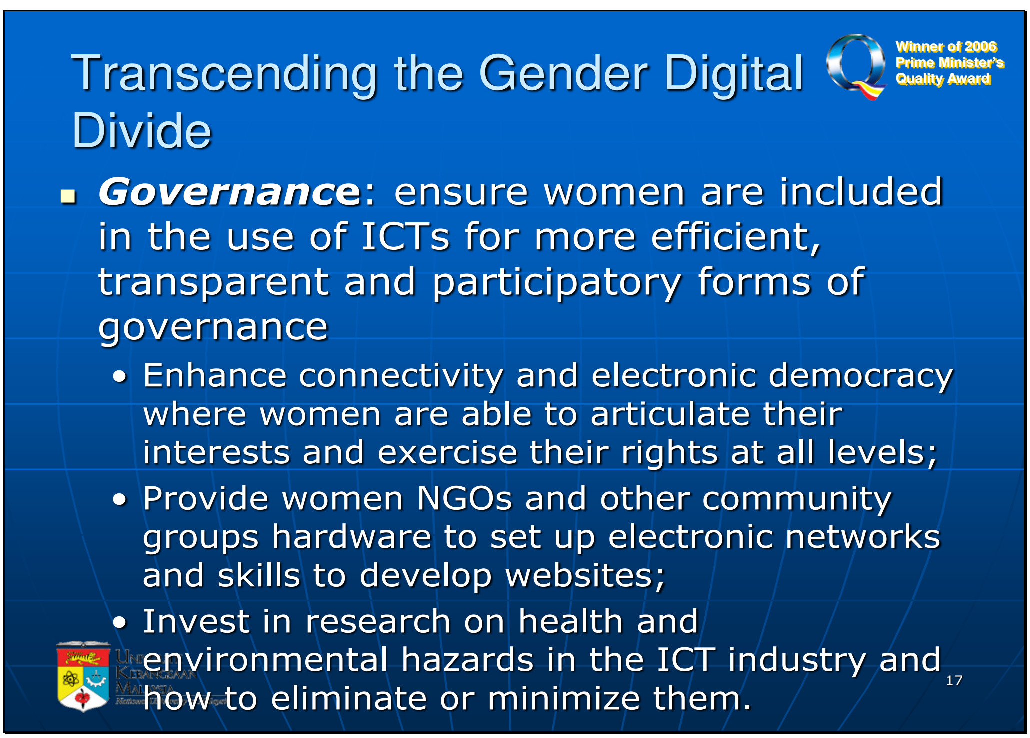

Figure 16. Transcending the Gender Digital Divide.

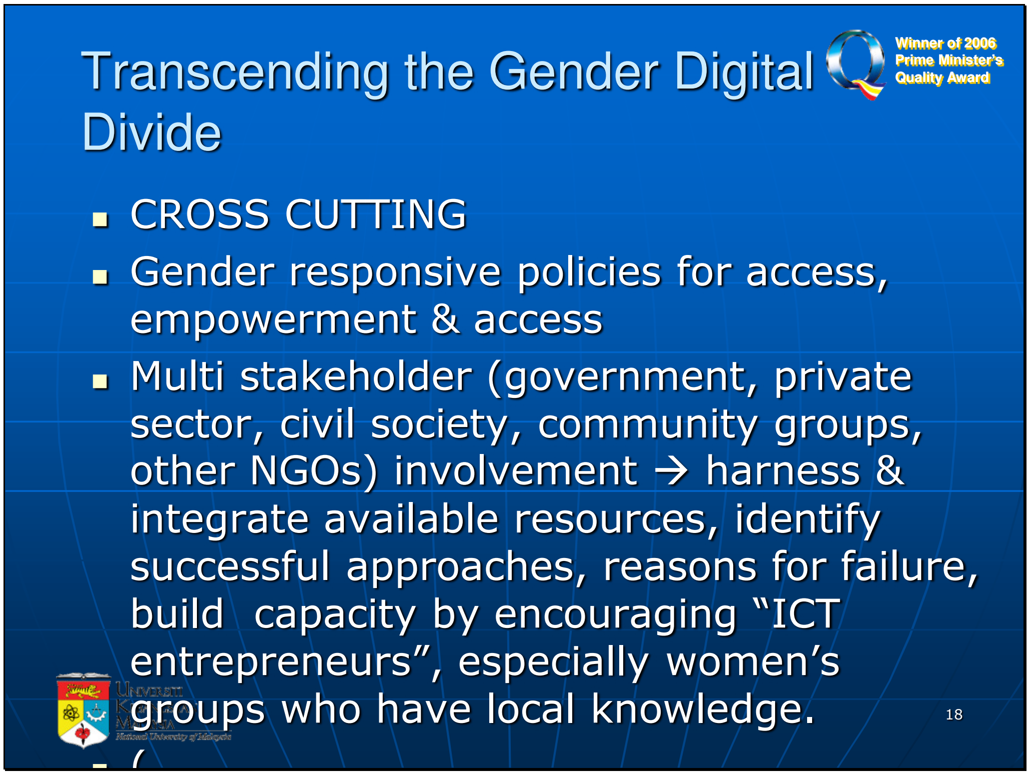

Figure 17. Transcending the Gender Digital Divide.

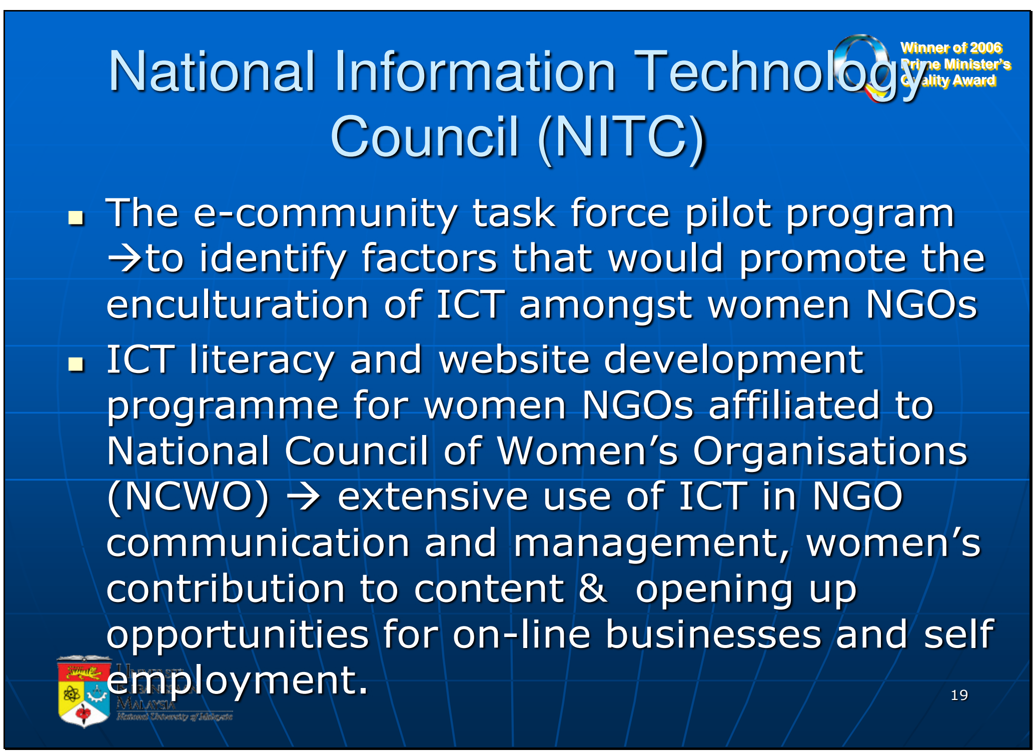

Figure 18. National Information Technology Council (NITC).

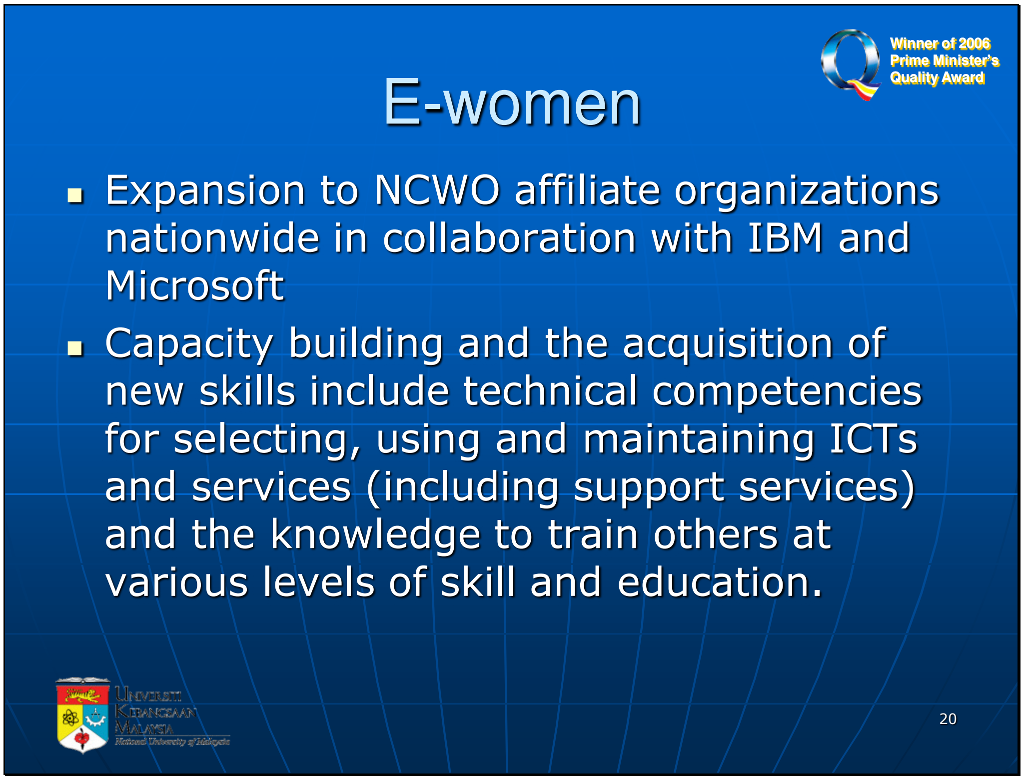

Figure 19. E-women.

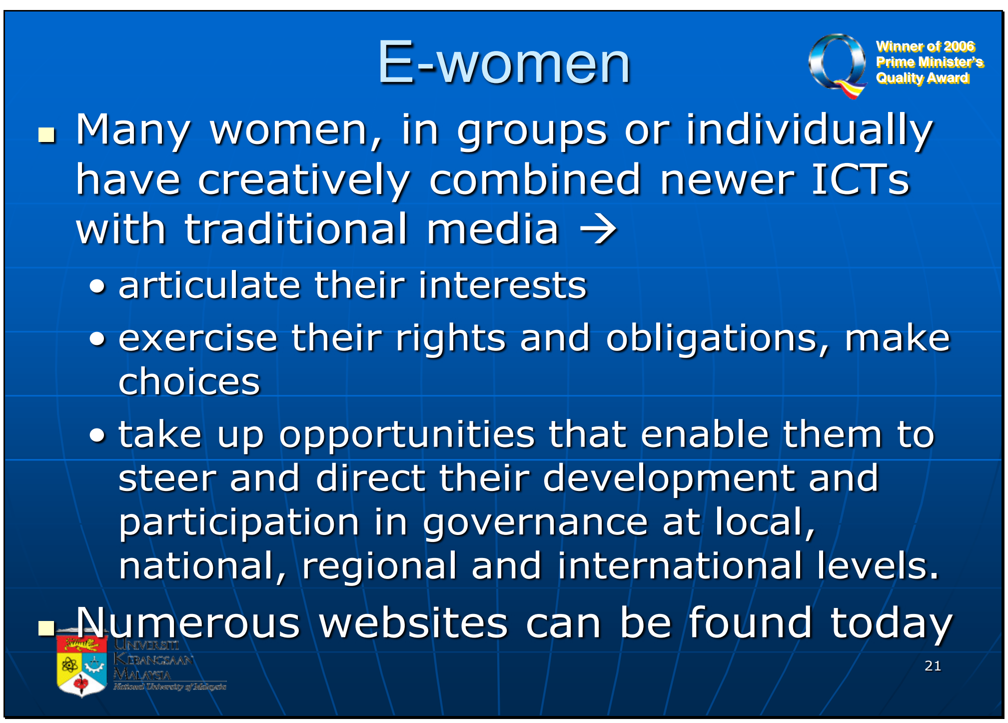

Figure 20. E-women.

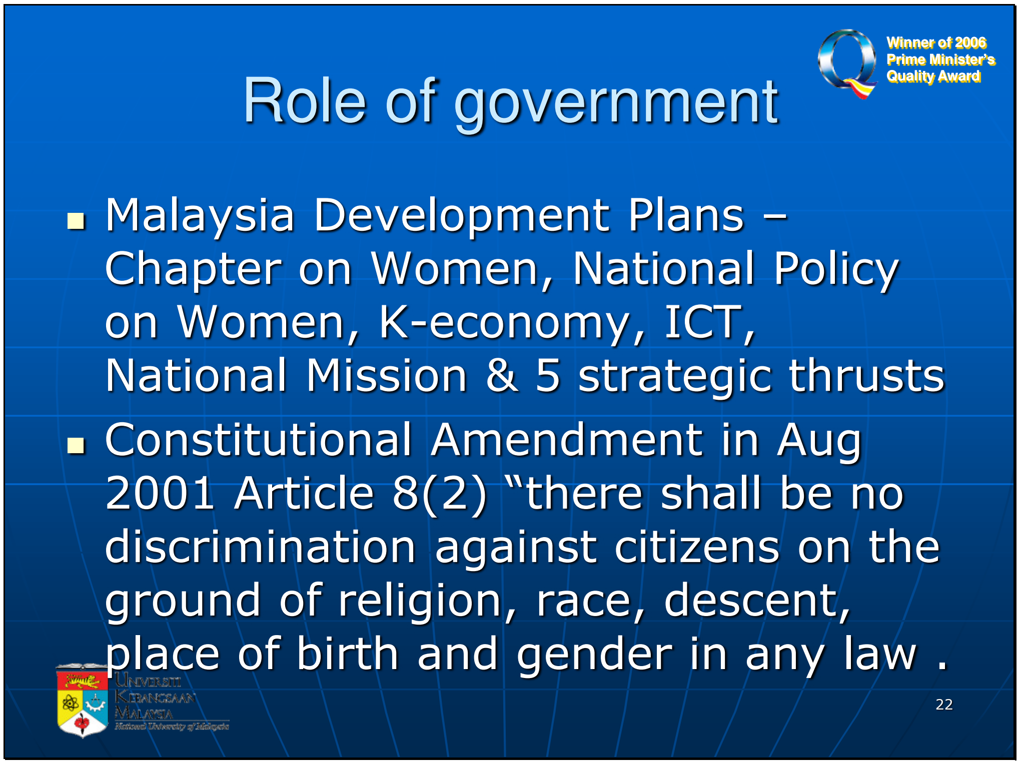

Figure 21. Role of Government.

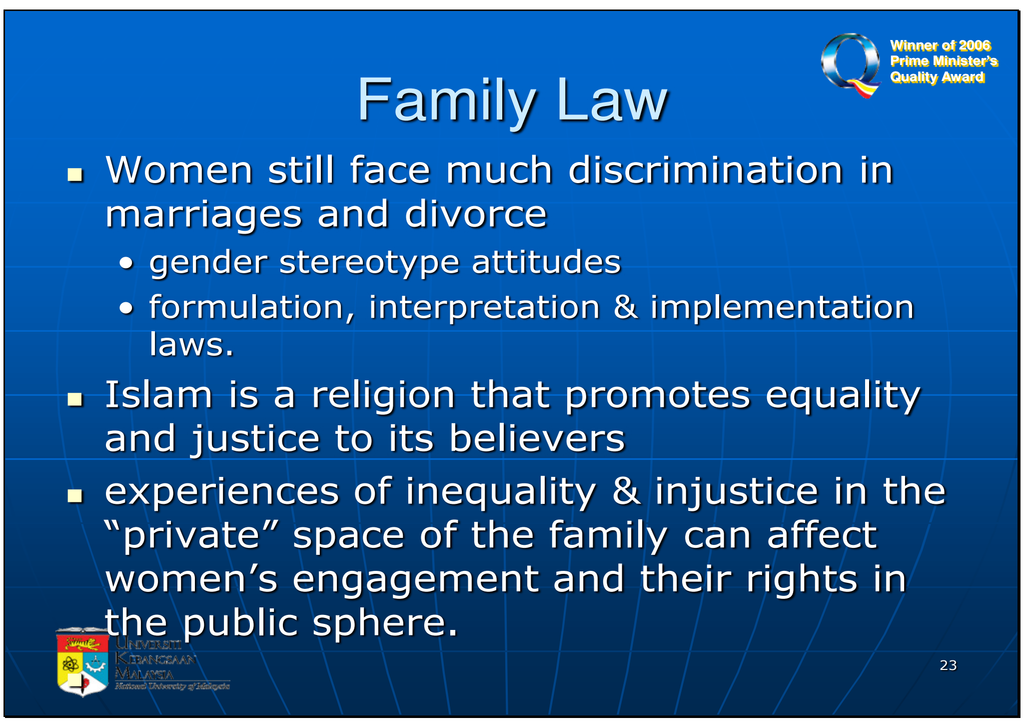

Figure 22. Family Law.

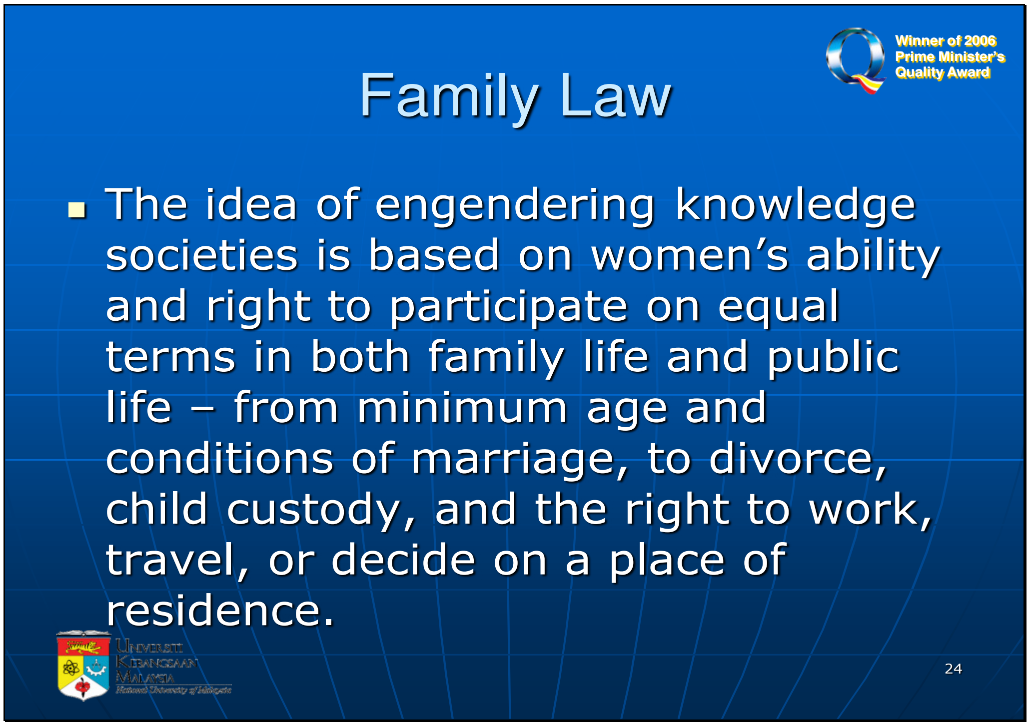

Figure 23. Family Law.

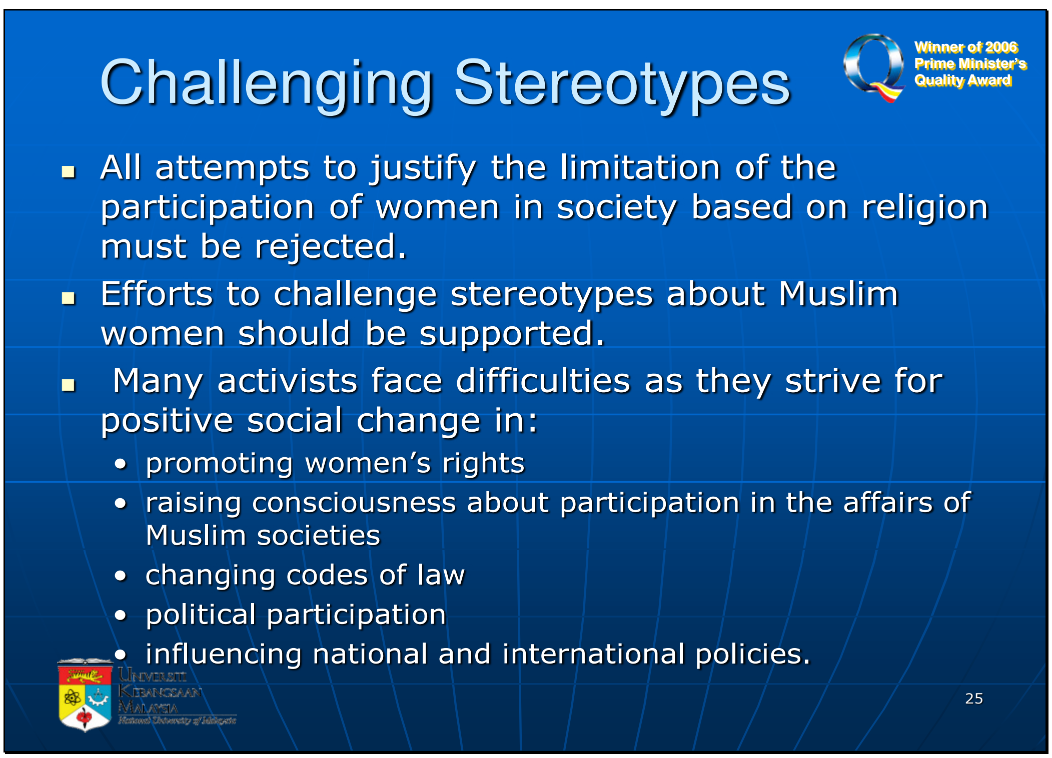

Figure 24. Challenging Stereotypes.

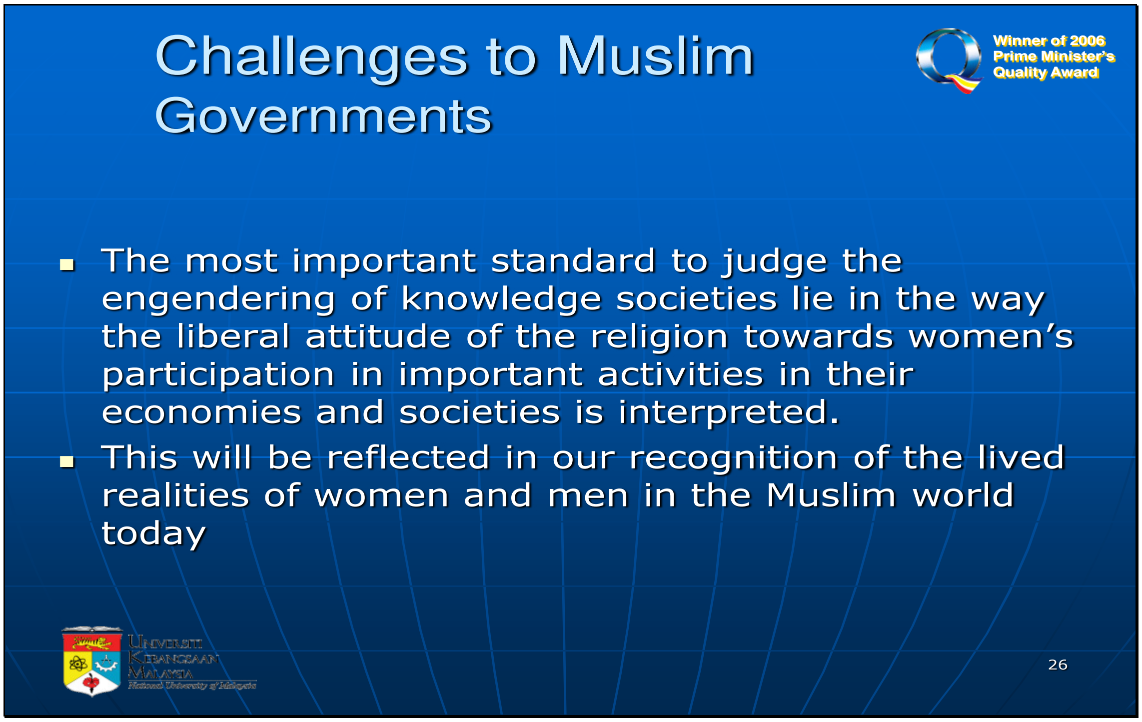

Figure 25. Challenges to Muslim Governments.

Figure 26. Challenges to Muslim Governments.

Universiti Kebangsaan Malaysia
National University of Malaysia

THANK YOU

PART FOUR

WHAT IS THE SCIENCE AND TECHNOLOGY ATLAS OF THE OIC?

The Atlas of Islamic World Innovation (AIWI)

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Secretary General
İslam Bilim ve Teknoloji Tarihi Vakfi
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1 ABSTRACT

The Atlas of Islamic World Innovation (hereinafter project) is a project jointly managed by the Statistical, Economic and Social Research and Training Centre for Islamic Countries (SESRIC) and the Royal Society of UK. It aims to produce a landmark study of science and technology-based innovation across the OIC member countries by looking in detail at a geographically and economically diverse sample of fifteen OIC countries, and offer an independent and authoritative assessment of how their innovation capabilities are changing, and the opportunities and barriers to further progress in order to identify new opportunities for collaboration between scientists, policymakers, the private sector and non-government sector, particularly directed towards shared global challenges of climate change, poverty reduction and sustainability.

The project was launched as one of the actions to implement the specific recommendations of the OIC Vision 1441 H for S&T adopted by the 10th OIC Summit Conference held in Putrajaya, Malaysia in October 2003 and the OIC Ten-Year Programme of Action adopted by the 3rd OIC Extraordinary Summit Conference held in Makkah-al-Mukarramah in December 2005. In fact, the launching of the project coincides with a number of eye-catching developments that reinforce the potential for a wider shift in the science and innovation capabilities of the OIC member countries with strong support from national governments, businesses, philanthropists and bodies like the Organization of the Islamic Conference (OIC).

The project is an international partnership that brings together the OIC General Secretariat, Statistical Economic and Research and Training Centre for Islamic Countries (SESRIC), Islamic Development Bank (IDB), Royal Society, Islamic Educational, Scientific and Cultural Organisation (ISESCO), Standing Committee on Scientific and Technological Cooperation of OIC (COMSTECH), British Council, the International Development Research Centre (IDRC), and many others[1].

This document presents a summary of the Atlas Project by introducing its background, aims, methodology, partners, that will make developments in science, technology and innovation more visible across the OIC and to the wider world, and produce a series of agenda-setting articles, publications and events which spark scientific, policy and media discussion and debate in the Islamic world and beyond.

2 INTRODUCTION

Centuries ago, scholars from the Islamic world led much of the world in medicine, astronomy and mathematics. But today, many countries with significant Muslim populations fall below the global average on key indicators of science and technology-based innovation.

Now there are signs of renewed ambition and investment, with strong support from national governments, businesses, philanthropists and bodies like the Organization of the Islamic Conference (OIC). If this is sustained, we could be witnessing the start of a second golden age of Islamic world innovation.

---

[1] The list of project partners are provided in the Annex I.

The project coincides with a number of eye-catching developments that reinforce the potential for a wider shift in the science and innovation capabilities of the Islamic world. To give just a few examples:

- In May 2007, Mohammed bin Rashid Al-Maktoum, Prime Minister of the United Arab Emirates and Ruler of Dubai announced the creation of a US$ 10 billion foundation to establish research centres in Arab universities and offer research grants to Arab scientists;
- In 2006, the government of Nigeria created a National Council for Research and Development and poured US$5 billion into its Petroleum Technology Development Fund to support research and education;
- In Qatar, a 2,500-acre Education City has been built outside Doha, containing international campuses of five of the world's top universities. The government has also set a target of 2.8 percent of GDP to be spent on R&D by 2010;
- King Abdullah University of Science and Technology was founded as an international, research university dedicated to inspiring a new age of scientific achievement that will also benefit the region and the world.
- Turkey has doubled its research spending in the past five years and is half way to its goal of spending 2% of GDP by 2010. Since 1997, it has risen from 27th to 19th in the world rankings for rates of scientific publication; and
- In January 2008, the United Arab Emirates announced the Masdar Initiative: a flagship sustainable city and S&I hub, which will become home for 50,000 people and 1,500 businesses focused on renewable energy and sustainable technologies.

How far and fast these countries move up the innovation league tables remains to be seen. But just as small nations such as Finland, Ireland and Singapore have proved some of the surprising success stories of global innovation in the past decade, individual countries within the Islamic world have the potential to make significant breakthroughs.

At the same time, the path to a more innovative Islamic world is not without obstacles. Salaries, infrastructure and research grants remain low, and there is still a substantial brain drain out of the Islamic world, with many talented scientists and engineers opting to pursue their careers in the US and Europe.

3 PROJECT AIMS

The Atlas of Islamic World Innovation has seven aims:

a. To map key trends and trajectories in science and technology-based innovation across the OIC Member Countries, and combine quantitative data with qualitative analysis gathered through interviews, workshops and other in-country fieldwork;
b. To look in detail at a geographically and economically diverse sample of fifteen OIC countries, and offer an independent and authoritative assessment of how their innovation capabilities are changing, and the opportunities and barriers to further progress;
c. To explore how relationships between science, technology, innovation, faith, culture and politics are unfolding within these sixteen countries, and across the wider Islamic world;
d. To identify new opportunities for collaboration between scientists, policymakers, the private sector and non-government sector in the Islamic world and Europe, particularly directed towards shared global challenges of climate change, poverty reduction and sustainability;
e. To make developments in science, technology and innovation more visible across the OIC and to the wider world, and to produce a series of agenda-setting articles, publications and events which spark scientific, policy and media discussion and debate in the Islamic world, Europe and beyond;
f. To build the skills and capacity of science and innovation analysts and decision-makers across the Islamic world, and create new networks for the exchange of ideas, policies and good practice both within the Islamic world, and between the Islamic world and Europe; and

g. To make the status of S&T commercialization opportunities more visible within OIC countries and the rest of the world, with the aim to attract S&T-focused investments to OIC member states, and to identify opportunities for matching the supply and demand sides of S&T, and joint S&T research and development programs, with the aim to promote integration among OIC countries.

4 PROJECT METHODOLOGY

The aim of *The Atlas of Islamic World Innovation* is to provide an insightful overview of science and science-based innovation across the Islamic world, an independent and authoritative assessment of how these capabilities are changing, and analysis of the opportunities and barriers to further progress. It will map key trends from which policymakers, universities, business leaders and other stakeholders will be able to drill down into more detail. As part of our analysis, a priority of the country reports will also be to consider the changes that need to be made in the light of international best practices so that the country's current policies to promote science, technology and innovation can be modified and enhanced, where relevant.

Detailed country studies are a key output of the project, but an equally important feature is its focus on building capacity, as well as catalysing new partnerships and collaborations. Opportunities for capacity building and inspiring new partnerships will be considered at pan-OIC and national levels, being sensitive to the different dynamics of national policy systems. The project is also deliberately designed in phases to ensure that we have the most robust and comprehensive methodology in place to measure and benchmark science and science-based innovation performance across the OIC. Phase 1 will be used to test the methodology and allow for refinements before the rest of the case studies take place.

The research is tailored as appropriate in each country to cover either additions or alternative elements of the national STI system. Country reports will also be written with substantial input from internationally reputed and eminent authorities in the various fields under consideration.

4.1 Conceptual and theoretical framework

The methodologies and approaches used in the project will draw upon a large body of academic and practitioner work carried out in, and at the boundaries between, development studies, economics, innovation studies and science policy. We will apply a highly interdisciplinary approach to understanding science and innovation systems and using a more holistic perspective, explore the roles and interactions between different actors in a national innovation system, and how these are affected by wider social or political factors.

Within this holistic understanding of innovation, the research will then look in more detail at the science and technology-based aspects of the system. The key actors that we will examine in all case studies include relevant government departments and funding agencies; a range of universities with scientific expertise (focusing on all aspects of the higher education system from undergraduates to PhDs, research to teaching); non-university research institutions; enterprise and venture capital funds; private R&D-focused businesses; multi-national companies; relevant think tanks/NGOs; science or innovation-based networks or associations; individual scientists and entrepreneurs; national science academies; and diaspora scientific communities.

Central to our analysis across all countries will be an appreciation of the different policies, regulations and legal/governance frameworks that are in place at both state and federal level, as they influence and often connect these actors in the innovation system and stimulate public and private sector investment and expertise. At the same time, given the increasingly complex international nature of innovation networks, our research will emphasise the international dimensions of science and innovation within the Islamic world, by tracing flows of people, ideas and investments across OIC countries, and between OIC countries and the wider world. And we will look closely at how international collaboration – between individual scientists/innovators, universities, firms and policymakers – can contribute to the strengthening of STI capacity, as well as building wider economic, political and cultural linkages.

A central strand of the project's international analysis will be the role of diaspora research communities. Both directly and indirectly, diaspora communities are key conduits for the transfer of knowledge, technology, capital and remittances to their country of origin. This is particularly important for developing countries where diaspora communities can encourage high tech-industries and act as bridges between foreign technology, markets, local innovators and entrepreneurs, whilst also understanding how such opportunities might best complement cultural factors and strengthen local institutions. The project will aim to help OIC-member countries develop policy tools which help diaspora connect and contribute to development in their home countries, particularly where they have chosen to settle in other Islamic world countries. Similarly, many countries have significant immigrant and emigrant populations, particularly in the manufacturing and services sectors. The influence of such communities on indigenous STI capacity building and the absorptive capacity of a country to leverage such opportunities will be one component of our research. Any analysis of diaspora networks will build on recent reports of the IDB, ISESCO and the Islamic World Academy of Sciences, as well as the latest analysis from policy institutes in the US, Europe and beyond.

4.2 Data collection and analysis: quantitative data

Science and technology indicators are crucial for monitoring scientific and technological development, and useful for formulating, adjusting and implementing S&T policies. Indicators are normally used to monitor global technological trends, conduct foresight exercises, and determine specific areas of investment.
The main objectives of this exercise will be to:

- Reflect the level and structure of the national efforts undertaken by 15 fifteen countries and assess the trends and developments in S&T;
- identify the challenges faced by different agencies in the economy in conducting S&T activities;
- compare where countries stand internationally; and
- propose recommendations for the continued developments of S&T in the respective countries;

For this purpose the project will use the most commonly used indicators on science and technology on an internationally comparable basis. The data may include final and provisional results as well as forecasts established by government authorities. The indicators will cover the resources devoted to research and development, patent families, technology balance of payments and international trade in highly R&D intensive industries, as well as the underlying economic series used to calculate these indicators.

The relevant data will be collected from the relevant government agency through the National Focal Point and the National Research Partner. In order to ensure the consistency and comparability, the methodology used in collecting all the data will be based on the internationally recognised guidelines as put forth by the Organisation for Economic Co-operation and Development (OECD), otherwise known as the Frascati Manual.

A useful list of proposed indicators is included as Annex II. It includes indicators focused on gross domestic expenditure on R&D, as well as data on human relations capacity and statistics based on sectors, business expenditure, government investment, educational resources, patents, and international trade. This list provides a robust indication of the types of data the research will draw on. Additional indicators may also be considered as appropriate, including broader economic and educational measures, statistics on talent flows, international collaborations, literacy, as well as data on mobile phone usage and broadband infrastructure.

4.3 Qualitative Fieldwork

This quantitative analysis will be complemented by an extensive amount of qualitative fieldwork in our case study countries, which will primarily involve interviews and workshops with key actors in the science and innovation systems of each country (as well as international collaborators, diaspora communities and other agencies).

The research will be tailored to the individual country context, whilst also ensuring enough complementarities across all countries to enable rigorous and accurate comparison. We have deliberately chosen a diverse cross-section of country case studies from different geographical and economic backgrounds and through our analysis, we will promote cross-OIC learning and successful models of science and innovation-led development.

Table 1. List of OIC Member Countries in the project

Middle East and North Africa	*Sub-Saharan Africa*	*Europe and Central Asia*	*South and East Asia and Pacific*
Iran	Nigeria	Turkey	Malaysia*
Egypt	Sudan	Kazakhstan	Pakistan*
Jordan*	Mozambique	Azerbaijan	Indonesia
Saudi Arabia	Senegal		
Qatar			
** proposed pilot study in Phase 1*			

The types of people/institutions we will wish to interview during the fieldwork include but are not limited to:

- Government departments/agencies;
- Universities (private and public);
- Research institutes;
- Think tanks;
- The private sector – including indigenous companies and foreign/MNCs;
- The National Academy of Science;
- Scientists/researchers;
- Academics;
- Venture capitalists;
- Entrepreneurs/Innovators;
- Business leaders;
- Politicians & leading public servants;
- Leading experts and thinkers of or on the country/specific sectors;
- Diaspora communities;
- Ambassadors and other dignitaries;
- Key figures in the national scientific ambition; and
- 'Home grown' heroes of science.

4.4 Our research in developing countries

At the OIC Conference on Science and Technology in Malaysia in 2003, OIC member states committed to a vision 'to become a community that values knowledge and is competent in utilising and advancing S&T to enhance the socio-economic well-being of the *Ummah* (the broader Islamic world)'. This project is seen as making an important contribution to developing that capacity – particularly within less developed OIC member states; and to identifying new opportunities for collaboration between OIC countries and beyond.

Our research in the less developed OIC member states will be grounded in the latest development, economics and innovation theory and practice, which looks specifically at the role of R&D and capacity building in reducing poverty. A major focus of our research will be the extent to which individuals, countries and regions have fostered an absorptive environment, which not only produces new knowledge, but is able to diffuse and adapt existing knowledge and technologies to meet local needs.

We will seek to understand the STI capacity building processes that are underway in each of these countries, specifically looking at initiatives related to healthcare, access to affordable energy and clean water. National partners will be a critical asset in helping to understand the local context but also in helping to develop mechanisms and collaborations which they can then take forward to address these critical issues. More broadly, we will consider the likely success of STI policies in the context of the country's 'framework conditions' – the policies, legal and financial systems, cultural parameters, and basic systems infrastructure – which are so fundamental to economic progress.

In addition to its economic benefits, this project will explore and promote scientific progress as an essential requirement needed to address today's most pressing global challenges, such as climate change, food security and public health. Every country is affected by these pressures, yet only a small number of countries account for the vast majority of the world's research efforts in response to them. There is significant opportunity for scientific engagement across the developing countries of the Islamic world to galvanise indigenous expertise to provide tailored solutions to problems at local and regional level, and at the same time to build capacity in these countries. By supporting the ambitions of developing countries in this regard, and identifying areas for partnership between Islamic countries and the rest of the world, the project will promote a more prominent role for developing countries in setting global research agendas.

4.5 Overarching research themes

This section gives some more detail of broader research themes within the AIWI. It is not an exclusive listing and themes will evolve throughout the project. Themes include:

1) Mapping Islamic world innovation

Science and innovation are coming from more people in more places as the 'core' and 'periphery' of global innovation networks become less distinctive. By drawing on and extending the mapping work carried out in recent years by the OIC, *Nature,* the Arab Development Report and others, this project will provide an authoritative and up-to-date account of how patterns and concentrations of advanced science and technology-based innovation, and innovation based on appropriate and indigenous technologies are changing across the Islamic world.

We will gather and interpret the latest data, trends and case studies to determine the rising hotspots for innovation, as well as looking to how STI can contribute to sustainable development and poverty reduction in some of the less-developed countries of the Islamic world. We will assess the distinctive features of national innovation systems within the OIC, and also review the progress of the OIC's own science institutions to strengthen innovation capabilities across the Islamic world.

2) New insights in history and heritage

The names of Nasir al-Din al-Tusi, Ibn al-Nafis and Ibn al-Shatir may be less familiar to speakers of European languages than those of Newton, Darwin, Copernicus and Einstein. But these and other Islamic world scholar-scientists belong in the pantheon of thinkers whose work has shaped the direction of modern science[2]. Like that of China, the history of Islamic era science and innovation is one of a period of great investment and flourishing followed by a slow, steep and seemingly irreversible decline.

The precise reasons are undoubtedly complex and remain the subject of much debate as well as new insights. One view is that there was a gradual move away from a more holistic approach to seeking knowledge across the domains of medicine, chemistry, mathematics, astronomy and religious studies, towards a focus solely on religious studies due to various historical setbacks and social calamities in the Islamic empire. More recent research, however, has extended the period of Islamic-era scientific advance, bringing the beginning of the decline closer to the time when Europe began to reassert itself as a world power, and the nations of the developing world began to be colonized. During the scoping phase of this project, we will review some of the latest historical research (including the work of OIC Secretary General Professor Ekmeleddin Ihsanoglu), and provide a contemporary assessment into the causes of scientific decline in the Islamic world.

3) Talent flows: from brain drain to brain circulation?

The story of emerging innovation economies is ultimately a story about people. This project will look in detail at the current and future potential of the scientific and research labour force across the Islamic world. And it will explore the challenges that still persist within national education systems.

[2] Saliba, G. (2007) *Islamic Science and the Making of the European Renaissance*, Boston: MIT Press.

Whilst *stocks* of human capital remain important, recent research has suggested that *flows* and *networks* of scientists, engineers and entrepreneurs have an even greater impact on innovation systems in home and host country[3]. How can we characterise talent flows in and out of the Islamic world? Are diaspora scientists and entrepreneurs now returning to certain countries in order to participate in their growing dynamism as knowledge economies? Where and to what extent is 'brain drain' now becoming 'brain circulation'? To what extent are visa restrictions and other forms of discrimination impeding the free flow of Islamic world scientists and researchers around the world?

4) Belief and reason in the modern world

In Europe and the US, there is a renewed tendency to portray science and religion as conflicting - or irreconcilable - systems of knowledge[4]. Debates can appear (at least to the wider public) as polarized and dominated by dogmatic voices. Outside of the West, however, the relationship is often different.

In many Muslim countries, faith is regarded by many as a person's primary identity. Often, religion is enshrined in national constitutions. But even where this is not the case, there is much greater public and political acceptance of the place of belief in policy-shaping, alongside other variables such as evidence from research, political influences, the opinions of business leaders, land-owners and, increasingly, multinational NGOs.

Paradoxically, however, an acknowledgement that religion is an active contributor to societies has been firmly kept out of higher education and research. This has had at least two effects: first, that science and technology fail to connect with an aspect of life that is important to most citizens. And second, that critical questions about religion and its role in society have become absent from research, inquiry and from public debate. These questions include the permissibility of organ transplants, cloning, genetic-modification, weapons of mass destruction and nanotechnology. In each of these examples, public discussion tends to be limited to a minority of people with access to European-language media. Pertinent to this analysis will include an analysis of the broader influences of governance and politics, and its relationship to science and religion.

Despite a recent resurgence of the trend to merge religious studies with science and technology in several Muslim countries, thinkers such as Ziauddin Sardar argue that such separation is among the reasons why innovation and creativity is thin and inconsistent in the OIC world today, and also why indices for higher education and research in the OIC states are among the lowest in the world.

5) The post-oil economy: innovation for sustainability

The prospect of a post-petroleum world presents significant challenges for the oil exporters of the OIC countries. Their largest markets (Europe and the United States) have set targets to reduce reliance on fossil fuels and increase the share of renewable forms of energy. For resource-rich OIC member states, a business as usual approach could lead to diminishing returns. On the other hand, smart thinking means that OIC member states could see this shift as an opportunity, rather than a threat.

The AIWI will identify examples of smart thinking on sustainability from within the OIC. Examples include engaging proactively in international negotiations to reduce greenhouse gas emissions; using the Clean Development Mechanism of the Kyoto Protocol; looking at the opportunities and uncertainties of biofuels; and finding ways to improve development and poverty eradication in sub-Saharan Africa – where most of the OIC Least Developed Countries (LDC) are located. And as the politics of access and availability to fresh water become more intense across large parts of the Islamic world, we will look in particular detail at the prospects for water-related sustainable innovation.

Related to this is the rapidly expanding field of Islamic finance, now estimated to be worth at least $300 billion dollars annually. From relatively modest beginnings, Islamic based financial products are today being used to lease aircraft, and pay for house-purchases. Islamic finance is a genuine example of Islamic innovation, and is a partnership between theologians, international banks, and often second-generation Muslims living in Western countries who are capable of bridging tradition and modernity. This project will

[3] Saxenian, A. (2006) *The New Argonauts: Regional Advantage in a global economy*, Cambridge, MA: Harvard University Press; Wagner, C.S. (2008) *The New Invisible College*, Washington: Brookings Institution Press.

[4] Dawkins, R. (2006) *The God Delusion*, London: Bantam Press; Dennett, D. (2006) *Breaking the Spell: Religion as a Natural Phenomenon*, London: Allen Lane.

explore how such financial innovation can support other forms of science and technology-based innovation – for example, through creative models of financing R&D and early-stage companies.

6) International collaboration
Just as the rise of innovation from China and India can at times fuel a climate of anxiety in Europe and the US, so a more innovative Islamic world may prompt fear or suspicion – particularly when set in the context of political Islam, or relations between Western countries and some countries in the OIC. Advances in Iranian nuclear technology are not viewed in the West with the same equanimity as developments in Malaysia's software industry.

But it is short sighted to view these developments purely or primarily as a threat. As the Islamic world's innovation capabilities grow, a central question is whether defensive, national strategies gather momentum, or whether the countervailing impulse towards global collaboration and exchange of new will prove stronger.[5] What are the current levels of collaboration and exchange both amongst Islamic country and beyond, and what historical, political or economic influences have shaped these relationships? How have events such as September 11 impacted on collaborative endeavours and relationships more broadly?

4.6 Shape and format of country case studies/ reports

The fieldwork analysis is fundamental to the country case studies, and the project overall. There are numerous players such as the World Bank, the OECD, UNESCO and others who also produce country case studies but these reports are often weighted towards data and statistics, and targeted at an informed and science-literate audience. Our work will draw on these reports but the niche for this project is to produce widely-accessible outputs that appeal to a range of policymakers, scientists, economists, social scientists, politicians, historians and innovators. Whilst grounded in empirical data and relevant literature, the project reports will adopt a more narrative style that uses stories and case studies of people and organisations to illustrate wider dynamics in each country's science and innovation system.

The Royal Society led a successful two-year project called 'The Atlas of Ideas' which resulted in a series of high-profile reports on the prospects for science and science-based innovation in China, India, Brazil and South Korea. 'The Atlas of Ideas' reports provide a useful example of the style and format of the country case studies, demonstrating the narrative-based approach as well as providing some suggestions to how different chapters of the reports might be structured. Whilst there will be some degree of flexibility on the format of different country reports, potential chapter themes include:

- *Mapping*: exploring the history, presenting the available indicators, identifying key institutions/ organisations in the country's innovation system as well as key areas of scientific strength and potential.
- *People*: analysing the human capital aspects of a country's STI system including its higher education structures and statistics, its diaspora networks, and inspiring leaders.
- *Places*: looking in detail at the current geographical distribution of STI in the country; the role of regional and centralised STI policy; and the emerging centres of scientific ambition and excellence.
- *Business*: considering current and future private sector research in both domestic and multinational firms; the potential for entrepreneurship; and the regulatory environment to foster business-led science-based innovation.
- *Culture*: exploring the distinctive features of a country's STI system, where appropriate looking at the relationship between science and development, as well as systems of governance, ethics and participation in scientific decision making.
- *Sustainability*: discussing how vulnerable the country is to some of the world's most pressing global challenges, such as climate change, poverty reduction and sustainability issues, as well as exploring what policies, research initiatives and practices are being employed to address these issues.
- *Collaboration*: looking at the current and future shape of scientific collaborations both regionally and globally and potential boosts and barriers to further collaboration.

[5] Leadbeater, C. and Wilsdon, J (2007) *The Atlas of Ideas: how Asian innovation can benefit us all*, London: Demos.

4.7 The overview/ Final report

Based on the country working papers and additional survey/desk-based research across the rest of the OIC member states, the project will produce an agenda-setting overview report, which highlights commonalities and differences between the countries, and draws wider conclusions about the prospects for science and innovation across the Islamic world, and closer collaboration with the rest of the world.

The report will include recommendations for governments, industry and higher education, and short commentaries from leading thinkers in the Islamic world. The final report will be translated into Arabic and French. All outputs, including country working papers and the overview report, will be peer reviewed, to ensure they are high quality, rigorous and independent.

ANNEX I:
PROJECT PARTNERS

1. **The Organisation of Islamic Cooperation (OIC),** with 57 member states it is the world's largest inter-governmental organization outside of the United Nations. This project has been designed with the backing and direct involvement of the OIC secretariat, based in Saudi Arabia. It will contribute to the OIC's Ten-Year Programme of Action, launched in 2005, which has science, innovation and sustainability as three of its core priorities. Significantly, a resolution in support of this project was adopted by the OIC Kings and Heads of State at the Eleventh Session of the Islamic Summit Conference in Dakar, Senegal on 13-14 March 2008. This Resolution (No. 2/11-S&T) welcomes the project and "Urges all member states and the relevant OIC institutions such as IDB, COMSTECH, and ISESCO to cooperate and collaborate in the preparation of this Atlas."

2. **The Statistical, Economic & Social Research & Training Centre for Islamic Countries (SESRIC),** was founded in 1978 as a subsidiary organ of the OIC, and is the lead agency for statistical data and other socio-economic information on and for the OIC member countries. SESRIC's new online searchable data system provides up-to-date statistical data on almost 250 indicators from the 57 member countries. In addition, SESRIC conducts research aimed at evaluating the economic and social developments of member countries to help generate proposals that will initiate and enhance co-operation among them. SESRIC acts as the Project Manager. Its unrivalled access to data from across the OIC means it is also well placed to coordinate the quantitative elements of project research.

3. **The Royal Society** is the independent scientific academy of the United Kingdom dedicated to promoting excellence in science. Its mission is to expand the frontiers of knowledge through the development and use of science, engineering, medicine and mathematics for the benefit of humanity. Founded in 1660, it is the oldest science academy in continuous existence and is made up of 1400 elected Fellows and Foreign Members, including nearly 70 Nobel Laureates. As the Society prepares for its 350^{th} anniversary in 2010, it is launching an International Science Policy Centre (ISPC), which will map, analyse and debate the latest developments in science policy around the world. Given its past experience and vast networking in the field of science and innovation the Royal Society will provide technical support for the project, especially during the implementation of the field work.

4. **Nature** is the world's foremost weekly scientific journal and Nature.com is one of the most popular scholarly websites on the internet, serving 12 million visitors a month. In November 2006, Nature published a special issue on "Islam and Science". The journal's involvement in this project will build on that special issue, and help to ensure that the index and country-papers will be of an unmatched quality. The outcomes of the project will be disseminated by Nature.

5. **The Islamic Development Bank (IDB)** is an international financial institution established in 1973 by the first conference of the Finance Ministers of the OIC. Its purpose is to foster the economic development and social progress of member countries and Muslim communities individually as well as jointly. Currently it has six priority areas: human development; agricultural development and food security; infrastructure development; trade among member countries; private sector development; and research and development in Islamic economies and finance. This project speaks directly to the last of these priorities, and the IDB is requested to provide financial support.

6. **OIC Standing Committee on Scientific and Technological Cooperation (COMSTECH)** supports the promotion and cooperation of science and technology activities among the OIC member states. COMSTECH is chaired by Pakistan's president Asif Ali Zardari and its Islamabad secretariat is headed by Prof. Atta ur Rahman. Its priorities are to assess the science and technology needs and requirements of OIC member states; build up their indigenous capability through cooperation and mutual assistance; and create effective institutional structures for planning, development and

monitoring of science and technology activities. There are obvious synergies between these aims and the AIWI, and COMSTECH plays an active role on the project's Joint Management Team.

7. **The Islamic Educational, Scientific and Cultural Organization (ISESCO)** is an international organization working within the framework of the Organization of the Islamic Conference. Its headquarters are in Rabat, Kingdom of Morocco, and its objectives are to strengthen, promote and consolidate cooperation among the Member States in the fields of education, science, culture and communication, as well as to develop and upgrade these fields. ISESCO actively supports this project, and Dr Faiq Bilal, Director of Science at ISESCO is a member of the project's Joint Management Team.

8. **The British Council** is the UK's international organisation for educational opportunities and cultural relations. Its purpose is to build engagement and trust for the UK through the exchange of knowledge and ideas between people worldwide. It operates in the UK and 110 other countries and territories worldwide, and in the past year its programmes have reached 128 million people, the highest number in its history. Its work draws on the artistic, scientific and educational components of cultural relations to construct long-term relationships that not only flourish in favourable conditions but also endure in testing times. The British Council plays a key role in the project's in-country fieldwork, networking and capacity-building, and in ensuring its longer-term legacy.

9. **Qatar Foundation (QF)** is dedicated to making the knowledge-based society a reality. Established in 1995 by His Highness Sheikh Hamad Bin Khalifa Al Thani, Emir of Qatar, as a vehicle to convert the country's current, but temporary, mineral wealth into durable human capital, the Qatar Foundation through its threefold mission of education, scientific research and community development, is helping build a sustainable society where the sharing and creation of knowledge will enhance quality of life for all. It is achieving this goal through a network of centres and partnerships that are dedicated to excellence in their respective specialisations and that are growing together into a powerful force for social change. Qatar Foundation's flagship project is Education City, a 1,000-hectare campus on the edge of Doha where most of its member institutions are located.

10. **The International Development Research Centre (IDRC)** is a Crown corporation created by the Parliament of Canada in 1970 to help developing countries use science and technology to find practical, long-term solutions to the social, economic, and environmental problems they face. Their support is directed toward creating a local research community whose work will build healthier, more equitable, and more prosperous societies. They fund applied research by researchers in developing countries on the problems they identify as crucial to their communities, provide expert advice to those researchers, and build local capacity in developing countries to undertake research and innovate.

11. **The Centre for the Development of Industrial Technology (CDTI)** works under the auspices of Spain's Ministry of Science and Innovation to help Spanish companies increase their capacity for R&D, technology and innovation. CDTI's headquarters are located in Madrid, but it also has a strategic network of offices and representatives abroad. It has a growing involvement across the Mediterranean region and the wider Middle East. CDTI will support the project and ensure links to other Spanish organisations with an interest in the Islamic world.

ANNEX II:
LIST OF INDICATORS

Indicators by subject:

Gross domestic expenditure on R&D (GERD):

1. Gross Domestic Expenditure on R&D -- GERD (million current PPP $)
1.a. GERD (million national currency - for euro area, pre-EMU euro or EUR)
2. GERD as a percentage of GDP
3. GERD -- (million 2000 dollars -- constant prices and PPP)
3.a. GERD -- Compound annual growth rate (constant prices)
4. GERD per capita population (current PPP $)
5. Estimated Civil GERD as a percentage of GDP
6. Basic research expenditure as a percentage of GDP

R&D Personnel (FTE):

7. Total researchers (FTE)
7.a. Total researchers -- Compound annual growth rate
8. Total researchers per thousand total employment
8.a. Total researchers per thousand labour force
9. Total R&D personnel (FTE)
9.a. Total R&D personnel -- Compound annual growth rate
10. Total R&D personnel per thousand total employment
10.a Total R&D personnel per thousand labour force

GERD by source of funds:

11. Industry-financed GERD as a percentage of GDP
12. Government-financed GERD as a percentage of GDP
13. Percentage of GERD financed by industry
14. Percentage of GERD financed by government
15. Percentage of GERD financed by other national sources
16. Percentage of GERD financed by abroad

GERD by performance sectors:

17. Percentage of GERD performed by the Business Enterprise sector
18. Percentage of GERD performed by the Higher Education sector
19. Percentage of GERD performed by the Government sector
20. Percentage of GERD performed by the Private Non-Profit sector

Researchers (headcount):

21. Total researchers (headcount)
21.a. Women researchers (headcount)
22. Women researchers as a percentage of total researchers (based on headcount)
22.a. Business Enterprise Sector: Total researchers (headcount)
22.b. Business Enterprise Sector: Women researchers (headcount)
22.c. Business Enterprise Sector: Women researchers as a percentage of total researchers (based on headcount)
22.d. Government Sector: Total researchers (headcount)
22.e. Government Sector: Women researchers (headcount)
22.f. Government Sector: Women researchers as a percentage of total researchers (based on headcount)
22.g. Higher Education sector: Total researchers (headcount)
22.h. Higher Education sector: Women researchers (headcount)

22.i. Higher Education sector: Women researchers as a percentage of total researchers (based on headcount)

Business Enterprise Expenditure on R&D (BERD):

23. Business Enterprise Expenditure on R&D -- BERD (million current PPP $)
23.a. BERD (million national currency - for euro area, pre-EMU euro or EUR)
24. BERD as a percentage of GDP 25. BERD -- (million 2000 dollars -- constant prices and PPP)
25.a. BERD -- Compound annual growth rate (constant prices)
26. BERD as a percentage of value added in industry

Business Enterprise R&D Personnel (FTE):

27. Business Enterprise researchers (FTE)
27.a. Business Enterprise researchers -- Compound annual growth rate
28. Business Enterprise researchers as a percentage of national total
29. Business Enterprise researchers per thousand employment in industry
30. Total Business Enterprise R&D personnel (FTE)
30.a. Total Business Enterprise R&D personnel -- Compound annual growth rate
31. Total Business Enterprise R&D personnel as a percentage of national total
32. Total Business Enterprise R&D personnel per thousand employment in industry

BERD by source of funds:

33. Industry-financed BERD -- (million 2000 dollars -- constant prices and PPP)
33a. Industry-financed BERD -- Compound annual growth rate (constant prices)
34. Industry-financed BERD as a percentage of value added in industry
35. Percentage of BERD financed by industry
36. Percentage of BERD financed by government
37. Percentage of BERD financed by other national sources
38. Percentage of BERD financed by abroad

BERD performed in selected industries:

39. BERD performed in the aerospace industry (million current PPP $)
39.a. Percentage of BERD performed in the aerospace industry
40. BERD performed in the electronic industry (million current PPP $)
40.a. Percentage of BERD performed in the electronic industry
41. BERD performed in the office machinery and computer industry (million current PPP $)
41.a. Percentage of BERD performed in the office machinery and computer industry
42. BERD performed in the pharmaceutical industry (million current PPP $)
42.a. Percentage of BERD performed in the pharmaceutical industry
43. BERD performed in the instruments industry (million current PPP $)
43.a. Percentage of BERD performed in the instruments industry
44. BERD performed in service industries (million current PPP $)
44.a. Percentage of BERD performed in service industries

Higher Education Expenditure on R&D (HERD):

45. Higher Education Expenditure on R&D -- HERD (million current PPP $)
45.a. HERD (million national currency - for euro area, pre-EMU euro or EUR)
46. HERD as a percentage of GDP
47. HERD (million 2000 dollars -- constant prices and PPP)
47.a. HERD -- Compound annual growth rate (constant prices)
48. Percentage of HERD financed by industry

Higher Education R&D Personnel (FTE):

49. Higher Education researchers (FTE)
49.a. Higher Education researchers -- Compound annual growth rate

50. Higher Education researchers as a percentage of national total
51. Higher Education Total R&D personnel (FTE)
51.a. Higher Education Total R&D personnel -- Compound annual growth rate

Government Expenditure on R&D:
52. Government Intramural Expenditure on R&D -- GOVERD (million current PPP $)
52.a. GOVERD (million national currency - for euro area, pre-EMU euro or EUR)
53. GOVERD as a percentage of GDP 54. GOVERD (million 2000 dollars -- constant prices and PPP)
54.a. GOVERD -- Compound annual growth rate (constant prices)
55. Percentage of GOVERD financed by industry

Government R&D Personnel (FTE):
56. Government researchers (FTE)
56.a. Government researchers -- Compound annual growth rate
57. Government researchers as a percentage of national total
58. Government Total R&D personnel (FTE)
58.a. Government Total R&D personnel -- Compound annual growth rate
Government Budget Appropriations or Outlays for R&D by socio-economic objectives (GBAORD):
59. Total Government Budget Appropriations or Outlays for R&D -- GBAORD (million current PPP $)
59.a. Total GBAORD (million national currency - for euro area: pre-EMU euro or EUR)
60. Defence Budget R&D as a percentage of Total GBAORD
61. Civil Budget R&D as a percentage of Total GBAORD
62.a.1. Civil GBAORD for Economic Development programmes (million current PPP $)
62.a.2. Economic Development programmes as a percentage of Civil GBAORD
62.b.1. Civil GBAORD for Health and Environment programmes (million current PPP $)
62.b.2. Health and Environment programmes as a percentage of Civil GBAORD
62.c.1. Civil GBAORD for Education and society (million current PPP $)
62.c.2 Education and Society as a percentage of Civil GBAORD
62.d.1. Civil GBAORD for Space programmes (million current PPP $)
62.d.2. Space programmes as a percentage of Civil GBAORD
62.e.1. Civil GBAORD for Non-oriented Research programmes (million current PPP $)
62.e.2. Non-oriented Research programmes as a percentage of Civil GBAORD
62.f.1. Civil GBAORD for General University Funds (GUF) (million current PPP $)
62.f.2. General University Funds (GUF) as a percentage of Civil GBAORD

R&D Expenditure of Foreign Affiliates:
63. R&D expenditure of foreign affiliates (million current PPP $)
63.a. R&D expenditure of foreign affiliates (million national currency - for euro area, pre-EMU euro or EUR)
64. R&D expenditure of foreign affiliates as a percentage of R&D expenditure of enterprises

Patents:
65. Number of triadic patent families (priority year) 65.a. Number of patent applications to the EPO (priority year) 65.b. Number of patent applications to the USPTO (filing year)
66. Share of countries in triadic patent families (priority year)
67. Number of patent applications to the EPO in the ICT sector - (priority year)
67.a. Number of patents granted at the USPTO in the ICT sector - (priority year)
68. Number of patent applications to the EPO in the biotechnology sector - (priority year)
68.a. Number of patents granted at the USPTO in the biotechnology sector - (priority year)

Technology Balance of Payments (TBP):
69. Technology balance of payments: Receipts (million current dollars)

69.a. Technology balance of payments: Receipts (million national currency - for euro area, pre-EMU euro or EUR)
70. Technology balance of payments: Payments (million current dollars)
70.a. Technology balance of payments: Payments (million national currency - for euro area, pre-EMU euro or EUR)
71. Technology balance of payments: Payments as a percentage of GERD

International trade in highly R&D-intensive industries:
72. Export market share: Aerospace industry
72.a. Total imports: Aerospace industry (million current dollars)
72.b. Total exports: Aerospace industry (million current dollars)
73. Export market share: Electronic industry
73.a. Total imports: Electronic industry (million current dollars)
73.b. Total exports: Electronic industry (million current dollars)
74. Export market share: Office machinery and computer industry
74.a. Total imports: Office machinery and computer industry (million current dollars)
74.b. Total exports: Office machinery and computer industry (million current dollars)
75. Export market share: Pharmaceutical industry
75.a. Total imports: Pharmaceutical industry (million current dollars)
75.b. Total exports: Pharmaceutical industry (million current dollars)
76. Export market share: Instruments industry
76.a. Total imports: Instruments industry (million current dollars)
76.b. Total exports: Instruments industry (million current dollars)

ANNEX III:
SAMPLE OF BROAD RESEARCH QUESTIONS

A sample of the broad research questions

Whilst fieldwork will be tailored to each individual country, there are some broad themes/ research questions which will help shape this research across all countries. Below is a sample of the types of questions and themes to be explored in this study. These sample questions also reflect the research priorities identified by the JMT as are listed in the Project's Terms of Reference.

Overarching Framework / Mapping:

- *What are the most eye-catching and distinctive features of this country's STI system?*
- *What are the main structures for science and innovation (institutions, policies, funding etc.)?*
- *What is the history and how rapidly are things developing?*
- *What are the key indicators and metrics that reflect the health of this system?*
- *What is the place of STI in the overall economic priorities of this country?*
- *Who are the 'home-grown heroes' of this country's science?*
- *What are the key transformational moments or snapshots of this country's science and innovation system?*
- *In which fields are the key STI strengths? What are the key areas of potential strength?*
- *How might recognised international best practices by applied or tailored to this country to promote and improve STI?*
- *What legal frameworks / regulations are in place to govern STI? What learnings from other systems might be applied /tailored to this country?*
- *What is the balance between basic and applied research in this country?*
- *How is government policy informed?*
- *How is STI promoted in this country? Does more need to be done in this regard? If so, how?*
- *Where appropriate, what is the place of STI in national development plans?*
- *How absorptive in this country to new and /or alternative technologies?*
- *How is technology diffused across the country?*
- *Where appropriate, what are the emerging centres of scientific excellence within this country? Are they internationally recognised?*

People & Human Capital:

- *Can we measure flows of scientific and research talent in and out of this system?*
- *What are the key trends in human capital production?*
- *How best can scientists, inventors and innovators be rewarded / acknowledged internationally?*
- *What are the strengths and weaknesses of the secondary and higher education system?*
- *How do the public and private institutions compare?*
- *How have university enrolment trends changed?*
- *What are the numbers of university graduates at PhD and Masters level?*
- *How well does the HE system prepare for careers in science? How employable are graduates from a business / government perspective?*
- *How do universities encourage a spirit of innovation and entrepreneurship?*
- *Is entrepreneurship / innovation embedded in the university curriculum?*
- *What place does engineering education hold within the broader STI system?*
- *Where are this country's diaspora of scientists/ entrepreneurs around the world? What impact do they have on the country's STI potential? To what extent do they contribute to international collaboration for the country?*

Places:

- *What is the current geographical distribution of STI and how are current patterns likely to change?*
- *Where are this country's science 'hotspots' and which are the places / institutions / companies to watch and why?*

- *What are the differences between the established centres and the 'rising star' cities?*
- *How strong is the divide between rich and poor within the country, and the related absorption and access to science and technology?*
- *What is the impact of different regional systems of innovation?*
- *Is STI policy governed by central and/or regional innovation policy and if so, what is the variable impact of these policy approaches?*

Business:

- *What are the innovation sectors and domains of particular strength?*
- *What is the balance between public and private sector R&D?*
- *What is the contribution of development assistance and philanthropy to R&D?*
- *How much (if any) multinational R&D takes place in this country? Is this sort of investment encouraged?*
- *How innovative is domestic enterprise? Is this changing?*
- *What is the potential for indigenous private sector R&D?*
- *Who are the major indigenous companies and are they doing cutting edge research?*
- *What mechanisms are in place to attract FDI? What other tools might be relevant?*
- *Where there is FDI, how effective has it been in transferring knowledge / skills / competitiveness into domestic industry?*
- *What is the climate for entrepreneurship / venture capital?*
- *How is entrepreneurship viewed in a cultural sense?*
- *What venture capital schemes exist? How effective are they? How might they be improved?*
- *How suited is the regulatory environment to supporting multinational R&D?*
- *Are science / tech parks and business incubators present in this country? How successful are they?*

Culture:

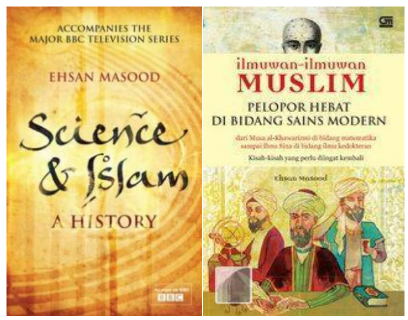
- *How does this country approach the governance and ethics of science?*
- *What role do women play in this country's STI system? How accessible are research careers to women this country?*
- *What national and institutional policies are in place to overcome obstacles faced by women in their scientific careers?*
- *How do we understand the relationship between Islam, science and politics in this country? How is this changing?*
- *What are the distinctive features of this country's STI trajectory? What do they mean for other world regions?*
- *What social / political trends have an impact on STI – such as the impact of governance / ethics systems, open source movements,*
- *What levels of public engagement are used in decision making on pertinent scientific issues*
- *What is the relationship between science and development?*
- *Is there a culture of cross-over and exchange between academia and business in this country? How successful are initiatives aimed at driving the commercialisation of research?*

Collaboration:

- *How well connected is this country to research and innovation hubs in Europe, the US, Canada, Japan, China, India and elsewhere?*
- *Which other Islamic world countries does this country collaborate with on science, and how have these relationships changed / evolved? Are they based on historical ties or more current drivers? To what extent does their country's OIC membership drive collaboration?*
- *How successful is the currently collaboration between this country and others?*
- *How can international collaboration be strengthened? What are the barriers to this?*
- *What are the boosts and barriers to collaborating in and with this country?*
- *What is the relationship between the country's foreign policy and its scientific collaborations?*
- *How have the flows of this country's students overseas or foreign students coming there influenced international collaboration trends?*

The Landscape of Science in the Islamic World: Historically and Contemporaneously

EHSAN MASOOD
Nature Magazine
United Kingdom



Masood's First Law of science policy

"Science doesn't come cheap"

Glorious-Past Lesson #1

"If you are a donor, be generous to your scientists."

Glorious-Past Lesson #2

"Try not to attack the beliefs of those you want to influence"

Glorious-Past Lesson #3

"Avoid Black Box Syndrome"

Read this book

Science and Learning in the Ottoman Empire

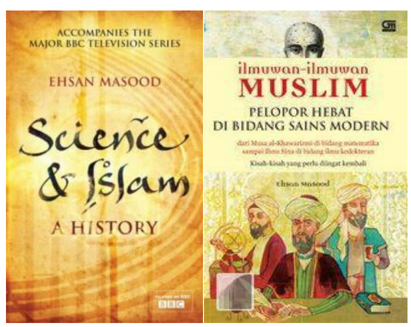
By Ekmeleddin Ihsanoglu

(Ashgate, 2006)

Glorious-Past Lesson #4

"Practise what you preach"

Thank-you, IAS, Unisel & IIALSB



PART FIVE

KNOWLEDGE SOCIETY AND THE BUSINESS SECTOR

Addressing the Challenges of the Knowledge Society: Charting the Way Forward for OIC Countries

MOHD AZZMAN SHARIFFADEEN
Fellow, Academy of Sciences Malaysia
Kuala Lumpur, Malaysia

ABSTRACT

This discussion addresses the challenges faced by OIC countries in Knowledge Society development by applying two frameworks. First, the 7i econometric model developed by M Nair is applied to analyse the current positions and ranking of OIC countries in innovation capacity vis-à-vis the leading countries of the world. The ability to empirically measure the innovation capacity of each country in relation to its peers, and to simulate potential future innovation trajectories, provides an effective means of analyzing and formulating proactive paths to accelerated development. Second, the author has used the *Maqasid al Shari'ah* as the foundation to develop a systems view of a Knowledge Society and a Knowledge Economy that is compatible with the basic precepts of Islam. The dynamic linkages between key social, economic and spiritual dimensions that become visible through this analytical framework enable the formulation of the strategic vision, mission and goals of a sustainable Knowledge Society and Knowledge Economy. Taken together, these two complementary frameworks enable effective policy analysis and strategic planning in knowledge-based development. A holistic and comprehensive view of human development is produced that integrates the three key relationships that condition life on earth: the relationship between humankind and the Creator; the relationship between fellow human-beings and the relationship between humankind and the natural order.

We conclude the discussion by suggesting a way forward for OIC countries to chart their path towards increased innovation through knowledge-based development and thereby enhance the well-being of their citizens.

Key questions

- Why have knowledge societies and knowledge economies become important?
- What lessons can we learn from recent efforts in initiating transformation to a knowledge society?
- How do we frame the challenges in knowledge society development for OIC countries?
- How do we chart the way forward in addressing these challenges?

Figure 1. Key Questions.

Islam – the religion of knowledge (‘*ilm*), appealing to reason (*aql*)

All knowledge comes from Allah, “all-knower of everything” (24:35). Three “books” containing the signs (*ayat)* of Allah have been provided to man which serve as Divine sources of knowledge:

- Quran: blessings confirming revelation (6:92); truth to give glad tidings and warn (17:105); book of wisdom (10:1, 31:2, 36:2); guide and mercy (16:64); taught by God (60:2)
- World of nature: signs in creation of heavens and earth (2:164, 3:190); in nature and all creation (10:5~6, 30: 20~27, 45:3~6)
- Signs in our own souls (*nafs*) (41:53, 51:21)

Figure 2. Islam – the Religion of Knowledge *(‘ilm)*, Appealing to Reason *(aql).*

Knowledge is what makes us human – so what is new?

- Barriers that have separated human societies are being dismantled to create borderless world; rise of connected societies spanning the globe
- Open communication and interaction between diverse cultures with their own systems of knowledge enriches human life
- ICT expands possibilities for sharing, storing and accessing knowledge
- Knowledge and intellectual capital have become the most important resource
- Traditional industrial production ceases to provide high growth and development

Figure 3. Knowledge is What Makes us Human – so what is New?

Knowledge and ICT in contemporary development context

- Technology
- Tool
- Industry and economic sector
- Infrastructure
- Network
- Channel for multimedia content
- Enabler of social and economic advancement

Figure 4. Knowledge and ICT in Contemporary Development Context.

Potential impact of knowledge and ICT

- ICT: premier bearer of information and codified knowledge
- Transformation to knowledge societies and economies
- Knowledge enhances capacity to take action: economic, social, political, etc
- Economic value and performance function of knowledge intensity

Figure 5. Potential Impact of Knowledge and ICT.

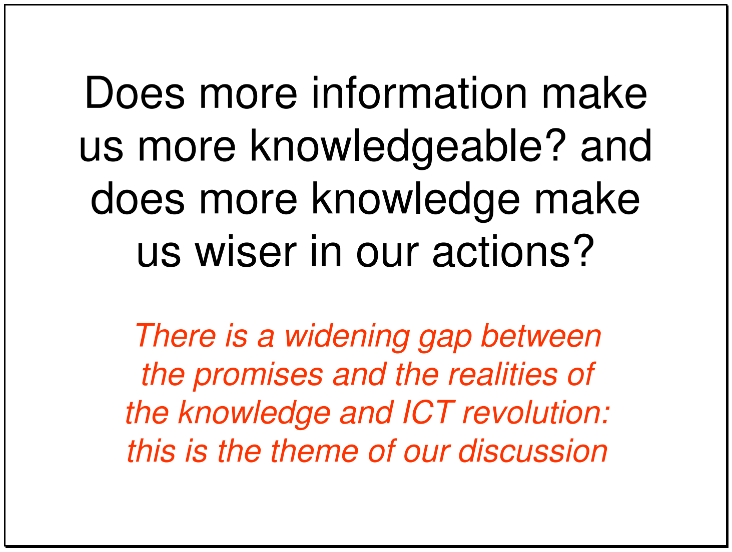


Figure 6. Does More Information Make us More Knowledgeable? And Does More Knowledge Make us Wiser in our Actions?

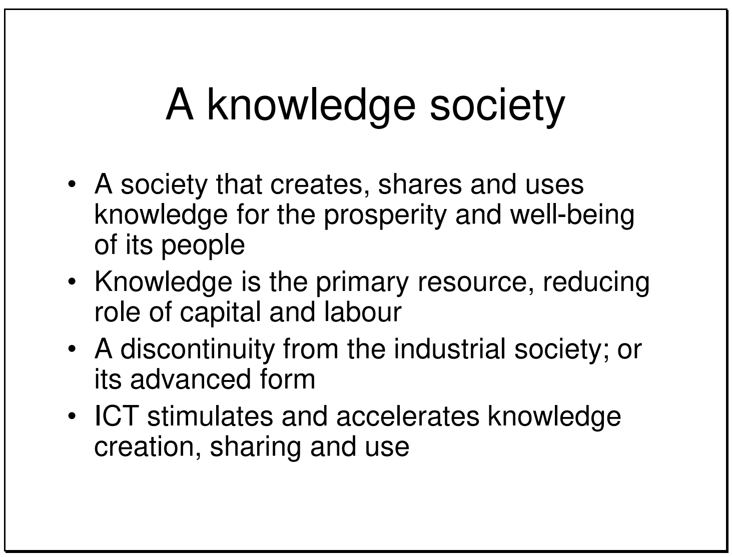


Figure 7. A Knowledge Society.

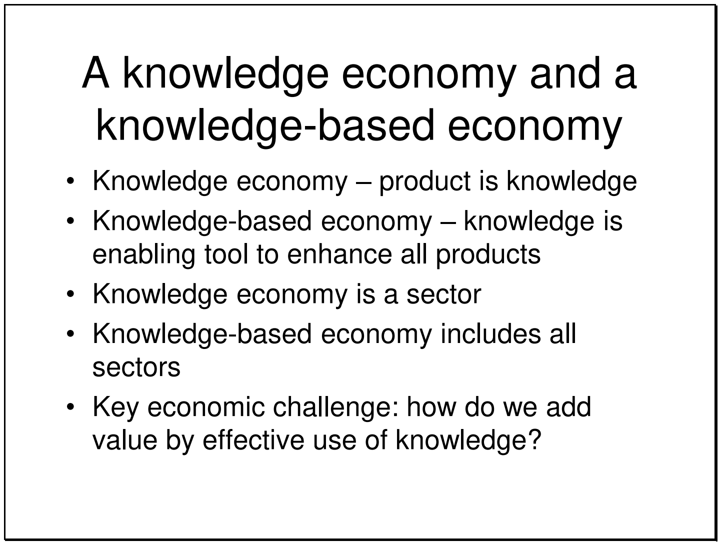


Figure 8. A Knowledge Economy and a Knowledge-Based Economy.

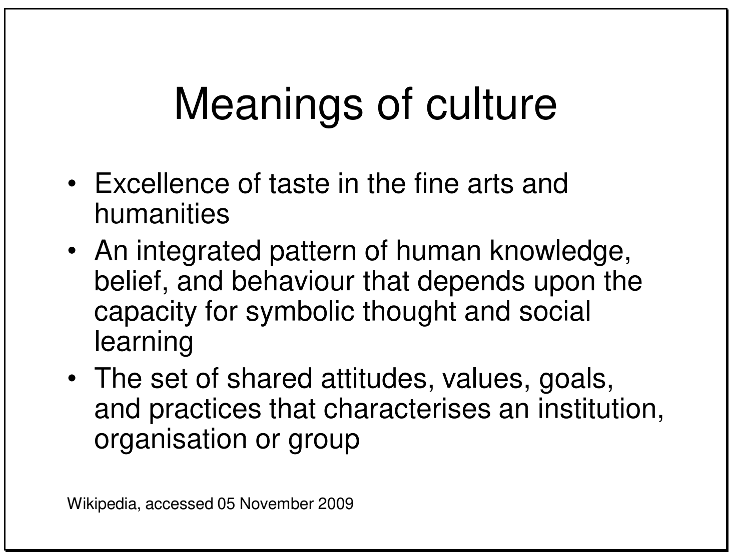


Figure 9. Meanings of Culture.

Innovation

- A new way of doing something
- Invention is not innovation
- Ideas applied successfully in practice
- Value and wealth creation is desired outcome
- Many kinds of innovation, but much life-changing transformation based on new knowledge in S&T
- Key role of public policy and strategy
- Importance of National Innovation Eco-system

Figure 10. Innovation.

An innovation culture

- "an integrated pattern of human knowledge, belief, and behaviour" that embraces innovation
- "the set of shared attitudes, values, goals, and practices that characterises an institution, organisation or group" that promotes innovation

Figure 11. An Innovation Culture.

Key features of an innovation culture 1/2

1. Mindset and attitudes
   - Embrace transformative change to knowledge society and economy as natural
   - Curiosity and inventiveness
   - All are capable of being creative and innovative
   - Become masters of change, not its victim
   - We can make a difference
   - Risk-taking and tolerance for failure
2. Values
   - Continuous learning and improvement
   - Shared vision
   - Openness
   - Trust in others – to share and borrow ideas
   - Integrity

Figure 12. Key Features of an Innovation Culture 1/2.

Key features of an innovation culture 2/2

3. Goals
   - Sustainable development enhanced by innovation
   - Well-being of citizens
   - Safeguard of human and natural environment
   - Just rewards for innovators
4. Practices
   - Top-down strategic planning complemented with bottom-up idea generation
   - Entrepreneurship – can be learned
   - Objective analysis based on empirical data
   - Institution and capacity building
   - Execution and implementation are keys to success

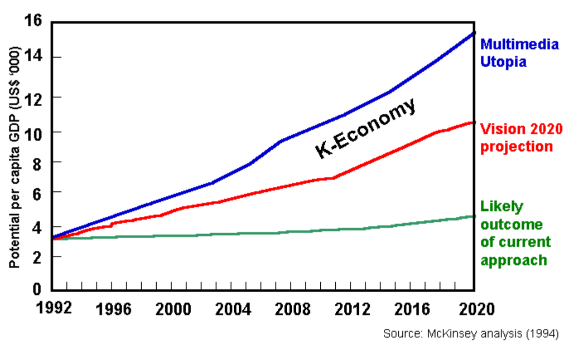
Figure 13. Key Features of an Innovation Culture 2/2.

Malaysia's Vision 2020 -
visionary development based on value system

- Malaysia … a developed country in our own mould
- a fully developed country by the year 2020: a united nation, with a confident Malaysian society, infused by strong moral and ethical values, living in a society that is democratic, liberal and tolerant, caring, economically just and equitable, progressive and prosperous, and in full possession of an economy that is competitive, dynamic, robust and resilient
- fully developed in terms of national unity and social cohesion, in terms of our economy, in terms of social justice, political stability, system of government, quality of life, social and spiritual values, national pride and confidence
- most important resource of any nation: the talents, skills, creativity and will of its people

Figure 14. Malaysia's Vision 2020.

Confronting Knowledge Economy with a wake-up call:
employ empirical evidence to unleash passion for change



Export-oriented industrial growth would not take Malaysia to Vision 2020 economic targets - (ICT) became the vehicle to make the quantum jump

Figure 15. Confronting knowledge Economy with a Wake-up Call: Employ Empirical Evidence to Unleash Passion for Change.

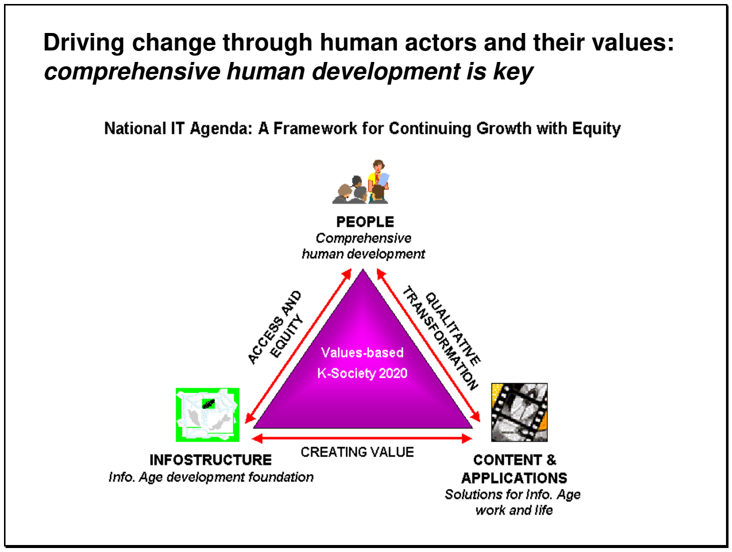


Figure 16. Driving change through human actors and their values: comprehensive human development is key.

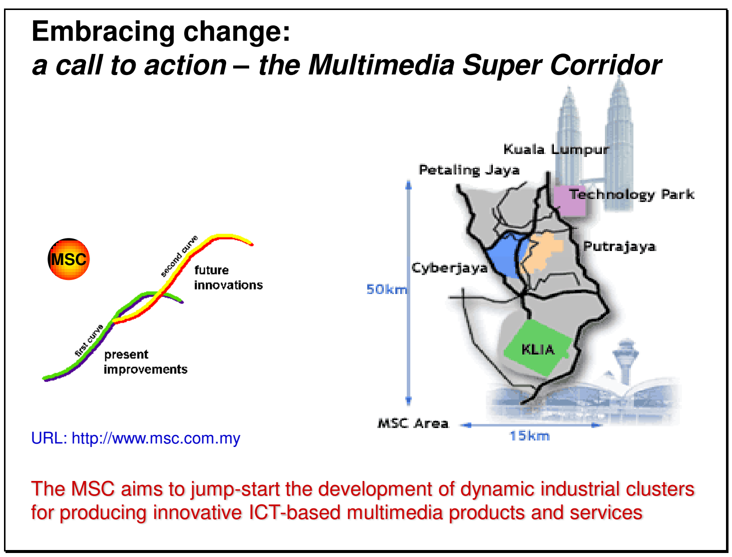


Figure 17. Embracing Change: a Call to Action – the Multimedia Super Corridor.

Changing the rules of the game:
MSC key features to attract investment

- Seven Flagship Applications
- Ten-point Bill of Guarantees
- One-stop implementing agency
- Cyberlaws and IP laws
- Cyber city: green-field site with comfortable living environment and advanced ICT infrastructure
- Strong government support

**Figure 18. Changing the Rules of the Game:
MSC key Features to Attract Investment.**

Applying lessons learned to a Middle-East country:
use visionary and strategic approach based on culture and values to reposition country

- Coaching, not consulting: build indigenous capacity
- Applying state-of-art strategic planning processes to explore visionary change
- Starting from belief system: invoke culture and values
- Reducing risk: work with independent think tank outside mainstream system
- Engaging key stakeholders: make it inclusive and participative
- Generating solutions: productise for implementation

**Figure 19. Applying Lessons Learned to a Middle-East country:
use visionary and strategic approach based on culture and values to reposition country.**

Heart of change

He will never change the condition of a people until they change it themselves (with their own souls) (13:11)

Figure 20. Heart of Change.

Twin pillars for initiating transformation

- A soft approach – touching the heart through spiritual principles and cultural values
- Complement with hard facts – using econometric modelling to provide empirical analysis and apply rational thinking

Figure 21. Twin Pillars for Initiating Transformation.

Maqasid al Shari'ah

"The very objective of the *Shari'ah* is to promote the well-being of the people, which lies in safeguarding their faith (*din*), their self (*nafs*), their intellect (*'aql*), their posterity (*nasl*) and their wealth (*mal*). Whatever ensures the safeguard of these five serves public interest and is desirable and whatever hurts them is against public interest and its removal is desirable."

Al Ghazzali, *al Mustasfa*

Figure 22. Maqasid al Shari'ah.

Din (faith)

- Provides strategic vision, intent and purpose
- Goal of creating a community which is at peace
- Shapes values, mindset, attitudes and behaviour of community members individually and collectively
- Strengthens brotherhood, solidarity and mutual trust
- Protecting life, property and dignity of every individual
- Safeguarding natural environment
- Promotes socio-economic justice and hinders injustice
- Provides foundation for enabling environment to development

Figure 23. Din (faith).

Nafs (self)

- Change must be driven from *nafs*
- Man given freedom, conscience, intellect, knowledge and Divine Guidance
- Man created in Creator's image: innate tendency towards the good
- All action towards the good is *ibadah*
- Man's forgetfulness needs continuous renewal of faith
- Man as *khalifah*: honour and dignity among all created beings
- Resources in natural world entrusted to man to fulfill needs of all in serving the Creator

Figure 24. Nafs (self).

Aql (intellect)

- Specific instrument of *nafs*: rational thinking and objective knowledge to meet challenges
- Revelation and reason interdependent, both necessary
- Reason used to derive knowledge from revelation – learning for life
- Well-ordered societies arising from disciplined use of intellect make possible human civilisation
- Education obligatory to train the intellect

Figure 25. Aql (intellect).

Mal (wealth)

- Trust from God, to be used for human well-being and environmental preservation
- A balanced life: neither asceticism nor pursuit of wealth for its own sake encouraged
- Neither materialism nor denial of material comfort
- Equitable distribution and poverty eradication encouraged: *zakah, waqf, sadaqah*

Figure 26. Mal (wealth).

Nasl (posterity)

- Continuous improvement: physically, mentally and spiritually
- Solidarity of society starting with family
- Moral and technical education
- Health and basic need fulfillment
- Avoidance of debt burden
- Clean and healthy natural environment
- Equitable use of natural resources leading to sustainability

Figure 27. Nasl (posterity).

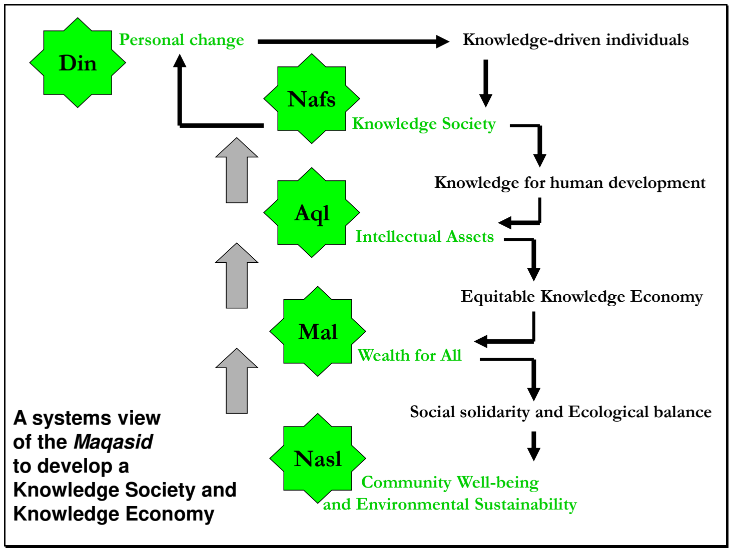


Figure 28.

Figure 29. Maqasid al Shariah as Foundation of Knowledge Society Development.

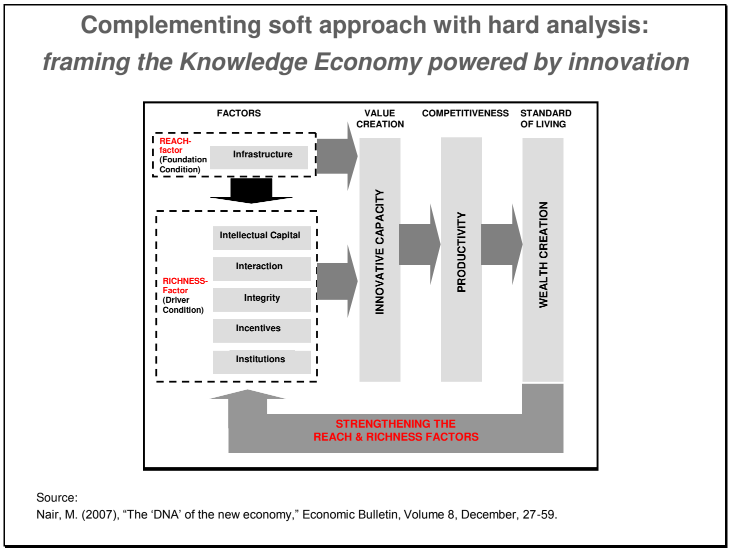


Figure 30. Complementing soft approach with hard analysis: framing the Knowledge Economy powered by innovation.

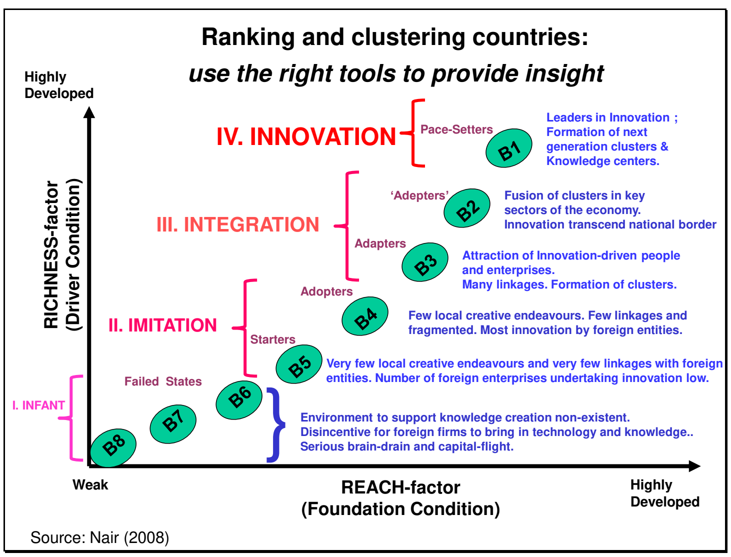


Figure 31. Ranking and Clustering Countries: Use the Right tools to Provide Insight.

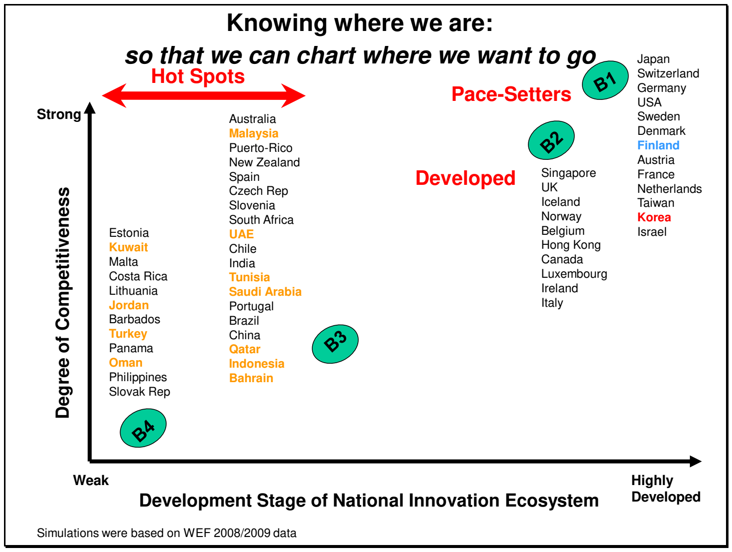


Figure 32. Knowing Where We Are:
So That We can Chart Where We Want to go.

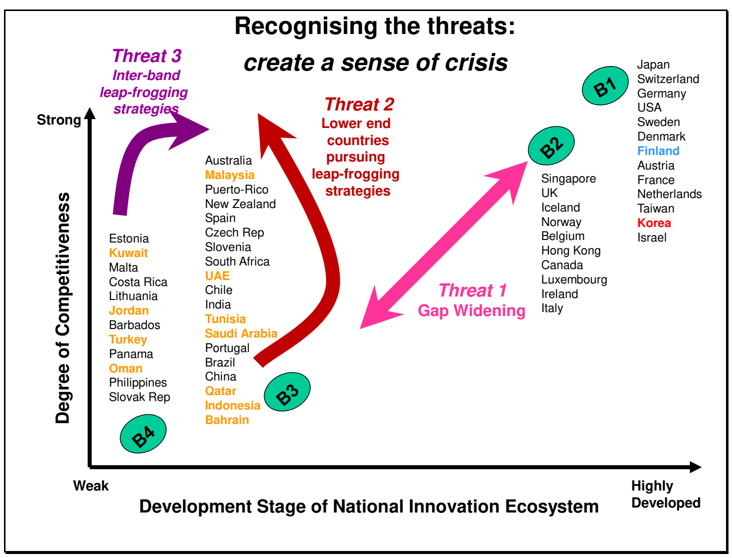


Figure 33. Recognising the Threats: Create a Sense of Crisis.

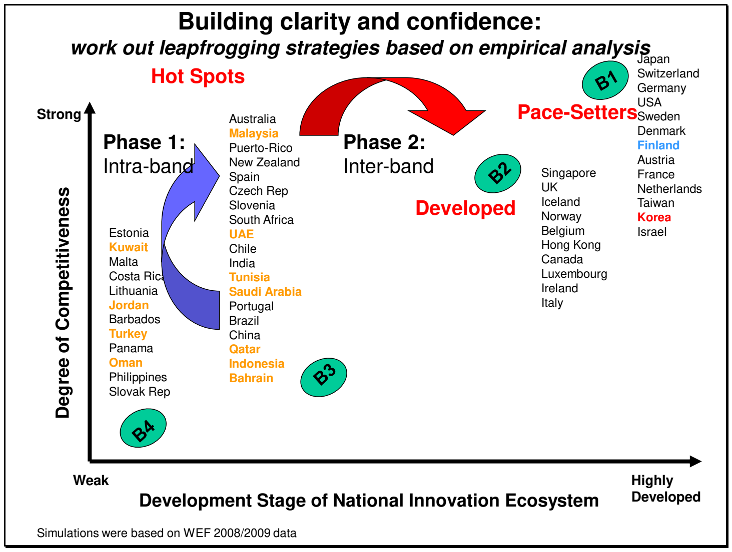


Figure 34. Building Clarity and Confidence.

Challenges in knowledge society development

- Political will and leadership
- Conceiving a knowledge society according to Islamic precepts – the vision
- Planning and implementing its establishment
- Mobilising sources of knowledge for development
- Building indigenous capacity – human capital, institutions, linkages
- Increasing innovation

Figure 35. Challenges in Knowledge Society Development.

Charting the way forward

- Change comes from within – begin transformation journey from Islamic principles
- Touch hearts and minds of community members to initiate sustained transformation
- Strengthen visionary leadership and political will by effective use of soft and hard approaches
- Build human capacity and institutions
- Enhance National Innovation Eco-system
- Exemplary execution will ensure success

Figure 36. Charting the Way Forward.

Closing remarks

- Initiate community-wide transformation from within – *Maqasid al Shar'iah* provides robust foundation
- Apply rational methods based on empirical evidence – 7i framework has demonstrated effectiveness for strategic planning
- Key role of leadership – at all levels
- Create networks to share knowledge and experience

Figure 37. Closing Remarks.

thank you
for
your attention

Supplementary materials

Vision 2020 nine challenges

- The first of these is the challenges of establishing a united Malaysian nation with a sense of common and shared destiny. This must be a nation at peace with itself, territorially and ethnically integrated, living in harmony and full and fair partnership, made up of one 'Bangsa Malaysia' with political loyalty and dedication to the nation.
- The second is the challenge of creating a psychologically liberated, secure, and developed Malaysian Society with faith and confidence in itself, justifiably proud of what it is, of what it has accomplished, robust enough to face all manner of adversity. This Malaysian Society must be distinguished by the pursuit of excellence, fully aware of all its potentials, psychologically subservient to none, and respected by the peoples of other nations.
- The third challenge we have always faced is that of fostering and developing a mature democratic society, practising a form of mature consensual, community-oriented Malaysian democracy that can be a model for many developing countries.
- The fourth is the challenge of establishing a fully moral and ethical society, whose citizens are strong in religious and spiritual values and imbued with the highest of ethical standards.
- The fifth challenge that we have always faced is the challenge of establishing a matured,liberal and tolerant society in which Malaysians of all colours and creeds are free to practise and profess their customs,cultures and religious beliefs and yet feeling that they belong to one nation.
- The sixth is the challenge of establishing a scientific and progressive society, a society that is innovative and forward-looking, one that is not only a consumer of technology but also a contributor to the scientific and technological civilisation of the future.
- The seventh challenge is the challenge of establishing a fully caring society and a caring culture, a social system in which society will come before self, in which the welfare of the people will revolve not around the state or the individual but around a strong and resilient family system.
- The eighth is the challenge of ensuring an economically just society. This is a society in which there is a fair and equitable distribution of the wealth of the nation, in which there is full partnership in economic progress. Such a society cannot be in place so long as there is the identification of race with economic function, and the identification of economic backwardness with race.
- The ninth challenge is the challenge of establishing a prosperous society, with an economy that is fully competitive, dynamic, robust and resilient.

Figure 38. Vision 2020 Nine Challenges.

MSC Seven Flagship Applications

- e-Government
- Smart Schools
- Tele-health
- R&D clusters
- Multi-purpose card
- e-business
- Technopreneur development

And two special initiatives

- Creative multimedia cluster
- Outsourcing and shared services centre

Figure 39. MSC Seven Flagship Applications.

MSC Bill of Guarantees

- Provide a world-class physical and information infrastructure
- Allow unrestricted employment of local and foreign knowledge workers
- Ensure freedom of ownership by exempting companies with MSC status from local ownership requirements
- Give the freedom to source capital globally for MSC infrastructure, and the right to borrow funds globally
- Provide competitive financial incentives, including no income tax for up to 10 years or an investment tax alllowance, and no duties on import of multimedia equipment
- Become a regional leader in intellectual property protection and cyberlaws
- Ensure no Internet censorship
- Provide globally competitive telecommunications tariffs
- Tender key MSC infrastructure contracts to leading companies willing to use the MSC as their regional hub
- Provide an effective one-stop agency – Multimedia Development Corporation

Figure 40. MSC Bill of Guarantees.

Cyberlaws and Intellectual Property Laws

- Communications and Multimedia Act 1998
- Malaysian Communications and Multimedia Commission Act 1998
- Digital Signature Act 1997
- Computer Crimes Act 1997
- Telecommunications Act 1997
- Optical Discs Act 2000
- Copyright Act 1987
- Trade Marks Act 1976
- Patents Act 1983
- Industrial Designs Act 1996
- Layout Designs of Integrated Circuits Act 2000
- Geographical Indicators Act 2000
- Trade Description Act 1972
- Intellectual Property Corporation of Malaysia Act 2002
- E-commerce Act 2006

Figure 41. Cyber laws and Intellectual Property Laws.

Opportunities and Challenges in Creating a Knowledge-Based Economy: A Viewpoint from the International Private Sector

QUSAI SARRAF
Chief Executive Officer
IVIS Group
London, UK

ABSTRACT

Qusai Sarraf, CEO of e-business pioneer IVIS Group will define the concept of knowledge workers from a practical and commercial perspective. He will then explain how critical it is for us to be ready for the new paradigm aggressively emerging. The presentation will focus on the opportunities and challenges facing us as we build our knowledge-based economy. Mr. Sarraf will also explain how his company built commercial applications using Business Rules to solve real-world knowledge, content and information management challenges. Examples from a number of industry sectors will be provided to demonstrate how to deliver results in complex multi-department, multi-business process environments by empowering the knowledge and workflow owners.

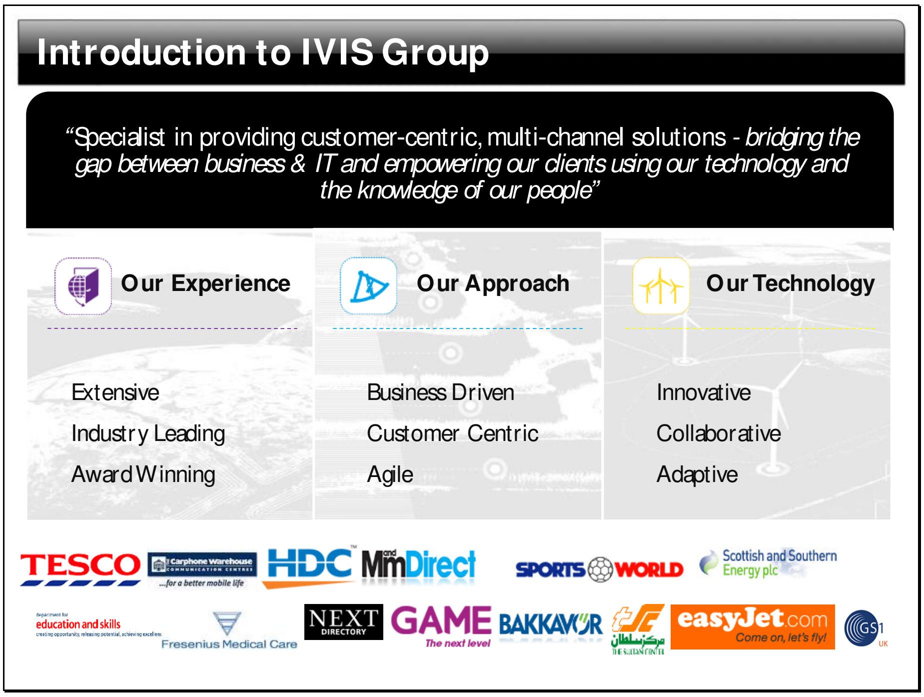


Figure 1. Introduction to IVIS Group.

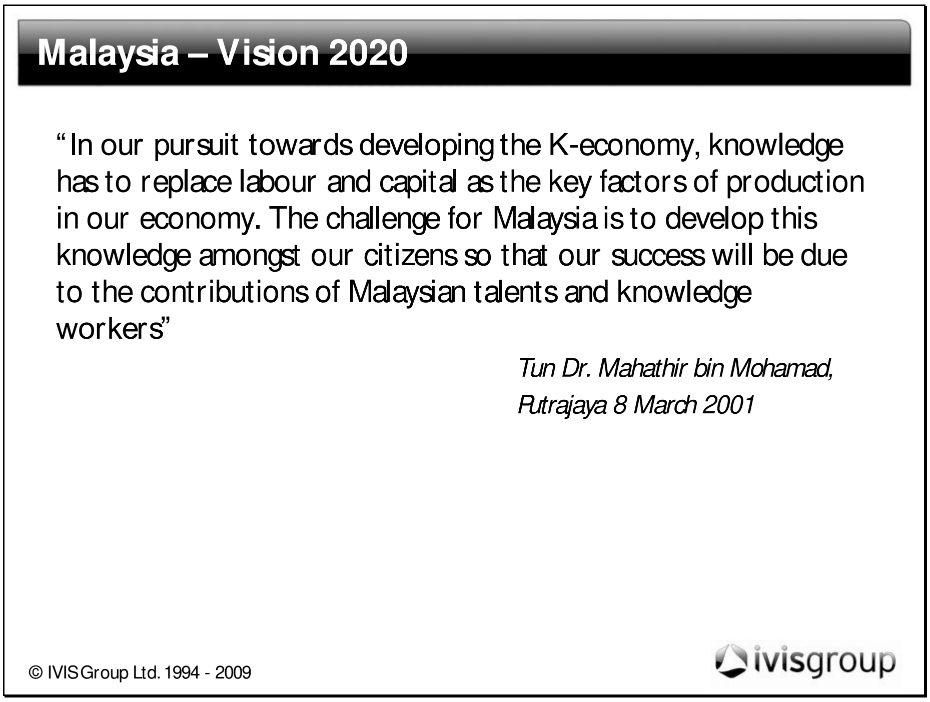


Figure 2. Malaysia – Vision 2020.

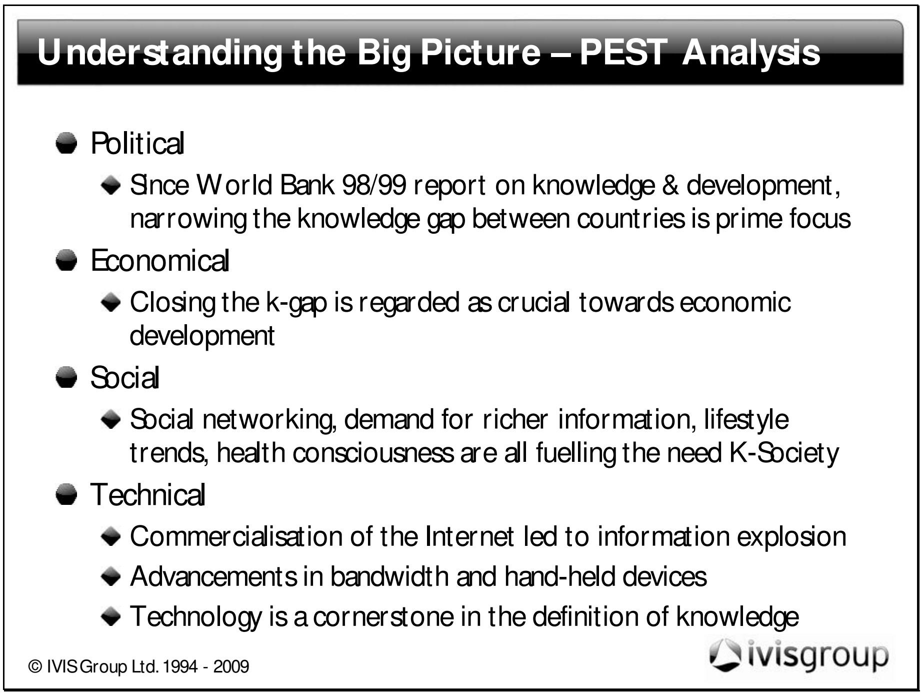


Figure 3. Understanding the Big Picture –PEST Analysis.

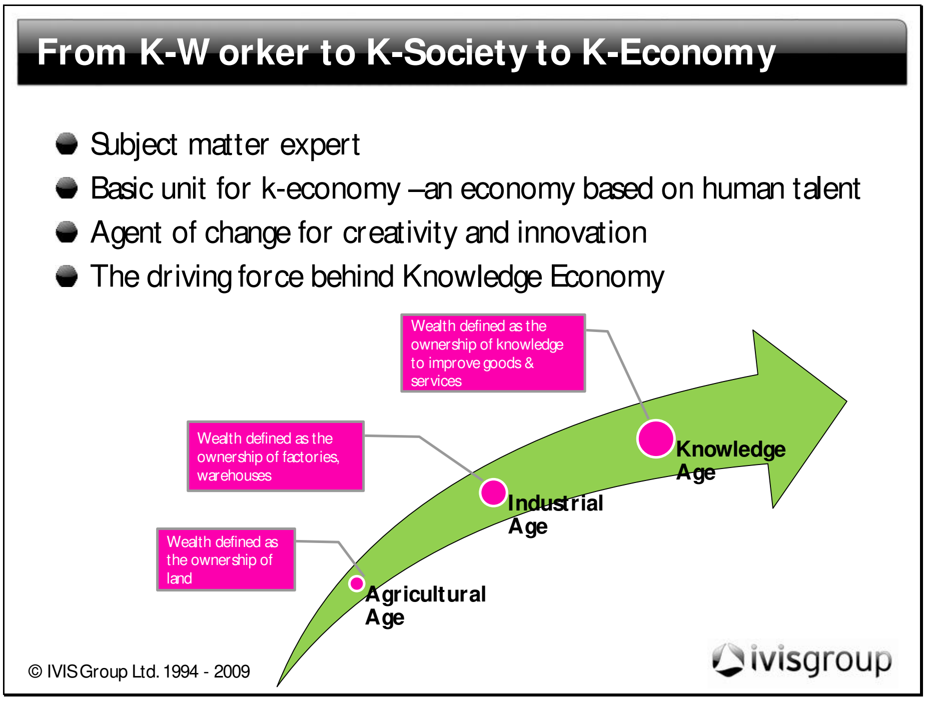


Figure 4. From K-Worker to K-Society to K-Economy.

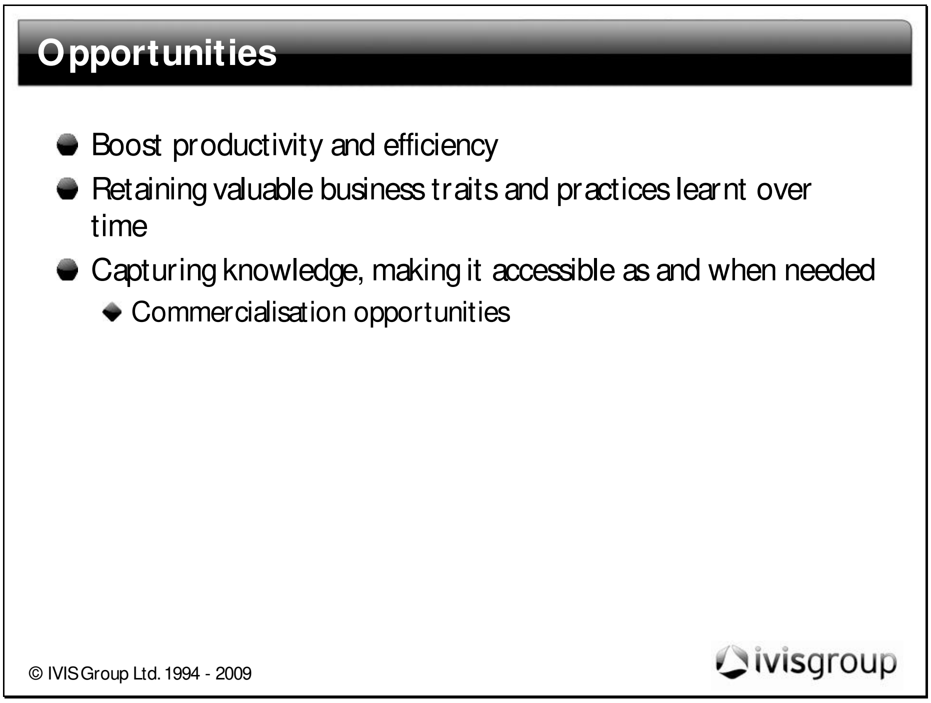


Figure 5. Opportunities.

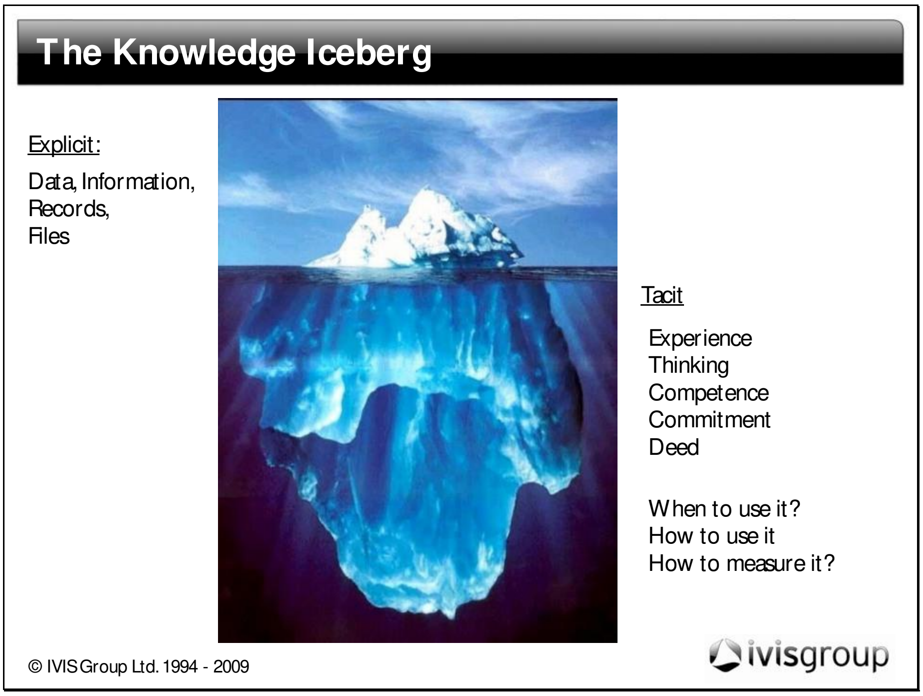


Figure 6. The Knowledge Iceberg.

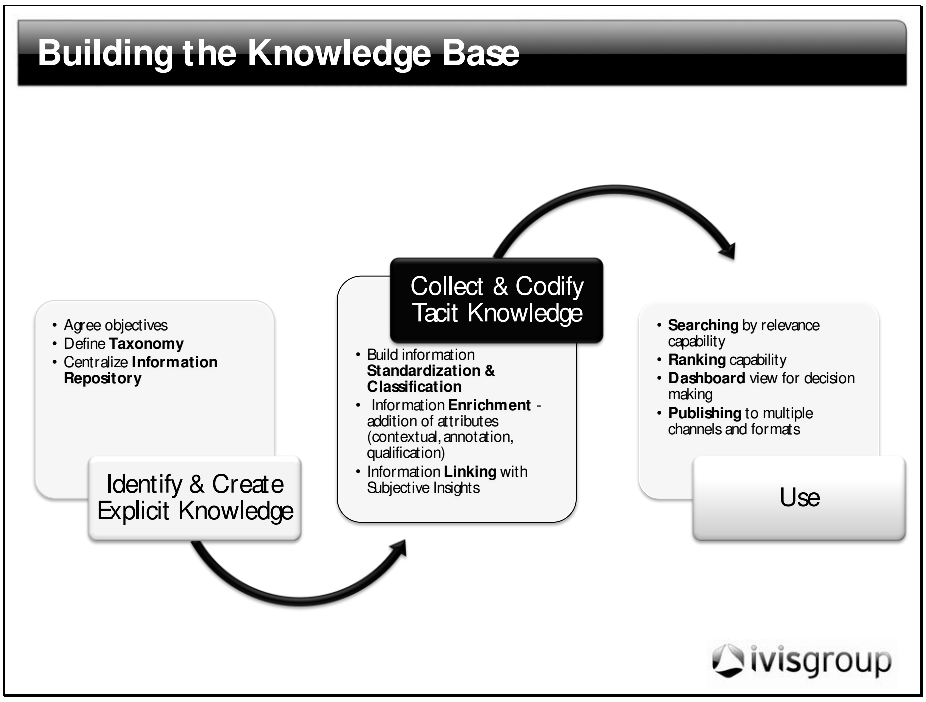


Figure 7. Building the Knowledge Base.

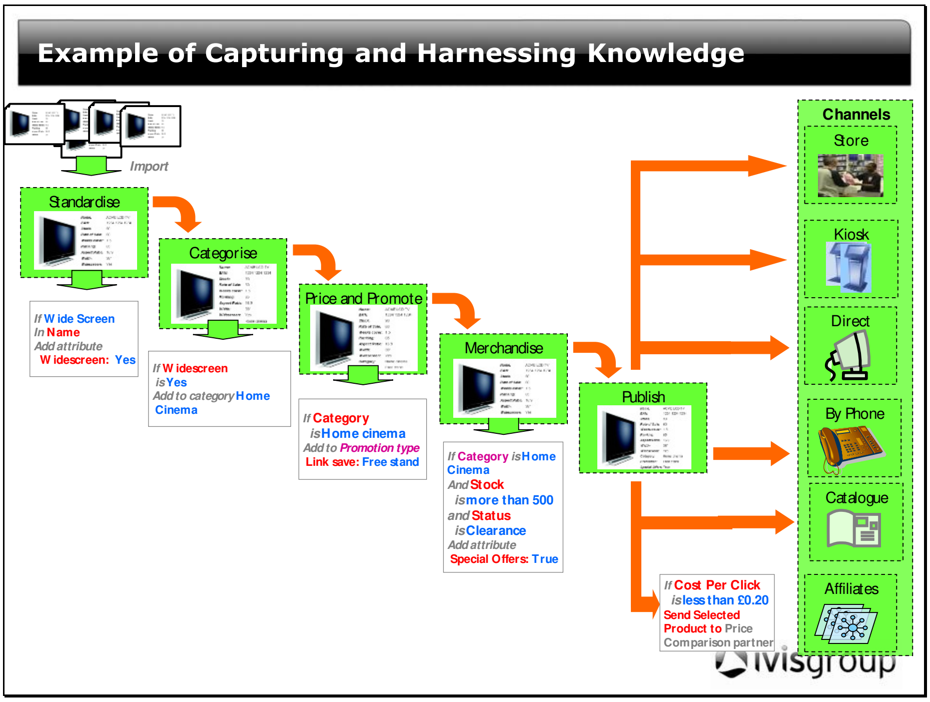


Figure 8. Example of Capturing and Harnessing Knowledge.

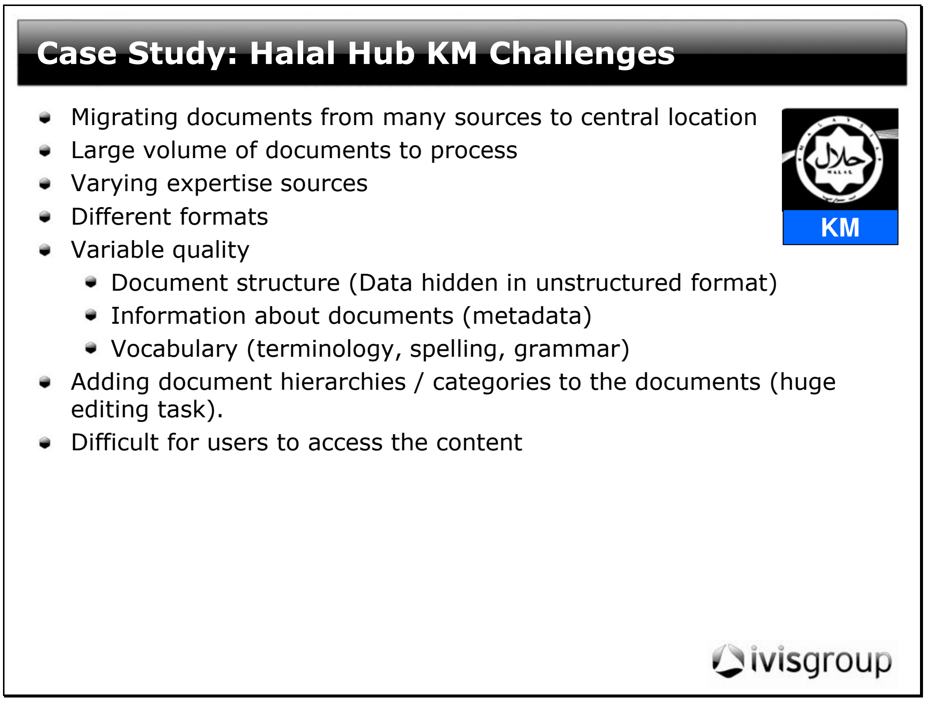


Figure 9. Case Study: Halal Hub KM Challenges.

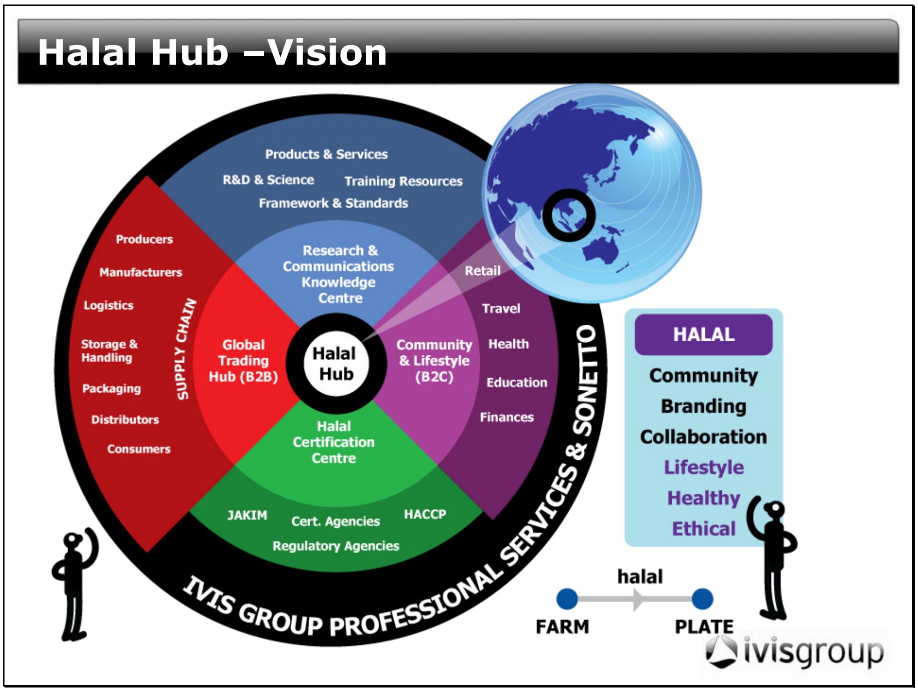


Figure 10. Halal Hub – Vision.

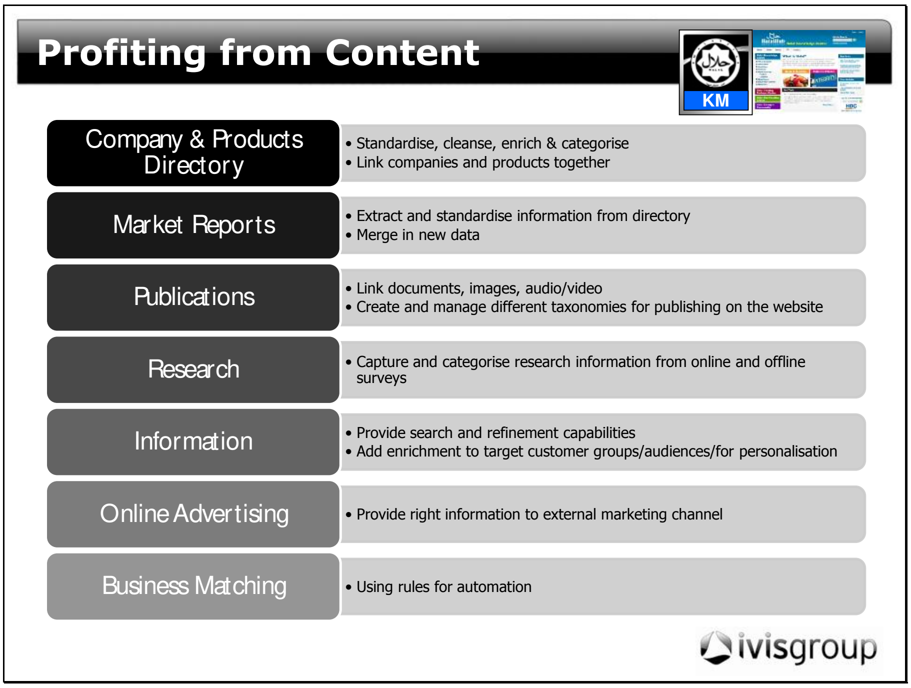


Figure 11. Profiting from Content.

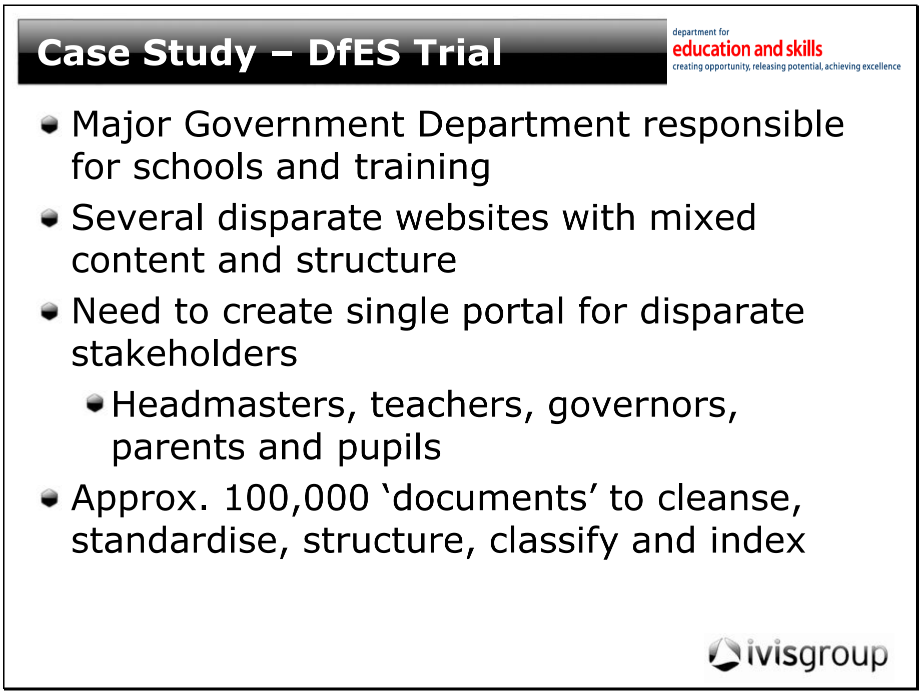


Figure 12. Case Study – DfES Trial.

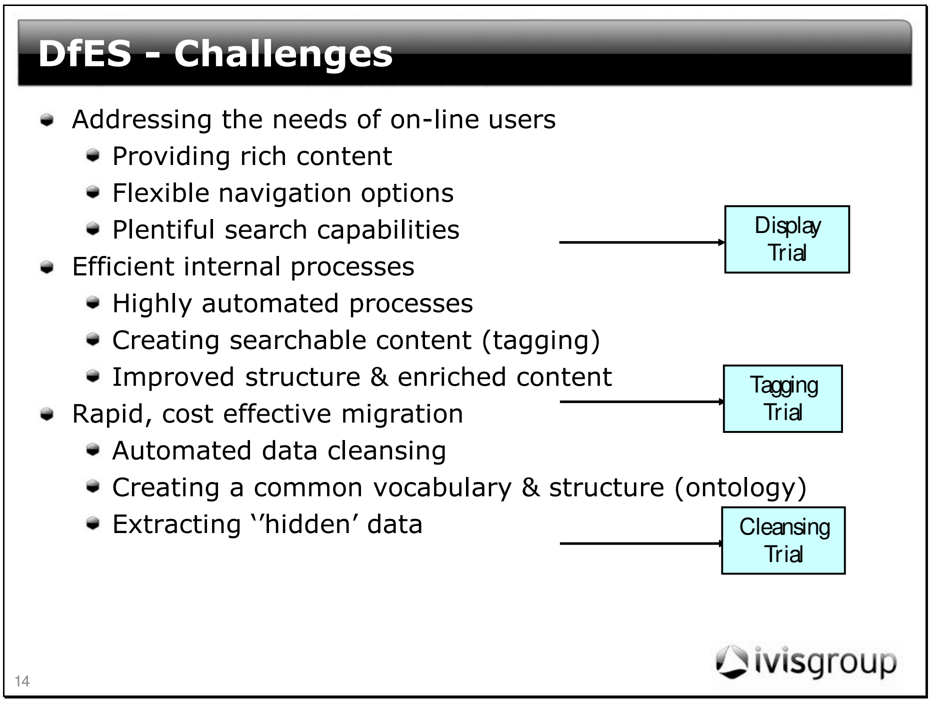


Figure 13. DfES – Challenges.

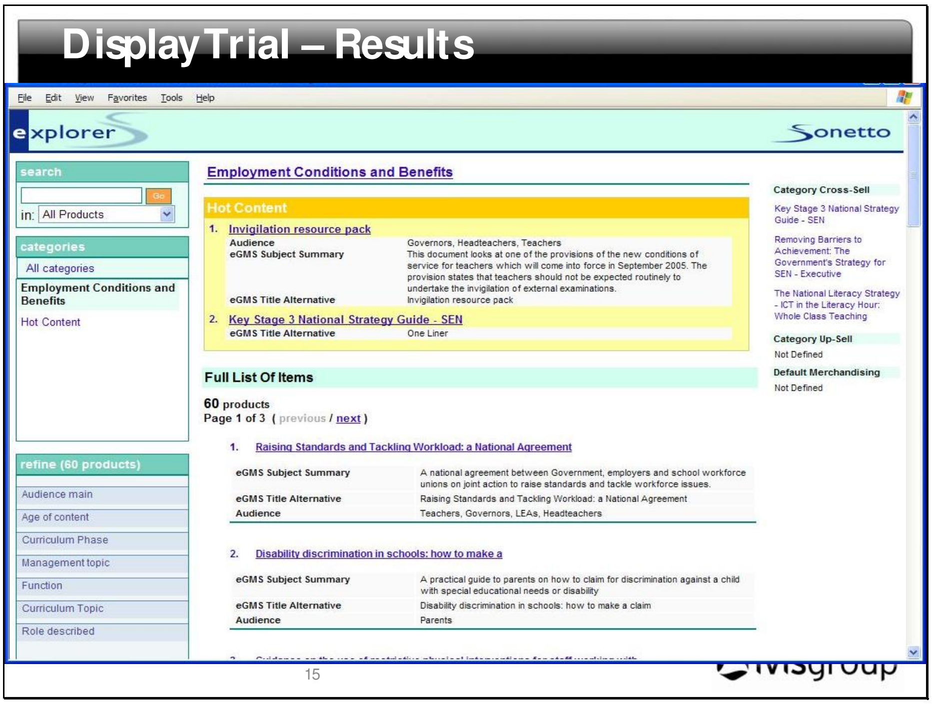


Figure 14. Display Trial – Results.

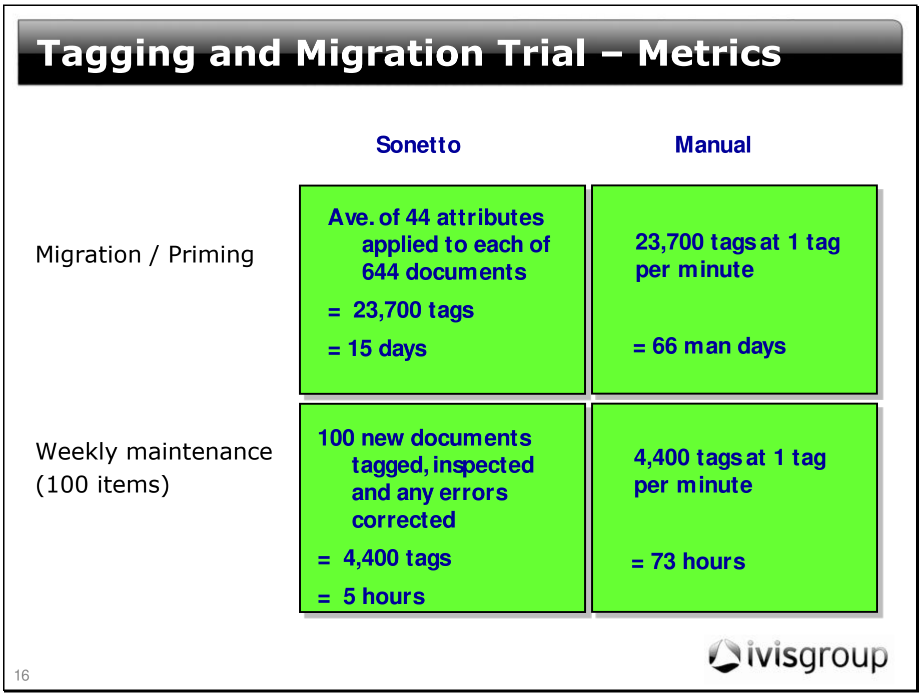


Figure 15. Tagging and Migration Trial – Metrics.

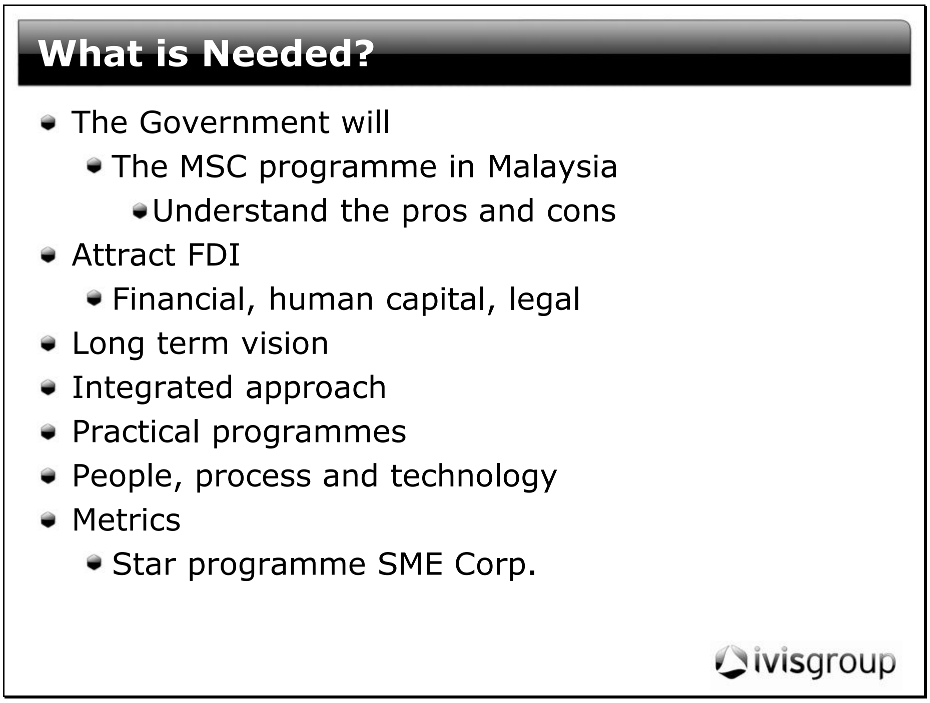


Figure 16. What is Needed?

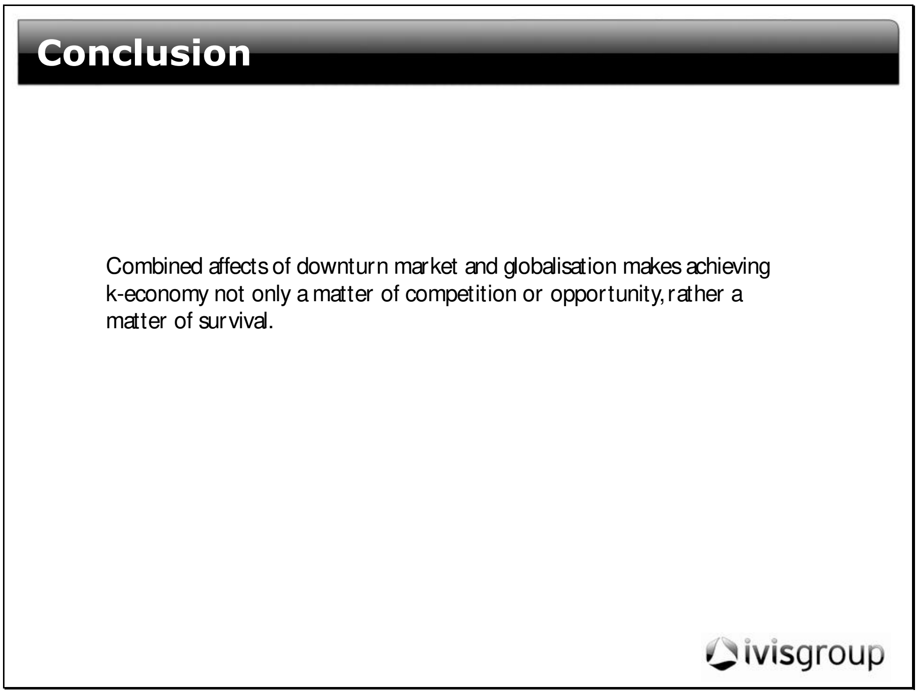


Figure 17. Conclusion.


End of presentation
ivisgroup
Multi-Channel Experts

Knowledge Workers in a Globalised World: From America to South East Asia

MICHAEL ALEXANDER GRIMES
President, EnvironTeq
Thailand

1 ABSTRACT

This presentation will attempt to expand on the understanding of Knowledge Workers in a Globalised World. First I will discuss the meaning of Globalization from the view point of the US, Asia and the world. Next I will cover Knowledge Workers again from the view point of the US, Asia and the world. Then I will give a general overview of the IT field in the US from a worker's point of view from the 80s to today. We will then discuss Going Global both from the US point of view both the internal and external impacts and benefits. I will then cover my move from the US to Asia and my experience, work and business ethics, and practices in the IT business. Finally I will talk about Education and Knowledge Workers as to what is seen in graduates today, what is needed from a global view and its benefits and impacts to the local economies and countries. Throughout the entire presentation I hope to convey my recommendations for future graduates on what skills they need to nurture to succeed in both a local and global economy.

I will also be giving a short overview of my current endeavor with my company EnvironTeq to provide green solutions to energy savings and greenhouse gas reductions with inexpensive technologies to Thailand.

2 ABOUT ME

I graduated from Portland State University 1982 with a degree in Computer Information Systems. I moved to San Francisco as at that time it was the center for IT and computers. I have over 20 years of experience in the IT field with over 10 years as Technical Management and Leadership. My experience includes many subjects and skills that include research, technical documentation, business strategies and opportunities, service level development and agreements, help desk support, prototyping, statistic analysis reporting, data architecture and database management, Quality Assurance and Quality control, vendor and client management, cross platform application development and project and process management, with skills in many operating systems, languages and databases.

I have had the opportunity to work with many well-known companies in the San Francisco/ Silicon Valley area over the years such as Citibank, McKesson Corporation, Wells Fargo, Intuit (developer of Quicken), and Charles Schwab, just to name a few.

I continued my education in the 90s to expand on management skills which I brought back to many of these companies through offering classes on process and management skills to the IT staff as well as championing the concepts of Self-Managed teams where management learns to manage the job not the person.

Today I continue my research and technical writing as a contractor, managing a startup company developing green energy savings technology and teaching martial arts in Thailand. I spend time with local colleges helping develop classes and courses for instructors on air-conditioning maintenance and energy saving technologies.

My startup company is called EnvironTeq and our first product that we are bringing to the market is converting air-conditioning systems to use Hydrocarbon refrigerants as an alternative to the harmful ozone depleting and greenhouse emitting F-Gasses. This also brings an added benefit to our customers with an energy saving of 25% or more.

3 GLOBALIZATION

Wikipedia defines globalization as:

Globalization (or globalisation) describes an ongoing process by which regional economies, societies, and cultures have become integrated through a globe-spanning network of communication and exchange. The term is sometimes used to refer specifically to economic globalization: the integration of national economies into the international economy through trade, foreign direct investment, capital flows, migration, and the spread of technology. However, globalization is usually recognized as being driven by a combination of economic, technological, socio-cultural, political, and biological factors. The term can also refer to the transnational circulation of ideas, languages, or popular culture.

Figure 1. Silk Road 4,000 years ago compared to Submarine Cables today.

Globalization has been around for well over 4000 years with the onset of travel and trade. The benefits and costs to local communities have remained the same; it's just the scope that has grown larger. It has been and still is being driven by monetary gains first and knowledge gains second. Today it is seen to also include control and power, which is just another monetary gain.

What does Globalization mean today?

- Is globalization the integration of economic, political, and cultural systems? Or is it US and Western dominance of world affairs?
- Is globalization a force for economic growth, prosperity, and democratic freedom? Or is it a force for environmental devastation, exploitation of the developing world, and suppression of human rights?

4 KNOWLEDGE WORKERS

Wikipedia defines Knowledge Workers as:

A knowledge worker in today's workforce is an individual that is valued for their ability to interpret information within a specific subject area. They will often advance the overall understanding of that subject through focused analysis, design and/or development. They use research skills to define problems and to identify alternatives. Fueled by their expertise and insight, they work to solve those problems, in an effort to influence company decisions, priorities and strategies.

Knowledge workers may be found across a variety of information technology roles, but also among professionals like teachers, lawyers, architects, physicians, nurses, engineers and scientists. As businesses increase their dependence on information technology, the number of fields in which knowledge workers must operate has expanded dramatically.

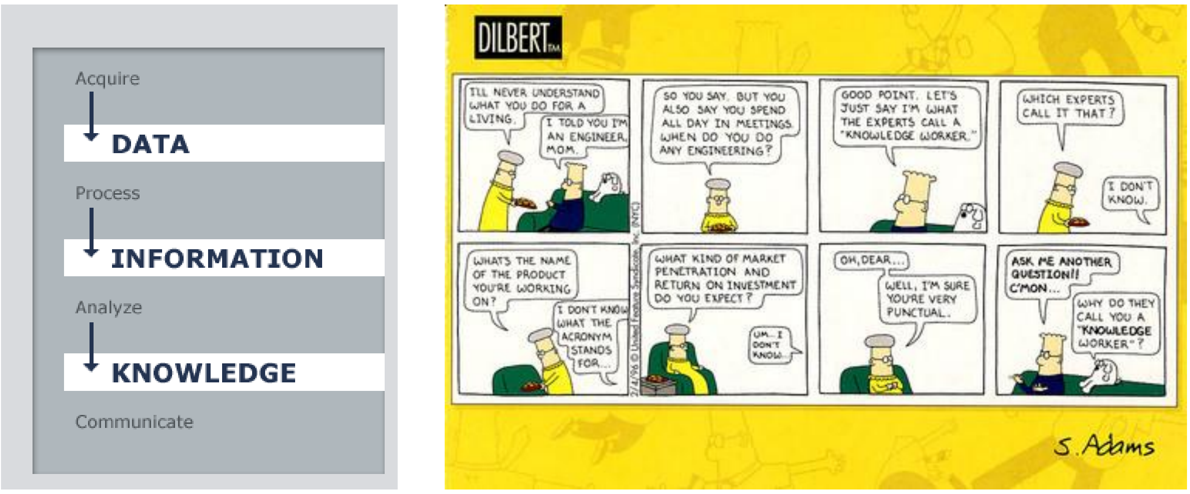


Figure 2. What is a Knowledge Worker.

A knowledge worker is defined as anyone who works for a living at the tasks of developing or using knowledge. Examples:

- planning,
- acquiring,
- searching,
- analyzing,
- organizing,
- storing,
- programming,
- distributing,
- marketing,
- or otherwise contributing to the transformation and commerce of information.

Knowledge Worker includes those in the information technology fields, such as programmers, systems analysts, technical writers, academic professionals, and researchers.

5 IT IN THE USA

5.1 Early Years+

While in School I met a Russian lady who had immigrated to the USA, while working on her citizenship she was also getting her degree in computer science. There was also an American lady who was very vocal about how foreigners where coming to the USA and taking jobs away from hard working Americans, bringing with them their culture and their beliefs.

This was my first images of globalization impacting the USA, news was heavy with stories of immigrants both legal and illegal taking American jobs and importing their culture, their ethics and their beliefs, from farm labor to high-tech.

After graduating and moving to San Francisco, I was exposed to a very international city where globalization was already well established and growing.

5.2 Ethnic Minority

San Francisco city has a population just under 800,000 and has a minority-majority population. Non-Hispanic whites comprise less than half the population.

- Asians with Chinese the largest make up 33%
- Hispanics at 14%
- Non-Hispanic whites less than 45%
- Other about 8%

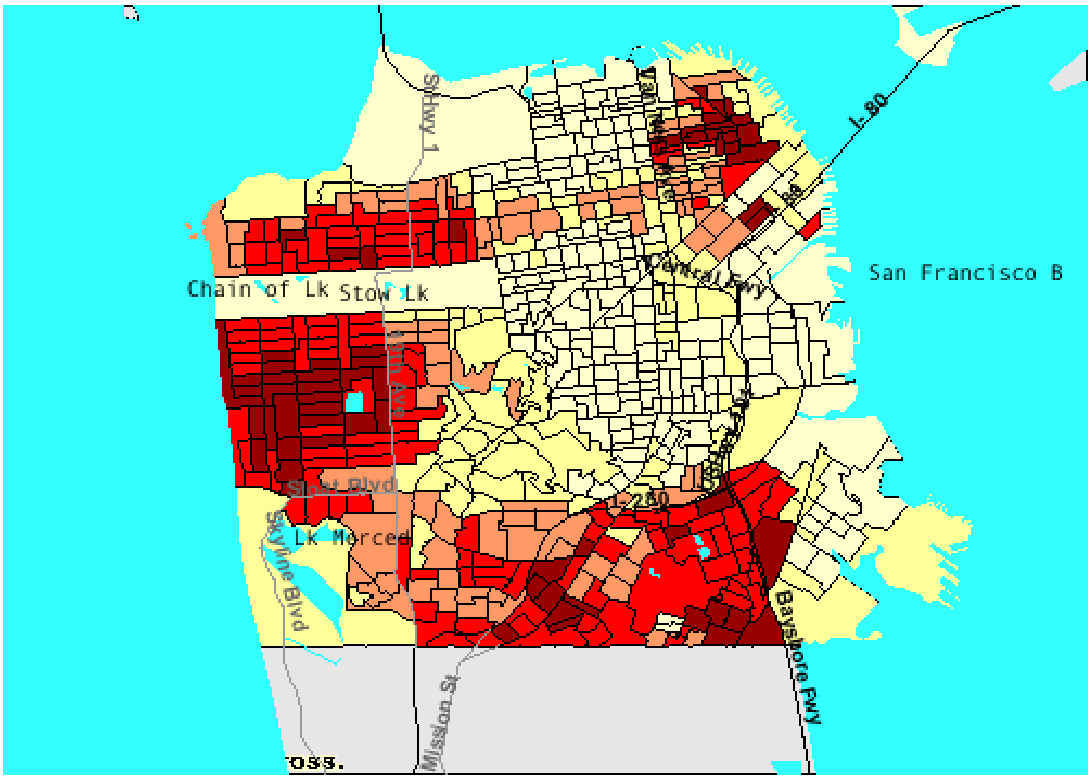


Figure 3. Demographic Map of San Francisco, Red is the Asian Population, with Darker Red Being Almost 100%.

5.3 Globalization

How is this globalization?

- Dining out is now almost exclusively Asian with Chinese restaurants dominating the market followed by Indian and Hispanic.
- All public services and information, voting papers, judicial papers and other material are printed in several languages.
- Police and other civil services actively recruit these ethnicity groups to better serve the populations.

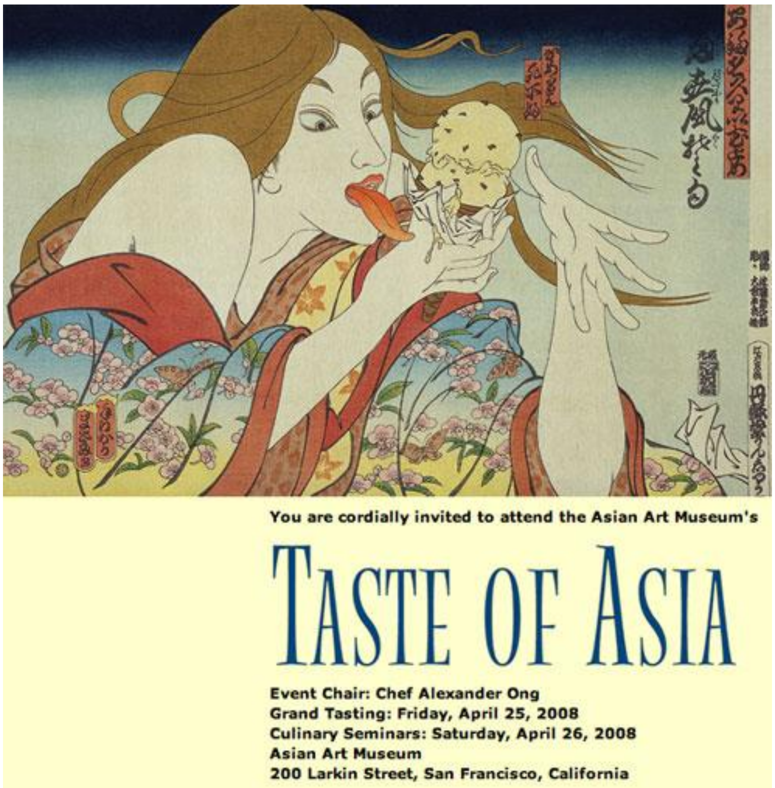


Figure 4. Event at Asian Art Museum San Francisco, 'Taste of Asia'

Figure 5. Asian Heritage Street Celebration San Francisco

These are just some of the Asian grocery stores that you'll find in San Francisco.

- Richmond New May Wah Supermarket
- Sunset Supermarket
- Ocean View Supermarket
- 99 Ranch Market

- Nijiya Japanese Supermarket
- First Korean Market

Figure 6. Common Asian Market Shelf in San Francisco

6 GOING GLOBAL

During my years in the IT field I saw that in the beginning there were very few immigrants or foreigners up to the last decade where as many as 8 out of 10 where either immigrants or foreigners on work visas.

In the mid 1990's we saw a rise in the H-1B visa workers, most of these were from India with some from China. They worked long hours for less pay impacting my field of work. Also during this time were the 'off-shore' efforts, moving much of the IT work to places such as India and China.

People became afraid for their jobs; worries of losing them lowered the pay for everyone and increased the hours.

There are still jobs in the US but they are moving to smaller towns and smaller firms, as the big high-tech jobs were all moving away. I saw this trend and also saw it was the way of the future. I had two choices, join or be left behind.

6.1 Moving to Asia

By the year 2000 I had made a decision that with all the influx of foreign high-tech and the outflow of high-tech work to foreign countries; it was time for me to embrace the changes and 'Go Global.'

At first I had plans to start an offshore IT center and bring work with me. This proved much more difficult than I had planned.

I did find a local IT shop with very smart management and staff to work with and spent almost two years in this effort.

We did manage to get foreign work, but only with those already residing or doing work in Thailand.

- We ran technical support teams for international companies;
- We setup help desk call centers for other international companies; and
- We made system upgrades and replacements for others.

Our biggest obstacle? Thai's are reluctant to speak English.

Some of the issues I found working in Asia:

Language:

- Unfortunate or not, English is the international business language. Countries such as India and Malaysia have invested well in learning this language and getting US off-shore work.

Environment:

- Working in Asia required much more time to close a deal, with many repeated social visits. (i.e. playing golf)

Degrees verses Experience:

- In Asia University Degrees are more valuable than experience and work skills, this sometime equates in staff with poor work skills as some degrees are bought and not earned.

Examples of Issues of working in Asia:

- I attended an International Communications and Technology event in Thailand where half the presentations where in English. This was okay, but when I went to the exhibition floor, I found that they only spoke Thai. This was a great disappointment not only to me but to many of the foreign visitors and was written up in the local English news as "International does not mean speaking Thai as Thai is not an International Language".
- When hiring technical staff, one requirement was reading, writing and speaking English proficiently, most applicants stated on their resumes and school transcripts that they read, wrote and spoke English proficiently, but during the interviews they could not speak or read English.

7 EDUCATION AND KNOWLEDGE WORKERS

When I graduated, I never saw myself as a Knowledge Worker. Work is work and many times it was spent typing, sorting and doing routine tasks mostly, and not considered as Knowledge Work.

After working for several years, I found my field lacked a very vital component, how to manage 'smart' people. I returned to school to expand my education to include management skills, which after this was the first time I actually viewed my work as 'Knowledge Work'.

The IT field was full of very intelligent, although not management savvy, people. The early management of these knowledge workers had no technical skills and failed in managing and motivating them due to management style and lack of respect from the staff. Those who were rewarded, were rewarded with promotions to management positions but they lacked any skills in management, which caused them to mostly fail as their models of management was incorrect and inefficient.

Once I had completed my management training, I challenged the IT management with my new ideas and after about a year of pushing, was rewarded with the opportunity to teach a new management style that would enable knowledge workers to realize their potential and benefit the organization.

What I taught was a change in management style where they learned to manage the job or processes and not the person. The knowledge worker was skilled enough to do the job; he knew what needed to be done and how to do it.

Management changed from managing the staff to being a supporter of the knowledge worker by removing obstacles that prevented them from completing their job.

This also led to my next venture, where I replaced the traditional management structure to 'self-managed' teams. Using the same logic, management gave this team a set of tasks or objectives and the team would rotate roles within itself to complete the tasks, eliminating obstacles and not hindered by old paradigms, they could complete the tasks in record time.

8 RECOMMENDATIONS

Types of Education or Skills needed for Knowledge Workers include:

- Debating Skills;
- Giving Speeches, Lectures and Presentations; and
- Critical Thinking.

"Never be afraid to talk, speak-up, ask questions, make statements and present ideas, you might make someone upset or uncomfortable, but right or wrong, the one who speaks-up and gets heard, wins in the end."

8.1 Debating Skills

Debate discipline has three goals:

- The enhancement of critical thinking and reasoning abilities;
- Academic advancement and development; and
- The promotion of communication skills.

Debating helps students develop the emotional maturity to win and lose graciously, acquire the social skills necessary to work with colleagues and compete against other students, and use language in an increasingly sophisticated way.

8.2 Giving Speeches, Lectures and Presentations

Skills you learn as a speaker:

- Researching Different Topics;
- Speaking with Clarity and Projection;
- Correct Enunciation and Pronunciation of words; and
- Speaking with Expression and Pace (vocal variety).

As knowledge workers, it is vitally important to be able to communicate your thoughts and ideas effectively, using a variety of tools and medium. As a knowledge worker or manager you can't get away from the fact that sometimes you have to speak in public.

Figure 7. Child Giving a Speach

8.3 Critical Thinking is a requirement of Knowledge Workers

Critical thinking is important as it enables one to analyze, evaluate, explain, and restructure our thinking, decreasing the risk of adopting, acting on, or thinking with, a false belief.

Critical thinking involves questioning. As Teachers it is important to teach students how to ask questions and think critically, in order to continue the advancement of the fields we are teaching.

Critical thinking is essential for effective functioning in the modern world.

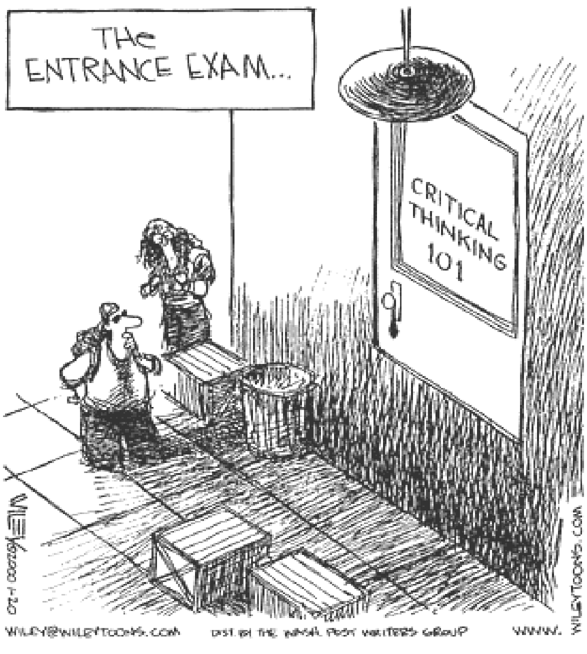


Figure 8. Cartoon for Critical Thinking Exam

9 CONCLUSIONS

1) Continuing Education

- Education should be a Lifetime Endeavor;
- Your skills need constant upkeep in our changing world; and
- Always approach each learning opportunity as a student, even if you know more than the teacher, you might just learn something.

2) Management and the Knowledge Worker

- Knowledge Workers need to learn to manage up, manage their managers, manage expectations
- Managers of Knowledge Workers need to learn to manage the job, not the person, remember you hired them because they know how to do the job

Academic Industry Partnership Towards the Innovation Economy: A Proposed Best Practice

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President/ Vice Chancellor,
Universiti Industri Selangor
Malaysia

ABSTRACT

Universiti Indusrti Selangor (UNISEL) the first and only state university in Malaysia has implemented several academic programmes aimed at establishing Selangor as the centre of education and research in science and technology for the Islamic world. Initially UNISEL is focusing on life sciences and biotechnology which are now widely recognized as the engine of growth for K-economy. For this purpose UNTSEL has established an Institute for Bio-IT Selangor which is an innovation and business center with ICT infrastructure to facilitate and accelerate the development of life sciences and biotechnology in Selangor. The institute will show case the role of UNISEL as industry oriented university that promote and practice the participation of the industry in the academic and research programme of the university. Several factors have been taken in consideration when planning the mission of the University which is to meet the needs of the industry. These are:

1. The industry must be equipped with the latest innovation technology to remain competitive and for that purpose require highly qualified and creative graduates in biotechnology.
2. The main roles of any universities are therefore to educate or prepare graduates who will meet the demand for manpower requirement of the industry.
3. The graduate must be exposed to the latest technological development and must be provided with the environment that provides them with the opportunity to interact with the industry through a mentoring session by the industry and industrial attachment as part of the curriculum.
4. It is important for the universities and industries to be part and parcel of the learning process to create a new paradigm in university learning.

To ensure that the skills and knowledge of graduates meet exactly the requirement of potential industrial employer, the following best practices were employed:

1. Establish academic excellence through an aggressive quality assurance program.
2. Adopt corporate identity practice to ensure customer's satisfactions are met-the customers are always right.
3. Promote industry harmonisation through the participation of industry in ensuing the skills and knowledge of graduates meeting the requirement of the potential employers.

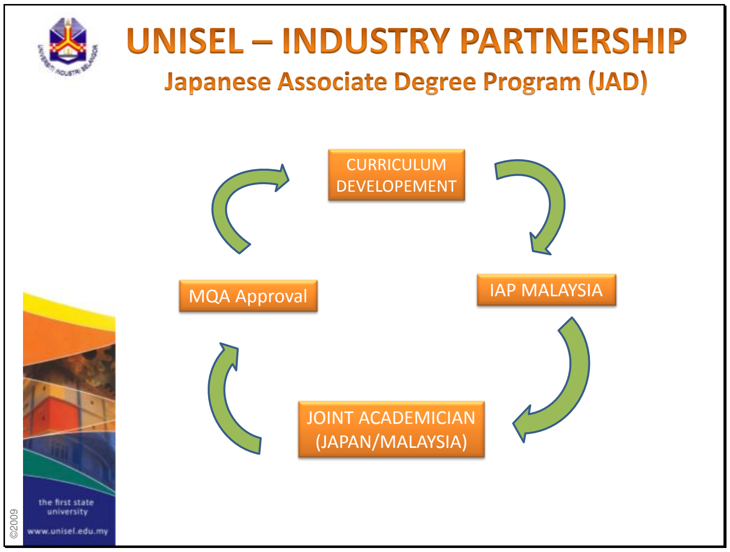

Figure 1. UNISEL – Industry Partnership.

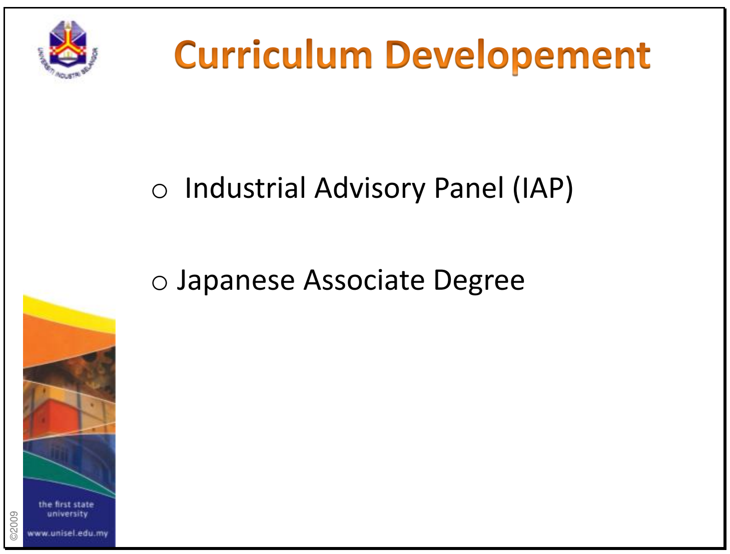

Figure 2. Curriculum Development.

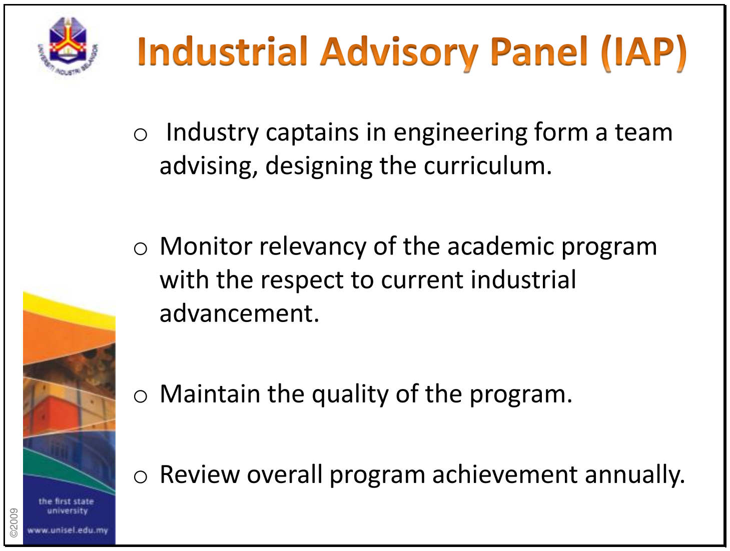

Figure 3. Industrial Advisory Panel (IAP).

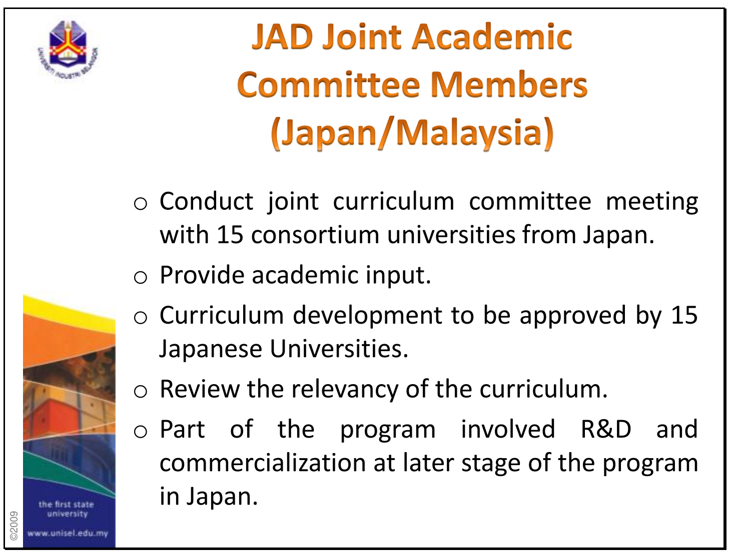

Figure 4. JAD Joint Academic Committee Members (Japan/ Malaysia).

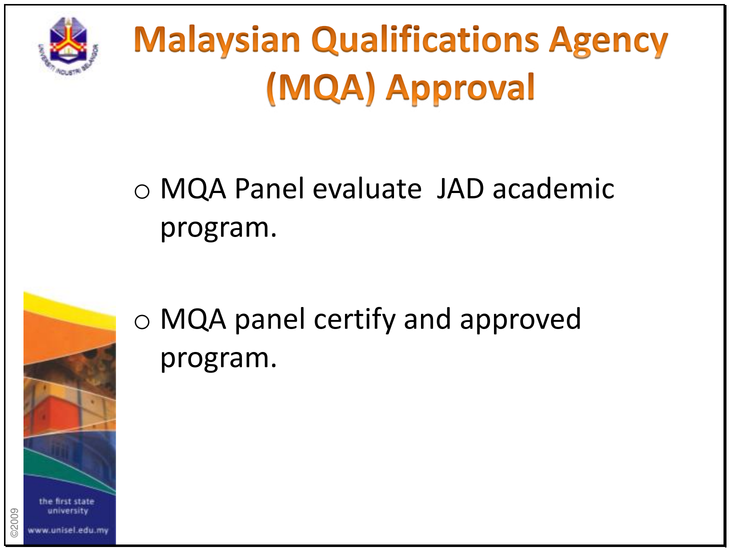

Figure 5. Malaysian Qualifications Agency (MQA) Approval.

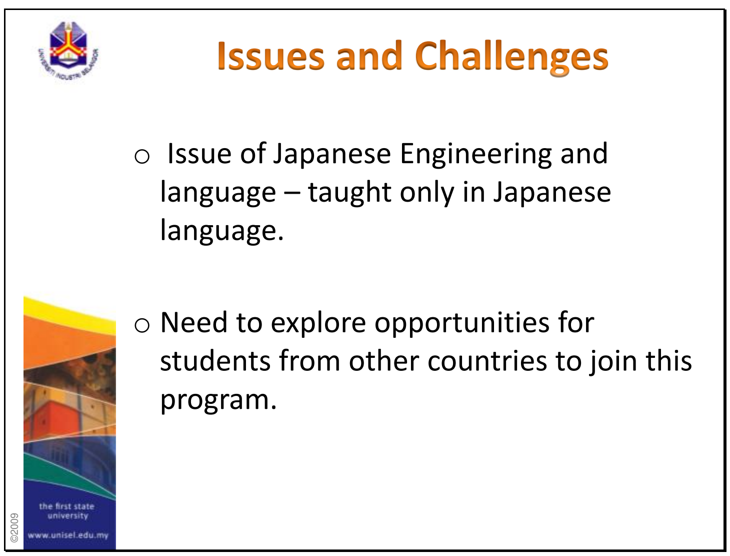

Figure 6. Issues and Challenges.

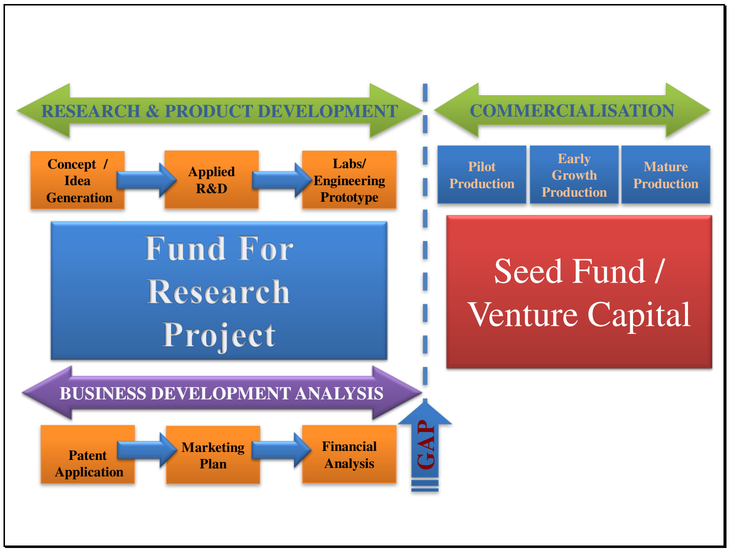

Figure 7.

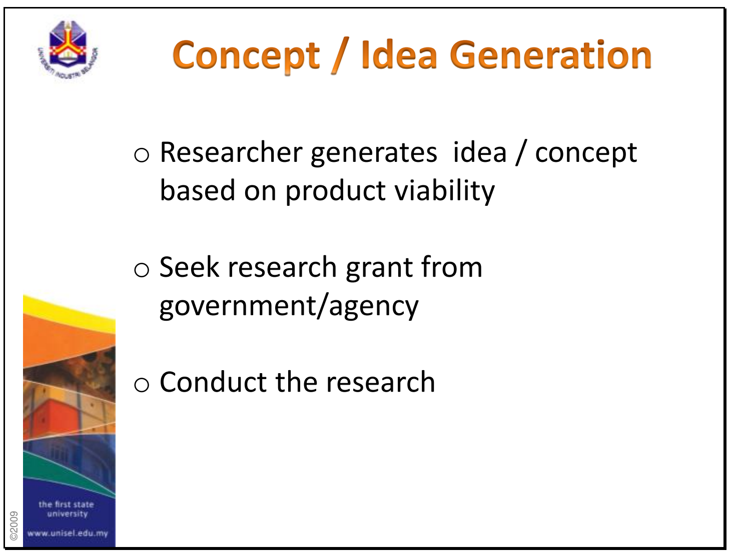

Figure 8. Concept/ Idea Generation.

Figure 9. Applied R&D.

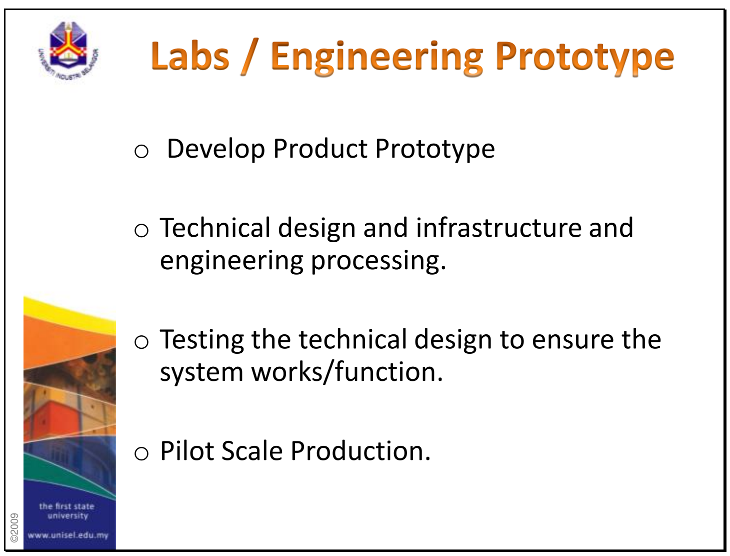

Figure 10. Labs/ Engineering Prototype.

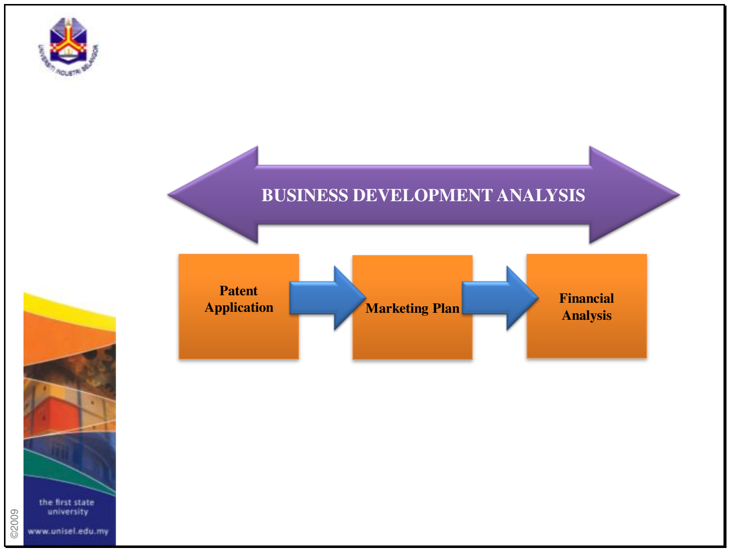

Figure 11.

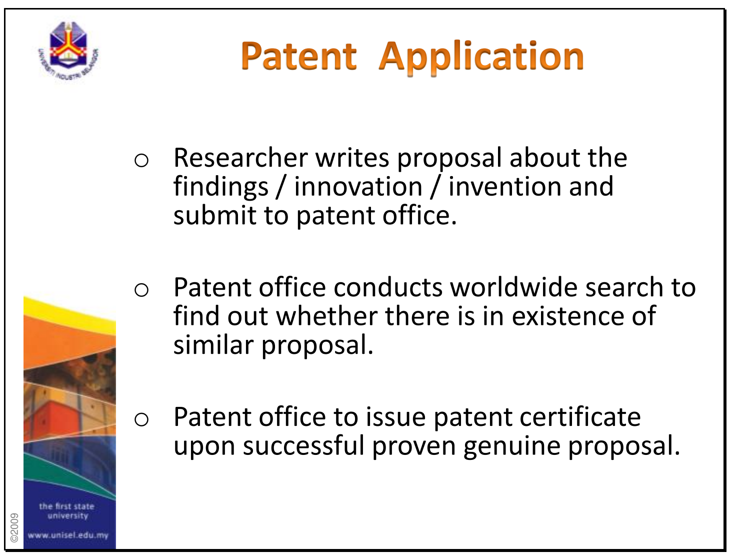

Figure 12. Patent Application.

Figure 13. Marketing Plan.

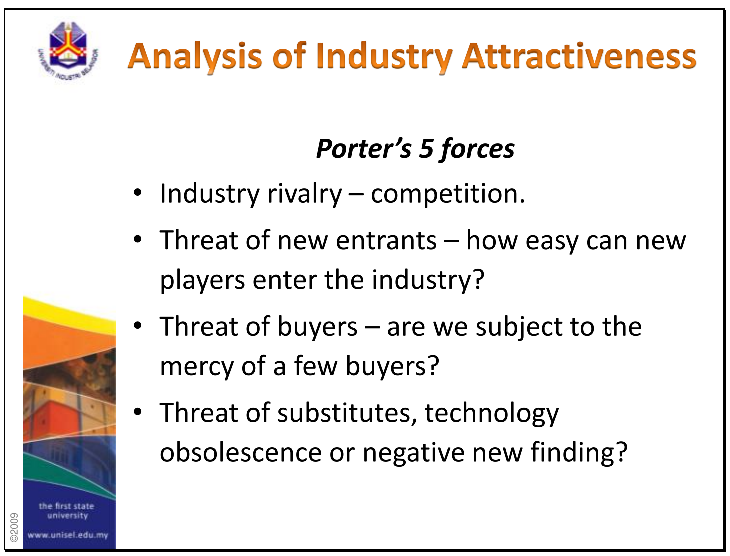

Figure 14. Analysis of Industry Attractiveness.

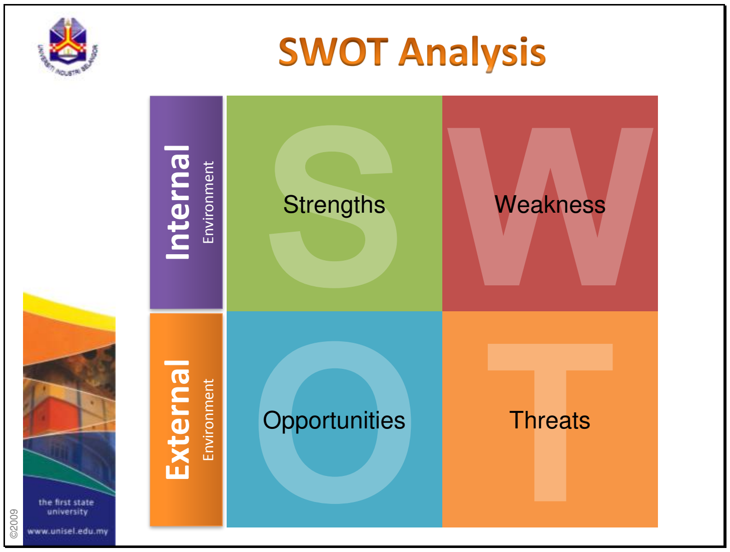

Figure 15. SWOT Analysis.

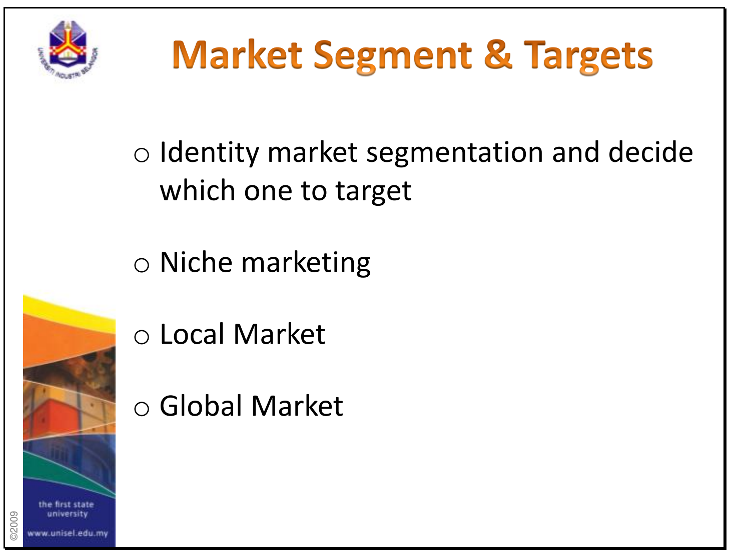

Figure 16. Market Segment & Targets.

Figure 17. Market Positioning.

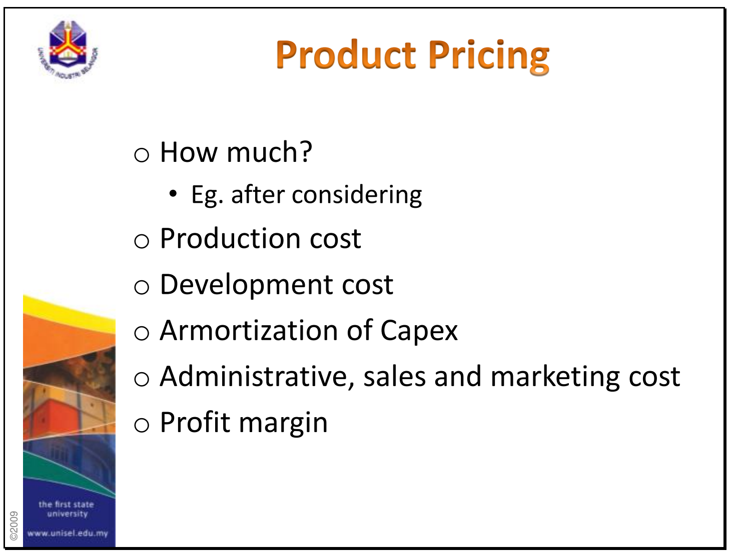

Figure 18. Product Pricing.

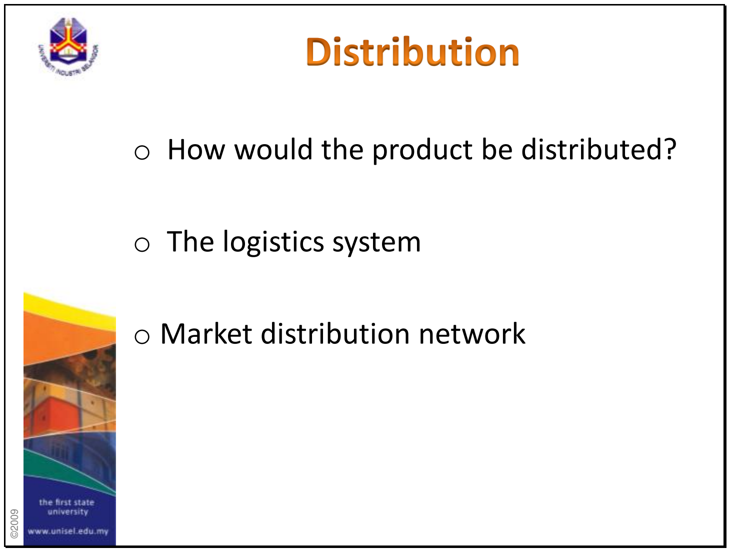

Figure 19. Distribution.

Figure 20. Promotion.

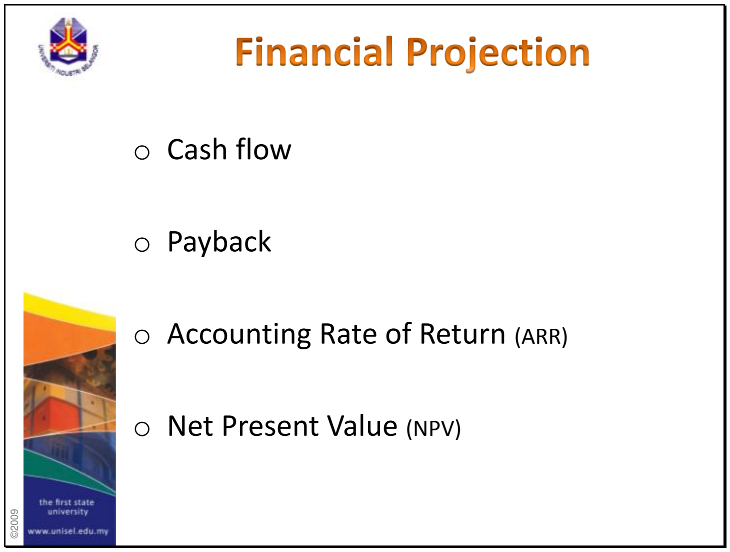

Figure 21. Financial Projection.

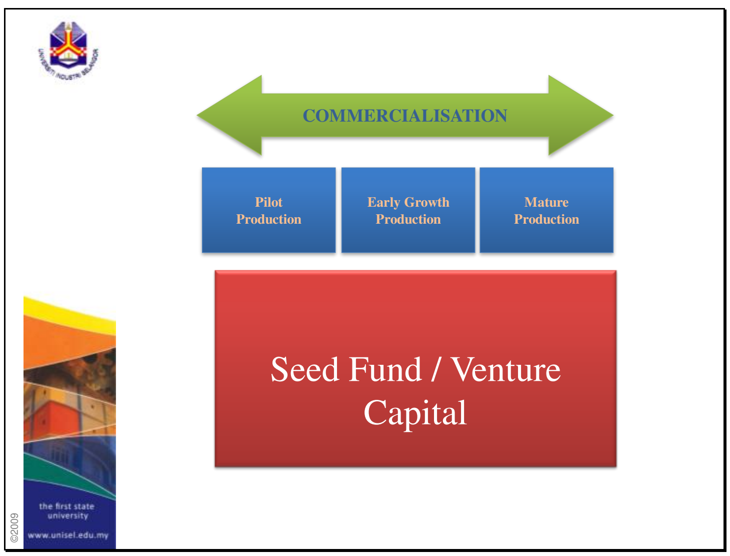

Figure 22.

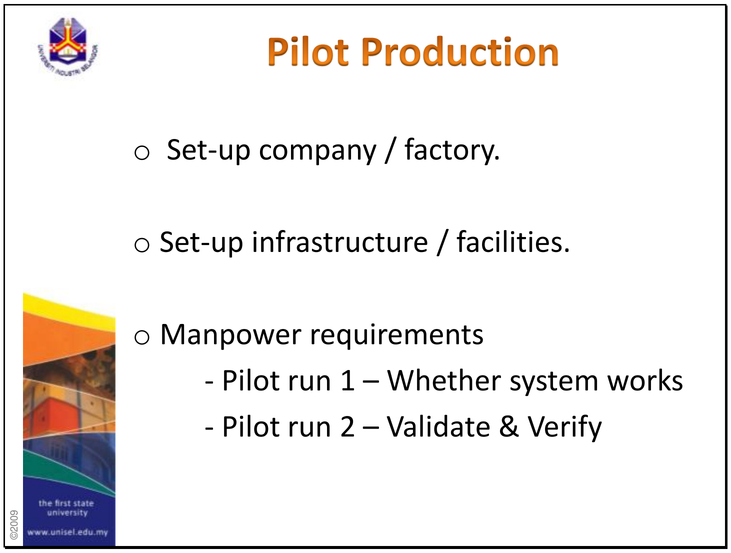

Figure 23. Pilot Production.

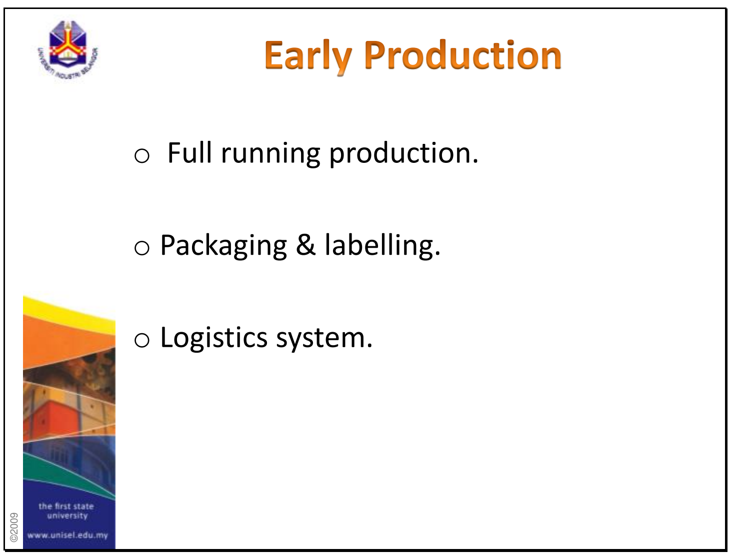

Figure 24. Early Production.

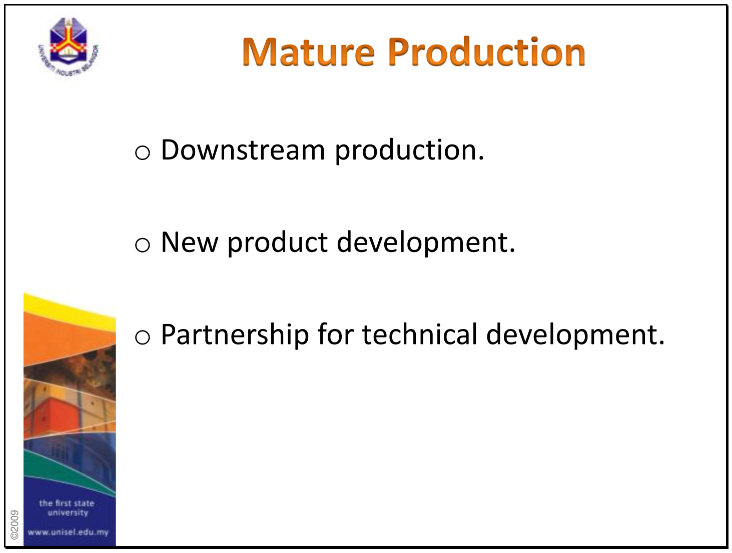

Figure 25. Mature Production.

Figure 26. Challenges.


Thank You
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PART SIX

KNOWLEDGE SOCIETY: POLICY ASPECTS

Science and Technology Landscape of the OIC
The Arab Countries in Focus[1]

ADNAN BADRAN
Former Prime Minister
President, Petra University
Jordan

ABSTRACT

1. Arabs are young. Over 30% of the population is less than 15 years, and 60% is less than 25 years (total population 318 million), this is an opportunity & a challenge.
   a. An opportunity to stimulate growth by investing in education and science, to produce the engines of growth, entrepreneurship, and K-based dynamic society, to release the Arab potential to new horizons of development, based on empowered scientific human resources.
   b. A challenge, to provide the needed infrastructure of schooling, health, housing and services and combat unemployment and poverty.
2. Arab summit (2009) identified priority areas of science and technology plan of action. Water, energy, food and agriculture were the Arab priorities to meet basic needs. This is in line with UN-MDGs to be reached worldwide by 2015.
3. GERD as a percentage of GDP has been low in Arab countries for over four decades, averaging (0.1% - 1.0%) of GDP as compared to over 2.5% of GDP on R&D in advanced countries.
4. Full Time Equivalents (FTEs) researchers in R&D in the majority of Arab countries are small in comparison to other countries. Per million population vary from 588 in Jordan, to 451 in Egypt, to 186 in Morocco, to 23 in Yemen; with an average of 136 across the Arab world, as compared to 832 in Chile, 1301 in Israel, or 2681 in Ireland. Unemployment within R&D community is high, especially among women who constitute 30% of total researchers in Arab countries.
5. The research output of the Arab region (2006) was 11107 research papers (SCI). Egypt lead the region for this indicator. However, in terms of articles per million populations, it is Kuwait which ranked first. The Arab average for this indicator was 37 as compared to world average of 148.
6. Scientific co-publication (joint research) in the Arab region with scientists in the diaspora increased, 60% originating in Algeria, and 59% and 48% originating from Morocco and Tunisia, respectively. Of the 3098 publications published by Egyptian scientists in 2006, one-third (1057) were co-authored with scientists abroad. According to NSF, Arab scientists living in U.S.A were: 12500 Egyptians, 11500 Lebanese, 5000 Syrians, 4000 Jordanians and 2500 Palestinians. Scientists from Morocco, Algeria and Tunisia tend to head for Europe.
7. Patents, as indicator of technology, increased in the Arab region to 67 registered in the U.S, but still lagging behind in comparison to other countries (i.e Finland 894 in 2008).
8. Arab High-tech exports are 10% of all national export, Morocco is leading in the Arab region, Malaysia higher-tech export is 55% of its total export.
9. Arab Knowledge Economy Index (KEI), UAE is leading of 5.77 down to 5.05 in Jordan, to 3.39 in Syria. Internet penetration is also lead by UAE of 50% of population (2008) down to 18.2% in Jordan, to 1.4% in Yemen, to 0.2% in Iraq.
10. Despite sizeable teaching community where Jordan leads in science graduates (53%) in B.Sc. & Masters in science (79%), in Ph.Ds where Tunisia leads, followed by Egypt. The student/teacher ratio

(1) Badran & Zoubi , UNESCO World Science Report 2010: Arab States

falls short of OECD average of 14 students per faculty member, or world average of 16 students, where Egypt ratio is 1:30, Jordan 1:27, only Lebanon surpass OECD and world ratio by a margin of 1:8 (2008).

11. Arab students in higher education has more than doubled from 3.2 million (1996) to 7.2 million (2006), but Arab universities have not been able to develop smart inductive R&D environment, over the past four decades, due to heavy teaching loads, lack of university autonomy, lack of funding and unstable governance, autocracy and loss of research culture; and for many reasons, the Arab region has missed the wave of liberalization and democratization that touched every other region of the planet.

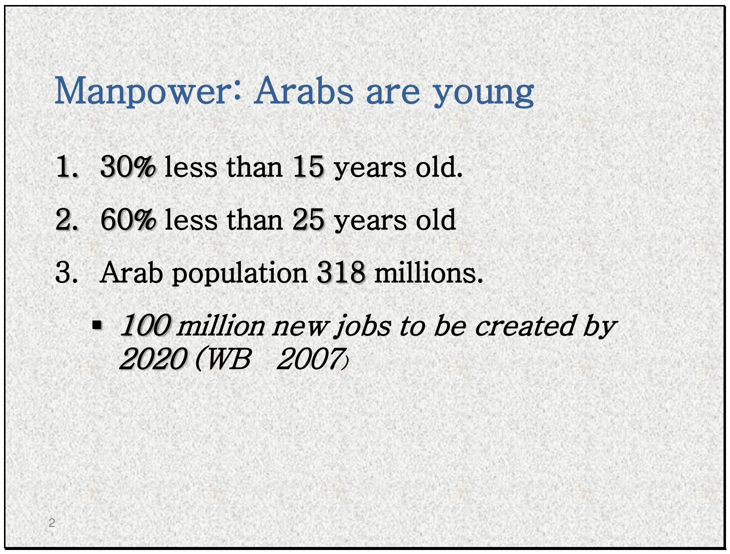

Figure 1. Manpower: Arabs are Young.

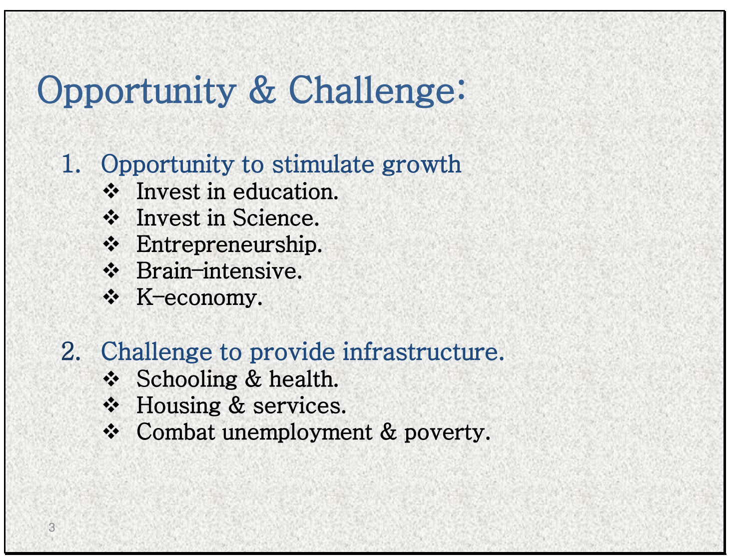

Figure 2. Opportunity & Challenge.

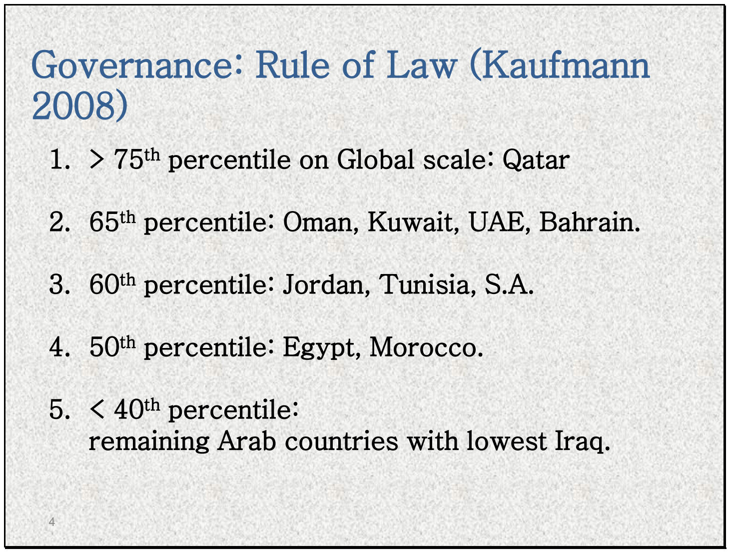

Figure 3. Governance: Rule of Law (Kaufmann 2008).

Figure 4. Innovation: Global Competitiveness Index (GCI).

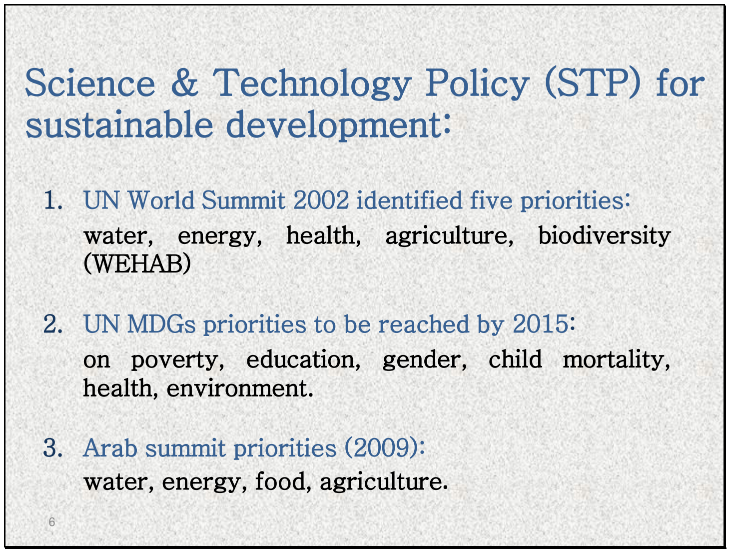

Figure 5. Science & Technology Policy (STP) for Sustainable Development.

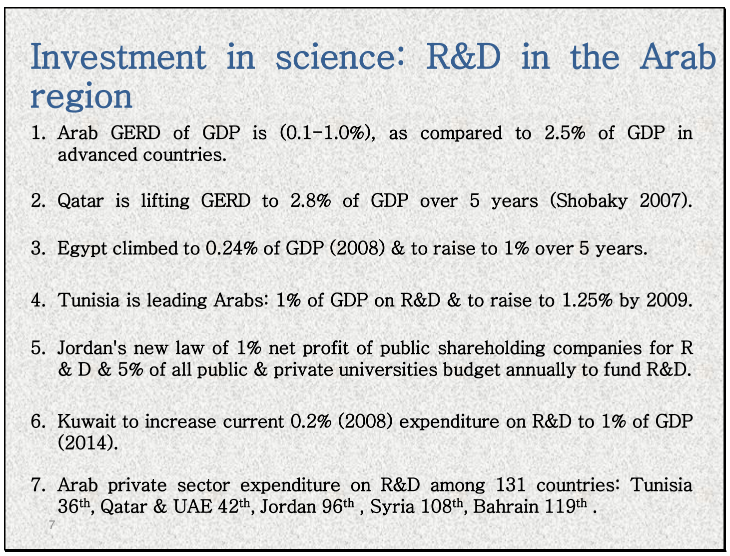

Figure 6. Investment in Science: R&D in the Arab Region.

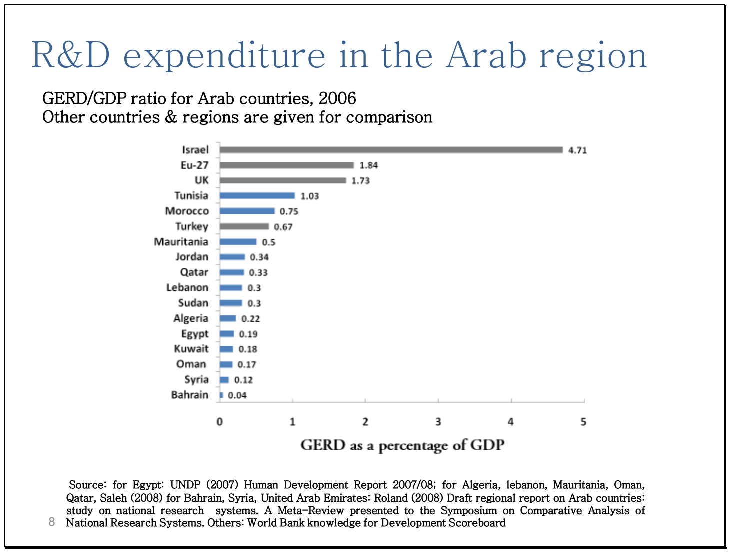

Figure 7. R&D Expenditure in the Arab Region.

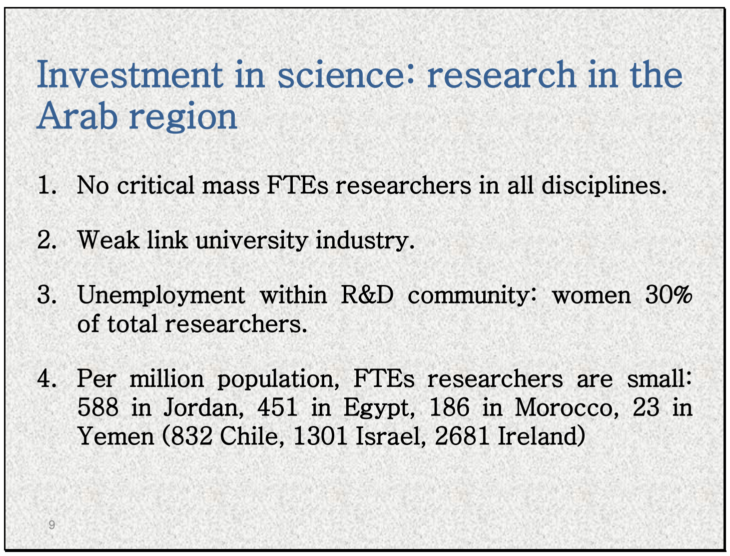

Figure 8. Investment in Science: Research in the Arab Region.

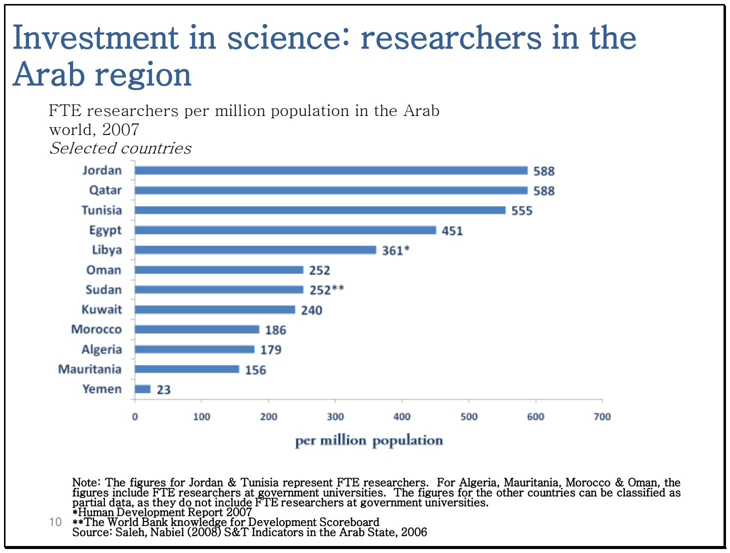

Figure 9. Investment in Science: Researchers in the Arab Region.

Figure 10. R&D Output: Scientific Publications (SCI).

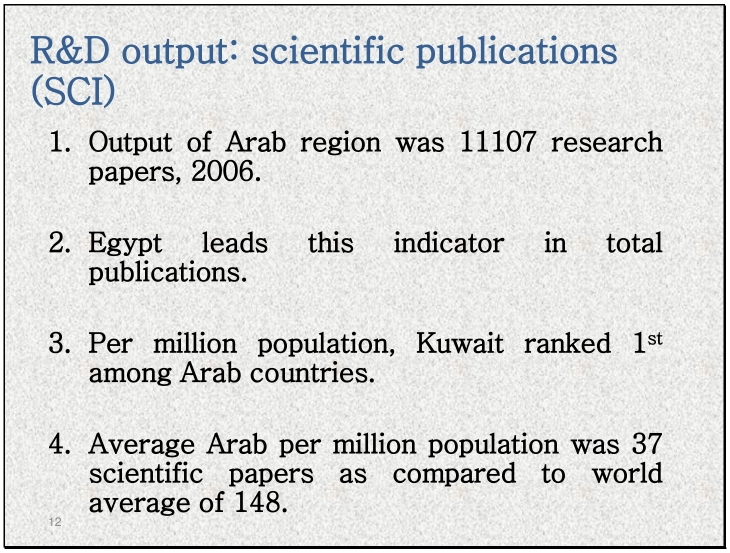

Figure 11. R&D Output: Scientific Publications (SCI).

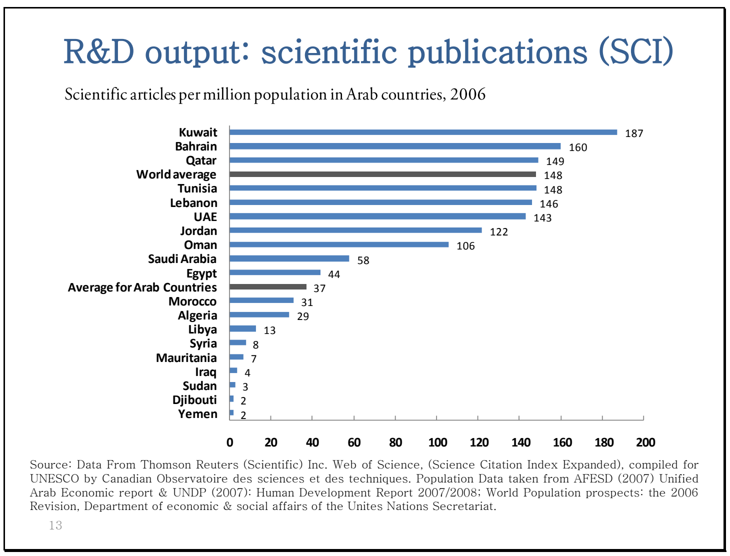

Figure 12. R&D Output: Scientific Publications (SCI).

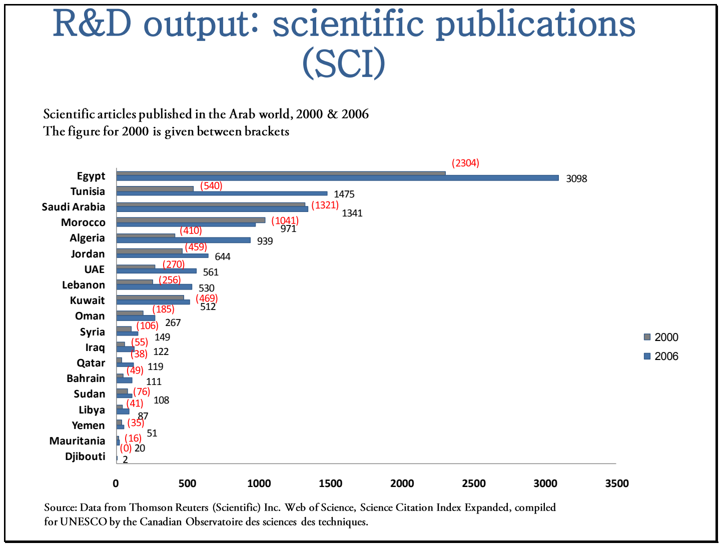

Figure 13. R&D Output: Scientific Publications (SCI).

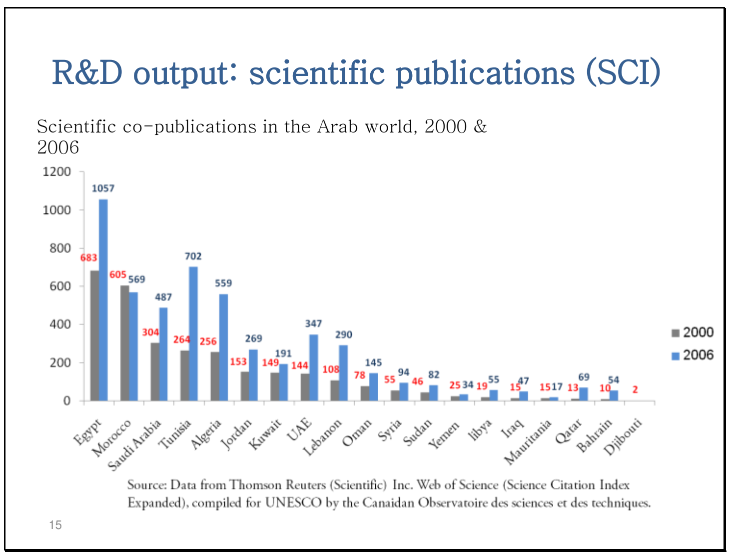

Figure 14. R&D Output: Scientific Publications (SCI).

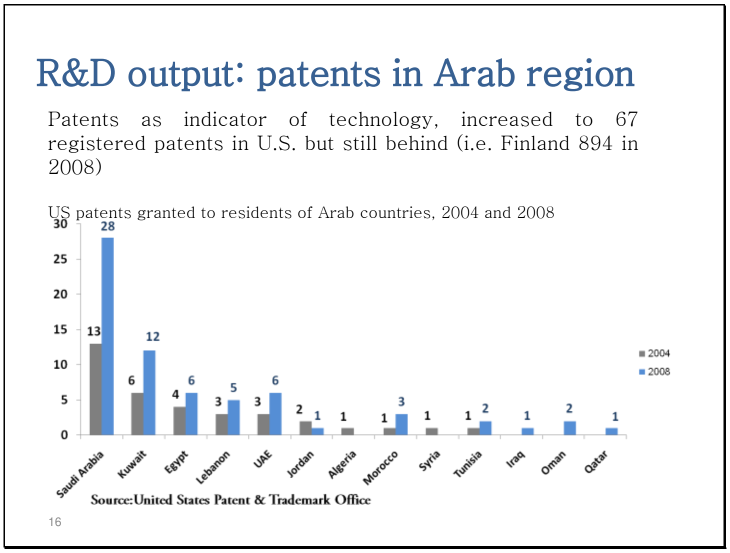

Figure 15. R&D Output: Patents in Arab Region.

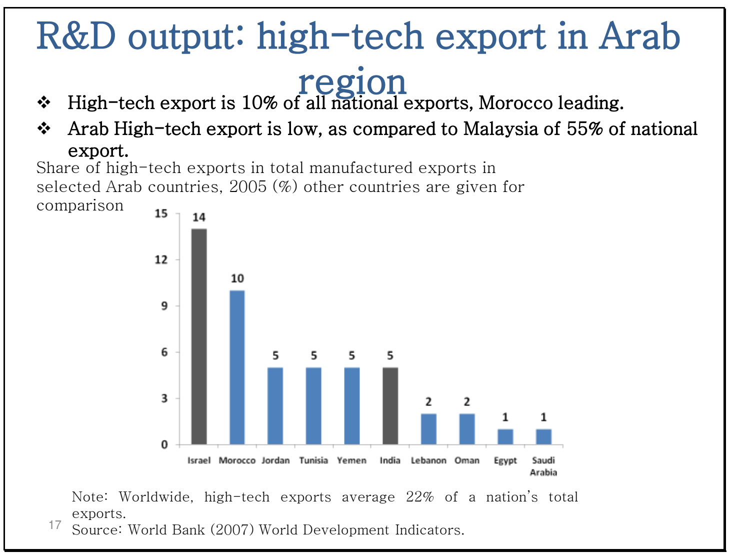

Figure 16. R&D Output: High-tech Export in Arab Region.

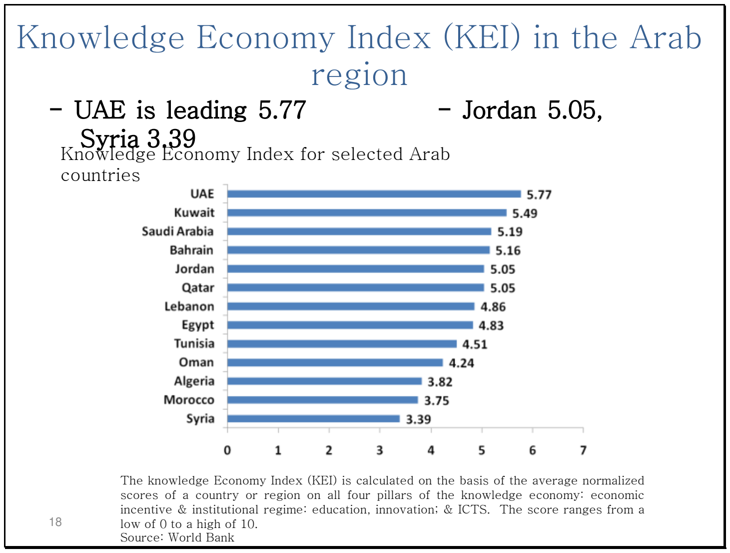

Figure 17. Knowledge Economy Index (KEI) in the Arab Region.

Internet penetration in Arab region (2008)

Penetration, leads by UAE of 50% of total population, 18.2% in Jordan, 1.4% in Yemen, 0.2% in Iraq.

Internet Penetration in the Arab region, 2008

Country/Territory	Percentage Growth In Use (2000–2008)	Penetration (% Population) 2008
UAE	213	49.8
Qatar	1070	37.8
Bahrain	525	34.8
Kuwait	500	34.7
Lebanon	217	23.9
Saudi Arabia	3000	22.0
Morocco	7200	21.3
Jordan	785	18.2
Tunisia	1665	17.0
Palestinian Territories (West Bank)	916	13.6
Syria	7007	10.8
Egypt	1816	10.5
Algeria	6900	10.4
Oman	233	9.1
Libya	2500	4.2
Sudan	4900	3.7
Comoros	1300	2.9
Djibouti	686	2.2
Yemen	2033	1.4
Mauritania	500	0.9
Iraq	[illegible]	0.2

Note: The most recent information on usage comes mainly from data published by Nielsen/Net ratings & the International Telecommunications

Figure 18. Internet Penetration in Arab Region (2008).

Higher Education: building S&T workforce

1. HE students doubled from (3.2) millions in 1996 to (7.2) million in 2006.
2. 2230 HE students for every (100.000) inhabitants.
3. 300 public & private universities (one univ. per million population), less than world average.
4. 10000 universities worldwide for global population of (6.7) billion.
5. 125000 faculty members in Arab countries (M.Sc & Ph.D holders), 30% women.
6. Student W teacher ratio → 1:14 in OCED & 1:16 world average.
7. Egypt 1:30, Jordan 1:27
8. Lebanon 1:8, Jordan leads in science graduates (53%) for BS.c and Master programs. Tunisia leads in Ph.D programs (79%) followed by Egypt

Figure 19. Higher Education: Building S&T Workforce.

Tertiary student enrolment in the Arab region, 2000 & 2006

as a percentage of the age cohort

	2000			2006		
Country	Male (%)	Female (%)	Total Student Enrolment (%)	Male (%)	Female (%)	Total Student Enrolment (%)
Lebanon	33	35	34	45	51	48
Palestinian Territories	27	25	26	44	53	48
Jordan	28	31	29	37	41	39
Egypt	–	–	37*	–	–	35*
Tunisia	–	–	19	26	37	31
Saudi Arabia	18	26	22	25	36	30
Oman	–	–	–	25	26	25
Algeria	–	–	–	19	24	22
Kuwait	–	–	23*	11	26	18
Iraq	15	8	12	20*	12*	16*
Qatar	8	27	16	8	26	15
Morocco	11	8	9	13	11	12
Yemen	16	4	10	14	5	9
Total Arab States	23	17	20	22	22	22

** Data refers to the preceding year.*
Source: UNESCO institute for Statistics

Figure 20. Tertiary Student Enrolment in Arab Region, 2000 & 2006.

Higher Education: ranking universities

- Shanghai Jiao Tong univ. of China ranking:
  Top 500, only one Arab university
  1.Cairo university in year 2007
  2.King Saud university in year 2009
- Times Higher Education, UK ranking.
- OIC ranking.

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Figure 21. Higher Education: Ranking Universities.

Times Higher Education–QS World University Rankings 2009
Top 200 World Universities

2009 rank	2008 rank	Institution	Country	Peer review score	Employer review score	Staff\ student score	Citations\staff score	International staff score	International student score	Overall score
1	1	Harvard University	US	100	100	98	100	85	78	100.0
2	3	University of Cambridge	UK	100	100	100	89	98	96	99.6
3	2	Yale University	US	100	99	100	94	85	77	99.1
4	7	University College London	UK	98	99	100	90	96	99	99.0
5=	6	Imperial College London	UK	100	100	100	80	98	100	97.8
5=	4	University of Oxford	UK	100	100	100	80	96	97	97.8
7	8	University of Chicago	US	100	99	97	88	77	83	96.8
8	12	Princeton University	US	100	96	82	100	89	81	96.6
9	9	Massachusetts Institute of Technology	US	100	100	89	100	31	95	96.1
10	5	California Institute of Technology	US	99	72	87	100	100	89	95.9

Figure 22. Times Higher Education – QS World University Rankings 2009.

Ranking of Arab universities in top 50 for Islamic countries

Composite index for number of citations 2001-06

University	Country	Ranking
American University in Beirut	Lebanon	8
United Arab Emirates	UAE	9
Suez Canal University	Egypt	10
Kuwait University	Kuwait	11
Cairo University	Egypt	25
King Fahd Uni. of Petrol & Minerals	Saudi Arabia	34
Tanta University	Egypt	43
Jordan University of Science &Technology	Jordan	44
Sultan Qaboos University	Oman	50

* *Source:* SESRTCIC (2007) Academic Rankings of Universities in the OIC Countries: A Preliminary Report: www.sesrtcic.org/files/article/232.pdf

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Figure 23. Ranking of Arab Universities in Top 50 Islamic Countries.

Higher Education: public expenditure

1. Government expenditure 1.4% of GDP in OECD (2007) as compared to:
   - 1.7% in Tunisia 25% of total education
   - 1.5% in S.A
   - 1.3% in Egypt 28% of total education
   - 1.2% in Yemen
   - 0.8% in Jordan 18% of total education
   - 0.5% in Syria
2. Jordan spends 4.3% of GDP on higher education & mostly comes from private sector. Many other Arab countries' private sectors are investing in higher education: Lebanon, S.A, UAE, Bahrain, Kuwait, Syria, Egypt, Sudan, Yemen.

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Figure 24. Higher Education: Public Expenditure.

Public expenditure on education in the Arab world, 2001 & 2006

Selected countries

Country	Public expenditure on education as % of GDP		Public expenditure on education as % of total government expenditure	
	2001	2006	2001	2006
Djibouti	7.8	8.3	–	22.4
Egypt	–	4.0	–	12.0
Kuwait	6.6	3.6	–	12.9
Lebanon	2.9	2.7	11.0	9.8
Mauritania	3.3	2.9	–	10.1
Morocco	5.6	5.5	25.0	26.1
Oman	3.9	4.0	21.5	31.1
Saudi Arabia	7.8	–	24.8	–
Tunisia	6.8	7.2*	18.2	20.8*
UAE	2.0*	1.4*	22.8*	28.3*

* Data refers to the preceding year.

Source: UNESCO institute for Statistics database, March 2009

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Figure 25. Public Expenditure on Education in Arab World, 2001 & 2006.

In Summary

1. Although higher education expanded in quantity, but was lagging behind in quality and relevance.

2. R&D was hampered by:
   - lack of smart inducive environment.
   - Heavy teaching load.
   - Lack of university autonomy.
   - Lack of funding.
   - Unstable governance.
   - Lack of research culture.
   - Slow Liberalization & democratization

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Figure 26. In Summary.

thank you

R&D and KE Performance in OIC Member Countries

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and
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1 ABSTRACT

Research in science and technology is of great importance and key to progress towards a knowledge-based, or an innovation-driven economy. On one hand, it promotes better understanding on different aspects of life while, on the other hand, it helps to improve the standard of living by creating new knowledge and technological innovation.

Today, there is severe competition among countries to become the most competitive and knowledge-based economy in the world. In this respect, gaining a competitive advantage against other countries, which is of particular importance to the OIC member countries in catching-up within this competitive world of knowledge economy, depends mostly on how well they perform in research activities.

Better applications of knowledge can provide comparative advantages in producing goods and services more efficiently. However, for most of the member countries, the transition to the knowledge economy is not an easy goal to achieve, as it warrants sustainable and coordinated education policies and development of effective strategies.

This article portrays an overview of the performance of the OIC member countries as well as their achievements in the field of research and development (R&D) and science & technology (S&T) in order to track the overall level of preparedness of the countries towards a knowledge-based economy. By using the cross-sectoral approach and employing a holistic view of a wide range of relevant factors, the main objective is to show to what degree the economic, human and technological structure and the overall environment in OIC member countries are conducive for knowledge to be used effectively for economic development, and to draw some policy implications for a better coordination and collaboration towards knowledge economy at OIC level.

2 HUMAN RESOURCES IN RESEARCH & DEVELOPMENT

The availability of abundant and highly qualified researchers is an essential condition to foster innovation and promote the scientific and technological development of a country. However, figures indicate that OIC member countries, on average, fall well behind the world average in terms of researchers per million people: 649 vs. 2,532, respectively[1]. The gap is much higher when compared to the EU that has an average of 6,494 researchers per million people and some other developed countries like New Zealand, Japan, and Republic of Korea (see Figure 1).

[1] Figures are the weighted averages of countries for which data are available.

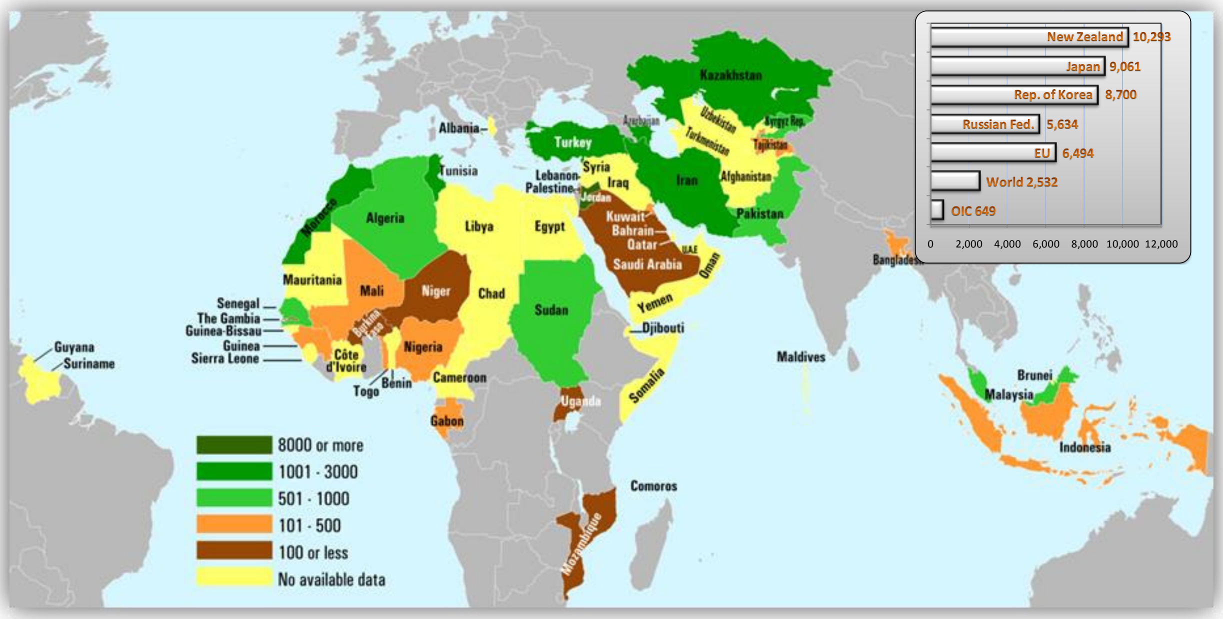

Figure 1. Researchers per Million People*.

Source: *UNESCO Institute for Statistics, Data Centre.*
* Headcount data for the most recent year available.

Figure 1 illustrates the OIC map of distribution of researchers employed in R&D and reveals the following observations:

- Only 7 of the 29 member countries with available data have more than one thousand researchers per million people, two of which –Jordan and Tunisia– are above the world average.
- 7 member countries have less than one hundred researchers per million people, most of which are in Sub-Saharan Africa.
- Great disparity exists among the member countries; Jordan has 8,060 researchers per million inhabitants while Niger has merely 53.

3 WOMEN IN RESEARCH ACTIVITIES

In the last decades, women, with better access to training and education facilities thanks to the rising awareness on gender in/equality, have become more qualified and motivated to participate in the labour force. Nevertheless, the progress achieved so far in the field of R&D seems to be unsatisfactory neither globally nor at the OIC level. Women, in the OIC, represent around 26.8% of the total researchers, slightly lower than the world average of 29.5%[2]. The gap is higher when compared to the EU and some other developed countries like New Zealand and Norway but still the OIC average is higher than some others like Republic of Korea and Japan (see Figure 2).

[2] Aggregate calculations are based on countries with available headcount data –for the most recent year available.

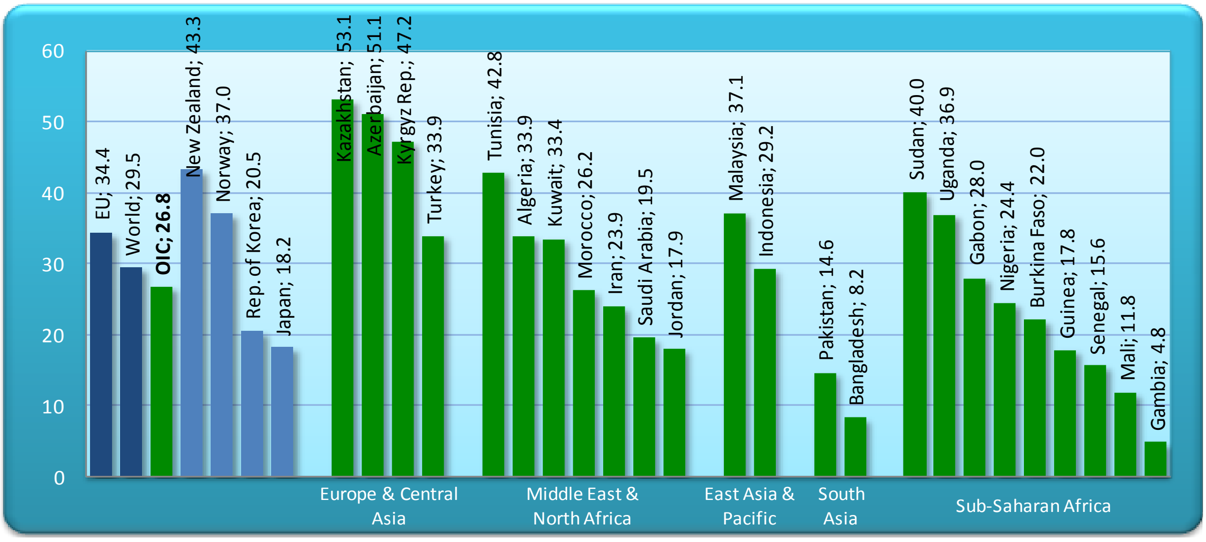

Figure 2. Women as a Share of Total Researchers (%)*.

Source: *UNESCO Institute for Statistics, Data Centre.*
* Headcount data for the most recent year available.

With respect to the data demonstrated in Figure 2, the following observations can be drawn:

- The share of women in total researchers is above the world average in 10 of the 24 OIC member countries with available data. 7 of them outperform the EU average as well.
- According to regional averages, OIC members in Europe & Central Asia and East Asia & Pacific report higher rates of women researchers, often above the world average.
- Members in the Middle East, on average, report lower rates of women researchers than those in North Africa. The share of women researchers range from 42.8% in Tunisia to 17.9% in Jordan.
- Intra-regional difference is even higher in Sub-Saharan Africa: on one hand, there are countries like Sudan and Uganda where women represent more than 35% of researchers while, on the other hand, there also are countries where women's share is less than 10% as in the case of Gambia.
- Kazakhstan and Azerbaijan are the only member countries to have more women researchers than men. Kyrgyz Republic, Tunisia, and Sudan –all with over 40% women researchers– are also close to achieving gender parity.

4 EXPENDITURES ON RESEARCH & DEVELOPMENT R&D INTENSITY

Today, around 80% of the global R&D expenditures is spent by developed countries, of which 33.5% by the USA, 23.5% by the EU, and 13.4% by Japan (Figure 3). The OIC countries account for only 1.8% of the world total Gross Domestic Expenditures on R&D (GERD), or 9.5% of the total GERD of developing countries. Nevertheless, what is more important than the volume of GERD is its weight in the total expenditures or, in other words, in GDP. Accordingly, R&D intensity (GERD as a percentage of GDP) is a widely used indicator of S&T activities. It reflects the innovative capacity of a country in that a higher R&D intensity indicates that relatively more resources are devoted to the development of new products or production processes.

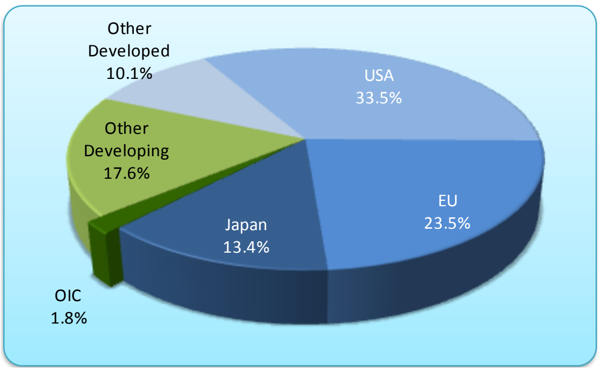

Figure 3. GERD, % of World Total
Source: *UNESCO Institute for Statistics, Data Centre.*

In this connection, the **OIC Ten-Year Programme of Action to Meet the Challenges Facing the Muslim Ummah in the 21st Century**, which was adopted at the Third Extraordinary Session of the Islamic Summit Conference held in Makkah al Mukarramah, Kingdom of Saudi Arabia, in December

2005, calls upon Islamic countries *to encourage research and development programmes, taking into account that the global percentage of this activity is 2% of the Gross Domestic Product (GDP), and request Member States to ensure that their individual contribution is not inferior to half of this percentage* (OIC-TYPOA, 1995, Part 2, Section V, Article 4). Nevertheless, available data show that OIC member countries' spending on R&D activities is significantly lower than the world average and still far away from the implied target of 1% of GDP by 2015 (Figure 4).

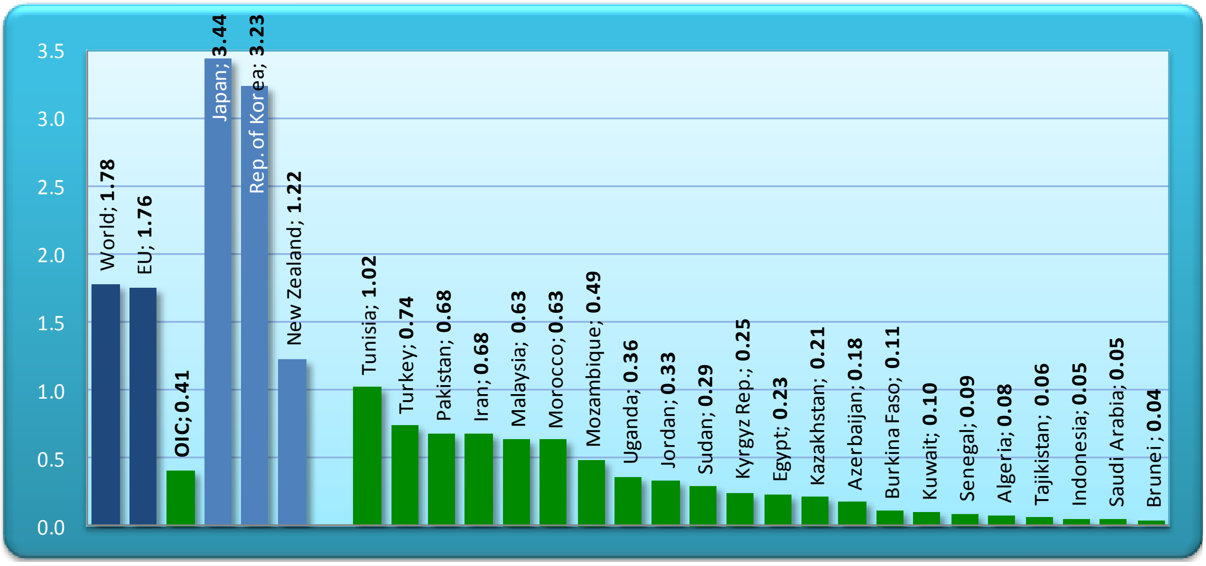

Figure 4. R&D Intensity (%).

Source: *UNESCO Institute for Statistics, Data Centre.*
* Data for the most recent year available between 2003 and 2007.

Regarding the R&D intensity in the OIC member countries, the situation can be summarized as below:

- Among the member countries with available data, Tunisia, the only country to have met the target so far, reports the highest level of R&D intensity (1.02%), followed by Turkey (0.74%) and Pakistan (0.68%), while the lowest spending level is recorded for Brunei (0.04%).
- Most of the member countries spend less than 0.5% of GDP on R&D.
- R&D intensity for the OIC member countries averages 0.41%, which is quite lower than the EU average of 1.76% and the world average of 1.78% as well as the targeted rate of 1%.
- Among the few Sub-Saharan members that can provide data, Mozambique, with 0.49% R&D intensity, is the only country to spend above the OIC average.
- Considering the figures in some other developed countries like Japan (3.44%) and Republic of Korea (3.23%), both of which owe their economic development largely to investments in advanced technology, OIC member countries need to allocate much more resources to R&D activities to bridge the gap with developed countries.

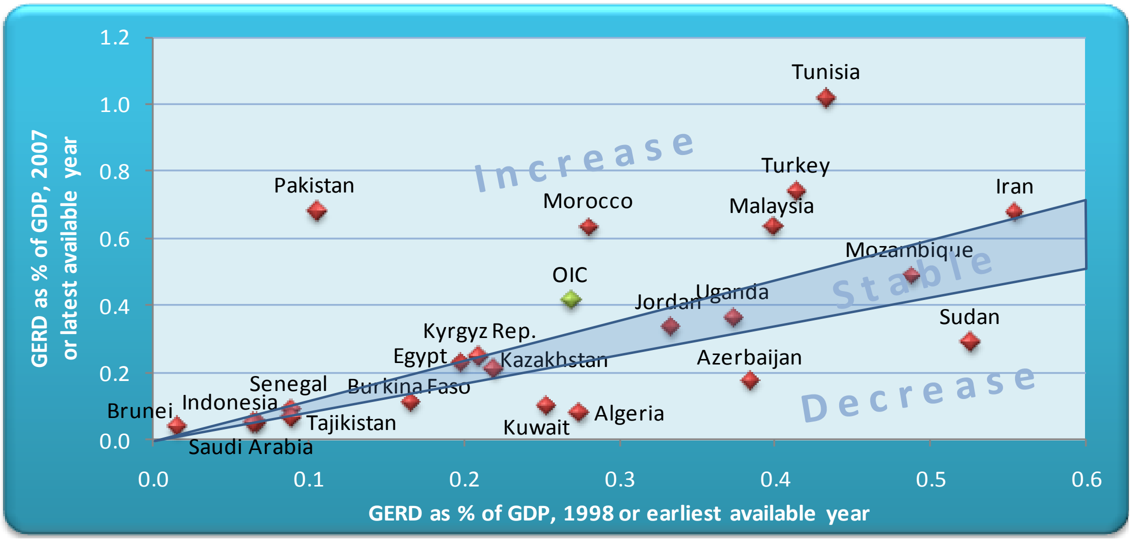

Figure 5. Trends in R&D Intensity.

Source: *GERD Data: UNESCO Institute for Statistics, Data Centre; GDP data; IMF, World Economic Outlook Database, October 2009.*

Figure 5 illustrates the change in R&D intensity between 1998 and 2007 for the OIC member countries for which data are available. Accordingly;

- In most of the member countries, R&D intensity remained relatively stable.
- Tunisia, Turkey, Pakistan, Morocco, and Malaysia managed to significantly increase their R&D intensity. It was more than doubled in Tunisia and Morocco while the increase in Pakistan was over 6-fold. Accordingly, although Iran, Sudan, and Mozambique had the highest R&D intensity rates in 1998, Tunisia and Turkey outperformed them while Pakistan caught up with Iran by 2007.
- Algeria, Azerbaijan, Sudan, and Kuwait reported a significant decrease in their R&D intensity.
- The average for the OIC increased by only 0.14 percentage point in that decade. Although it is higher than that for the EU members (0.09 percentage point), which already have high R&D intensity, it is still lower than that for the world (0.16) which implies that OIC countries cannot reach the world average R&D intensity with such a low rate of improvement in their R&D expenditures.

5 R&D EXPENDITURES PER CAPITA

“R&D expenditures per capita” is also a frequently used indicator to make comparisons among countries with respect to the level of spending on R&D. Accordingly, the following observations can be drawn for OIC countries from Figure 6 that presents data for the change in the indicator in the last decade with available data.

- Of the OIC countries with available data, Turkey has the highest R&D expenditures per capita ($95.2), followed by Malaysia ($79.0), Iran ($66.7) and Tunisia ($65.9).
- The lowest rates are recorded for Tajikistan, Burkina Faso, Senegal, and Indonesia, all with less than $2 of R&D expenditures per capita.
- The average for all OIC countries with available data is calculated as $23.3, which is well below the world average of $194 and the EU average of $524. In Japan, this figure reaches up to $1155, higher than GDP per capita values of 10 OIC countries.
- In a decade, from 1998 to 2007, R&D expenditures per capita increased by an average of only $13 for OIC countries, compared to $81 for the world and $193 for the EU, which could be considered as another source and indicator of divergence between OIC countries and the rest of the world with respect to scientific development.
- In the same period, Turkey, Tunisia, and Malaysia were the top three countries to have most increased their GERD per capita; $61.5, $47.4, and $46.9, respectively.

➢ On the other hand, 7 of the 23 OIC countries with available data reported decline in their GERD per capita. Kuwait, which once had the highest value of $73.8, experienced the sharpest decline in this period so that its GERD per capita fell down to $37.2.

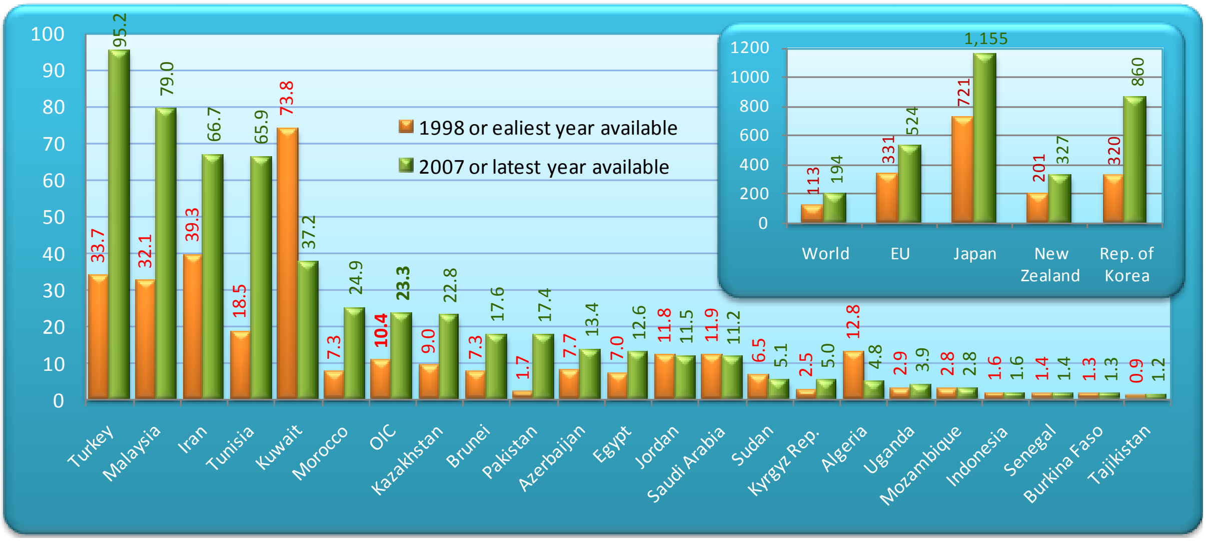

Figure 6. R&D Expenditures per Capita (PPP $).

Source: *GERD Data: UNESCO Institute for Statistics, Data Centre; Population data: IMF, World Economic Outlook Database, October 2009.*

6 R&D EXPENDITURES BY SECTOR

Given that GERD is the sum of R&D expenditures of the performing sectors, it is useful to disaggregate it into individual sectors to see how much R&D each sector performs. This sectoral disaggregation is based on the United Nations classification that defines four major sectors of performance: Government, Business Enterprise, Higher Education, and Private Non-Profit. In this respect, Figure 7 presents the distribution of GERD among these sectors in the OIC member countries for which data are available. The figures are based on total available resources, regardless of their source of funds.

Considering the data illustrated in Figure 7, sectoral distribution of GERD can be summed up as below:

➢ In most of the OIC member countries (10 out of 17 with available data), more than 50% of GERD is spent by government sector. This share reaches up to 100% in Kuwait and over 90% in Indonesia, Tajikistan, and Brunei Darussalam.

➢ Despite having a share of less than 50%, government sector in Tunisia and Sudan is the dominant sector, spending more on R&D than the other sectors do.

➢ The share of Business Enterprise in GERD is highest in Malaysia with 84.9%. Moreover, in Kazakhstan, Turkey, and Sudan, Business Enterprise is responsible for more than one third of the GERD.

➢ GERD of Business Enterprise is not available or at negligible levels in Kuwait, Tajikistan, Brunei Darussalam, Pakistan, Burkina Faso and Senegal.

➢ Higher Education is the leading sector in Senegal, Morocco, and Turkey, accounting respectively for 66.7%, 52.4%, and 48.2% of the total GERD. Furthermore, more than one quarter of the GERD in Pakistan, Iran, Tunisia, and Sudan is also performed by this sector.

➢ The share of R&D expenditures by the Private Non-Profit sector is at a negligible level in all of the member countries except Uganda (25.0%) and Burkina Faso (21.1%).

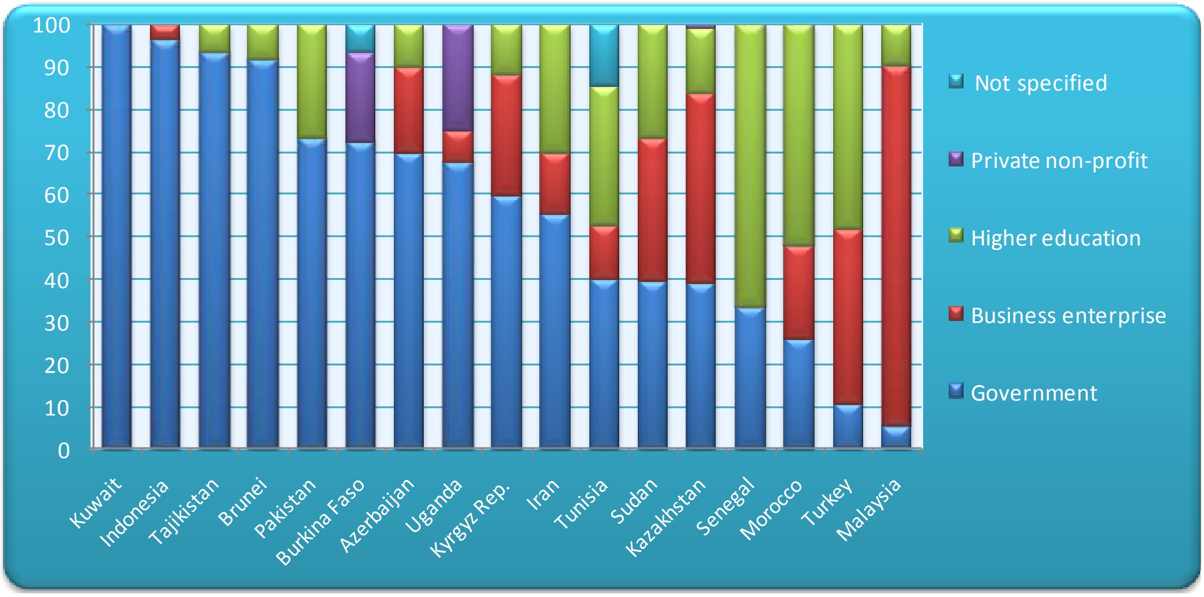

Figure 7. Distribution of GERD by Sector of Performance (%)*.

Source: *UNESCO Institute for Statistics, Data Centre.*
* Data for the most recent year available.

7 R&D EXPENDITURES BY SOURCE OF FUNDS

Figure 8 presents information on the funding sources of R&D in OIC member countries. Source distribution of the GERD has been made again on a sectoral basis as specified above, yet including additionally the funds from abroad.

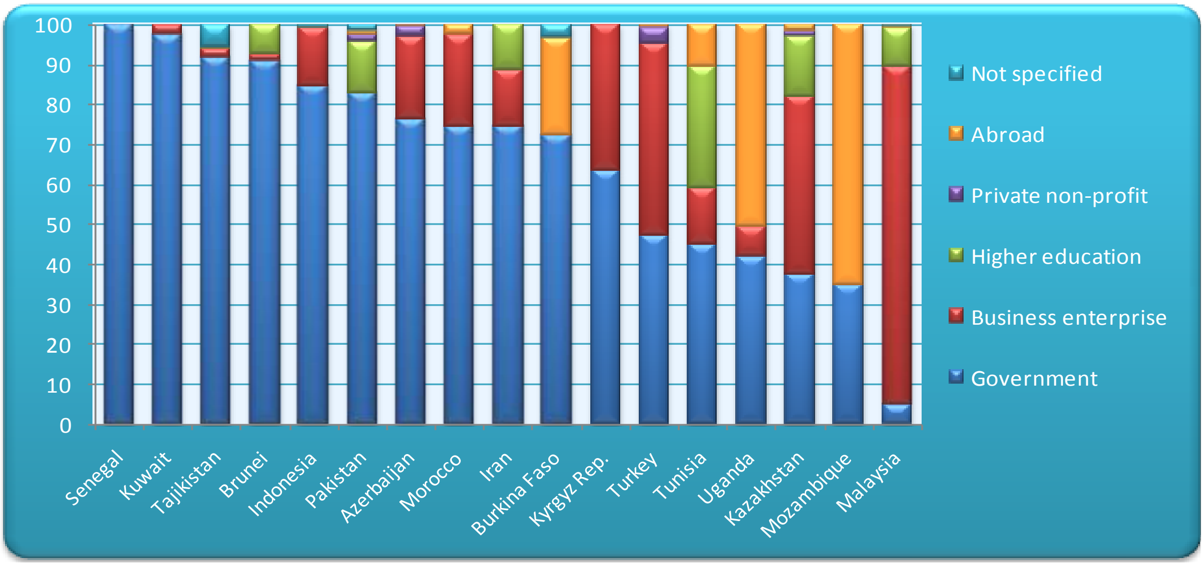

Figure 8. Distribution of GERD by Source of Funds (%)*.

Source: *UNESCO Institute for Statistics, Data Centre.*
* Data for the most recent year available.

Accordingly, given the data illustrated in Figure 8, the situation in OIC member countries can be summarized by the following observations:

- In most of the OIC member countries, R&D is mainly financed by the government sector. Out of the 17 member countries for which data are available, 11 countries are receiving more than %50 of R&D funds from the government.

- GERD in Senegal is completely funded by government sector and, in Kuwait, Tajikistan, and Brunei Darussalam, the share of government funding is over 90%
- Despite having a share of less than 50%, government sector in Tunisia is the dominant sector, providing more R&D funds than the other sectors. Government's role in Turkey is also at a significant level since it provides almost half of the funds (47.1%), slightly lower than those provided by business sector.
- In Malaysia, government's share in R&D funding is as low as 5%, which is the lowest rate among all OIC countries with available data.
- Business Enterprise in Malaysia accounts for 84.7% of the total R&D funds. In Turkey and Kazakhstan, the business sector is also dominant, providing respectively 48.4% and 44.5% of the total R&D funds.
- Higher Education sector in Tunisia provides 30.5% of the total R&D funds, which is the highest rate among all OIC countries with available data. Additionally, sector's share exceeds 10% in Kazakhstan, Pakistan, and Iran.
- Mozambique and Uganda deserve special attention as their R&D funds mostly come from abroad, 65.3% and 50.7% respectively.

8 HIGH-TECHNOLOGY EXPORTS

High-technology exports (HTE) are products with high R&D intensity, including aerospace, computers, software and related services, consumer electronics, semiconductors, pharmaceuticals, scientific instruments and electrical machinery, which mostly depend on an advanced technological infrastructure and inward FDI in high-tech industries. World high-technology exports are estimated to have reached over $1.7 trillion in 2007. Around 70% of that amount originated from developed countries, of which 33.3% from the EU members, 13.1% from the United States, 7.0% from Japan, and 6.3% from Republic of Korea (Figure 9).

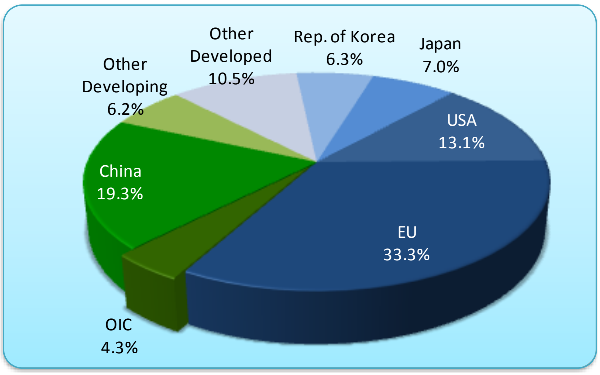

Figure 9. HTE, % of World Total.

Source: *World Bank, World Development Indicators (WDI), Online Database.*

China is the largest exporter of HTE, accounting for almost one-fifth of the world total HTE and two-thirds of the total HTE of developing countries. Confirming the lack of adequate infrastructure and FDI in most of OIC countries, it is observed that all the member countries for which data are available accounted for only 4.3% of the world HTE (Figure 9), or 14.4% of the total HTE of developing countries. Data for OIC countries are illustrated in Figure 10, which yield the following observations:

- Malaysia and Indonesia are, by far, the top ranking OIC member countries by high technology exports, together representing 93.5% of the total HTE of the OIC.
- With $64.6 billion, Malaysia, on its own, accounts for 86.5% of the total HTE of the OIC. It is also the 9th largest exporter of high-technology products in the world, accounting for 3.7% of the world HTE.
- Kazakhstan, with around $1.5 billion of HTE, accounted for 2% of the total HTE of the OIC countries, rendering it the 3rd largest exporter of high-technology products in the OIC.
- HTE of the other leading member countries ranges from $100 million to $1 billion.
- In Sub-Saharan Africa, Benin, Guinea, and Sudan records even less than $30 thousand of HTE.
- Cote d'Ivoire, with more than $450 million of HTE, gets far ahead of the other Sub-Saharan members. It also ranked as the 6th largest exporter of high-technology products in the OIC.

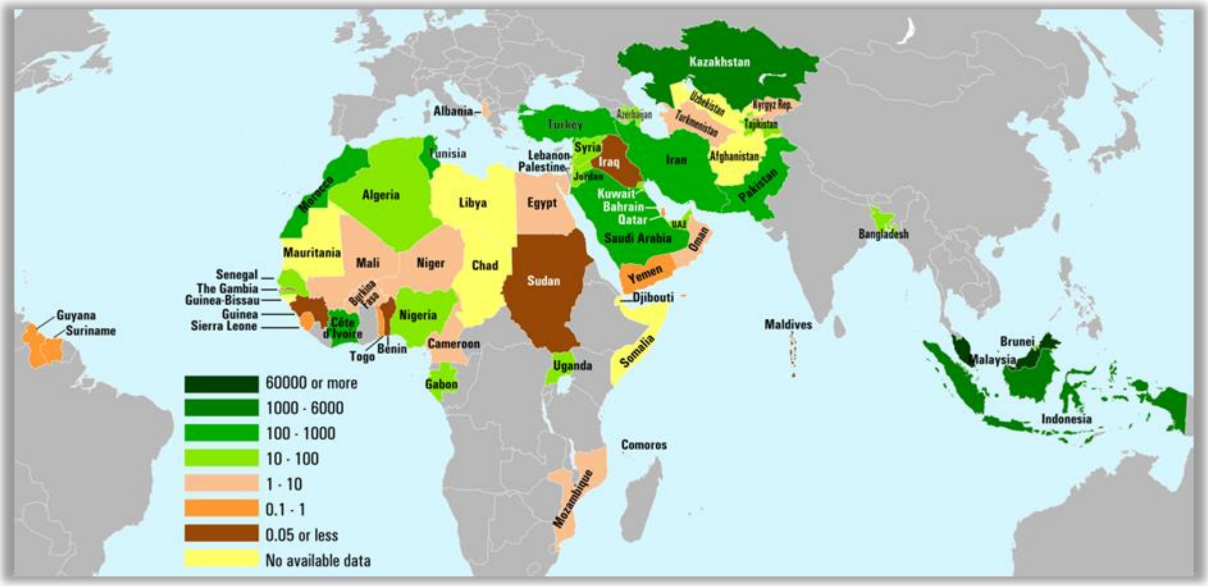

Figure 10. High Technology Exports (Million US$)*.

Source: *World Bank, World Development Indicators (WDI), Online Database.*
** Data for 2007 or latest available year.*

For a better understanding of the importance of HTE to a country, it is useful to look at the share of these exports in its total manufactured exports. Figure 11 presents these shares for 48 member countries for which data are available in a comparative manner to reflect any change over time.

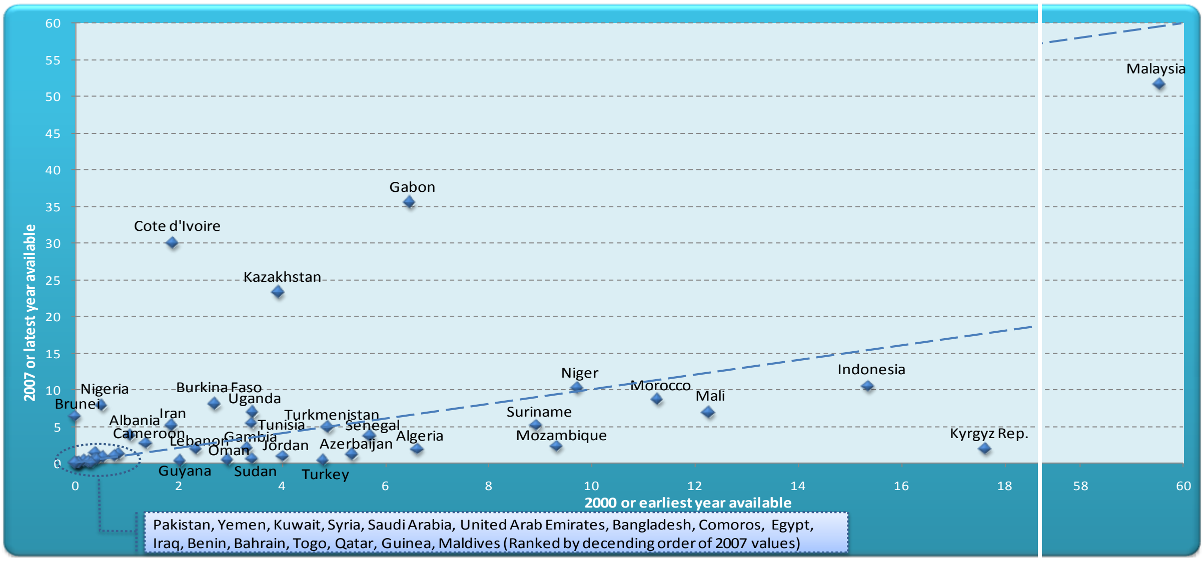

Figure 11. High Technology Exports: 2000 vs. 2007 (% of Manufactured Exports).

Source: *World Bank, World Development Indicators (WDI), Online Database.*

With respect to the data illustrated in Figure 11, the evolution of high technology exports in the OIC member countries during the period 2000-2007 can be summarized as below:

- Largest improvements across the OIC are recorded by two Sub-Saharan members, namely Gabon and Cote d'Ivoire, having managed to increase the share of HTE from below 7% to over 30% of their manufactured exports.
- Kazakhstan also reported relatively high expansion rate in the share of HTE, from 3.9% to 23.2%.
- In 16 member countries listed at the bottom of the Figure, HTE continue to account for less than 2% of their manufactured exports. Nevertheless, there were improvements in 9 of them though to a limited extent.

- Decline in the share of HTE in manufactured exports has also been observed in many countries, particularly in Kyrgyz Republic with 15 percentage points. Overall, there were 22 OIC countries having reported a decline in the share of HTE in their manufactured exports.
- Representing over 90% of the total HTE of the OIC, Malaysia and Indonesia have also witnessed a decrease in the share of HTE in their manufactured exports, 7.9 and 4.9 percentage points, respectively. Yet again, Malaysia continues to have the largest share of HTE in manufactured exports (51.7%).
- Although the average for OIC countries declined by 10 percentage points to 20.2%, it was still higher than the world average of 18.9%. Nevertheless, when Malaysia, which accounted for about 87% of the total HTE of the OIC, is excluded, the average for OIC countries falls down to 4.1%.

9 SCIENTIFIC PUBLICATIONS

Academic research is an important component of all research activities conducted in a country. To a certain extent, the performance in academic research can be well reflected by the number of scientific articles published in indexed journals. In this regard, the quantity and the growth of the research output, i.e. articles, are common indicators used to measure the research performance of a given institution or country. Indeed, such bibliometric indicators have been widely used in national science and technology statistics publications to measure scientific capacity and linkages to world science[3] and particularly in national and international rankings of universities[4].

10 PUBLISHED ARTICLES

Compared to 18,391 articles they published in the year 2000, OIC member countries as a whole published 63,342 articles[5] in 2009 in journals that are covered by Science Citation Index Expanded (SCI-EXPANDED), Social Science Citation Index (SSCI), and Arts & Humanities Citation Index (A&HCI)[6]. Although it is an over three-fold increase in a decade, the amount reached is still below those of some individual countries in the world, such as the United States, China, Germany, Japan, and England (Figure 12).

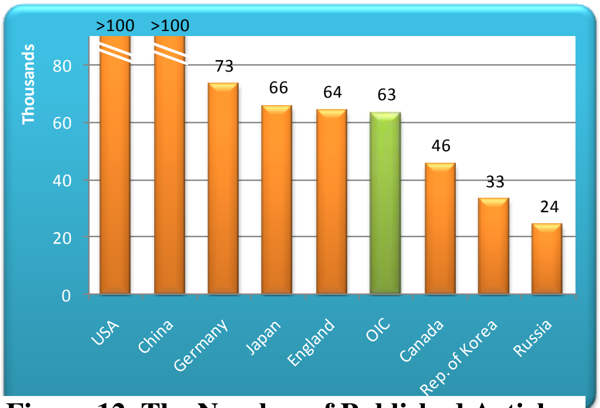

Figure 12. The Number of Published Articles, 2009.

Source: *ISI Web of Knowledge [24.03.2010].*

Figure 13 presents information on the contribution of each OIC member country to this output. In this respect, the following observations outline the performance of the OIC member countries in publishing articles:

- Production of scientific publications –here articles– in the OIC is heavily concentrated in a few of the member countries.
- More than half of the articles (52.7%) originate from only two member countries, namely Turkey (31.6%) and Iran (21.1%).
- Adding Egypt (7.0%), Malaysia (6.2%), and Pakistan (5.3%), these five countries account for 71.2% of all published articles.

[3] UNESCO Institute for Statistics, "What do bibliometric indicators tell us about world scientific output?", *UIS Bulletin on Science and Technology Statistics*, Issue 2, September 2005.
[4] For example, Academic Ranking of World Universities by Shanghai Jiao Tong University (SJTU), World University Rankings by the Times Higher Education Supplement (THES), and also the OIC University Ranking make use of the research output as an important indicator in their ranking methodologies.
[5] The total reflects the sum of individual OIC countries and it is not refined for internationally co-authored papers.
[6] Data are collected from the ISI Web of Knowledge maintained by Thomson Reuters. For further information, see http://isiwebofknowledge.com/

- Some other member countries in the Middle East & North Africa, South Asia, and East Asia & Pacific also perform well while those in Latin America, Sub-Saharan Africa, and Central Asia are generally lagging behind.
- Individually, there are 10 countries that published less than 20 articles in 2009. These countries are not concentrated in one region but dispersed across regions: for example; from Guyana in Latin America to Somalia in Sub-Saharan Africa, and from Turkmenistan in Central Asia to Maldives in South Asia.
- The number of countries having published less than 100 articles reaches 24.
- Nigeria stands out as the only Sub-Saharan member to have produced over one thousand articles (1,922), the closest ones in the region being Uganda and Cameroon, each with over 450 articles.

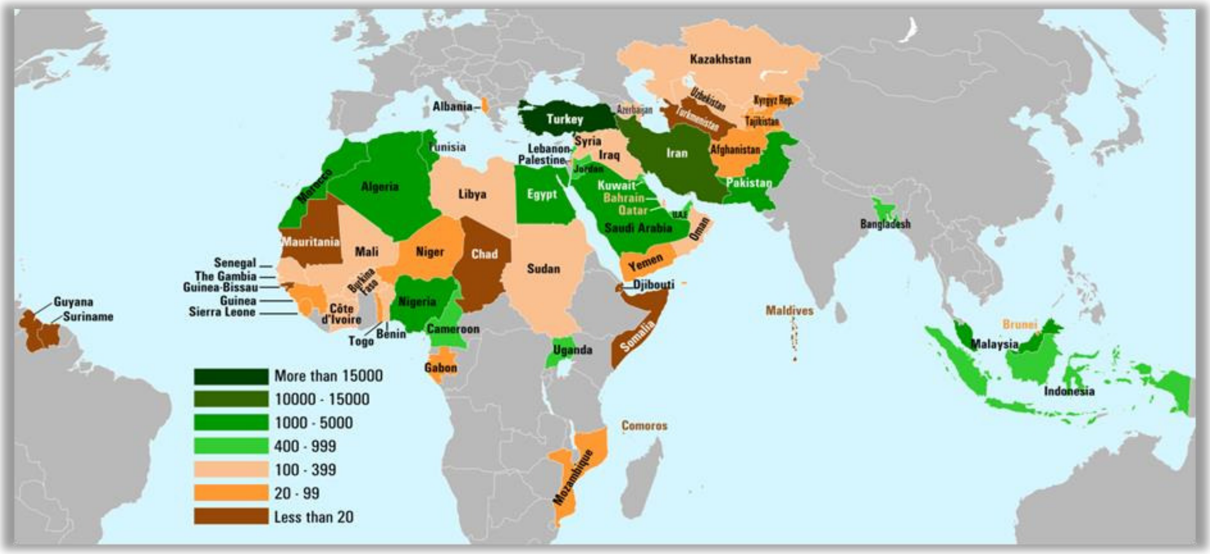

Figure 13. Articles Published in International Journals, 2009*.

Source: *ISI Web of Knowledge [24.03.2010].*
* Total number of articles published in journals covered by Science Citation Index Expanded (SCI-EXPANDED), Social Science Citation Index (SSCI), and Arts & Humanities Citation Index (A&HCI).

11 THE EVOLUTION OF PUBLICATION OUTCOME

The growth in the number of articles on a per-capita basis reflects a better indicator of productivity in scientific publications as it takes into account the relative size of the population in the countries compared. In this respect, Figure 14 presents data on articles per million people (pmp) in OIC member countries in a manner to reflect the evolution in the last decade of 2000-2009. Accordingly:

- On average, OIC member countries produced only 15 articles (pmp) in 2000 while this number increased to 42 in 2009, which still could be considered low given that this number reached up to 1355 in Canada, 1241 in England, 894 in Germany, 682 in Republic of Korea, 516 in Japan, and 172 in Russia.
- 49 out of the 57 member countries recorded an increase in that decade, but this increase in 29 of them was no more than 10 articles. This implies, in general, that the expansion recorded in countries with low number of articles (pmp) remained quite limited compared to those with high numbers.
- Turkey, in absolute terms, took the lead in boosting scientific productivity with an increase of 205 articles (pmp), followed by Iran (161), Tunisia (160), Malaysia (108), and Qatar (103).
- Four other countries, namely Bahrain, Lebanon, United Arab Emirates, and Jordan, recorded an increase of over 50 articles (pmp).

- 8 out of the 57 members, namely Kuwait, Suriname, Guyana, Turkmenistan, Uzbekistan, Mauritania, Togo, and Comoros, recorded a decrease in their articles (pmp). The highest decrease was reported for Kuwait (43 articles), while the decrease for the others was by only 3 articles. Yet still, Kuwait continues to rank in the fourth place with respect to articles per million people.
- Overall, according to 2009 data, there are only 16 members performing above the OIC average in terms of articles per million people. Turkey, with 284 articles took the lead, and followed by Tunisia (213), Iran (181), Kuwait (172), and Qatar (169).
- United Arab Emirates, Jordan, Lebanon, Bahrain, Malaysia, Oman, and Brunei also ranked at the top, having produced over 100 articles per million people.
- At the other side of the spectrum, there are member countries with even less than one article (pmp), like Afghanistan Turkmenistan, and Somalia.
- To this end, it is observed that most of the high ranking member countries are located in the Middle East. Articles per million people averaged at 98 in this region in 2009, compared to 28 in 2000.
- The average for the members in Europe & Central Asia increased from 44 to 147 in that period. Excluding Turkey, these averages fall down to 11 and 14, respectively.
- Except for the Latin American members, the averages for the other regions also increased in the period under consideration (North Africa: from 30 to 58; East Asia & Pacific: from 5 to 18; South Asia: from 3 to 12; and Sub-Saharan Africa: from 6 to 11).

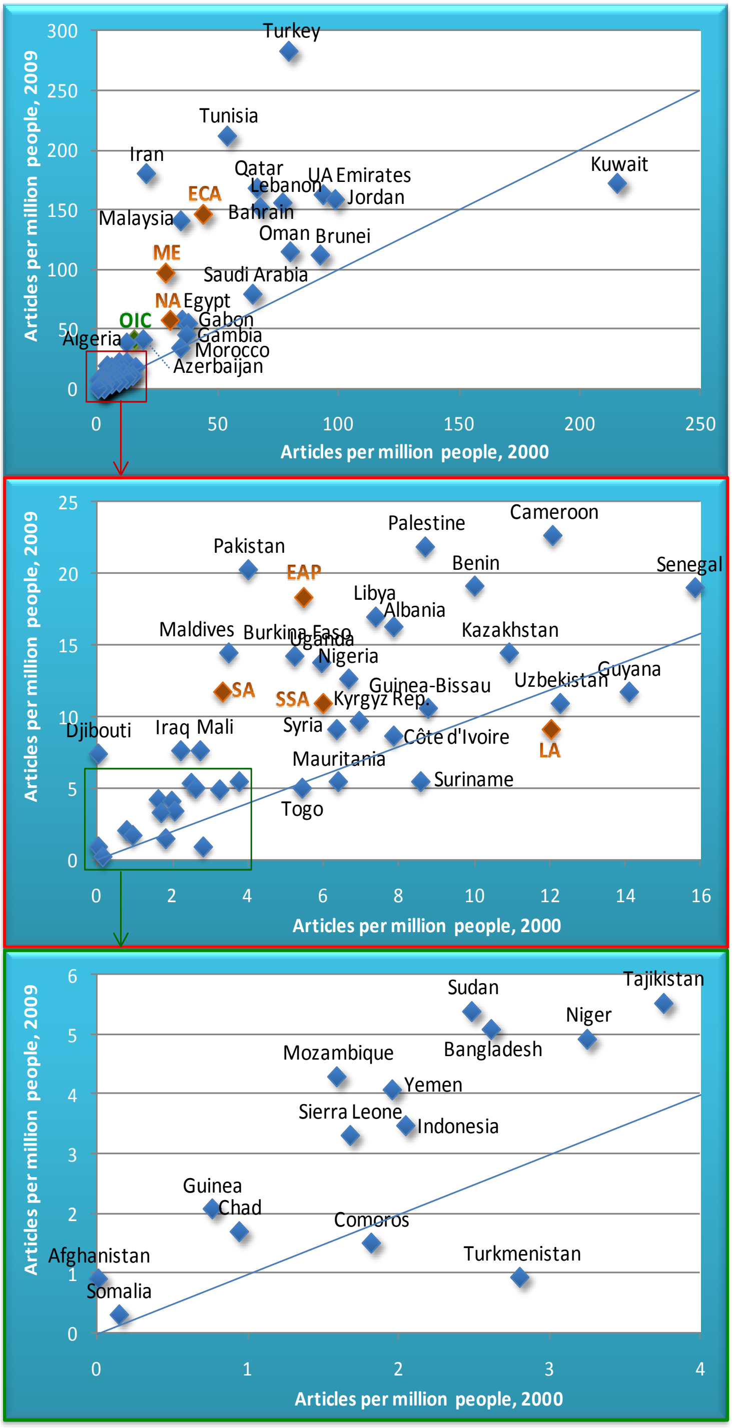

Figure 14. Articles per Million People: 2000 vs. 2009

Source: *Articles data: ISI Web of Knowledge [24.03.2010]; Population data: IMF, World Economic Outlook Database, October 2009.*

OIC Regional Averages:

ECA: Europe & Central Asia **NA:** North Africa
EAP: East Asia & Pacific **SA:** South Asia
LA: Latin America **SSA:** Sub-Saharan Africa
ME: Middle East

12 PATENT APPLICATIONS

Intellectual property rights, especially patents, are the key factors contributing to advances in innovation and scientific development. As a product of R&D activities, patents strengthen the link between science and technology, as the outcomes of research translate into new products or services. In this regard, although not all inventions are patented, the quantity of patent applications may be considered as a proxy for the degree of innovative capability in a country.

According to statistics from the World Intellectual Property Organization (WIPO), the total number of patent applications around the world in 2007 is estimated to have been 1.85 million, and only around 1% of them were filed in OIC member countries –for which data are available. To shed light on the situation in individual countries, Figure 15 presents statistics on patent applications in countries for which data are available.

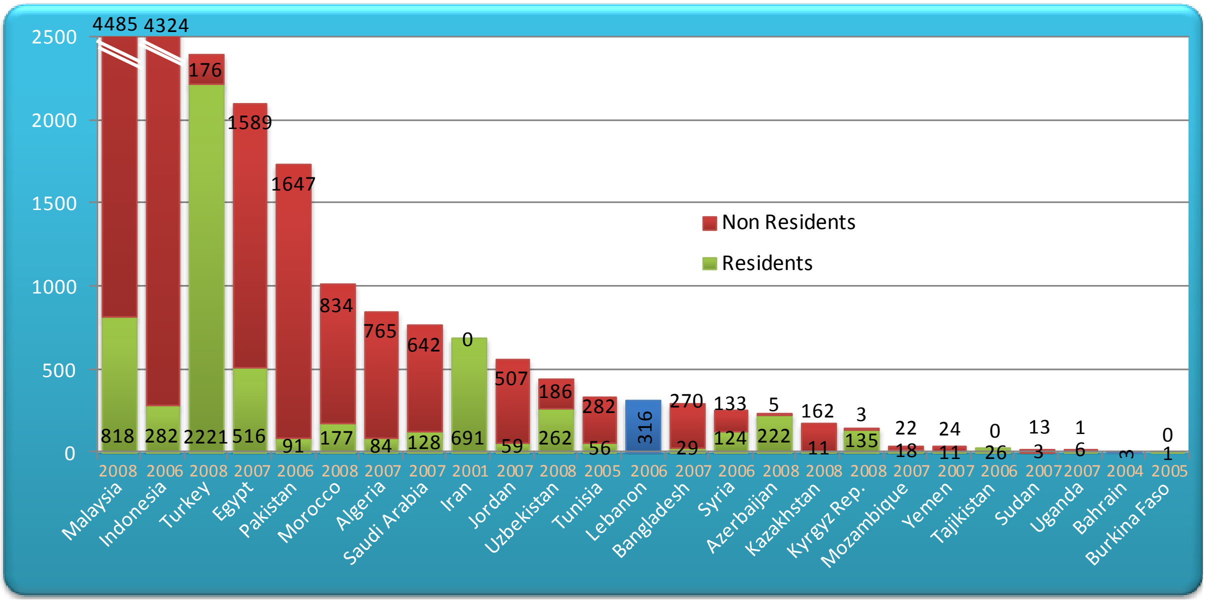

Figure 15. Patent Applications by Office: Residents and Non-residents.

Source: *World Intellectual Property Organization, Statistics on Patents, December 2009.*

In this respect, the following observations can be made to summarize the situation in the OIC member countries:

- Patent activity is highest in Malaysia and Indonesia. In 2008, total patent applications (by residents and non-residents) amounted to 5,303 in Malaysia and 4,606 in Indonesia.
- Still, none of the OIC members could reach the world average patent applications even when the top countries –USA, Japan, China, and Republic of Korea that account for 70% of the total patent applications in the world– are excluded (the corresponding average is 5,460).
- In most of the countries, applications by non-residents are higher than those filed by residents; in fact, in almost half of the 23 countries with available data, they account for more than 80% of the total applications. In quantity, they are highest in Malaysia (4,485) and Indonesia (4,324), accounting for, respectively, 85% and 94% of the total applications.
- Applications by residents dominate only in eight of the member countries, and, in quantity, they are highest in Turkey (2,221) and Malaysia (818).

13 KNOWLEDGE ECONOMY

As the global economy forces the limits of tangible resources in the modern era, knowledge based resources gain more importance in determining the growth, welfare and competitiveness of countries the application of knowledge creates significant comparative advantages through providing more efficient and less costly ways of "doing the business" in areas such as entrepreneurship, innovation, R&D, software and design, education, etc.

14 KNOWLEDGE ASSESMENT METHODOLOGY (KAM)

For most of the countries including the member countries of OIC, the transition to the Knowledge Economy is not an easy goal to achieve: It requires an extensive search about the country's needs and capabilities in order to develop effective strategies, to direct potential investments and to coordinate institutions accordingly. In this regard, the **Knowledge Assessment Methodology (KAM)** designed by the World Bank, acts as an interactive benchmarking tool for helping countries identify the challenges and opportunities they face in making the transition to the knowledge-based economy. Using a wide range of relevant factors affecting the overall performance of an economy, it also provides a cross-sectoral approach and presents a country's ability to generate, diffuse and apply knowledge rather than just focusing on one area.

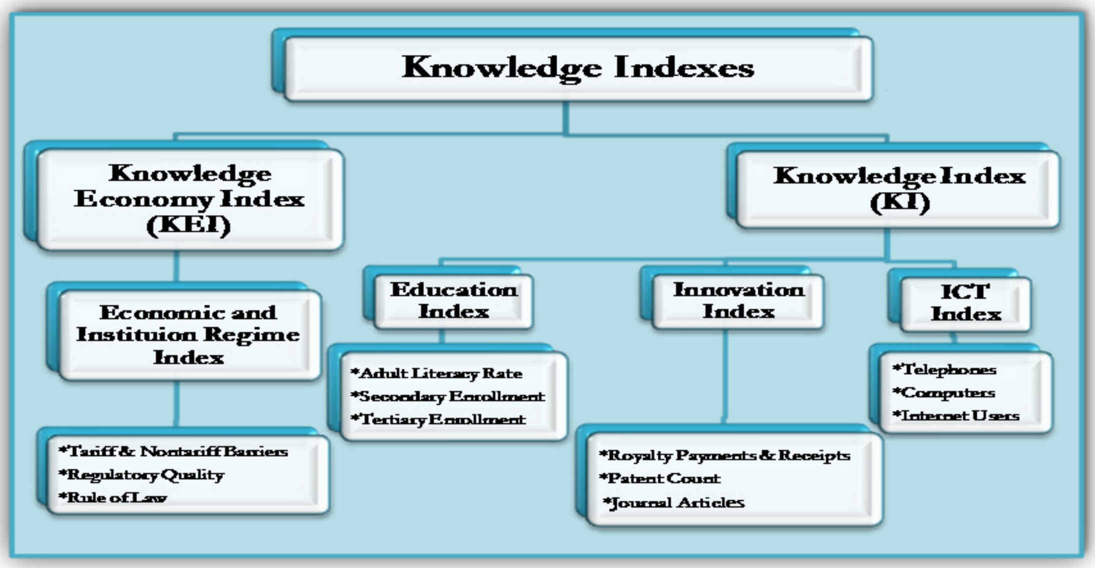

Figure 16. Knowledge Indexes.

Source: *World Bank, Knowledge Assessment Methodology.*

Under this methodology, a country's preparedness to compete in the knowledge economy is measured using 109 structural and qualitative variables[7], which are used as proxies for the four pillars of the Knowledge Economy Framework (Figure 16):

1) **Economic Incentive and Institutional Regime:** An economic and institutional regime provides incentives for the efficient use of existing and new knowledge and the flourishing of entrepreneurship.
2) **Education:** An educated and skilled population shares and uses knowledge well.
3) **Innovation:** An efficient innovation system of firms, research centers, universities, consultants and other organizations adds into the growing stock of global knowledge, assimilates and adapts it to local needs, and forms new technology.
4) **Information and Communications Technologies:** Information and communication technology facilitates the effective dissemination, and processing of information.

Depending on these 4 pillars, KAM presents two indices[8] to track the overall level of preparedness of the countries towards knowledge based economy:

A) **Knowledge Economy Index (KEI):** takes into account whether the environment is conducive for knowledge to be used effectively for economic development. It is an aggregate index that represents the overall level of development of a country or region towards the Knowledge Economy. It is the average of the normalized performance scores of countries on all four pillars.

[7] The variables are normalized on a scale of 0 to 10 relative to other countries in the selected comparison group.

[8] For calculating the basic scorecard mode of KEI and KI, each pillar is represented by 3 key variables plus two variables serve as proxies for the overall economic and social performance leading to a total of 14 variables

B) Knowledge Index (KI): measures a country's ability to generate, adopt and diffuse knowledge. This is an indication of overall potential of knowledge development in a given country. It is the simple average of normalized performance scores of countries on pillars #2, #3 and #4.

15 OIC MEMBER COUNTRIES UNDER KAM

For year 2009, 146 countries are analyzed through KAM and 41 of them are OIC Member Countries. 16 OIC Member Countries that are not included in KAM 2009 analysis are Afghanistan, Brunei, Chad, Comoros, Gabon, Gambia, Guinea-Bissau, Iraq, Libya, Maldives, Niger, Palestine, Somalia, Suriname, Togo and.

Figure 17 presents the overall KEI ranking of OIC Member Countries under basic scorecard mode of KAM 2009 framework weighted by population. Accordingly, the following observations can be made:

- In year 2009, Qatar, UAE, Malaysia and Bahrain recorded KEI scores higher than the average KEI of the World, 5.95, and were among the top 50 countries in the overall index.
- Though there is still a difference of 1.5 point, the scores of Qatar and UAE are getting closer to the average KEI score of high income countries, 8.23, while Malaysia, Bahrain and Kuwait are above the upper middle income average of 5.66.
- The KEI scores of 12 OIC Member Countries are higher than the average of middle income countries, 3.78.
- Outside the MENA region, Malaysia, Turkey, Kazakhstan, Kyrgyzstan, Albania, Azerbaijan and Guyana are the only countries managing to enter top 100 countries.
- 19 OIC Member Countries improved their rankings compared to 2008. Among them, Mauritania, Yemen, Sudan and Pakistan took the lead by moving up 15, 13, 11 and 9 ranks, respectively.
- Like Pakistan, Qatar and Saudi Arabia also changed their position up by 9 ranks.
- 4 OIC Member Countries, Malaysia, Mozambique, Uganda and Bangladesh maintained their ranks in year 2009

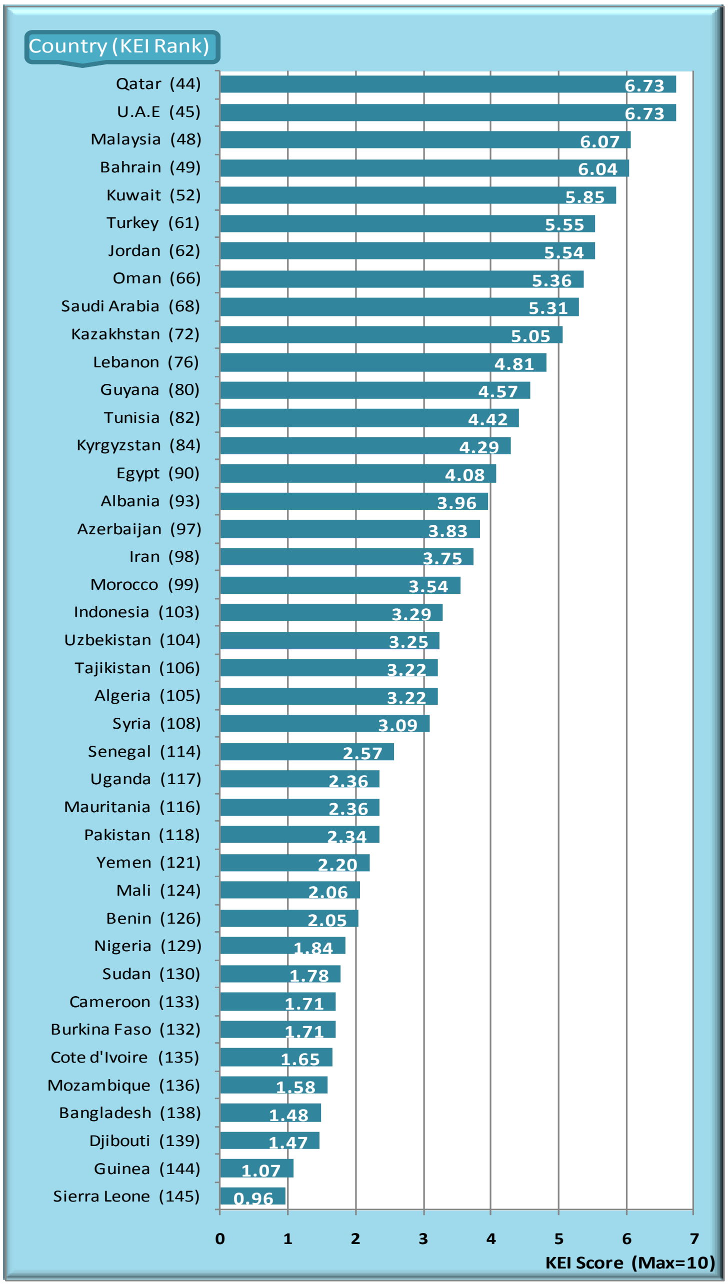

Figure 17. KEI Scores and Ranks of OIC Member Countries, Weighted by Population.

Source: *World Bank, KAM 2009.*

➢ When the countries are analyzed over time, 4 member countries, namely Qatar, UAE, Oman and Saudi Arabia showed progress compared to their KEI scores in 1995. Meanwhile, regression is observed for the average KEI score of World.

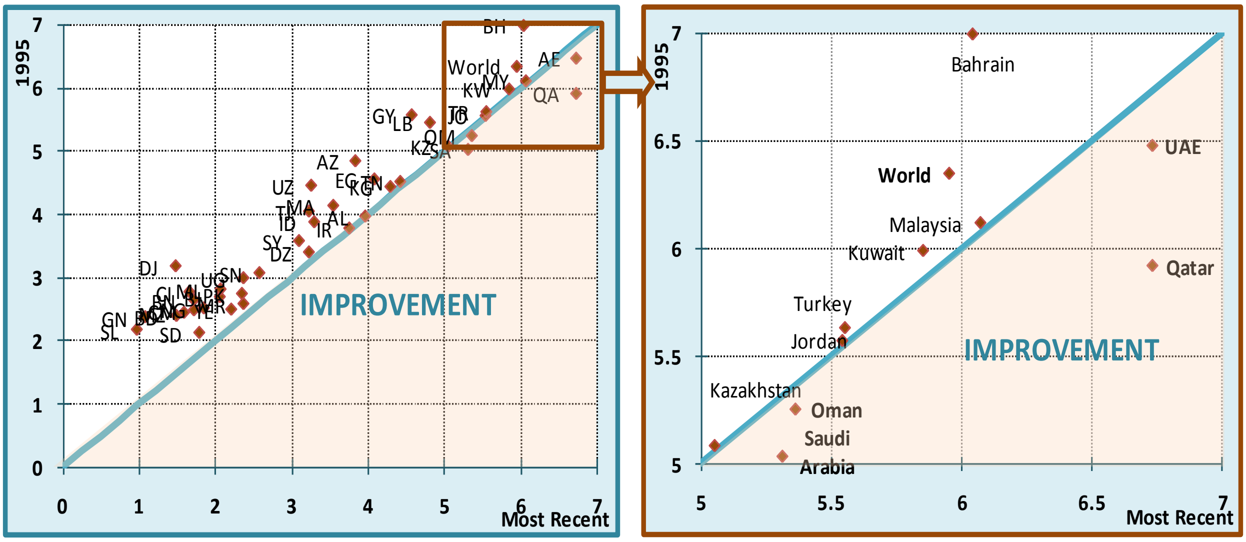

Figure 18. Over Time KEI Progress of OIC Member Countries, Weighted by Population.

Source: *World Bank, KAM 2009.*

➢ Additionally, if the separate scores from each four composite pillars of KEI are also taken into consideration, the top five positions in 2009 were held by:
- Oman, Qatar, Turkey UAE and Bahrain for *Economic Incentive & Institutional Regime*;
- Malaysia, U.A.E, Qatar, Turkey and Jordan for *Innovation;*
- Kazakhstan, Kyrgyzstan, Uzbekistan, Guyana and Bahrain for *Education*;
- U.A.E, Qatar, Bahrain, Malaysia and Kuwait for *ICT*.

➢ Furthermore, the following member countries increased their scores compared to year 1995 for the composite pillars of:
- **Economic Incentive & Institutional Regime (17):** Algeria, Azerbaijan, Cameroon, Jordan, Kazakhstan, Kuwait, Kyrgyzstan, Mauritania, Oman, Qatar, Saudi Arabia, Senegal, Tajikistan, Turkey, Uganda, Uzbekistan and Yemen;
- **Innovation(14):** Algeria, Benin, Indonesia, Iran, Lebanon, Malaysia, Mauritania, Pakistan, Qatar, Syria, Tunisia, Turkey, UAE and Yemen;
- **Education (20):** Albania, Algeria, Bangladesh, Benin, Burkina Faso, Djibouti, Guinea, Guyana, Jordan, Kuwait, Kyrgyzstan, Malaysia, Mali, Oman, Saudi Arabia, Senegal, Tunisia, UAE, Uganda and Yemen;
- **ICT (3):** Malaysia, Qatar and UAE.

16 POLICY IMPLICATIONS

Given the importance of evidence-based policy making and the role of S&T in the development of countries, national statistical offices of the member countries should give special attention to the collection and dissemination of statistical data on science and technology. Considering the available data, the following conclusions can be drawn for the member countries:

➢ Although the availability of researchers varies considerably among the OIC member countries, most of them lag behind the world, with inadequate quantity of researchers employed in R&D activities.

➢ Women, as researchers, are underrepresented in R&D activities, yet the OIC average is slightly lower than the world average and many OIC countries have higher shares than even the average for the EU members.

- R&D intensity is quite low in the OIC, with only one country spending more than 1% of GDP on R&D while the world average is around 1.8%. On the other hand, some countries have recorded significant increases in their R&D intensity while most of the other countries have reported stable expenditures on R&D. In this regard, although the OIC Ten-Year Programme of Action called upon the member countries to encourage R&D programmes and ensure their individual R&D intensity is not inferior to half of the world average, the OIC countries are currently far away from the target and it seems difficult to meet the Programme target in time under the current trends. Therefore, there needs to be more efforts exerted in this area to close the gap with the world.
- In most of the member countries, R&D activities are financed and performed by the public sector while, in few cases, business sector or higher education takes the lead.
- In parallel with the low R&D intensity and inadequate technological infrastructure, high technology exports of the OIC member countries remain quite limited, accounting for only 4.3% of the world high technology exports, yet again mostly originated from only two members.
- Moreover, high technology products do not occupy much part in manufactured exports of the members, and this does not seem to improve significantly over time except for few of them.
- Production of scientific articles is also concentrated in a few of the members. In 2009, the OIC member countries produced more than 63 thousand articles, yet, 71% of them originated from only 5 countries and 24 of the members each produced less than 100 articles.
- In the last decade, from 2000 to 2009, the number of articles per million people, on average, increased by 27 articles to reach 42, which is still low given that in some countries it exceeds one thousand.
- Patent statistics are not available for most of the member countries. Available data on 25 members indicate that patent applications are below the world average and mostly filed by non-residents, implying that indigenous innovation capability in most of these countries is at low levels.
- Although, of the 41 OIC Member Countries analyzed under Knowledge Assessment Methodology in 2009, only Qatar, UAE, Malaysia and Bahrain recorded higher KEI scores than the World average, most of the member countries achieved progress compared to their scores in 1995.

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Science and the Information Society

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1 THE BIRTH OF THE INFORMATION SOCIETY

There are very few transforming events in history that could be dated so precisely as the birth of information age or information society. In March 1989, a British physicist, Sir Tim Berners-Lee, submitted a proposal to his boss, Mike Sendall, seeking authorization for the development of an information management system to keep track of the information flow among the numerous scientists and scientific institutions involved in the work of the European Council for Nuclear Research, known by its French acronym CERN (see box). Mike Sendall gave his approval and wrote on top of the proposal "vague but exciting" '(Figure 1).

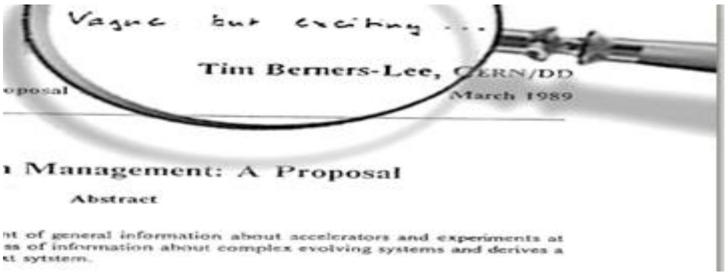

Figure 1. Berners-Lee proposal annotated by Mike Sendall.

Dr Berners-Lee (Figure 2), using a NeXT computer (Figure 3), developed a system which was based on the idea of facilitating access to documents by hypertext thus allowing scientists involved in CERN's experiments and research to have access to, and share all documents stored in their computers and those at CERN, thereby having a single information network.

Figure 2.Sir Tim Berners-Lee .

Figure 3.The NeXT computer.

With the help of another scientist, Robert Cailliau, they invented what we know today as the World Wide Web in May 1990. The NeXT computer became the first web server. The first web page had the following address: http://info.cern.ch/hypertext/WWW/TheProject.html.

The development of World Wide Web continued on 1991 when the CERN tested a universal line mode, which allowed the spread of servers all over Europe. But the breakthrough came in February 1993 when the University of Illinois at Urban –Champaign released the first version of Mosaic, which allowed ordinary people to have access to the Web using normal PCs or MACs. The Information age began!

So, the World Wide Web, which was invented as a tool to allow scientists share information and conduct collaborative research in the area of nuclear physics, gave birth to the Information Society. Billions of people from all over the world now exchange information, data by using hypertext.

Following the disastrous Second World War and its target event of the atomic bomb, a number of leading European scientists (Louis de Broglie, Niels Bohr, Pierre Auger, Raoul Dautry, Edoardo Amaldi and Lew Kowarski) started advocating for the creation of a European atomic physics laboratory. The UNESCO General Conference, at its fifth Session in Florence in June 1950, adopted a resolution presented by the American Nobel laureate physicist, Isidor Rabi tabled, authorizing UNESCO to "assist and encourage the formation of regional research laboratories in order to increase international scientific collaboration…" The resolution concerning the establishment of a European Council for Nuclear Research was adopted in a UNESCO meeting in Paris in December 1951. CERN, convention was ratified by 12 European states; the Organization for Nuclear Research (CERN) was officially born on 29 September 1954.

Today's world is influenced by the information and communication technologies to the extent that it became virtually impossible to develop capacities in science and technology without a good infrastructure and a good access to scientific knowledge. The World's Bank coined the term "Knowledge-based Economy (KBE)" and developed an indicator to measure it: the Knowledge Index. Among the main factors that distinguish the KBE from the normal traditional economy is the information technologies that facilitated the connection of the various markets and opened the ear of globalization. Today's world is also characterized by wide divide between rich countries and a large number of developing countries having very low GDP (Figure 4). The problems of these countries are many; suffice to list only four of them: a) poverty, b) unemployment time-bomb, 3) end of petroleum and 4) environmental deadlines

Can ICT help developing countries bridging this widening knowledge gap? Can it facilitate their integration in the global economy? We shall try to illustrate how this is possible

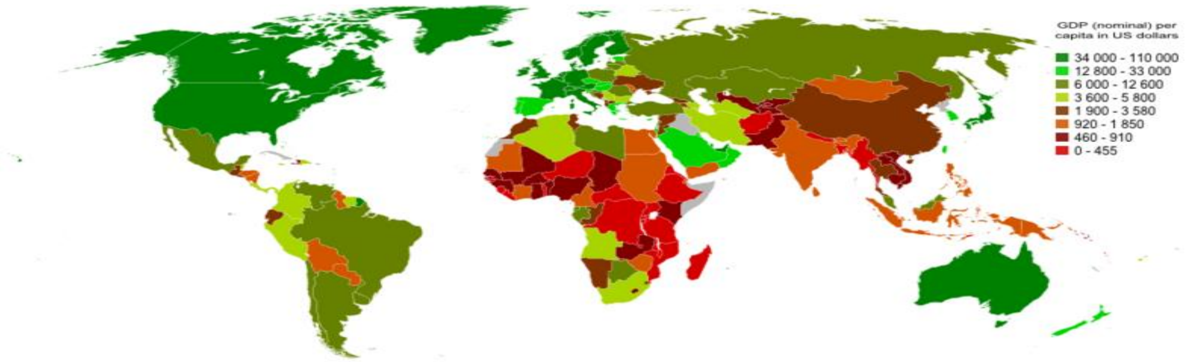

Figure 4. Distribution of GDP per capita World Bank, 2009.

The KBE is often demonstrated by a classical example comparing a fast growing economy (Korea) with a lagging economy (Ghana). There are two reasons for this choice: one reason is that both economies were at the same level in the early sixties; and the second is that one of them developed and the other did not. (Figure 5). The conclusion of the WB experts seems to point to the "knowledge factor" as the main reason for this discrepancy.

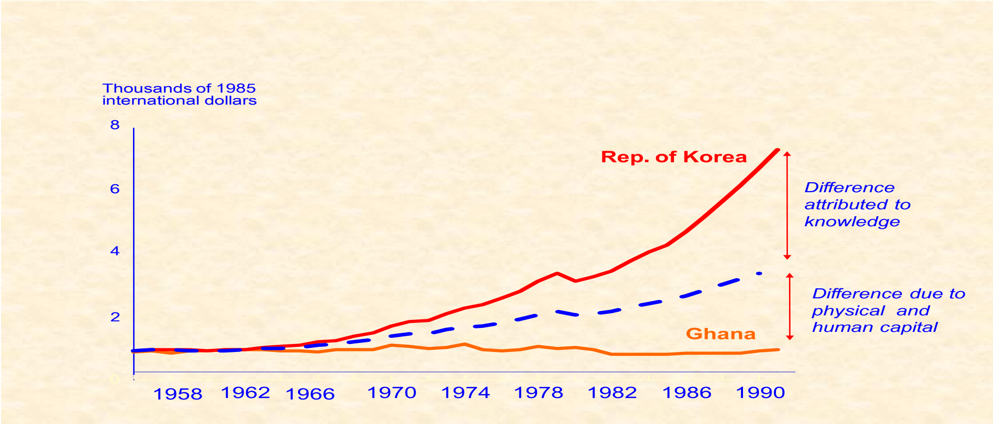

Figure 5. Evolution of GDP/of Korea and Ghana over the last 30 years.

This is certainly an oversimplification. There are many other factors that influence the growth of a country's economy. Let's mention a few: political stability, climatic conditions, access to capital and foreign aid, etc. However, it is certainly true that science and technology can make a difference. It is for these reasons that the scientific community represented by CERN, UNESCO, ICSU and TWAS organized an international conference on the role of science in the information society. They concluded their meeting by submitting a number of recommendations which were adopted at the World Summit of the Information Society (WSIS). They called upon the Summit to:

- Promote affordable and reliable high-speed Internet connection for all universities and research institutions worldwide to support partnerships, international scientific cooperation and networking between these institutions
- Promote electronic publishing and open access initiatives to make scientific information affordable and accessible in all countries on an equitable basis.
- Promote the long-term collection, dissemination and preservation of essential scientific digital data in all countries.

This conference was organized in response to a call from the UN Secretary-General, Kofi Annan, who wrote in a science magazine, while "*recent advances in information technology, genetics and biotechnology hold extraordinary prospects for individual well-being and humankind as a whole, the way in which scientific endeavours are pursued around the world is marked by clear inequalities."* He then called on the world's scientists to work with the United Nations to extend the benefits of modern science to developing countries

Let's now have a closer look at the scientific potential of the developing countries. Professor Abdul Salam once said: - "***Creation, mastery and utilization of modern science is basically what distinguishes the South from the North".*** If these countries need science and technology, then they need to have an adequate number of trained scientists and technologies. So, how many scientists are there? According to the latest UNESCO statistics (Figure 6), the number of scientist per capita is very low in the developing countries.

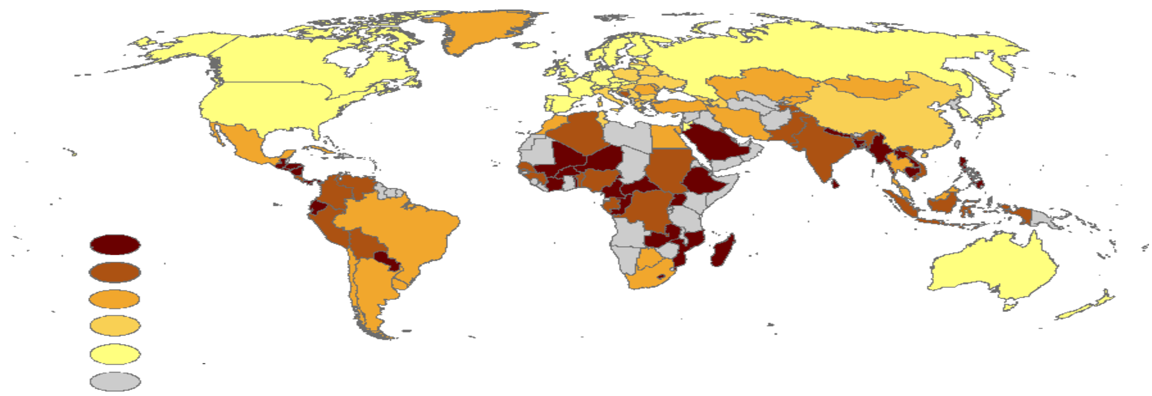

Figure 6. Number of researchers: all developing countries are below 1000 per million.

2 SCIENCE EDUCATION

Can ICT help in increasing the number of researchers? The answer to this question is yes. ICT has become an extraordinary tool for science education. Examples of this could be found in all countries. We all know of the famous Harvard open courseware initiative, which led the way for other universities to do the same. Now, the ITunes platform gives access through its link “ITunes U”, to a very wide range of courseware, in the form of filmed lectures. UNESCO also developed several projects in the use of ICT in science education at the university level. The first of such projects was the Avicenna Virtual campus, a virtual network of 17 centers in 14 Euro-Mediterranean countries that allowed, through a common platform (Figure 7) exchange of programmes among these universities.

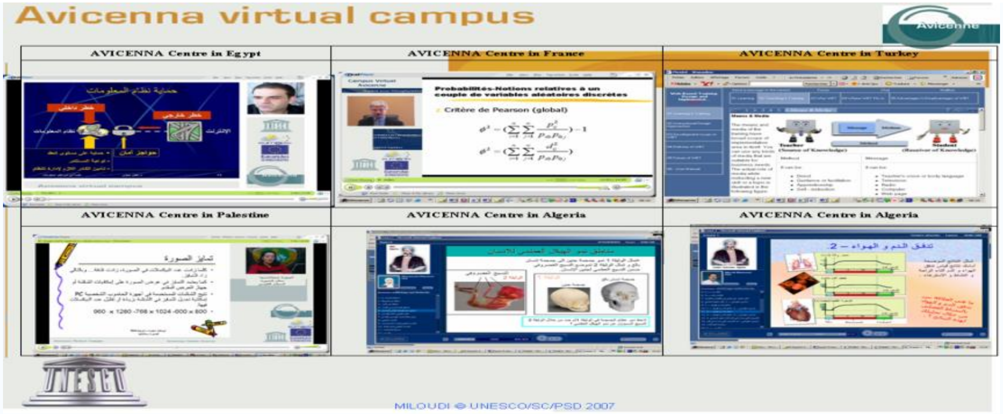

Figure 7. Avicenna Virtual Campus Platform, UNESCO.

3 E-SCIENCE

We have demonstrated above that scientific research was at the origin of the Information Society. Having said this, it is also true to say that the information society proved to be a tremendous support for scientific research, as it enabled access to scientific knowledge, permitted the organization of networks and thematic scientific grids and triggered the development of new technologies.

There are many examples to illustrate this fact. The Human Genome Project (HGP) was one of the first successful works that benefited from this technology. The HGP, completed in 2003, attained many of its objectives which included the identification of all the genes of the human DNA, the determination of the sequences of chemical pairs of which the DNA is composed and the storage of all this information into a database.

A new area of science, combining the application of ICTs to the field of biology, known as bioinformatics, was born. This field deals with genomics, genetic and the mapping and analyzing DNA and protein sequences. The most important contributions of bioinformatics are in the area of drug design and drug discovery through protein-protein interaction techniques.

The World Wide Web made possible what is known as Grid Computing, which allows sharing computing power and storage capacities of many PCs through the internet. The best known Grids are run by CERN in the area of high-energy physics: the Large Hadron Collider (LHC) Computing Grid and the Enabling Grid for E-Science. The LHCG has some 200 sites around the world, connecting more than 20 000 PCs which allows running tens of thousands applications per day.

There are many such Grids. For example the World Community Grid that links Researchers who are studying the protein-protein interactions of some 2000 proteins to identify those that play a role in neuromuscular diseases. Another Grid is the MammoGrid which aims acts as a database of mammograms for the whole of Europe.

The area of astronomy benefited tremendously from ICTs, both in terms of research and exploration as well as in the area of popularization. The study of the dark matter and dark energy are based on very complex simulation and calculations (Figure 8)

Figure 8. Simulation of the concept of dark matter and dark energy.

These observations, simulations and computation of gravitational effects, point to the existence of an invisible substance that we call dark matter as it does not emit any radiations. This phenomenon is detected through their gravitational effects. Scientists also assume that there exists what they call Dark energy; it may represent up to 70% of the Universe.

Another effect tool of scientific collaboration that is based on ICT is what is known as peer-**to-peer**, commonly abbreviated to **P2P**. This takes the form of a network of individuals that agree to provide part of their processing and/or storage capacities to be used by other members of the network.

The World Wide Web also allowed the building of knowledge portals of a very large scale. One of the most important efforts is the Encyclopedia of Life Support System (EOLSS) supported by UNESCO. EOLSS is largest body of knowledge of sustainable development. More than 8000 scholars from 102 countries contributed to this impressive web-based knowledge for sustainable development (Figure 9). Unlike other on-line encyclopedias; EOLSS is composed solely of peer-reviewed articles.

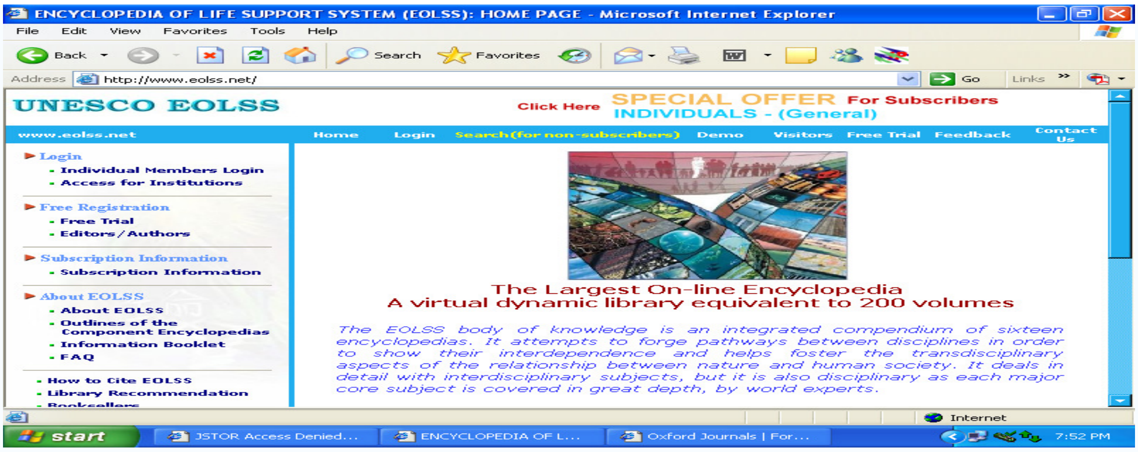

Figure 9. Webpage of the Encyclopedia of Life Support Systems.

The World Wide Web is also enabling its translation in more than ten languages through another application known as the UNL, which is an UN-patented method of automatic translation.

4 CONCLUSION

Scientific research was at the origin of the information society. It brought the world closer together and led to the globalized world in which we live. On the other hand, this revolution made possible huge advances in science from physics to astronomy and from biology to bioinformatics. The WWW also is making it possible for the developing countries to expand and improve science education through e-learning and building capacities in science and technology through better interaction with the world scientific community through e-science. Finally the WWW made possible the development of large databases and on-line scientific encyclopedias.

Hubs of Knowledge and information Flows in Islamic Countries: Challenges and Potentials

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1 ABSTRACT

This paper discusses the importance of global knowledge and information flows in shaping development and advancement in Islamic countries during the era of globalization. It focuses on the hubs or places that trigger these flows from the global domain to the local context. I classify these hubs into three main types: 1) Micro hubs which include small places as homes and offices that have access to knowledge and information through new modes of communication such as the internet, satellite dishes, and mobile phones. 2) Intermediate scale hubs such as schools, universities, and business headquarters which feature more concentrated agglomerations of knowledge and information flows. 3) Mega hubs or places that host very intense and massive flows. Huge research centers, universities, science cities, knowledge and information villages, and media and internet cities are all examples of mega hubs that aim to intensify specialized flows of knowledge and information to their local contexts. These three types of hubs contribute significantly to the development of contemporary societies. In this paper I analyze the nature of these hubs with reference to case studies from Islamic countries. I then discuss the potentials and challenges they pose to those countries.

2 INTRODUCTION

Knowledge is the main foundation for development. The advancement of societies is triggered not only by their capability of generating knowledge, but also by their capacity to attract and digest global flows of ideas and information. We live in the era of globalization which features what David Harvey refers to as time-space compression (Harvey 1990). The revolution in communication and transportation technologies has contributed to the acceleration of the experience of time and the shrinkage of the significance of distances. This has facilitated the integration of economic, cultural, political, and social systems across the globe, or what we call "globalization."

The movements of capital, people, goods, information and knowledge currently feature unprecedented rates and magnitudes (See Held & McGrew 2002). These movements are referred to as flows because of its rate and scale. These flows have increased long distance connectedness, economic interdependence and cultural integration. Besides, it caused the restructuring of spaces and urban forms of cities (See Held 1995, Hannerz 1996). Globalization implies connectivity and interdependence of developments in different parts of the world where steady multiplication and intensification of links and flows occur (Petras and Veltmeyer 2004).

Billions of dollars are flowing across the globe every second. In 2007, nearly 900 million people traveled internationally.[1] Information, knowledge, and ideas are exchanged with the speed of light. All these dramatic changes in the ways people interact and communicate have significant impacts on development. It poses challenges to local identities and cultures. However, it also offers opportunities to developing countries that can benefit from the open access to the world advanced forms of knowledge and scientific achievements.

[1] World Tourism Organization (UNWTO)

Cities that experience significant exposure to global flows usually feature distinct landscapes or what Arjun Appadurai calls "scapes of flows" (Appadurai 1990). He identifies five of these scapes. 1) E*thnoscapes* which are created by the interaction of diverse cultures and ethnics activated by the revolution in transportation technology. Tourists, immigrants, travelers and refugees moving from one place to another contribute to the production of these landscapes. 2) *Mediascapes* which are triggered by the expanding role of media as a result of the revolution in information technology. Today, newspapers, movies, and TV shows are major sources of information and knowledge. 3) *Finanscapes* or the landscapes created by flows of capital that are triggered by currency markets, stock exchanges, and transnational corporations. 4) *Technoscapes* which reflect the influence of advanced technologies of communication and networking on contemporary life. 5) *Ideascapes* or the ideologies and counter-ideologies that are spreading in unprecedented rate because of the revolution in methods of communication (Appadurai 1990). Appadurai refers to these "scapes" as the critical players that shape the social practices in the era of globalization.

The five dimensions discussed by Appadurai (1990) emphasize the importance of recognizing the role of global flows in shaping contemporary development. These flows are shaping the urban structures of most of the cities today. Cities referred to as "global" or "world" cities are the ones exposed to more flows than others. New York, London, Tokyo, Paris and Los Angeles are examples of top *world cities*. They feature intense agglomeration of capital, people, and knowledge flows. These cities have hubs or places that attract these flows and transmit them to the local context. Business headquarters, stock markets and transnational corporations for example attract global capital to these cities. Airports, tourist attractions, hotels and international events trigger flows of people. Free zones, ports and mega malls encourage the movement of goods. Universities, libraries, convention centers and even homes equipped with computers, internet service and satellite channels all trigger flows of knowledge, information, and ideas.

In this paper I focus on flows of information and knowledge and its role in the development of Islamic cities. Knowledge is defined by the Oxford Dictionary as the expertise, and skills acquired by a person through experience or education. It is the theoretical or practical understanding of a subject, what is known in a particular field or in total; facts and information. The concept of the knowledge economy or the production and management of knowledge is becoming crucial in discussions on development in the era of globalization. Knowledge management is defined as "the systematic process of identifying, capturing, and transferring information and knowledge people can use to create, compete, and improve."[2] It is the "production and services based on knowledge-intensive activities that contribute to an accelerated pace of technical and scientific advance, as well as rapid obsolescence" (Powell and Snellman 2004). It could be argued that knowledge is the main pillar of sustainable development in the era of globalization.

The World Bank has developed the Knowledge for Development (K4D) Program which offers advice to countries on four Knowledge Economy (KE) pillars: economic and institutional regime, education, innovation, and information and communication technologies (ICTs) to help them make the transition to a KE. According to them, "making effective use of knowledge in any country requires developing appropriate policies, institutions, investments, and coordination across the above four functional areas".[3]

What distinguishes the notion of knowledge in the era of globalization is its hybrid and dynamic nature. Knowledge is no longer bounded to a particular context. It might be generated in one place. However, information technolgy facilitates its diffusion across the globe. New modes of communication have made knowledge global. It is more accessible than ever. However, bringing this knowledge to a local context requires hubs that can host it and then transmit it to the local context.

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[2] The American Productivity and Quality Center (APQC)

[3] World Bank website: Education for the Knowledge Economy

3 HUBS OF KNOWLEDGE FLOWS

Certain place typologies can trigger global knowledge flows to the local context. Many of these places can regulate flows and assimilate it to serve particular interests and intentions. In the early phases of globalization, flows of knowledge and information occurred spontaneously and on individualistic levels through the new modes of communication as the internet and satellite channels. The spontaneous nature of these flows allowed it to penetrate cultural and social boundaries with minimum resistance. This open access has partially fulfilled the starving need of many developing societies for knowledge and information. However, it also managed to contaminate many cultures and overwrite their local identities. This has raised many concerns regarding the threats posed by these flows and the western domination of its components.

The power of knowledge and information in the era of globalization and their possible role in activating development have urged many globalizing cities to focus on attracting these global flows. As noted by Manuel Castells (1996), information is the raw material of the new technological paradigm that shape contemporary life (Castells 1996). Flows of knowledge, ideas, and information began to take more institutionalized forms. Institutions as governments, civic organizations, and public and private enterprises started to invest in projects that can trigger more flows to the local context. Places as international universities, mega research centers, media cities, knowledge villages, and science museums began to emerge in many of the developing countries. These places perform as hubs that attract and host agglomerations of flows and then transmit them to the local context.

Countries around the world and developing ones in particular, need these knowledge- hubs in order to trigger scientific advancement and development. These hubs differ in size, scale and the intensity of flows they host. They also vary in the degree of control, regulation and specialization. Besides, their significance and contribution to development takes various forms. They basically complement each other. The producers of knowledge hubs are numerous. Governmental institutions, private enterprises, NGOs, international corporations and even individuals contribute to the production of these hubs.

In this paper I classify these hubs of knowledge flows into three main types:

1) Micro Hubs:

Micro hubs are the small places that connect a local context to the global domain. These hubs perform individually and spontaneously with minimum regulations. They also don't feature any forms of coordination. Homes, offices and cafes exposed to global flows of information via internet and satellite channels fall under this category. These places represent the micro units of the network of hubs that host agglomerations of flows and transmit them to the local context. Micro hubs mainly rely on basic means of communication as internet, media and mobile phones.

In the era of globalization, micro hubs play a significant role in spreading knowledge. They allow global flows of information and ideas to penetrate most of the political, social, and cultural boundaries. These hubs form the basic infrastructure that exposes societies to free open sources of knowledge. Micro hubs are the first indicator that reflects the degree of connectivity of a society to the global network. Penetration rates of computers, internet service, and mobile phones within the population are among the important measures used by the United Nations to evaluate development in countries.

Since the mid 1990s, most of the Islamic countries have been trying to cope with the global revolution in information technology and communication. Governments and the private sector have been investing in the basic infrastructure in order to connect the local context to the global domain. Internet services, satelitte channels, and mobile phone networks were introduced. During the last ten years, these technologies expanded significantly. For example, between 2000 and 2008 the number of internet users in Syria has increased by 117 folds (11700%). Saudi Arabia increased 3500%. In Egypt it has increased 1200% and in Indonesia nearly 1150%. All Islamic countries have experienced significant growth in the rates of internet penetration.[4] Malaysia tops the list with a penetration rate of 65.7% at 2008 (65.7 users per hundred of the population).[5] It is followed by the United Arab Emirates and Qatar at rates of 59.6% and 52.3% respectively.

Although these figures might seem impressive, the fact remains that most of the Islamic countries are still way behind in internet penetration compared to developed countries. The rate in most of the Islamic countries is below the world average which is 23.8%. A developed country like Finland for example, has a penetration rate of 82.9%. Australia has a 79.6% rate and North America has 73.9%. Except for Malaysia, Iran, Turkey and some of the Gulf countries, most of the Islamic countries have a penetration rate below 15% (See chart 1).

The low rate of internet penetration in many Islamic countries is attributed to the poor economic condition. The capacity of individuals to own a computer is also very limited. Computers penetration rates in all Islamic countries is way below the average of developed ones. Based on 2007 data, the United Arab Emirates, Qatar and Malaysia top the list of Islamic countries with rates 26.4%, 26.3% and 22% respectively. Most of the Islamic countries fall below 10% penetration rate which means that there is one computer for every 10 people (See Figure 2).

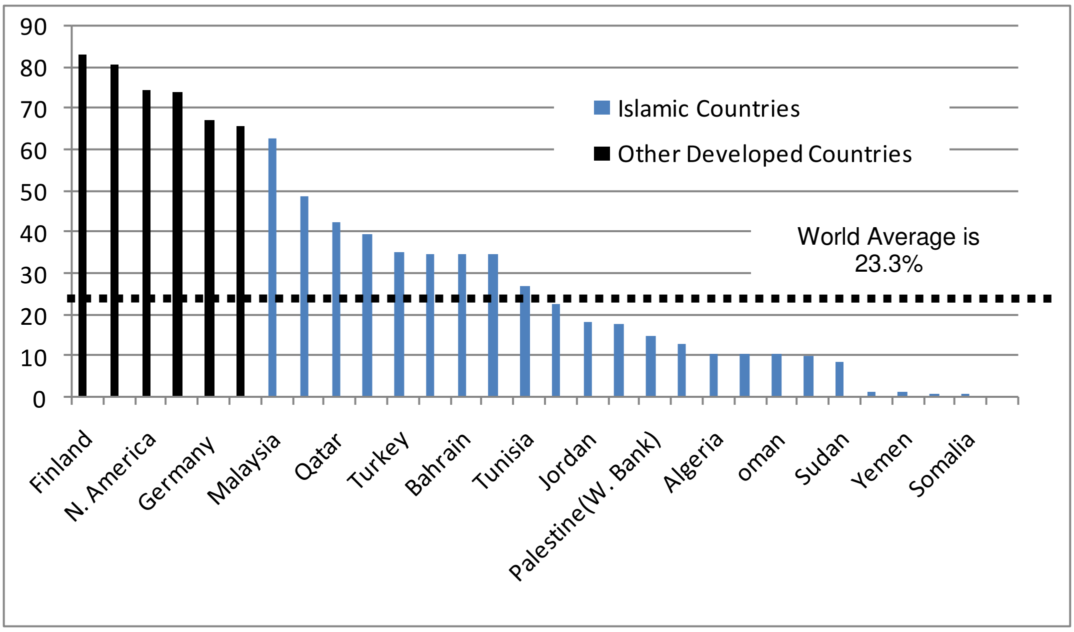

Figure 1. % of Internet Penetration in Some Islamic and Other Developed Countries in 2008.

Source: *Internet World Statistics. Link: http://www.internetworldstats.com/*

[4] Internet penetration is measured by the number of users per 100 inhabitants.

[5] Source: Malaysia communication and multimedia commission

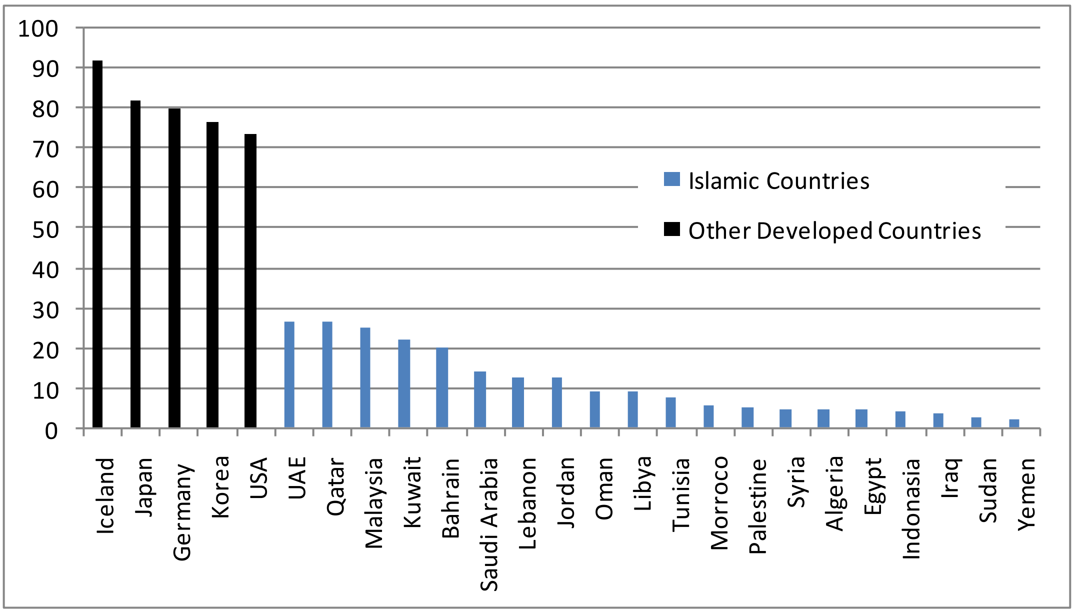

Figure 2. % Computers Penetration in Some Islamic and Other Developed Countries in 2007.

Sources:
Madar Research in conjunction with marketing communications consultancy Orient Planet
Malaysia: Malaysia Information Technology Report Q2 2008
Indonesia: the International Telecommunications Union.
USA: Nielsen Media Research reports.
Korea: National Internet Development Agency Korea Internet Survey
Iceland: Economy of Iceland, Central Bank of Iceland Germany & Japan: OECD Science, Technology and Industry Scoreboard 2007

Mobile phones are other example of devices that trigger flows of knowledge and information from one place to another. They contribute to the expansion of micro hubs of knowledge and information flows. Whether through their internet surfing capabilities or the SMS services, these phones are spreading information and knowledge in huge scales. Besides, these phones offer communication services to many places in developing countries that have no access to land phone. Mobile phones not only facilitate communication, but also contribute to economic development. These devices are considered catalysts for small scale industries. They empower small businesses and individuals by offering efficient ways of information exchange.

The majority of Islamic countries have a satisfactory mobile phones penetration rate. The United Arab Emirates, Saudi Arabia and Bahrain have penetration rates that exceed 100% which means that some people even have more than one phone (See Figure 3). Even in less wealthy countries as Jordan, Oman, Algeria and Egypt, the number of mobile phones is growing significantly. Global telecommunication enterprises are playing the major role in the expansion of this service across the Muslim world. For example, Orascom Telecom invests in mobile phone networks in Egypt, Algeria, Tunisia, Iraq, Afghanistan, Pakistan and Bangladesh.[6] Vodafone invests in Egypt, Qatar, Bahrain, United Arab Emirates, Afghanistan, Indonesia and Malaysia.[7] These global enterprises managed to attract huge numbers of

[6] Orascom Telecom official website: http://www.orascomtelecom.com/regional_Presence/default.aspx
[7] Vodafone official website: http://enterprise.vodafone.com/discover_global_enterprise/global_reach.jsp

subscribers by offering affordable packages and plans. Although these enterprises contribute to the exchange of information and knowledge, it could be argued that the billions of dollars they absorbed from local markets have hindered in some way, economic development.

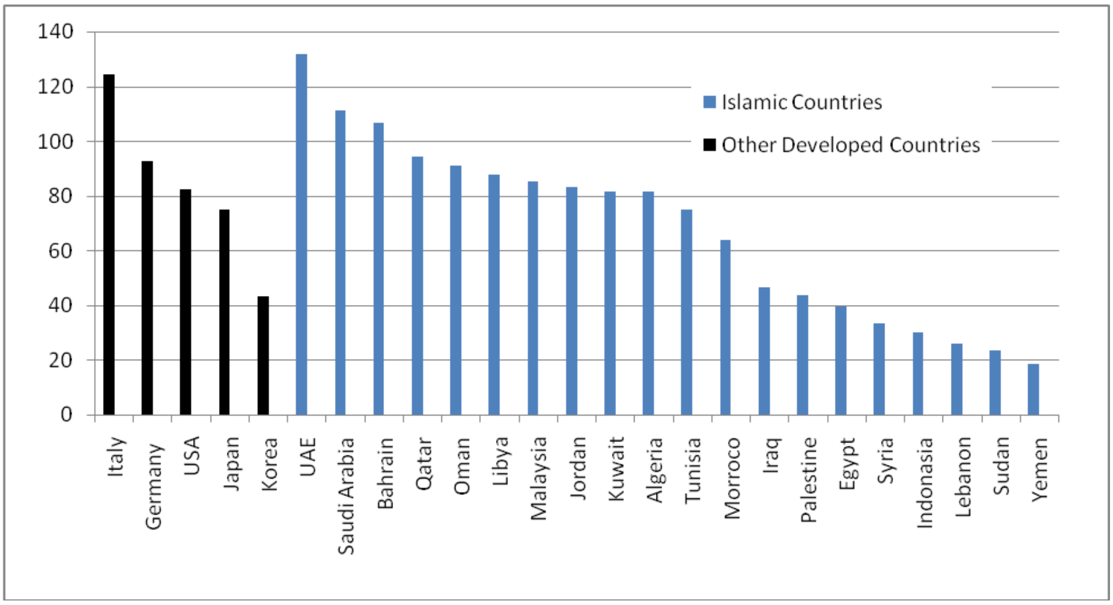

Figure 3. % of Mobile Phones Penetration in Some Islamic and Other Developed Countries in 2007.

Sources:
Madar Research in conjunction with marketing communications consultancy Orient Planet
Malaysia: The Malaysian Communications and Multimedia Commission
Indonesia: 2007 Asia - Telecoms, Mobile and Broadband in Indonesia and Timor Leste, Paul Budde Communication Pty Ltd, September 3, 2007
Korea: 2008 Asia - Telecoms, Mobile and Broadband in North and South Korea, Paul Budde Communication Pty Ltd
Communities Dominate Brands, Business and marketing challenges for the 21st century, By Tomi T Ahonen and Alan Moore

Micro hubs of knowledge flows are usually huge in number. They provide a horizontal form of coverage within the urban fabric. These hubs are expanding in almost every city across the globe. Having a computer, internet connection, or a satellite dish receiver is becoming more affordable than ever. In many low income communities, people even create alternatives to afford having these networking tools. They buy used computers, share internet connections, and crack the code of channels that require subscription. In Egypt for example, many households rely on illegal access to satellite channels. According to *Al Ahram Newspaper,*[8] it is estimated that 5 million families use illegal satellite dish connections.[9] Thanks to local technologies, having a satellite dish and a receiver in Egypt costs less than $50. Besides, many Egyptians have access to coded channels that require subscription using very cheap illegal decoding cards or by getting a connection from one of the illegal local service stores. Same phenomenon is common in many countries as India, Pakistan, Indonesia and Bangladesh.

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[8] Al Ahram is the number one newspaper in Egypt. It is owned and run by the state.
[9] Al Gergawy, Nagi 2008. 5 Million Families Use Illegal Dish Connections and the Losses of Copyrights Piracy is 100 million L.E., Al Ahram Newspaper, April 12, 2008. Issue 44322

In many Islamic countries, micro hubs are becoming not only recipients of flows, but also generators of knowledge and exporters of local ideals and news. Political and cultural blogs and internet forms are playing a significant role in exposing the political and cultural conditions in many Islamic countries. It is estimated that in Iran for example, there are nearly 2.5 million blogs drawing approximately 5 million hits per day. This makes it the third in the world after the United States and China.[10] These micro hubs are now major sources of knowledge and information about Islamic societies. They are becoming places of flows of knowledge, information, and ideas to and from Islamic countries.

Although micro hubs are not directly managed nor regulated by any institutions, they are in many cases, monitored and controlled by governments or service providers. Many governments block particular websites and satellite channels that expose locals to ideals that might not fit the political, social or cultural ethos in place. For example, the Chinese government blocks many websites that criticizes the regime and promote ideals of democracy and freedom of speech. In Iran, adult and some political websites are strictly banned. It is estimated that nearly 5 million sites have been banned in Iran.[11]

Although micro hubs of knowledge flows don't feature organized forms of coordination, they create what Howard Rheingold (2006) describes as the "smart mobs" (Rheingold 2006). He means by smart mobs, groups of people who manage to use communications technology to activate and organize social actions and events in the real world (Rheingold 2006). They initiate events, protests and political activities. In the recent years, smart mobs have been very effective. In Egypt, they organized a nationwide strike in April 6, 2008. In Lebanon, they organized huge protests in 2005 condemning the assassination of Rafiq Al Hariri. And recently, those smart mobs organized many protests in Iran rejecting the results of the presidential elections.

2) Intermediate Scale Hubs of Knowledge Flows:

Intermediate scale hubs are places that feature more intense flows of knowledge and information than micro hubs. Business centers, governmental headquarters, schools, universities and cultural centers are examples of this category. These places host agglomerations of flows of information and knowledge in a relatively more regulated and coordinated manner. They are run by institutions and have the capability of filtering information and knowledge to serve their interests and intentions. These places act as nodes of concentrated flows within the fabric of micro hubs.

In the era of globalization, business headquarters hosting financial corporations, transnational corporations, local and international organizations supported by high tech communication infrastructure are becoming crucial for cities aiming to become part of the global economy. These headquarters mainly rely on knowledge and information flows. They feature a very high rate of internet, computers and cell phones penetration. Besides, they trigger the emergence of training and development centers to support their need for skilled workers who can communicate effectively with the global market. These advanced headquarters are hubs of knowledge and information flows that contribute to the development of the local context.

Some Islamic cities are experiencing the emergence of these advanced business headquarters. The Petronas Twin Towers in Kula Lumpur, Malaysia, The World Trade Center in Cairo Egypt, and Burj Al Mamlakah in Riyadh, Saudi Arabia are all examples of these intermediate scale hubs of information and knowledge flows. These places are strongly connected to the global network. They are significantly exposed to outside knowledge, ideas, and information that serve their business interests.

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[10] Habibinia, Omid 2009. "Iran's New Internet Attacks on Dissenters" in World Press, February 25, 2009. Link: http://www.worldpress.org/Mideast/3310.cfm

[11] Habibinia, Omid 2009. "Iran's New Internet Attacks on Dissenters" in World Press, February 25, 2009. Link: http://www.worldpress.org/Mideast/3310.cfm

The cost of intermediate scale knowledge hubs is relatively high. The economic conditions in many of the Islamic countries limit their chances of having this type of hubs. A study by AMI-Partners shows that of the 3.73 million small businesses in Indonesia, only 18 percent have bought PCs. In Egypt, only 34% of the enterprises use the internet in communication.[12] These rates are significantly low compared to countries like Singapore and Hong Kong with rates of 82% and 70% of computer penetration in businesses respectively.[13] In Korea, establishments with 10 employees or more have a computer penetration rate of 97.5% and an internet access rate of 96.9%. Malaysia is the only Islamic country that has a high computer penetration rate in businesses. Nearly 66% of the businesses in Malaysia use computers.

Educational facilities are another form of intermediate scale hubs. Due to their direct contact with a huge segment of the population, these places play a significant role in transmitting knowledge, ideas, and information between the global domain and the local context. Education facilities equipped with tools of communication as internet, video conferencing and access to online digital libraries are definitely more capable of triggering flows of knowledge and information than others.

Educational facilities are institutionalized hubs of flows. Many of the countries that aim to upgrade their economic and technological capacities are establishing international universities that focus on foreign knowledge. These universities internationalize education and research. According to Olds (2007), this internationalization occurs in four different modes. 1) Cross-border supply as on-line distance education; 2) Consumption abroad of education services by sending students to study in other countries; 3) Commercial presence in the form of establishing foreign campuses in the city; and 4) Presence of faculty teaching in another country or bringing foreign faculty (Olds 2007). The new emerging transnational educational institutions also include schools, libraries and training centers. Partnership between local and foreign educational institutions is becoming a common phenomenon in many globalizing cities. These institutions are becoming places of intense flows of knowledge and information.

In Egypt, there are many of these international educational institutions that focus on the idea of partnership with foreign universities. The American, British, Canadian, German, Russian, Japanese (under construction) and French universities are all examples of these hubs. These places are run by both local and foreign faculty members from the university home country. They are usually funded and managed by the foreign embassies in Egypt to promote their educational ideals and ethos. Students in these universities have access to foreign education depending on the affiliated country. Many international schools have also emerged in Egypt. They offer foreign degrees as the American Diploma or the British International General Certificate of Secondary Education IGCSE. In these programs, students study same syllabi and course contents as their equivalents in the U.S. or Britain. Similar places exist in the United Arab Emirates, Qatar, Jordan and Lebanon.

Today, sources of knowledge that can serve educational facilities are more available than ever. Thanks to the multiple projects of digitalizing publications, education institutions that cannot afford establishing or updating their libraries now have an open access to digital books and the world largest libraries for free or by affordable subscriptions. Students, researchers, and educators in these facilities can access the latest publications and in many cases, watch online lectures from top world universities. The revolution in communication technologies has empowered many education facilities in developing countries. Schools and universities that managed to transform themselves to host flows of knowledge are now playing a significant role in the development and advancement of their societies.

The major distinction between intermediate scale hubs and micro ones is that the former performs in a more regulated and planned manner. Unlike micro hubs, these places don’t work spontaneously. They are usually more focused and specialized in selected forms of knowledge and information. They are responsible for the spread of particular types of knowledge that serve educative, economic and technological interests. Intermediate scale

[12] Source: Ministry of Communication and Information Technology, The Future of Internet Economy in Egypt, Statistical Profile, May 2008.

[13] Source: AMI-Partners

hubs perform under the control of institutions. Besides, they usually require larger investments compared to micro ones.

3) Mega Hubs of Knowledge Flows:

Mega hubs are places that host very intense and massive scales of knowledge and information flows. They feature a concentration of research and education activities. Because of their huge cost, these places are usually developed by governments and non-profit organizations. They require huge funding which make them a feature of top world cities. Many developing countries are currently developing mega hubs of knowledge flows in an attempt to push development and economic progress.

Mega hubs are very specialized in the types of knowledge they offer. Scientific research centers, mega world class universities, science museums and knowledge villages are examples of these places. In the era of globalization, these huge projects mainly focus on bringing the most advanced scientific and technological forms of knowledge to the local context. They rely on attracting the best experts, intellectuals, scientists, researchers and professionals to work in these hubs. Mega hubs of knowledge flows usually follow the highest international standards and methods of research, education, and scholarship. They perform as engines that trigger flows of the most advanced forms of knowledge.

King Abdullah University of Science and Technology (KAUST) is an example of these mega hubs. This new project is funded by a $10 billion endowment from the Saudi government. The university has a partnership with three prominent American universities: Stanford, Texas Austin, and University of California Berkeley. These three universities are responsible for developing syllabi, selecting faculty and guiding research projects in king Abdullah University.[14]

Qatar Education City is another example of these mega hubs. Developed by The Qatar Foundation for Education, Science and Community Development, this project hosts branches of six American Universities: Virginia Commonwealth University School of the Arts, Carnegie Mellon University, Georgetown University School of Foreign Service, Northwestern University, Texas A&M University, and Cornel University Medical College. Students and researchers in Qatar Education City will enjoy the same quality of education, scholarship and access to knowledge as that offered by these distinguished universities in their home campuses in the United States.

Dubai Knowledge Village in the United Arab Emirates launched in 2003 is another example of mega hubs. This huge international educational center with a one kilometer long building is designed to host any knowledge based activities. The village includes professional training centers, HR consultancies, linguistic centers, and assessment centers. As stated in its mission statement, the main objective of Dubai Knowledge Village is “to provide quality infrastructure, services and support to the Human Resources Management community to enable their growth and support Dubai’s moves into a knowledge based economy.”[15] Dubai International Academic City is another hub of flows of information and knowledge. It focuses on international higher education and is owned and run by the state of Dubai.

The Smart Village in Egypt is another example of mega hubs that trigger flows of knowledge to the local context. The project was jointly funded by the Egyptian state and the private sector. It was founded in 2003 by the Smart Village Company on 741 acres. The Village hosts many international IT corporations as IBM, Oracle, Microsoft and Vodafone. The total number of professional working in the Village’s 100 corporations is estimated by 12,000 and is expected to reach 80,000 by 2014.[16] The smart Village, as described by the developing company, is:

> *“The first fully operational technology and Business Park in Egypt, that accommodates multinational and local telecommunications and information technology companies,*

[14] Tamar Lewin, U.S. Universities Join Saudis in Partnerships, *The New York Times*, March 6, 2008.
[15] Dubai Knowledge Village official website: http://www.kv.ae/page/about-dkv
[16] The Smart Village website: http://www.smart-villages.com/docs/about.aspx

financial Institutions and banks, together with governmental authorities on three million square meters in the west of Cairo. The efficient mix of business services boosts the competitiveness and profitability of enterprises taking advantage of fiber optic network, multi-source power supply, district cooling and heating redundant network plant." [17]

Image 1: The Smart Village, Egypt

Image 2: Cornel University Medical Campus, Qatar

Dubai internet city (DIC), launched in 2000, is another example of mega hubs of knowledge flows. This project managed to bring major world IT corporations like Microsoft, Cisco Systems, IBM, HP, Dell, Siemens, Sun Microsystems, Computer Associates, PeopleSoft and Sony Ericsson to Dubai. In its mission statement, there is a clear emphasis on the notion of connecting the local to the global. It states that "the mission of Dubai Internet City is to create an infrastructure, environment and attitude that will enable Information and Communications Technology (ICT) enterprises to operate locally, regionally and globally, from Dubai, with significant competitive advantage."[18] In its early years, DIC offered major global enterprises very attractive deals to open branches in Dubai including subsidized office spaces. Enterprises in DIC pay no taxes since the whole project is a free zone.

Dubai Internet City was followed by a series of information technology hubs as Dubai Media City (DMC), a place that offers world class services for the media industry. The project is owned by the state and its main objective is "to transform Dubai into a knowledge-based society and economy."[19] DMC with the newly established Dubai International Media Production Zone and Dubai Studio City tend to attract international media production companies to Dubai. They offer all types of media services and enjoy the same free zone regulations as the Dubai Internet City.

Convention centers, expos and grand museums are another form of mega hubs of knowledge flows. For example, Egypt in building Cairo Expo City, a huge convention center designed by the world renouned Architect Zaha Hadid. The 450,000 m^2 development aims to attract international expos, events, and confrences to Cairo. The Grand Egyptian museum is another example of mega hubs. The $550 million project will be the largest knowledge hub in the world for those interested in Ancient Egyptian history and archeology. The museum will attract millions of tourists and researchers who will be able to interact with local scholars and archeoligists.

The Museum of Islamic Art in Qatar is another example of mega hubs of knwledge flows. By it diverse collection, the museums aims to provide information on Islamic art around the world. As noted in the mission statement, this project is "a museum for the world. It will bring the world to Doha, but it will also connect Doha to the world."[20] Its main objective is to

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[17] The Smart Village Website: http://www.smart-villages.com/docs/about.aspx
[18] Dubai Internet City Official Website: http://www.dmc.ae/
[19] Dubai Media City Website: http://www.dmc.ae/
[20] The Museum of Islamic Art in Qatar official website: http://www.mia.org.qa/english/index.html#about/vision

create a national and international resource for research, learning, and creativity and to build partnership with museums and culture institutes around the world.

The Saadiyat Island's Cultural District in Abu Dhabi is one of the largest mega hubs in the world. This $27 billion development is planned to host four spectacular museums designed by four of the most renowned architects in the world. A Louvre Museum by jean Nouvel, a Guggenheim Museum by Frank Gehry, a performing arts center and a concert hall by Zaha Hadid, and a Maritime Museum by Tadao Ando. The government of Abu Dhabi signed a $1.3 billion contract with the French Louvre to use its name and also borrow some of its art work. This place will be one of the largest cultural hubs in the region.

Image 3: Cairo Expo City, Egypt **Image 4: Performing Arts Museum, UAE**

The three types of knowledge hubs discussed above play a significant role in shaping urban development in globalizing countries. They are also critical for countries seeking to become part of the global network. Hubs of knowledge flows can help developing Islamic countries to enrich their intellectual and scientific capabilities. These places are no longer a luxury. In today’s highly competitive global system, knowledge and information are essential not only for the sake of educational advancement, but also economic and development quests. These hubs facilitate the introduction of new forms of knowledge, information and ideas to the local context. The three types of hubs of knowledge flows complement each other. Poor countries might not have the capability to establish mega or even intermediate scale hubs. In some cases, international organizations as the UNESCO and World Bank support these projects. However, the fact remains that the absence of these hubs in many Islamic countries is contributing to the expansion of the scientific and technological gap between them and developed countries.

	Developer	Control and Regulation	Specialization	Cost	Penetration of the Society	Forms of Knowledge
Micro Hubs	Individuals	Least	Not specialized	Low	Large numbers, high penetration	Very spontaneous
Intermediate Scale Hubs	Government, Private sector	Average	Relatively specialized	Average	Average penetration	Educational, economic, and business oriented
Mega Hubs	Government, NGOs	Very strict	Extremely specialized	Very High	Focus, limited penetration	Advanced educational and research oriented forms of knowledge

Figure 1. Major distinctions between the three types of knowledge flows hubs

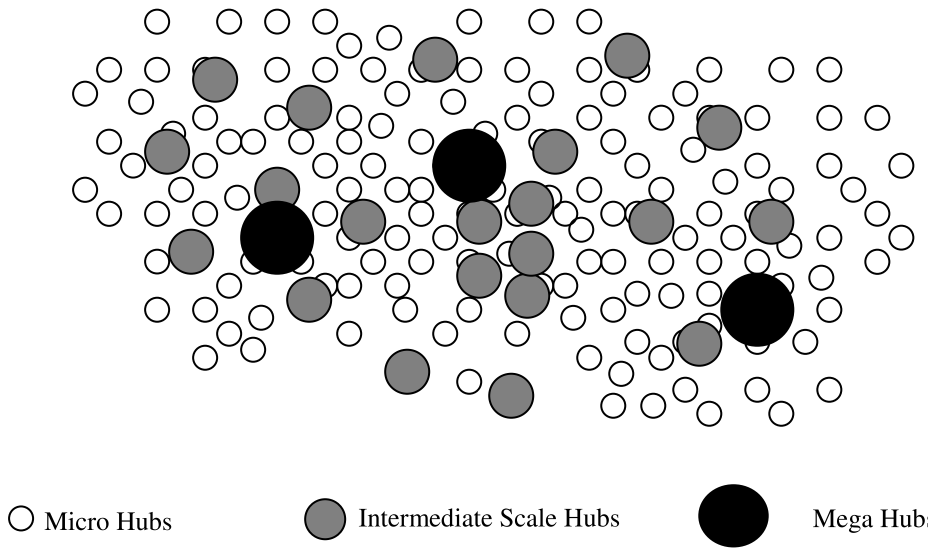

Figure 2. A typical urban fabric of a *global city* featuring the presence of the three types of hubs with different scales, numbers and concentrations of flows

4 KNOWLEDGE FLOWS: CHALLENGES AND POTENTIALS

Hubs of knowledge flows can contribute to development. However, they also pose many challenges to local ideals and ethos. Anthony Appiah (2006) refers to the impact of global flows of ideals and ideas on local culture as a process of contamination. In *The Case of Contamination* (2006) Appiah argues that globalization "can produce homogeneity, but it is also a threat to homogeneity." He means by producing homogeneity, the tendency of global flows to blend traditions and identities into one global culture. This threatens the purity and uniqueness of local cultures. Globalization can contribute to the hybridity of some places; however, it can also overwrite others' unique identities.

It could be argued that western (mainly American) ideals and ethos are more dominant when it comes to global flows. Most of the developing countries have been recipients rather than generators of what is referred to as the "global knowledge." Lenchner and Boli use the term ‘westoxication’ to describe this process of intrusion of foreign ideas, symbols goods, and lifestyles (Lenchner and Boli 2004). George Ritzer (1993, 2008) uses the term “McDonaldization” to describe the socio-cultural transformation that is occurring in response to globalization. Ritzer discusses the integration and interdependence of world societies and the spread of the cultures of consumption, standardization and rationalism (Ritzer 2008). Other scholars have used terms as Disneyfication, Cocacolonization and Walmarting to describe the spread of American ideals across the globe. These ideals are reshaping the way people eat, do shopping and build their cities in different parts of the world.

Since the late 1990s, many cities in the Islamic world have been experiencing dramatic urban transformation in response to global flows. No doubt that the exposure of these societies to foreign ideals and beliefs is not a new phenomenon. Since the medieval times, many major Islamic cities have been melting pots of diverse cultures and ethnics through trade, migration and wars. However, what actually distinguishes the contemporary forms of flows is its rate and magnitude. The massive and accelerating rates of knowledge and ideas flows have dramatically influenced many of the local ideals and ethos in Islamic cities. The time- space compression that features contemporary forms of globalization has made the process of change more rapid and aggressive. These changes could be traced in multiple dimensions.

First is the *urban form*, or the way many globalizing cities are being transformed physically. Flows of knowledge have contributed to the advancement of building sciences, urban planning and design in many Islamic countries. Most of the major infrastructure projects, bridges, five star hotels and mega structures have benefited from foreign knowledge and expertise in some way. However, one of the challenges that face many Islamic countries today is the gradual loss of their urban identity. The spread of American models of development during the last decade in many of these countries is very noticeable. New urban typologies such as shopping malls, gated communities and skyscrapers have emerged in many of these countries. For example, gated communities named Beverly Hills, Sunset, Hyde park and European Countryside offering single family houses, shopping malls, golf courses and office parks are emerging everywhere in Cairo’s suburbs. These projects mimic western places not only on the scale of planning but also the smallest architectural details. Their facades have no relation to the local architectural heritage or the geography of the place. Pitched roofs, Doric columns, pavilions and porches constitute the current most common prototype of housing in the middle of the Egyptian desert.

The Kota Wisata gated community in Indonesia is another example of urban developments that mimic western places. This project includes residential clusters named Amsterdam, Barcelona, Toronto, Orlando and Beverly Hills. The architecture replicates the styles of these places and has no reference to local identity. This project and many others around the Muslim world tend to fulfill the interest of local elites who are fascinated with these western places. They see it on television and internet and it became as observed by Anthony King (2004), “a space of freedom, imagination, escape and fantasy” (King 2004, p.106). These gated communities are described by Silverstone (1997) as “a consuming culture fueled by the increasing commoditization of everyday life” (Silverstone 1997, cited by King 2002 p. 98).

Global flows have triggered a culture of consumption in many Islamic cities. It could be traced in the new trends of residential development, shopping centers and places of leisure. American chains as McDonald’s, Starbucks, Coffee Beans, Pizza Hut, Papa Johns and KFC are emerging in most of the major cities in the Islamic world. These places are changing many of the social patterns and lifestyles of locals. Before emerging in these cities, media has played a significant role in promoting these American places across the globe. Images of the American lifestyle were spread around the world through movies, internet and satellite channels.

Other types of places themed after western places are emerging in many Islamic countries. Mercado Mall in Dubai replicates the architecture of old Venice. The Villagio Mall in Qatar follows a similar theme. Skyscrapers as Burj Dubai, Sports Tower in Qatar and the proposed Mile Tower in Jeddah are all new urban typologies imported from the west. These projects contrast significantly with the local context. They reflect the way western ideals are gradually overwriting the local architectural identity. Many of these projects are designed and built by foreign expertise. They represent a form of imported knowledge and technologies.

The second dimension that features forms of transformation in response to global flows is *culture*. The introduction of foreign ideals, images, and cultural models to Islamic countries have influenced many aspects as art, music, street dialects, fashion, and even sports. Today there are Saudi rappers, Hip-Hop Contests in Dubai and Rock concerts in Egypt. Most of the global fashion chains as Gucci, Guess, Prada and Hugo Boss have stores in Major Islamic cities. These chains respond to the local interest in the western lifestyle. They benefit from the emerging culture of consumption in the Islamic World.

The domination of western ideals and its aggressive invasion have triggered what Manule Castells (1997) calls "resistance identity" (Castells 1997). Although many people welcomed these new forms of change, others have expressed rejection to this western domination. According to Castells, "resistance confronts domination" (Castells 1997) and accordingly, a collective identity of rejection begins to emerge. Hall argues that local identities usually strengthen in response to the process of cultural globalization (Hall 1992). The aggressive invasion of western ideals has initiated counter trends of cultural and religious revivalism. Frank Lechner argues that fundamentalism is a response to the invasion of global culture. It is an attempt to restore the sacred traditions that is threatened by greedy universalizing ideologies (Lechner 2004).

Other scholars are optimistic regarding the capability of local cultures to digest these global flows. Frank Watson (2004) notes that people might embrace some of the patterns of the American lifestyle, however; he argues that this doesn't mean that have been stripped of their cultures (Watson 2004). According to him, these forms of Americanization usually take superficial forms and in many cases face local resistance (p.126). It seems premature to judge whether globalization will manage to blend world cultures into one. However, it could be argued the current influences of global flows on Islamic cities are alarming.

The third dimension that experiences significant forms of transformation in response to global flows is *education*. Globalization has contributed significantly to the quality of education in places that have access to global flows of knowledge, information, and ideas. However, it also managed to introduce new ideals that contrast with local beliefs and teachings. Many of the new international research and educational institutions tend to strictly follow western models of scholarship. For example, one of the core objectives of the American University in Cairo (AUC) is to promote American ideals related to freedom, liberty, human rights and democracy in Egypt. Quoting from its mission statement:

> *"Throughout its history, AUC has balanced a strong commitment to liberal education with a concern for the region's needs for practical applications and professional specializations. Today, AUC emphasizes liberal education and all undergraduate students study a common set of courses in the humanities and the natural and social sciences as part of the university's core curriculum."*[21]

Although the university tries to maintain some consideration to the local culture and religious beliefs, the fact remains that American ideals always prevail. Similar patterns could be traced in international schools in the United Arab Emirates, Qatar, Bahrain, and Kuwait.

The appreciation of western education in most of the Islamic countries is encouraging the establishment of these international schools and universities. These institutions perform as hubs that bring foreign advanced forms of knowledge to the local context. International schools and universities offer not only quality education, but also prestige and social status. In many of the Islamic countries, these places are limited to the rich elite. International education can narrow the gap between developed and developing countries. However, it also poses challenges to Islamic countries when it prioritizes foreign ideals and ethos over locals ones.

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[21] American University in Cairo website:
http://www.aucegypt.edu/aboutauc/HistoryandMission/Pages/history.aspx

The fourth dimension that features significant transformation in response to global flows is *politics*. Global flows of knowledge, information, and ideas have empowered many political movements in the Islamic world and triggered a new sense regarding the importance of political participation. New modes of communication as the internet and satellite channels have changed the relation between citizens and their regimes. Blogs , Facebook, Youtube, and many other internet forums are becoming the new political arenas where people express their political opinions and criticize the performance of their governments. People organize protests, petitions and polls on these arenas. Opposition movements being conservatives as the Muslim Brotherhood in many Islamic countries or liberals as Kefaya movement in Egypt are using these cyber spaces to spread their ideals and beliefs. They campaign for followers, present their agendas and held discussions and debates online or on satellite channels. The new modes of communication have proven to be effective in campaigning people for elections, protests or petitions. These modes are causing much nuisance to authoritarian regimes who are gradually losing control over their citizens.

The fifth dimension influenced by global flows is the *economy*. Global economy relies heavily on information and knowledge. Developing countries need to have access to accurate information through efficient means. Knowledge economy offers great opportunities for developing countries especially those lacking natural resources. Billions of dollars are moving across the globe every second. Countries that have the know-how can manage to attract some of this capital. Knowledge economy is not bounded to a specific geographic location. It relies on advanced modes of communication which facilitates global reach.

One of the challenges posed by this type of economy is the interdependency it creates between world economies. The transformation of the manufacturing oriented cores in many developing countries towards new urban service economic ones has contributed significantly to this economic interdependency (Sassen in Knox and Taylor 1995, p. 65). The service economy relies mainly on global flows. Sectors as financial investment, tourism and information technology are gradually dominating the economic system in many Islamic countries. Egypt, Malaysia and most of the Gulf countries are experiencing this shift towards service economy. The abundance of flows of people, capital, and information are encouraging these countries to transform their economies and become part of the global market.

Recently, the interdependency of world economies was reflected on the exportation of the American economic crises to the whole world. In fact, many developing countries are currently suffering more severely because of this financial crisis that was caused by the fall down of the mortgage market in America. This mortgage problem was caused by the deregulation of the financial system in the United States. However, all the financial systems around the world have paid a price for it. It could be argued that although the global economy offers many developing countries a golden opportunity to develop, it also imposes on them many economic problems and challenges.

5 CONCLUSION

In the era of globalization, access to information and knowledge is crucial for sustainable development. The revolution in information technology has facilitated the exchange and flow of information and ideas across the globe. Countries that have the capacity to host and agglomerate these flows are more capable of achieving progress and technological advancement. This requires the presence of hubs that can receive these flows and transmit them to the local context. The three types of knowledge hubs discussed in this paper are essential for any country seeking development. They determine the country’s capacity to host and assimilate knowledge and information. Each type has different scope, specialization and range of influence.

Few Islamic countries are investing heavily in the three types of knowledge and information hubs. However, the majority of the Islamic world is still struggling in achieving this quest. Compared to developed countries, the Islamic world falls behind when it comes to the capacity of dealing with global flows. The poor economic conditions are limiting the chances of these developing countries to construct a satisfactory infrastructure of hubs that can connect them to the global network. The data presented in this paper shows that very few Islamic countries have managed to balance investment in the three types of knowledge flows hubs. Governments and private enterprises whether domestic or transnational should give more emphasis to the construction of these places in order to trigger development and progress.

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PART SEVEN

KNOWLEDGE DISSEMINATION FORUM

Renaissance of Science and its Integration with Islamic Thought

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and
M.D. SHAMI, FIAS[2]

1 INTRODUCTION

Science, Culture and Religion are three aspects of the intellectual doings of various civilized societies, but all through recorded history, the relationship between the three has varied from time to time and society to society.

A great deal has been written in this field, but perhaps we can begin with straight-forward definitions of these three. The first two are as follows:

Science is defined as: knowledge about structure and behavior of the natural and physical world, based on facts that you can (observe and) prove; (also defined as organized knowledge);

Culture is defined as: the customs and beliefs, or, way of life and social organization of a particular group or country; and
Religion is defined as: the belief in the existence of a god or gods and the activities that are connected with the worship of these.

In case of Muslims, as: the complete way of life to be practiced in obedience to ALLAH, the Creator, as shown by the life of Prophet Muhammad (SAW). So, it is understandable that 'the desire to acquire knowledge had become a deep-seated yearning and craving, so much so that never before and never since those days of Islam has the spectacle of acquiring knowledge been witnessed in such a passionate manner particularly by those who ruled and governed in that day. This was a great advance, considering that in many cultures, reading and writing was looked down upon or else knowledge was supposed to be an exclusive preserve of the privileged and the exalted. But in Islam "to every mosque was attached a school; wazirs vied with their master in establishing public libraries, endowing colleges, funding bursaries for impecunious students. Men of learning, irrespective of race or religion, took precedence over all others; honours and riches were showered upon them, they were appointed to the Government of provinces, a retinue of professors and a camel-train of books accompanied the *Khalifs* in their journeys and expeditions". According to Briffault (1980) "It is highly probable that, but for the Arabs, Modern European civilization would never have arisen at all, it is absolutely certain that but for them, it would not have assumed that character which has enabled it to transcend all previous phases of evolution. For, although there is not a single aspect of European growth in which the decisive influence of Islamic culture is not traceable, nowhere is it clear and momentous as in the genesis of that power which constitutes the paramount distinctive force of the modern world and the supreme source of its victory- natural science and the scientific spirit. It was under the influence of Arabian and Moorish revival of culture, and not in the 15th Century, that real renaissance took place, and Spain not Italy was the cradle of rebirth of Europe.'

The Islamic View of Science: The Qur'an invites us to see, to think, to meditate, to ponder, to consider, to discriminate, to rationalize the various aspects of nature's functioning- what the Qur'an calls "signs" that appear on the horizon and in ourselves. References to these invitations are found in various places in the Qur'an. Knowledge and wisdom are two of the attributes of Allah (SWT). In the context of knowledge, it is the duty of every Muslim to endeavor to learn the orders of Allah (SWT) in his domain, in order that he may be able to act upon them properly. So,

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it is desirable to examine the nature of knowledge. Indeed, Allah (SWT) knows all that is in the heavens and earth, while man can know only as much of knowledge as is granted by Allah (SWT). Indeed, it is Allah (SWT) who has given man knowledge of the universe, and so it is clear that the sum-total of man's knowledge is a small part of the totality of knowledge.

2 HISTORICAL PERSPECITIVE

There are at least 3 broad categories or sources of knowledge, Siddiqi (1991) viz.:

(a) Logical knowledge or knowledge by inference: this category of knowledge depends either on the truth of basic assumptions, as in the case of application of "deductive" logic, or on the most probable result, in accordance with the application of the process of "induction". This category of knowledge is *'Ilmal Yaqeen'* because it is dependent on belief in the premises of our knowledge;

(b) Observational knowledge or knowledge by perception and observation: this knowledge is just obtained by studying various objects and phenomena in the physical world, either through the use of the eyes, hands, etc., or by their extension through any other method of measurement or observation; this means that we can call it as *'Ainal Yaqeen'* or that seen by the eyes. Scientific knowledge basically stems from this one category of knowledge or its modern version, based on observation, using various implements to study the large variety of natural phenomena. It may be stated here that the natural phenomena are in fact the manifestations of the power of Allah (SWT) and may be called *"Aayaat of Allah";* this particular expression occurs in the Qur'an repeatedly, exhorting mankind to observe, study and ponder over them;

(c) The third category of knowledge is that with the name: '*Haqal Yaqeen'*. Allah (SWT) not only provides and indeed invites proof of His existence through the observation of the external world, but also through the inner experiences of the mind and the heart, which may perhaps be described in modern terminology by psychology - a subject that deals with various levels of the human mind. This knowledge comes to man through various modes, which include instinct i.e. *Jibillah,* intuition i.e. *Wijdan*, inspiration i.e. *Ilham* and revelation i.e. *Wahi.* The last category (revelation or *Wahi*) is, according to the Islamic view, limited (by definition) to the Prophets of Allah (SWT).

The ideal of the Muslim is to use the knowledge from these sources in a coordinated and harmonious manner. Hence, the parallel activities of scientific and religious developments.

Comparative Survey of Scientific & Intellectual Activity from 1 to 1,000 H:

Muslim Scientific Activity is now well documented. In the first place, these achievements are the result of the work of almost a dozen outstanding scientists of the early Muslim period, whose works were so well-known and widely read that the Latinized versions of 9 of their names are still current, viz:

Table 1. Latinized Versions of Names of Renowned Muslim Scientists

Name of Scientist	Jabir Ibn Hayyan	Al Khwarizmi	Al Kindi	Al Razi	Al Zahrawi
Latinized Version	Geber	Algorizm	Kindus	Rhazes	Abulcasis
Name of Scientist	Ibn Sina	Ibn al Haytham	Ibn Zuhr	Ibn Rushd	Ibn Khaldun
Latinized Version	Avicenna	Al Hazen	Avenzoar	Averroes	

It is noteworthy that the last of these (Ibn Rushd) was active in 550-580 H.
We may now undertake a more detailed survey of Intellectual Activity.

3 A QUANTITATIVE SURVEY OF INTELLECTUAL ACTIVITY

This survey of Intellectual Activity is based on a 12-page compilation entitled a "Backward Glance (Ik Nazre-Wapasin) published in the 14th Century Hijra Issue of Siyyarah Digest. The data were worked out from this compilation, ignoring the few names of mere conquerors & rulers entered therein (See Appendix-I) by enumerating the intellectuals in successive 30-year periods, taking the 2nd 30 years period as 1-30 H. The numbers so obtained are shown plotted against the middle of the relevant periods from – 10 H to 1300 H in Figure.1. The persons at or near the minima were responsible for the subsequent rise of activity, and those are found to be a composite of outstanding spiritual and scientific personalities (see Qurashi, 2009).

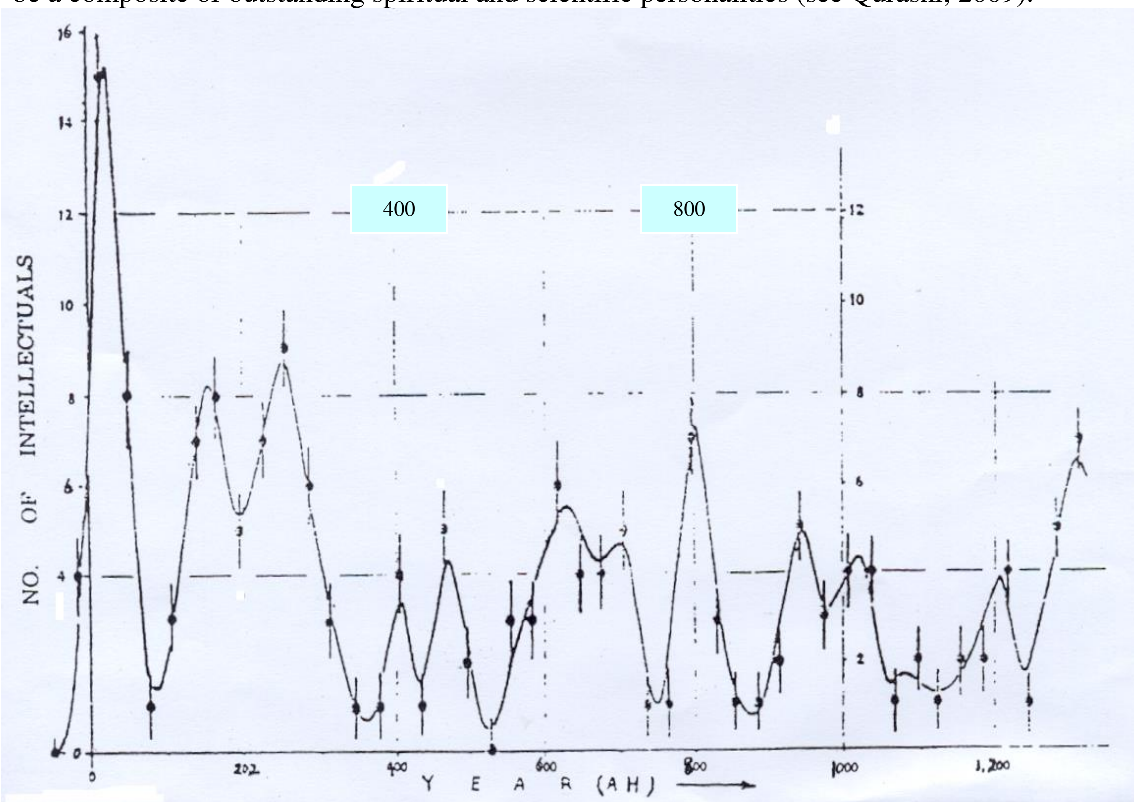

Figure 1. The persons at or near the minima were responsible for the subsequent rise of activity

Mosques also functioned as repositories for books. Through gifts and bequests, mosque libraries became specially rich in religious literature. Other libraries established by dignitaries or men of wealth as semi-public institutions housed collections bearing on logic, philosophy, astronomy and other sciences. Scholars and men of standing had no difficulty in finding access even to private collections. Al Mawsil had before the middle of the tenth century a library, built by one of its citizens, where students were even supplied with free paper. The library (Khizanat al-Kutub) founded in Shiraz by the Buwayhid ‘Adud-al-Dawlah (977-82 A.D) had its books arranged in cases and listed in catalogues and was administered by a regular staff. In the same century, al-Basrah had a library whose founder granted stipends for scholars working in it (Al Farabi 1347 H) (Urdu).

The General State of Science: The Muslim scientists fused the practical approach to scientific problems with the abstract thought. Their highly developed scientific techniques, the labelled diagrams of their scientific apparatus, the elaborate discussions of chemical reactions and physical phenomena confirm this thesis. Muslims studied particular facts experimentally and drew inferences in the form of general principles or scientific laws. In other words, the inductive method was employed. For instance, Ibn al Haytham studied the course of rays of different types of light falling on various types of mirrors at various angles of incidence and then formulated the second law of reflection[9]. He also gave the laws of refraction of light. Muslim scientists recognized both the physical or qualitative and the mathematical or quantitative aspects of science 1347 A.H. They made qualitative as well as quantitative study of numerous scientific problems. For instance, Ibn Khurdadhbeh determined the latitudes and longitudes of various places in the Muslim world; Al Biruni ascertained the specific gravity of a number of substances.

The makers of good instruments were highly esteemed. Among them were Hamid and Ali Ibn Isa who were compared by a famous astronomer, Ibn Yunus, to Galen and Ptolemy. This shows how much importance Muslims attached to good instruments. On account of the desire for utmost accuracy in observations and calculations, the valuable (scientific) records used to be signed on oath in the presence of judges (Briffault 1980).

Scientific observations are sometimes tedious, and sometimes they require a long interval of time to finish them: firstly because they have to be repeated for verification and elimination of errors, if any, and, secondly, because sometimes the nature of observations is such that they cannot be finished before a certain minimum time. Therefore, the detailed and long observations, patient investigation and examination, the procurement of positive knowledge and curiosity for experimentation are all the pre-requisites of scientific research, for which Muslim scientists were adequately oriented. To quote an instance, Ibn al-Baitar collected botanical specimens from the Muslim world, and compared the floras of India and Persia with those of Greece and Spain. His work, consisting of the description of 1,400 plants, has been considered by Meyer to be a monument of industry (Briffault 1980).

On the educational side, there always was an elaborate system of training for the Muftis and Qadis in the Muslim world. A number of *madrasas* were established in the Ottoman empire by the sultans and their viziers and they were all generously endowed; they were generally built as annexes to grand mosques or even to small-town mosques. The number of students was always large. A census taken as early as the days of Murad II (1421-1451 A.D.) showed that 20,000 students were studying Muslim law in these *madrasas,* This would correspond to having 0.2 or more million persons in the relevant legal, judicial and administrative professions. There were grades in their curriculum and the course lasted seven years. A student who had completed his training was called a *Danishmand* or the holder of knowledge. It was a better title than the modern one of Bachelor (or Master) of Arts. After his graduation, he had the choice of three professions: he could either be a teacher, a preacher or a lawyer/ magistrate. For a proper development of the Muslim world today, this state of affairs needs to be shifted back to what it was in the glorious period of the 3rd-5th centuries Hijra when it appears that science and technology had at least an equal share in the educational system.

We may now take a quick look at the situation after 400 H.

Al Ghazzali: The turn of the 11^{th} (to the 12^{th}) century was a time of intense and politically motivated sectarian strife. A brilliant young Iranian scholar from Khorasan, Abu Hamid al-Ghazzali, was appointed as the Principal, at the age of 34, of the most renowned university in the Islamic world at the mid-point of the 11th century - the Nizamiyah in Baghdad. An authority in all aspects of Islamic knowledge and learned in Greek Philosophy, he resigned his position before he achieved his 40th year to begin an extended search for the renewal of his faith, which he found first in Damascus in the company of Sufis. Now he was able to reconcile to his own satisfaction the exoteric and esoteric aspects of Islam. This reconciliation of orthodoxy with his own mystical experience became a key benchmark for subsequent Islamic thinkers, theologians and mystics in the social, cultural, political, ethical and metaphysical aspects of Islamic life.

In effecting this reconciliation, Ghazzali was not able to allow the free utilization of rational discourse either in the further development of philosophy or in the natural sciences and in theology.He profoundly changed the intellectual atmosphere, with notable contributions like "Ihyaul Uloom al-din" and "Al Munqidh minal Dalal". In the latter book, he has also debated on the interconnection between religious belief and scientific laws of motion of celestial bodies. He says, "Another difficulty is created by a bigoted follower of religion who thinks that, in order to save religion, it is essential to deny all science. As a matter of fact, there is nothing in religion which is against the sciences, nor is there anything in the sciences which is against religion".

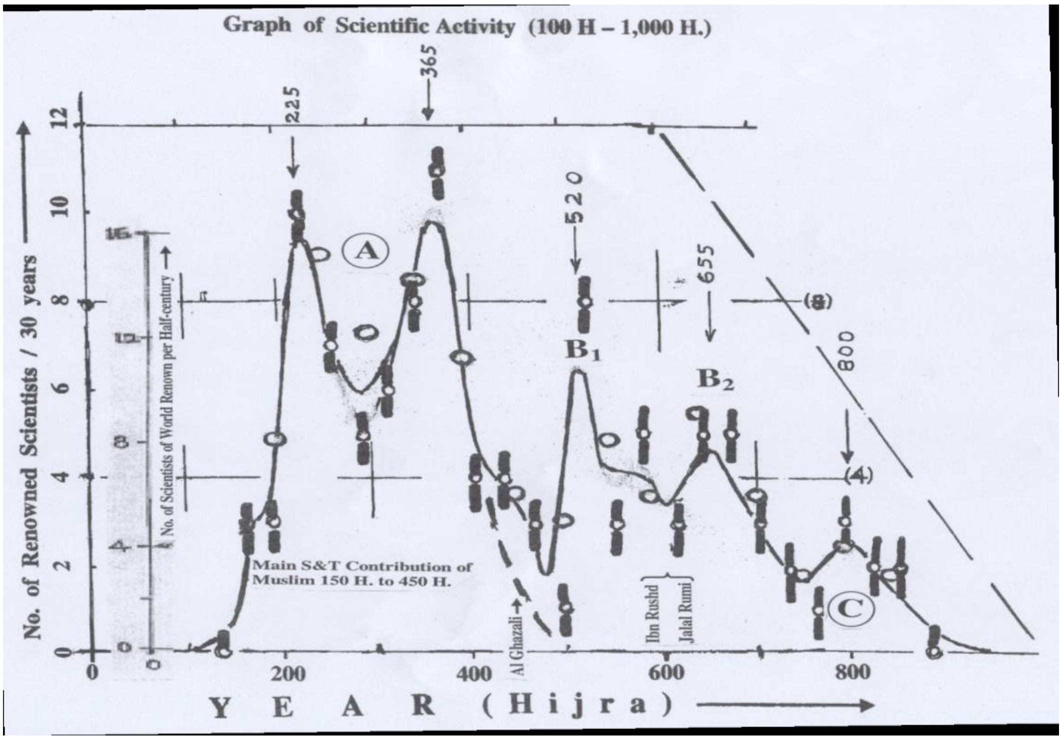

Figure 2. Graph of Scientific Activity (100H – 1,000H)

Again, he says, "in this respect natural science resembles medical science, which deals with the human body and its vital and subsidiary organs, and with the changes of the temperament. Hence, as it is not necessary to deny the validity of medical science in order to believe in religion, in the same way, it is not necessary to deny the validity of natural science either". Our studies show that Al-Ghazzali can be readily considered as the main causative factor leading to the Scientific Activity Peak at 520 H. (Figure 2), about 90 years after his impact. However, his colleagues and successors were of a different mettle.

4 ANALYSIS

Sakir Kocabas (1993) in a recent study refers to a conceptual change that occurred way back in the 11th century (i.e. 5th century Hijra), which had a profound and lasting effect on the Muslim psyche. In fact a very drastic change about the concept of knowledge (Ilm) had taken place in the history of Islamic thought; today this seems to have been divided into two broad and different categories: "Ilm ad din" and "Ilm ad dunya". In his study conducted on this concept, using the Qur'an and the six authentic books of Ahadith as basic sources, he found that there was no indication of any such categorization in these books. On the contrary, their concept appeared to be holistic and indivisible. This obviously indicated that a conceptual division of knowledge (as 'religious knowledge and worldly knowledge') was introduced for the first time in the subsequent centuries.

But the fact is that this conceptual division of ‘knowledge’ was planted deep in the minds of Muslims by the 11th century (5th century Hijra). People may argue that the categorization of knowledge into ‘religious knowledge and worldly knowledge’ came into being as a necessity to classify knowledge. We maintain that this conceptual division was introduced in the 11th century (5th century Hijra) by Muslim theologians for purposes other than taxonomic necessity. These purposes primarily included the ‘protection of Muslims from certain heretical beliefs and ideas.’ In fact it was an introduction of a simpler but contradictory concept-system, in place of a rich, complex but consistent conceptual structure in the Qur’an.

While insisting on the necessity of certain sciences for the preservation of Islamic society, e.g. mathematics and medical science, Al Ghazzali was ambivalent about the use of rationality and of mathematics. He in fact denied the basic principle of causality: this view is typified by his arguments in his well-known book ‘Tahafut-al-Falasifa’ (the Incoherence of the Philosophers).

The definitive response to Ghazzali’s ‘Tahafut-al-Falasifa’ was given some decades later by another remarkable Muslim savant, Abul Waleed Mohammad ibn Ahmad ibn Mohammad ibn Rushd, known as Averroes in the West. Born in Cordova, Spain, in 1126 during the reign of the Ummayad Caliph Al-Hakam, Ibn Rushd is universally acknowledged as a versatile genius, perhaps the greatest philosopher of Islam and one of the greatest of all times. He was an authority in literature, law including fiqh, medicine and astronomy. His contemporary Abdul Kadir, who was a deeply religious ‘Alim, described Ibn Rushd as a person constantly anxious to establish harmony between religion and philosophy. He maintained that ‘those things whose causes are not perceived are still unknown and must be investigated, precisely because their causes are not perceived: and since everything whose causes are not perceived is still unknown by nature and must be investigated, it follows necessarily that what is not unknown has causes which are perceived.’

The results of Ibn Rushd’s work, while eagerly accepted and further developed in the West, had little effect on his fellow Muslims. Unfortunately, Ibn Rushd’s refutation of Ghazzali came too late to make any significant impact on the opinions of the Muslim Ulema.

According to M. Moeen Farooqi (1995), this division virtually amounted to a separation of science from religion. Its chief exponent al-Ghazzali considered religious knowledge obligatory for all Muslims and dismissed basic sciences, except Medicine, as futile, superfluous or even useless. Popular sentiment weighed heavily in favour of the former and gradually distanced itself from the latter; scientific tradition fell into oblivion. The disrepute permeated through the centuries and was palpable until the first half of the current century.

The Situation in the late Ottoman Empire: At the end of the fifteenth century, the tradition of scientific activity in the Ottoman Empire had nothing but an embryonic form. The jurists were firmly implanted in the administration. Consequently, only the sustained scientific interest of the Sultans could guarantee the survival and the development of this embryo. The royal interest in science and technology had been miraculously sustained for approximately two centuries. The jealousy of jurists attained its apogee when Murad III approved the project of the Astronomer Royal, Takiyuddin (Taqi al-Din), to build a great observatory in Istanbul on the heights of Galata. Besides enhancing scientific and technological developments, this observatory could have the potentiality to advise the Sultan in the affairs of the Empire by astrological predictions. This gave rise to a great calumny instigated by jurists against Takiyuddin Ozemprp, 1995.

According to Salih Zeki in Asar-i-Bakye (AH. 1329), the Shaykh ul-Islam claimed in his fetwa that: “...Observing the sky is cause of ominousness! And the desire to penetrate insolently the mysteries of the sky is a grave act which is certainly punished (by God)...” Takiyuddin had carefully observed a comet, which appeared on the 1st Ramadan 985 (September 1577), and presented a scientific report of this event to the Sultan. But the superstitious population had interpreted the appearance of the comet as a bad presage.

It seems that these absurdities also played some fatal role in the final decision of the Sultan who well received the fetwa of the Shaykh ul-Islam and ordered thereupon the destruction of the Istanbul Observatory, which was destroyed by a massive cannonade of the Imperial Fleet (1580 A.D.). Thus the embryonic scientific research tradition quickly faded out and the positive sciences lost their attractiveness for the young people (Ozemere, 1995).

Thus, today we need to have:

1. Unity of Knowledge

This was stressed continuously by the late Ismail Al Faruqi, see for example, the 1983 "Statement on Scientific Knowledge from Islamic Perspective".

2. Interactions

The continual positive interactions between Science, Islam and Society are essential components for advancement of the Islamic World.

Two urgent needs are:

(a) ---Islamization of Modern Social Sciences

This has been attempted from 1980 onwards by the International Institute of Islamic Thought, U.S.A. Work on this led to the publication of at least three books on Islamisation, including one on the Concepts of Present day Sociology.

(b) ---Integration of Education

This has grown steadily out of the 4 World Conferences on Islamic Education, held from 1975 to 1980, with the results described below.

5 INTEGRATED CURRICULA

(a) In Malaysia and Indonesia, under the title of KBSM

The contents of KBSM include knowledge, skills, attitudes, and relevant values for the development of the potentials of students in a comprehensive and integrated manner, so that they become harmonious and balanced people in intellectual, spiritual, emotional and physical aspects. The development of potentials of the students in intellectual aspects includes the following elements: to receive useful knowledge, to develop thinking ability, arithmetical skill, problem- solving skill, reasoning as well as communication and interaction.

In structuring the learning activities under KBSM, some subjects are considered as the core that is obligatory for all students. These subjects are for the fulfillment of the need for overall and integrated individual development. There are also some subjects that are optional or elective. In lower secondary level, the elective subjects are called additional subjects.

Integration of curriculum necessarily implies the *integration of the two parallel systems of education prevalent in Muslim countries,* leading to the enrichment of both and not with any detrimental effect upon either.

(b) Experiences of Turkey, Pakistan and Iran

In Turkey, the "Quran Schools" have provided a parallel system of instruction at Primary and Secondary School levels, through various Waqfs. An attempt at amalgamation of this system with the European system met with partial success two decades ago. Further efforts are needed to bring about an effective integration.

In Pakistan, a recent initiative is one by a lone educationist, Mrs. Sadia Chishti, who has brought out eight small books depicting the linking of Quranic ayaat with various physical concepts, for use in teaching physics to Muslim students at under-graduate level.

In Iran, the process of integration was taken in hand seriously about two decades ago, and a series of well-designed initiatives were undertaken. The results obtained now speak for themselves.

6 A LOOK AT THE FUTURE

The World Development Report 1992 suggested a three-fold strategy for meeting the challenge of sustainable development in the future, viz.

Break the Negative Links: Rising incomes and technological advances make sustainable development possible, but they do not guarantee it. Effective environmental policies and institutions are essential.

Build on the Positive Links: Policies that are effective in reducing poverty, will help reduce population-growth and also help provide the resources to enable the poor to take a long-term view.

Clarify and Manage the Uncertain Links: Investment in information and research, and the adoption of precautionary measures, such as safe minimum standards, where uncertainties are great and there is a potential for irreversible damage or high costs in the long-run.

The success of sustainable development hinges on balance of actions by the few rich people/nations, on the one hand, and the millions of poor people, at the other end.

For this purpose, it is necessary to generate: An inner urge to create knowledge, and be self-reliant. Unless there is an urge to create and to attain self-reliance in a society, it is doomed to a position of dependence and subjugation.

An Environment conducive to Creativity: S&T development requires a congenial environment in which creativity and talent are encouraged, patronised and duly rewarded.

Effective Exchange of Ideas and Collaboration with other Nations: Modern science is truly international. It requires exchange of ideas, collaborative research and visits to top-class research laboratories.

Patronage to support S&T: An essential pre-requisite for fruitful S&T activity is provision of adequate support-facilities, availability of library and documentation services, and exchange of views/information.

7 REQUISITES FOR THE DEVELOPMENT OF S&T AND ITS POSITIVE OR NEGATIVE INTERACTIONS WITH SOCIETY

Out of the four pre-requisites listed above, the first two depend entirely on the individual and the social and cultural structure of the society, while the last two are largely dependent on economic, political and technical status of the countries and their relationship with others. Let us take a look at some of the human characteristics in countries of the Islamic world. In this context, it is revealing to make the following comparison:

Table 2. **Qualities Required for Good S & T**	**Table 3.** **Temperament in Various Muslim Countries**
Individual 1. Willingness to Observe & Experiment. 2. Accuracy & Verifiability of Observations. 3. Rational Interpretation. 4. Willingness to accept findings of others. 5. Take results to their logical Conclusion. 6. Persistence. 7. Working in a Group. **Society** 1. Readiness to accept New Ideas. 2. Dissemination of New Ideas. 3. Judicious Mix of Innovation & Tradition. 4. Adventurous in Utilizing S & T.	**Individual** 1. Prone to theorize and generalize without factual data. 2. Pre-conceived Notions and Unwilling to admit One's Ignorance. 3. Subjectiveness. 4. Self-conceit. 5. Jumping to conclusions, without valid Proof. 6. Leaving things Half Done and Flitting from one thing to another. 7. Lone-worker attitude. **Society** 1. Authoritarian Approach. 2. Ridiculing/Resisting New Ideas. 3. Tradition-Bound. 4. Unwilling to take Risks in new developments.

A comparison of the qualities required for good science with the temperament existing in various Muslim countries shows a rather glaring contrast in the Individual characteristics, as well as those of the society as a whole. Among the individual ones, the two most serious are (i) self-conceit and (ii) leaving things half done. These need to be especially remedied, in view of the fact that today, Science and Technology are driven by commerce and industry in the western world.

As regards to the Islamic Society as a whole, the most rampant evil is that of Authoritarianism, with the next one being unwillingness to take risks in new development. This perhaps characterizes our society so fully that the technological developments accomplished by the Western civilization of today seem like a fantasy. How to modify this situation appears to be the pressing need of the time in all our educational and training programmes, especially those involving Science and Technology.

The introduction of Integrated Curricula provides a ray of hope in this matter, and needs to be pursued vigorously, so that scientific and technological development spreads fully among the common people. The basic step of course, is to gradually combine into one, the two divergent streams based, respectively on (i) the local educational system and (ii) the Western-Style universities. This integration would not only remedy most of these short coverings, noted above, but also help to provide the scientists and technologists with a large supply of motivated technicians and supporting staff drawn from all quarters of the country.

8 FIFTEEN YEARS ACTION PLAN

In the light of the foregoing considerations and keeping in view the appropriate measures, a Plan has been chalked out extending over fifteen years, which attempts to:

(i) produce an integrated system at the primary and secondary levels;
(ii) develop the system at college and university levels; and
(iii) extend this concept into the whole scientific, industrial and commercial spheres.

Table 4 (A). Fifteen-Year Action Plan (2010-2025) in 3 Phases- Schematic Outline

<table>
<tr><th colspan="4">2011-2015</th></tr>
<tr><th></th><th>2011&12</th><th>2013&14</th><th>2015</th></tr>
<tr><td>I.</td><td>Framing/Development of integrated Curriculum Textbooks</td><td>Teacher Training at Primary Level</td><td>Integrated Curriculum Teaching at Primary Schools</td></tr>
<tr><td>II.</td><td colspan="2">Curriculum and Textbooks Development with emphasis on Practical in Secondary and Vocational Schools</td><td>Introduction of Group Activity in Secondary Schools and Vocational Schools</td></tr>
<tr><td>III.</td><td>Development of Curricula for Degree and Technical Colleges</td><td colspan="2">Plan for Training of Teachers for Scientific Methodology at Degree and Technical College Levels, including a component of Social Sciences and Humanities</td></tr>
<tr><td>IV.</td><td colspan="2">Plan and Curriculum Updating and Practical Activity at University Level</td><td>Plan for Research at University Level</td></tr>
<tr><td>V.</td><td>Initiate Dialogue for University R&D Institute, Industry Cooperation</td><td>Initiate Proposals for Technology Development and Industrialization</td><td>Plan for University R&D Institute Industry Cooperation</td></tr>
</table>

Table 4 (B). Fifteen-Year Action Plan (2010-2025) in 3 Phases- Schematic Outline

2016-2020		2021-2025		
2016&17	**2018-2020**	**2021&22**	**2023&24**	**2025**
Dialogue for Coordination between Madrasah & Traditional & Western type Education	Plan for Coordination between Madrasah & Traditional & Western type Education	Integrated Curriculum made operational at Primary Schools and Madrasah & Traditional Schools		
Training of Teachers for Integrated Curriculum at Secondary and Technical Schools Level		Integrated Curriculum made operational at operational at Secondary and Technical Schools Level		
Cooperative Research Activity in Degree and Technical Colleges in emerging fields, e.g., Bio-Tech, Electronics, etc	Training of Teachers for integrated Curricula at Degree College Level	Training of Teachers for integrated Curricula at Technical College Level	Integrated Curricula to be made operative and Scientific Methodology at Degree & Technical Colleges	
Establish Practical and Group Activity at University Level	Establish R&D Groups in Universities and Institutes	R&D Groups to be made fully operational progressively at various Universities and Institutes		
Establish Operative R&D Groups in Selected industries Outline Plan for Industrial Policy	Plan for Inter-Islamic S&T Policy Development of Industrial Policy	Undertake preliminary Technology Transfer and Development	Develop bilateral and international cooperation; Technology Transfer and Development	

Table 4 has been drawn up bearing in mind the fact that the basic aim is not to 'Islamize Knowledge.' but rather to integrate the Islamic and the scientific interpretations all through the teaching and the training process. Accordingly, the first half of the Table 4 (A) is fairly straightforward and involves essentially an effort to apply the basic concept of integration to the two streams of education at the primary and high-school levels over a period of 10 to 15 years. It involves, among other things, the selection and training of teachers for this task, as well as the careful preparation of Guide-books to be used by them in teaching the various courses.

It is to be hoped that this process can, with careful planning, be completed adequately in 10 years, so that the last 5 years of the 15-year plan would see the production of high-school graduates having the necessary integrated outlook and approach to work as well as problems-solving. This would, of course, need carefully organized interactions between the three categories - of teachers, students and the employers of the students.

It is here that the various items of the second half of the Table 4 (B) would become of great importance. These items cover important areas, such as environment, water and energy.

Major societal interactions, include the cooperation and collaboration for benign use of S&T. The solutions to these can only be guessed at this stage, and would hopefully evolve in the course of decades, through the efforts of a living, vibrant far-sighted Ummah.

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A Vehicle for the Dissemination of Knowledge: The Qatar Qur'anic Garden

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ABSTRACT

Qatar is establishing a Qur'anic Garden that comprises all the plant species mentioned in the Holy Qur'an and those in the *Sunnah* and the Sayings of the Prophet (PBUH) and is concerned also with the botanical terms mentioned in the Holy Qur'an. Its activities are supporting the dissemination of knowledge about innumerable topics. The garden has a vision of preserving and promoting the appreciation of the natural, cultural and spiritual heritage of the Islamic-Arabic nation in a global context by providing unique and world class opportunities for discovering and learning. Among the objectives of the garden is to integrate the education, entertainment, scientific culture in the activities of the garden to support the culture of integrated management of the resources and their conservation. The garden is concerned with the knowledge production, application and dissemination.

Here arises the issue of the type of knowledge to be disseminated. The equivocal natures of the English word 'know' does not differentiate between 'knowledge by acquaintance' and 'knowledge by description'. The garden will be supporting a very important Islamic vision and order of Allah, i.e. pondering in the world and all creatures. This is an important Islamic concept and represents a core of worshipping Allah. Pondering is the first step in the 'knowledge by acquaintance', where the knowledge is obtained through a direct causal (experience-based) interaction between a person and the object. This conforms with the word: *Alema* علم. In Islam, knowledge (Arabic: علم, *ilm*) is given great significance. 'The All-Knowing' (*al-Aleem*) is one of the 99 names reflecting distinct attributes of God. In the Holy Qur'an, the term *Arafa* عرف and its derivatives are mentioned in a fewer verses than those in which the term *Alema* علم and its derivatives. Both words have different meanings. There is a difference between knowing the name of something (*Arafa*عرف) and knowing something (*Alema* علم).

Figure 1. The Doha Qur’anic Garden.

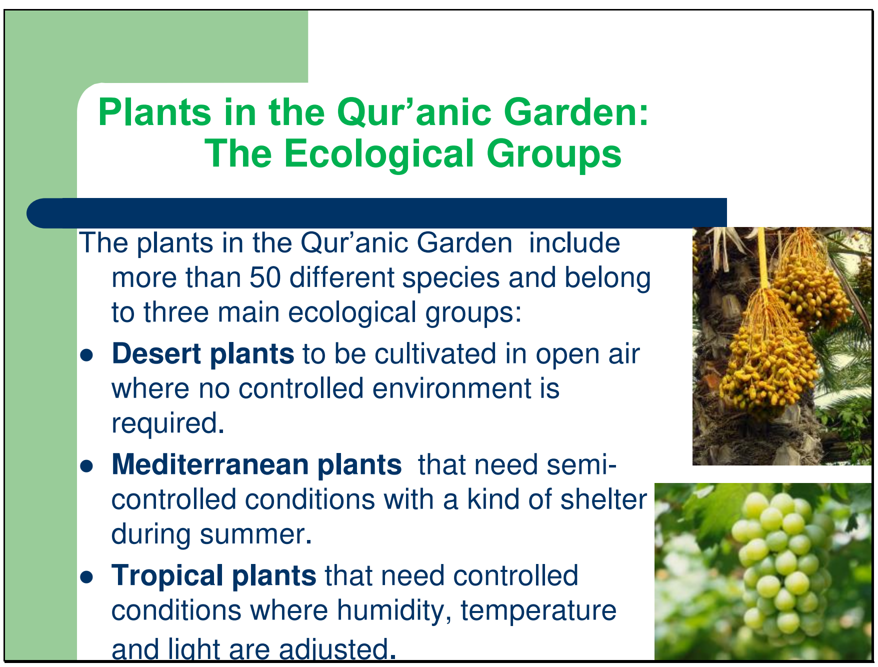

Figure 2. Plants in the Qur’anic Garden: The Ecological Groups.

Figure 3. Botanical Terms in the Qur'anic Garden.

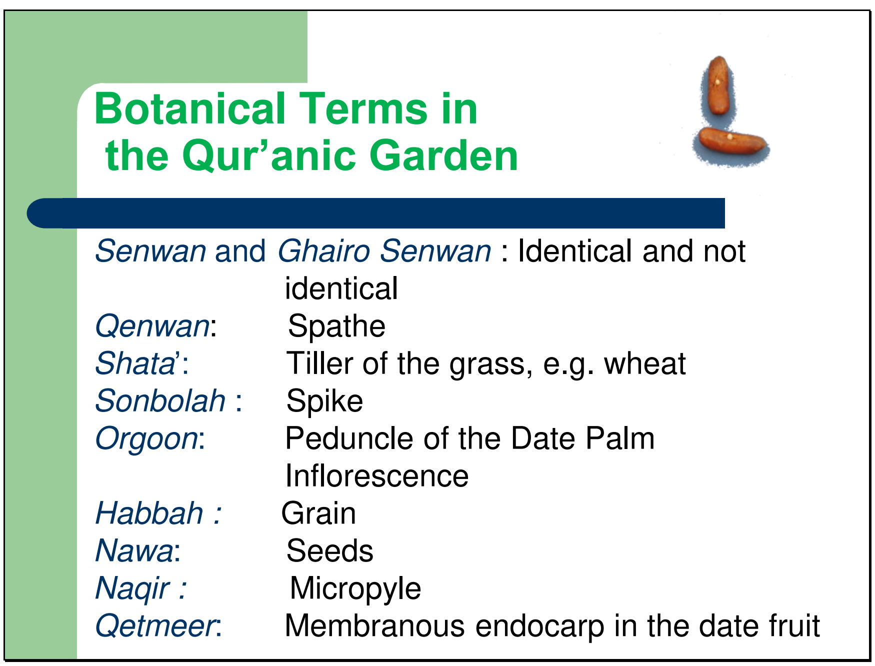

Figure 4. Botanical Terms in the Qur'anic Garden.

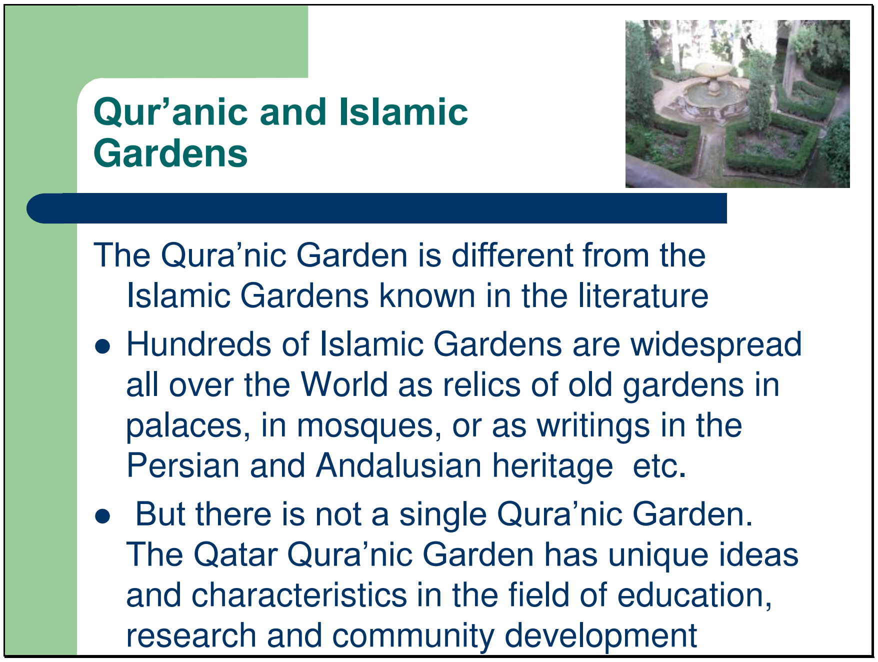

Figure 5. Qur'anic and Islamic Gardens

Figure 6. Pondering on Allah's Signs: An Islamic Vision.

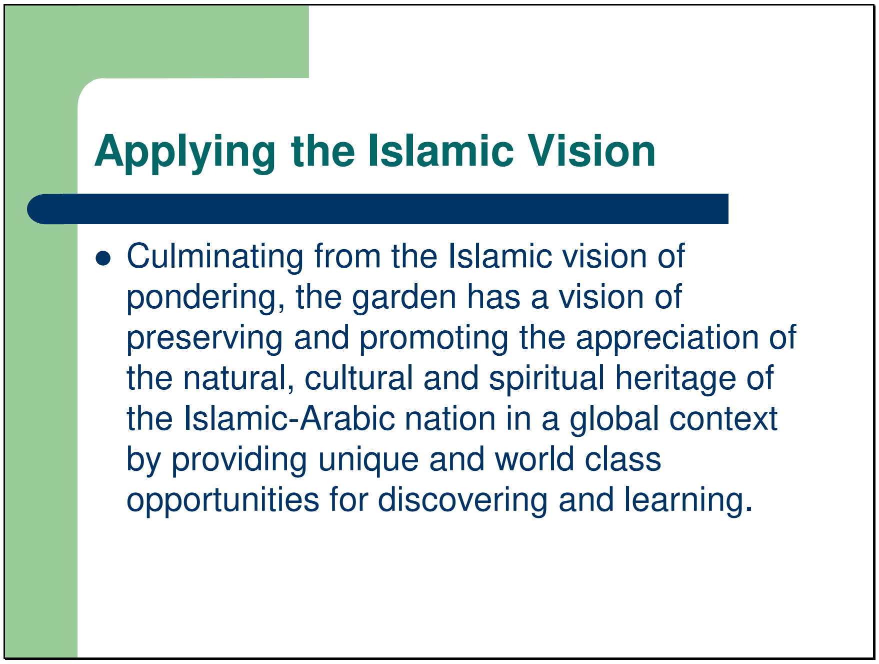

Figure 7. Applying the Islamic Vision.

Figure. 8 Our Vision Conforms to Pondering on Allah's Signs.

Figure 9. Objectives of the Qur'anic Garden.

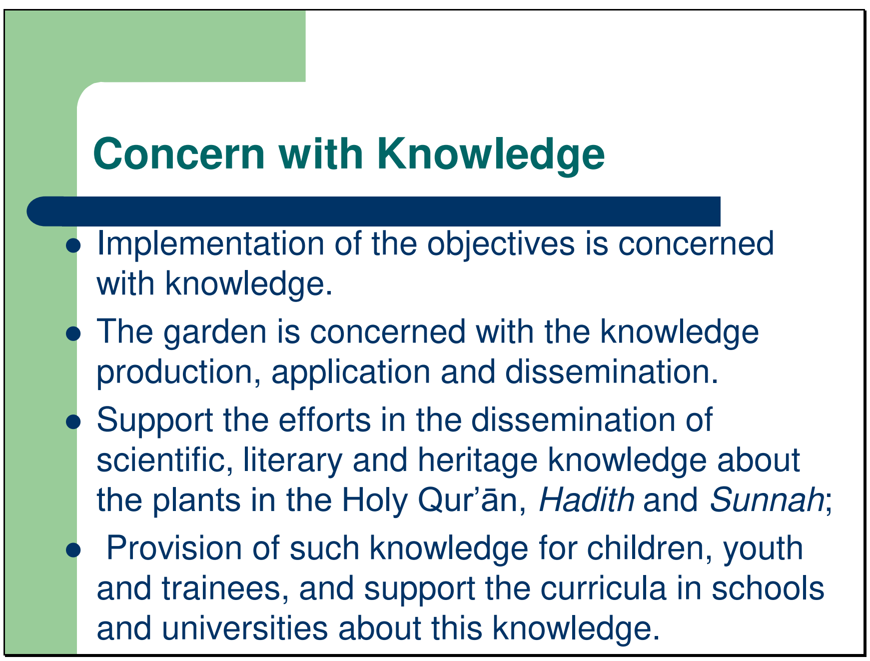

Figure 10. Concern with Knowledge.

What is Knowledge?

- **Knowledge** is defined by the Oxford English Dictionary as
- (i) expertise, and skills acquired by a person through experience or education; the theoretical or practical understanding of a subject,
- (ii) what is known in a particular field or in total; facts and information or
- (iii) awareness or familiarity gained by experience of a fact or situation

Figure 11. What is Knowledge?

What kind of Knowledge we are looking for?

- In Arabic we know: *Arafa* عرف and Alemaعلم
- In English: to know does not differentiate between the knowledge that is a mere familiarity with a phenomenon and the knowledge that can be understanding of this phenomenon.
- Other languages differentiate between both terms. The Latin (*noscere* and *scire*), German (*kennen* and *wissen*), and French (*connaître* and *savoir*) are examples.

Figure 12. What kind of Knowledge we are looking for?

Arefa عرف and *Alema* علم

- One can know the name of a plant in all the languages of the world, but this does not mean that he knows important things about the plant. What counts is knowing what the plant is and its life. This conforms to Richard Feynman (US Educator and Physicist ;1918-1988) who states that there is a difference between knowing the name of something and knowing something.
- In Arabic, the first case refers to *Arefa* عرفwhile the second refers to *Alema* علم

Figure 13. Arefa and Alema.

Knowledge as *Elm* علم

- In Islam, knowledge (Arabic: علم, *ilm*) is given great significance. "The All-Knowing" (*al-Aleem*) is one of the 99 names reflecting distinct attributes of Allah (SWT).
- The Qur'an asserts that knowledge comes from Allah (2:239). The Prophet (PBUH) encourages the acquisition of knowledge. He is reported to have said "Seek knowledge from the cradle to the grave“, "Verily the men of knowledge are the inheritors of the prophets“ and “Seek knowledge even in China” Islamic scholars, theologians and jurists are often given the title *alim*, meaning "knowledgable".

Figure 14. Knowledge as Elm.

Knowledge and Islam

- Islam is the path of "knowledge." No other religion or ideology has so much emphasized the importance of *'ilm*. In the Qur'an the word *'alim* has occurred in 140 places, while al-*'ilm* in 27. In all, the total number of verses in which *'ilm* or its derivatives and associated words are used is 704. The Islamic revelation started with the word ***iqra'*** ('read!' or 'recite!').

Figure 15. Knowledge and Islam.

Knowledge Value in Islam

- As evident, one can see that Islam stresses the importance of knowledge many centuries before the statement by Francis Bacon which is often paraphrased as "knowledge is power". The phrase implies that with knowledge or education one's potential or abilities in life will certainly increase.

Figure 16. Knowledge Value in Islam.

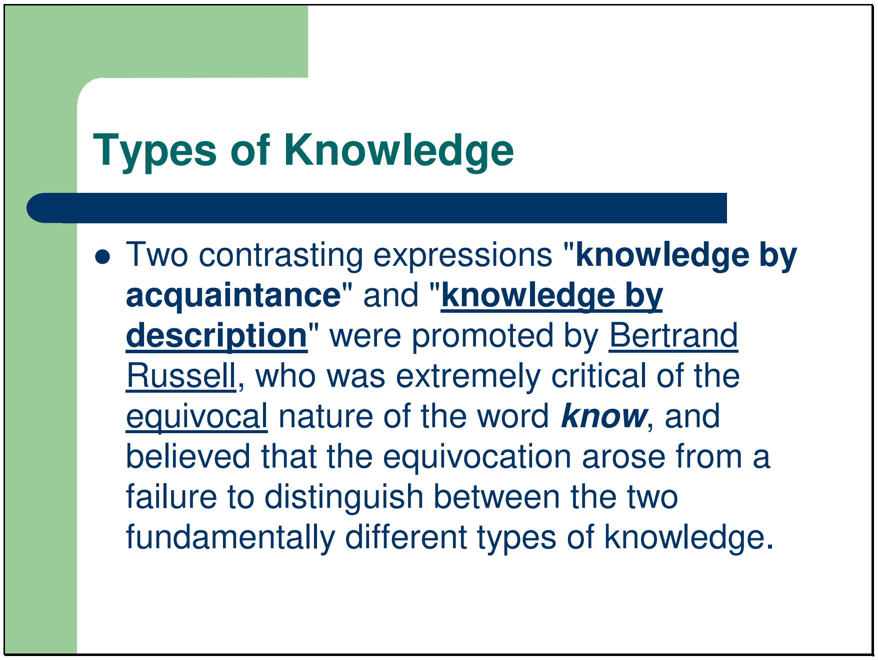

Figure 17. Types of Knowledge.

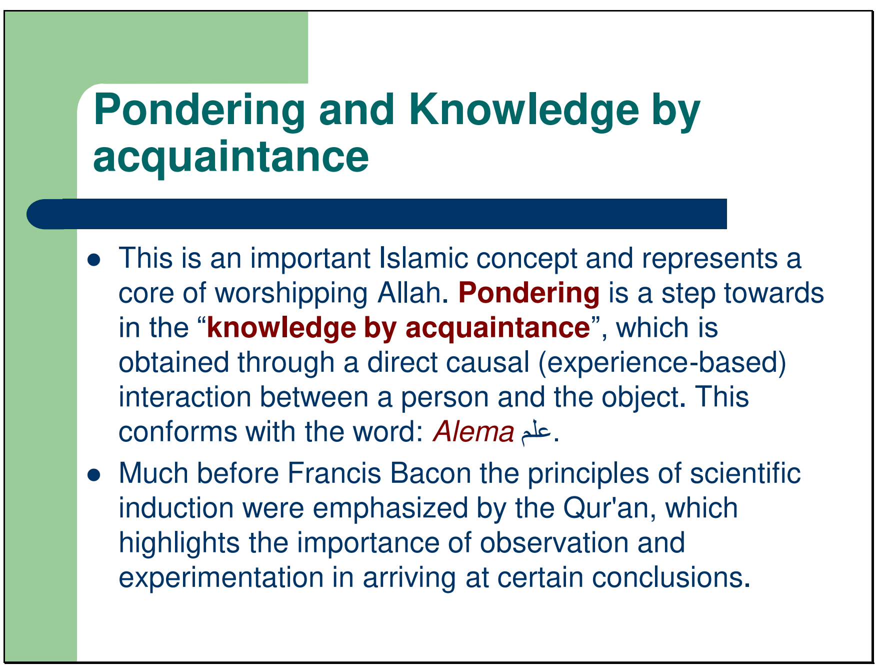

Figure 18. Pondering and Knowledge by Acquaintance.

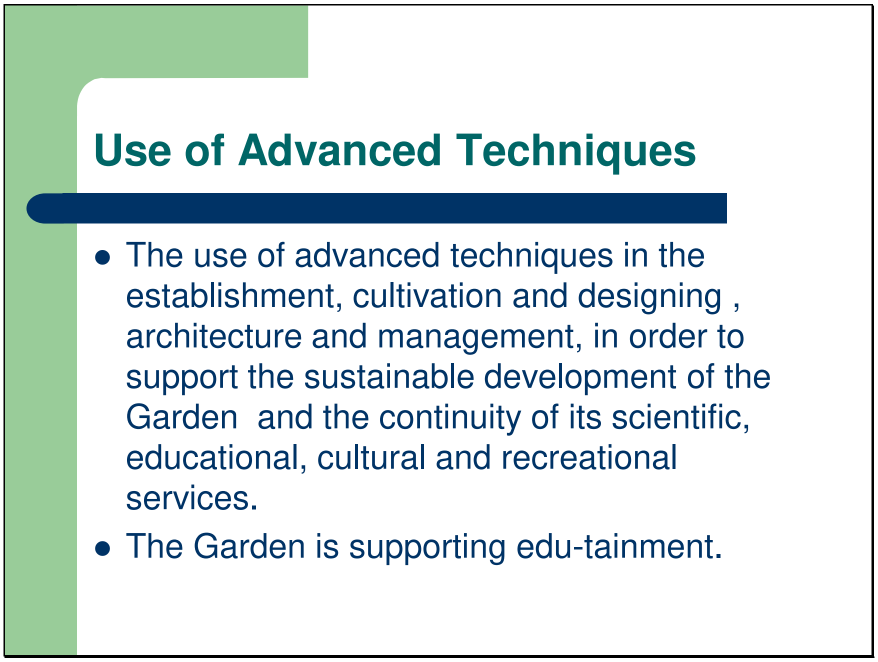

Figure 19. Use of Advanced Techniques.

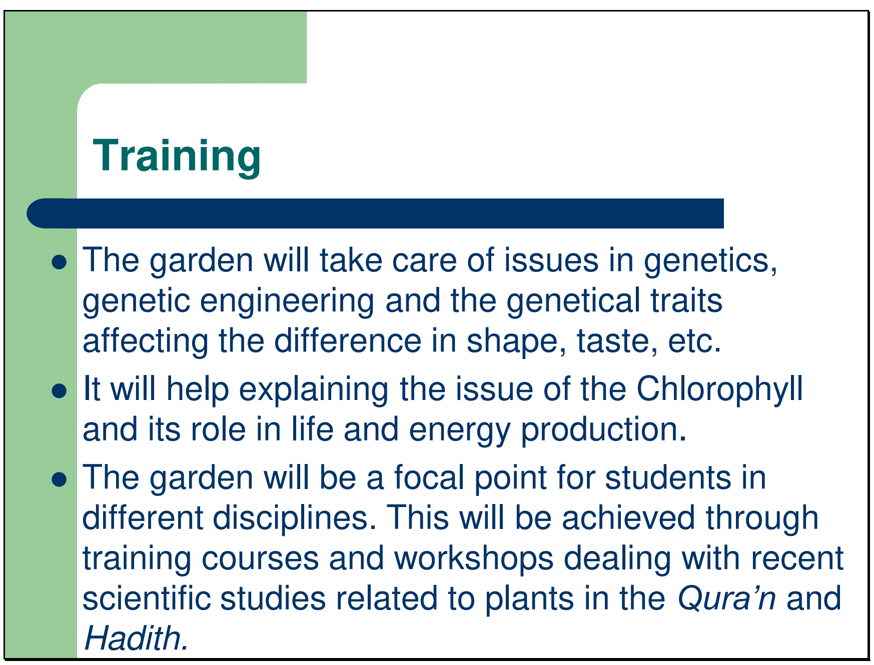

Figure 20. Training.

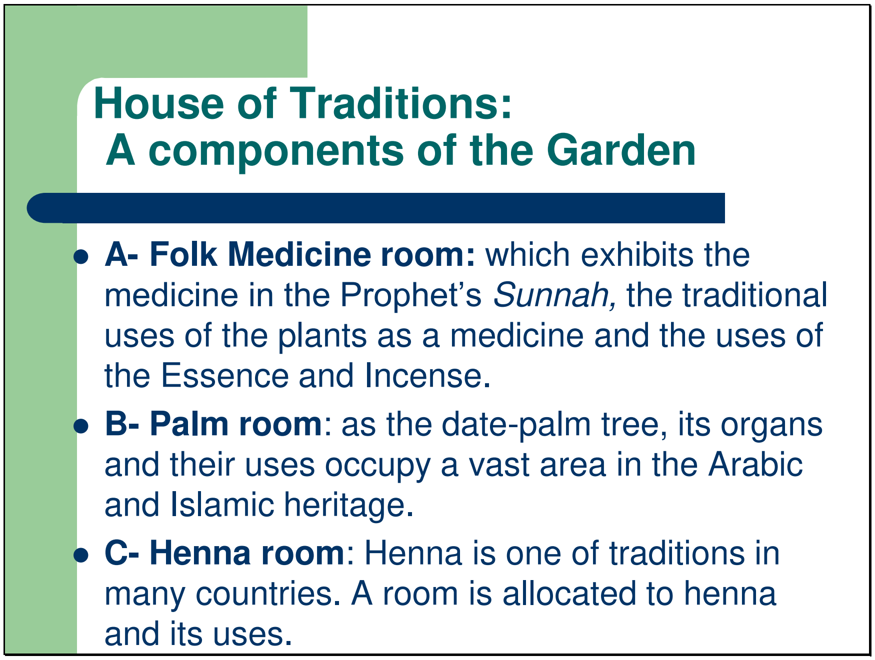

Figure 21. House of Traditions: A Components of the Garden.

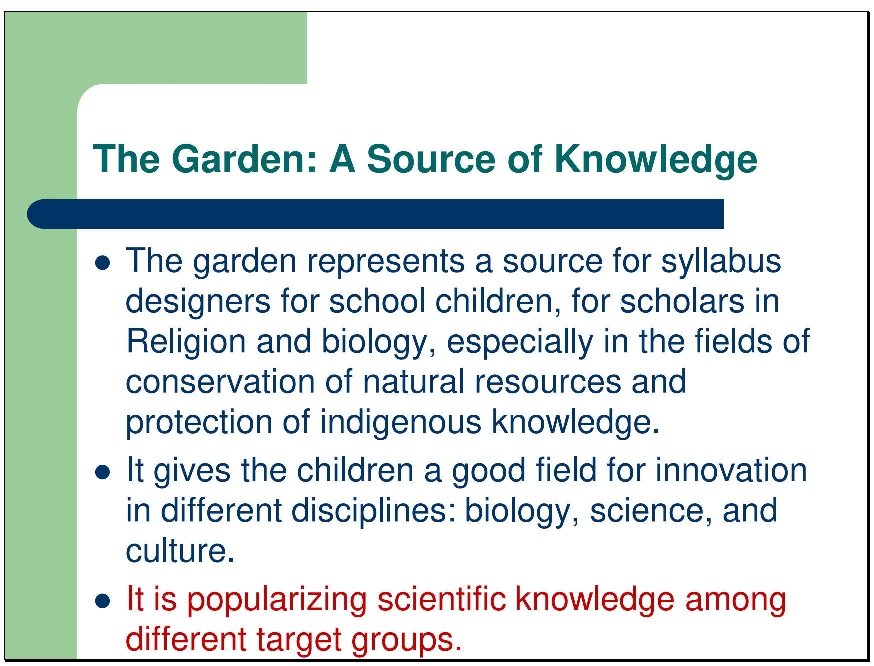

Figure 22. The Garden: A Source of Knowledge.

Some Neglected Factors in Science Planning in the Islamic World

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The issue of advancement of science & technology, their priorities and the criteria for the assessment of success in this area are of much concern in the Islamic world, but in my judgment they are neither well-defined, nor properly planned. There seems to be some very crucial factors which are either neglected or are not given proper weight.

The scientific study of nature and the motive behind it is an old issue and there have been various schools of thought about it. One well-known perspective has been 'the acquisition of knowledge for its own sake'. In this view, the scientific study of nature satisfies our sense of curiosity and beauty and gives us much pleasure.

Another well-known view is that of monotheistic religions. Here, the study of nature is considered to be an understanding of God's signs in the world, and acting as God's vicegerents on earth, to make proper use of what God has provided for us in the heavens and the earth.

In recent centuries, especially the last century, a new attitude towards science appeared in the West: seeking knowledge for gaining power and wealth and realizing materialistic ends. This is a relatively prevalent attitude in the industrially advanced countries, and it has been fortified by the fact that a large proportion of the budget used for scientific activities is supplied by governments and big industries. These countries, however, spend a great deal of budget and effort on pure science as well, just for advancing the frontiers of human knowledge.

Now, the question arises about the kind of attitude that is currently prevalent in the Islamic countries concerning the development of science and technology. In my view, we are not following any of the aforementioned goals, i.e. we are seeking science neither for the sake of power and wealth, nor for the sake of realizing Islamic ideals.

Our universities and research centers have rarely long-term and major goals. To show this point it is enough to look at what seems to be indicators of scientific achievement in our societies. For example, a major indicator for our scientific advancement is the number of papers published in peer-reviewed journals, irrespective of their practical effects on our societies or their qualities. But, what is basically the characteristic of the majority of these papers? They are mostly low in quality and are footnotes to what is done in the West, without either taking care of our national needs or being innovative relative to what has been achieved in the West. Our scientific societies are after what is called 'normal science,' to use Kuhn's terminology.

Neglecting some exceptions, scientists in the Islamic world are rarely after new theories or generalizations of the current theories or finding new interpretations of the prevalent theories. In Weinberg's words:

There are talented scientists who have come to the West from Islamic countries and do work of great value here, among them the Pakistani Muslim physicist Abdus Mohammed Salam, who in 1979 became the first Muslim scientist to be awarded a Nobel Prize, for work he did in England and Italy. But in the past forty years I have not seen any paper in the areas of physics or astronomy that I follow that was written in an Islamic country and was worth reading. Thousands of scientific papers are turned out in these countries, and perhaps I missed something. Still, in 2002 the periodical Nature carried out a survey of science in Islamic countries, and found just three areas in which the Islamic world produced excellent science, all three directed towards applications rather than basic science. They were desalination, falconry, and camel breeding[(1)].

There is an urgent need in the Islamic world to work on the extension of the frontiers of knowledge. This means that we should not confine ourselves to short-term results. Rather, we should let our brilliant scientists spend their time on important topics, without being under pressure for producing immediate results. The present trend of basing faculty members' annual ranking heavily dependent on the number of their publications has the side effect of elevating the position of those that are well-versed in mathematical or experimental work ,without being concerned for novel ideas. This makes the situation hard for those talented researchers who are after new ideas or techniques. But the history of science shows that major breakthroughs have often taken place by those who have not followed the prevalent fashion and have sought new ways of solving major problems present in their fields. Alain Connes**,** one of the world's leading mathematicians and receiver of the Fields Medal, has the following recommendation:

> *What is significant for the progress of physics is the presence of courageous people who do not follow the prevalent ideas-those who break the custom and devise different models*(2).

Thus, it is necessary that conditions be provided for talented students and researchers to use their creativity in extending the frontiers of knowledge, making *Darul-Islam* a source of innovative ideas and steps in both science and technology.

Throughout the Islamic lands one feels a pervasive sense of humiliation with respect to the West, arising from the present superiority of the West in science and technology. The lack of self-reliance and the prevalence of inferiority complex among our youth is a serious obstacle which should be overcome.

The second forgotten factor is the neglect of paying enough attention to the obviation of national needs. Today, Islamic countries import most of the modern products or their ingredients from the West, whereas there are eminent scientists in the Islamic world which are capable of taking care of their national needs or the needs of the Islamic world. It is obvious that taking care of our needs is not of interest for the journals in the West. But since faculty members' annual merit ranking depends on the number of their publications, many scholars prefer to concentrate on things that have reflection in the Western scientific journals. Thus, we have many situations in the Islamic world, where a Muslim country has a relatively large number of talented scientists in some fields, e.g. chemistry , but at the same that country has the biggest size of import in that field. This means that the priority of these scientists is not taking care of their country's needs. Thus, they are not seriously using their expertism to solve their country's socioeconomic problems.

To change the present situation and to pay attention to the aforementioned forgotten factors, it is necessary that encouragements and prizes be given mostly to those who have either scientific innovations or produce things that are effective in taking care of national needs. Furthermore, universities and research institutes are supposed to give primacy to the priorities of their country.

Another major problem in the scientific planning of the Islamic countries is that they are very often concentrating on technology, without strengthening their scientific base. All of those countries who have advanced in recent decades, have invested enough on basic sciences and have gone beyond confining themselves to the assemblage of foreign technologies. Unfortunately, the attention of Muslim rulers to technology is a superficial one, as there is little concern for developing indigenous ability in technology development and its maintenance in most of the Islamic countries.

In order to revive attention to the aforementioned forgotten factors, the following actions should be taken:

1. Changing policy makers' mentality about science.

At the moment, most of the Muslim governments' attention is on the importation of the Western technologies without paying due attention to their scientific base or caring for the establishment of a proper base for scientific innovation. Under the present circumstances, it is a duty of the academic circles to give proper advice to their governments through various channels available to them.

2. Providing opportunities for brilliant scientists.

Both universities and research institutions should pay special attention to the brilliant scientists, supporting them and providing their needs, without pressuring them for producing regular outcomes. In his keynote address to TWAS, Nobel Laureate Ahmad Zewail explains the reason for his own success:

> *There is a widespread misconception in the developing world that progress in science can be driven by buildings and slogans. That is simply not the case. As a youthful untenured professor at Caltech I was given an empty laboratory and some start-up funds. That was all, except for one other thing: enormous freedom to do what 1 wanted. I did not have a boss. Not even Caltech's president was my boss….We were not encumbered by bureaucracy. Tens of forms did not have to be signed; tens of seals did not have to be put on paper; and tens of personal status reports did not have to be completed. No push from high-up officials was invoked.* ***A*** *simple, well-defined, transparent system had been put in place – one with sufficient flexibility to ensure that achievement was rewarded fairly, efficiently and effectively….The fanciest building is not responsible for producing breakthrough ideas. What you need is the right scientific atmosphere and the right scientific support….I am convinced that the developing world – even with its limited resources - is capable of producing such an atmosphere. There are scientific centres in the South that have sufficient resources to conduct good research. It's not just a question of money It's also a question of nurturing a scientific culture that encourages researchers to seek new knowledge and, in the process, challenges them to reach their full potential*(3).

3. Giving priority to taking care of the nation’s needs.

At the moment most of the Muslim countries try to imitate the West in their effort to build their science and technology capacities. This is often done blindly and without considering their national needs, socioeconomic condition, cultural identity or moral values. Universities and research institutes should have an extensive search for identifying the priorities and needs of their respective society and industry, and they should define projects for taking care of them, seeking help from both the government and the private sector. This requires having a strong interaction between universities and research institutes of a country with its industry and private sectors.

4. Prevailing a critical attitude in the academic circles.

Critical attitude is very weak in the academic circles of the Islamic world and it is rarely encouraged. At the moment, most of our universities are simply centers for knowledge dissemination, rather than having authentic search for extending the frontiers of human knowledge. This attitude destroys creativity in young scientists. This should be changed at all levels of learning and research, especially at our centers of excellence.

5. Concern for quality.

Throughout the Islamic world, people give preference to western products. An important factor for this is the poor quality of the products produced in the Islamic world. Thus, one of the important factors in the self-reliance of the Islamic world is giving priority to the quality of its research and products.

6. Attention to specialists and experts.

Islamic countries are losing a large proportion of their capable scientists and technicians due to the lack of internal attractions, the presence of some avoidable obstacles, and the neglect of specialists in scientific and technological programming. In order to lessen the brain drain of Muslim scientists to the West, proper attention should be given to them, rewarding their achievements, so that they are encouraged to stay at home, trying to advance the frontiers of knowledge and taking care of their society's needs. In this direction, competency should be the rule of thumb in giving responsibilities.

7. The Governance of Islamic World-view.

Finally an important ingredient in the development of science in the Islamic world is the necessity of the ruling of Islamic world-view over all scientific planning and activities. This is the element needed to differentiate the products of Muslim science and technology from the materialistic outcome of science and technology in the West, and conforms to the program set for the believers by the Holy Qur'an and the Prophetic tradition.

At the moment, there is rarely any difference in the scientific outlook between Muslim scientists and the Western ones. Furthermore, the spiritual dimension of science and its role in the elevation of human mind and in bringing humanity closer to God is forgotten.

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Nanotechnology: The Urgent Necessity for OIC

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1 ABSTRACT

Nanotechnology is the "nano scale", technology and involves the study, control, manipulation and use of materials of atomic and molecular sizes and their structures. These sizes are in the range of nanometers, one nanometer being one-billionth of a meter. By international nomenclature the material sizes of 1nm - 100 nm fall in the realm of Nanotechnology. The use of material sizes at these small sizes greatly enhances their physical, chemical, biological, electronic and magnetic properties as compared to same properties of the same materials at the bulk scale. The Nanotechnology based products thus made have greatly improved performance and efficacy.

Nanotechnology is the fastest developing technology of the 21^{st} century with great emphasis on applications in public healthcare and has extensive industrial applications in: Medicine, Energy, Textiles, Cosmetics, Paints, Pharmaceuticals, Electronics, Information and Communication, Water, Food and Agriculture, Auto-engineering, Sports goods, Oil and Gas and Defense etc. It is being termed as another 'Industrial Revolution' in the offing, with 1-2 trillion $ marketing potential of Nanotechnology products and 2-3 million jobs creation by 2015.

Some of the exotic applications include; the treatment of Cancer and Aids at cell size without the side effects of Chemotherapy on healthy cells .On the defense scenario there are exotic applications like the one where Israel is working on a project of developing a spy 'Drone of Bee-size' which could collect and relay information and may not be even noticed .These mind-boggling applications and industrial products of Nanotechnology are forcing nations to make heavy investments in this technology which will dominate our lives for next 40-50 years.

The advanced nations of the world like USA, Japan, EU Countries, China, Russia etc are making annual investments in Nanotechnology to the tune of billions of dollars. USA has already invested about 12 billion dollars. Other industrially based countries like Korea, Singapore, Taiwan, Australia etc and even a small country like Israel are also seriously following up the developments of Nanotechnology for economic, strategic reasons and for the welfare of their people. Nanotechnology is going to be the cornerstone of all types of industries for the next 40-50 years.

OIC countries urgently need to attend to Nanotechnology Research and Development and its consequent applications to Industrial products and strategic applications for security and welfare of their people. Any lapse or delay in attending to this urgent need will certainly lead to heavy dependence on and exploitation by the advanced countries, although OIC has great wealth of human and natural resources.

2 INTRODUCTION

By international nomenclature the material sizes of 1 nm-100 nm fall in the realm of Nanotechnology. These sizes are at the scale of atoms and molecules and at these sizes, the nano scale, their physical, chemical, biological, electronic and magnetic properties are greatly enhanced as compared to same properties of the same materials at the bulk scale. This is because that as the particle size of the material goes smaller the surface to volume ratio becomes larger thereby improving the physical and chemical properties where the surface properties are involved. Further the physics at the nano scale is the quantum physics rather than the classical physics which does not explain such different behaviour of materials at nano scale. The Nanotechnology based products thus made have greatly improved performance and efficacy .Further it introduces a significant value-addition to these products resulting in great potential for economic aspects.

The use of nano materials is revolutionizing the applications in all spheres of domestic life. Some of these are listed below.

Applications of Nanotechnology

1. Medical and Health Care: Anti-cancer drugs, Bio-sensors, Implants, Dental Pastes.
2. Energy: Solar, Fuel cell, Bio-fuels, long-life Batteries.
3. Automobiles: Lubricants, Glass Coatings, Resins, Phosphors.
4. Industry: Ceramic Insulation, Hard Materials, Mechanical, Spray, Coatings.
5. Computer/IT: Bio-molecules for nano-electronics, Large Memories.
6. Defense: Special Materials, Sensors, Intelligent and Fire-proof clothing.
7. Cosmetics: Skin Creams, Sun-screen creams.
8. Agriculture: Food Safety, Quality Assurance, Water purification.
9. Environment: Filters, anti-toxicants.
10. Textiles: Special Anti–terrorist Clothes, Antifungal Socks, Bullet-proof Shirts.
11. Sports: Sunglasses, Rackets, Hockey Sticks, Tennis and Golf balls.
12. Aerospace: Communication, High Strength Light Weight Materials.
13. Nanotechnology in Oil and Gas Exploration: Nano plated hard.tools, Sensors, 50% Increased extraction, Diesel cleaning Commercial Plants using Nano-catalysts.

Figure 1. Applications of nanotechnology.

Nanotechnology is the fastest developing technology of 21st century with great emphasis on applications in public healthcare and has extensive industrial applications in: Medicine, Energy, Textiles, Cosmetics, Paints, Pharmaceuticals, Electronics, Information and Communication, Water, Food and Agriculture, Auto-engineering, Sports Goods, Oil and Gas and Defense etc. It is being termed as another 'Industrial Revolution' at the door-steps with 1-2 trillion $ marketing potential of Nanotechnology products and 2-3 million jobs creation by 2015 and almost all types of industries are converging to the applications of Nanotechnology in industrial products.

The advanced nations of the world are making annual investments to the tune of billions of dollars. USA has already invested about 12 billion dollars on Nanotechnology since 2001 and China, Russia, Japan and Europe are also competing to this extent. Russia has recently invested 7.7b $ to be spent on Nanotechnology by 2015 of which 5b$ have already been released. Other industrially based countries like Korea, Singapore, Taiwan, Australia and even a small country like Israel are also seriously following up the developments of Nanotechnology for economic and strategic reasons and for the welfare of their people.

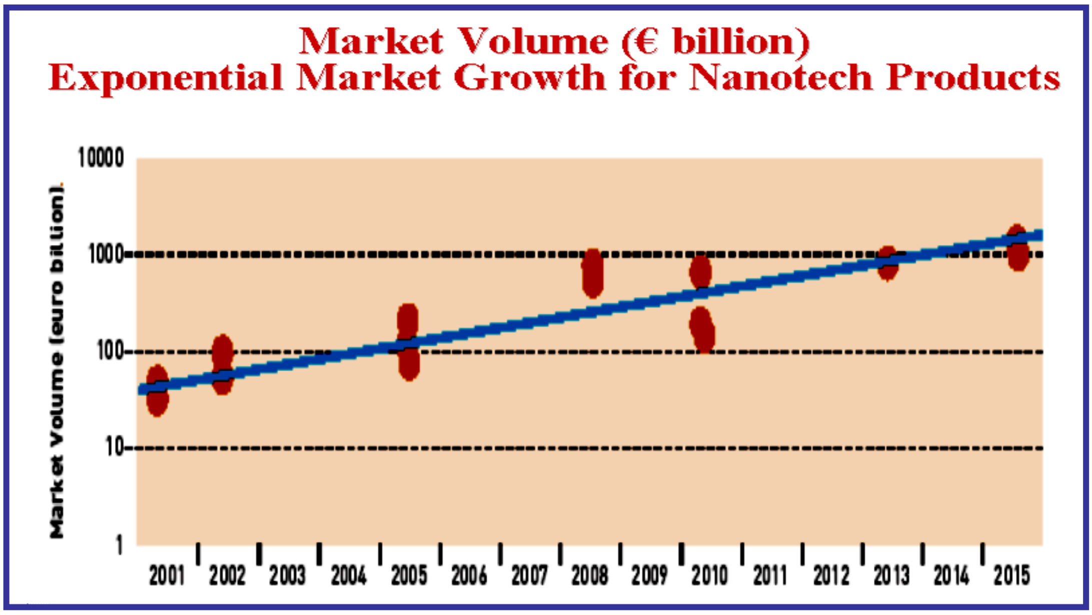
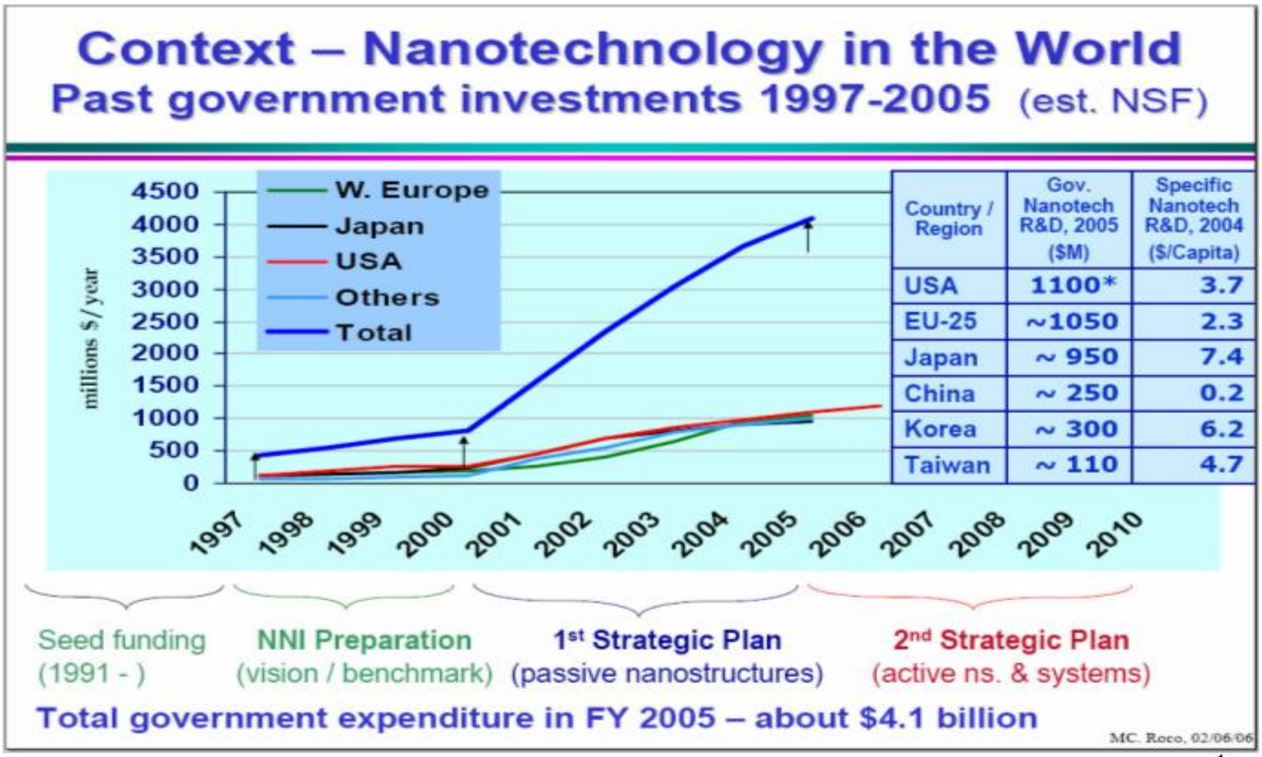


Figure 2. Market volume (€ billion) exponential market growth for nanotech products.

PROPOSED NNI BUDGET FOR 2009 ($m)

	Fundamental Phenomena & Processes	Nanomaterials	Nanoscale Devices & Systems	Instrument Research, Metrology, & Standards	Nano-manufacturing	Major Research Facilities & Instr. Acquisition	Environment, Health, and Safety	Education & Societal Dimensions	NNI Total
DOD	227.8	55.2	107.7	3.6	12.8	22.1	1.8		431.0
NSF	141.7	62.5	51.6	16.0	26.9	32.1	30.6	35.5	396.9
DOE	96.9	63.5	8.1	32.0	6.0	101.2	3.0	0.5	311.2
DHHS (NIH)	55.5	25.4	125.8	5.9	0.8		7.7	4.6	225.7
DOC (NIST)	24.5	8.5	22.7	20.9	15.3	5.7	12.8		110.4
NASA	1.2	9.8	7.7			0.2	0.1		19.0
EPA	0.2	0.2	0.2				14.3		14.9
DHHS (NIOSH)							6.0		6.0
USDA (FS)	1.7	1.3	0.7	1.1	0.2				5.0
USDA (CSREES)	0.4	0.8	1.5		0.1		0.1	0.1	3.0
DOJ				2.0					2.0
DHS			1.0						1.0
DOT (FHWA)	0.9								0.9
TOTAL	550.8	227.2	327.0	81.5	62.1	161.3	76.4	40.7	1,527.0

Figure 3. Proposed NNI budget for 2009 ($m).



Source: M.C. Roco 2006

Figure 4. Context – nanotechnology in the world.

S.No.	Country	$m
1	**USA, NNI (2008)** **USA, NNI (2009) Proposed** (www.nano.gov)	**1,444.2** **1,527.0** **[8.3 b $ SINCE 2001]**
2	**EU (2008)** (www.nanowerk.com)	**1,200** **3.5 b € [2007-2013]**
3	**RUSSIA (2008)** (www.nanowerk.com)	**5,000** **(7.7 b$ up to 2015)**
4	**TAIWAN** (Market value) (Investintaiwan.nat.gov)	**578**
5	**INDIA (2008)** **(www.scidev.net)**	**255**
6	**PAKISTAN (2008)** **National Commission on Nano-science and Technology (NCNST)**	**15**
7	**China**	**b$ / year investment**
8	**Indonesia** **http://www.nsti.org/news/item.html?id=372**	**$25M**

Figure 5. Investment in Nanotechnology (2008).

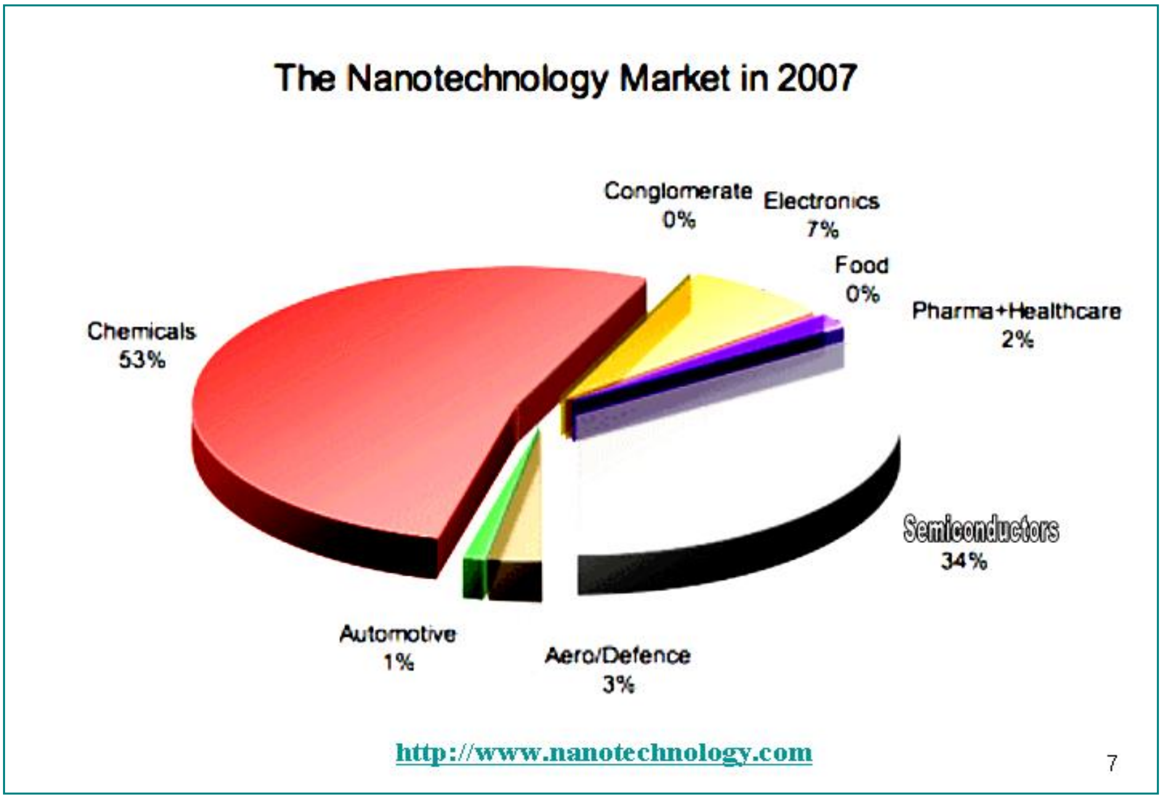


Figure 6. The Nanotechnology market in 2007.

3 PUBLIC AWARENESS AND HUMAN RESOURCE VISION

Concentrating on future vision to meet the requirements of human resource experienced in knowledge and skills in nano science and technology in times to come, in addition to industrial emphasis, advanced countries are already having at their universities the degree courses leading up to B.S, M.S and Ph. D degrees in nano science and nanotechnology and putting specific emphasis on 'nano-education'. US National Science Foundation (NSF) has special budget for awareness of nano education to about 50 % of American by 2015. For awareness of Nanotechnology Germany has already a double-decker 'High-Tech from the nanocosmos' exhibition traveling in European countries for the last several years and in 2007 the Deutsches Museum in Munich opened an exhibition 'Everyday Life with nanoproducts' for public awareness with over 70 nanotechnology products already commercially available involving coatings, clothing, kitchenware, domestic products and nano-electronics on the one hand, and the most sophisticated instruments like STM, AFM, TEM etc.. used in research and development in nanoscienece and nanotechnology on the other.

Nanotechnology is going to be the cornerstone of all types of industries for the next 40-50 years.

4 SOME EXOTIC APPLICATIONS

Some of the exotic applications include; the treatment of Cancer and Aids at cell size without the side effects of Chemotherapy on healthy cells. Drug delivery at the targeted diseased-sites, greatly improved medical diagnostics, cosmetic creams, dental cements, body implants, food preservation, clean drinking water, plants, oil cleaning plants, bullet proof thin shirts, micro machines to clean cholesterol in the arteries, anti-terrorist electronic sensors for explosive detection which could detect a very small amounts of explosives, which even the sniffing dogs would not detect, making the sniffing dogs go out of job etc.

On the defense scenario it is interesting to note that

(i) Israel is working on a project of developing a spy 'Drone of Bee-size' which could collect and relay information and may not be even noticed.

(ii) For the protection of soldiers, MIT in USA is executing a project of Inst of Soldier Nanotechnology (ISN) with funding of $50million from the Ministry of Defense whereby about 50 professors and about 90 graduate students are engaged in producing gadgets for protecting soldiers from explosives through intelligent nano-textiles, shirt thickness bullet-proof and fire-proof clothing, lightweight guns and wireless communication equipment etc.

(iii) NASA has a Nano-centre for development of light weight strong aerospace nano-materials and nano-electronics based communication and other defense equipment.

These mind-boggling applications and industrial products of Nanotechnology are forcing nations to make heavy investments in this technology which will dominate our lives for next 40-50 years.

5 WHY NANOTECHNOLOGY FOR OIC

Viewing the above given world scenario it is easily evident that OIC countries urgently need to attend to Nanotechnology research and development and its consequent applications to Industrial products and strategic applications for security and defense of the people of their countries. Any lapse or delay in attending to this urgent need will certainly lead to heavy dependence on and exploitation by the advanced countries in spite of the fact that OIC has great wealth of natural resources.

The first effort on reviewing Nanotechnology at the IAS forum was made in the conference held in 2002 in Islamabad [**1**]. In this conference a review on Nanotechnology was given by Butt [**2**] while a paper on fabrication of micro devices and nano components was presented by Professor Xie Sishen of the Institute of Nanotechnology, Beijing, China. Since then no serious emphasis has been laid as a continuous effort of IAS to keep pace with the world in this important and fast advancing Technology. The world in these years has progressed in Nanotechnology with amazing speed creating already a big gap between the level of OIC and the advanced countries.

'OIC countries must keep hands on control of emerging Nanotechnology, making judicious use of their wealth for the security and economic welfare of their people.'

The following are the main reasons to justify the above statement:

(i) OIC has the potential of human resources of high calibre which can be effectively pooled up for optimum utilization just like the EU is effectively pooling up their Human and Financial resources for common programmes in Nanotechnology.
(ii) To obtain self-Reliance in Nanotechnology and strengthening the economy by industrial applications.
(iii) To cater for the security and welfare of the people of the OIC countries.
(iv) To safeguard the interests of our people from the exploitation by the advanced countries. Such exploitation should be learnt from several examples of the past years.
(v) The appropriate selection of Nanotech industry focus of national priority of each Member of OIC in particular for the value-addition to the export oriented products whether based on Industry or based on Natural Resources. For an Oil producing country, for example, the relevance is applications of Nanotechnology in Oil and Gas exploration.

6 BRIEF VIEWS ON NANOTECHNOLOGY EFFORTS IN OIC COUNTRIES:

It is however encouraging to note that the awareness about utilizing the benefits of Nanotechnology is being realized in some OIC countries like Iran, Turkey, Pakistan, Saudi Arabia, Malaysia, Indonesia, Egypt etc.
It is worth noting that the President of Iran has Nanotechnology advisors that work in his office that coordinate the Nanotechnology programmes with various ministries in the country.

. Several industrial products are being patented and several trading companies are in operation in Iran. The cooperation between Russia and Iran is in setting up oil-cleaning “Commercial Plant” using the nano-catalysts developed by Russian scientists in collaboration with UNIDO in addition to other cooperatives projects, a “Commercial Clean Drinking Water Plant” is also being set up.

In Saudi Arabia, King Abdullah Institute of Nanotechnology has also been established with the support of King Abdullah. Recently King Abdul Aziz University (KAU) has made a specific MoU with the Islamic Development Bank for Centre of excellence in Nanotechnology in Riyadh [**3**]. The purpose is to concentrate on R&D on Nanotechnology & awareness in Saudi Arabia and OIC countries through cooperation with COMSTECH.

Indonesia has recently allocated $ 15m towards Nanotech Program [Ref]. In Malaysia serious interest was shown and already in 2001 some of the universities started some work in Nanotechnology areas adjacent to materials science. Further serious concern was shown on this emerging technology of great industrial applications and the Ministry of Science, Technology and Innovation (MOSTI) in its third Industrial Plan (IMP3) which will span (2005-2020) allocated in the budget year of 2006 an amount of RM868 million for R&D [**4**]. The focus was laid on biotechnology, nanotechnology, advanced manufacturing, advanced materials, ICT and alternative energies including solar energy. Some well-equipped Institutes on nanoscience and technology have been set up like, Ibnu Sina Institute for Fundamental Studies (IIS),Universiti Technology Malaysia, Institute of Micro Engineering and Nanotechnology (IMEN), Universiti Kebangsaan Malaysia, Advanced Material Centre of Malaysia (AMREC) of SIRIM Bhd and the Combinatorial Technology and Catalysis Research Centre (COMBICAT), University of Malaysia, have been set up.

At the Yousef Jameel Science and Technology Reseach Centre (YSTRC) of the American University in Cairo, there has been recent focus on research in the areas of detection of the Hepatitis C virus, cancer biomarkers, a new generation of nano devices, smart bricks with nanosensors for buildings safety and warnings for fires and earth quakes

In Pakistan in 2003 a National Commission on nano Science and Technology (NCNST) was established by the Ministry of Science and Technology (MoST). Pakistan has already invested about $18m on research on Nanotechnology at 7 Universities/Research Centres.

The funds were provided by the Government of Pakistan and the projects were assessed by a Committee of senior scientists of the NCNST.

Research Projects

Following research projects in Pakistan are being carried out in various organizations/institutions, evaluated and recommended by NCNST

No.	Project	Institution	Rs million	Funded by
i.	Synthesis and Characterization	PIEAS	60	HEC
ii.	Nano-magnetism	QAU	137	HEC
iii.	Micro/Nano electronic devices	CIIT	189	HEC
iv.	Nano-Composites	GIK	195	HEC
v.	Nano-biotechnology	NIBGE	155	MoST
vi.	Nano-devices, L.E.D. etc	PINSTECH	196	MoST
	Total (US$ 15 million):		**932**	

Figure 7. Research projects.

While the award of formal B.S level degree in Nanotechnology is not common across the world as yet, some universities have however started a 4 year B.S degrees. In Pakistan, recently, Preston Institute of nano Science and Technology (PINSAT) has been established at the Preston University, Islamabad, a private University. Although some research in nano Science & Technology is being carried at several Universities in Pakistan, Preston University is the first University to launch B.S (4 year) undergraduate degrees in nano Science & Nanotechnology. The University has a programme for M.S and Ph.D in Nanotechnology and has a strong link with the local industries and holds specific training workshops for skilled industry workers to cater for their needs. These degrees will have specific needs of Industries for Nanotechnology applications, particularly to protect the exports and to reduce the imports of nano based products.

This degree programme is indeed, the need of Pakistan for production of human resource in Nanotechnology which will be required in the industry as well as in academic and research centers for advanced research. Apart from degree programmes the Preston Institute will train Nanotech skilled technicians for the Industry of Pakistan.

It is therefore imperative to have a pool of properly trained human resource in Nanotechnology, the universities in OIC countries must pay serious attention to B.S, M.S and Ph.D courses in nano Science and Technology. Further, these countries must have strong links with the local industry, particularly to protect the exports and decrease the imports of Nano base industrial products

It is an encouraging sign that there is some consciousness at the highest level of the governments in these OIC countries but much more is needed in the OIC countries individually and collectively. On similar lines the EU is pooling up financial and human resources in executing joint strategies and programmes in applications of Nanotechnology [**5**] to compete with Japan, China and USA. It is therefore suggested that:

(i) A network on nano activities as ‘OIC Network’ which should have backing of the Islamic Development Bank and the mandatory contribution of the OIC countries and under this network a few specialized-centres should be set up in various countries depending on the level of advancement in Nanotechnology of that country. Such cooperative programmes could be focused at COMSTECH too. For example the following could be a tentative suggestions:

(a).Centre for Oil and Gas applications in Saudi Arabia.
(b) Centre for device Micro and Nano devices Fabrication in Turkey.
(c) Centre for applications in Food and agriculture in Pakistan
(d) Centre for applications in Medicine in Iran

(e) Centre for electronics industry in Malaysia.
(f) Centre for Human Resource/Nano Education in Saudi Arabia.

There may be other suggestions for joint efforts on Nanotechnology under the umbrella of OIC nano-network could come up in time.

(ii) A Nano –News letter for cross- communication among OIC countries could be housed in Pakistan.

7 SOME FUTURE SUGGESTIONS

To obtain further benefits from this revolutionary emerging technology which will increasingly dominate the world economy, OIC should set up Joint Nanotechnology Centres where the talented OIC scientists and engineers should compete with the EU Nanotechnology and then interact with them on cooperative basis on equal footing. The resources of the Islamic Development Bank (IDB) should be tapped to support these OIC Nanotechnology Centers.

8 CONCLUSION

The Nanotechnology is the most relevant emerging technology for the uplift of the Socio-economic aspects of the people of all nations, OIC countries are no exception. The more rapidly we tap its benefits, the better it is, lest we miss the train and would then have to depend on the mercy of the technically advanced nations for years to come.

9 ACKNOWLEDGEMENTS

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Design, Simulation and Fabrication of Polysilicon-based Piezoresistive Microcantilever Biosensor for Human Stress Measurement

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FIRDAUS ABDULLAH[4]

1 ABSTRACT

This paper deals with the development of Piezeoresistive Microcantilever biosensor and the signal transduction to detect human stress by using salivary alpha amylase activity. A Piezoresistive Microcantilever biosensor can be used to detect saliva-amylase activity by deflecting upon interaction with a specific receptor. By measuring the amount of bending the microcantilever beam experiences in response to interactions with the molecules, and the amount of analyte in the solution can be quantified. When the Microcantilever beam deflects it caused the stress change within the microcantilever beam and applied strain to the piezoresistor material thereby causing the resistance change which can be measured with the Wheatstone Bridge circuit. The Piezoresistive Microcantilever sensor integrated with transducer components coverts the biochemical signal into measurable signal when it react with salivary amylase enzyme. The enzyme concentration signal is converted to a voltage signal by the transducer. The device was designed specifically that it enables the small resistivity change due to the enzymatic reaction to be measured.

Key-Words: - Biosensor, Piezoresistive, Microcantilever, Signal Transduction, Resistance change, Saliva, Alpha Amylase

2 INTRODUCTION

A biosensor is commonly defined as an analytical device that uses a biological recognition system to target molecules or macromolecules. The development of biosensors for numerous diagnosis of infectious diseases, detection of oxidizing of free radicals in saliva [1], glucose determination[2-5] and also stress measurements[6] has lead to the technological advancement of microsensors for biological sensing.

Biosensors can be coupled to physiochemical transducers that convert this recognition into a detectable output signal. Typically, biosensors are comprised of three components: the detector, the transducer and the output system which involves amplification and display the output in an appropriate format.

A microcantilever biosensor is a device that can act as a physical, chemical or biological sensor by detecting changes in microcantilever bending or vibrational frequency. Microcantilevers are simple mechanical devices. They are tiny plates or leaf springs, typically 0.2-1µm thick, 20-100µm wide, and 100-500um long, which are connected on one end to an appropriate support for convenient handling.

3 PROBLEM FORMULATION

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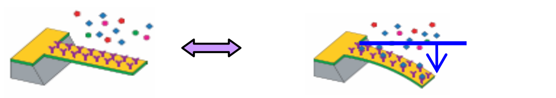
Biosensing applications demand fast, easy-to-use, cheap, and highly sensitive methods for the recognization of biomolecules. A high degree of parallelization is also desirable because of the demands made by the pharmaceutical industry for high-throughput screening. All these points can be fulfilled by micromachined cantilever sensors, which are ideal for biosensing applications. An increasing number of reports confirm the potential of Microcantilever (MC) sensors for environmental such as gas detection, mass effect and gas sensitivity[7] and biomedical application[3].

The sensitivity of a microcantilever biosensor depends on its ability to convert biochemical interaction into micromechanical motion of the microcantilever. The deflections of the microcantilever biosensor are usually of the order of few tens to few hundreds of a nanometer. Such extremely low deflection requires an advanced instrument for accurately measuring the deflections.

As a consequence, most of the applications of microcantilever biosensors are done in laboratories equipped with sophisticated deflection detection and readout techniques. This paper proposes and analyses a self-sensing Piezoresistive Microcantilever for electrical measurement of microcantilever deflection. Microscale cantilever beams can be used to detect biomolecules by deflecting upon interaction with a specific biomolecule as in Figure 1[8, 9].



Immobilisation of bioreceptor produces Biochemical Event

Conversion of Biochemical Event into Deflection of micromachined cantilever beam

Figure 1. Microcantilever beam response.

By measuring the amount of bending each microcantilever beam experiences in response to interactions with the molecules, the amount of analyte in the solution can be quantified.

4 METHODOLOGY

A. Piezoresistive Microcantilever Deflection Detection

Piezoresistive Microcantilever deflection method involves the embedding of a piezoresistive material such as doped polysilicon at the top surface of the microcantilever to record the stress change [8]. When the microcantilever beam deflects a stress change occurs within the beam that will apply strain to the piezoresistor. Thereby causing a change in resistance that can be measured by electronic instruments. The resistance of the piezoresistive material changes when strain is applied to it. The relative change in resistance as function of applied strain can be defined as

$$\frac{\Delta R}{R} = K\delta \qquad (1.1)$$

Where K is a Gauge Factor which is an important material parameter, δ is the strain in the material and R is the piezoresistor resistance.

B. Thin film Piezoresistive Microcantilever Fabrication

The fabrication process started from patterning a 0.9µm – thick photoresist of Boron Phosphosilicate Glass(BPSG) sacrificial layer on a silicon substrate by standard photolithography. The microcantilever beam is then formed by depositing a polysilicon layer of 5000A (0.5µm) thickness using Low Pressure Chemical Vapor Deposition (LPCVD). Next, a 500nm-thick Silicon Nitride (SiN) layer are deposited by Plasma Enhanced Chemical Vapor Deposition (PECVD) which will act as an insulator. Another polysilicon layer is then deposited with a dimension of 195µm x 75 µm u-shape resistor pattern and blanket implanted to achieve a resistor value of 1.2kΩ. Then the electrode pad was patterned and deposited with Aluminum and finally the cantilever beam is released by wet etching. The cross section SEM image of the designed piezoresistive microcantilever is as shown in Figure 2.

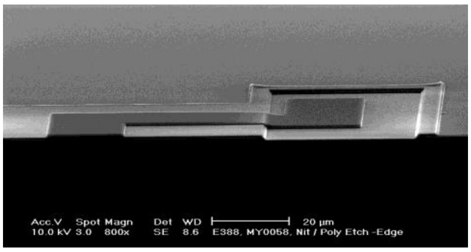


Figure 2. FESEM of microcantilever sensor cross section.

C. Wheatstone Bridge Circuit design

Figure 3 shows a Piezoresistor Microcantilever which can be connected to a Wheatstone Bridge circuit as shown in Figure 3.

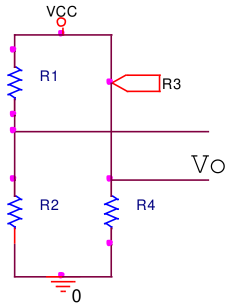


Figure 3. Wheatstone Bridge Circuit used for the Piezoresistive Microcantilever deflection detection.

For a piezoresistor embedded on to the surface of the microcantilever has a length of l µm, with cross-section area of Aµm^2 and a resistivity of ρ Ωµm, the resistance is given by

$$R = \frac{\rho l}{A} \quad \Omega \quad (1.2)$$

When the piezoresistor material is stressed mechanically by a load W newtons, a stress,σ occurs where

$$\sigma = \frac{W}{A} \quad (1.3)$$

By using a Taylor's series expansion method on resistance R, the resistance changes can be determined by:

$$\Delta R = \left(-\frac{L}{A^2}\right)\Delta A + \left(\frac{L}{A}\right)\Delta\rho + \left(\frac{\rho}{A}\right)\Delta L \quad \Omega \ (1.4)$$

Then, to obtain the fractional change in R, divide eqn. 1.4 with eqn. 1.2 and we will get

$$\frac{\Delta R}{R} = -\frac{\Delta A}{A} + \frac{\Delta\rho}{\rho} + \frac{\Delta L}{L} \quad (1.5)$$

A differential amplifier is used to measure biomedical signals where it's applied between the inverting and non-inverting input of the amplifier. The signal therefore amplified by the differential gain of the amplifier. Figure 4 shows the sensor integration consist of Wheatstone bridge and different op-amp circuit.

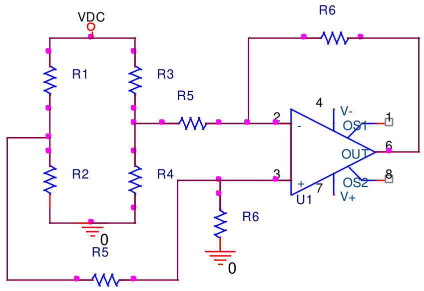


Figure 4. Sensor Integration Circuit.

If the following resistor ratios equal, R6/R5 = R6/R5, the output voltage is:

$$\Delta V = V_O \left\{ \frac{R_2}{R_1 + R_2} - \frac{R_4}{R_3 + R_4} \right\} \qquad (1.6)$$

Where $R_3 = R + \Delta R$

5 RESULTS

From testing with the actual Piezoresistive Microcantilever sensor, it is found to have a resistance value of 5.767 kilo ohms. Table 1 shows the voltage output from the bridge at and slightly off the null bridge conditions. It can be confirmed that the null bridge condition is obtained when R2 equals 6.245 kilo ohms for actual sensor testing.

Table 1. Nulling of Wheatstone Bridge Circuit

(R3 kΩ) PZR	(R2 kΩ) Rpot	Vout(mV) (theoretical Calculation)	Vout (mV) (experimental)
5.767	6.000	-49.40	-45.102
5.767	6.100	-28.88	-24.37
5.767	6.200	-8.500	-8.04
5.767	6.210	-6.500	-6.143
5.767	6.220	-4.400	-4.247
5.767	6.230	-2.400	-2.176
5.767	6.240	-0.400	-0.519
5.767	6.241	-0.180	-0.955
5.767	6.242	0.020	-0.481
5.767	6.243	0.220	-0.374
5.767	6.244	0.420	-0.059
5.767	6.245	0.620	0.414
5.767	6.246	0.820	0.616
5.767	6.247	1.021	0.883
5.767	6.248	1.221	1.241
5.767	6.249	1.420	1.481
5.767	6.250	1.600	1.623
5.767	6.260	3.600	3.723
5.767	6.270	5.600	5.432
5.767	6.280	7.600	7.250
5.767	6.290	9.600	9.021
5.767	6.300	11.50	10.768

With reference to experimental outcome on the deflection of Piezoresistive Microcantilever range, a range of 6.245 to 6.25 kilo ohms is chosen as variable resistance range. The output from the differential amplifier ranges from 0.616 millivolts to 1.623 millivolts on actual experiment. A discrepancy within 13.16% (Table 4.2) on the average is detected, which could be attributed to tolerances of electronic components and wiring.

Table 2. Integration of Sensor and Transduction Stage

(R3 kΩ) PZR	(R2 kΩ) Rpot	Vo1 mV (Theoretical)	Vo1 mV (Experimental)	% Discrepancy
5.767	6.246	0.820	0.616	24.88
5.767	6.247	1.021	0.883	13.52
5.767	6.248	1.221	1.241	-1.64
5.767	6.249	1.420	1.481	-4.30
5.767	6.250	1.600	1.623	-1.44

Figure 6 depicts the outcome from a comparative study between theoretical and experimental results with the integration of sensor and transduction stage. It can be observed that the voltage output from the differential amplifier is linearly related to the resistor, R2, the variable resistor.

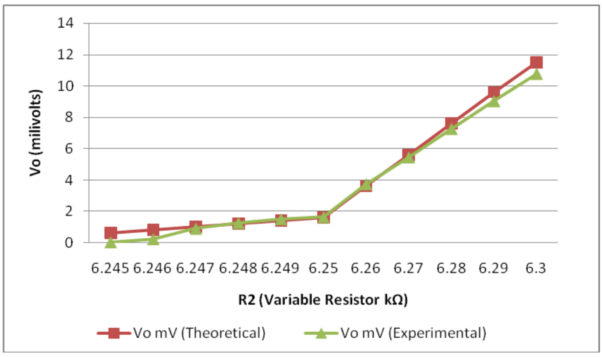


Figure 6. Comparative study between Theoretical, Simulation and Experimantal results on output voltage of Integration of Sensor and Transduction Stage.

6 CONCLUSION

The Piezoresistive Microcantilever biosensor can be used to detect the small biological signal in response to the proposed biosensor system. The deflection of the Microcantilever beam caused a resistance change within the beam and therefore generated signal which is converted to voltage by the Wheatstone Bridge circuit. By investigating the integration of the Piezoresistive Microcantilever sensor with the developed transducer, the result shows that the percentages different between the software simulation and the hardware developed transducer was very low and insignificant to each other. Thus, it is proven with theoretical result. The software simulation and hardware implementation have been successfully completed; this finding is useful for the future enhancement of the bioamplifier design.

7 ACKNOWLEDGMENTS

The work performed was supported by the Malaysia Science and Technology (MOSTE) IRPA grant code: 50043. The authors would like to thank the National Biosensor Research Group (NBRG) and UiTM Research Management Institute (RMI), UNISEL Centre of Research and Innovation (CRI), MIMOS.

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Health and Human Well-Being: An Extrapolation into the Future

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ABSTRACT

The low life expectancy of 50 years in Sub-Saharan Africa has hardly changed during the last 20 years despite the general improved economic situation in most African countries. The discovery of mineral and oil deposits in many countries have lead to a general increase in GDP, but has sadly not translated into an increased investment in the health and education sector in these very countries.

International donors are focusing almost exclusively on infectious diseases such as HIV/AIDS, TB and malaria probably due to the fact that these diseases are more prominent in Sub-Saharan Africa than in any other part of the world.

However, what has been completely neglected is the fact that the disease pattern in Sub-Saharan Africa is rapidly changing and many countries are facing a growing threat from non-communicable diseases. This change has occurred very slowly, and has been largely masked by the high incidence of infectious diseases, leaving these countries completely unprepared to confront this new challenge.

Figure 1. What is the International Centre for Genetic Engineering and Biotechnology?

Figure 2. A Centre of Excellence for Research and Training in Genetic Engineering and Biotechnology; addressing the needs of developing countries and economies in transition.

Figure 3. 2007: ICGEB is one centre, made of three components and a network of affiliated centres.

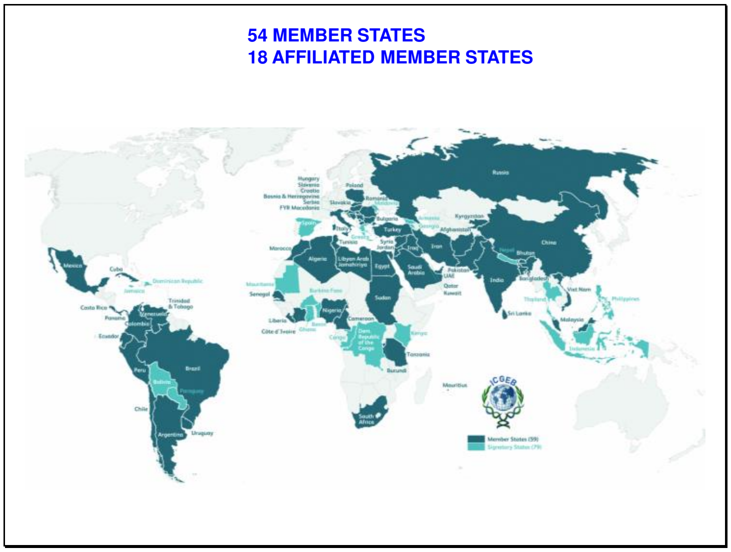

**Figure 4. 54 Member states
18 Affiliated member states.**

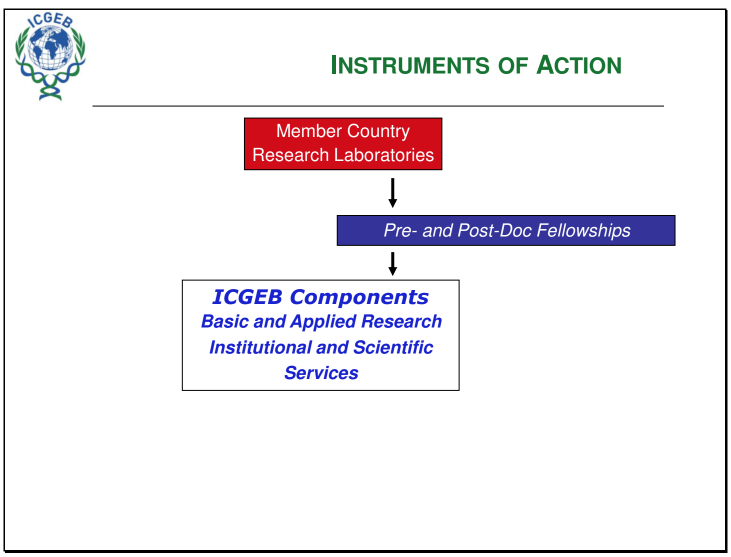

Figure 5. Instruments of action.

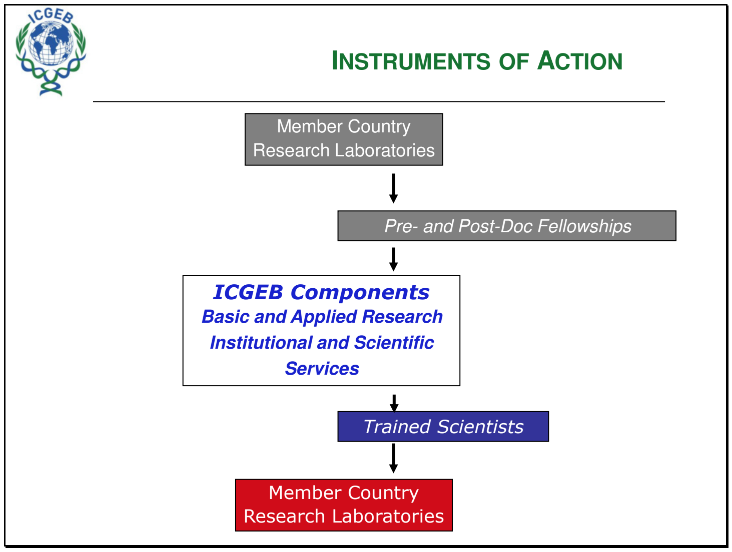

Figure 6. Instruments of action.

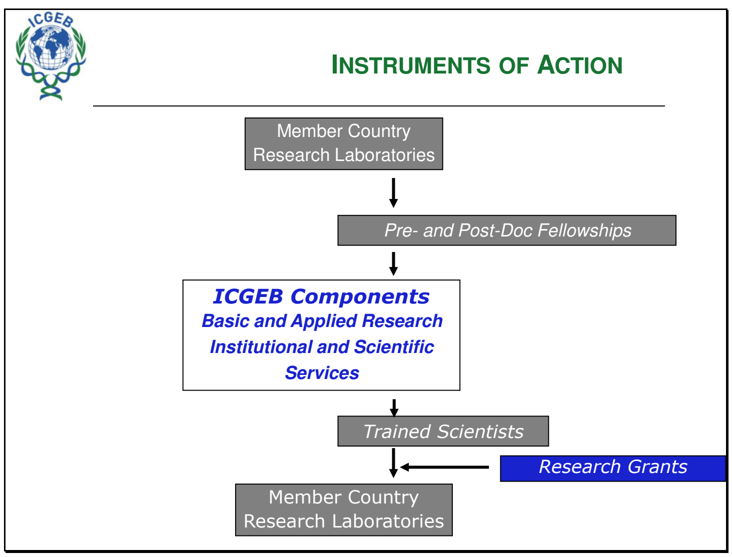

Figure 7. Instruments of action.

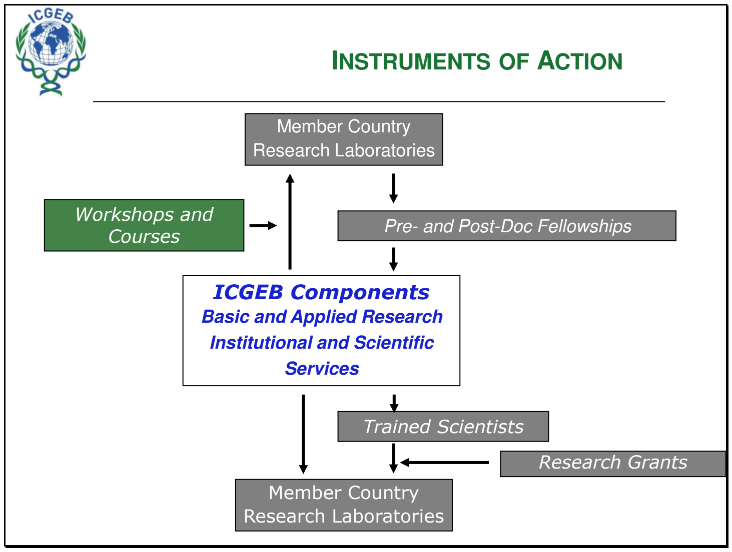

Figure 8. Instruments of action.

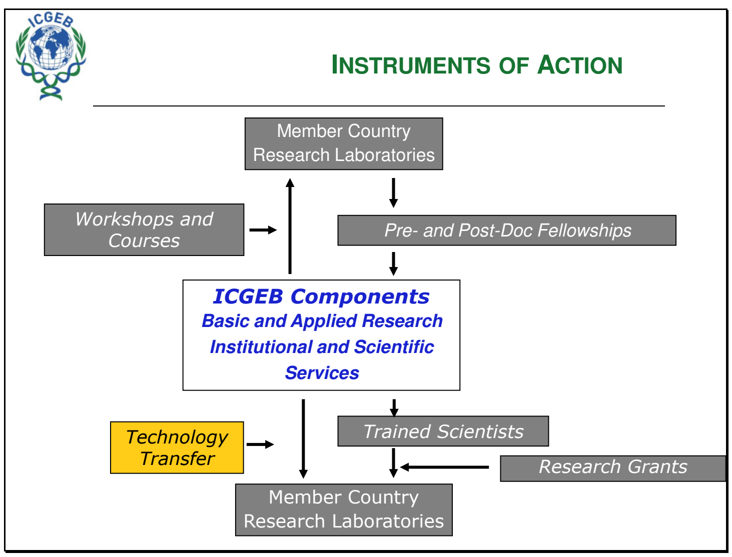

Figure 9. Instruments of action.

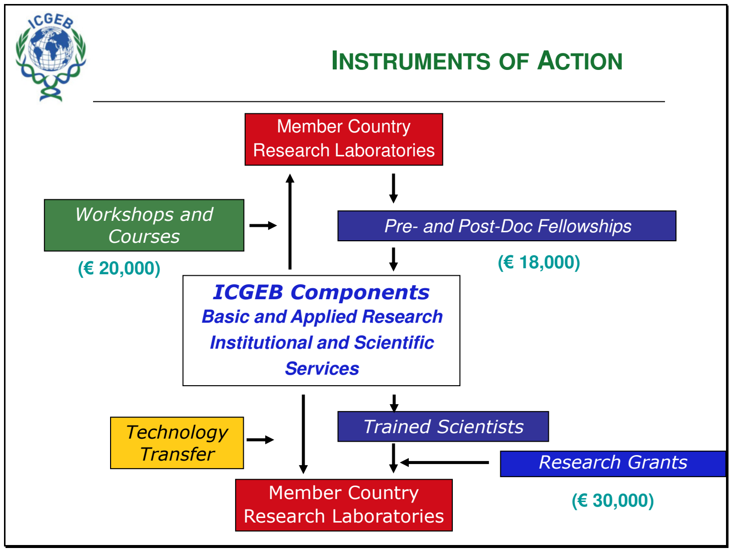

Figure 10. Instruments of action.

CHALLENGES

Life Expectancy in Sub-Saharan Africa is 50 (same as 20 years ago) despite:

- **Improved economic situation (average GDP growth above 5%)**
- **Average FDI increasing 13 fold**
- **African economies less affected by global financial crisis**

Figure 11. Challenges.

Why no improvement in health and life expectancy?

• AIDS epidemic - 1 in 5 deaths due to AIDS
- 17% of Disability Adjusted Life Years

BUT…

Disease pattern in SSA is rapidly changing……

Growing threat from chronic diseases
- Hidden by high incidence of infectious diseases
- Gaining momenum

Figure 12. Why no improvement in health and life expectancy?

CURRENT HEALTH PRIORITIES

Millennium Declaration in 2000 promises "to combat HIV/AIDS, malaria <u>and other diseases</u>"

- Global Fund to fight AIDS, TB and Malaria (GFATM)
- US Presidents Emergency Plan for AIDS Relief (PEPFAR)
- EDCTP

"….other diseases" ??? ⟹ TB

Figure 12. Current health priorities.

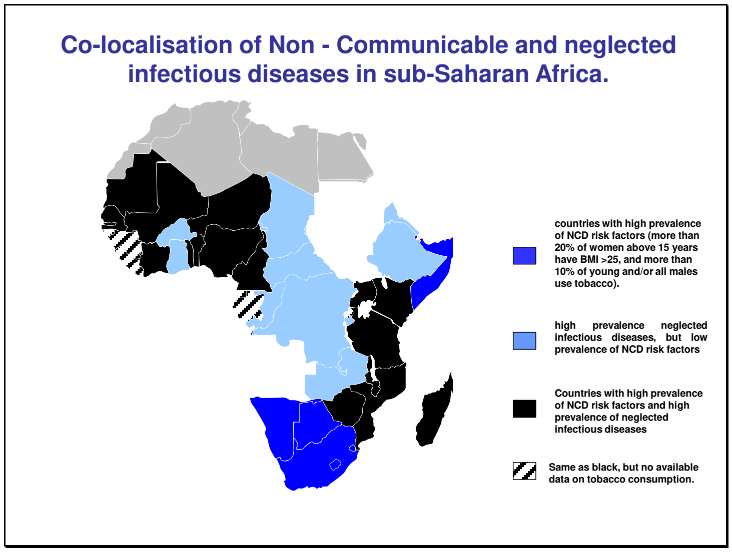

Figure 13. Co-localisation of non - communicable and neglected infectious diseases in Sub-Saharan Africa.

DISEASE BURDEN in SSA

• HIV/AIDS, Tb & malaria:	25%
• Other Neglected Infectious Diseases	27%
• Non Communicable Diseases	23%

Figure 14. Disease burden in SSA.

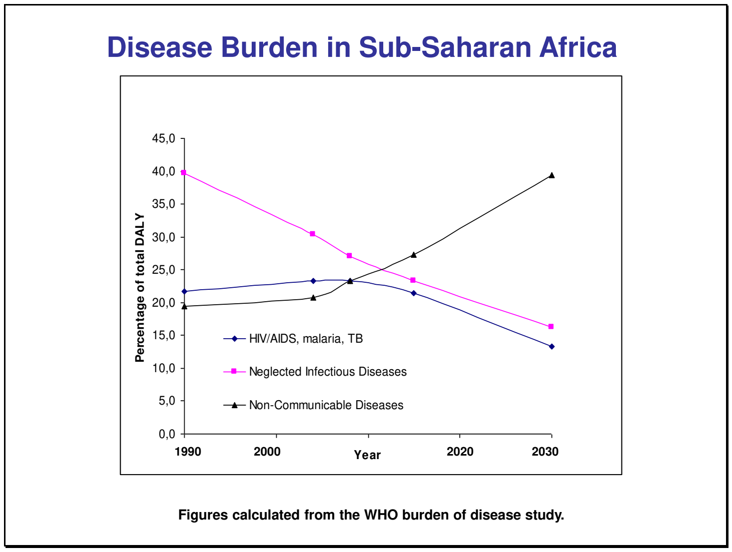

Figure 15. Disease burden in Sub-Saharan Africa.

WHAT DOES THIS MEAN ?

- HIV/AIDS, TB & malaria ……< 15% of disease burden
- Cancer prevalence will increase by more than 50%
- Diabetes deaths increase by 40%
- DALY of cardiovascular diseases increase by 100%

Figure 16. What does this mean?

Research Funding

Cancer kills more people annually in Developing Countries than HIV/AIDS, TB & malaria combined,

YET…

WHO spends - US$ 0.50 per person on chronic diseases
- US$ 7.50 per person on HIV/AIDS, TB, malaria

NIH – US$ 109million on research group in SSA, 3% on NCD
1% on NID

EU-FP-7 ???

Figure 17. Research funding.

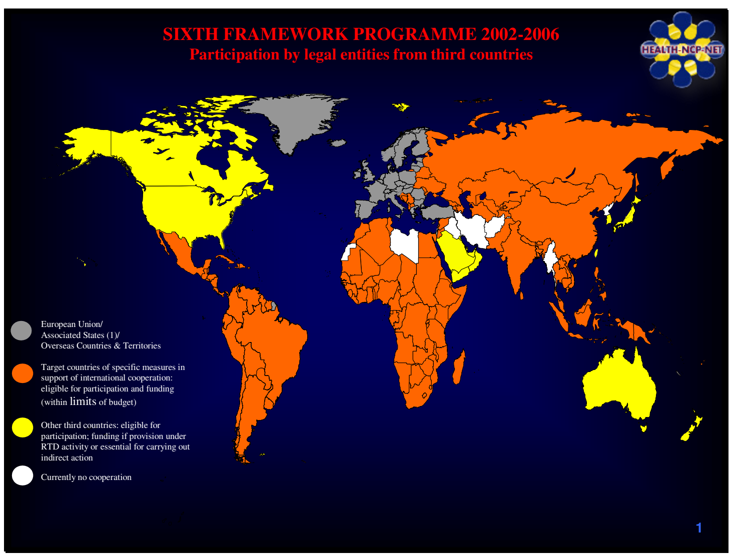

Figure 18. Sixth frame work programme 2001-2006.

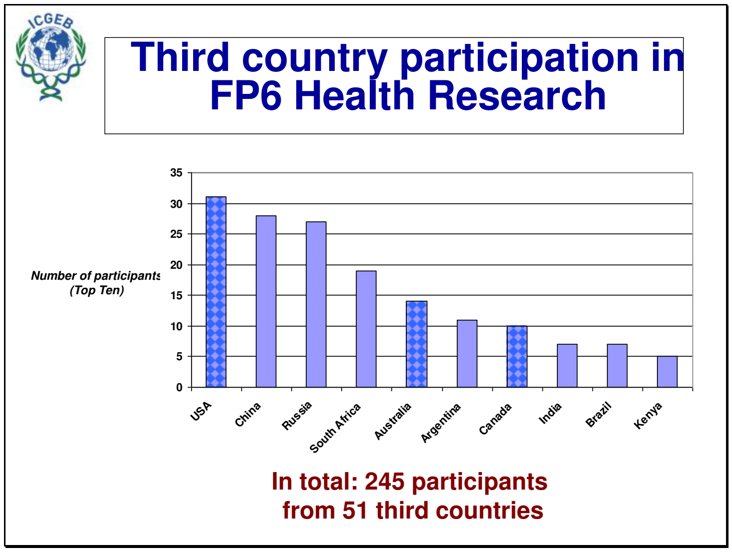

Figure 19. Third country participation in FP6 health research.

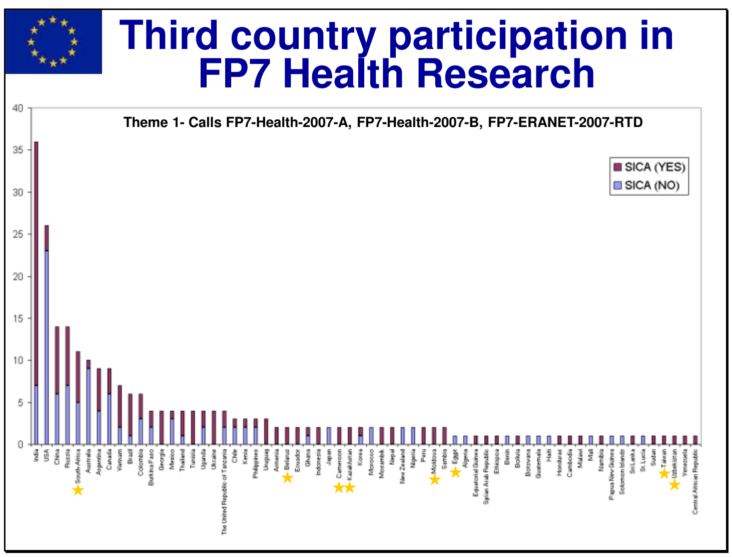

Figure 20. Third country participation in FP7 health research.

Research Funding 2

FP-6: €13million to health in SAA; 90% on HIV/AIDS,TB & malaria

Bill & Melinda Gates Foundation

Wellcome Trust

Rockefeller Foundation

Figure 21. Research funding 2.

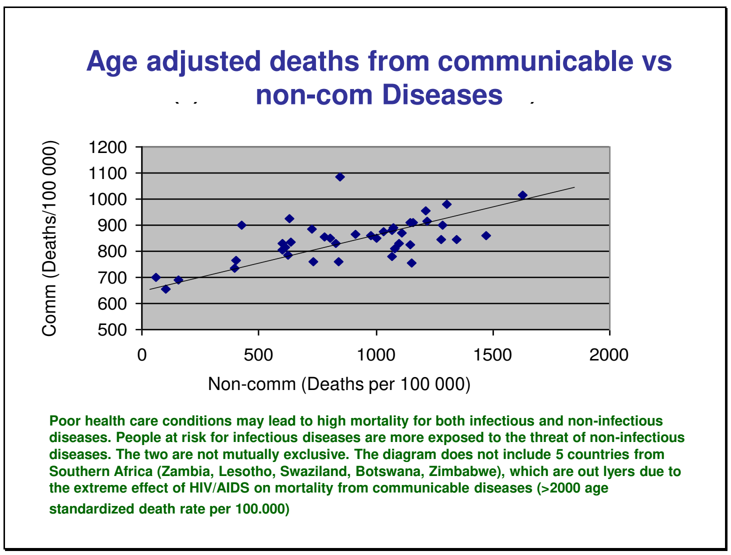

Figure 22. Age adjusted deaths from communicable VS non-com diseases.

Some infectious agents responsible for non-communicable diseases in Sub-Saharan Africa.

Infectious Agent	Non-communicable disease
EBV virus (EBV)	Burkitt's & Hodgkin lymphomas
Malaria	Increases risk of Burkitt's lymphoma
Chlamydia pneumoniae	Asthma, CVD, heart diseases
Schistosomiasis	Liver fibrosis, Bladder cancer, Hepatomegaly, chronic renal disease
Trichuriasis	•inflammatory bowel disease •asthma
Loa loa	may cause endomyocardial fibrosis
HPV	Cervical cancer
Chlamydia trachomatis	Increases risk of Cervical cancer
Hepatitis B virus	Liver cancer
Hepatitis C virus	Liver cancer
Helicobacter pylori	gastric cancer
HIV/AIDS	depression and anxiety
HIV	Increases risk of Kaposi's sarcoma
Hookworm	Anemia
Group A streptococcus	Rheumatic heart disease
Herpesvirus 8	Kaposi sarcoma

Figure 23. Some infectious agents responsible for non-communicable diseases in Sub-Saharan Africa.

Challenges of Co-Morbidity

The change from a low to a high burden of NCD in Africa will be significantly different from the epidemiological shift that occurred in the highly industrialised countries during last century.

- First of all, it will occur over a relatively short period, giving little time for the health care systems to adjust their priorities.
- Second, the underlying infectious agents will remain in the environment, either as latent infections in large proportions of the human population or in animal reservoirs.
- Third the knowledge and technology to control an increasing number of tropical infectious diseases is becoming available, but the tools are often insufficient to eliminate the pathogens.

Figure 24. Challenges of co-morbidity.

Conclusion

SSA is currently heading towards a disease pattern, where high levels of infectious agents will co-exist with an increasing incidence of NCD.

This is an unprecedented situation, which calls for a better understanding of the epidemiological changes, including the spatial and temporal trends in disease patterns across Africa.

Importantly very little is known about the co-morbidity between infectious and non-infectious diseases and how they may impact public health in the short- and long-term. Understanding the scientific basis of diseases in Africa will require detailed studies on the molecular interactions between infectious and chronic diseases, to Understand the pathogenesis of the two groups of diseases and how they interact with each other.

Figure 25. Conclusion.

ICGEB

THANK YOU!

Enhancement of Nuclear Knowledge for Application in Medicine, Particularly in Positron Emission Tomography

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1 ABSTRACT

With the advent of Positron Emission Tomography (PET), new vistas in diagnostic nuclear medicine have opened up. It is an *imaging* technique which makes use of short-lived positron emitting radionuclides like C-11, O-15, F-18, etc., produced at a cyclotron, processed on-site in a radiochemical/radiopharmaceutical laboratory, and applied for investigation of metabolic processes in a living system. Thus it demands an efficient interdisciplinary collaboration. The technology is well developed and is now reaching all corners of the globe, especially for routine patient care. Further development, however, calls upon extensive fundamental nuclear studies and accompanying chemical and biological research to be able to produce novel radiotracers. This article demonstrates the necessity of enhancing nuclear knowledge for extending the scope of PET investigations. In particular, the role of three recently developed longer lived positron emitters, Cu-64, I-124 and Y-86, in establishing a versatile combination of PET and internal radiotherapy is described. Some economical and educational aspects of this type of research are outlined.

2 INTRODUCTION

2.1 General

Nuclear sciences are often regarded as dealing only with weapons development and electric power production. This misconception exists, somehow, both in the developed and developing parts of the world. The extreme importance of a third area of nuclear science, namely nuclear techniques in medicine, is generally not well appreciated, although worldwide nuclear methods of diagnosis and therapy constitute a multibillion Euro enterprise per annum. Every year several million patients are subjected to nuclear treatment.

Extensive knowledge exists in the realm of nuclear sciences, and quite a bit of it is used in medicine dealing with routine patient care. However, extending a known nuclear medical procedure or developing an altogether new methodology, often involves some research work in the nuclear field as well. This article gives a brief account of nuclear know-how implicitly embedded in established medical procedures. It also shows the need of enhancement of knowledge in connection with tomographic studies with novel positron emitters. The latter aspect is treated in more detail, giving some examples from own research in the area.

2.2 Scope of Nuclear Medical Studies

Nuclear medical procedures make use of both radionuclides and radiation beams. The radionuclides are produced using nuclear reactors as well as cyclotrons, and the radiation beam, especially the gamma beam, is obtained either via the decay of some special radionuclides (e.g. Co-60) or is generated at specifically designed small accelerators. In special cases, large-sized accelerators delivering protons or heavy ions, or producing fast neutrons via secondary reactions, are also used for therapeutic purposes. Whereas the source of the radiation beam is invariably outside the human body, the radionuclides are generally administered into the human body, either mechanically to cause a local therapeutic effect (*brachytherapy*), or more commonly, via a biochemical pathway to allow diagnostic studies via *emission tomography* (i.e. imaging from outside the body) or *internal radiotherapy*, also known as open source radiotherapy. In all those procedures the nuclear knowledge plays a paramount role. On one hand, all aspects of interactions of radiation with matter (i.e. constituents of a living system) have to be well understood to make the radiotherapy safe and effective and, on the other, the physical properties of the emitted radiation have to be known accurately to perform the diagnostic studies efficiently.

2.3 Criteria for Use of Radionuclides

The radionuclides have been in medical use for more than 70 years, but a realization of their full potential started only about three decades ago. The introduction of a radionuclide into a living system has to meet two major criteria:

a) suitable physical properties; and
b) suitable chemical form

The physical (or nuclear) properties of a radionuclide decide whether it is suitable for use as a diagnostic or a therapeutic agent. The underlying principle in diagnostic studies is that the radiation dose to the patient is minimum. This is achieved through the use of short-lived radionuclides (with half-lives between a few minutes and a few hours), emitting predominantly a low-energy gamma ray or a positron, but no other corpuscular radiation. The low-energy gamma ray facilitates convenient imaging of the human organ from outside of the body by simple gamma scanning or via a more detailed analysis through single photon emission computed tomography (SPECT). The positron emitter, on the other hand, constitutes a special case since it allows quantitative tomographic imaging through positron emission tomography (PET), a technique discussed in more detail below. Imaging via SPECT is semi-quantitative and rather slow. However, it is more economical way of functional imaging and hence finds wide application. The most commonly used SPECT radioisotope Tc-99m ($T_{½}$ = 6 h) is a reactor nuclide. Its widespread use is mainly based on its convenient availability as a Mo-99/Tc-99m generator. SPECT technology is available in almost all nuclear medical centres of the world and the status of nuclear knowledge regarding its application is fairly good.

The therapeutic application of a radionuclide stipulates that a certain amount of radiation dose is deposited into the target organ to bring about the therapeutic effect. This necessitates the use of longer lived radionuclides (with half-lives between about one and seven days) that emit corpuscular radiation, i.e. beta particles, alpha particles or low-energy secondary electrons. This is a fast expanding field and efforts are called for to extend the relevant nuclear knowledge as well.

The chemical form of a radionuclide plays a decisive role in nuclear medicine since it helps bring the radionuclide to the organ under investigation. For example, fatty acids are the source of energy for the heart and glucose for the brain. Thus for investigation of those organs, specific molecules labelled with suitable radionuclides are needed. Another important factor is the mass of the radioactive tracer. Ideally it should be at sub-nanogram level so that the biological equilibrium of the target organ is not disturbed. Two other important requirements are sterility and apyrogenicity. Obviously very stringent quality control of the radioactive material is required prior to its injection into the human body. The production of radionuclides and radiopharmaceuticals has thus to be done under “good manufacturing practice (GMP)” conditions.

The application of radionuclides (or better said radiotracers) in humans thus calls upon expertise and knowledge in various areas such as nuclear physics, radiochemistry, general technology, organic and biochemistry, radiopharmacy and radiopharmacology, physiology and medicine, radiation physics and biology, nuclear instrumentation for imaging, medical physics for image unfolding, etc. Obviously interdisciplinary and multidisciplinary cooperation is absolutely necessary. In this article the emphasis is on enhancing nuclear knowledge for medical applications, particularly in molecular imaging via positron emission tomography (PET).

3 POSITRON EMISSION TOMOGRAPHY (PET)

3.1 Principle

The principle of PET is outlined in Figure 1. The positron emitting radiopharmaceutical is injected in the blood. Part of it gets selectively accumulated in a specific organ. The positron emitted during decay (e.g. from the radioactive nucleus F-18) traverses the tissue, loses energy and, when thermalized, reacts with an electron and gets annihilated. During this process two photons, each of 511 keV energy, are produced which are correlated by 180°. The activity measurement is performed via a ring of detectors, whereby oppositely lying detectors function in a coincidence mode. It is thus possible to locate the position of annihilation in the organ under investigation, and hence develop the image quantitatively. Evidently, the overall resolution of the scan depends on the energy of the emitted positron and the inherent resolution of the tomograph. In modern tomographs, using suitable radiopharmaceuticals, it is possible to achieve a resolution of about 3 mm. With the help of biomathematical models, turnover rates of metabolic substrates can be determined.

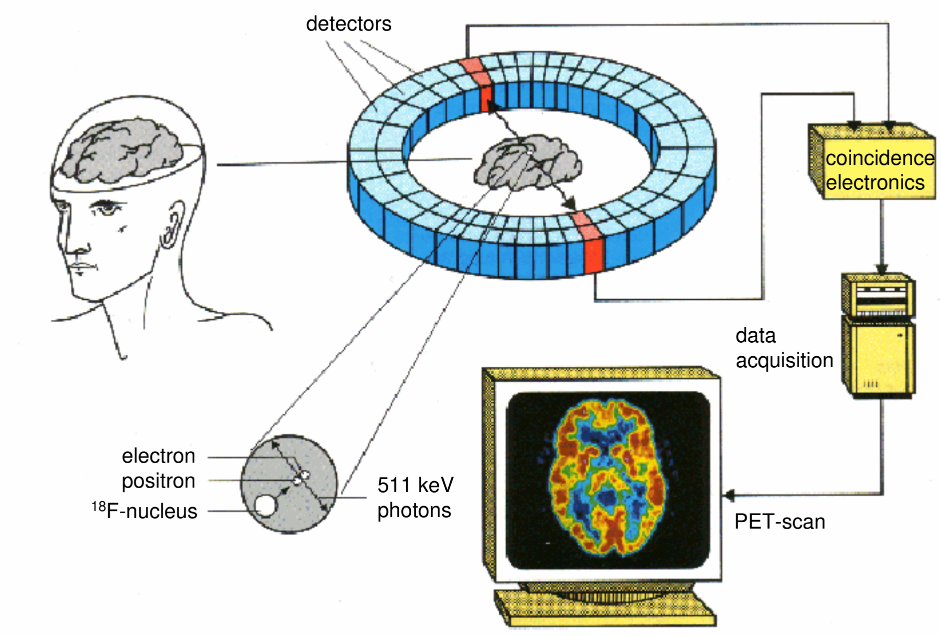

Figure 1. Principle of positron emission tomography (Courtesy H. Herzog, Research Centre Juelich).

3.2 Commonly used Radiotracers

Four short-lived organic positron emitters, namely C-11 ($T_{½}$ = 20.4 min), N-13 ($T_{½}$ = 10.0 min), O-15 ($T_{½}$ = 2.0 min) and F-18 ($T_{½}$ = 110 min), are commonly used in PET studies. They are all produced at cyclotrons [cf. 1], with energies below 20 MeV, using low-energy nuclear reactions. The tagging of a short-lived positron emitter to an organic compound requires new concepts. Thus a new type of fast organic radiochemistry has emerged [cf. 2]. It involves the production and separation of the radionuclide, the labelling of an organic compound with the radionuclide, as well as the purification and quality control of the product on a very fast scale. An extreme example is O-15 with its 2 min half-life. It is extensively used in simple chemical forms like O_2 labelled with O-15 for studying oxygen metabolism in the brain, or H_2O labelled with O-15 for measuring blood flow. In general, F-18 with a half-life of 110 min allows more elaborate syntheses and applications. Furthermore, due to its very low positron end-point energy the resolution of PET scans is high. In fact F-18 has become the standard PET nuclide.

Its easy production via the O-18(p,n)F-18 nuclear reaction [3,4] using a pressurized water target (enriched in O-18) at a small cyclotron, combined with a simple and efficient labelling of fluor-desoxy-glucose via a nucleophilic substitution reaction [5] paved the way for large scale availability of 2-[F-18]FDG. This is presently the most commonly used PET tracer.

Besides the four organic positron emitters mentioned above, two other short-lived positron emitting radionuclides, viz. Ga-68 ($T_{½}$ = 68 min) and Rb-82 ($T_{½}$ = 1.3 min), are produced via generator systems. The former is widely used for PET attenuation corrections and labelling of some compounds, and the latter in myocardial blood flow studies at PET centres without cyclotrons. Their respective long-lived parents.

Table 1. Major PET radiodiagnostics (after Refs. [1,2])

Radiopharmaceutical	Application	
	Neurology	
$[^{15}O]O_2$	Oxygen consumption	
$[^{15}O]H_2O$	Blood flow	Dementia,
$[^{15}O]$butanol	Blood flow	Ischaemia,
2-$[^{18}F]$FDG	Glucose metabolism	Stroke
L-6-$[^{18}F]$FDOPA	Presynaptic dopaminergic function	Parkinsonism
L-[S-methyl-$^{11}C]$methionine	Amino acid metabolism and -transport	Brain tumors
$[^{11}C]$raclopride	D_2-receptor density or -occupany	Schizophrenia,
$[^{18}F]$N-methyl-spiperone	D_2-receptor density or -occupany	Therapy control
$[^{11}C]$flumazelin	Benzodiazepine receptor mapping	Epilepsy
	Cardiology	
$[^{13}N]NH_3$	Blood flow	
2-$[^{18}F]$FDG	Glucose metabolism	Ischaemia,
$[^{11}C]$acetate	Oxidative metabolism (oxygen consumption)	Viability
$[^{11}C]$ or $[^{18}F]$ fatty acids	β-oxidation	
	Oncology	
2-$[^{18}F]$FDG	Glucose metabolism	
$[^{11}C]$methionine	Amino acid metabolism	
5-$[^{18}F]$fluoruracil(FU)	Therapy control	
5-$[^{18}F]$fluordeoxyuridine (FUDR)	Cell proliferation	

Ge-68 ($T_{½}$ = 271 d) and Sr-82 ($T_{½}$ = 25 d) are produced via intermediate energy reactions at cyclotrons with energies up to above 100 MeV.

Molecular imaging via the PET technology is now widely used in neurology, cardiology and oncology. It finds application both in patient care and medical research. Some of the positron emitting radiopharmaceuticals, commonly used in diagnostic nuclear medicine [cf. 1,2], are given in Table 1.

3.3 Increasing Significance

Nuclear medical imaging using PET has undergone tremendous development during the last two decades. This is attributed to concerted efforts in many directions, e.g. (a) novel efficient nuclear routes utilizing isotopically enriched materials as targets, (b) high-intensity cyclotrons dedicated to radionuclide production, (c) high-current targetry and efficient radiochemical separations, (d) fast methods of labelling organic compounds with radionuclides, (e) fast separation and purification methods (gas chromatography (GC), high performance liquid chromatography (HPLC), etc.), (f) tracer evaluation and (g) construction of high-resolution PET scanners. The whole technology (consisting of cyclotron, radionuclide production unit, and automated radiosynthesis apparatus and tomograph) is now commercially available and is reaching all corners of the globe, including several Islamic countries like Egypt, Iran, Malaysia, Pakistan, Saudi Arabia, Syria, etc. The facility is generally installed in a hospital environment and it functions under GMP conditions. It is estimated that more than one million injections of 2-[F-18] FDG alone are administered to patients per year.

It should be emphasized that PET is a non-invasive, fast and quantitative technique and is unique in the sense that it allows investigations of metabolic processes in living systems. It is very suitable for study of biological phenomena at the real molecular level and has great potential for early diagnosis of diseases like epilepsy, Alzheimer and Parkinson. The increasing significance of PET technology therefore demands further research and development in several areas. The major effort today is directed towards development of new radiopharmaceuticals utilizing three major positron emitters, namely C-11, F-18 and Ga-68. Here the available nuclear knowledge is sufficient and emphasis is on chemistry and biochemistry. A second area of development aims at a combination of imaging modalities, e.g. computer tomography and positron emission tomography (CT/PET), magnetic resonance imaging and positron emission tomography (MRI/PET). This involves development of both novel imaging agents and new medical instrumentation. A third area of interest deals with the development of novel positron emitters. This field of investigation demands considerable enhancement of nuclear knowledge and is treated in somewhat more detail below.

4 DEVELOPMENT OF NOVEL POSITRON EMITTERS

4.1 Motivation

Considerable demand has arisen for more versatile positron emitters than the ones discussed above. On one hand longer-lived positron emitters (with half-lives between several hours and a few days) are needed to be able to study slow metabolic processes and, on the other, positron emitting analogues of SPECT and therapeutic radionuclides are desired for quantification purposes. Some of the important or potentially important positron emitting radionuclides now known as *non-standard positron emitters* have been reviewed [cf. 6]. Among them, three radionuclides, namely Cu-64 ($T_{½}$ =12.7 h), I-124 ($T_{½}$ = 4.18 d) and Y-86 ($T_{½}$ = 14.7 h), are of considerable current interest and are receiving worldwide attention. Their basic production methodologies were developed at Juelich [7-9].

4.2 Nuclear Data

The development of a novel positron emitter for medical application involves, as discussed above, interdisciplinary work. In this article only the nuclear aspects [cf. 10] are treated in detail. The first need is to clarify the decay scheme of the radionuclide since quantitative imaging and radiation dose calculation depend strongly on the accuracy of the available data. In general, the decay data are well-known except for some special details, like positron emission intensity, abundance of some gamma line, etc. In the case of Cu-64 and I-124 some discrepancies existed in the data. Using very pure sources the positron emission intensities were determined through a comparison of the intensities of the X-rays and annihilation radiation.

The revised decay scheme of Cu-64 [cf. 11] is shown in Figure 2. The exactly determined positron emission intensity of 17.8 % allows an accurate estimate of the total accumulated activity in a specific organ. The intensity of the weak 1346 keV gamma ray was also rather doubtful; it has now been measured precisely. From the point of view of medical application this gamma ray has no significance. However, since some experimenters use this gamma ray for assay of Cu-64 in physical experiments, it is advantageous to have an accurate knowledge of its intensity. As far as I-124 is concerned, the literature values for the positron emission intensity ranged between 22 and 26 %. Our exactly determined value [cf. 11] of 22.0 ± 0.5 % should render the quantification of this radionuclide more accurate.

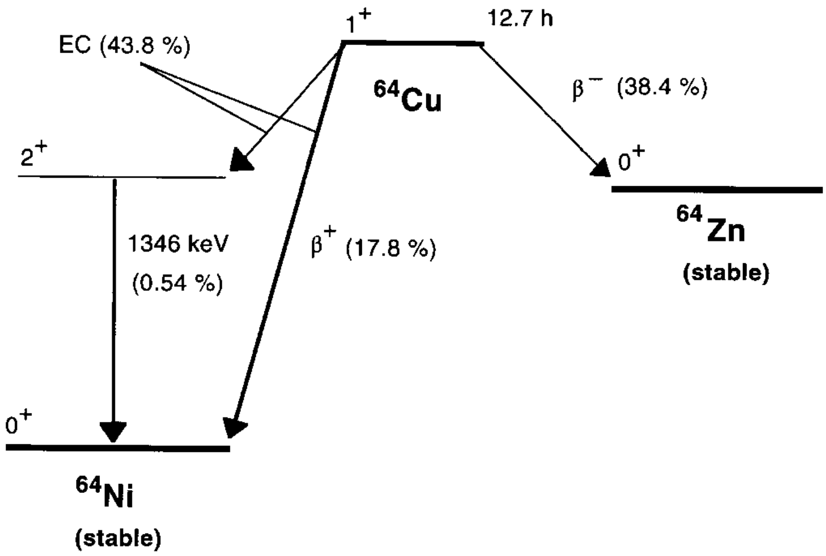

Figure 2. Decay scheme of Cu-64 with intensities of emitted radiations (after Ref. [11]).

Regarding the development of a production route of a novel radionuclide, it should be pointed out that the non-standard positron emitters (in contrast to standard positron emitters) are often associated with isomeric states. Furthermore, a large number of reactions may lead to the desired product, though with different yields and purity levels. Extensive and challenging experimental and theoretical work is thus necessary to be able to define the optimum conditions for production of a radionuclide via a given nuclear route, i.e. an efficient energy range of the projectile in a target that will give the maximum yield of the product compatible with the minimum radionuclidic impurity. We discuss the case of I-124 to illustrate this aspect.

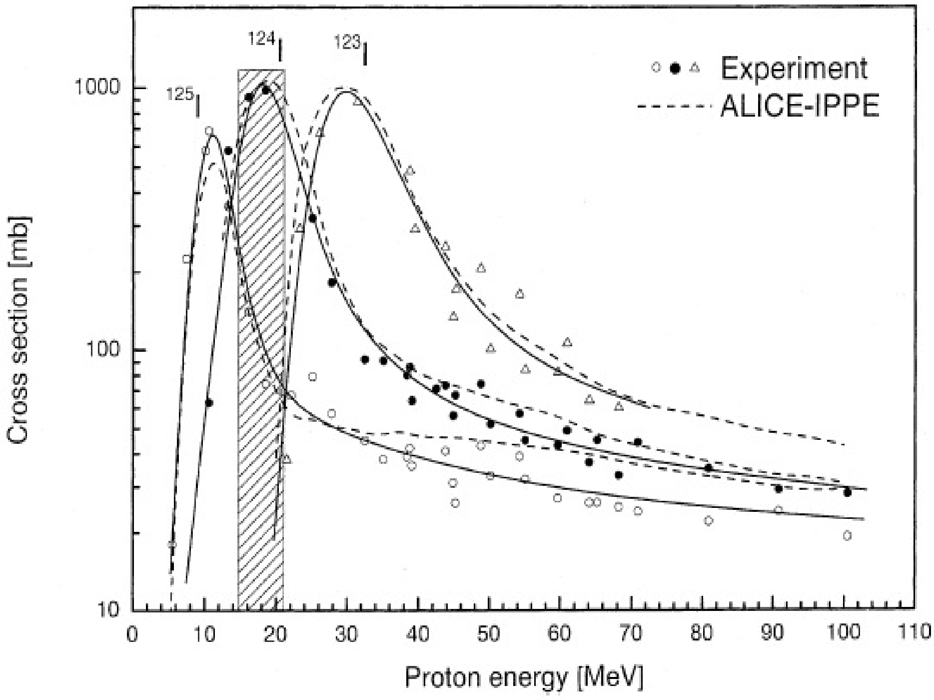

Figure 3. Excitation functions of (p,xn) reactions on Te-125 leading to the formation of the radionuclides I-125, I-124 and I-123. The solid lines are eye-guides through experimental data. The broken lines show the results of nuclear model calculations using the code ALICE-IPPE. The shaded area gives a suitable energy range for the production of I-124 (after Ref. [12]).

The nuclear reactions induced by protons on enriched Te-125 were investigated in detail [cf. 12]. The experimentally determined cross sections as a function of the proton energy (called excitation function) for the reactions Te-125(p,n)I-125, Te-125(p,2n)I-124 and Te-125(p,3n)I-123 are shown in Figure 3. The theoretically calculated cross sections based on a precompound model code ALICE-IPPE are also shown. The agreement between experiment and theory is quite good, except for the high energy part of the (p,n) reaction, which is rather difficult to reproduce due to direct interactions. The obtained data show that pure I-124 can be produced only over a very narrow energy range, extending from 15 to 21 MeV. At lower energies the I-125 impurity increases and at higher the I-123 impurity. In an attempt to find a yet another more suitable process, several other reactions, induced by protons, deuterons, He-3 and He-4 particles were also investigated. It was found that the Te-124(p,n)I-124 reaction is very suitable. In spite of its rather low yield, the nuclear reaction is presently the method of choice for the production of I-124, mainly because it leads to the lowest level of the long-lived I-125 ($T_{½}$ = 60.0 d) impurity. The method is now being commercialized. The nuclear data research is thus of direct relevance to the production of positron emitters with high radionuclidic purity.

4.3 Imaging Problems

Positron emission tomography is considered to be a unique quantitative way to image radioactivity *in vivo*. In order to achieve this, satisfactory corrections for dead time of the detectors, for random and scattered coincidences and for attenuations of photons are necessary. They have been developed and are commercially available for standard positron emitters which have no gamma rays. PET studies with most of the novel non-standard positron emitters, on the other hand, are disturbed in different ways due to the additional gamma rays and their coincidences. In this regard Cu-64 is an exception since it hardly emits any gamma ray. The radionuclides I-124 and Y-86, however, deserve special attention since in their decay several gamma rays are emitted.

PET phantom images [cf. 13] exhibited considerably higher radioactivity concentrations over absorbers of various materials, especially while using the radionuclide Y-86. This was interpreted to be due to appreciable scattering of gamma rays from the radioactive source. By applying suitable background corrections it was, however, possible to obtain reliable values. This correction amounted to about 20 % in the case of I-124 and about 80 % for Y-86. Efforts are therefore underway to develop suitable algorithms which would introduce corrections in case of positron emitters like Y-86 which have a lot of gamma rays. This would then allow the use of full potential of novel radionuclides in PET studies.

4.4 Applications

Based on the nuclear knowledge gained on the decay properties as well as on the most suitable reactions for production of a potentially important novel positron emitter, further development work was carried out to ensure its large scale production in a highly pure form. The subsequent conversion of the radionuclide to a radiopharmaceutical and its quality assurance entailed considerable chemical and biochemical effort. To date about a dozen non-standard positron emitters have been developed and their medical uses have been demonstrated. They are listed in Table 2. The basic nuclear data for their production were mostly determined at Juelich. Some of the emerging applications of the three most important non-standard positron emitters are described below.

Table 2. Novel positron emitters for medical applications

Nuclide	Major production route	Energy range [MeV]	Application
^{38}K (7.6 min)	^{35}Cl(α,n)	22 → 10	Cardiology
^{55}Co (17.6 h)	^{58}Ni(p,α)	15 → 7	Tumor imaging;
	^{54}Fe(d,n)	10 → 5	Neuronal Ca marker
^{64}Cu (12.7 h)	^{64}Ni(p,n)	14 → 9	Radioimmunotherapy
^{73}Se (7.1 h)	^{75}As(p,3n)	40 → 30	Selenpharmaceuticals
^{75}Br (1.6 h)	^{75}As(^{3}He,3n)	35 → 25	Bromopharmaceuticals
^{76}Br (16.0 h)	^{76}Se(p,n)	15 → 8	Radioimmunotherapy
^{86}Y (14.7 h)	^{86}Sr(p,n)	14 → 10	Therapy planning
^{94m}Tc (52 min)	^{94}Mo(p,n)	13 → 8	Quantification of SPECT-pharmaceuticals
^{120}I (1.3 h)	^{120}Te(p,n)	13.5 → 12	Iodopharmaceuticals
^{124}I (4.2 d)	^{124}Te(p,n)	12 → 8	Tumor targeting; dosimetry

The radionuclide Cu-64 has a suitable half-life, a low positron end-point energy and practically no gamma ray. These decay properties are almost ideal for PET imaging. It forms good metal chelates which specifically accumulate in some organs [cf. 14]. Due to its multiple decay mode (i.e. electron capture, beta particle and positron emission) it is very suitable for combining PET imaging and targeted therapy [cf. 15]. In particular, labelling of monoclonal antibodies with Cu-64 has led to several new therapeutic approaches.

The radionuclide I-124 is both a diagnostic and a therapeutic agent. Concerning diagnostic studies, the slow uptake kinetics of an iodo-radiopharmaceutical by an organ can be conveniently followed using this radionuclide and positron emission tomography. For example, the α-methyl tyrosine (an amino acid) labelled with I-124, studied for the first time by Langen et al [16] has become a well established tracer in tumor research. A further application entails quantification of biodistribution of I-123-radiopharmaceuticals used in SPECT, for example β-CIT [17]. Regarding therapeutic use, I-124 was found to be very suitable for labelling biomolecules for tumor research. Because`e of the combination of PET and endoradiotherapy, allowing precise dosimetry, this radionuclide is superior to the commonly used reactor radionuclide I-131. The cost of I-124, however, is appreciably higher than that of I-131.

The radionuclide Y-86 finds application as a positron emitting analogue of the pure beta emitting therapeutic radionuclide Y-90. The uptake kinetics are measured via a PET study of Y-86 and the therapeutic effect is induced by Y-90. As an example, the uptake kinetics of Y-86-citrate in normal spine, liver and five different metastases are given in Figure 4 [18]. The activity concentration found in the metastases is higher than in the normal bone (spine). By obtaining this type of activity accumulation data via PET, it is possible to do proper dosimetric calculations while using Y-90-therpeuticals. This is a relatively new approach and is finding interest in internal open source radiotherapy.

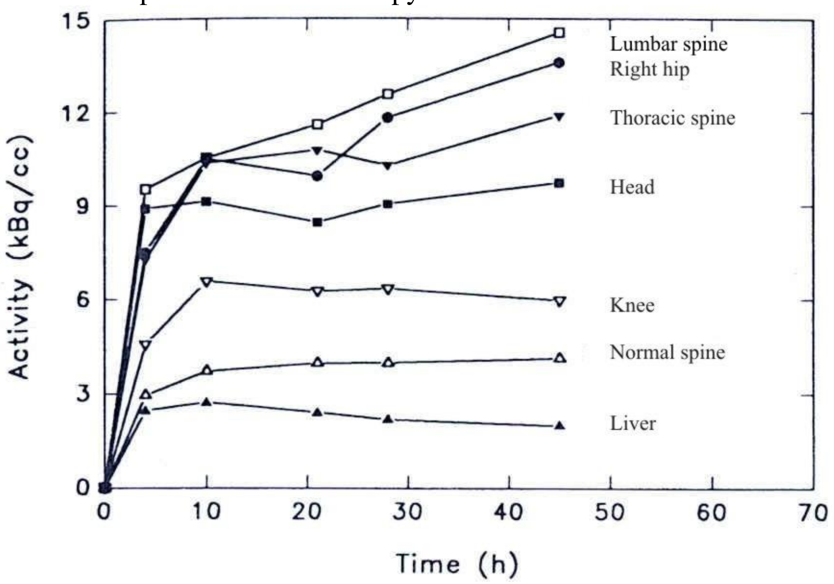

Figure 4. Uptake kinetic of Y-86-citrate in normal bone (spine), liver and five metastases (in knee, head, thoracic spine, right hip and spine) of a female patient, measured via PET (after Ref. [18]).

5 CONCLUDING REMARKS AND PERSPECTIVES

Nuclear methods have revolutionized medicine. Radionuclides and radiopharmaceuticals play a key role in diagnostic investigations and therapy. Emission tomography (SPECT and PET) is a rapidly proliferating technology. It is not only important for clinical diagnosis in patient care, but has also opened new vistas for probing biochemistry *in vivo*. Especially the PET has provided a new window to the chemistry of brain, heart and tumors. This technology is well established and is now reaching even remote corners of the globe. In order to maintain high standards, however, a continuous interdisciplinary education, extending over many areas of nuclear, physical, chemical and biological sciences is necessary.

Due to its fast, quantitative and dynamic nature the PET technology appears to have very good prospects. It is superior to most of the other non-nuclear techniques as far as biofunctional studies are concerned. However, continuous research and development work is absolutely necessary to maintain the lead taken by nuclear methods. In this connection most of the effort is directed to radiopharmaceutical research. For studying slow metabolic processes and for quantification of new SPECT-agents, however, novel positron emitters are required. This article has presented some salient features of nuclear research which have led to the enhancement of knowledge of direct relevance to the production and medical application of several potentially important positron emitters. Obviously even in the application oriented research, some fundamental work on nuclear structure and nuclear reactions is essential to be able to guarantee the quality of the product demanded from both medicinal and imaging points of views. The novel positron emitters are opening new perspectives in radioimmunotherapy and radiation dosimetry.

The significance of nuclear research work described in this article may also be judged from two other aspects, namely, economical and educational. Regarding the former, several PET-cyclotron companies are now modifying the facilities to incorporate solid target systems. This would allow production of the three most important non-standard positron emitters, namely Cu-64, I-124 and Y-86, according to the basic nuclear methodology developed at the Research Centre Juelich. Automated apparatuses for chemical separations and quality control are also being developed. As regards imaging, new algorithms are being introduced to take account of scattering of gamma rays associated with novel positron emitters. Thus a new phase in PET technology has started. As far as educational aspects are concerned, 15 doctoral theses have been completed at Juelich over the last 20 years on the topic of cyclotron radionuclide development. They deal with diverse themes like nuclear data measurements, high-current targetry, radiochemical processing, radiation dosimetry and imaging quality. The knowledge gained has been disseminated also to Egypt, Hungary, Pakistan and South Africa under bilateral agreements between Germany and those countries. The enhancement of nuclear knowledge for application in medicine is thus of great benefit to the mankind.

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Quality of Medical Education: How to Assess Customer Satisfaction? How Relevant is the ISO 9001-2008 to Educational Quality Assessment?
Experience of the National College, Sudan's first ISO certified HE Institution

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and
ELTAYEB HAA[4]

1 ABSTRACT

The quality policy of an educational organization, medical or other discipline, should include a "commitment to provision of top quality services that satisfy the needs of students and their sponsors and exceeds their expectations". This is achievable through: (1) adoption of standard international quality management systems, (2) compliance with local and international educational regulatory requirements, (3) setting quality objectives and continually review their performance, (4) designing world-class system of processes and assessment, (5) application of accurate selection criteria of academic staff with vision of their training policy and (6) work to achieve realization of the policy from all concerned and evaluate for continuous suitability"[1,2] . The indication of success is fulfillment of objectives as extracted from customer satisfaction surveys.

Who is the customer in medical education institutions? Some medical colleges do not entertain the idea of students' opinion, and may not have taken one throughout student's stay in the college. International medical professional bodies have all adopted the student's role as a criterion of innovation. Total quality management (TQM) systems consider students as the main beneficiary of the process. In addition, student's sponsors, national and international regulatory bodies and patients (customers of customers) have been considered. In a 20-year-old study in one institution, the University of Gezira, community leaders have been recognized as stake-holders and their opinion was taken[3].

No single instrument is suitable for all groups, of course. The National College has designed four inventories for students, sponsors, regulators and patients[2]. The most comprehensive is the one for students. It included sections on byelaws, philosophies, curriculum map, educational strategies, educational process and procedures, evaluation, and services.

The inventories are instruments of "educational" system research.- They have to be reviewed and re-assessed, whenever possible. Even the quality and coverage of subject contents are areas in which students can have an input. During our search for students' role, we have encountered responsible students who can give simple solutions to contents, resources and implementation problems. Inventories should remain simple and bilingual to remove any ambiguity. A group of educationist and statistician need to sit down to design the analysis.

The notion that the product in education, as compared to ISO 9001-2008, is itself the main customer raises issues of modifications in the standards to be more appropriate to education. The statements in Standard 7 series of "product realization", particularly 7.3 "design and development", have to be

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rephrased. Elimination of non-conformity after delivery is irrelevant to educational products, but the term "design" is used as a synonym of curriculum "development" in many an educational research, and the ISO has to adapt in this case.

2 INTRODUCTION

The objectives of this communication are to: (1) answer the obvious question "Why should there be quality in HE?", (2) review the definitions of quality terms and ISO systems, (3) overview the QMS principles ISO 9001:2008 standards, and their meaning in HE terms in relation to the "customer" in the health professions, and (4) state the limits of implementation of ISO 9001:2008 - to HE in general, with some hints for the medical profession, as the system is applied in the example of the National College, Sudan.

Without 'quality' the educational processes cannot be properly controlled, the outcome is like "putting rubbish in, getting rubbish out", knowledge produced is useless, research results lead into wrong directions, and the criteria used for comparing institutions will be limited and confused. On the other hand, with quality, the road maps are carefully designed, skillfully monitored, meticulously reviewed and continuously improved. The outcome is like "flowers and perfume industry cycle", research obsesses with accuracy, and the criteria for comparison are reliable and multifaceted, for the benefit of customers. When the customers are patients, quality is a matter of life and death.

3 DEFINITIONS OF QUALITY TERMS

Quality means 'fitness for the purpose, conformance to requirements that lead to customer satisfaction/delight'. Quality assurance refers to 'all the planned and systematic activities implemented within the Quality Management System [QMS] and demonstrated as needed to provide adequate confidence for an entity to fulfill requirements for quality'. Quality Control means 'operational techniques and activities that are used to fulfill requirements for quality'. Quality assurance is therefore 'pro-active' in nature, where quality control is 'reactive'. QMS uses both and is defined as 'all activities of overall management function that determine 'Quality Policy', 'Objectives and Responsibilities', and implement them by means of 'Quality Planning', 'Quality Control', 'Quality Assurance' and 'Quality Improvement'. Quality policy outlines the activities of overall management functions in pursuit of quality including objectives and commitments according to a set of standards. For example, the quality policy of the National College reads as follows:

The International Organization for Standardization (ISO) is a worldwide federation of national standards' bodies from approximately 150 countries (1 from each). It is a non-governmental organization established in 1947. Its objective – is to promote the development of standardization in the world with a view to facilitate the international exchange of goods and services, and to develop cooperation in the spheres of intellectual, scientific, technological and economic activity. It is thought that the abbreviation 'ISO' might have come from the Greek word "isos" means "equal".

ISO 9000 is the most successful set of standards in ISO history and is accepted worldwide[4]. Nearly 1,000,000 registrations have been issued world-wide, in over 157 countries from all continents, for a variety of organizations in over 40 "sectors" or industry classifications, pioneered by electrical/optical equipment, metal products, chemicals, construction, machinery, wholesale and retail trade. It is growing in acceptance by many sectors like information technology, health and social work, utilities, transportation, public administration, education and other services. The educational institutions preferred to use these specific standards for both reference and certifications, instead of using ill-defined, less specific and variable criteria. The most recent and most comprehensive is ISO 9001-2008 which allows for detailed application in services, as well as products.

Table 1. The ISOs

Standard	Purpose	Remarks
ISO 9000:2005	Establishes the starting point to understand the standards and defines the fundamental terms and definitions used in the ISO 9000 family	Only for reference
ISO 9001:2008	This is the requirement standard used to assess the ability to meet customer and applicable regulatory requirements and there-by address customer satisfaction	Against which is the third party certification
ISO 9004:2008 (To be released in 2009)	This provides guidelines for continual improvement of QMS to benefit all parties through sustained customer satisfaction	Only for reference

4 PRINCIPLES OF QMS

QMS is based on principles. How do they relate to higher education customer requirements as shown by the experience of our college:

1. Customer focus: who is the customer in higher medical education? The NC recognizes as customers the student, student sponsor or guardian, regulatory bodies like the medical councils, professional unions, ministries of higher education and health, international reference bodies, and the patients who are actually "customer of the customer". Organizations depend on their customers and therefore should know their customers, be aware of the current and future customer needs, and meet their requirements which include standard education, that the institution is concerned with international recognition and accreditation and accordingly active in research - the single most important criteria of ranking an institution. Institutions must strive to exceed customer expectations, which represent comparison of notes with other academic institutions in relation to upgrading educational environment or practices and aligning with reputable national or international partners. Customers may expect to see the visibility of the institution in web popularity, membership of international college or university associations and in research literature citation. The NC has adopted lengthy inventories dealing with all aspects, targeting the specific customer. The most extensive is the one for students. The major components include: (a) rules and regulations, (b) services, (c) interpersonal relations, (d) curriculum facilities and commitments and (e) college reputability, with variation in the depth of coverage in both depending on specific relevant interest of customers. The regulations have special questions on college's conformity with external regulatory documents and directives and the international visibility[5] .
2. Leadership commitment: the presidents, vice chancellors, deans, rectors and their deputies should have undoubted commitment to quality. QMS minimizes the role of the autocratic bossy environment, and this is often resisted. The stake holders in private institutions usually encourage the executive leadership to apply QMS. The leaders of educational institutions should: (a) establish unity of purpose and direction of the educational institution, if it has professional role, like medical, it has to find a suitable service direction, college objectives and characteristics of the graduate, (b) create and maintain the internal environment in which people can become fully involved in achieving the organization's objectives,
3. Involvement of people: QMS cannot be brought to fruition at the higher levels only- even if fully committed. The full-time and part-time academic teachers, the administrative staff, the students, the stake holders and the public. Involving students is the essence of an organization and their full involvement enables their abilities to be used for the organization's benefit. This includes: (i) students' role in QMS training workshops, (ii) incorporating students in quality teams, (iii) testing

all systems and students in internal audits and (iv) rewarding all students committed to quality in final certification

4. Process approach: the college has to prepare standard operating procedures (SOPs), both for the academic and supervisory activities, in addition to those related to pure administrative functions. These procedures in non-ISO oriented colleges are absent or dispersed in bylaws, circulars, non-written conventions that vary tremendously on applications and lead to disputes in college boards and senate meetings. Process is the 'activity that transforms input into output'. Organizations need to do more than simply monitor process outputs, typically through inspection activities: They must also control all process inputs or resources, which includes people, facilities, equipment, materials and methods, processes of attendance, teaching, evaluation of modules, staff, students and facilities, and validation. They must establish appropriate controls over the transformation activities, results are to be achieved consistently and efficiently. These include products, services, performance. There should be means of monitoring and measuring the processes, making sure the inputs are right, the transformation activities consistently work, and the desired results are achieved, then - improve the process as needed. Usually educational institutions have inherited processes, no one can doubt their credibility. The input includes: (1) selection of students, (2) selection of qualified people through strict criteria for each academic or administrative position, (3) purchase of the right facilities and efficient equipment, (4) use of correct materials, (5) application of proven methods. The output will be: (1) quality products of graduates and research, (2) quality services offered by professionals. The processes can be measured by customer satisfaction and sellable qualifications of labor market value, institutional reputable values and research records.
5. System approach: members of the educational institutions (e.g. staff and students) must understand that a system is a set of interrelated processes, and that the output of one process is or may be the input to one or more subsequent processes. For example, registration precedes instructional techniques, attendance, self-directed learning and evaluation. In any organization, particularly education, there are some interfaces or 'white spaces' between processes and the system should account for these to ensure effectiveness. The gaps in the medical profession are numerous, ranging from the wide range of entrance requirements to the role of pre-requisites and co-requisites in the instructional flow. The quality system management model (Fig. 1) is based on customer issues at the start and end of the processes.
6. Continual improvement: the search for non-conformance, mainly in the planning and execution of timetables and evaluation of students and programs. This involves having the courage to accept failure and carry out corrective and preventive actions. Continual improvement of the organization's overall performance should be a permanent objective; improvement must be a planned activity if the organization desires to improve overall performance and capabilities. Improve process through PDCA cycle. The QMS must be used for continual improvement. Measure/monitor results against objectives - Improve process and change QMS as needed to be mutually beneficial to supplier relationship to achieve and sustain desired results.
7. Factual approach to decision making: effective decisions are based on analysis of data and information. The analysis of surveys through customer questionnaires, comments, academic and vocational records that require taking daily administrative decisions. Amendments to selection criteria, laboratory equipments, instructional techniques and evaluation are channeled into administrative decisions to improve quality and correct and prevent non-conformance.
8. Mutually beneficial supplier relationships: an organization and its suppliers are truly interdependent, deciding on supplier selection and lists, contractual services, purchase system and procedures. A mutually beneficial relationship enhances the ability of both to create value. This is particularly so in the supplies for education, which include: (1) building contracts' activities, (2) general and specialized laboratory furniture, (3) teaching and hospital equipments and supplies, (4) housekeeping and maintenance contracts and (5) employment firms for specific staff hiring.

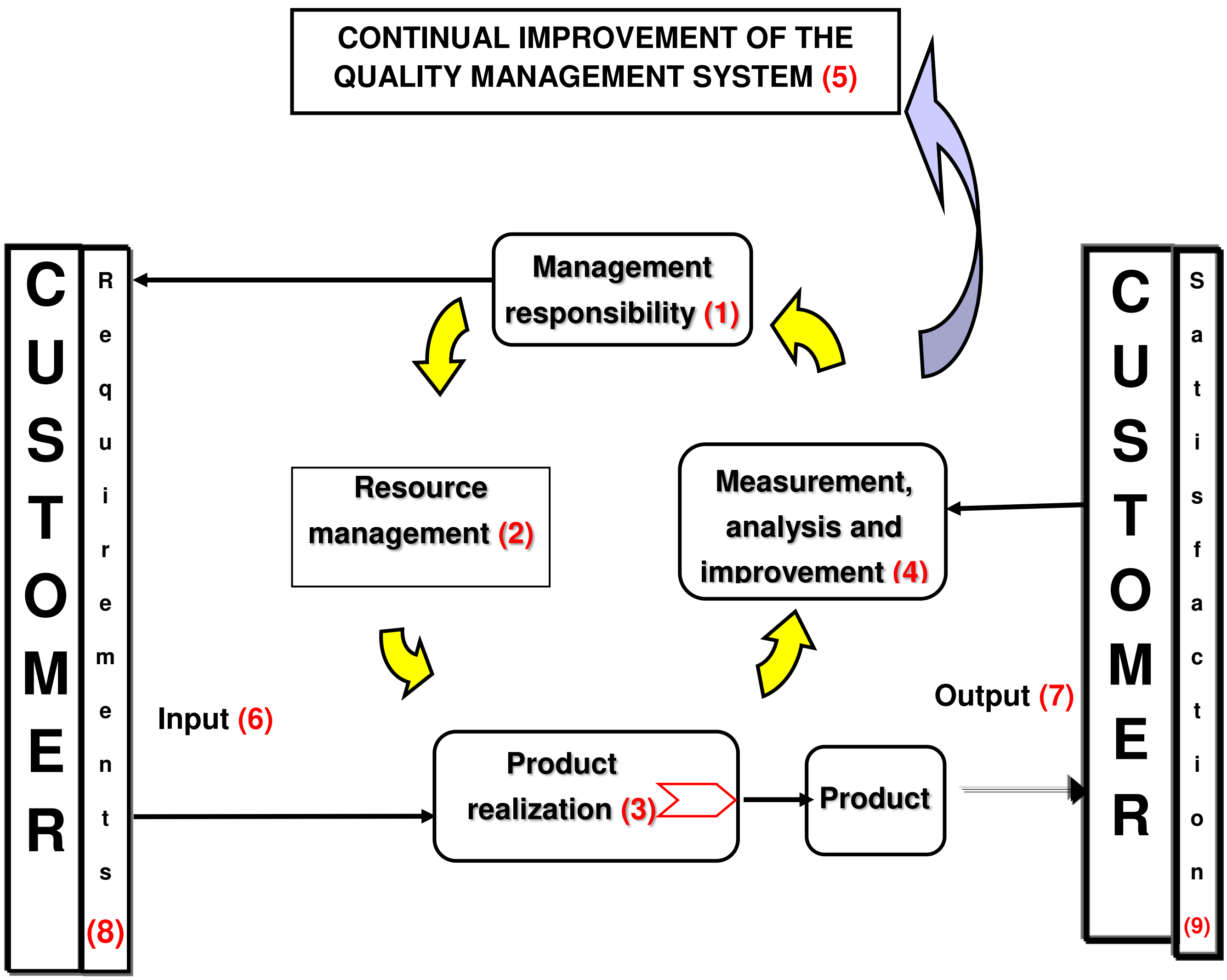

Figure 1. National college process sequences & interactions.

(1) Management Responsibility = Setting for Mission & Vision, Quality Policy, Quality Objectives (College Objectives, Program Objectives & Courses Objectives).
(2) Resource Management = National College buildings, labs, lecture rooms...etc. Maintenance planning & follow up Processes, Recruitments & Selection Processes for Academic staff & Sub contracting staff.
(3) Product Realization = Students Registrations & enrollments, Academic Services Processes, Administrative Processes, Control of Services Processes, Purchasing processes, Validation processes & calibrations for equipments processes.
(4) Measurement, Analysis & Improvement = Monitoring of Objectives, Academic Services, Customers' Satisfaction.
(5) Continual Improvement = Corrective/Preventive Actions Reports, Management Review Meeting.
(6) Input = Academic Staff, Administration Staff, Educational Materials including books, References, labs equipments.
(7) Output = Qualified, well educated Students.

(8) Customer (Requirements) = defined during stage (1) (Planning Stage), the top management define the customer requirements and ensure availability of resources in accordance with clauses (5.1 to 5.5), also defined during stage (3) (Operation stage), the National college shall ensure the commitments in accordance with clause (7.2.1).

(9) Customer (Satisfaction) = Assured by measurements of their perception towards National College Services after delivery of courses, at the end of the semesters & by measuring of all trends during the Measurement, analysis & Improvement stage on (04).

5 ISO 9001-2008 STANDARDS AT THE NATIONAL COLLEGE

5.1 Standard 1 Scope

General: The document specifies the quality management system of *National College for Medical and Technical Studies*. The systems requirements of this manual are aimed at achieving customer satisfaction by consistently providing conforming services and meeting or exceeding customer and applicable regulatory requirements through application of the system, continuous improvement and the prevention of nonconformity. This document ensures that the National College adequately identifies customer requirements, through all quality management system processes, to achieve customer satisfaction with a closed-loop process model methodology. This document applies to all National College educational services as confirmed by the scope and satisfies the Quality Assurance requirements as required in ISO 9001: 2008. National College documentation is in Arabic & English Languages, as all Staff is well competent to use both languages.

Permissible exclusions: sub-clauses of Product Realization (Clause 7 of ISO 9001:2008) have been excluded from the scope of National College. This is *sub clause Design & Development (7.3)*.
As all academic services provided by National College are regulated and accredited by legal bodies, and regularly reviewed by these bodies to continually confirm adherence to these regulations.

5.2 Standard 2 terms and definitions

Product	The academic or education services provided by National College which include -only- all the courses programs defined by the National college as follows: Medicine, Pharmacy, Dentistry, Physiotherapy, Radiography & Health Informatics program.
Customer	*Students* who benefit directly from educational services provided by the National College, and Students Sponsors - who may be persons such as students' parents, or Organizations' which pay for the students fees, *The community* which benefits from services provided by graduates of the National College such as National & Private sectors, Hospitals, Clinics & Universities. etc. When mentioning the word (Customer), it may mean all the defined (Students, Students Sponsors & The Community).
Employee	Full Time Staff working for National College, which includes The Academic Staff & Administrative Staff.
Sub-Contractors	Part Time Academic Staff who work temporary with National College.
Suppliers	All vendors that provide services to National College, including all types of purchases, technical services such as Maintenance, Cleaning etc.
Out Source Process	The process/es that National College has chosen to be performed by external parties.
Department	When the word "Department" appears within this document & all other National College documents, it means all the main departments which appear

on the Organization structure. The College programs (Medical, Pharmacy…etc) are also defined as separate departments, moreover, all the programs coordinators' acts as Department managers.

5.3 Standard 3= Quality management system

GENERAL REQUIREMENTS (Clause 4.1 of ISO 9001:2008)

The NC has established documented, implemented, maintains and continually improves a quality management system covering the requirements of ISO 9001:2008. To implement the quality management system, the NC has managed to: (1) identify process, (2) determined sequence and interaction, (3) criteria of operation, and (4) measure and implement actives to achieve planned results. The NC manages these processes in accordance with the requirements of this standard.

The NC has chosen to outsource the process of "Maintenance "to External Party [EP]. The NC applies control through: (1) EP should provide plan, a system to regulate responsibilities, flow charts and checklist of required steps. The Share of responsibilities between the National College & the Contracted party, and control over all the purchased spare parts and suppliers in accordance with clause (7.4)

6 DOCUMENTATION REQUIREMENTS (Clause 4.2 of ISO 9001:2008)

6.1 Type of Documents

The NC has prepared its quality management system documentation, which includes: (1) quality system manual, as a top level policy document, (2) quality system procedures/ standard operating procedures, as a second level quality system documents, (3) work instructions, as the third level quality document.

Important documents are the Educational Semesters' plans which describe all the key operations or processes to be carried out during the services provision or realization of academic services and specifies what quality requirements are to be met to ensure compliance with customer requirements. These Plans are prepared by *Programs Coordinators,* reviewed by *Deputy Dean* and approved by *The Dean*.

The Reference Regulations and Standards' documents include all the legal and regulatory requirements that apply to various aspects of the NC academic services. Some of these are external documents issued by the National Council of Higher Education and Scientific Research or the quality criteria of the Sudan Medical Council.

Fillable documents (or forms) Quality Records, the fourth level quality system documents which include: (1) semesters' plans, (2) programs reports, program, staff and evaluation forms, (3) log sheets and (4) other reports generated while performing routine activities, e.g. attendance.

Control of Documents

The NC has established, maintained & implement a documented procedure for controlling of documents used in its quality management system. This control ensures that the documents are: (1) approved prior to release, (2) reviewed, updated and re-approved, (3) identified with their current revision status, (4) legible, readily identifiable, retrievable, and properly distributed. The accuracy of versions and speed of retrieving are criteria for ensuring satisfactory management.

Standard 4 Management responsibility

7 MANAGEMENT COMMITMENT

The NC management has been certified as fully committed to Quality and demonstrated its commitment to the development and improvement of the quality management system by: (1) communicating to all levels the importance of customer and regulatory requirements, (2) establish and deploy quality policy, (3) performing management reviews and (4) ensuring availability of resources.

CUSTOMER FOCUS

The NC management, at appropriate levels, determines appropriate students' needs and requirements, and converts them into the form of defined requirements with the goal of achieving their confidence, without ignoring the regulatory and legal requirements The priority of customer focus is ensured through customer satisfaction measurement, customer needs identification using: (1) open meetings with NC Dean and staff, (2) Customer Needs Identification Records, and (3) Customer Satisfaction Surveys (for all types of customers, as specified above).

QUALITY POLICY (Clause 5.3 of ISO 9001:2008)

The National College has established its policy for quality and communicated it and enforced through management reviews, training, displays in Arabic and English at appropriate locations in tutors' offices & labs and all College premises and the main corridors. The text of the policy is:

> *"The primary objective of the National College for Medical and Technical Studies is to become a leading, expert, effective and trustworthy higher educational institution that designs, monitors, benchmarks and continuously improves academic performance, services and organization. The top management and all academic and administrative staff are committed to provide top quality educational services that satisfy the needs of students and their sponsors and exceed their expectations through the following: (1) adoption of the Quality Management System International standards as per ISO9001:2008 requirements, (2) compliance with all local and international Legal and regulatory requirements, (3) adoption of the World class system in their educational process and assessments, (4) application of accurate selection criteria for academic staff with professional background, and enhancement for their career advancements with on job training and continual evaluations and (5) setting of Quality Objectives and continually review of their performances.*
>
> *To achieve realization of this policy, the top management ensures the distribution of this policy to all major locations of the National College, plus, its well communications at all College advertising media.*
>
> *To ensure the continual suitability, the National College Councils– annually evaluate the policy in accordance with all other process effectiveness reports and the final Management Review meeting outputs."*

PLANNING (Clause 5.4 of ISO 9001:2008)

Quality Objectives

The NC has established quality objectives at appropriate functions and levels within the organization. These objectives are defined in measurable terms and are the interpretation goals of policy deployment in each department. These objectives are set for each educational program separately (College Objectives), for Curriculum (Characteristics of the medical graduate) and for each course separately. Results and key performance indicators are measured and evaluated annually at the end of each semester. Results of outputs are directly reflected on amendments or updates of quality policy, vision & mission, and provision of the needed resources.

Quality Planning

The National College has established plans identifying the resource needed to achieve the quality objectives. Quality planning covers the following issues: (1) processes of the quality management system, considering permissible exclusions, (2) resources needed and (3) continual improvement of the quality management system.

RESPONSIBILITY, AUTHORITY, AND COMMUNICATION (Clause 5.5 of ISO 9001:2008)

Responsibility and Authority
Functions and their interrelationships within the NC including responsibilities and authorities are defined and communicated in order to facilitate effective quality management as in:.(1) the Organizational Chart describes the hierarchical structure of the college, (2) the Job descriptions of individuals describe the responsibilities and authorities of the college personnel and (3) the Quality System Procedures, which also describe the responsibilities of personnel in relation to various quality system requirements.

The Management Representative (MR)

The MR has been appointed by the top management. The MR defined responsibility and authority for the Quality Management System, which includes: (1) ensuring that processes QMS are established and maintained, in accordance with the requirements of ISO 9001:2008, (2) reporting to top management on the performance of the QMS, including needs for improvement, (3) promoting awareness of customer requirements throughout the organization and (4) liaison with external parties on matters relating to the quality management system.

Internal Communication

The NC has established and maintains a proper system for internal communication between various levels and functions of the organization regarding the QMS and its effectiveness, through the following: *Regular Meetings, Board Meeting, Notice Boards,* This ensures that the quality policy, goals, procedures, and records are properly communicated to relevant persons on time to keep them fully aware.

MANAGEMENT REVIEW (Clause 5.6 of ISO 9001:2008)

General

The NC has adopted a system of annual review to the QMS. These reviews ensure the continuing suitability, adequacy and effectiveness of the whole Quality System. The review includes evaluation of the need for changes to quality management system, including quality policy and quality objectives.

The review input included issues related to: (1) results of audit reports, (2) students feedback, (3) examiners' feedback, (4) process performance and education services conformance, (5) status of preventive and corrective actions, (6) follow-up actions from earlier management reviews, (7) changes that could affect the QMS and (8) recommendations for Improvements.

The review output include actions related to:

Review output

The outputs from management review include actions related to: (1) improvement of QMS and its processes, (2) improvement of product related to customer requirements, and (3) resources needed. The results of the management reviews are recorded as: Management Review Meetings and Action Plan Minutes.

Standard 6= Resource management

PROVISION OF RESOURCES (Clause 6.1 of ISO 9001:2008)

In light of the management reviews and other management controls, the top management of NC considered the requirements for appropriate resources, and ensured that they are provided on a timely manner. These include the resources to: (1) implement and improve the processes of the QMS and (2) continually respond to customer needs and enhance their satisfaction.

HUMAN RESOURCES (Clause 6.2 of ISO 9001:2008)

General

Resources at NC are represented by people (academics, administrative staff and sub-contractors), infra-structure, work environment, information, suppliers and partners, and financial resources. The NC assigned responsibilities defined in the QMS to personnel ensuring that they are competent on the basis of applicable education, training, skills and experience. Their qualification and experience data are effectively maintained as outlined in the document entitled: Selection Criteria.

Training, Awareness and Competency

Competences planning process is being implemented to ensure that proper training, awareness and competence development of people. This plan is carried out while taking into account the organizations processes, students and their sponsors' needs and expectations, the stages of development of people and the culture of the organization. The objective is to provide people with knowledge and skills, together with experience, improve their competence and capabilities. The National College has established and maintains a procedure to ensure proper capabilities of personnel working. This includes: (1) identification of competence needs, (2) providing training for additional tasks needed, (3) evaluation effectiveness of training provided, (4) ensure awareness of employees of their importance to achievement of quality objectives, and (5) maintain appropriate records. All are shown in Recruitment Regulations and Training Regulations for NC Staff, NC Staff Training Process Flow Chart, and permanent staff and subcontractors files.

INFRASTRUCTURE (Clause 6.3 of ISO 9001:2008)

The requirements are: (1) buildings, work space and associated facilities, (2) process equipment, both hardware and software, and (3) supporting services such as transport or communication. The documentation include: Maintenance Process Flow Chart, Maintenance Reports (including Maintenance Plan, Corrective and Preventions Records).

WORK ENVIRONMENT (Clause 6.4 of ISO 9001:2008)

The work environment of the NC is considered an important process to manage the quality system. In this regard, the top management ensures that a healthy, safe, and conducive environment is maintained in each department. The National College has determined and managed the work environment needed to achieve conformity to product requirements. This includes health and safety conditions such as lighting, humidity. etc. in addition to ambient working conditions. The documents include housekeeping, cleaning, building security, health and safety follow up reports.

Standard 7= Product realization

PLANNING OF REALIZATION PROCESSES (Clause 7.1 of ISO 9001:2008)

The product realization processes are represented by the following educational services process; (1) medicine, (2) pharmacy, (3) dentistry, (4) radiography, (5) physiotherapy and (6) health informatics program. An effective planning is carried out for realizing all these processes, a process flow chart describing the main stages of programs planning and execution.
In planning for these processes, the NC determines the following: (1) requirements for the program, (2) the need to establish processes, documents, and provide resources specific to the course program, (3) required verification, validation, monitoring, inspection and control parameters specific to the course program during the course/s execution till final completion of the course program and (4) records needed to provide the evidence that the course programs processes provided and resulting output fulfils requirements. Courses Programs' plans are prepared for all NC programs which describe the sequence of realization processes including: (1) the verification activities, (2) related control parameters, (3) reference standards and (4) related documentation such as Course Programs' Plan. Records are maintained.

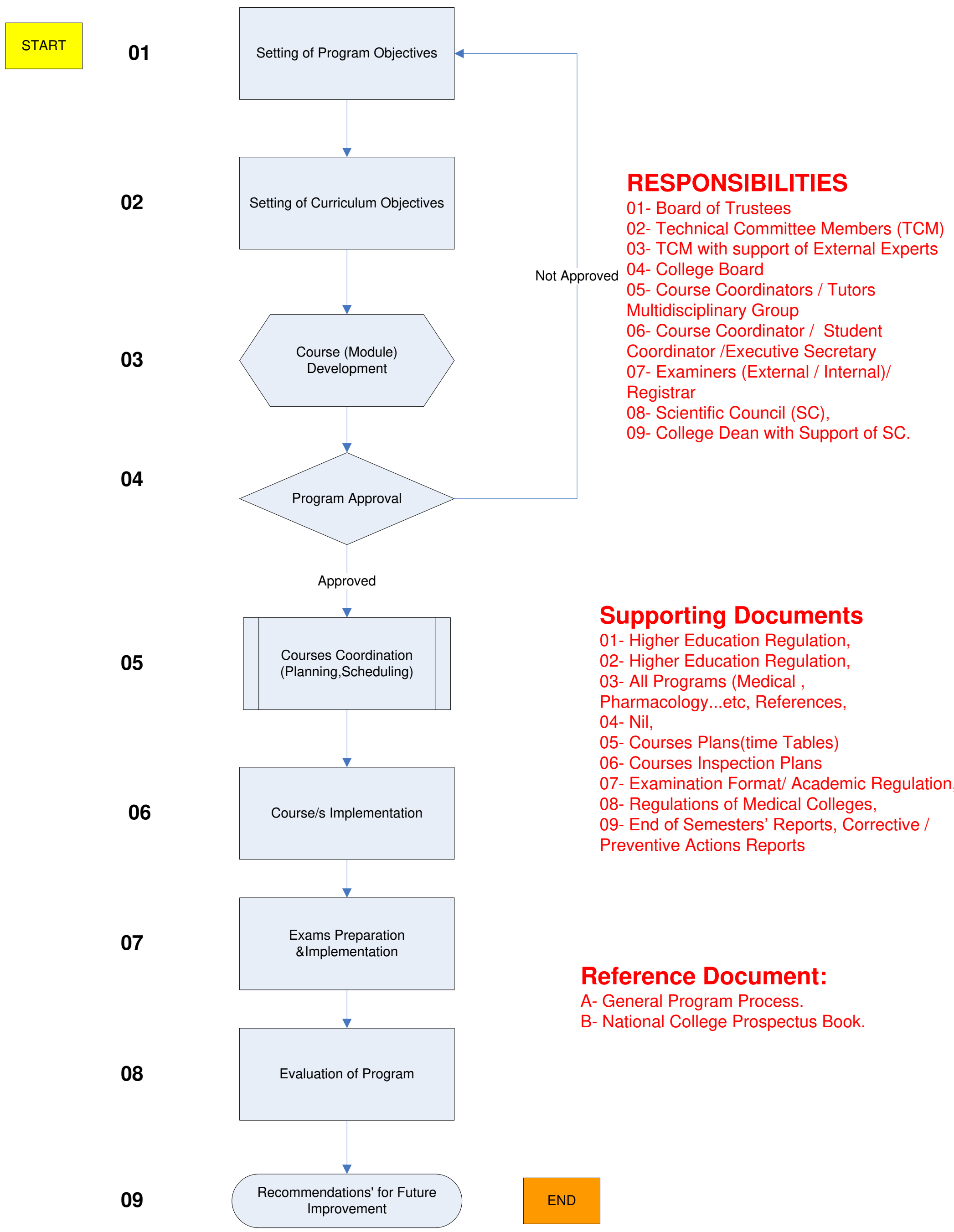

Figure 2. National College educational planning & execution flow chart.

CUSTOMER-RELATED PROCESSES (Clause 7.2 of ISO 9001:2008)

Determination of Requirements related to the product

The NC determines the following prior to commitment for education services realization: (1) requirements specified by the students or their sponsors, (2) requirements not stated by the college students nor their sponsors' but necessary for specific use or known and intended use, (3) statutory and regulatory requirements related to the courses provided and (4) any additional requirements determined by the NC.

Review of Product Requirements

The NC reviews the requirements prior to commitment to provide courses to the students and ensures that: (1) courses requirements are clearly defined, (2) where the customers provides no written statement of requirement, these requirements are confirmed before acceptance, (3) contract or order requirements differing from those previously expressed, are resolved and (4) NC has the ability to meet the customers' requirements for the course/s. The results of reviews and subsequent follow-up actions are recorded.

The National College ensures that relevant documentation is amended on changes in contracts/courses programs requirements. The changed requirements are communicated to all relevant personnel.

Customer Communication

The NC has defined and implemented effective liaison with customers, with the aim of meeting customer requirements. The NC has defined communication requirements relating to: (1) courses/programs information, (2) enquiries, contracts including amendments and (3) customer complaints and their feedback. The most important documents are: Student Manual Book and National College Prospectus

PURCHASING (Clause 7.4 of ISO 9001:2008)

Purchasing Process

It is ensured that effective and efficient purchasing processes are defined and implemented for the evaluation and control of purchased products, to ensure that purchased products satisfy the NC needs and requirements. The NC controls its purchasing processes to ensure that the purchased product and/or service(s) conform to purchase requirements. The type and extent of control is dependent on the effect of the purchased product and/or service(s) upon final educational services conformance.

The NC evaluates and selects suppliers based upon their ability to supply product and/or services in accordance with National College requirements. Evaluation, re-evaluation and selection criteria for suppliers are established. The results of evaluations and subsequent follow-up actions are recorded.

Purchasing Information

Purchasing documentation contains information clearly describing the product and/or service(s) ordered. The NC reviews and approves purchasing documents for adequacy of the specification of requirements prior to release, to ensure the effectiveness of purchasing information, the final purchase orders are finally verified, confirmed and signed by the Dean prior to release to suppliers. Records of purchasing activities containing suppliers' quotations, prices analysis, purchases requisitions and purchase orders are maintained.

Verification of Purchased Product

The NC determines and implements the inspection or other activities necessary for ensuring that purchased product meets the specified requirements. Where the NC or its customer proposes to perform verification activities at the supplier's premises, the National College specifies the required verification arrangements and method of product release in the purchasing documentation. The documents are: Purchasing Regulations, Purchasing Process Flow Chart, Suppliers' Selection Form, Purchasing Documentation Records, Suppliers' Approval Lists, Suppliers' Re-evaluation Records.

PRODUCTION/SERVICE PROVISION (Clause 7.5 of ISO 9001:2008)

Control of Production/Service Provision

The National College programs, semesters scheduled plans are carried out under controlled conditions. Controlled conditions include: (1) availability of regulations, standards and course/s curricula that define the characteristics of courses, (2) availability of work Instructions at each stage of implementation, (3) use of suitable education tools and equipments, (4) availability and use of suitable measuring and monitoring equipment, (5) implementation of suitable monitoring and measurement activities (Courses performance follow up by Course coordinators & Students Coordinators, Midcourse & Final exams) and (6) implementation of defined processes for course execution and final evaluation test (Final Exams). The documents are: Course Plans and Reports, Examinations' Reports and Senate Minutes.

Validation of Processes

The NC has defined the process of "Recruitments and Selection Criteria of Permanent Staff and Sub-contractors" as special process, at which top management assure of their competencies prior to delivery of the courses to students, as these competencies cannot be verified till real educational services are provided to students. To validate this process, the NC makes sure of the following: (1) criteria are confirmed in accordance with Clause (6.2.2), (2) approval of the Recruiting Committee and assuring their commitment, (3) fulfilling the legal requirement of validation of qualification and experience, (4) testing of a presentation demo, (5) reports presented by recruits when they fulfill a course and (6) all other reports generated during probation period and end of semester evaluation. Reports of validation are maintained by MR.

Identification and Traceability

The status of the courses programs executed or in progress can be identified during all stages of educational services provision. Records of students, registrations numbers, certificates, examinations' results, tutors, programs, courses/semesters' progress or existing programs can be traced to ensure controlled condition during the service provision or for future/data analysis traceability if required.

Customer Property

The NC takes necessary measures to ensure that any customer property, including students' health and safety are properly safeguarded. Accidents and property reports and their related records are maintained

Preservation of Product

The NC ensures control and conformity over processes during all stages of program implementation, this includes: (1) control on courses during executions to ensure on time and accurate implementation, (2) continual appraisal for competences of tutors and administrative staff, (3) continual updates of plans and remedies of non-conforming results, if any, and (4) application of control on course/s materials, reference books validity and backups of information.

CONTROL OF MEASURING AND MONITORING DEVICES (Clause 7.6 of ISO 9001:2008)

Measuring and Monitoring devices or equipment are used for educational purposes, to ensure confidence on the laboratory testing experiments. The measuring and monitoring processes include: (1) confirmation that the devices are fit for use and are maintained to the suitable accuracy and accepted standards, as well as a means of identifying the status of the devices. All measuring and monitoring equipment used for verification of products and for monitoring processes are regularly calibrated and/or checked.

The equipment are calibrated in accordance with approved written calibration schedule. Calibration standards are traceable to recognized national/international standards. The NC provides the basis for the standards used where no national standards or certified master standards exist.

Complete calibration records are documented and maintained. Records are evaluated periodically to ascertain adequacy of calibration, inspection levels and calibration methods in use.

All measuring and test equipment are identified with a tag, sticker, marking or other suitable identification to indicate their calibration status. If it is not possible to put an identification mark, the calibration status is recorded on an appropriate quality document, which is traceable through an indexing system.

Where equipment is found to be defective or out of calibration, the results of the previous testing are re tested by the concerned student/s and appropriate action is taken by the responsible laboratory technician. To ensure that all equipment are safeguarded from unauthorized adjustments and/or calibration, labeled instructions are distributed on each lab and usages of certain equipment are demoed by the lab technician to students prior to usage. The NC document is the List of Equipment and Calibration Status Log.

Standard 8= Measuring, analysis and improvement

GENERAL (Clause 8.1 of ISO 9001:2008)

The NC plans and implements monitoring, measurement, analysis and improvements over the processes needed to: (1) demonstrate conformity of educational services provided, (1) ensure conformity of the QMS and (3) continually improve the effectiveness of the QMS, this may include the determination of the need for and use of applicable statistical techniques.

MEASUREMENT AND MONITORING (Clause 8.2 of ISO 9001:2008)

Customer Satisfaction

The NC has determined and established processes for monitoring information on students & their sponsors satisfaction and/or dissatisfaction to assess whether the NC has met their requirements. The methods and measures for obtaining this information and its use are defined in the relevant procedures. The documents include: Customer Satisfaction Surveys or Inventories, Customer Complaints, Students' Suggestions' Box and Open Meetings with the Dean.

Internal Audit

The internal audit process acts as a management tool for independent assessment of any designated process or activity. The internal audit process provides an independent tool for use in obtaining objective evidence that the existing requirements have been met. The NC has established a process for performing internal audits in order to determine if the QMS: (1) conforms to the requirements of this international standards and (2) has been effectively implemented and maintained.

The College plans audit program, which is based on the status and importance of the activities, areas or items to be audited, and the results of previous audits.

The College has documented and implemented internal audit procedure that covers the audit scope, frequency and methodologies, as well as the responsibilities, requirements for conducting audits, recording and reporting results to management. Audits are performed by personnel other than those who performed the work being audited. The management of the company takes timely corrective actions on deficiencies found during audit. Follow up actions include the verification of the implementation of corrective action and the reporting of verification results. The supporting document is Quality System Procedure for Internal Quality Auditing.

Measurement and Monitoring of Processes:

The NC applies suitable methods for measurement and monitoring of processes necessary to meet customer requirements and to demonstrate the processes continuing ability to satisfy its intended purpose. Performance is evaluated towards the processes to achieve the planned results of courses and programs objectives plus, any other objectives regarding the competences required of the Academic & Administrative staff, the ability of infrastructure, course/s materials and tools…etc to achieve results.

In case of non-conformance with the planned result, correction and corrective action are taken to ensure conformity of services provided. The supportive document of this standard is Programs/Courses Evaluation Reports.

Measurement and Monitoring of Product

The NC applies suitable methods for measurement and monitoring of the characteristics of the courses programs to verify that requirements for the courses are met. Evidence of implementation of required measurement and monitoring and conformance with the acceptance criteria used is recorded.
Course/s shall not proceed to next execution stage until all specified activities have been satisfactorily completed and the related pre-requisites are available and authorized. The supporting document is Course Implementation Follow up Report.

CONTROL OF NONCONFORMITY (Clause 8.3 of ISO 9001:2008)

The NC ensures that courses content, tutors, laboratory materials and methods, study materials that do not conform to requirements is controlled to prevent its delivery to students. The controls and related responsibilities and authorities for dealing with non-conforming services are defined and documented. The nonconforming services may be dealt with any of the following ways: (1) taking actions to eliminate the detected nonconformity, (2) authorizing non conformity use, or acceptance under concession by the relevant authority, legal bodies and, where required, by customer and (3) taking actions to preclude its original intended use or application. Records of nature of nonconformity and any subsequent actions taken are maintained. Any nonconforming product that has been corrected is subjected to re-verification to ensure conformity to the requirements. In case the nonconformity is detected after course/s has been delivered, the NC shall take action appropriate to the effects, or potential effects, of the nonconformity. The supporting document is: Quality System Procedure for Control of Non-conformity of Product.

ANALYSIS OF DATA (Clause 8.4 of ISO 9001:2008)

The NC collects and analyzes appropriate data to evaluate the suitability and effectiveness of the quality management system and to identify areas for continual improvement. This includes data generated by measuring and monitoring activities and other relevant sources. Decisions are based on effective and efficient use of appropriate statistical techniques. The analysis of data provides information on: (1) customer satisfaction and/or dissatisfaction, (2) conformance to customer requirements, (3) characteristics of courses program conformance to requirements and their final trends including opportunities to preventive actions and (4) suppliers and dub-contractors ability to meet College QMS requirements.

IMPROVEMENT (Clause 8.5 of ISO 9001:2008)

Continual improvement

The NC strives to continually improve the effectiveness of QMS through the use of quality policy, quality objectives, audit results, analysis of data, corrective and preventive action and management review. The quality objectives are up-graded gradually on routine basis for improving performance of different departments, through the Department of Educational Audit.

Corrective Action

The NC takes action to eliminate the causes of nonconformities in order to prevent recurrence. The extent of corrective actions depends on the impact of the problems encountered.

Preventive Action

The NC determines actions to eliminate the causes of potential nonconformities in order to prevent their occurrence. Extent of preventive actions depends on the impact of the potential problems.
NC has documented, implemented and maintained a procedure to ensure successful identification for non-conformity and implementation of the required corrective and preventive actions needed to prevent (recurrences) of non-conformity detected during course of processes implementation and to prevent (occurrences) of the potential problems. The supporting document is the Quality System Procedure for Improvement.

CONCLUSIONS

Governance in higher education cannot be achieved without the application of a quality management system that has specific standards. ISO 9001-2008 is most suitable for this purpose.

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The Living Dead

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1 ABSTRACT

The first-ever species of a plant-parasitic nematode was reported only in the year 1743 by Needham using a primitive microscope for his study. The naked eyes obviously could not detect the presence of these tiny creatures either in the soil or inside the plant tissues.

"Upon opening lately the small black Grains of smutty Wheat, which they here distinguish from blighted Corn, the latter affording nothing but a black Dust, into which the whole substance of the Ear is converted; I perceived a soft fibrous Substance, a small Portion of which I placed upon my Object-plate: It seemed to consist wholly of longitudinal Fibres bundled together; and you will be surprised, perhaps, that I should say, without any the least Sign of Life or Motion. I dropped a Globule of Water upon it, in order to try if the Parts, when separated, might be viewed more conveniently; when to my great surprise, these imaginary Fibres, as it were, instantly separated from each other, took life, moved irregularly, not with a progressive, but twisting Motion; and continued so to do for the Space of Nine or Ten Hours, when I threw them away".

Needham had found the nematode juveniles in this condition in 1743 as is recorded in his very important, significant and historical discovery. This nematode was *Anguina tritici,* one of the finest examples of cryptobiosis or suspended animation not only in nematodes but in the entire Animal Kingdom.

The almost death-like state of cryptobiotic organisms such as the Protozoa, Rotifera, Tardigrada, Nematoda, etc., has some times been referred to as *anabiosis,* which literally means, "return to life" from the death. Earlier it was thought that organisms were actually dead and are resuscitated by some amazing supernatural ways. The use of term *"suspended animation"* for this state was preferred by some biologists. It gives the impression rather appropriately that the life activities in the concerned animals have been suspended for some time. The term *cryptobiosis* coined for this phenomenon denotes *"hidden life".* It indicates that though the organisms appeared virtually dead they had life hidden into them. How else they could come back to life? It was also realised that the organisms go into this state only during adverse or unfavourable environment when their existence is threatened and hence it is basically for their survival. Interestingly, the term *suspended animation* has also been used in politics. Whenever a Legislative Assembly, Council or Parliament is made functionless, it is said to be in suspended animation. When an Ordinance is promulgated to this effect member can not perform their normal functions but they do not lose their seats. Upon revival, as and when ordered, the members can start to do their work again. It would therefore appear that temporary dormancy or quiescence is a very beneficial activity enabling organisms to overcome a certain death by halting their vital body functions. Once organisms have gone into cryptobiosis they are better adapted to resist the impact of adverse conditions of the environment. The rotifers and tardigrades, for instance, in a state of cryptobiosis can tolerate heating up to 151° C and cooling to -272° C whereas active forms get killed rapidly only at 50 ° C. In this state they can also withstand high levels of ionising radiation. Although only 500 roentgen of X-ray is sufficient to kill a human being, the cryptobiotic tardigrades could bear an exposure, which is nearly 1000 times more than this for 24 hours with only 50% mortality. They can also tolerate 4 times more exposure of ultraviolet radiation than the live tardigrades. The nematodes found in high altitudes or on the snowy peaks as also those in the hot arid deserts, can revive from their inactive cryptobiotic state as the environmental conditions become suitable and more tolerable. A large number of species of this group of animals supposedly go into dormancy in order to tide over conditions that are unsuitable for their survival. The cryptobiosis can take place in various organisms due to a number of factors. The most common being the loss of water and is thus called *anhydrobiosis* or absence of water. But the loss of water may be mainly due to rising temperatures of the habitat. The other type of cryptobiosis is due to the extremely low temperatures of the environment. The animals living in colder regions of the world with temperate climate are affected by this including those found on high altitudes. This phenomenon is referred to as *cryobiosis.* The low levels or total absence of oxygen can also lead to cryptobiotic conditions called *anoxybiosis.* The *osmobiosis* is yet another form of cryptobiosis that is induced due to high osmotic pressure. The majority of organisms that enter into anhydrobiosis, both from the animals and plants, belong to the lower groups. Many a times cryptobiosis due to low temperatures or high osmotic pressures may also in effect be a type of anhydrobiosis because of the non-availability of water which is so essential for carrying out their life activities. But *anoxybiosis,* due to lack of oxygen or low oxygen tension, is not at all related to these three factors. So, the suspended animation is either due to a single factor or a combination of two or may be three factors.

The causative agent of the white-tip disease of rice, *Aphelenchoides besseyi* is also a very good example of suspended animation *(anhydrobiosis).* The nematodes feed cctoparasitically on rice leaves and stem and move from one part of the plant to another, usually during rain, dew or when the humidity is high. Finally, they find their way into panicles and eventually inside the hull. The grains, as they ripen, become hard due to heat and dryness. The nematodes which are usually in the preadult stage then go into dormancy. In this state they lie beneath the hull of rice kernel and can remain quiescent for up to two years or more. The infested seeds get soaked in water when planted. As they sprout, the nematodes come back to life and begin feeding and develop into adult males and females.

The first stage juveniles of the species of *Heterodera,* the cyst-forming nematodes, can also enter into cryptobiosis. The cysts inside contain quite a large number of eggs, which develop to the first stage juveniles but do not hatch until they are activated by the hatching factor called root diffusates or root exudates, which is released by their host plant(s). It is interesting to note that all juveniles do not hatch at one time. Those, which do not hatch, remain viable but in a state of dormancy for up to 10 years or even more, though some may continue to hatch every year. This way a cyst can retain its viability and the infectivity of its young ones for a very long time, releasing its juveniles, little by little, year after year, as and when a suitable host is grown.

While organisms, particularly the lower ones such as nematodes can go into this virtual death-like state, but generally they are not dead. Their bodies do not decay and disintegrate as is inevitable upon death. It is believed that there is some mechanism that prevents this from happening. The body cuticle of the animals becomes highly resistant and almost impermeable. A very small and undetectable amount of water and Adenosine triphosphate (ATP) is retained inside the body tissues. It is this that prevents the organism from death and decay and is extremely vital in their revival. This ability of cryptobiotic organism saves them from dying in case they come in contact with chemicals (nematicides) that are used for their elimination in the fields with crops. When fields are kept dry and fallow during the hot summer months for the same purpose, the cryptobiotic nematodes survive and escape the heat and drought. It has therefore rightly been said that eradication of plant-parasitic nematodes, once they have gained a foot-hold in an agricultural field, is very difficult due to their cryptobiotic abilities.

2 NEMATODES TO MAN

The food and its availability in sufficient quantities is of paramount importance for all organisms. In an ecosystem, the various component species of animals and plants have not only different food preferences but also have different feeding types so that competition for the same type of food be as little as possible. In the game of life and death, called struggle for existence, every organism is a source of food for the other organism and battle goes on uninterrupted forever. For survival, day-to-day life activities and for reproductive purposes availability of food to the animal is absolutely essential. This is to ensure that metabolic processes of the body could go on to provide energy so vital for the body machine to function. The organism respond to daily changes in the environment with particular reference to day and night as the body goes into fatigue after some length of time due to its various activities. For many animals and plants the night comes as a relief as, they take rest and go to sleep. During the period of rest the body metabolism becomes low and the body gets time to repair any damage that might have occurred to its tissues due to the activities in the day. The resultant inactivity of a large number of organisms of an ecosystem in the night also lessens the competition for food for the nocturnal animals that are active largely only during the night and rest in the day. The nocturnal animals have developed through evolution an ability to see in the darkness of night which the diurnal animals lack and consequently have no option but to hide and take a rest. The nocturnal animals like-wise rest during the day-time. This shows that the mechanisms of nature are indeed so precise, perfect and well-balanced.

It is quite evident from the above that animals, like the plants, go into a period of inactivity, as and when the environmental conditions are not optimal. During such periods their life activities are slowed down considerably along with their body metabolism so as to minimize on the energy requirements. The phenomenon is also quite evident in some species of plants that shed their leaves as the winter approaches. They become very inactive and go into suspended animation with considerably reduced or minimal energy needs. At the approach of spring, when the conditions gradually return to normal, these plants come out of their sluggishness and long sleep. Their leaves, flowers, etc., literally burst out. The same happens to many species of animals too, .practically at every level of organisation, right from Protozoa to Mamarnalia. It may be noted that the animals have adapted to varying strategies to cope up with the rise and fall of their body temperature. This is considered essential because reduced body activity may prove often fatal. The animals in their sluggishness may get killed by other animals such as the predators. The birds and mammal have developed very special mechanisms to keep their body temperatures constant (warm blooded animals) as against the amphibians and reptiles whose body temperatures fluctuate with the environment (cold blooded animals). But the warm-blooded animals have to pay very dearly in term of energy requirement for keeping a constant body temperature. For instance, a man even on a reasonably warm day uses nearly half his intake of food just to keep his body warm.

The temperature regulating mechanism apparently does not provide foolproof protection to the birds and mammals from environmental fluctuations. Though the modern man uses central heating or heat convectors during the winters and air-conditioning or air-cooling devices in summers so as to keep the cold/heat as close to a desirable limit as possible. But the poor animals unfortunately do not have the luxury of such artificial devices. This is precisely the reason why many species of animals migrate from one place (breeding grounds) to another (feeding grounds), often separated by several thousands of miles. This is particularly true in case of birds, in which this phenomenon is well known and has thoroughly been studied. The migratory ducks and cranes as they come each winter to India from Siberia and other colder regions of the world are just for the purpose of avoiding the vagaries of extreme climate in their breeding grounds. When environment in their feeding ground starts warming up, it is the time for them to return home as conditions over there become hospitable once again. The appearance of the pied-crested cuckoo, *Clamator jacobinus* during monsoon months in India especially in North along with the rain clouds is a familiar sight each year, but these beautiful birds quietly disappear after a few months.

All animals, especially those with simpler body organizations cannot do what many animals like the birds and mammals are capable of. So they must face the environmental fluctuations right in their habitat by making suitable adjustments in their physiology. These adaptations are absolutely essential in the cold-blooded animals but more so in the lower organisms such as nematodes, protozoans, tardigrades, rotifers, etc. The latter group of animals has very limited locomotory abilities particularly the nematodes. They have primitive body organisation and are thus largely devoid of suitable adaptations to surmount environmental changes which may at times be very swift. For some organisms seasonal changes bring about death, to others it may be start of a desperate struggle for survival; still others are able to maintain only a borderline existence (cryptobiosis) hanging between the-life and death. But for a few lucky ones the changes may be welcome as these would suit them. Those lower invertebrate animals which do not have the ability to enter into cryptobiosis largely perish, but before this happens they usually leave behind their eggs or young life stages which are better adapted to withstand environmental fluctuations.

The vertebrate group of animals generally faces two opposite kinds of problems at different times of the year, but both due to changes of temperature in their habitat. One of them is due to the considerably low temperatures and the other is due to very high temperatures that may also cause problems even for these animals. To counter these changes in environment, many animals go into a long sleep called *hibernation* during the winter. At higher temperatures also some animals go into hiding and this is called *aestivation* or summer sleep. In both situations the animals respond by slowing down the body metabolism considerably and surviving only on reserve food of their body such as fat.

3 THE HUMAN ANGLE

The human beings, in all ages have cherished to live a long life. In the early part of human history the life span was short because of lack of knowledge of medicines for treating ailments, diseases and discomfort. But with the development and advancement of science, modern medicine and surgery, people all over the world now have much longer life expectancy then in the past. In India, it has nearly doubled during the last 150 years, but is still far lower than in America or Europe. Being at the apex of evolutionary scale, a warm blooded mammal, and possessing great perfection in body organization, man has the ability to survive practically in all kinds of environmental conditions. Further, with the brainpower and intellect at his command, man has created artificial ecosystems for his comfort and has made it possible to control the rise and fall in the environmental temperature, humidity, etc., to suit his convenience.

The desire to prolong life span and "cheat" death, for as long as possible, has not ended in spite of increased life expectancy. On the contrary, such a desire has risen sharply in the western countries and is rising in India and China too. The hot temperatures, which bring about aestivation in vertebrate animals and cryptobiosis (anhydrobiosis) in microorganisms and the lower groups of animals and plants is not quite feasible for the human beings. It is considered, that they would not be able to quite tolerate extreme heat and would consequently, die. But the low temperatures which human beings themselves use for the preservation of many items of food as also for preserving body organs and tissues such as blood, cornea, semen, ovum, etc., have given rise to some ideas and a little hope. The biggest question in the minds of many biologists is that whether the entire human body can be induced to a long and deep sleep (hibernation)? This would be somewhat close to being cryptobiotic (hypobiosis) much the same way as in nematodes, protozoan or the tardigrades. Though at present it may appear to be a remote possibility but such a thing could become a reality in times to come. It may also be kept in mind that hibernating/aestivating animals remain in that state as long as the conditions that had brought about this state persist. So, theoretically a man may be induced to hibernation and can be kept in this state of suspended animation up to a desired length of time, which may vary from a few years to thousands of years. In the laboratory of hypobiosis at the Russian Medical Academy the scientists have by injecting some chemicals blocked the release of catecholamine. By doing this they claim that they were' successful in making a warm blooded animal loose its temperature regulating mechanism. They thus behave almost like a cold-blooded animal whose body temperature will change with that of the environment. This has enabled the scientists to lower their body metabolism considerably by subjecting these animals to cold temperatures. Attempts were also made to create such mechanisms by which hibernating animals could survive freezing temperatures and yet succeed in maintaining their vital life activities, possibly only at 2-3 percent of the normal non-hibernating animals. It is believed that in such conditions the human patients can be safely transported from one place to another for better medical attention in case of life threatening emergencies. During such transportation the element of risk shall be greatly reduced. The treatment with cold temperatures is not really new as doctors all over the world have since long been using it. Giving cold baths to patients with higher fever or using ice around certain parts or on entire body is well known.

The application of cold temperatures to human beings thus seems to hold tremendous possibilities as a means of conserving life temporarily for a short or long duration as also for preserving organs and tissues for transplantation, transfusion, etc. All these scientific activities have given birth to a new discipline called *cryobiology* and arising out as its offshoot is *cryosurgery,* which is self-explanatory. Many rich people in the western countries now desire to get their bodies preserved upon death in a frozen state hoping that in the future when the medical science makes sufficient progress in this direction, it could well be possible to resuscitate them. There are some scientists who feel that one day this might turn out to be true. But there are others who rightly believe that if somebody is dead, he is gone forever, and do whatever you may like, it would be impossible to bring him back to life. However, a few biologists believe that if someone is induced to hibernation a little before his death then chances of his coming back to life are rated as high. *Cryopreservation* has thus become an essential tool in breeding programmes for improved varieties/breeds of animals and plants and very soon it may be used in case of human beings as well.

The mere thought is exciting, that human beings like animals could be frozen to a state in which the heart beat and breathing would be brought to such a level that these may be hardly detectable. If we can achieve the desired state of *hypothermia* than the prolongation of human life may become a real possibility. The lowered metabolism would keep a person in suspended animation and the same shall indeed be of great biological and medical significance and surgical importance. It would, also be of great value in space programmes particularly because of the fact that it involves long and hazardous journey to the outer space and to other planets. In a state of suspended animation, it would be easier to withstand heavy irradiation en route the journey in space programmes. However, the possibilities that human beings could be brought artificially into a cryptobiosis-like state opens up a Pandora's box as far as some ethical questions pertaining to human society are concerned. Will the human society accept a person who has risen from his "sleep" after say thousands of years? How will that person be able to react to a totally different human society and ethical values, before and after his resuscitation? How will he and his relatives react to each other? Though these things appear to be very remote and mere fantasies at present but some day these possibilities may become realities. The rate at which the technological and biotechnological innovations are being made, the day is not far off when such human dreams will be realized in the 21^{st} century. Who would think a few decades back that cloning can be done in animals and that too in mammals? But this has now been successfully achieved in sheep and monkeys and most likely in the human beings as well. The made to order humans with desired genomes are a real possibility and not merely a dream, produced either through normal reproductive methods or by cloning.

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Islamic World Through the Societies of Knowledge: Vision of Morocco

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1 PREAMBLE

One of the facets of the vast cultural movement of the Islamic world resides in the creation and the organization of societies of knowledge to which the Islamic world could dominate the lasting rest of the world for many centuries.

These knowledge or learned societies have deeply influenced the civilization of the Muslim world and have long been the culture medium of human progress. This progress has been achieved with the prior consent of the enthusiasm of the scientific spirit and above all, personal observation.

Before Islam, relationships existed with Europe, Africa and the Orient. Trading posts operated along the Atlantic and Mediterranean coasts of Morocco and represented many opportunities to build relationships and promote the installation of chains of knowledge.

These contacts are very interesting to note because they are the harbinger of the great Islamic civilization, which bloom later.

During centuries Moroccans had contacts with the Egyptians, Assyrians, Greeks, Romans, Carthaginians and later the Arabs, therefore these civilizations were not unknown by Morocco.

Since the advent of Islam, we have documents that tell us about the organization of corporate knowledge through the Islamic world. These documents are as many about the Prophet concerning knowledge, its development and dissemination.

Since the dawn of time, knowledge societies in North Africa and across the Islamic world are subject to renewals of modes and aspects that are perpetuated to the present day with ups and downs. Every civilization and each culture shines through the modes of acquisition, processing, production and transfer of its own.

The important thing is not to turn the impact of knowledge societies in the Islamic countries, but through a clear example experienced in our country: Morocco. The state of progress, refinement and development operated at a target population and the means used for this purpose at the beginning of the 21sh century.

2 THE KNOWLEDGE SOCIETY IN THE ISLAMIC WORLD THROUGHOUT HISTORY

Knowledge societies, their nature and variety, the way they are acquired, their acquisition process, their value, their role in human societies, have been studied by a variety of disciplines since the advent of Islam. We shall recall some of the most significant steps in the history of mankind.

2.1 The Muslim Spain and the Maghreb through Knowledge Societies

Since the 9th century, The Maghreb and Muslim Spain have been the cultural fertile environment (fecund milieu) in the production of knowledge societies. The 12th century was the great age of the Muslim Spain. On the eve of being reduced to a small kingdom of Granada, Muslim Spain

crowned five centuries of a brilliant civilization, a rich flourishing of philosophers, scientists and doctors. Dethroned of its political greatness, it was long reigning in the realm of thought. Never, however, despite its obstacles, the thought has enjoyed such a free boom or such audacity, witnesses, Averroes, the greatest philosopher of Spain and one of the biggest names in Islam.
This superiority owes to philosophes. Through his work and philosophical commentaries on Aristotle, he exercised the greatest influence on the progress of ideas in the Middle Age and became, for the scholastic theory, the personification of free thought.

Averroes, Ibn Tofail, Ibn Badja, Ibn Zohr, lived under the reign of Abdelmoumen, Yacoub El Mansour and Abu Yacoub, kings of Morocco from 10 to 14th Centuries. Throughout this period, these illustrious figures were considered as the various knowledge societies leaders.

Indeed, the progress of the West in all knowledge fields could only be achieved through patience and hard work of investigation, exploration and research that men of genius have, here and there, fructified, but still from first and fundamental acquisitions, those which were transmitted to Europe by the knowledge societies of Arab expression. The evolution state and progress in various scientific disciplines at present, is due, largely, to medieval Europe's own patrimony, and to what it has inherited from the Arab civilization, that carried gratitude to the Multiple knowledge societies, science of antiquity, of the Orient and the Far East.

2.2 The Muslim world subject to troubles in the transfer of knowledge

During the 15th, 16th and 17th centuries, there was a mysterious transfer of knowledge in the Muslim world.

Knowledge itself, originating from the Muslim world, was gradually sinking into a routine empiricism increasingly vague and imprecise, to be lost eventually in the maze of esoteric science of geomancy, astrology and talismanism.

These occult practices, condemned by the Koran, made their comeback. Organized in doctrines, the divination, the cabalistic practise, the incantation art found an unexpected refuge in a religion whose rationality and universality would be undermined.

The opening - since the 18th century - of Arab Islamic scientists on the Paracelsus science, and later in the 19th century on that of Latin Europe, could not change anything fundamental to a weakness whose underlying reasons exceeded the scope of fundamental sciences.

The revival of Medicine and Science in the Islamic world, under a new civilization, will occur precisely from the 19th century and will be projected in the 20th and 21st.
This period, which covers the beginnings of the renewal, is a crossroad stage, the search for identity, achievements and challenges.

Inaugurated in the early 19th century, and unabatedly continuing without any difficulties, it is characterized by new and valuable acquisition; however, by significant weaknesses that are inherent to the condition of the societies being developed.

2.3 Diffusion of knowledge in the history of the Islamic world

From the beginning of the 19th century, the first North African students are sent to Europe while at the same time missions of their Egyptian comrades, Turkish, Iranian, had preceded them in France, in Austria, in Germany, in Italy and Great Britain. As Magnien said: "In the decades that followed, the waves of people seeking knowledge and understanding do again, for their benefit, the same effort that made their predecessors succeeded in the East from the 9th to the 12th century. The only difference this time, they will resume some of their own heritage through the teaching of their European professors, and later American ones." paragraph needs work

This evolution will be accentuated and diversified with the construction and the organization of the universities, of the modern hospitals and health care centers. The effort continued throughout the 20th century, testify to them the ultra modern hospitals and sometimes fabulous as those which we see in certain Islamic countries. They are located in the line of the legendary establishments of the golden age of Islamic medicine and does not exceed of them less the latter by their magnificence, the luxury of their hospitality and the sophistication of their techniques. But if the technological improvement is introduced more and more in practice medical like condition first with the effectiveness of care and the access to the cure, on the other hand, are in parallel marked, the return if not permanence of a major attachment with the ancestral humanistic values of Islamic medicine.paragraph needs work

From where nowadays, ground growing interest of Islam, for arabo-Islamic medical sciences of last times whose teaching is likely to provide us invaluable lessons. This teaching relates to not only the étique one and the deontology but it still interests all the history of the men, the facts, the ideas and the doctrines and in general of the conditions which governed acquisitions of sciences arabo-Islamic, in its times more the records and its strongest moments.paragraph needs work

3 THE TRANSFER OF KNOWLEDGE

During the history, humanity developed a variety of techniques intended to preserve, transmit or work out knowledge, like school, encyclopedias, the press and the computers.

The acquisition of knowledge takes part in the social mobility. When, thanks to knowledge which it acquired, an individual of a lower social category succeeds in climbing the levels of the company by the professional recognition that it draws some.

3.1 Companies and laboratories ensuring the transfer of knowledge

How to transfer the knowledge of an institution to another? Here is the challenge which arose for people of the laboratories. How, for example, the research programs developed in a university can be adapted to the problems of a whole area?

The beauty of this project lies in its capacity to answer the interests of the three partners the purpose of who are:

- To be able to develop a wide and solid know-how quickly;
- To make the best practices explicit and transferable; and
- To develop an expertise in the transfer of knowledge by reinforcing its theoretical bases in particular on the matter, by identifying the best organisational practices and by developing tools adapted to these problems.

The work of the researchers in particular consists of identifying the best practices of laboratory, adapting them to reality and facilitating their establishment in the area. If need be, the researchers subject new solutions. “The challenge is of size”: it will be necessary to target the tools which function well, to include/understand the needs for the area, to find solutions valid and to propose pilot projects which answer their specificity. Each one of these stages is quite rich in teachings for the initiates and the initiators.

The expertise acquired in this field is applicable to all the cases of transfer of knowledge. The field of the transfer of knowledge is vast. It touches in particular stowing between the world of research and that of practice, the passage of a culture with another, that of the private with the public, a generation with another, and I pass from there. Within a company, for example, the question of the transfer of the knowledge, a generation with another, often takes the form of the making of knowledge of the future pensioners to the young employees.

3.2 General aspects of the transfer of knowledge

More than the general aspects of the transfer of knowledge, they are the practical aspects, the techniques of this transfer, which are re-examined in two parts:

The first part, "the stakes", gives an outline of the importance of the transfer of knowledge and geographical spaces in which seat this transfer takes. These spaces come in general; one tends too to forget it, of an acknowledged or hidden political will, national or international.

However, one will note a reference to the installation of a "technological survey, which echoes "the technological alarm" claimed at the European level and the "scientific and technical day before" exerted by the sectoral workshops of scientific information circulation, proposed in certain countries in the process of development.

The second part: milked with the "Novel methods, new approaches".
She recalls the interest of the novel methods: word processing, leading data processing, email, computer-assisted translation, computer-aided design, synthesis computer-assisted, and study of the relations structure-activity for the production and the transfer of knowledge. Data processing also makes it possible to ensure the follow-up and the planning of research thus providing tools of assistance to research but also of decision-making aid.

Some noted that the development of the use of these novel methods was sometimes slow, that they allowed a better access to knowledge but could be at the same time a brake with knowledge.

Interesting fact, the important place granted to the technology of the networks. It proves to be, as much in France that in England and in the countries in the process of development, an organisational form particularly adapted to solve the problem of the transfer of knowledge. They are at the same time the networks of equipment, and the networks of the actors of the transfer.

3.3 The transfer of knowledge, process of appropriation

It is not enough to distribute results of a search, to give access to the programs considered to be effective, to announce a new policy, to make known the new approaches taking into consideration problems; still should it be wondered how people will manage "to make their" this new knowledge and to integrate them in their practice. The stake of the transfer of knowledge is posed here advantage in terms of appropriation.

It appears essential that the people mobilize themselves in the acquisition and the application of new knowledge and that simultaneously the organization sets up a series of conditions supporting the acquisition and the integration of knowledge to contribute to the process of appropriation. Also, of the concrete actions must be defined to testify to this common will to engage in a process of appropriation of knowledge:

- To allow the participation in activities of diffusion which aim at giving access to knowledge under development; and
- To apply a measurement of sensitizing so that people define their intention to develop their professional competences in a new field of knowledge.

The appropriation is thus a *continuous* process, which allows a gradual passage of the acquisition of knowledge towards an experimentation of competences as people acquire a control on what concerns. The process of appropriation thus conceived wants to be a support for the development of competences taking into consideration knowledge new to be controlled, and the ultimate goal, at the same time for the individuals and the organization, is the development of the professional practices.

The follow-up of an activity, beginning at the end of the process of appropriation, that it makes it possible to have an idea of the number of people who were exposed to new knowledge and to estimate a rate of impregnation while following the course of the people until integration in practice daily.

According to the nature of knowledge to be acquired and according to the aimings of the organization with regard to those, it is important to determine as a preliminary, which will be the stages to be crossed and for which type of participants.

This process can be stopped constantly since each action constitutes a stage in the process of appropriation and that each stage of the process comprises its own coherence and its own objectives. However, the more advances in this process, the more the stakes of the appropriation of new knowledge become more and more complex. Indeed, it will be understood that to contact new knowledge does not comprise the same requirements and same engagement on behalf of the individuals of the organization.

3.4 Any company of knowledge implies transfer of knowledge

- **What is it about?**

The question tackled here is particularly delicate. No doubt that it is related to the problematic character of the expression even of *transfer of* knowledge: even if one draws aside *a priori the* psychoanalytical connotations and that one affirms that one speaks deliberately about another thing, even if these are only knowledge that one transfers, it is well the mediation of the Master or the trainer who is questioned and, with it, the traffic control of affects which one cannot, per decree, to abolish the existence. Moreover, the expression *transfer* lets us think of a "transport" and the metaphor indicates here an object which would pass from a point to another while remaining identical. However, we know well that regarding knowledge, it is nothing if not precise??, if it were thus, there would be never acquisition nor of progression. Lastly, the expression unquestionably suggests that one acquires initially and that one transfers after… what all current work contradicts, showing that the transfer is the condition of the training and not the reverse.
Then, is it really necessary to speak about the *transfer* of knowledge? Isn't this to introduce there unnecessarily, in the problems of the training and the formation, a useless concept, even a "concept screen"? If it is observed, indeed, by the smallest entry, it is likely to merge with the process of training itself and to bring back for us to the couple "assimilation accommodation"… And if it is looked at in a larger way, by describing it as the movement by which a subject adapts the knowledge, integrates them into its person by re-using them with her own initiative, the transfer of knowledge is likely to be only another name for acculturation or the autonomisation, even education.

Under these conditions, wouldn't it be wiser to give up this expression and to undertake research on another ground?

We do not believe it. Because, which shows all work, *it is well the heuristic fruitfulness of the concept*. Even if the things are not really stabilized with the psychological level, even if modelings are still groping, even if the prospects are not really convergent, the question of the constrained transfer us to think and reinterrogate our theories and our practices… It is that the transfer of knowledge, before lending itself to the least observation, least research on the conditions of its good progress is initially a teaching requirement and therefore it interests us:

• An education which would not place the transfer in the middle of its concerns would not be by no means émancipation, it would not be an education

• An acquisition which would maintain the dependence with the conditions, the context and the materials to which it is produced, would assign the subject with a mimetic repetition, moreover impossible and absurd.

• A training which would not worry to open new prospects of training would be simple conditioning.

In this direction, the transfer is well initially a requirement and we must paradoxically, curiously, recognize his statute before even beginning the work on the conditions of its implementation.

Strange assertion, and yet essential: the requirement precedes here, for us, the existence. Thus the teaching practices seem tools for exploration of the possibilities of transfe and not of the techniques deduced from an attested observation. Thus much of debates of schools lose all their

interest: to know if the transfer is possible in itself does not mean anything and will never make it possible to slice on the validity of such or such method On the other hand, knowledge if such or such practice the transfer supports and with which conditions is essential. More still, to include/understand how the requirement of the transfer can nourish all the teaching practices is determining: because it is when these practices carry this concern and wonder about the means of incarnating it which they will have some chance to become truly émancipatrices.
The basic concepts of the transfer of knowledge are stated as follows:

The majority of contemporary research in the field of pedagogy and the trainings meet the question of the transfers of knowledge…

1. This question is, with many regards, constitutive of the educational step itself: how a training carried out in a situation of formation given can be used elsewhere and on the initiative same of the subject which learned? Can one define knowledge which is transferable compared to others which would not be it or would be it less?
2. This question makes it possible to consider in a closely dependant way dimensions cognitive, emotional and social of the trainings: how a subject can be released from the bonds which have been necessary to him to a given moment of its evolution?
3. This question in the think tank on the interdisciplinarity is: does "common knowledge" exist to the whole of the disciplines of teaching and, if so, how to acquire them?
4. This question is in the middle of the reflection on the installation of any strategy of formation: is it necessary to give priority to the "logical and methodological" trainings or to stick to strictly disciplinary trainings?
5. This question questions didactic disciplinary themselves: are there knowledge founders likely to be used as matrix with various trainings of the same discipline?
6. This question, finally, returns to the relationship between declaratory knowledge and procedural knowledge: how are they built and which reports/ratios they between them maintain?

4 THE ISLAMIC WORLD THROUGH THE COMPANIES OF KNOWLEDGE: VISION OF MOROCCO

4.1 Basic principles

In Morocco, various channels intervene in acquisition, the transformation and the transfer of knowledge.

The diffusion of knowledge, sometimes named diffusion or transfer of knowledge is a discipline practiced by the few research centres: agronomic, forest, veterinary, universities:

- at ends of information of the public agencies, companies or other research centres;
- at end to promote their works in progress, with a view to the technology transfer.

This diffusion is practiced at scientific meetings or at congress, and published in various media.

It constitutes one of the information sources of what one calls the technological survey, a way of supervising the evolution of knowledge of know-how, feasibility and inventions in a field and his environments of development.

The diffusion of knowledge can be also made by the publication of thesis, articles, memory and encyclopedias (encyclopedias printed or digitized, encyclopedias on Internet etc…).

Morocco, like any developing country, seeks and uses any means likely to make, evolve and move its population so that it reaches a level of good being and progress acceptable.

We know the capacity of the communication. In these times of multiple crises, it is crucial to be able to provide exact information and in good time throughout the world.

The media offer a platform to make various concerns be heard. They can help to support the dialog, to fight against the false ideas and to dissipate the stereotypes. A true comprehension and tolerance between the people start truly with information.

In the age of cellphones of third generation and high band, whereas the news can travel the world instantaneously, millions of people do not have any access to information and technologies of the communication, which are the engine of our Societies of knowledge.

To support an accessible and adequate access for all to the super highway of information is thus a central aspect of the challenge to take up regarding human development.

Information and the communication by free media and the access to information for all are absolutely essential elements to build a better world for all.

To illustrate what occurs in the kingdom from Morocco, regarding the companies of knowledge, we wanted to approach one of the pilot schemes which is spirit to upset all the social base of the country: it is the national initiative for human development (INDH).

The national initiative for human development (INDH) is a Moroccan project of national scale aiming at raising the level of the Moroccan Societies at all the stages of its social layers.

The INDH has as a program of:

1. To fight against poverty with rural environment;
2. To fight against exclusion in urban environment;
3. To fight against precariousness.

The programs of the INDH are formulated as follows:

The INDH aims at the reduction of poverty, precariousness and social exclusion, through actions of:

- support for the income-generating activities;
- development of the capacities;
- improvement of the access terms to the services and infrastructures basic (education, health, worship, road, water and cleansing, environmental protection etc);
- support for the people in great vulnerability.

The INDH makes it possible to found a dynamics in favor of human development, coherent with the objectives of the millenium, having for values:

- the respect of the dignity of the Man;
- the protection and the promotion of the women's rights and of the child;
- the anchoring of the confidence of the citizens in the future;
- the implication and the integration of all the citizens in the economic channel.

The INDH is based on a decentralized step which respects the following principles:

- participation;
- strategic planning;
- partnership and convergence of the actions;
- good governance.

Each program must observe a precise procedure of identification and selection of the projects for its implementation.

2. True charters around human development

The INDH is organized around and according to the alive man within a company with principles directed well towards social environment.

The company has a role of protection, support and development of the Man. It must be organized in order to fulfill this role. The company must respect the Man and his needs.

The Man must be in the center of the system. Each individual must be considered and developed. In return, each one must contribute its share to the company.

The human society exists because the Men need the others to survive. The community protects the Man, supports it and significance gives him. The human society must thus be structured so as to fulfill this role near their members. They must respect the needs for the Man and give him the means of opening out.

The organization of Societies must thus be based on the respect of the human values, like fraternity and solidarity. These values must guide the men in the development of their policy, their economy and even their financial system. They are the essential base of any durable company.

The Man must be in the center of the Societies and his organization. All must be thought and conceived so as to allow its safety, its wellbeing and its development.

Only Societies which respects the Man can last. Indeed, a Society which does not respect the Man creates forcing of the categories of people disadvantaged, lowered or exploited. These situations generate frustrations and angers. That can lead to disturbances, riots, even a revolution. Such a company will thus be destabilized of this fact.

It is essential that our Societies are concerned with all. All the individuals count and must be taken into account. Each one has its value and its importance. Each one can contribute to the prosperity of its community.

Each one can bring something: work, ideas or resources. Each one can and must take part according to its aptitudes and its means.

It is thus important that a Societie makes it possible to each one to live decently, that it brings education and the instruction necessary and grants to all freedom to undertake and to be achieved.

The project of the INDH was launched by its Majesty Roi Mohammed VI in the months of May 2005 which was addressed to the people in order to explain the policy issues, economic and social of this great project.

All the provinces and communes of the kingdom were targeted; all nongovernmental associations (ONG) were associated with the project.

3. Principal tools used

One of the major assets taken into account in the INDH is represented by the TIC (information technologies and communication).

The TIC offer new opportunity employment, new tools for storage and the data processing, research, education, the formation, an easier access to the public service…

However this knowledge is a factor of discrimination between individuals and companies. The risk, it is that this company of knowledge remains for many citizens, a company of knowing, exclusive. To avoid that, it is necessary to take up the challenge of the formation in order to ensure its access to all of them. That is neither a whim, nor a fashion, but rather a need, translated by the need for a transformation related on the access and the use of the TIC. It is indeed, the first of the works of which the INDH was occupied and that well before its launching through the country.
The challenge for many countries is to build a culture of access to the Societie of knowledge.

a) Right to knowledge with the contents adapted to the needs

The training courses, which are available today thanks to communication and information technologies (TIC), allow the acquisition of knowledge and competences even apart from the structures of traditional education and training: each one, if it wishes it, can learn through the networks telematics, Internet, satellite television, etc In the case of the INDH, the role was delegated to nongovernmental associations (ONG).

It should be noted that the integration of the TIC in the countries in the process of development and particularly the countries African for examples, led to offers of service accessible to the greatest number. The TV-center thus represents an access to the Societies of knowledge as well to the profit of the rich urban populations or the weak income as rural communities and that through all the cities and communes of the Kingdom of Morocco

With what could have served the access to new technologies not having any utility for our daily life, our human development, cultural, social? To leave insulation, it is not only need to communicate with the others, it is also useful to fill its aspirations. The company of knowledge is carried out starting from the creation of contents and the use of tools meeting definite needs. This, through a dialog lived by adults, young people, children, each one with his manner, emphasizing a diversity of life, know-how, of creativity.

However, with the TIC, it is utopian to want to impose single contents. The contents of the TIC, cannot be circumscribed. That is with the telephone, television, Internet, it is difficult to have applicable standard contents solidified everywhere and for all. One creates media, not contents because it is personal, flexible, variable, transitory. Altogether, it adapts to the needs and the one moment requirements, of urgency, a context.

b) Adequate infrastructures and liberalization of knowledge.

The access and the use of the TIC suppose preconditions. A country which does not have infrastructures of telecommunication cannot engage in the formation of its population. This country must initially have basic infrastructures like electricity, the computer material, of the services of maintenance, as well as trainers etc

Questions such as the property and the control of the production and the division of knowledge, of the design of software, the use of the local languages and the choice of technology represent a handicap with the access and the equality of all for the Societies of knowledge.

One of the solutions would consist in forging Partnerships. Also, of strategic alliances at the national and regional level will have to be encouraged and launched to build networks and this, in order to create the bases for active and new policies. Associations, the co-operatives, the foundations with non lucrative goal constitute in Morocco the ideal partnership. Collaboration between the sectors public and private is a collaboration dictated by human development. These initiatives are accompanied by the fall of the tariffs of subscription, of facilities of importation of the materials… It should be noted that the private sector constitutes the main motor of the diffusion of the TIC.

In this world dominated by the TIC, nothing must never again remain secret. The knowledge must be universal and each one must have access there. It is for what the Community télécentres are spirit to be set up on the Moroccan territory. The purpose of they are to entitle the population to use.

The télécentre Communautaire called club of cyber is a meeting place and of promotion of the TIC for the populations. For this reason its main objective is not to make benefit, but to promote the TIC, by training the beginners and by giving access to most underprivileged. Nongovernmental associations, for example, intervene in the installation of the collective accesses to social vocation.

Associative work is an effective resource having for goal to touch the people who do not have means to learn or use these tools. The collective access thus makes it possible to return the training cost and the use of the material cheaper. Offering to those which would never have had the means of granting a computer or a connection Internet, opportunity of profiting, of thus making from it accessible and available the computer tools even in the moved back places.

The creation of spaces and virtual campuses (in the process of planning) by the setting in network of the universities, the schools, the training centres, supports the multiplication and the development of centers of acquisition of the knowledge accessible to all and adapted to the needs for the company. The multiplication of this remote lesson will support the development of education in general, the exchanges of good practices and the common experiments.

c) Competences and perpetuation of knowledge

The knowledge and know-how play a fundamental role in the development and the consolidation of competences. They are besides the keystone in the challenge of the formation and the access for all to knowledge. Also, any training policy will have to be more moved by demand rather by.

The formation is a challenge with which all the companies are confronted. It guarantees a participation in the company of knowledge. The training programs for a better access to the TIC require investments on all the levels. The training programs TIC in Morocco are conceived not only for the universities but also for primary and secondary education in the courts, means and long runs. Such programs target also the institutions of professional training. From the point of view of the training policy, it is necessary to develop professional training in order to provide a labor to guarantee functional networks. The access to the company of knowledge thus depends on the successful integration of new technologies, of the provision of relevant services and contents and quality. To reach this company confers the feeling to belong to a group, of communier and to communicate.

Nowadays, which pushes the individual to be registered with training courses, to seek the knowledge; it is the possibility of being able to acquire a competence which enables him to remain in the productive system and to find a new place there.

The question of the training in term of use and contents makes it possible to apprehend what can be local development, to seize the evolution like its implementation. Within this framework, the important thing is the pegging in collaboration with the populations, the policies and the determination of the modes of appropriation necessary.

New technologies are not an end in itself but simply mean which can make it possible to take part in the development. The democratization of the access to the company of information is to allow the many ones and various communities the appropriation of the knowledge.

Create in 2005, on the initiative of its Majesty Roi Mohammed VI, the INDH has the role to insert the Moroccan territory in the company of knowledge.

With the turn of new technologies Morocco became since 2006 experimental territory of new technologies, transmission, digitalization and exploitation of information, the contents and knowledge.

The power, the flexibility and the user-friendliness of these new approaches made it possible to combine mobility and nomadism, essential new Internet.

The first results of the INDH in Morocco currently show that today more than ever, information and the knowledge are factors of transformation of the companies to the planetary scales. The economic growth related to the increase in the productivity profits from the control of information technologies. In addition the appropriation of the knowledge seems the key component of human development. If science is useful for the company, it is also a source of profitable economic exchange and comprehension between the people.

Communication and information technologies nowadays upset the daily life of the majority of the inhabitants of Morocco. In the field of our economies, the upheaval makes it possible to reach and of globaliser the exchanges of tangible properties. Without Internet it would be probably inconceivable to manage in a so fluid way the production of goods of the other end of planet and their routing towards other markets on various continents.

In the near future, new technologies will support the emergence of new marketing activities based on the sale of works, ideas, of services, in short of tangible properties whose value is estimated indirectly.

It is there one of the facets positive of human development which we take into account in the progress which takes place nowadays through the countries of the Islamic world.

5 CONCLUSION

In this beginning of the 21st century one speaks about the collapse of Communism and his revolutionary flame. The relay is taken from now on by the Islam, today again moving, on an increasingly assured rate/rhythm having highly effective companies of knowledge.

His awakening, sometimes restless, does he not follow the logic of painful nightmares that have tormented during his long sleep? Listen more carefully, the profound message of Islam is today reborn.

No one better, than the scientist or the doctor is likely to confer on this message its more strong accents of truth, serenity and justice.

No one another ground that of medical sciences, for example, does not lend itself better to a dialog which, without asking of precondition, would not be involved for more and more beneficial. The knowledge introduced by the studies of arabo-Islamic fundamental sciences, according to the lighting which one will carry on such or such of his dimensions, can, by many sides, to help to look further into the reflection around the choices which arise for the man, at the beginning of this 21st century.

They are likely to interest largely as well the doctor, the well-read man, the scientist, the historian, the orientalist, the philosopher, the moralist, without speaking about the sociologist and the politician. They are likely to enrich, the horizons of a general public which seeks, to bring answers useful to some of the questions which do not cease challenging us today.

By leaning us on the modes and the assets of the companies of knowledge within the Islamic world, we will be able only there to find a new confirmation of the accuracy of the current currents of the evolution of the progress of humanity.

Admittedly, the fields of the scientific research and the permanent discoveries are still in an embryonic state. But there still, the perspicacity of the arabo-Islamic leaders is surrounded by judicious councils and the advent of 21st century proves to be full with promises for the realization of the culture medium essential to research. In testifies to this walk about better days, the many publications of fundamental research coming from the Islamic countries and the Maghreb in particular. They represent the index of the tireless efforts made by our leaders, who, by the dint of their personal relationship assert themselves as a guarantor of the creativity in the field of knowledge in all his forms.

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The challenge to Access a Knowledge-based Economy: The Case of Algeria

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ABSTRACT

The knowledge based economy is an important challenge because in the meantime it was limited to the developed countries. However, the strategies adopted in the advanced countries could also succeed in the less affluent countries and the less developed.

The globalisation process is a result of more than two decades of the emergence of the knowledge economy and society. Today no country can expect to be developed if it does not meet the challenges of a globalised economy based on knowledge. In other words, if it does not tend to build an economy and society of knowledge.

The sudden decrease of oil prices in 1986 led two years later to the multidimensional crisis that caused the popular uprising of October 1988, followed by the civil war of the nineties. The Algerian society was forced to submit to the structural readjustment plan advocated by the International Monetary Fund and to recompose/ reconstruct itself on new basis in order to change the hydrocarbons economy into a productive one by turning towards a development strategy based on knowledge.

The experts of the World Bank believe that the knowledge economy in Algeria should be based on four pillars which are: Education at all levels, capacities for innovation in various forms, information and communication technologies and business climate.

Algeria has a lot of steps to catch up with countries like Jordan and Malaysia, in terms of knowledge based economy. Nonetheless, it has significant means /resources; a very young population, a telephony network of a remarkable density, all these factors can contribute quickly to the establishment of a knowledge based economy.

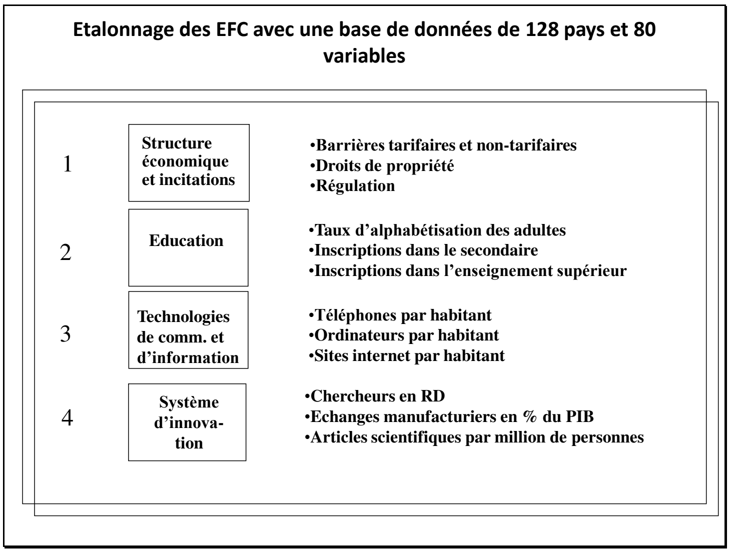


Figure 1. Etalonnage des EFC avec une base de donnees de 128 pays et 80 variables.

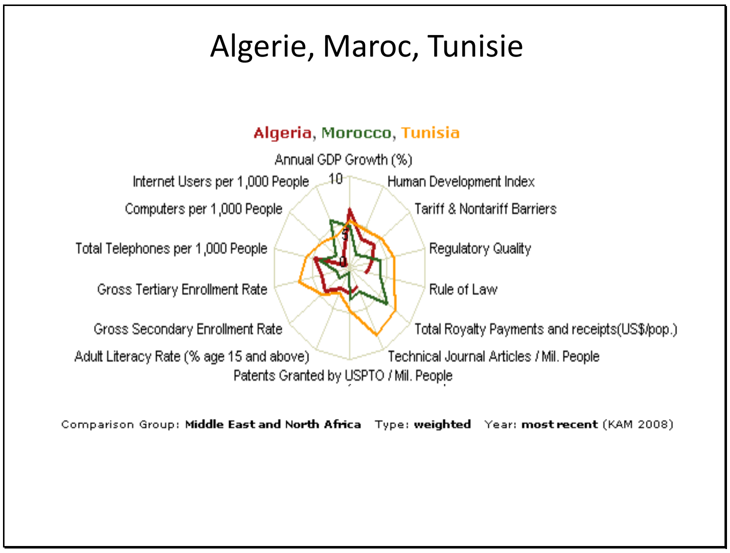
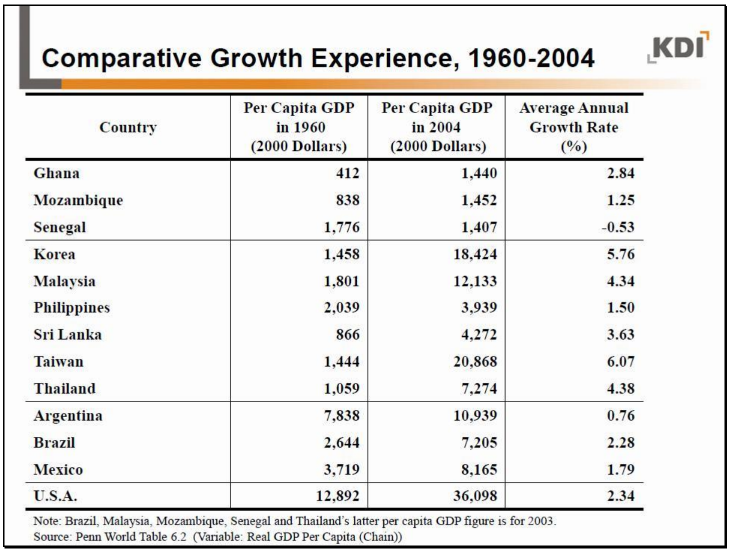


Figure 2. Algerie, Maroc, Tunisie.



Comparative Growth Experience, 1960-2004

Country	Per Capita GDP in 1960 (2000 Dollars)	Per Capita GDP in 2004 (2000 Dollars)	Average Annual Growth Rate (%)
Ghana	412	1,440	2.84
Mozambique	838	1,452	1.25
Senegal	1,776	1,407	-0.53
Korea	1,458	18,424	5.76
Malaysia	1,801	12,133	4.34
Philippines	2,039	3,939	1.50
Sri Lanka	866	4,272	3.63
Taiwan	1,444	20,868	6.07
Thailand	1,059	7,274	4.38
Argentina	7,838	10,939	0.76
Brazil	2,644	7,205	2.28
Mexico	3,719	8,165	1.79
U.S.A.	12,892	36,098	2.34

Note: Brazil, Malaysia, Mozambique, Senegal and Thailand's latter per capita GDP figure is for 2003.
Source: Penn World Table 6.2 (Variable: Real GDP Per Capita (Chain))

Figure 3. Comparative Growth Experience, 1960-2004.

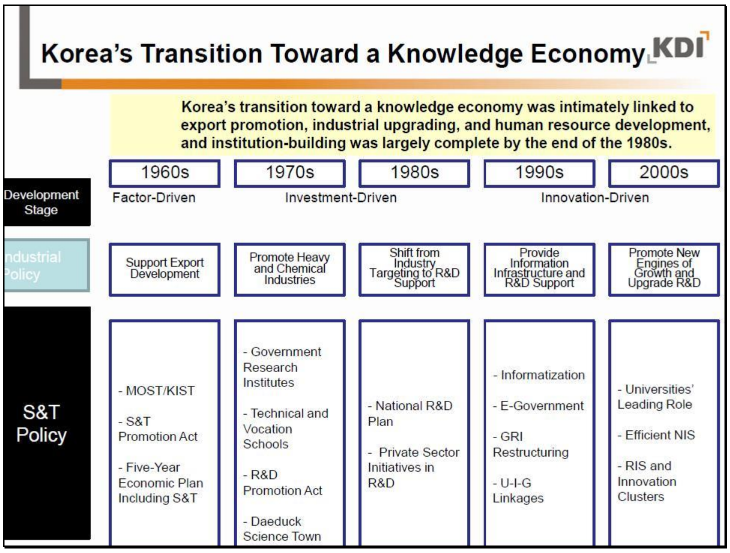


Figure 4. Korea's Transition Towards a Knowledge Economy.

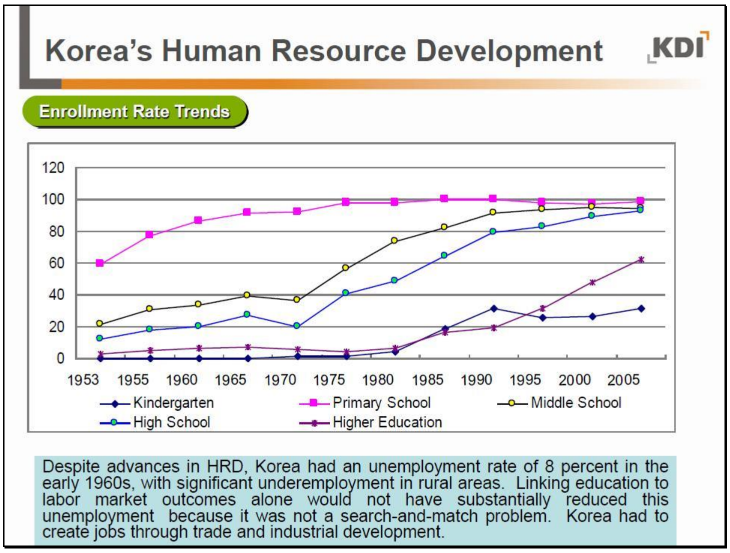


Figure 5. Korea's Human Resource Development.

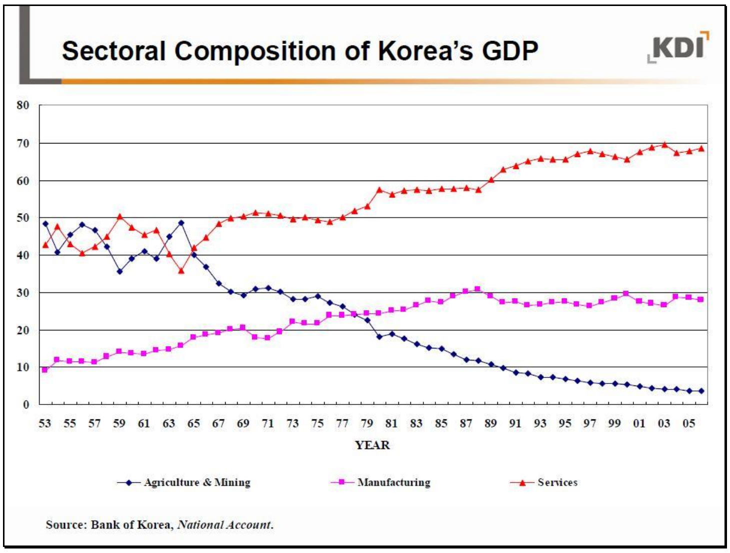


Figure 6. Sectoral Composition of Korea's GDP.

KBE : ALGERIAN COURSE OF ACTION

- **Objective** : sustainable development through better Integration into the global trading process
- **Course of action**: To take a fresh look at the economy sharing information the basis of economic, social and cultural operation of the country
- **Methodological Basis**: National report: ''And economy based on knowledge: Inventory of fixtures'' (December 2008)
- **Partner**: World Bank Institute (WBI)-CNES symposia; WBI devoted to the KBE, Algiers (09/10-11/2007 ands 09/23-24/2008

Figure 7.KBE: Algerian Course of Action.

Approach

- National committee KBE (25 members)
- Representatives:
  - ❑ public institutions
  - ❑ economic operators public and private
  - ❑ academic sector
  - ❑ civil society
  - ❑ Media
- Intersectoriality, inclusiveness, integration

Figure 8. Approach.

Conditions of success :

- An economic and institutional appropriate context
- Well formed and creative populations
- Developed Infrastructures T.I.C.
- A system of dynamic innovation

Algerian specificity

Culture

Territorial view

Figure 9. Conditions of Success.

- **The Context**
- ❑ Political will at the highest level
- ❑ Operational Realization : Institution of "KBE" focal point in Each Department on prime minister instruction
- ❑ "KBE" national report being finalized

- **The global view** :
- ❑ To capitalize the Algerian youth population
- ❑ To release the initiatives, in particular local
- ❑ Paradigm founder after oil resources
- ❑ Getting to a new growth regime
- ❑ Diversification of the national economy
- ❑ Re- revitalize the services sector

Figure 10. The Context.

The K.B.E. mainstay perception

- Human capital (vs education)
- Governance (vs climate business)
- Information Technologie and Communication
- Innovation
- Culture

Figure 11. The K.B.E Mainstay Perception.

The Human capital

- Indisputable progress in schooling and health
- Attenuation of regional disparities
- Strong action of adult literacy (voluntary movement)
- Professional training support
- …
- Rate of schooling according to the sexes (2008)

General census of population 2008

	Boys	Girls	Together
Maximum	95,2	95,9	95,5

Figure 12. The Human Capital.

NEGATIVE FACTORS/POSTIVE FACTORS

- Weakness of the sector services
- Banking
- informal sector
- Access to finance
- Access to industrial land

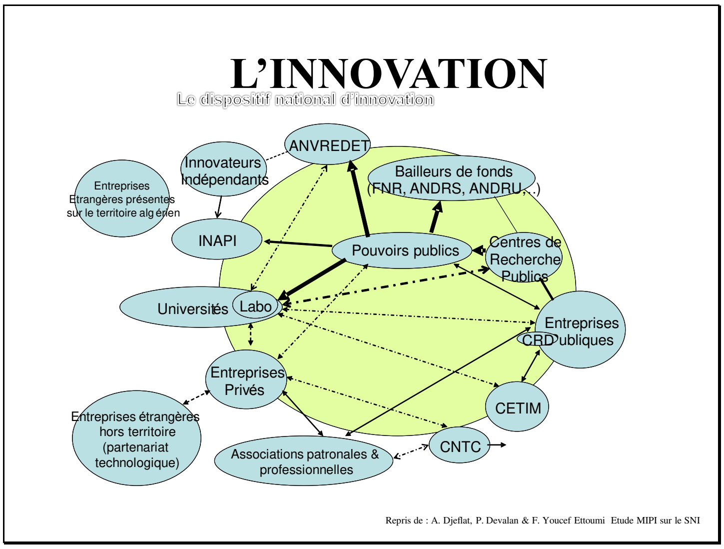
Constraints :

- Meet the social demand

- Justice reform
- Penal code/ civil code
- Public Procurement code…

- **Advantages :**
- Market size
- Labour costs
- Energy costs
- Geographical position

Figure 13. Negative Factors/Positive Factors.



Figurre 14. L'innovation.

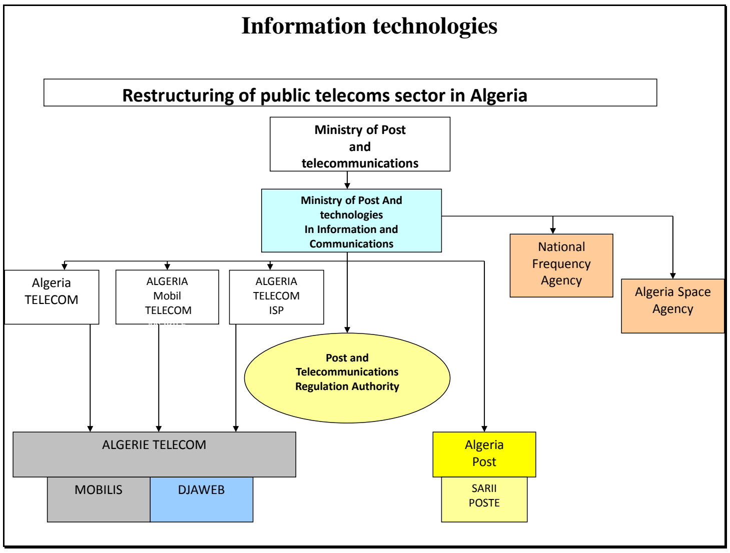


Figure 15. Information Technologies.

INFORMATION TECHNOLOGIES

- Education: Generalization of computer education at all levels
- Strategy in Algeria 2013
- Increase of the e-services
- Internet transaction
- Explosion of mobile telephony
- Ousratic operation
- High tech.Business Zones
- ...

Figure 16. Information Technologies.

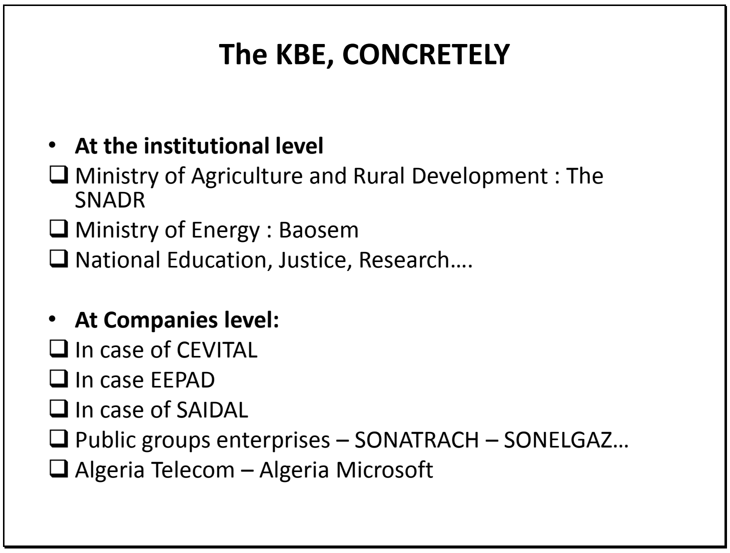


Figure 17. The KBE, Concretely.

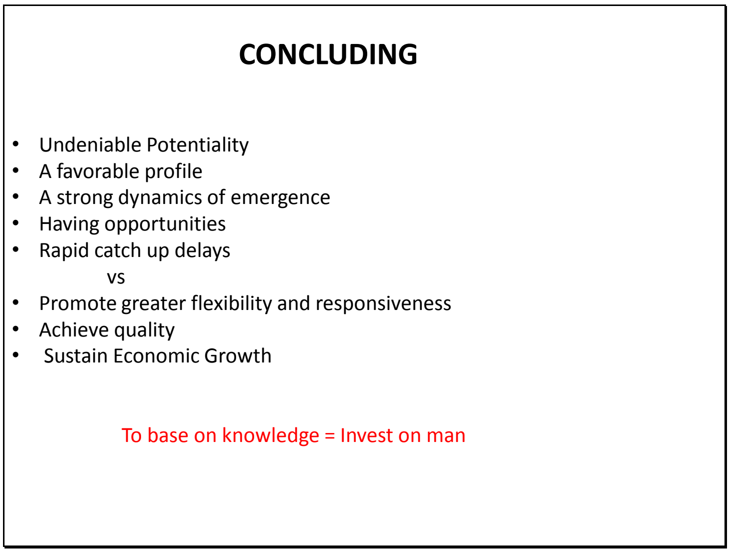


Figure 18 Concluding.

PART EIGHT

KNOWLEDGE AND THE MEDIA FORUM

Genome-based Discovery Platform Uncovers Biotechnology Potential of Papaya and Rubber Genomes

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Chief Executive Director
Centre for Chemical Biology
Universities Sains
Malaysia

ABSTRACT

Papaya is a fruit crop cultivated in the tropical and subtropical regions, and is known for its nutritional benefits and medicinal applications. The Advanced Studies in Genomics, Proteomics and Bioinformatics, University of Hawaii, in 2008 completed the draft genome of transgenic papaya (*Carica papaya* Linnaeus). It provides the foundation for revealing the basis of papaya's distinguishing morpho-physiological, medicinal and nutritional properties, including disease resistance protein family.

Rubber is a very important cash crop, second only to oil palm in Malaysia. The export earnings of the rubber industry, including heveawood products, is ~RM24.3 billion, accounting for 4.2% of national exports earning. The Centre for Chemical Biology at the Universiti Sains Malaysia (CCB@USM) has decoded the first-ever draft of the approximately 2 billion base genome of the Rubber Tree *Hevea brasiliensis* using its seamless chemical biology discovery platform. To validate the assembly and annotation, decoded genes were then used to map out the rubber biosynthetic pathways whose end-products are used world-wide to support a multi-billion dollar global industry.

Figure 1.

Figure 2. Genome-Based Discovery Platform.

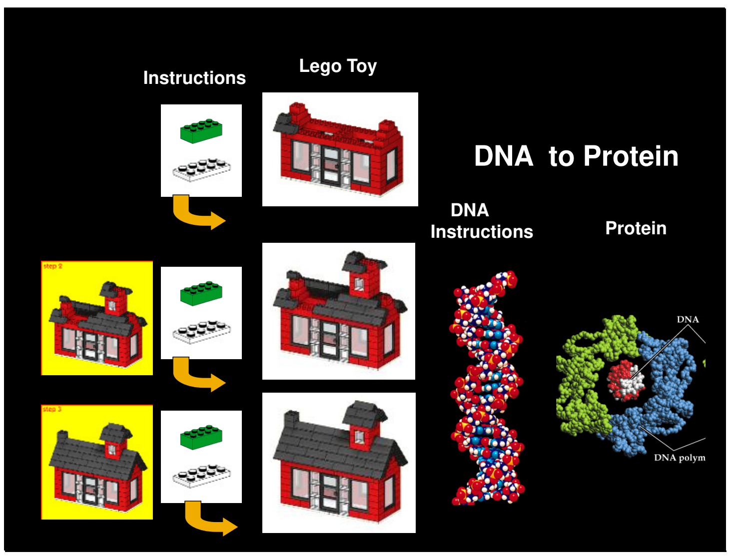


Figure 3. DNA to Protein.

Figure 4.

Figure 5. Malaysia's Hottest Hot Springs.

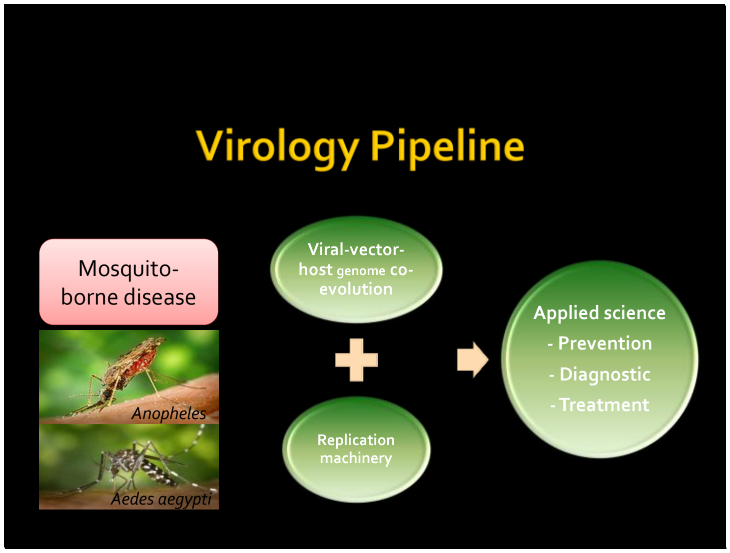


Figure 6. Virology Pipeline.

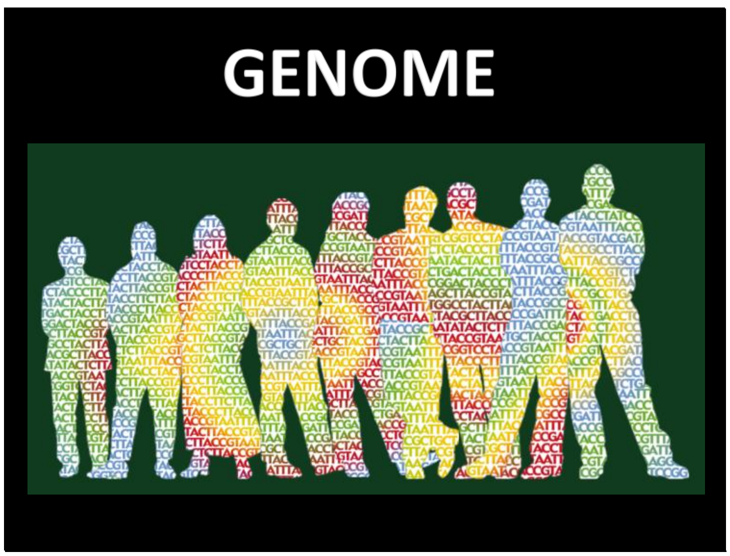


Figure 7. Genome.

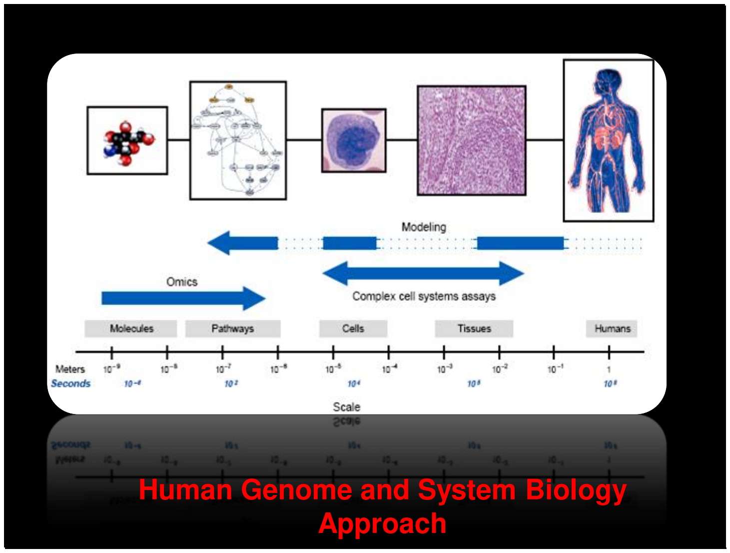


Figure 8. Human Genome and System Biology Approach.

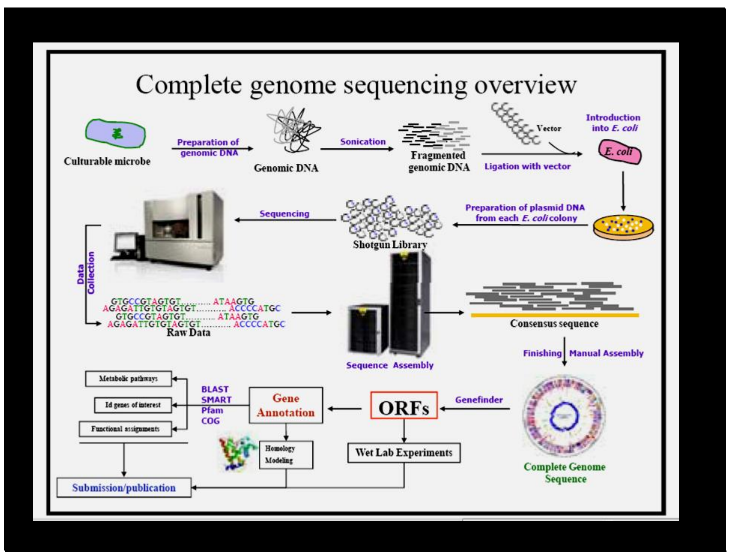


Figure 9. Complete Genome Sequencing Overview.

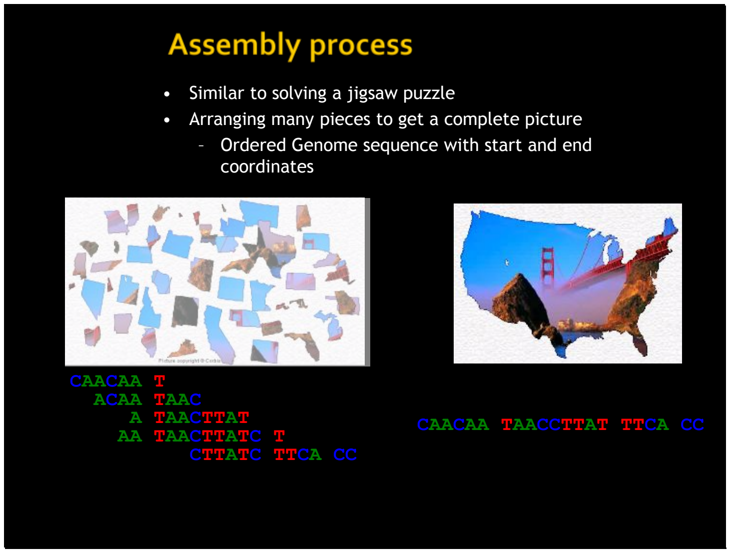


Figure 10. Assembly Process.

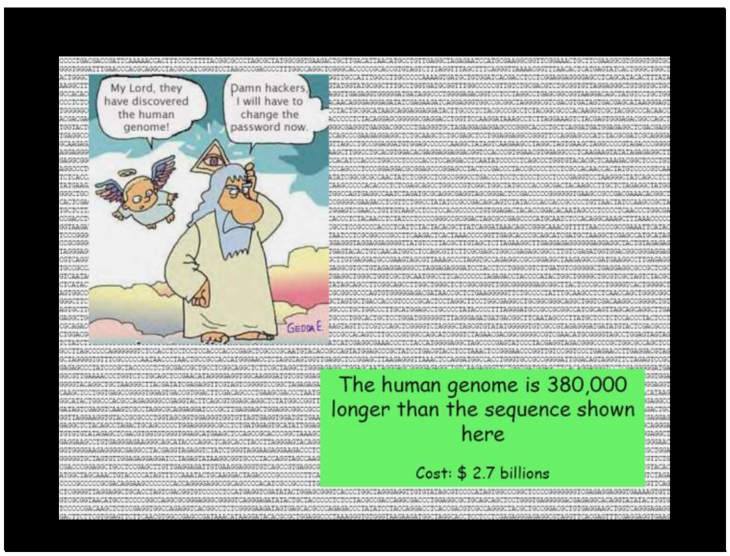


Figure 11. The Human Genome.

Figure 12.

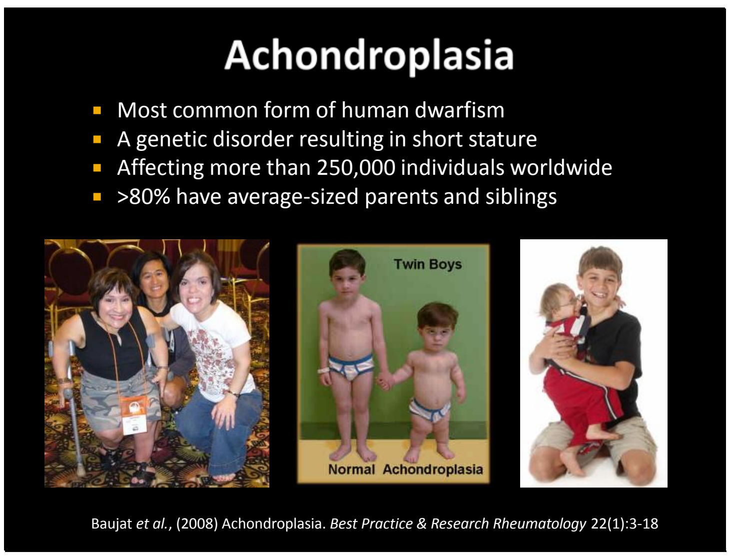


Figure 13. Achondroplasia.

Figure 14. Driving Inspirations Into Reality.

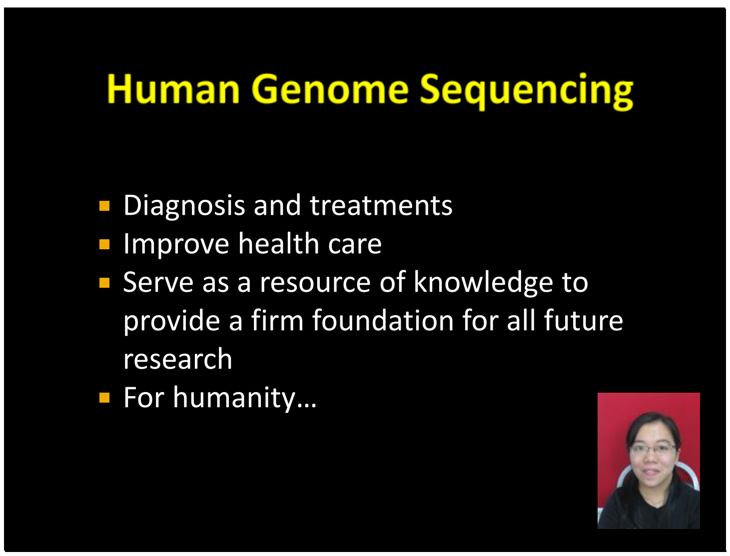


Figure 15. Human Genome Sequencing.

Figure 16.

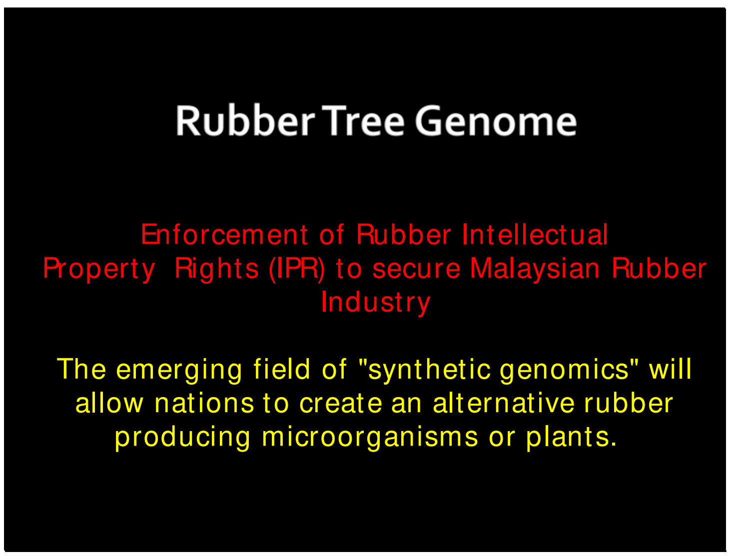


Figure 17. Rubber Tree Genome.

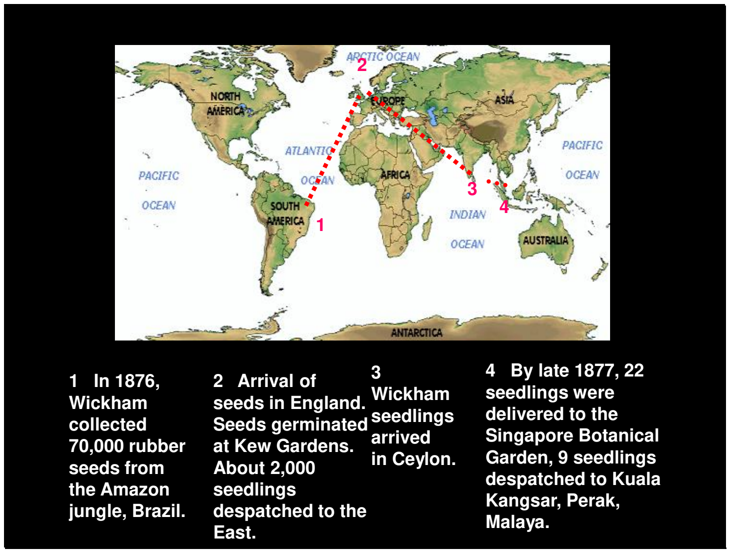


Figure 18.

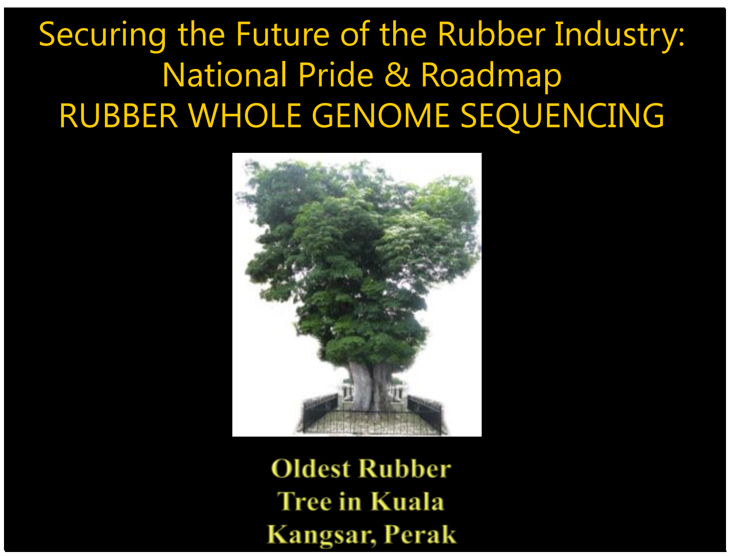


Figure 19. Securing the Future of the Rubber Industry: National Pride & Roadmap.

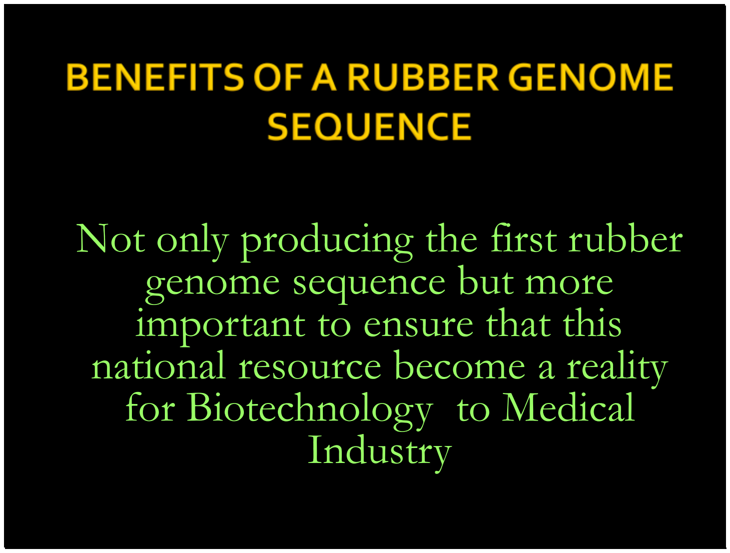


Figure 20. Benefits of a Rubber Genome Sequence.

Figure 21.

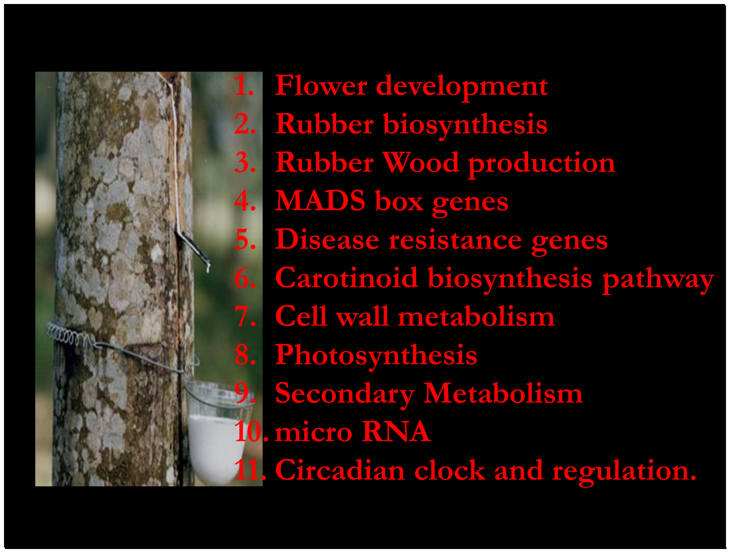


Figure 22.

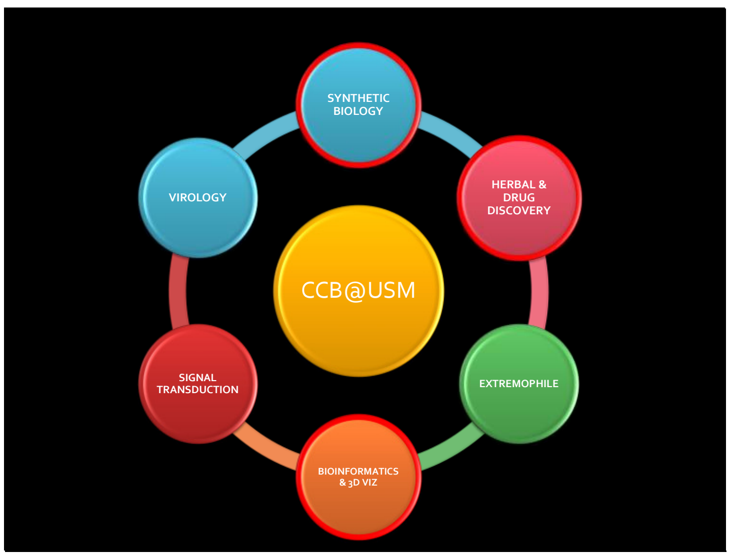


Figure 23.

Figure 24. Natural Product – Plants.

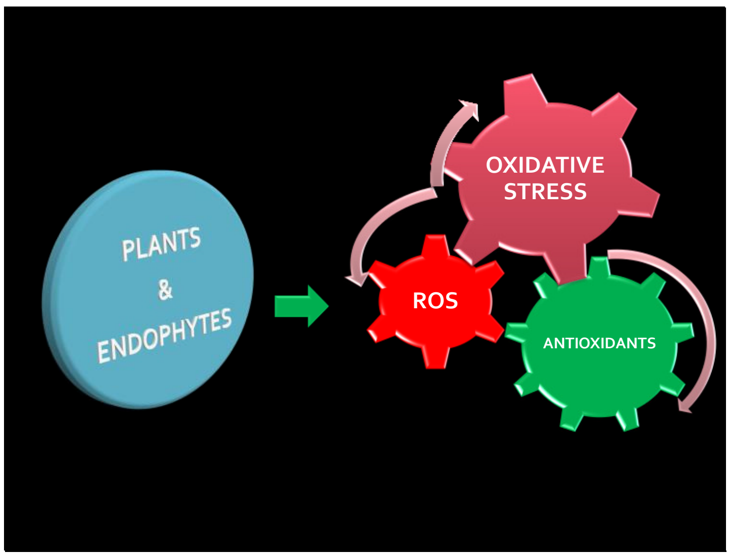


Figure 25.

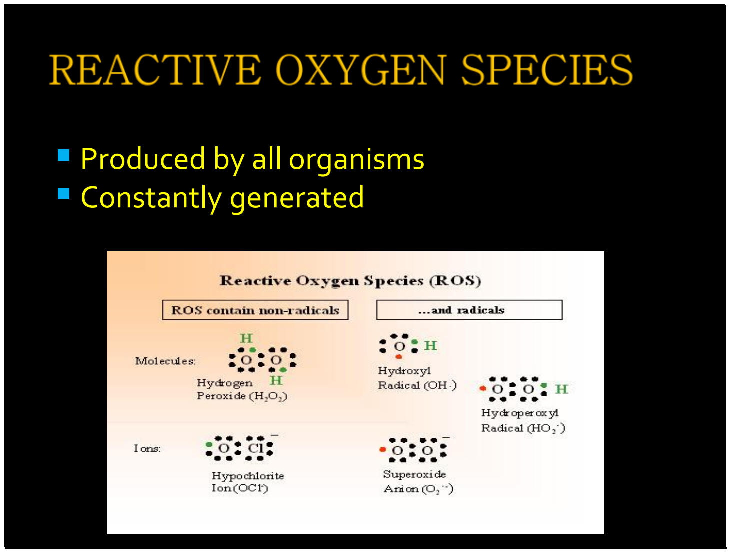


Figure 26. Reactive Oxygen Species.

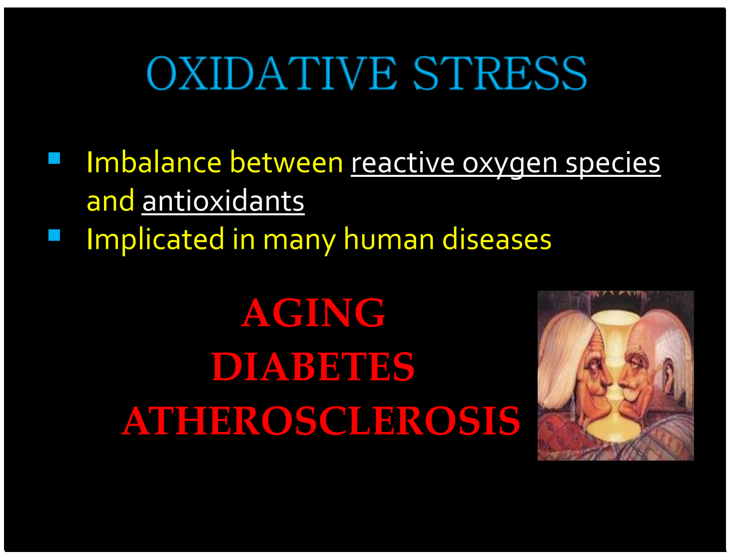
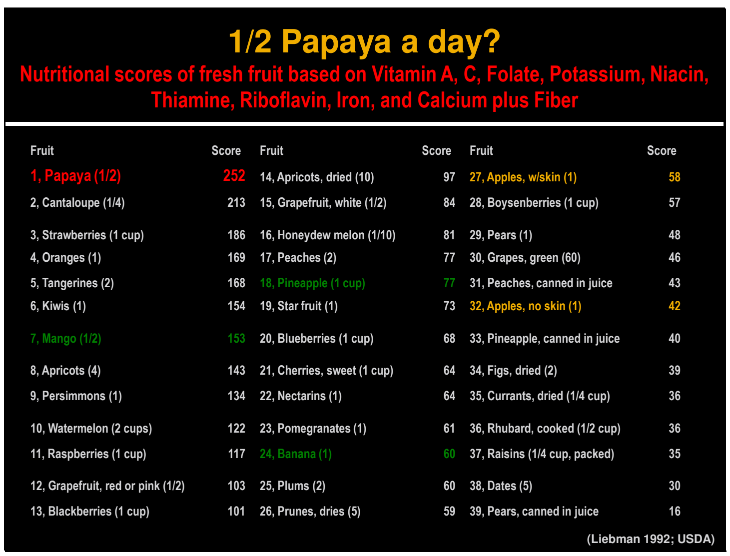


Figure 27. Oxidative Stress.

Figure 28. Antioxidants.



Fruit	Score	Fruit	Score	Fruit	Score
1, Papaya (1/2)	252	14, Apricots, dried (10)	97	27, Apples, w/skin (1)	58
2, Cantaloupe (1/4)	213	15, Grapefruit, white (1/2)	84	28, Boysenberries (1 cup)	57
3, Strawberries (1 cup)	186	16, Honeydew melon (1/10)	81	29, Pears (1)	48
4, Oranges (1)	169	17, Peaches (2)	77	30, Grapes, green (60)	46
5, Tangerines (2)	168	18, Pineapple (1 cup)	77	31, Peaches, canned in juice	43
6, Kiwis (1)	154	19, Star fruit (1)	73	32, Apples, no skin (1)	42
7, Mango (1/2)	153	20, Blueberries (1 cup)	68	33, Pineapple, canned in juice	40
8, Apricots (4)	143	21, Cherries, sweet (1 cup)	64	34, Figs, dried (2)	39
9, Persimmons (1)	134	22, Nectarins (1)	64	35, Currants, dried (1/4 cup)	36
10, Watermelon (2 cups)	122	23, Pomegranates (1)	61	36, Rhubard, cooked (1/2 cup)	36
11, Raspberries (1 cup)	117	24, Banana (1)	60	37, Raisins (1/4 cup, packed)	35
12, Grapefruit, red or pink (1/2)	103	25, Plums (2)	60	38, Dates (5)	30
13, Blackberries (1 cup)	101	26, Prunes, dries (5)	59	39, Pears, canned in juice	16

(Liebman 1992; USDA)

Figure 29. ½ Papaya a Day?

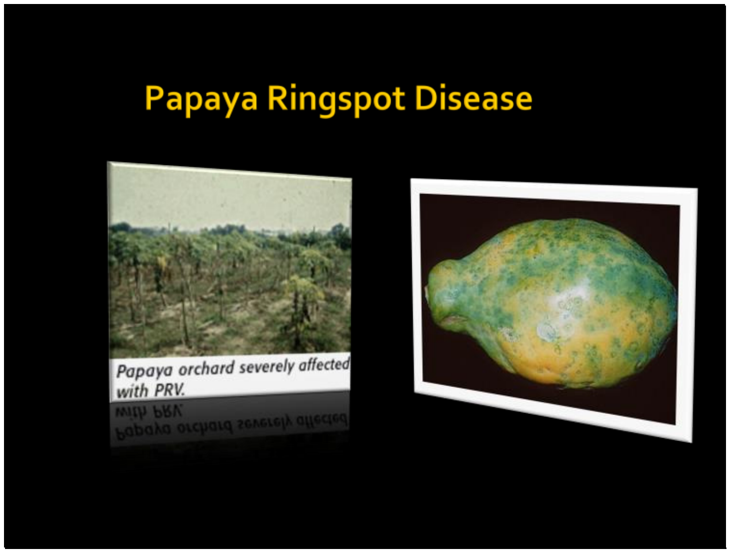


Figure 30. Papaya Ringspot Disease.

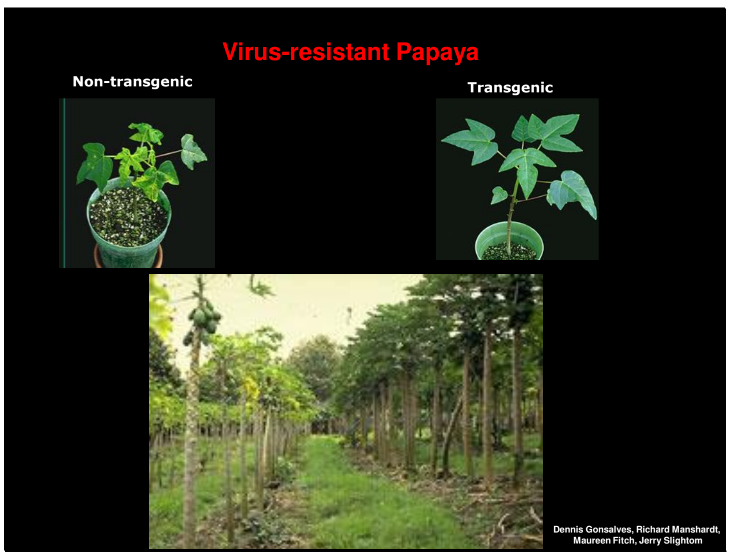


Figure 31. Virus-Resistant Papaya.

Figure 32.

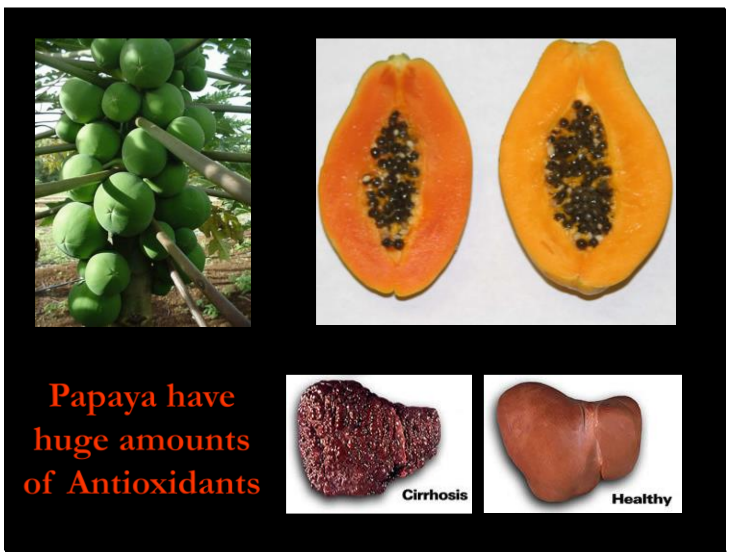


Figure 33. Papaya Have Huge Amounts of Antioxidants.

Figure 34. Nature.

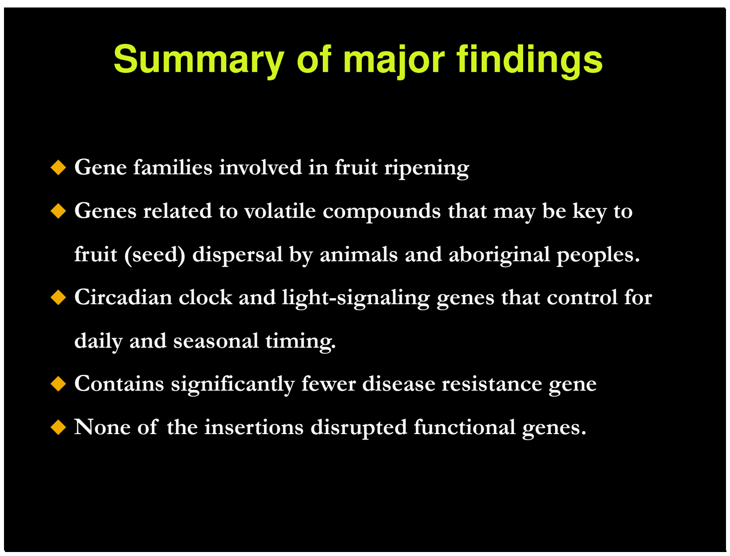


Figure 35. Summary of Major Findings.

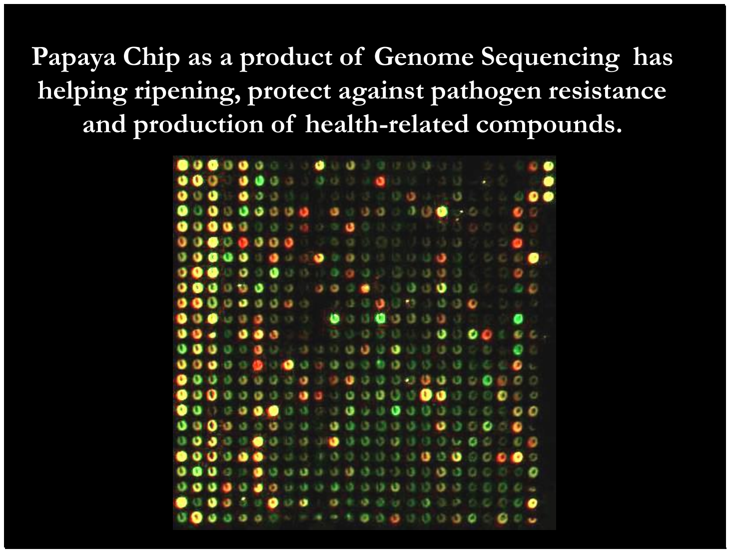


Figure 36.

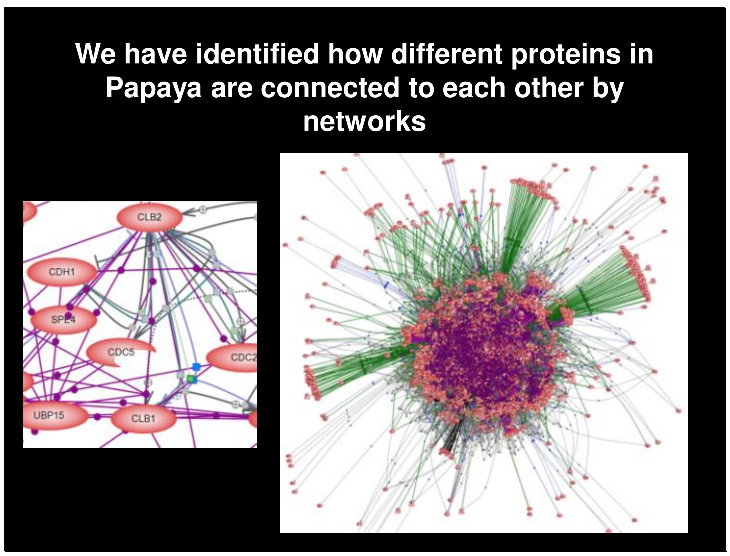


Figure 37.

Figure 38.

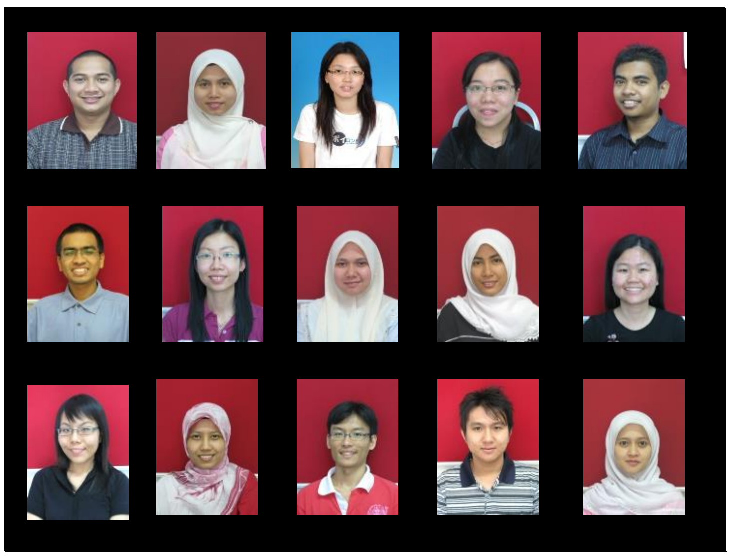
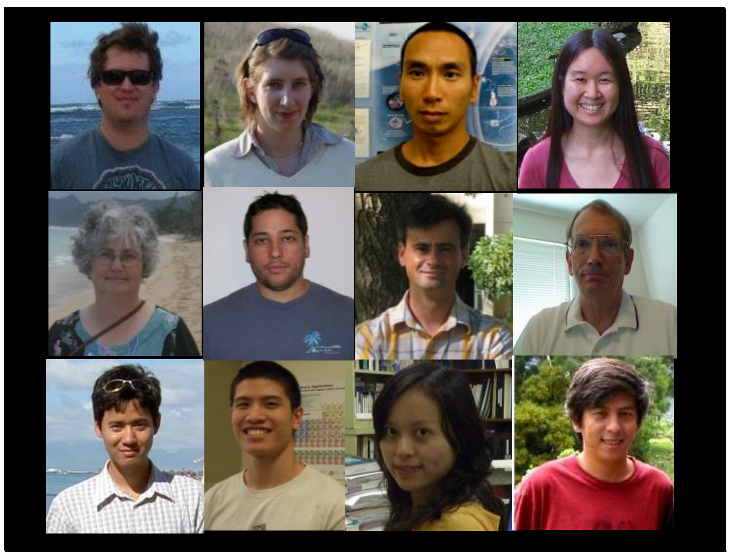
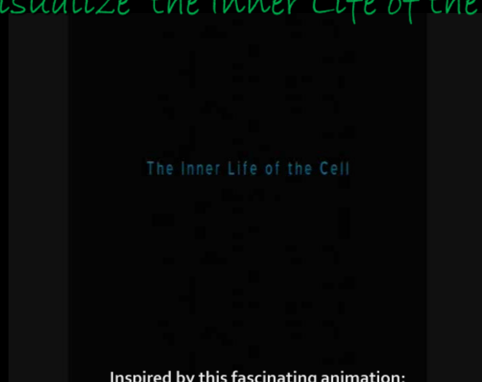


Figure 39.



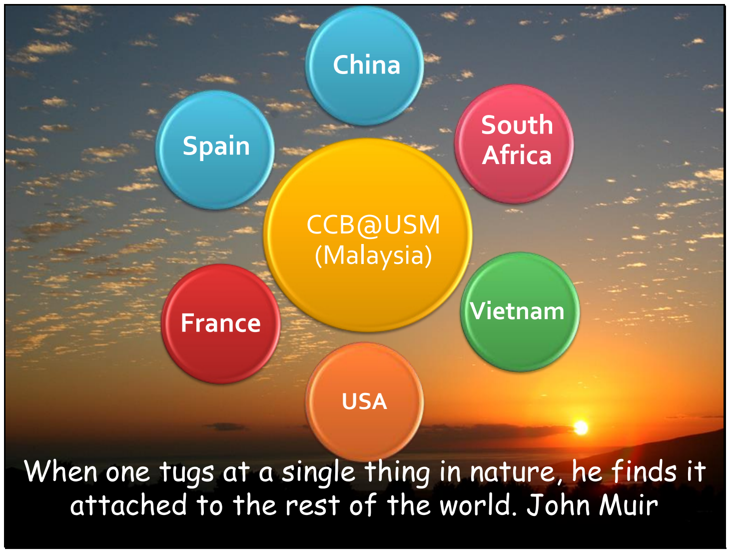
Genome-based Discovery Platform helps to visualize the Inner Life of the Cell



Inspired by this fascinating animation:

Inner Life of the Cell Animation Conception and Scientific Content by Alain Viel and Robert A. Lue.

Animation by John Liebler/XVIVO and Harvard University


China
Spain
South Africa
CCB@USM (Malaysia)
France
Vietnam
USA
When one tugs at a single thing in nature, he finds it attached to the rest of the world. John Muir

Towards the Knowledge Society: The Gambia as an OIC Country Starting–up

MUHAMMADOU M. O. KAH
Vice Chancellor, Professor of Information Technology & Communications
University of Gambia

ABSTRACT

This paper aims to dispassionately present the facts, informed by research, professional experience and existing literature, on the Knowledge Economy, ICTs and how they can help in revitalizing and transforming The Gambia into a knowledge economy and the role of the private, public and NGO sectors, as well as the University of The Gambia in this quest. This non prescriptive reflection does not suggest a parody and/or a mirage in The Gambia's quest to augment and/or shift aggressively to the next frontier- the knowledge economy, neither is it pessimistic nor lack faith in the current abilities of these entities to execute and propel the development engines. Rather it acknowledges the huge investments and intellectual capacity needed to empower these entities and the people working tirelessly to develop them.

To provide a logical build up to the central theme of this discourse – the knowledge economy, the linkages between economic development, poverty reduction and social capital are highlighted. While discussing the factors contributing to knowledge based systems, this paper contextualizes these by relating them to The Gambia's local environment including its developmental blueprints of Vision 2020 and the Silicon Valley quest of the Government of The Gambia.

As the Gambia's premier and only University, the centrality of The University of The Gambia in the requisite paradigm shift is critically reviewed leading to the concluding recommendations that among other interventions, The Gambia requires investments in basic science education, higher level research and development, innovative business models, ICT integration in the socioeconomic fabric of society, as well as increased public and private sector partnerships.

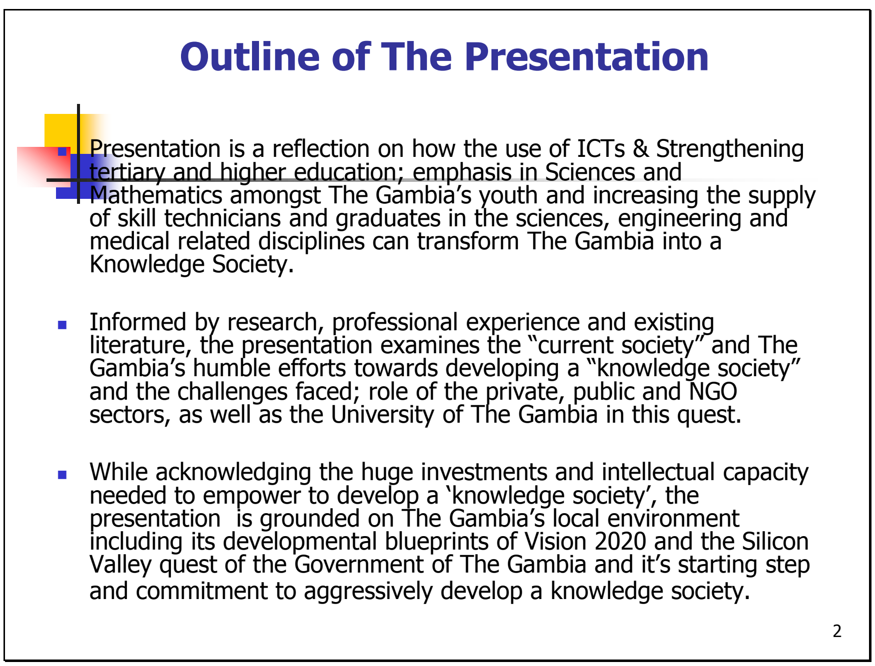


Figure 1. Outline of the Presentation.

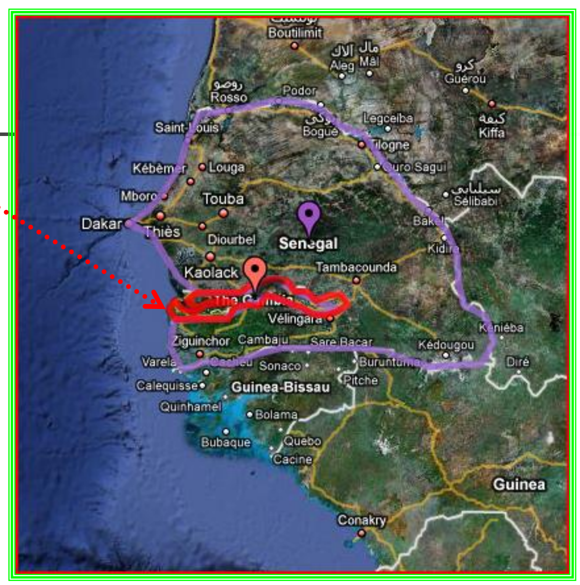
The Gambia – A Brief Country Profile

- "Smallest country in Africa"
- Land area of 11,300km square; 50 km wide from North – South and 320 km from East to West
- Total population:1.4 Million (2004 Census)
- Gained independence in 1965 and has a Parliament and Executive President
- Economy is dominated by the productive sectors of agriculture and tourism as well as the re-export trade to the sub region

3

Figure 2. The Gambia – A Brief Country Profile.

GAMBIA



4

Figure 3. “Transforming The Current Society”: Gambia’s Socio Economic Background.

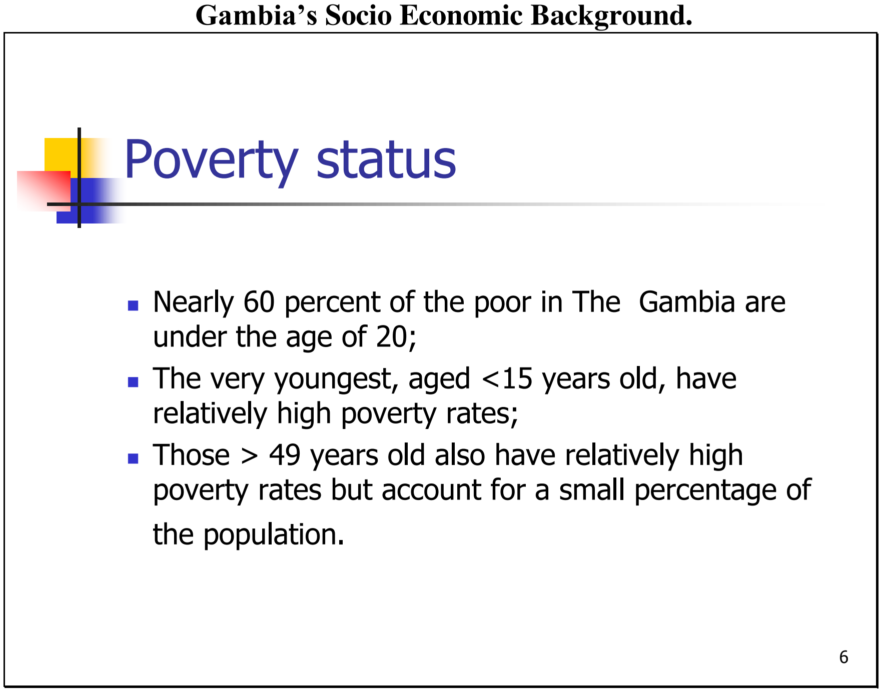


Figure 4. Poverty Status.

Cont.

- Poverty assessment indicates that Gambians are migrating out of the agriculture sector into industry and services;
- Rural to urban migration: over the past 15 years, the economically active population in urban areas grew by an annual average rate of 4.65 percent compared to 1.29 percent in the rural areas;

7

Figure 5. Cont.

Sector growth and employment opportunities

- Hotels generate more than 4000 jobs, or 2700 in equivalent full-time jobs;
- Similar amount of direct employment (in restaurants, excursions, taxis, shopping)
- 3000 indirect jobs with suppliers;
- Jobs in tourism are also relatively well paying. The average monthly earnings of a hotel worker, including tips, have been estimated at Dalasi 5,000 (source DTIS, 2008);

8

Figure 6. Sector Growth and Employment Opportunities.

Time use among the young people in the Gambia: results from the 2008 IHS survey

- 35 percent of 15-24 year-olds are still in full-time education
- 25 percent is in full time work and 2 percent is actively seeking work
- About 9 percent combine the two activities

Employment status by age group

		Unique activity categories						Aggregate activity categories		
	Age group	(1) Only in work	(2) Only in education	(3) Combining work and education	(4) Unemployed and not attending school	(5) Inactive	Total	Employed (1)&(3)	In education (2)&(3)	Jobless and not attending school (4)&(5)
Total	15-17	14.1	53.6	14.0	0.2	18.0	100	28.1	67.6	18.2
	18-19	20.7	40.8	11.3	1.4	25.8	100	32.0	52.1	27.2
	20-24	34.0	18.3	5.1	4.4	38.3	100	39.1	23.4	42.7
	15-24	**24.5**	**34.8**	**9.4**	**2.3**	**28.9**	**100**	**33.9**	**44.2**	**31.2**

Figure 7. Time Use Among the Young People in the Gambia: Results from the 2008 IHS Survey.

Time use among the young people in the Gambia: Results from the 2008 IHS survey

Important differences exist: **By age group:**

There are large differences in involvement in education, with relatively few people continuing education beyond their teens into young adulthood;

School attendance decreases substantially between ages 15 and 19 but drops in enrolment are not accompanied by similar increases in employment (i.e as students drop out of school they are likely to become jobless).

Figure 8. Time Use Among the Young People in the Gambia: Results from the 2008 IHS Survey.

Time use among the young people in the Gambia: Results from the 2008 IHS survey

By gender: females are less likely to be employed and less likely to be in education than their male counterparts;

By area of residence: rural young people are much more likely to be employed and less likely to be unemployed.

Youth Employment status by gender and location

Gender and location	(1) Only in work	(2) Only in education	(3) Combining work and education	(4) Unemployed and not attending school	(5) Inactive	Total	Employed (1)&(3)	In education (2)&(3)	Jobless and not attending school (4)&(5)
	Unique activity categories						Aggregate activity categories		
Male	**24.6**	**35.2**	**11.2**	**2.2**	**26.7**	**100**	**35.8**	**46.4**	**28.9**
Female	**24.4**	**34.5**	**7.7**	**2.5**	**30.9**	**100**	**32.1**	**42.2**	**33.4**
Urban	**16.8**	**39.6**	**7.1**	**3.1**	**33.4**	**100**	**23.9**	**46.7**	**36.5**
Rural	**37.7**	**26.8**	**13.3**	**1.1**	**21.1**	**100**	**51.0**	**40.1**	**22.2**

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Source: Calculations based on *the Gambia Integrated Household Survey, 2008*

Figure 9. Time Use Among the Young People in the Gambia: Results from the 2008 IHS Survey.

Unemployment and joblessness: Results from the 2008 IHS survey

Youth unemployment characteristics, by age group

Age group	**Unemployed to population ratio**[(a)]	**Unemployment rate**[(b)]	**Inactivity**[(c)]	**Joblessness**[(d)]
15 - 17	0.9	3.0	18.0	18.9
18 - 19	1.6	4.8	25.8	27.4
20 - 24	4.8	10.8	38.3	43.1
15 – 24	**2.8**	**7.6**	**28.9**	**31.7**

Notes: (a) Unemployment ratio refers to total unemployed expressed as a proportion of total population in same age range;
(b) Unemployment rate refers to total unemployed as a proportion of total workforce in the same age range;
(c) Inactivity refers to total inactive expressed as a proportion of total population in the same age range;
(d) Joblessness refers to total jobless expressed as a proportion of total population in same age range.

Source: Calculations based on *the Gambia Integrated Household Survey, 2008* 12

Figure 10. Unemployment and Joblessness: Results from the 2008 IHS Survey.

Unemployment and joblessness: results from the 2008 IHS survey

Levels of measured **unemployment** are relatively low:

3 percent of the total population aged 15-24 years and 8 percent of 15-24 years in the labour force are unemployed

Levels of **joblessness** are higher:

Some 32 of the population aged 15-24 years are jobless

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Figure 11. Unemployment and Joblessness: Results from the 2008 IHS Survey.

Unemployment and joblessness: Results from the 2008 IHS survey

Young women have higher unemployment rates than young men.

Most youth unemployment is in urban areas, especially the Banjul area.

Youth unemployment characteristics by gender and location

Gender and location	Unemployed to population ratio[(a)]	Unemployment rate[(b)]	Inactivity[(c)]	Joblessness[(d)]
Male	2.6	6.6	26.7	29.3
Female	3.0	8.5	30.9	33.9
Urban	3.7	13.3	33.4	37.1
Rural	1.2	2.3	21.1	22.3

Notes: (a) Unemployment ratio refers to total unemployed expressed as a proportion of total population in same age range;
(b) Unemployment rate refers to total unemployed as a proportion of total workforce in the same age range;
(c) Inactivity refers to total inactive expressed as a proportion of total population in the same age range;
(d) Joblessness refers to total jobless expressed as a proportion of total population in same age range

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Figure 12. Unemployment and Joblessness: Results from the 2008 IHS Survey.

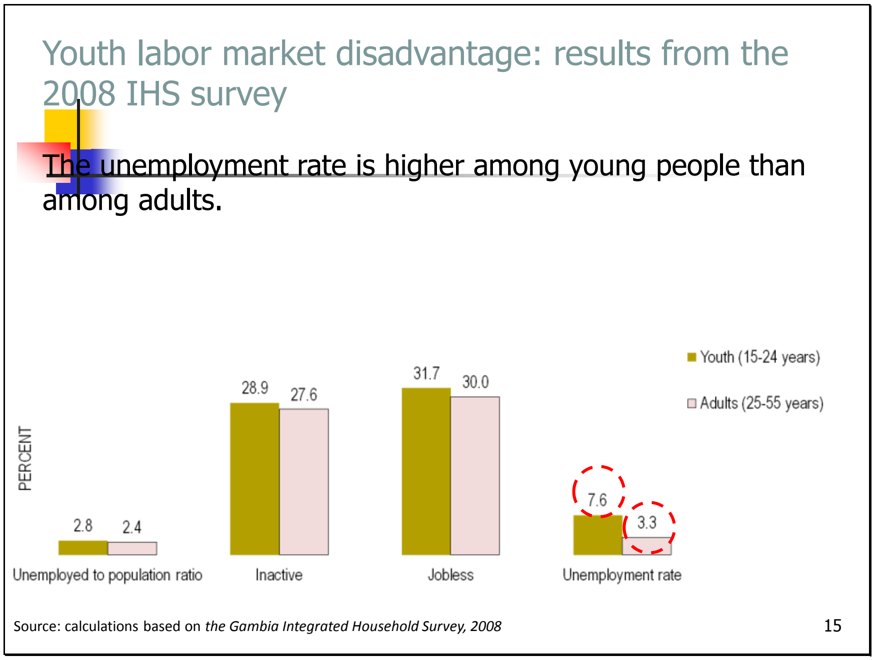

Figure 13. Youth Labor Market Disadvantage: Results from the 2008 IHS Survey.

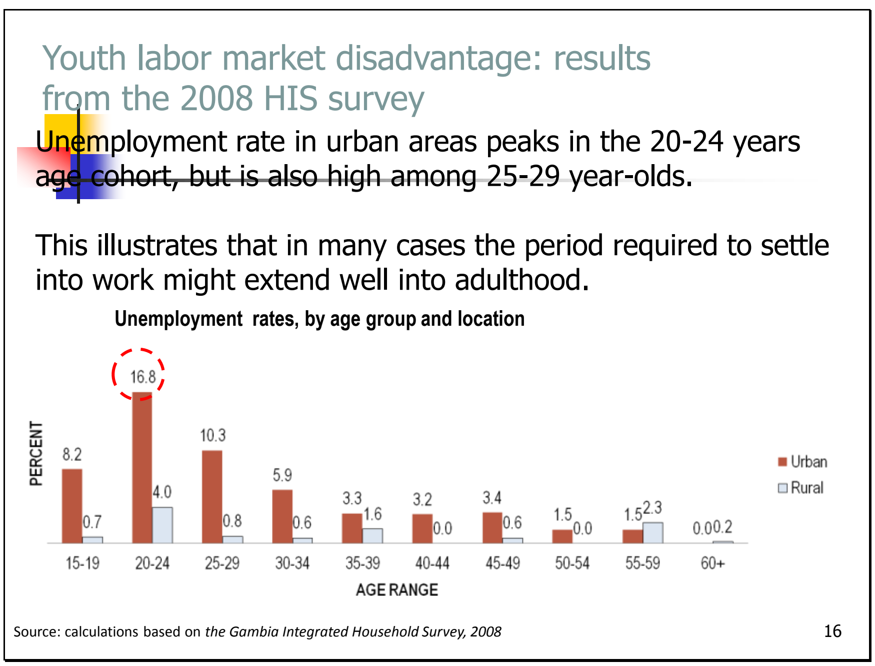

Figure 14. Youth Labor Market Disadvantage: Results from the 2008 IHS Survey.

Composition of youth employment: results from the 2008 IHS survey

Non wage labour performed within the household and self-employment are the most important forms of work

Agriculture absorbs most of the young LF

Modality and sector of youth employment by age

Age group		Modality				Sector				
		Wage employee	Self-employed	Unpaid family worker	Total	Agriculture	Manufacturing	Services	Other	Total
Age	15 -17	8.4	34.0	57.7	100	81.1	4.1	14.8	0.0	100
	18-19	20.8	36.7	42.5	100	73.7	2.8	22.8	0.8	100
	20-24	23.8	41.3	35.0	100	59.9	7.8	29.3	3.0	100
	15- 24	**20.2**	**39.1**	**40.7**	**100**	66.4	6.2	25.3	2.0	100

Source: UCW calculation based on *the Gambia Integrated Household Survey on Consumption Expenditure and Poverty Level Assessment, 2002/03*

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Figure 15. Composition of Youth Employment: Results from the 2008 IHS Survey.

Composition of youth employment: results from the 2008 IHS survey

Large differences exist between rural and urban ares: while agriculture predominates in rural areas, the services sector is the most important source of youth employment in cities and towns.

Paid employment is preponderate in cities and towns while unpaid family work is relatively more important in rural areas.

Modality and sector of employment by location

Location	Modality of employment				Sector of Activity				
	Paid employee	Self employed	Unpaid family work	Total	Agriculture	Service	Manufacturing	Other	Total
Urban	**48.9**	**25.8**	**25.4**	**100**	**16.4**	**64.8**	**14.4**	**4.4**	**100**
Rural	**10.9**	**43.4**	**45.7**	**100**	**82.4**	**12.7**	**3.6**	**1.2**	**100**

Source: calculations based on *the Gambia Integrated Household Survey on Consumption Expenditure and Poverty Level Assessment, 2002/03*

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Figure 16. Composition of Youth Employment: Results from the 2008 IHS Survey.

Composition of youth employment: results from the 2008 HHS survey

Large differences exist between male and female youth: while agriculture predominates among female youth, services sector is an important source of employment among male youth.

Females are more commonly found in agricultural and manufacturing work, and males in service sector.

Modality and sector of employment by gender

gender	Modality of employment				Sector of Activity				
	Paid employee	Self employed	Unpaid family work	Total	Agriculture	Service	Manufacturing	Other	Total
Male	**28.8**	**32.0**	**39.2**	**100**	**56.5**	**31.2**	**8.8**	**3.4**	**100**
Female	**11.6**	**46.2**	**42.2**	**100**	**76.5**	**19.4**	**3.6**	**0.6**	**100**

Source: Calculations based on *the Gambia Integrated Household Survey on Consumption Expenditure and Poverty Level Assessment, 2002/03* 19

Figure 17. Composition of Youth Employment: Results from the 2008 IHS Survey.

Composition of youth employment: results from the 2008 IHS survey

Compared with adult workers, employed youth are more likely to be in non-waged family activities.

Youth and adult: modality of employment and sector of activity, by age and location

Location and age group		Modality				Sector				
		Paid employee	Self employed	Unpaid family work	Total	Agriculture	Service	Manufacturing	Other	Total
Total	15 - 24	20.2	39.1	40.7	100	66.4	25.3	6.2	2.0	100
	25 -55	29.7	50.8	19.5	100	48.6	42.3	4.7	4.4	100
Urban	15 - 24	48.9	25.8	25.4	100	16.4	64.8	14.4	4.4	100
	25 -55	52.3	36.1	11.7	100	10.1	76.7	7.7	5.5	100
Rural	15 - 24	10.9	43.4	45.7	100	82.4	12.7	3.6	1.2	100
	25 - 55	18.1	58.5	23.5	100	66.7	26.1	3.4	3.9	100

Source: Calculations based on *Gambia Integrated Household Survey on Consumption Expenditure and Poverty Level Assessment, 2002/03*

Figure 18. Composition of Youth Employment: Results from the 2008 IHS Survey.

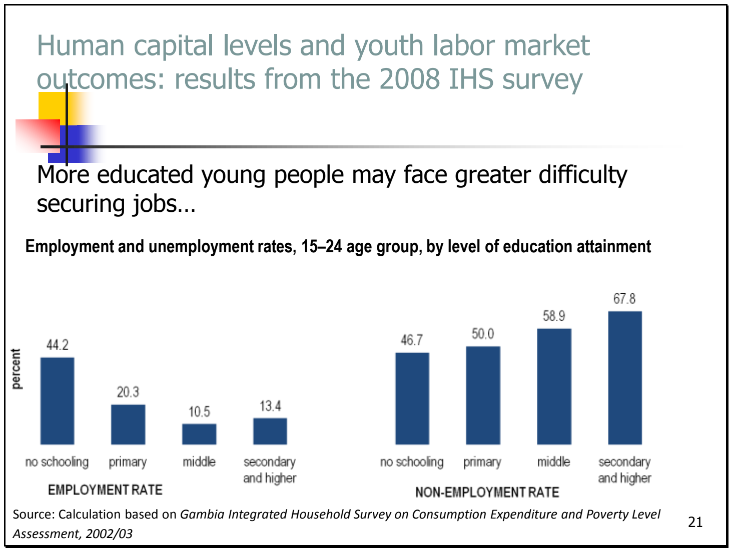

Figure 19. Human Capital Levels and Youth Labor Market Outcomes: Results from the 2008 IHS Survey.

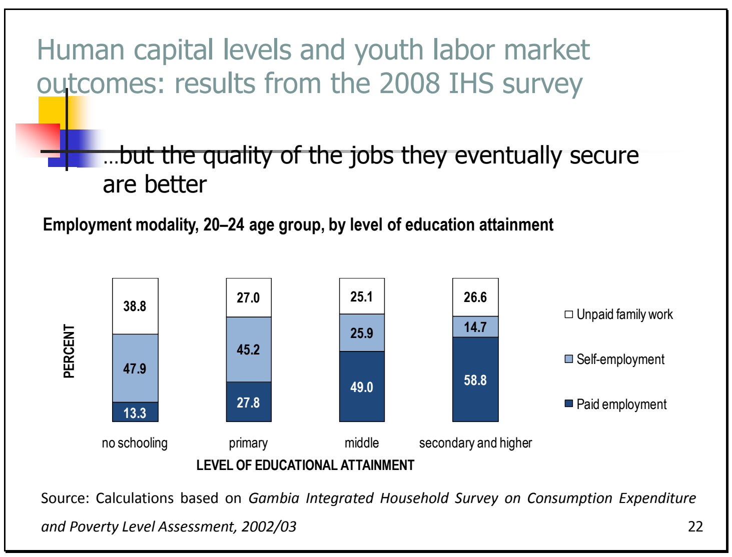

Figure 20. Human Capital Levels and Youth Labor Market Outcomes: Results from the 2008 IHS Survey.

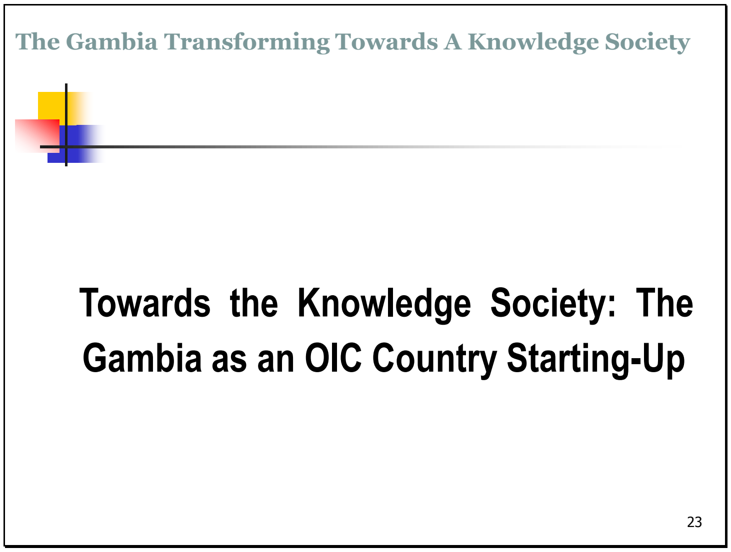

Figure 21. The Gambia Transforming Towards a Knowledge Society.

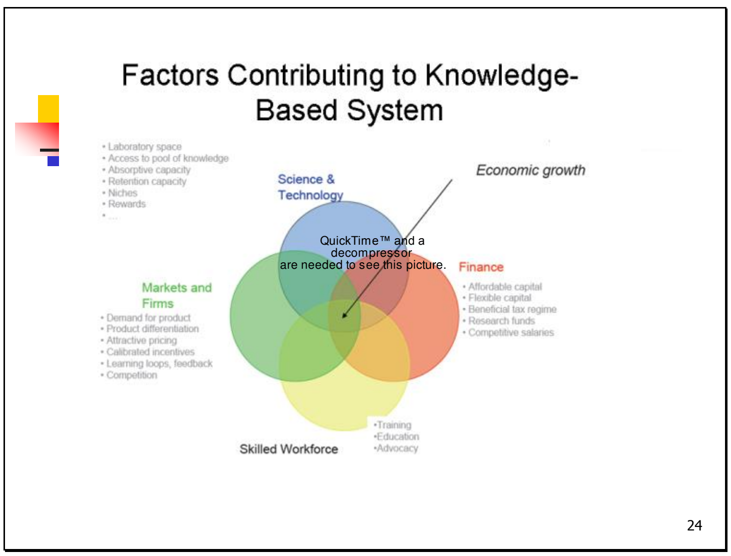

Figure 22. Factors Contributing to Knowledge-Based System.

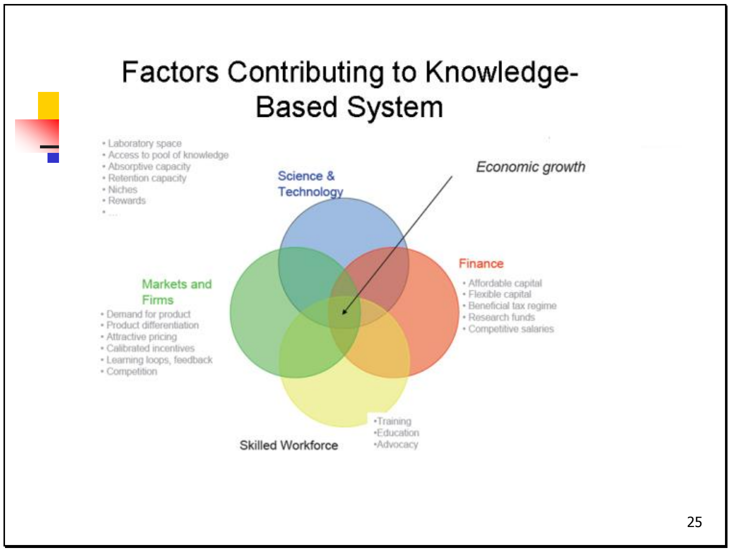

Figure 23. Factors Contributing to Knowledge-Based System.

Figure 24. Necessary but Insufficient Conditions for Take off into the Knowledge Society/ Economy.

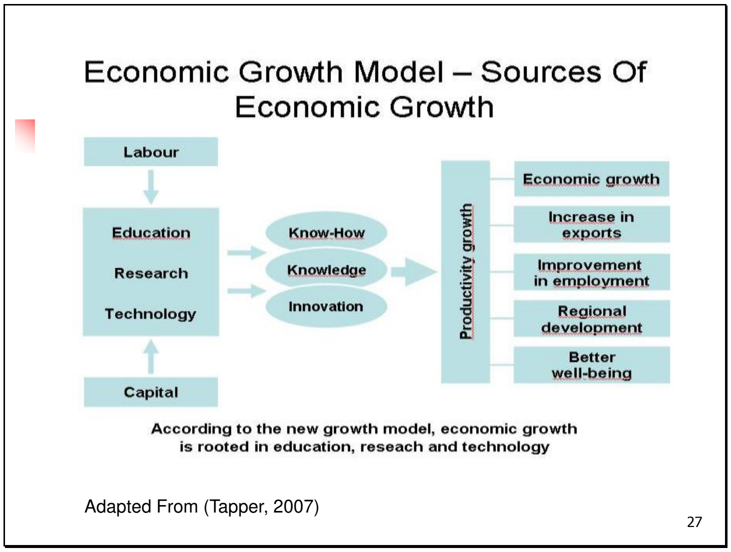

Figure 25. Economic Growth Model – Sources of Economic Growth.

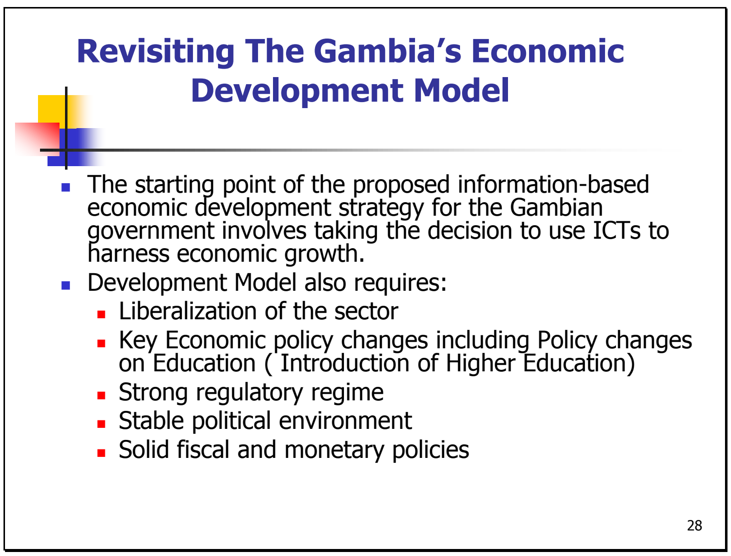

Figure 26. Revisiting the Gambia's Economic Development Mode.

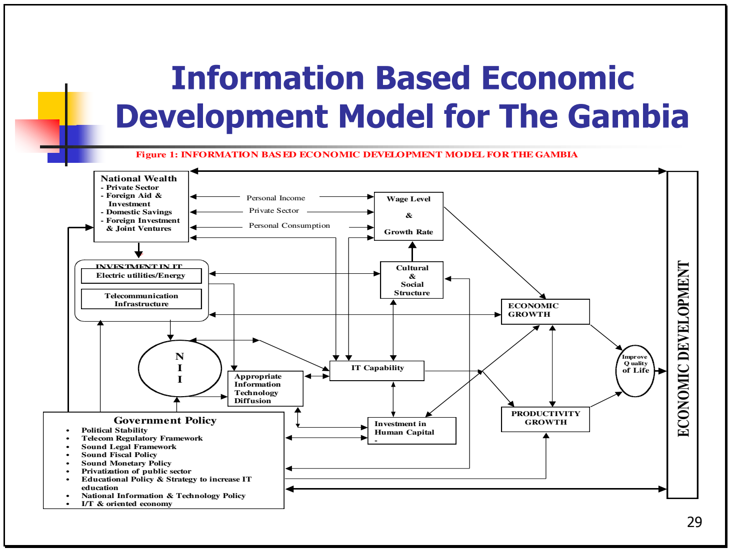

Figure 27. Information Based Economic Development Model for the Gambia.

Figure 28. A Discourse: ICTs, Economic Development, Poverty Reduction and Social Capital.

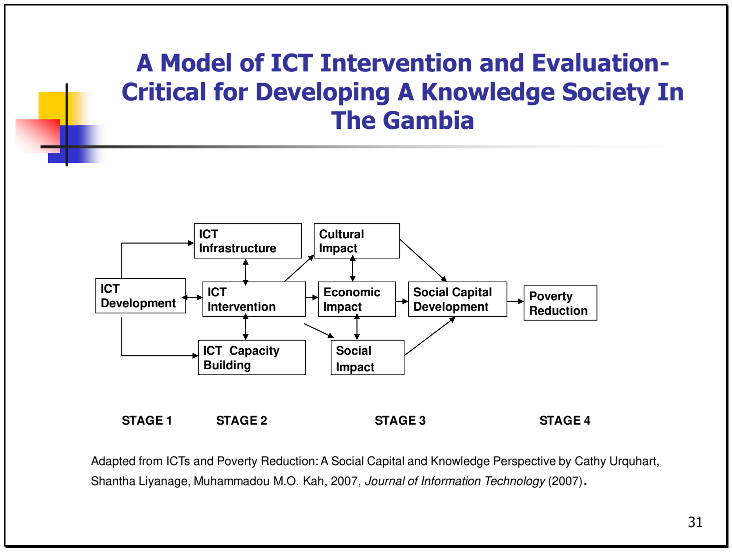

Figure 29. A Model of ICT Intervention and Evaluation- Critical for Developing A Knowledge Society In Gambia.

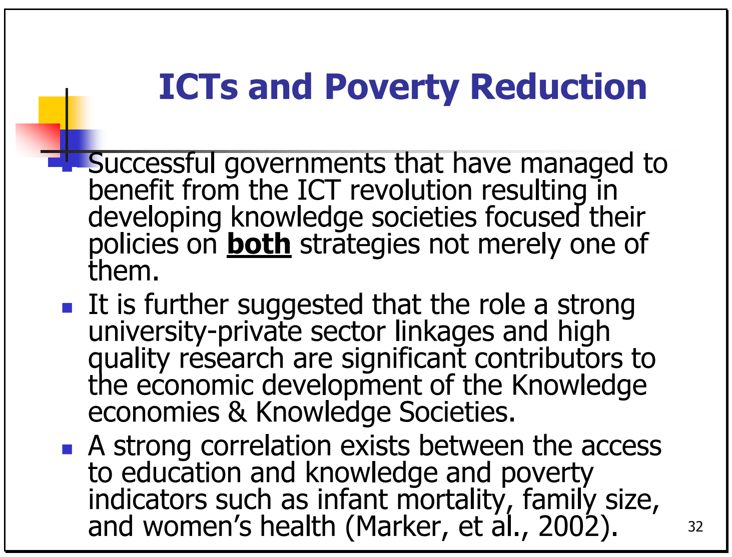

Figure 30. ICTs and Poverty Reduction.

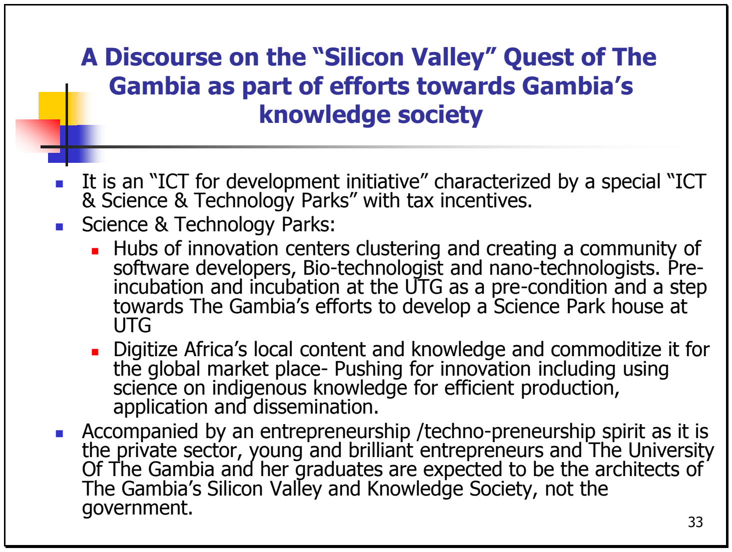

Figure 31. A Discourse on the "Silicon Valley" Quest of Gambia as Part of efforts Towards Gambia's Knowledge Society.

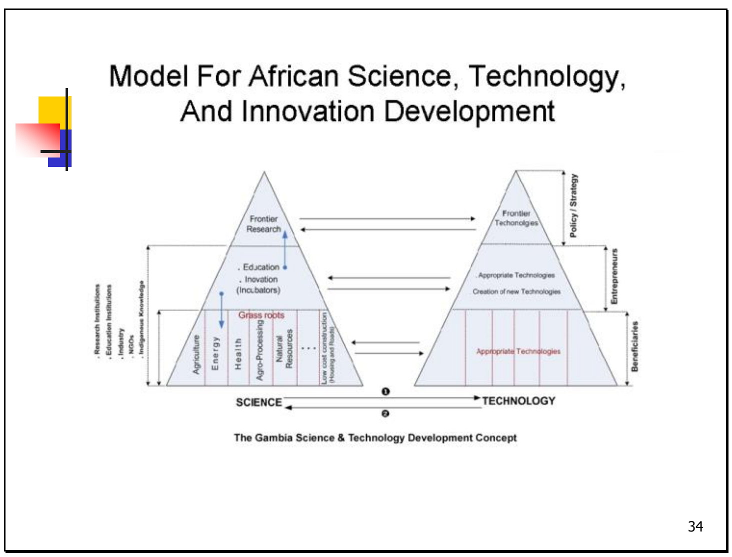

Figure 32. Model for African Science, Technology, and Innovation Development.

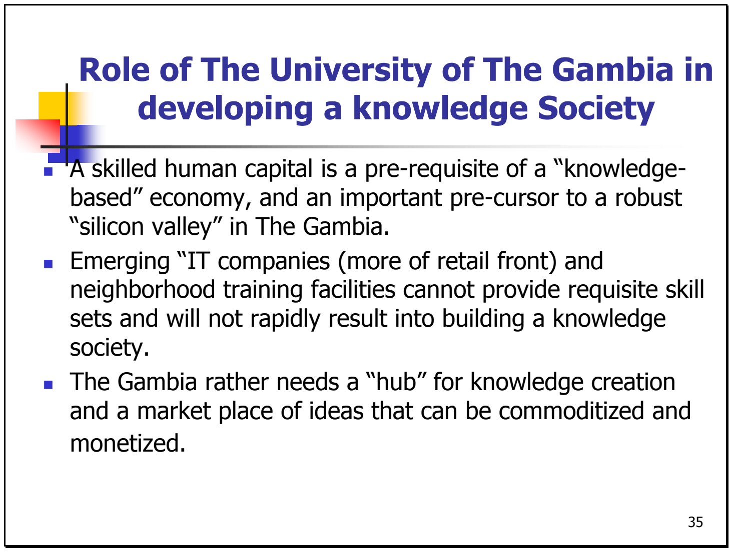

Figure 33. Role of the University of Gambia in Developing a Knowledge Society.

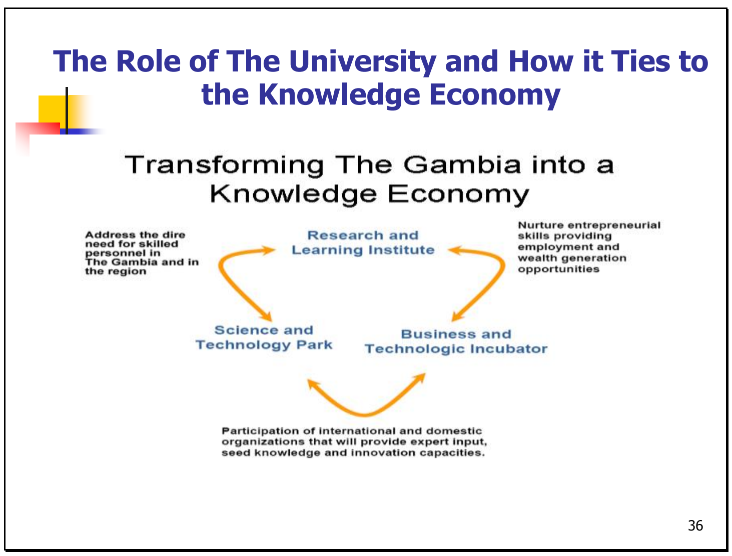

Figure 34. The Role of The University and How it Ties to the Knowledge Economy.

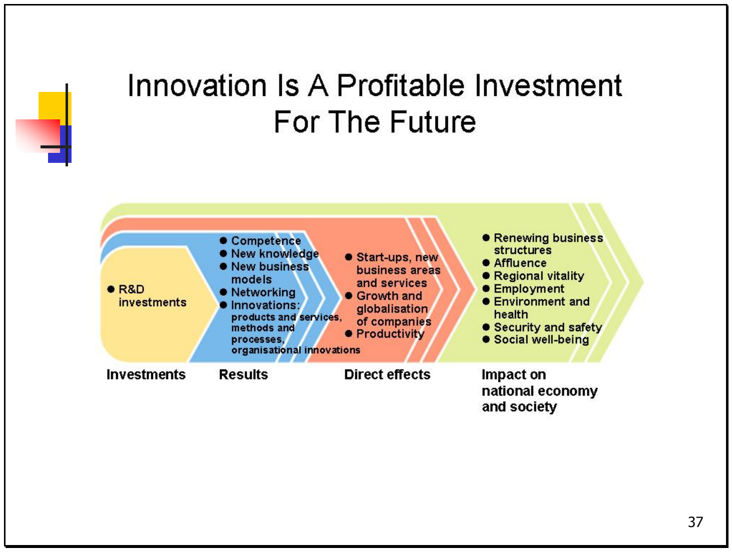

Figure 35. Innovation is a Profitable Investment for the Future.

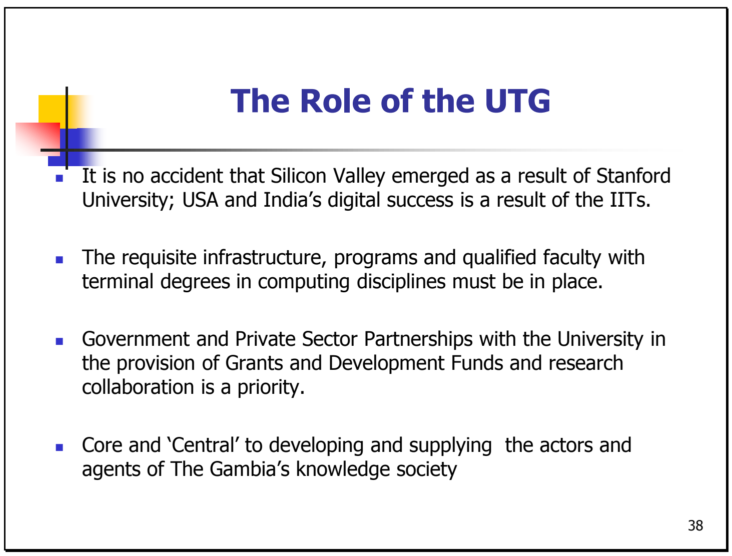

Figure 36. The Role of the UTG.

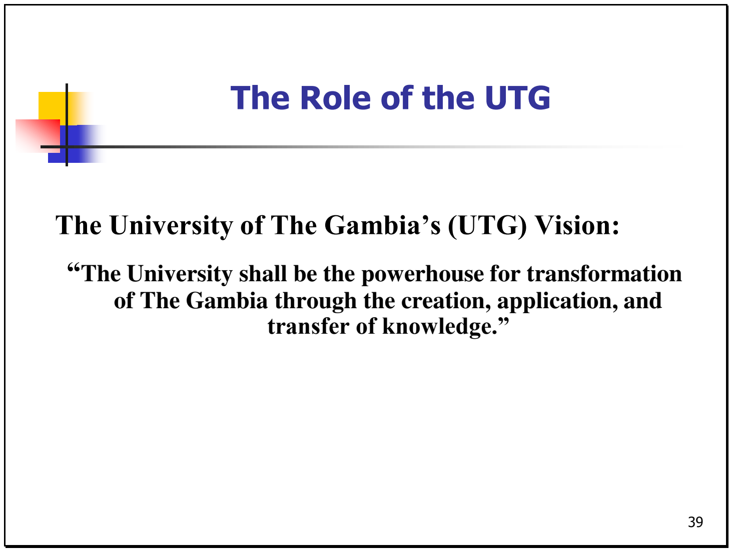

Figure 36. The Role of the UTG.

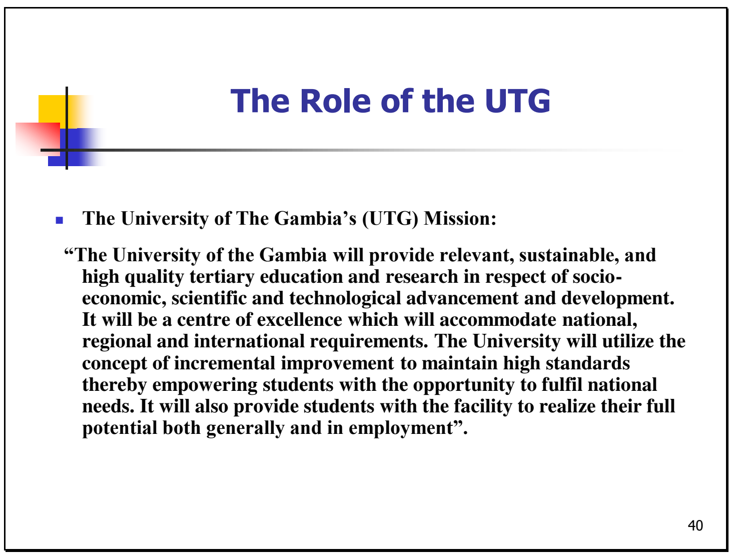

Figure 37. The Role of the UTG.

HISTORICAL BACKGROUND

- The University of The Gambia was established by an Act of the National Assembly of the Gambia in March 1999.
- The enactment, which was a bold step to fulfill a long-standing desire of the people of The Gambia and to respond to several years of advocacy both within and outside the country for a university, ended years of indecision on the university question.

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Figure 38. Historical Background.

- The first Vice-Chancellor, Prof. Donald E.U Ekong was appointed and assumed office in October 1999.
- Since then, the University has had 3 Vice Chancellors. The First Gambian Vice Chancellor, Professor Muhammadou M.O. Kah was appointed as the University’s third Vice Chancellor in May 2009.

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Figure 39.

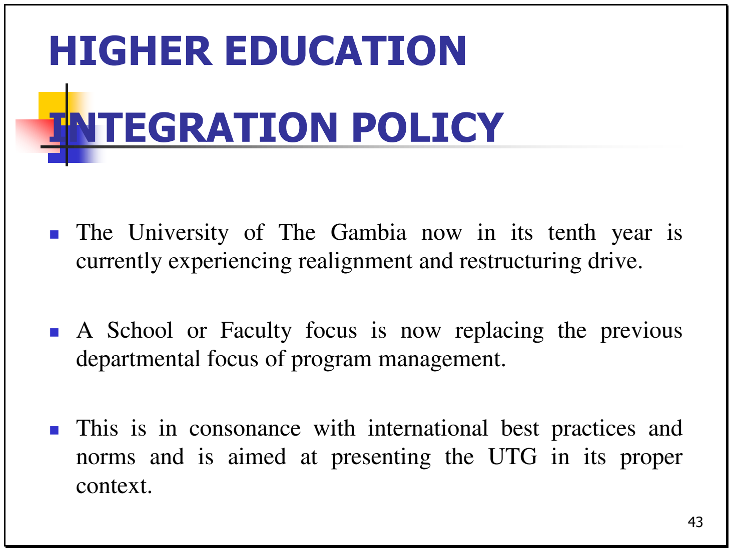

Figure 40. Higher Education Integration Policy.

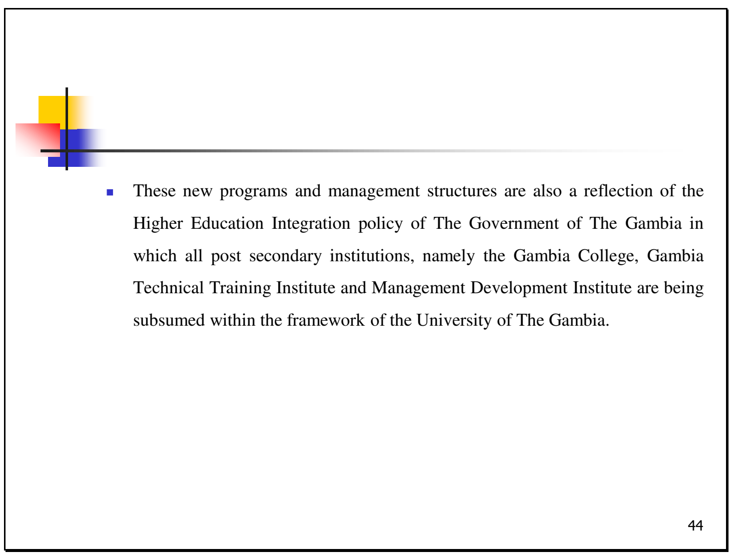

Figure 41.

This integration policy is at an advanced stage of implementation; the legal instruments are being consolidated by the Government's legal arm and some programs of the University are poised to relocate their administration and teaching facilities to the Gambia College and the Management Development Institute.

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Figure 42.

- ***1. Integration Tertiary Education System***
  - a. Cabinet paper has been approved; legal instrument has been drafted and is being processed through the system. In the meantime, a number of actions have been undertaken by the institutions as detailed below.
  - b. UTG has reorganized itself from the previous structure which had only departments to a new structure comprising 8 Undergraduate Schools and a School of Graduate Studies and Research. The eight UG Schools are:
    - i. School of Agriculture and Environmental Sciences
    - ii. School of Arts and Sciences
    - iii. School of Business and Public Administration
    - iv. School of Education
    - v. School of Engineering and Architecture
    - vi. School of Law
    - vii. School of Medicine and Allied Health Sciences
    - viii. School of Information Technology and Communication

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Figure 43.

- a. **The Management Development Institute (MDI)** currently hosts the School of Business and Public Administration (SBPA). The SBPA includes an institute to offer the non-degree programs formerly offered by MDI.
- b. **New bachelors and masters degree programs in Public Administration** will be offered by the SBPA under its new Department of Economics and management Sciences in order to build GoG capacity in public administration as per the original mandate of the MDI
- c. The School of Agriculture at Gambia College (GC) and the Department of Agriculture at UTG have merged into the School of Agriculture.
- d. **The School of Education at Gambia College** and the Department of Education at UTG will merge into the UTG. Existing non-degree teacher training programs at GC (PTC and HTC) will continue to be offered. Enrollment in HTC will be increased to meet rising demand for teachers in secondary schools and to compensated for anticipated decrease of immigrant teachers in the Gambia (because terms and conditions of service for teachers in neighboring countries has been improving) who constitute a significant proportion of secondary school teachers. UTG will put in place a system to allow articulation from PTC to HTC to degree studies. UTG will also (i) expand its certificate course in school management ; and (ii) establish a Bed in Information Technology to produce teachers for ICTs in Education.

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Figure 44.

- a. GTTI will eventually evolve into the School of Engineering and Architecture. In the immediate term, GTTI will:
- i. Continue offering in collaboration with Dalhousie University in Canada, a joint Bachelors Degree in Community Building and Design
- ii. Continue to offer certificate and diploma programs in engineering disciplines and work on offering these disciplines at BTech level;
- iii. Work on an articulation framework to allow GTTI graduates advance through the system to degree level. UNESCO is providing assistance in this regard.
- b. UTG will start new degree and technician level programs in Tourism though its Business School. Teeside and Leeds Metropolitan universities in the UK have expressed interest in collaboration.
- c. With support from the AUF, UTG will **establish a digital campus on pilot basis** at the Gambia College premises to facilitate distance learning and to provide access to learning materials at French universities.
- d. **UNESCO is providing technical support for a feasibility study on a virtual campus. Focus will be on teacher training.**
- e. Digital Link of the UK is providing support for a pilot to enable access to e-learning materials (e-library resources, e-books, low-cost technology for students to access e-learning materials, etc).)
- f. The **National Agricultural Research Institute (NARI)** will integrate into UTG and host the School of Agriculture.

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Figure 45.

Detailed in the table below are the enrolment figures for University of The Gambia for the last three years.

Table 1: University of The Gambia Enrollment Figures

		2009/2010 (Fall 2009 Only)*			2008/2009			2007/2008		
S/N	Department	Male	Female	Total*	Male	Female	Total**	Male	Female	Total**
1.	Economics and Management Sciences	157	45	202	136	50	186	70	18	88
2.	Arts, Languages & Humanities	25	11	36	21	4	25	17	4	21
3.	Medicine	11	23	34	21	24	45	42	13	55
4.	Nursing & Reproductive Health	17	4	21	8	6	14	8	16	24
5.	Public & Environmental Health	14	8	22	18	4	22	16	2	18
4.	Agriculture	33	6	39	12	2	14	29	0	29
5.	Science & Technology	34	10	44	93	23	116	52	13	65
6.	Education	22	6	28	31	2	33	7	1	8
7.	Social Sciences	71	35	106	52	12	64	38	8	46
8.	Science & Technology	34	10	44	93	23	116	52	13	65
9.	Law	10	10	20	11	3	14	10	10	20
	GRAND TOTAL	394*	158*	552*	403	130	533**	289	85	354**

* This is only for Fall 2009 Enrolment for the 2009-2010 academic Year. The next enrollment cycle for the academic year (Spring 2010) is in January 2010. ** This figure is for both Fall (August or September Intake) and Spring (January In take) enrollment combine. The figure reflect total enrollment for the academic year (two Semesters)

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Figure 46. University of the Gambia Enrollment Figures.

The University of The Gambia Graduation Profile

Detailed in the tables below are the graduation statistics for UTG clearly demonstrating the role of the university in building capacity in The Gambia.

Table 1: University of The Gambia Graduation Statistics, 2004-2008

YEAR	MALE	FEMALE	TOTAL
2004	40	9	49
2005	216	48	264
2006	144	28	172
2007	138	38	176
2008	98	28	126
TOTAL	636	151	787

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Figure 47. The University of the Gambia Graduation Profile.

Table 1: Graduation Statistics By Department/Faculty, 2008

Department/Faculty	Male	Female	Total
Economics/Mgt Scs	23	6	29
Arts, Lang/Humanities	6	5	11
Social Sciences	11	5	16
Science/Tech	15	5	20
Agriculture	6	2	8
Nursing	8	1	9
Public/Env. Health	9	1	10
Medicine	0	0	0
Education	20	3	23
LAW	0	0	0
TOTAL	98	28	126

Table 1: Graduation Statistics by Department/Faculty, 2007

Department/Faculty	Male	Female	Total
Economics/Mgt Scs	26	4	30
Arts, Lang/Humanities	16	1	17
Social Sciences	19	8	27
Science/Tech	14	6	20
Agric/Bio Sciences	8	1	9
Nursing	5	0	5
Public/Env. Health	8	0	8
Medicine	8	4	12
Education	36	12	48
Law	0	0	0
TOTAL	140	36	176

Table 1: Graduation Statistics by Department/Faculty, 2006

Department/Faculty	Male	Female	Total
Economics/Mgt Scs	19	3	22
Arts, Lang/Humanities	6	3	9
Social Sciences	9	3	12
Science/Tech	4	4	8
Agric/Bio Sciences	9	8	17
Nursing	6	1	7
Public/Env. Health	8	1	9
Medicine	10	1	11
Education	72	5	77
Law	0	0	0
TOTAL	143	29	172

Table 1: Graduation Statistics by Department/Faculty, 2005

Department/Faculty	Male	Female	Total
Humanities/Soc Scs	64	29	93
Economics/Mgt Scs	51	6	57
Science/Agriculture	36	5	41
Nursing	6	2	8
Public/Env. Health	11	0	11
Education	49	5	54
TOTAL	217	47	264

Table 1: Graduation Statistics by Department/Faculty, 2004

Department/Faculty	Male	Female	Total
Humanities/Soc Scs	9	5	14
Economics/Magt Sc	1	1	2
Nursing	4	0	4
Education	22	3	25
Public/Env. Health	2	0	2
Science/Agriculture	2	0	2
TOTAL	40	9	49

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Table 1: Academic Staff Numbers, 2008-2009

		2008/2009			2007/2008			2006/2007		
S/N	Department	Full-time	Part-time	Total	Full-time	Part-time	Total	Full-time	Part-time	Total
1.	Economics & Management	9	19	28	7	13	20	5	15	20
2.	Arts, Languages & Humanities	18	0	18	18	3	20	5	15	20
3.	Medicine	8	7	15	9	9	18	10	6	16
4.	Biomedical Sciences	7	0	7	9	0	9	9	0	9
5.	Public Health	8	8	16	4	8	12	5	9	14
6.	Nursing & Reproductive Health	3	10	13	3	11	14	3	6	9
7.	Surgical Sciences	2	3	5	1	4	5	2	8	10
8.	Agriculture & Biological Sciences	10	3	13	6	3	9	12	4	16
9.	Science & Technology	13	8	21	19	3	22	14	2	16
10.	Education	4	0	4	4	0	4	5	0	5
11.	Social Sciences	16	7	23	15	7	22	17	8	25
12.	Law	0	10	10	0	6	6	0	6	6
	Grand Total	98	75	173	95	67	161	87	79	166

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Figure . Academic Staff Numbers, 2008-2009.

1. Table 1: Academic Staff and Gender Distribution, 2008-2009

		2008/2009					2007/2008					2006/2007				
S/N	Departments	Full-time		Part-time		Total	Full-time		Part-time		Total	Full-time		Part-time		Total
		M	F	M	F		M	F	M	F		M	F	M	F	
1.	Economics & Management	7	1	18	1	28	7	0	12	1	20	5	0	15	0	20
2.	Arts, Languages & Humanities	14	4	0	0	18	14	4	1	2	20	15	4	1	1	20
3.	Medicine	7	1	6	1	15	6	3	8	1	18	8	2	3	3	16
4.	Biomedical Sciences	4	3	0	0	7	4	5	1	0	9	8	1	0	0	9
5.	Public Health	6	2	7	1	16	4	0	7	1	12	5	0	8	1	14
6.	Nursing & Reproductive Health	2	1	5	5	13	2	1	6	5	14	2	1	1	5	9
7.	Surgical Sciences	2	0	2	1	5	1	0	3	1	5	2	0	6	2	10
8.	Agriculture & Biological Sciences	7	3	3	0	13	6	0	3	0	9	10	2	4	0	16
9	Science & Technology	12	1	8	0	21	18	1	3	0	22	13	1	2	0	16
10.	Education	4	0	0	0	4	4	0	0	0	4	5	0	0	0	5
11.	Social Sciences	15	1	5	2	23	14	1	6	1	22	16	1	7	1	25
12.	Law	0	0	8	2	10	0	0	5	1	6	0	0	5	1	6
	Grand Total	80	17	62	13	173	80	15	55	13	161	89	12	52	14	166

Figure . Academic Staff and Gender Distribution, 2008-2009.

1. Table 1: Academic Staff, 2008-2009 by Nationality

		2008/2009					2007/2008					2006/2007				
S/N	Departments	Full-time		Part-time		Total	Full-time		Part-time		Total	Full-time		Part-time		Total
		G	F	G	F		G	F	G	F		G	F	G	F	
1.	Economics & Management	2	10	2	20	4	1	14	1	20	2	10	2	20	4	1
2.	Arts, Languages & Humanities	6	1	1	20	12	5	1	2	20	6	1	1	20	12	5
3.	Medicine	2	2	5	18	1	9	2	4	16	2	2	5	18	1	9
4.	Biomedical Sciences	0	0	1	9	1	8	0	0	9	0	0	1	9	1	8
5.	Public Health	3	6	0	12	2	3	7	1	14	3	6	0	12	2	3
6.	Nursing & Reproductive Health	0	11	0	14	3	0	6	0	9	0	11	0	14	3	0
7.	Surgical Sciences	1	2	2	5	0	1	1	8	10	1	2	2	5	0	1
8.	Agriculture & Biological Sciences	2	3	0	9	7	5	3	1	16	2	3	0	9	7	5
9.	Science & Technology	6	1	1	22	11	3	1	1	16	6	1	1	22	11	3
10.	Education	0	0	0	4	5	0	0	0	5	0	0	0	4	5	0
11.	Social Sciences	4	2	5	22	12	4	9	0	25	4	2	5	22	12	4
12.	Law	0	6	0	6	0	0	6	0	6	0	6	0	6	0	0
	Grand Total	67	31	66	9	173	75	26	44	17	161	58	39	50	18	166

Nationality
- G = Gambian
- F = Foreign

Figure . Academic Staff, 2008-2009 by Nationality.

1. **Table 1: Academic Staff Numbers, 2008-2009 by Qualifications**

F/T = Full Time ; P/T = Part Time

S/N	Departments	Status	PhD 2008/2009		MSC		Others		Total
			M	F	M	F	M	F	
1.	Economics & Management	F-T	1	0	4	0	3	1	9
		P-T	1	0	17	1	0	0	19
2.	Arts, Languages & Humanities	F-T	4	1	7	3	2	1	18
		P-T	0	0	0	0	0	0	0
3.	Agriculture & Biological Sciences	F-T	1	1	4	1	2	1	10
		P-T	1	0	2	0	0	0	3
4.	Social Sciences	F-T	5	0	8	1	2	0	16
		P-T	0	0	5	2	0	0	7
5.	Science & Technology	F-T	3	1	2	1	5	1	13
		P-T	0	0	8	0	0	0	8
6.	Education	F-T	0	0	3	0	1	0	4
		P-T	0	0	0	0	0	0	0
7.	Law	F-T	0	0	0	0	0	0	0
		P-T	1	0	6	1	1	1	10
8.	Medicine	F-T	2	0	4	2	0	0	8
		P-T	0	0	2	1	4	0	7
9.	Biomedical Sciences	F-T	0	0	2	3	2	0	7
		P-T	0	0	0	0	0	0	0
10.	Public Health	F-T	0	0	4	2	2	0	8
		P-T	0	0	6	2	0	0	8
11.	Nursing & Reproductive Health	F-T	1	0	0	0	1	1	3
		P-T	0	0	4	5	0	1	10
12.	Surgical sciences	F-T	0	0	2	0	0	0	2
		P-T	0	0	2	1	0	0	3

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Figure . Academic Staff Numbers, 2008-2009 by Qualifications.

Table 1: Academic Staff Rank, 2008-2009

S/N	Departments	Professor	Associate Professor	Senior Lecturer	Lecturer I	Lecturer II	Assistant Lecturer	Graduate Assistant	Visiting Lecturer	Teaching Assistant
1.	Economics & Management	0	0	1	1	4	0	3	1	0
2.	Arts, Languages & Humanities	1	0	3	6 1(Arts Fellow)	4	1	2	0	0
3.	Medicine	1	1	0	0	0	0	0	6	
4.	Biomedical Sciences	0	0	0	0	0	0	0	5	1
5.	Public Health	0	0	0	1	1	0	2	4	0
6.	Nursing & Reproductive Health	0	0	1	0	0	0	2	0	
7.	Surgical Sciences	0	0	0	0	0	0	0	2	0
8.	Agriculture & Biological Sciences	0	1	0	4	1	1	3	0	0
9.	Education	0	0	0	1	2	1	1	0	0
10.	Science & Technology	0	0	2	1	2	1	7	2	0
11.	Social Sciences	0	0	4	1	7	1	2	0	0
12.	Law	0	0	0	0	0	0	0	1	2
	Grand Total	2	2	11	16	21	4	22	21	3

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Figure . Academic Staff Rank, 2008-2009.

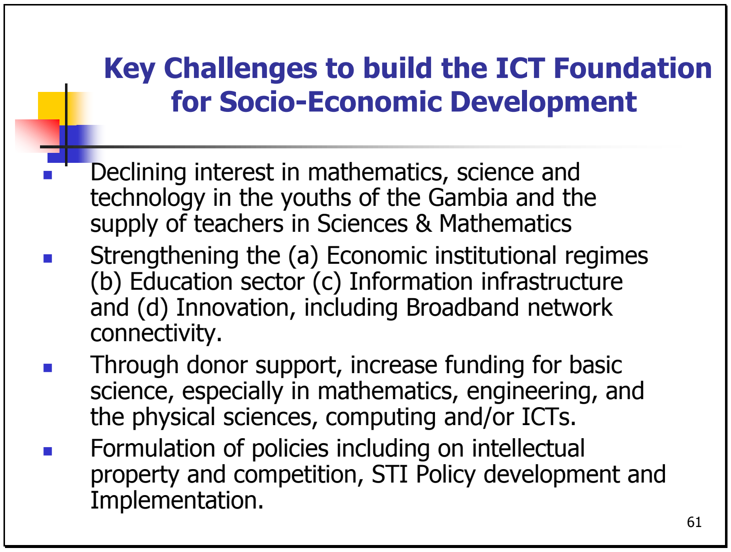

Figure . Key Challenges to build the ICT Foundation for Socio-Economic Development.

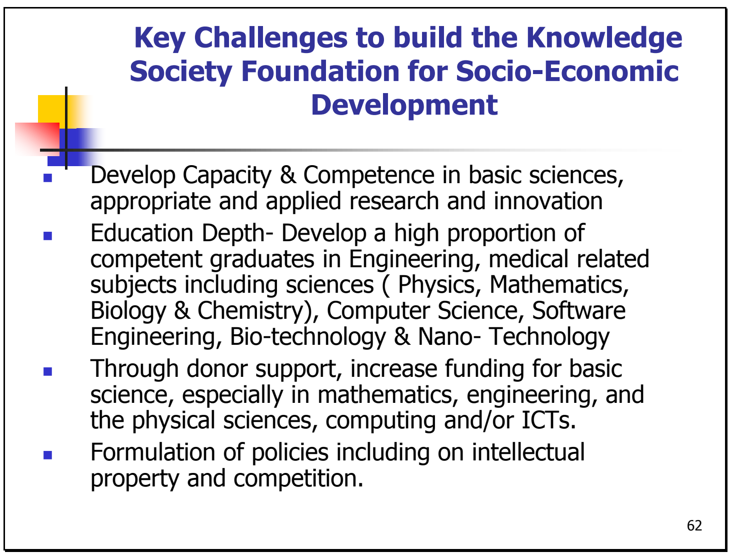

Figure . Key Challenges to build the ICT Foundation for Socio-Economic Development.

Conclusion

- 'Oil' is good but 'software' is brilliant, much more sustainable in the long run and is the fuel of the 21st century and beyond. It is a fundamental ingredient in the architecture and building of an efficient and sustainable knowledge society.
- Sciences and Mathematics is core and all efforts must be made by the Islamic World to provide the necessary resources to equip our youths and to develop national capacity & competence.
- The 'economics of software' is much better than the 'economics of oil'. It does not require huge investments in drilling plus its environmental costs. The knowledge society can only be develop with prioritization of investments in education and specifically on higher education, research and innovations.
- Retain and nurture talent to slow the 'brain drain' problem and put in place strategies and incentives that will encourage 'brain circulation' and to aggressively recruit Gambian academics and professionals in the Diaspora. This will require thinking outside of the box and do the needful when talent and value is found.

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Figure . Conclusion.

Conclusion Cont.......

- Modify the approaches and methods of teaching our youths Mathematics and the Sciences; developing the learning infrastructure for the sciences and mathematics and centers of excellences in the sciences including Bio-technology and nanotechnology. As an intervention, The Gambia develops the Kanilai Science Institute to identify and nurture students with abilities and potentials in the sciences . This is project conceived and launched by the President of the Gambia- HE, Shiekh Professor, Alhagie, Yahya Jammeh.
- Upgrade and/or develop ICT infrastructure as a core to the national education infrastructure to enable access and strengthen continuous and interactive learning at all levels and give incentives to instructors and the best and brightest youths. Attractive wages and benefits for teachers at all levels- at least comparable to regional norms and for key experties needed for the knowledge societies, wages and benefits must be comparable to international norms.
- Academic collaborations including research, faculty and student exchanges, mentoring at the individual and institutional level amongst OIC member states academics; Developing The Gambia Academy of Sciences
- Youths will even have jobs and women will be more empowered. Governments will be amazed with the outcomes!!

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Figure . Conclusion Cont.

Thank You

Looking Forward for your Support….

PART NINE

KNOWLEDGE PRODUCTION FOR DEVELOPMENT

Towards the Knowledge Society in the Islamic World: Knowledge Production and Dissemination through Joint Research

HAMMADI AYADI
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Sfax, Tunisia

ABSTRACT

Since 1956, date of independence, Tunisia invested in education and capacity building.

During the last couple of decades, the Tunisian Government efforts have been concentrated on Research & Development investments within a planned strategy. The budget allocated to the research sector jumped from of 0.6% of GDP in 1996 to 1.25% in 2009 and is expected to reach 1.5% in 2014. The strategy would aim to set up the R&D infrastructure, develop human resources, implement R&D with industry technology transfer, promote public- private partnership and encourage the international cooperation.

It is hoped this strategy will end to improve higher education, teaching and research activities within the country boosting the cooperation with other countries.

We have, unfortunately, to recognize the very small scale of cooperation programs in R&D between the OIC countries particularly in the promising field of Biotechnology. The paper will present the case of the Centre of Biotechnology of Sfax (CBS) illustrating the very limited number of collaboration projects between the CBS and similar centres within the Islamic World. Basically, these projects are often bilateral ones and don't involve many institutions from different countries.

On the other hand, the multilateral aspect of R&D cooperation projects will be approached since more than 50% of R&D Cooperation Agreements with European countries are established on the base of networking with non-European countries. For (4) European projects belonging to the FP6 research and development program have been launched in the CBS during the 5 last years. One of these projects concerns a public health problem: “The Childhood Hereditary Hearing Loss” entitled: “Euro-Hear Therapeutics.” Different aspects of the project will be extensively presented and particularly the following:

- How networking is efficient & productive for young Scientists;
- The opportunity to build up a trans-disciplinary training programs addressing the major fields of expertise;
- How to understand the mechanisms underlying normal and impaired hearing; and
- How to develop tools for prevention and cure of hearing impairment.

Countries from Europe and outside are involved in the “Euro-Hear Project” with a 12.5M Euros financial support from the European Commission over 5 years (2005-2009).

12 countries with 27 Research Teams specialized in different fields: genetics, biochemistry, cell biology, physiology, biophysics, bioinformatics and medicine are participating in the project.

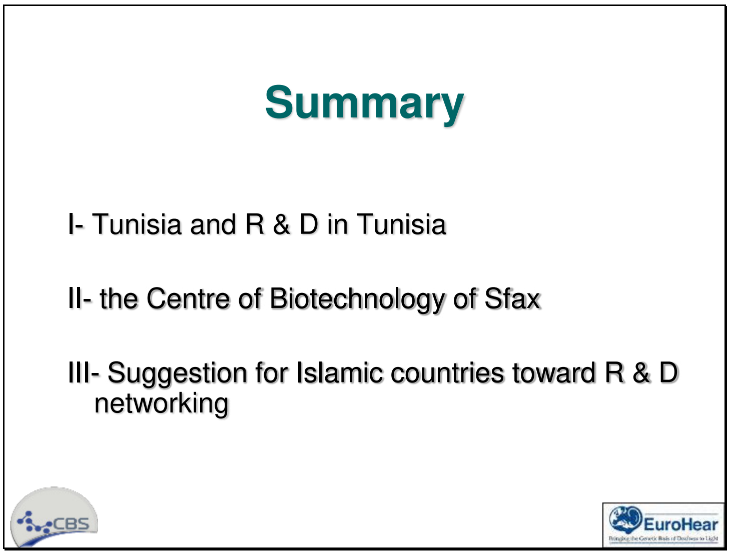


Figure 1. Summary.

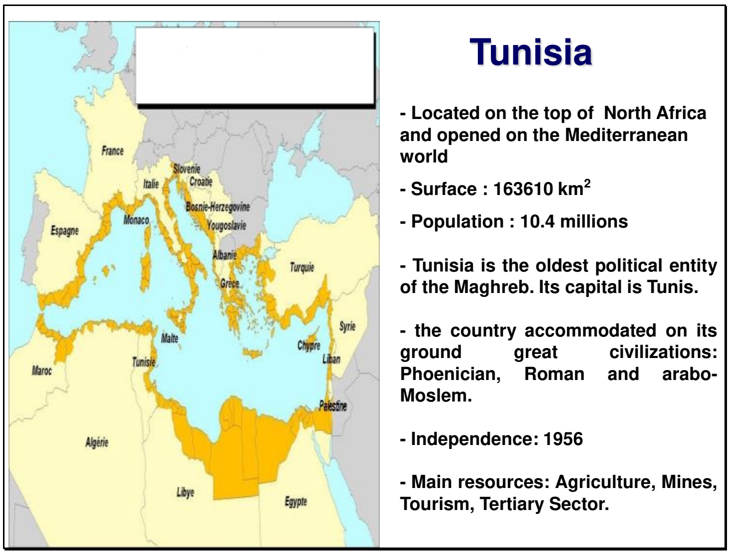
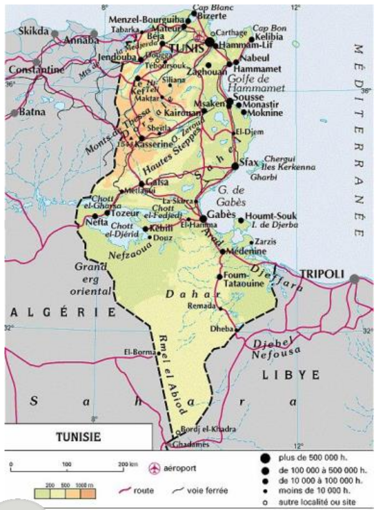


Figure 2. Tunisia.



- **Currency :** Tunisian Dinar (DT)
1DT = 0.54 Euro
- **GDP running price :**
54.1 milliards DT
- **GDP per inhabitant running price :**
4810 DT
- **GDP Répartition :**
• Primary : 11.3 %
• Secondary : 28.5 %
• Tertiary : 60.2 %
- **Inflation:** 5%
- **Investment rate :** 25.1 %
- **Exportations :** 23.6 milliards DT
- **Importations :** 30.2 milliards DT
- **Source :** Jeune Afrique 2009

Figure 3.

R and D

Since 1956, date of independence, Tunisia invested in

Education and capacity building.

During the last couple of decades

the Tunisian government efforts have been concentrated

On R & D investment within a planned strategy.

Tunisia, is now reinforcing this orientation

Figure 4. R and D.

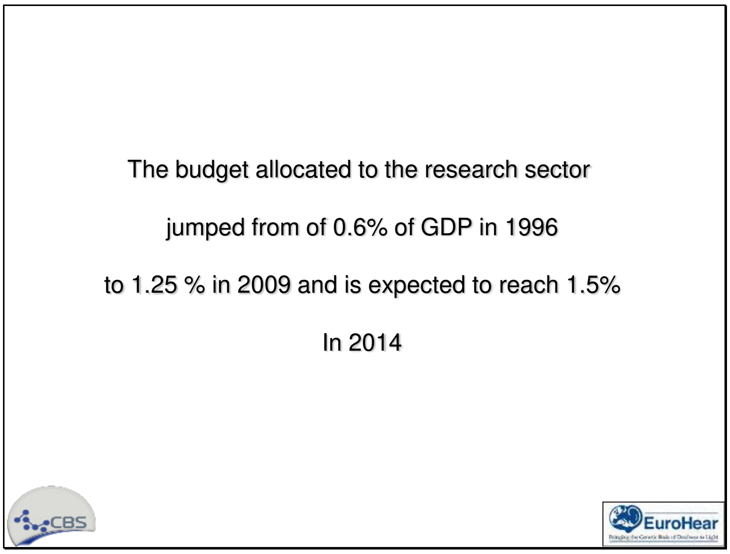


Figure 5.

Figure 6. Aims of this Strategy.

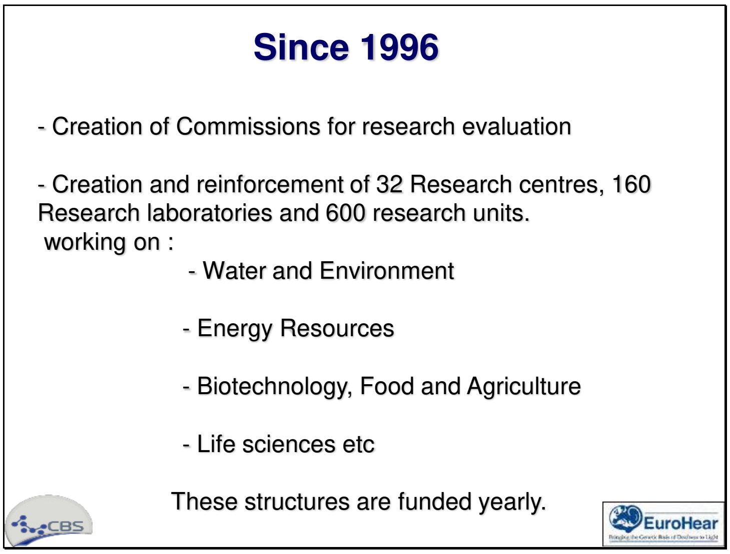


Figure 7. Since 1996.

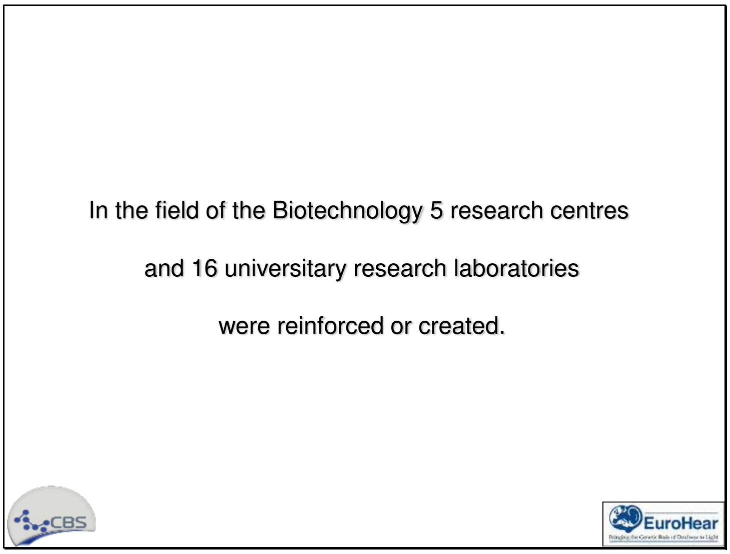


Figure 8.

Figure 9. Centre of Biotechnology of Sfax.

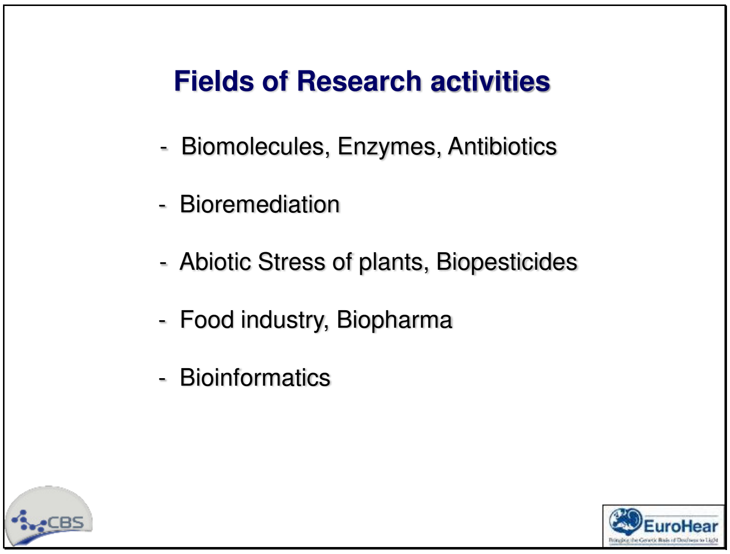


Figure 10. Fields of Research Activities.

The Biotechnology research approach require
A multidisciplinary investigation which needs multidisciplinary research. Different groups should collaborate to tackle the different aspects of the problem.

Since majority of research teams in the world can not master all technologies, the collaboration between these teams using joint research allow to overcome this obstacle.
Many international agreements and programs finance networks regrouping teams of different specialities to get tangible achievment.

Figure 11.

During the last 5 years the CBS is engaged in
42 international and regional
Joint research.
Among them :

• 4 EC projects relevant to the FP6 programme (EUROHEAR, CEDROME, PROMENBRANE and PURATREAT)

• 7 projects under the Joint Committee for Universital Cooperation between France and Tunisia CMCU

Figure 12.

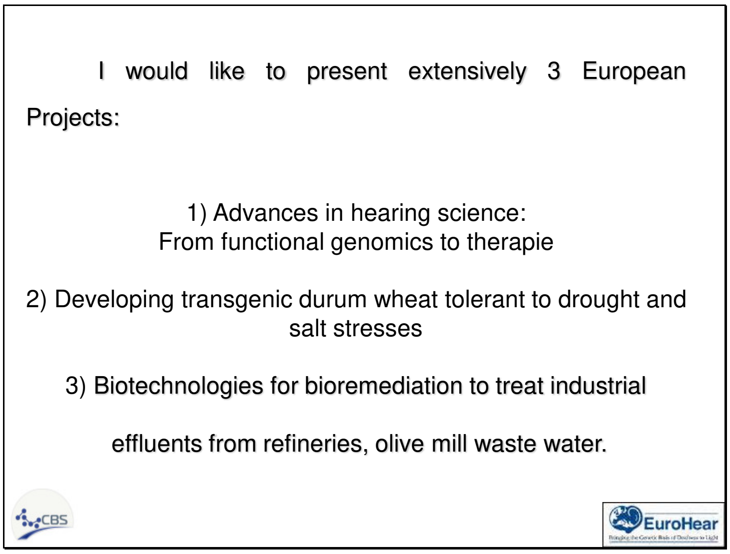


Figure 13.

Figure 14. Eurohear.

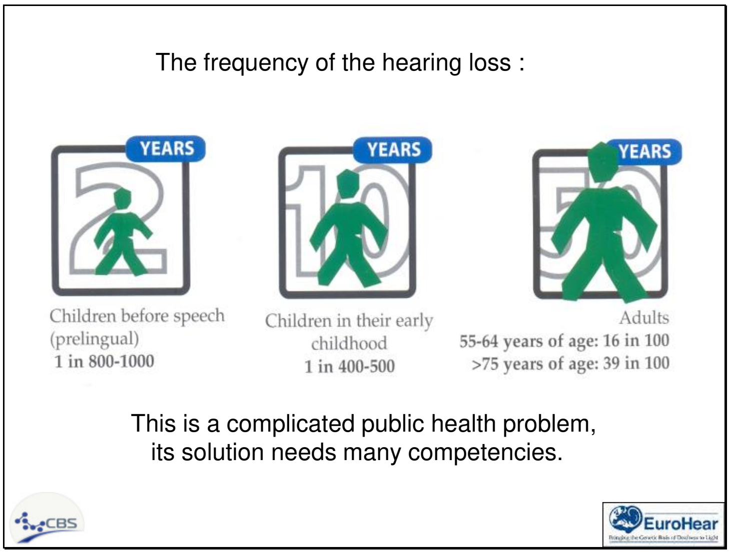


Figure 15. The Frequency of Hearing Loss.

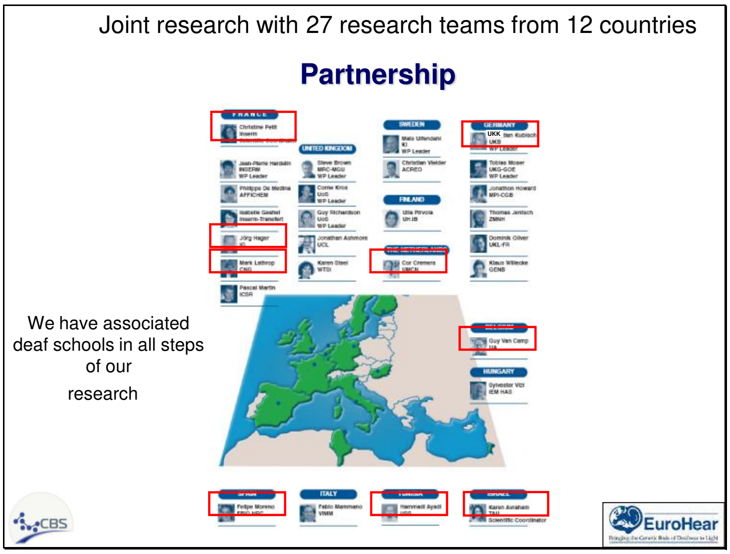


Figure 16. Partnership.

EuroHear plans to test novel findings, and expects to prove the new concepts and confirm their therapeutic efficacy .

EuroHear has three closely interrelated objectives :

- To identify genes that underlie sensorineural hearing Impairment

- To understand the mechanisms underlying normal and impaired hearing

- To develop tools for the prevention and cure of hearing impairment

Figure 17.

The European Commission is supporting Euro Hear with a 12.5 M euros grant over 5 years (2005-2009).

This project involves 27 Research teams specialized in 8 fields : genetics, biochemistry, cell biology, development, physiology, biophysics, bioinformatics and medicine.

Figure 18.

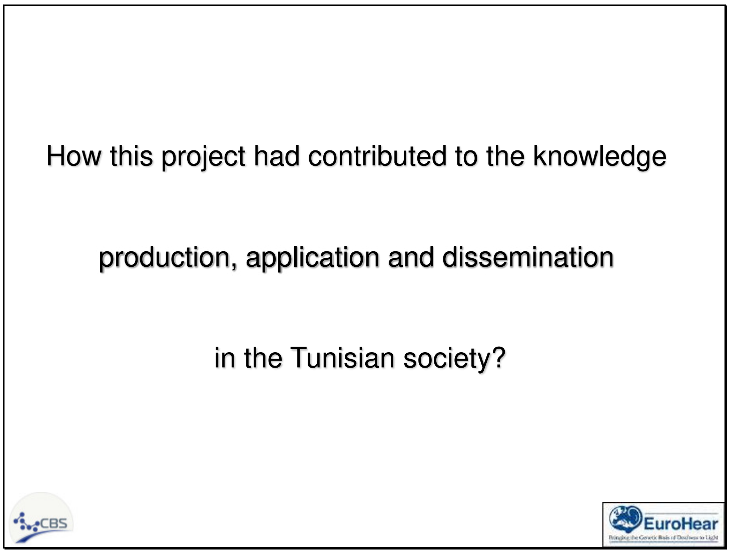


Figure 19.

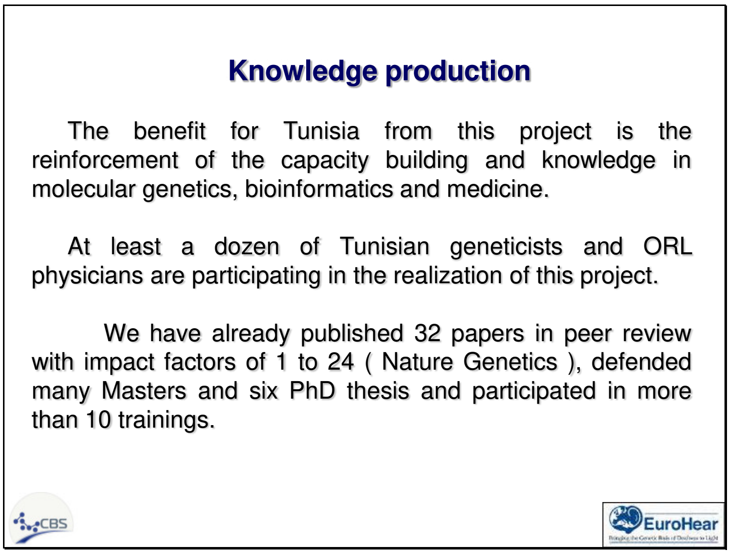


Figure 20. Knowledge Production.

Moreover, we are now using our own results and indications concerning hearing and hearing loss in teaching in medical school and in up graduated studies.

The identification of the responsible mutation of childhood hearing impairment in all Tunisia allowed us to draw up a molecular map of the whole Tunisian population, to determine carrier and to serve affected families with a very efficient genetic councelling.

Figure 21.

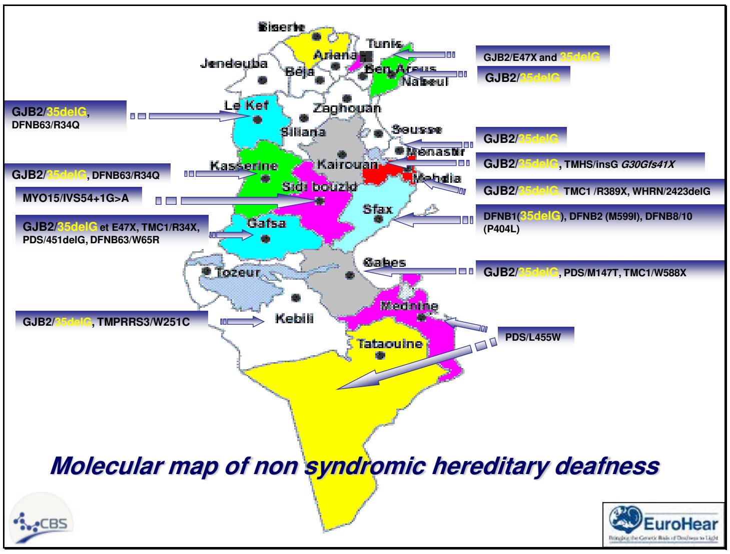


Figure 22.

Knowledge dissemination

Moreover, meetings, visits and workshops were organized in order 1) to disseminate the findings in the social sector, particularly in families suffering from hereditary diseases

2)To convince families to avoid interfamily marriages which favorise the expression of these mutations.

CBS

EuroHear

Figure 23. Knowledge Dissemination.

Figure 24.

we have given several interviews to
Tunisian and European radios, news papers and TV.

Figure 25.

This joint research allowed us to set up early the genomic technology,
to obtain useful results for affected families and
a better efficiency for the genetic councelling.

The dissemination of our results among areas with high rate of consanguineous marriage have contributed to decrease considerably this rate
(from 69% to 13%) in one area.

Figure 26.

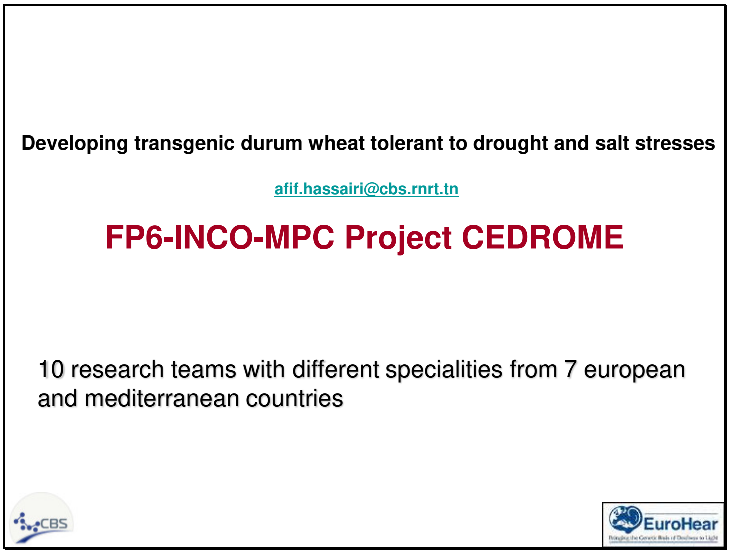


Figure 27.

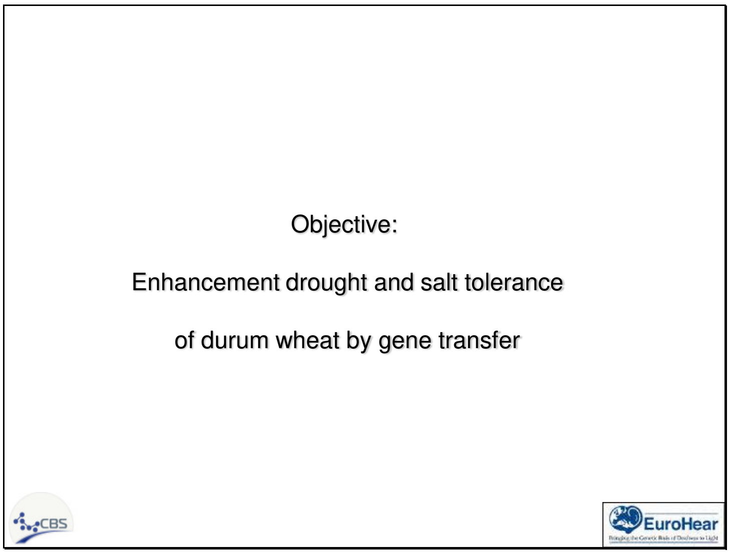


Figure 28.

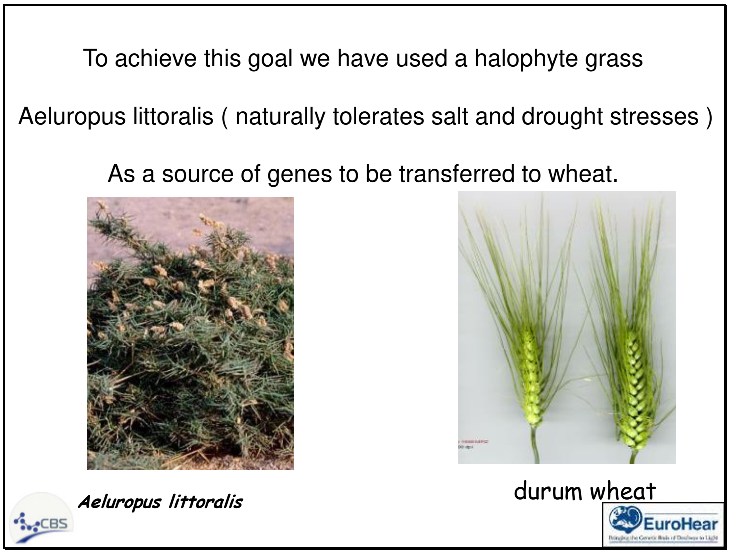


Figure 29.

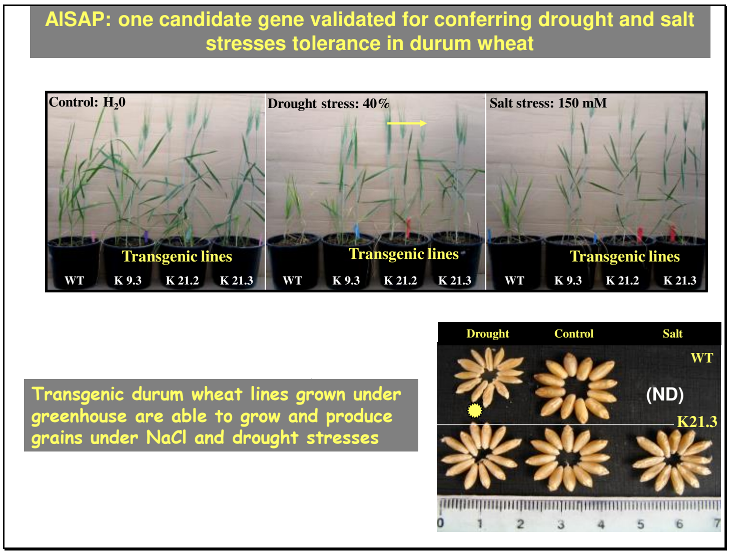


Figure 30.

The obtention of transgenic durum wheat resistant to salinity and drought conditions will lead us to use many land hectares and open the road to massive culture of this essential foodstuffs for our food security and alimentary independance.

Figure 31.

Biotechnologies for bioremediation to treat industrial effluents from refineries, olive mill waste water.

PURATREAT PROJECT CEE- STREP

CONTRACT Number 015449

12 research teams of different specialities

Figure 32.

The oleic Olive mill waste water, a very polluting by-product of industry, is valorised by the obtention of an antioxidant, fertilizer, water for irrigation and biogas production.

Pilot plant experimented for olive mill waste water treatment

Figure 33.

Award of the French Magazine "La Recherche" Field « Environment » 2006 for Prof. Sami SAYADI (CBS, Sfax) spensorized by « *Veolia* Environnement »: http://www.leprixlarecherche.com/; www.veoliaenvironnement.com/

- **Contract 1: Production of antioxydants from olive by-products (Agreement CBS-AGRITEX).**

- **Contract 2: Toward the Implementation of a full scale biogaz production plan from Olive mill effluent (Agreement CBS-SSH-ANGED).**

CBS

EuroHear

Figure 34.

This joint research leads us to propose

to the government

a solution for removing olive by products by its valorisation

in biogas and fertilizer and to demonstrate to the population

how we can valorise polluting products.

Figure 35.

Suggestions for Islamic Countries toward R & D Networking Drawn from FP, EU.

http://cordis.europa.eu/fp7/dc/index.cfm

CBS

EuroHear

Figure 36.

Islamic countries (IC) should create a fund in order to finance IC joint research. These programmes should have two main strategic objectives:

- to strengthen the scientific and technological base of IC industry;
- to encourage its international competitiveness, while promoting research that supports IC policies

Figure 37.

4 main blocks of activities forming 4 specific programmes should be lunched:

1. Cooperation - Collaborative research
2. Ideas - Research council
3. People - Human potential,
4. Capacities - Research capacities

Figure 38.

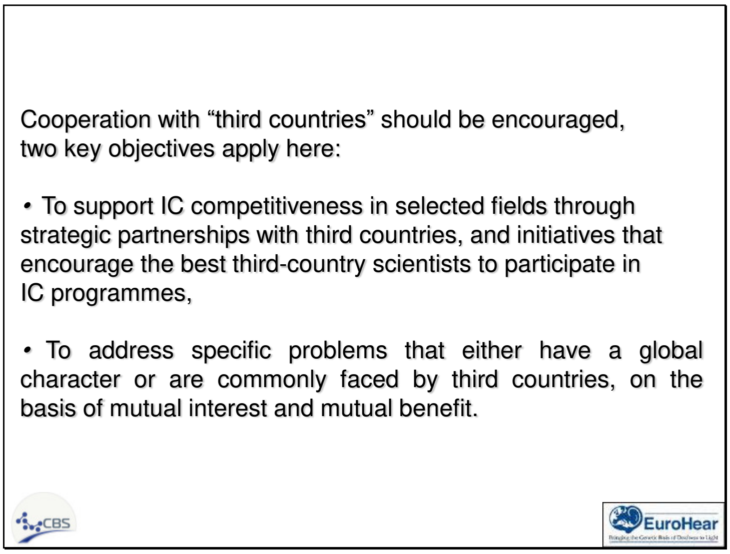


Figure 39.

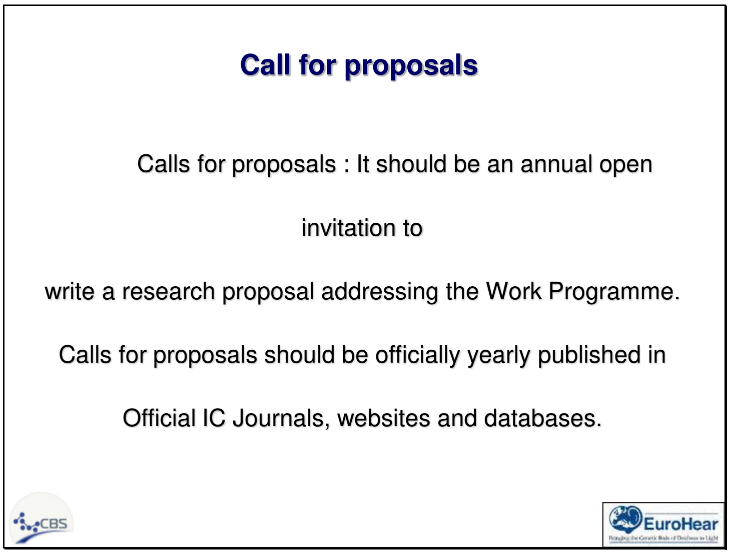


Figure 40. Call for Proposals.

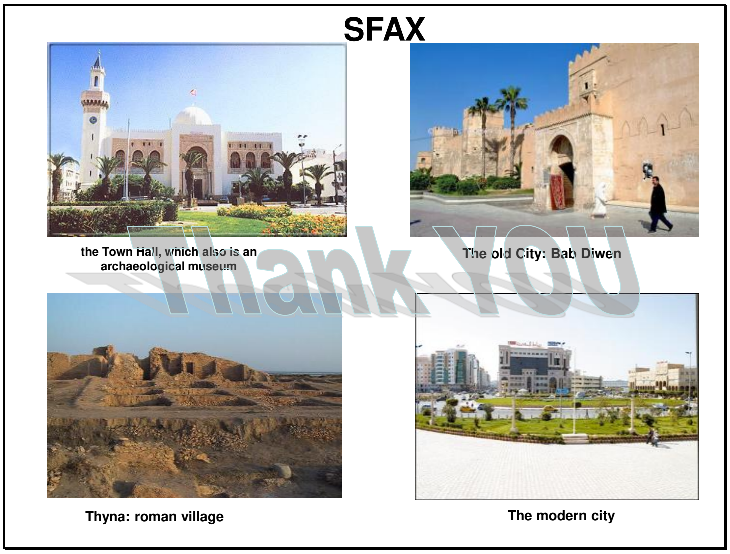


Figure 41. Situated on the Gulf of Gabes, in front of the Mediterranean Sea, in the middle of Tunisia , Sfax has one of Tunisia's most lively old cities.

Views Regarding Academic Publishing in the Information Age

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ABSTRACT

The information age has brought about many different ways of disseminating publication. This has also changed the ways of the researchers

The information age has brought about many different ways of disseminating publications. This has also changed the way the researchers publish, review, search, and access the academic (journal) publications. Although the media of publication and review have evolved, the basic steps of producing an academic publication still remain the same: submission, review, publication, and dissemination. This paper will try to present a short review of recent developments in each of these steps with a special focus on the "peer review" aspect. The review process is mainly responsible for the quality, i.e., the impact factor, of any publication. However, reviewing a paper is customarily a voluntary task. Given the increase in the publication speed, finding enough reviewers in a given specialty area has become a burden on the editors. More often than not, the reviews are carried out by people that share similar (but not same) interests with the author. This brings about a dilemma: if the interests of the author and the reviewer match perfectly they turn out to be rivals in the academic arena whereas if their interests weakly overlap than the review process will require an excessive level of effort for a voluntary job and will most probably yield a poor review. The fact that originality is the most important criterion for a publication deepens this gap. If the reviewer is competent, then the author will be giving away his "trade secrets" to his rival before anyone ever sees it. On the other hand, if the reviewer is not very proficient on the topic, it will make it even harder for him to comprehend the gist of the paper to the point that he cannot spot the possible errors in it. As a result, several types of mishaps such as pre-publication plagiarism and rejection of innovations prevail.

This paper will point out some efforts that are pacing towards elimination of this dilemma by using the free publication power of the internet. Also, suggestions on a new open system of publication will be presented. This internet based system still relies on the voluntary participation of the involved parties. However, thorough the ability of the computer technology, the new system aims at solving the reviewer dilemma while providing the readers critical information about the strengths and weaknesses of the manuscripts that appear in this system.

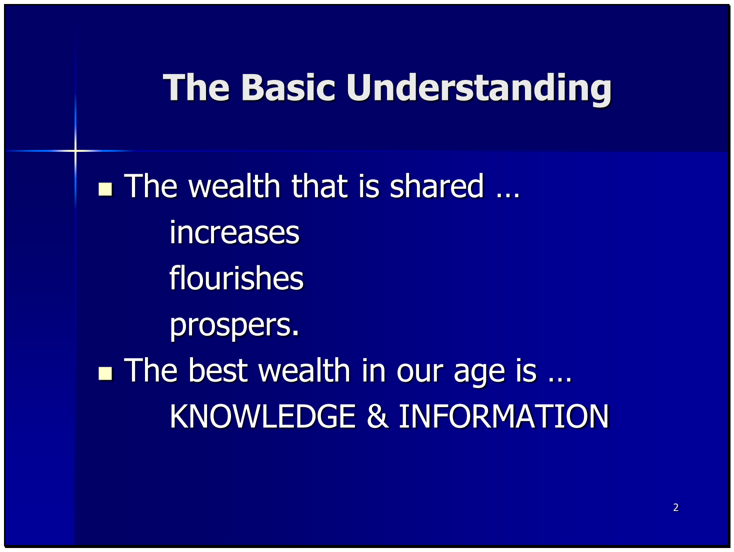


Figure 1. The Basic Understanding.

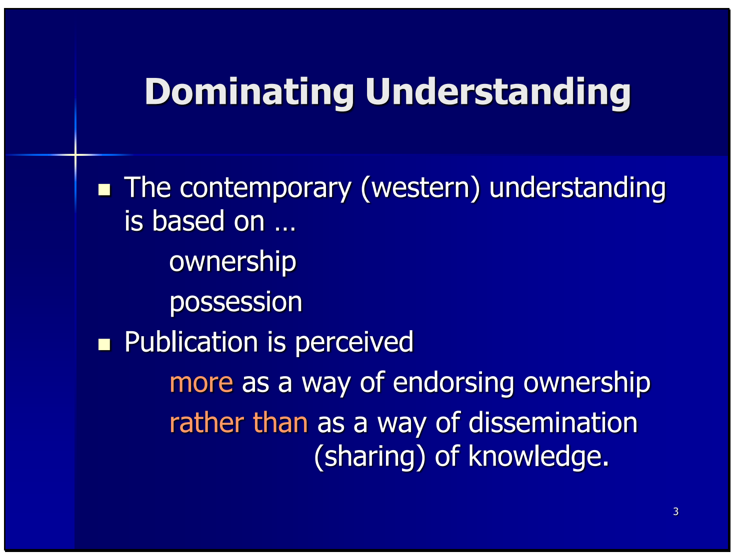


Figure 2. Dominating Understanding.

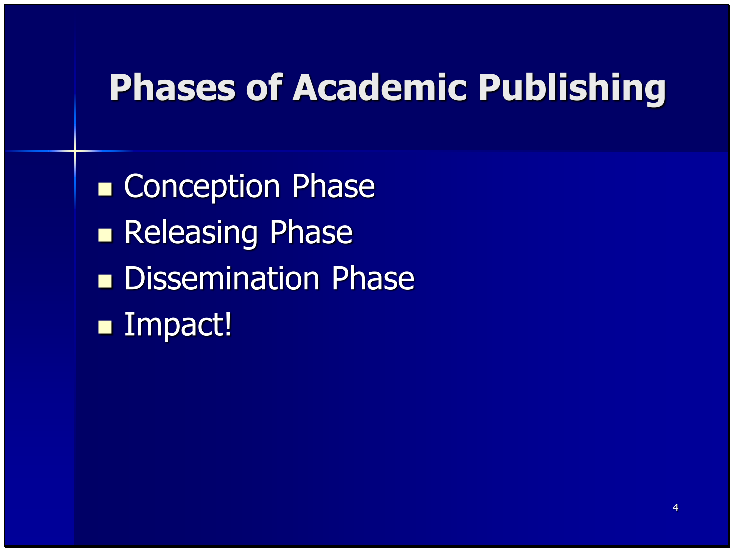


Figure 3. Phases of Academic Publishing.

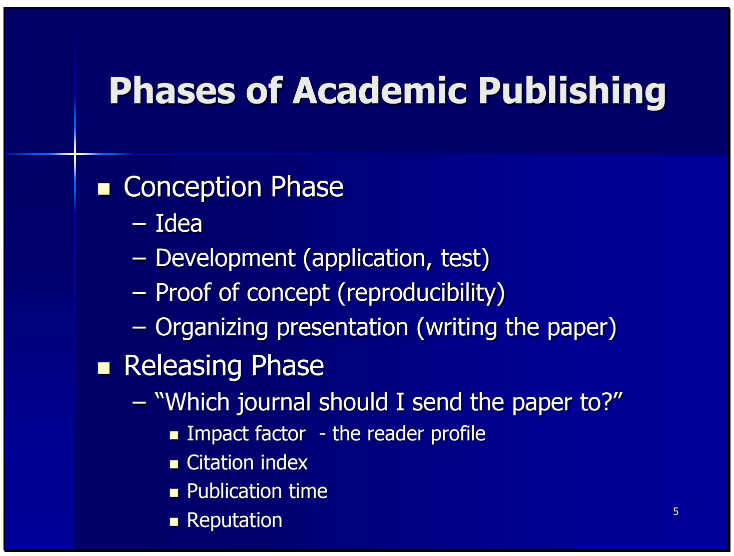


Figure 4. Phases of Academic Publishing.

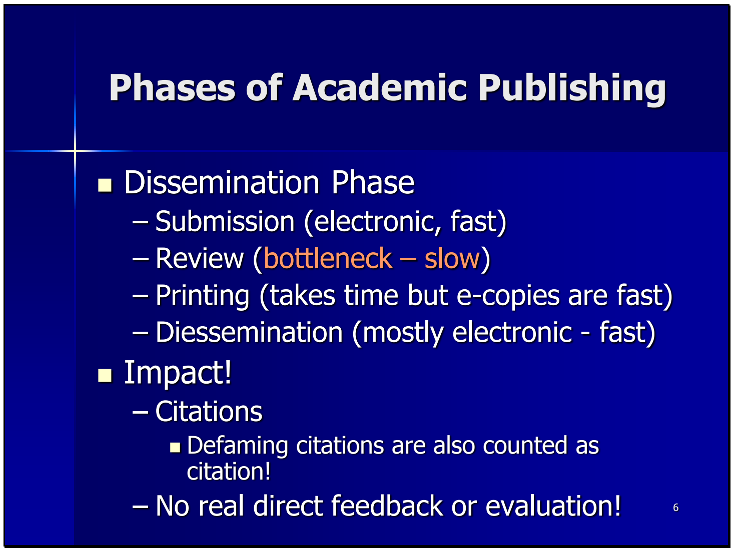


Figure 5. Phases of Academic Publishing.

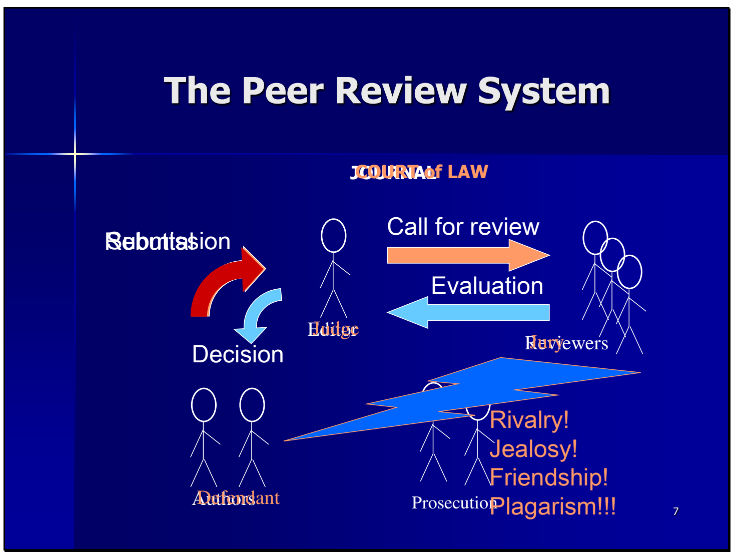


Figure 6. The Peer Review System.

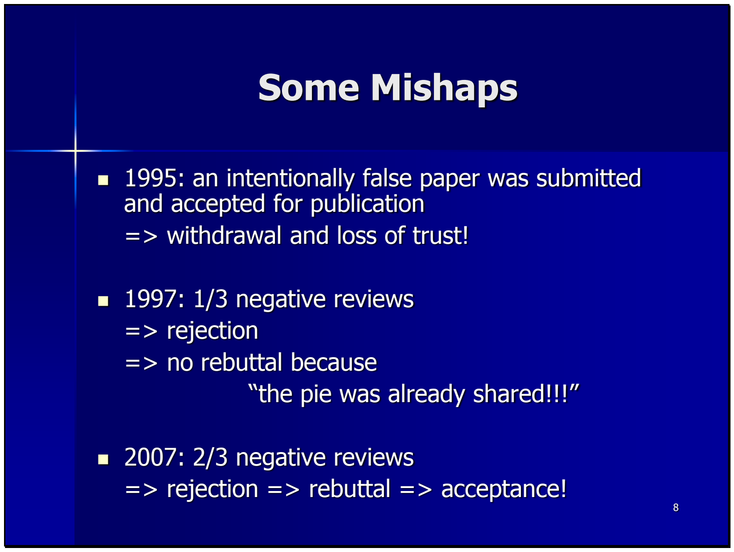


Figure 7. Some Mishaps.

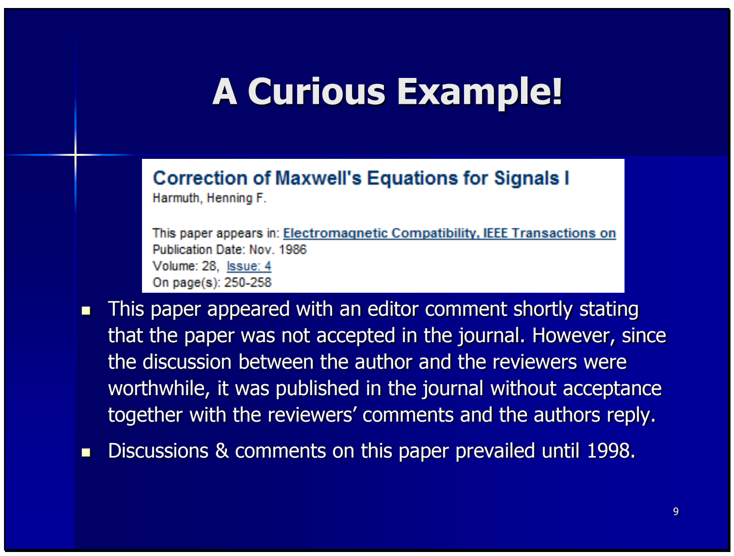


Figure 8. A Curious Example!

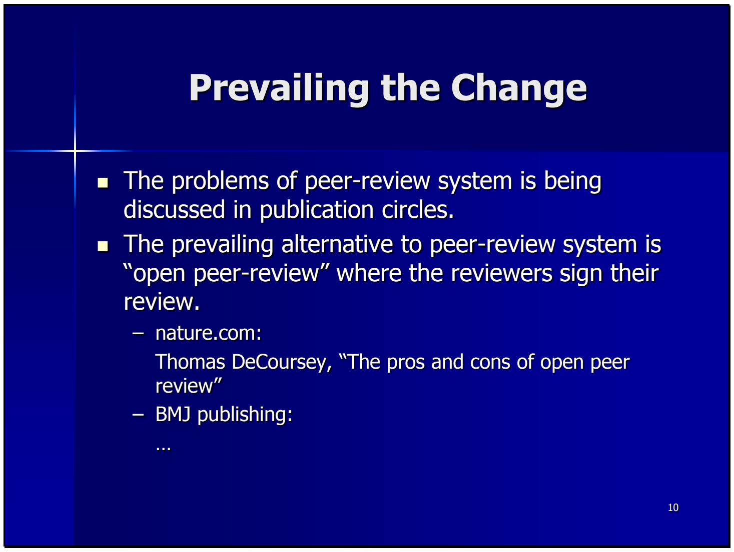


Figure 9. Prevailing the Change.

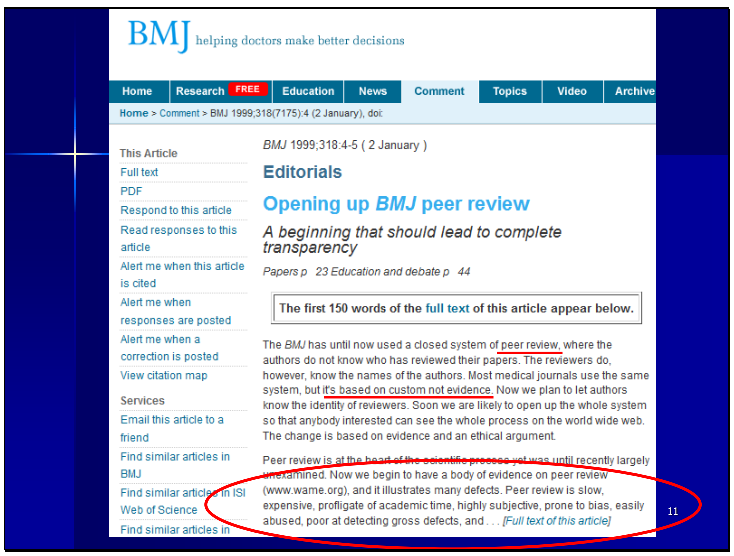


Figure 10. BMJ.

Figure 11. A New Novel Alternative.

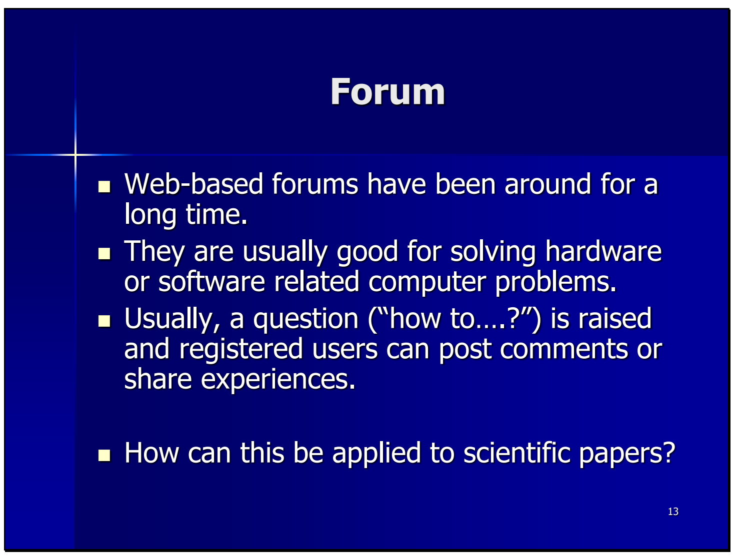


Figure 12. Forum.

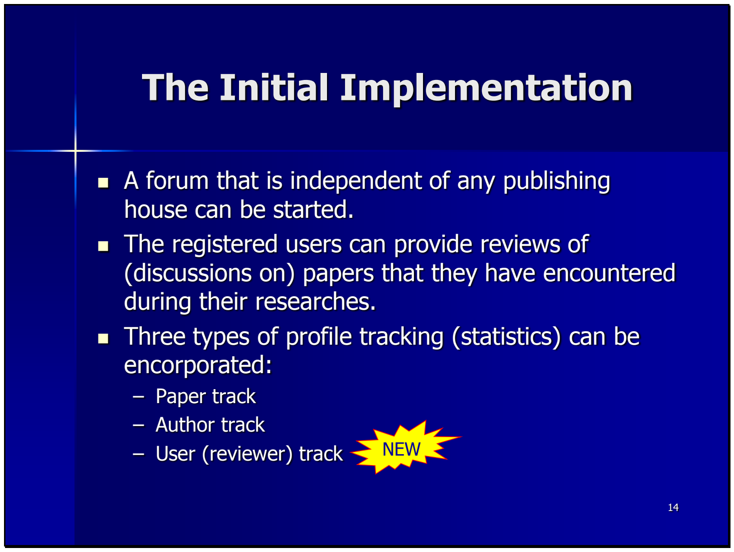


Figure 13. The Initial Implementation.

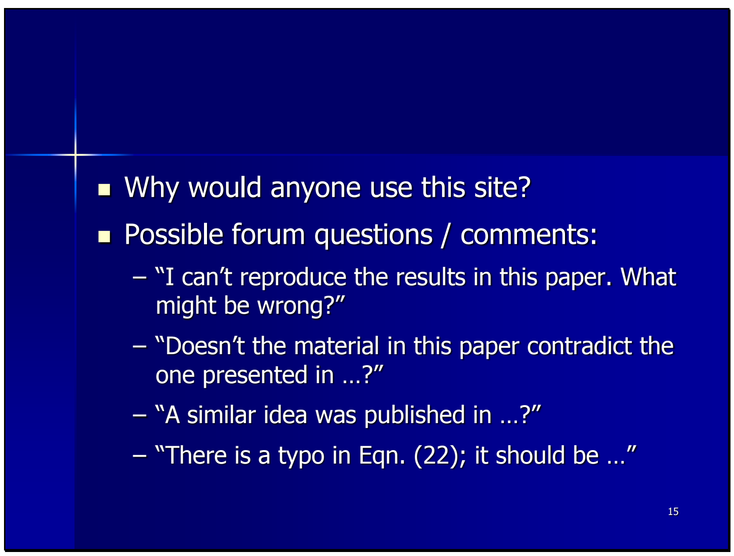


Figure 14.

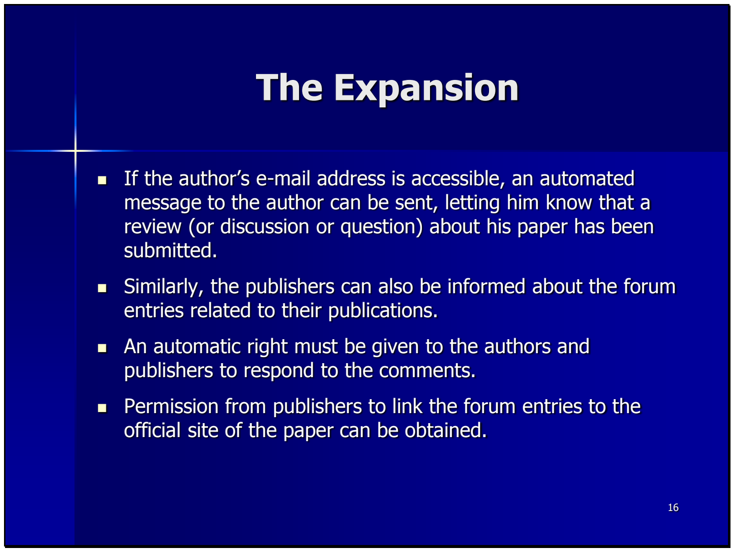


Figure 15. The Expansion.

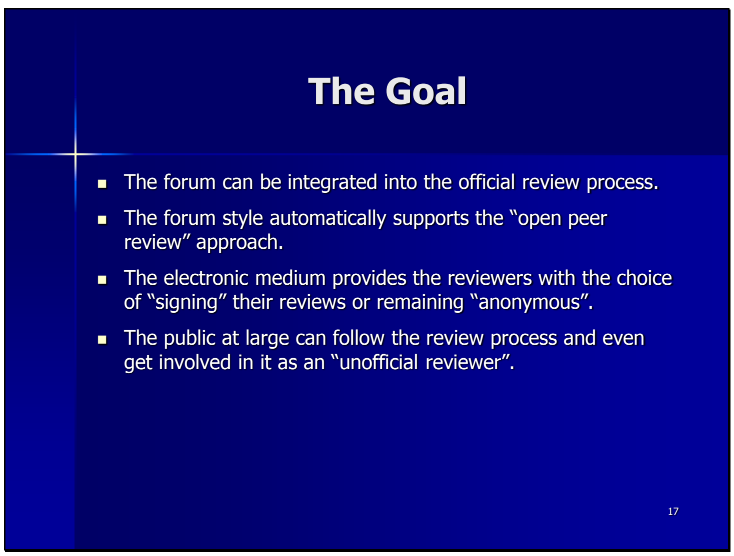


Figure 16. The Goal.

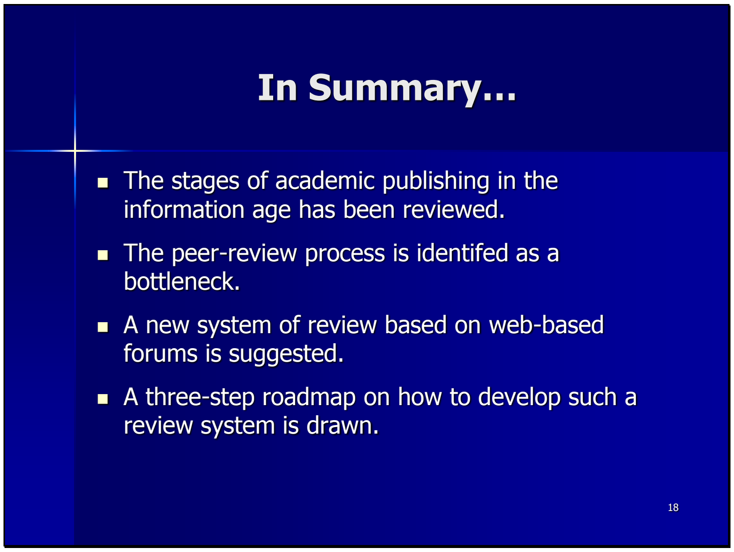
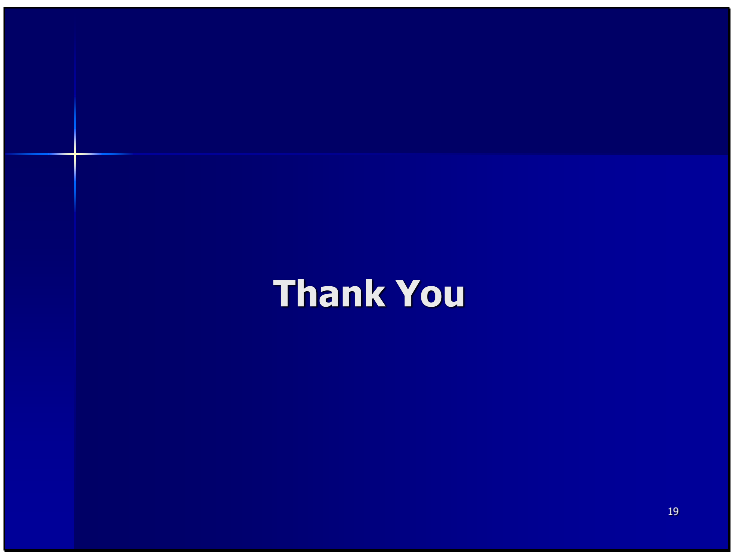


Figure 17. In Summary.



Science Growth in Iran in the Last Decade

MOHAMMAD ABDOLLAHI[1]
and
SHABNAM KHARABAF[2]

1 ABSTRACT

In an aim to determine Iran's scientific activities during the last 10 years and its progress in different scientific fields in a comparison with other countries, database of Essential Science Indicators (ESI) from Thomson Reuters ISI Web of Knowledge and SCImago Journal & Country Rank from Scopus were searched and analyzed. Web of Science and ISI Web of Knowledge were searched for Iran during 1998-2009. Number of papers each year, top 15 authors, top 15 institutions, and top 15 subject areas were discovered. ESI was searched for Iran to discover place of Iran in all 22 scientific categories in the world on the basis of number of publications and citations. In the third step, SCImago Journal & Country rank which developed by Scopus was used to discover ranking of Iran between 233 countries of the world. Number of publications, citable publications, citations, citation per publication, and h-index were the factors which were indicated for each country.

Results of the present investigation showed that Iran had a strong progressive growth in quantity and quality of publications year by the year. Considering year 2009 that is not completed yet, year 2008 is on the top. Chemistry has the most number of papers in Iran (12,719 papers). Economics & Business is in the last place with only 69 papers. Iran with rank of 38 in the world has the second rank after Turkey among its neighbors and the eighth in Asia after Japan, China, India, Korea, Taiwan, Hong Kong, and Singapore.

Taking collectively all results and regarding the existing scientific background, considering the growth rate of science in Iran, it would not be surprising to see Iran among top 30 countries of the world in at least 15 ESI categories most probably by 2015.

2 INTRODUCTION

Over the last century, progress in science and technology (ST) has been a key driver of human and social development. ST indicators are basic tools to quantitatively and objectively understand not only trends in S&T fields but also in society as a whole and in the national economics growth. Therefore, investing heavily in research & development seems to be logical for the countries (Wilson 2003). Iran allocates around 0.5% of its gross domestic product (GDP) to research and development, which ranks it far behind industrialized societies' that spend 1.4% of their GDP on average (Malekzadeh et al. 2001).

Although scientometric indicators such as number of papers, number of articles and citations per paper are not absolute but have become increasingly important as instruments for analyzing scientific activities and their relationship with economics and social development. Research output measurements are based on indicators such as publication and citation, because publication and citation rates differ significantly among various fields of science, universities or nations (Leydesdorff 2008). The quality and quantity of published articles of each country indexed by reputable databases are important in determining the country's contribution to the world sciences and status in international academic rankings (Amirpour 2009). On the other hand, evaluation of science production is generally difficult because of

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lack of appropriate scientific indicators, scarcity of available data and annual changes in economic growth parameters (Moein 2005).
To understand place of Iran in the world and its growth trend in the science in the last decade, a scientometric analysis of relevant databases from Thompson Reuters ISI and Elsevier was conducted.

3 METHODS

Searching the information was on the basis of the name of "Iran" in all databases. In web of science, limitation of time between1998-2009 was considered. Top 15 authors, top 15 Institutions, top 15 subject areas, and top 15 journals were extracted from ISI Web of knowledge. 233 countries of the world are shown in comparison with each other between 1996-2007, from Scimago Journal & Country rank. Number of publications, citable publications, citations, self-citations per publication, and H-index were the indicators specified for each country.

In ESI, 10 years of activities in 22 subjects' areas are specified as human knowledge. These 22 fields include chemistry, engineering, clinical medicine, physics, plant & animal sciences, materials science, mathematics, biology & biochemistry, pharmacology & toxicology, agricultural sciences, computer science, geoscience, environmental/ecology, social sciences/general, neuroscience & behaviour, molecular biology & genetics, microbiology, immunology, psychiatry/psychology, multidisciplinary, space science, and economics & business.

Any of these twenty two titles have covered some sub-titles which are as follows:

AGRICULTURAL SCIENCES: agricultural engineering, agronomy, tillage research, agroforestry, horticulture, crop protection and science, agrochemistry, phytochemistry, agricultural biochemistry, food chemistry, cereal chemistry, carbohydrate and lipid research, food science and nutrition, composition, additives and contaminants, microbiology and technology, engineering and processing, meat and dairy science, nutrition science, nutrition and metabolism and nutritional biochemistry

BIOLOGY & BIOCHEMISTRY: structure and chemistry of biological molecules, molecular, cellular and clinical studies of the endocrine system, regulation of cell, organ and system functions by hormones, experimental research in general biology and biological systems, regulation of biological functions at the whole organism level, exploitation of living organisms or their components, industrial microbiology, pollution remediation, industrial chemicals and enzymes, biosensors, bioelectronics, pesticide development, food, flavor and fragrance industry applications and waste treatment.

CHEMISTRY; analytical chemistry, spectroscopy, instrumentation, inorganic and nuclear chemistry, organic chemistry, physical chemistry, polymer science, food chemistry, chemical methods and structures, natural and laboratory syntheses, isolation and analysis of clinically significant molecules, medicinal chemistry and chemical engineering.

CLINICAL MEDICINE: anesthesia, cardiovascular medicine, dentistry, dermatology, general & internal medicine, endocrinology, environmental medicine, gastroenterology, gynecology, hepatology, hematology, nephrology, nuclear medicine, obstetrics, oncology, ophthalmology, otolaryngology, pediatrics, pharmacology, radiology, toxicology, respiratory medicine, rheumatology, surgery and urology.

COMPUTER SCIENCE: computer hardware and architecture, computer software, software engineering and design, computer graphics, programming languages, theoretical computing, computing methodologies, broad computing topics, interdisciplinary computer applications, information systems and information technology, acquisition, processing, storage, management, and dissemination of information, communications via various devices and systems.

ENVIRONMENT/ECOLOGY: pure and applied ecology, ecological modeling and engineering, ecotoxicology, evolutionary ecology, environmental contamination and toxicology, environmental health, environmental monitoring and management, environmental technology, environmental geology, soil science and conservation, water resources research and engineering, climate change, biodiversity conservation and Natural history.

ECONOMICS & BUSINESS: theoretical, political, agricultural, and developmental economics, business, finance, management, organizational science, strategic planning and decision-making methods, industrial relations and labor.

ENGINEERING: aerospace engineering, mechanical engineering, nuclear energy, electrical and electronics engineering, civil engineering, water resources and supply, transportation, and municipal engineering, effects of humans on the environment, controls to minimize environmental degradation, artificial intelligence, robotics and automatic control, engineering mathematics, mathematical modeling, optimization techniques, statistical methods in engineering systems, development, manufacture, and application of instruments.

GEOSCIENCES: geology, geochemistry, geophysics, geotechnics, economic geology, petrochemistry, mineralogy, meteorology and atmospheric sciences, hydrology, oceanography, petroleum geology, volcanology, seismology, climatology, paleontology, remote sensing, geodesy, geological, petroleum and mining engineering.

IMMUNOLOGY: cellular & molecular studies in immunology, clinical research in immunopathology, infectious diseases, autoimmunity and allergy, host-pathogen interactions in infectious disease and experimental therapeutic applications of immunomodulating agents.

MATERIALS SCIENCE: ceramics, paper and wood products, polymers, textiles, composites, coatings & films, biomaterials, metals and alloys, metallurgy, application of chemistry to materials design and testing, superconductors and semiconductors, ferroelectrics and dielectrics.

MATHEMATICS: pure mathematics, applied mathematics, statistics and probability.

MICROBIOLOGY: biology & biochemistry of microorganisms (bacterial, viral and parasitic), medical implications of the subsets of these organisms known to cause diseases, and biotechnology applications of microorganisms for basic science or clinical use.

MOLECULAR BIOLOGY & GENETICS: biochemistry, molecular biology, biophysics, pharmacology, receptor biology, signal transduction, regulation of gene expression, developmental genetics and biology, morphogenesis, cell-environment interactions, molecular genetics, mechanisms of mutagenesis, structure, function and regulation of genetic material, clinical genetics, patterns of inheritance, genetic causes, and screening and treatment of diseases.

MULTIDISCIPLINARY: The MULTIDISCIPLINARY category includes journals of a broad or general character in the sciences and covers the spectrum of major scientific disciplines. It also includes journals devoted to a multidisciplinary approach to the study of particular regions, ecosystems or biological systems, and interdisciplinary journals designed to illuminate significant connections between fields.

NEUROSCIENCE & BEHAVIOR: cellular and molecular neuroscience, neuronal development, basic and clinical neurology, psychopharmacology, biobehavioral psychology, molecular psychology and neuronal function underlying higher cognitive processes.

PHARMACOLOGY: pharmacology, pharmaceutics, cellular and molecular pharmacology, drug design and metabolism, mechanisms of drug action, drug delivery, natural products, xenobiotics, mechanisms of action for clinical therapeutics, toxicology, molecular and cellular effects of harmful substances, environmental toxicology, occupational exposure and clinical toxicology.

PHYSICS: mathematical physics, particle and nuclear physics, physics of fluids and plasmas, quantum physics, theoretical physics, applied physics, condensed matter physics, physics of materials, optics and acoustics.

PLANT & ANIMAL SCIENCE: regional botany, mycology, bryology, plant physiology, forestry, weed science, plant pathology, economic botany, aquatic botany and toxicology, marine ecology, plant nutrition, photosynthesis research, experimental botany, cellular and molecular biology or physiology of plant cells and plant systems.

ANIMAL SCIENCE: animal behavior, animal production science, poultry science, wildlife research, lab animal science, zoology, primatology, mammalogy, herpetology, nematology, malacology, entomology and pest control, veterinary medicine, animal health, marine and freshwater biology, fisheries science and aquaculture.

PSYCHIATRY/PSYCHOLOGY: applied, biological, clinical, developmental, educational, mathematical, organizational, personal, social, diagnosis and treatment.

SOCIAL SCIENCES, GENERAL: communication, environmental studies, library and information sciences, political science, public health and administration, rehabilitation, social work and social policy, sociology, anthropology, law, education.

SPACE SCIENCES: astronomy and astrophysics, celestial bodies, observation and interpretation of radiation from the component parts of the universe.

In this database the number of papers, citations, and citation per paper for each of the fields in Iran were extracted and in the next step Iran's place in each field was specified among 233 countries.

The very important problem in searching universities is different forms of recording the name of the institutions seeming a mistake of databases. For example, different recorded forms of Tehran University of Medical Sciences is “University of Medical Sciences Tehran”, “University of Tehran Medical Sciences”, “Tehran Medical Sciences University”, and “Tehran University of Medical Sciences TUMS”. In addition, the word "Tehran" has been also recorded as "Teheran" in some cases. These mistakes have been considered and corrected in the present study.

4 RESULTS

In this study a glance at scientific production in the last decade extracted from ISI/web of knowledge indicated rising trend of paper production in Iran. Considering year 2009 that is not finished yet, year 2008 with 16652 articles is on the top (Figure 1). Comparing different universities in terms of number of published articles, University of Tehran with 9175 articles stands on top of the list, followed by Sharif University with 5852. Table 2 shows journals from ISI Web of Knowledge where most of Iranian papers have been published in. Table 3 presents the ranking of all countries of the world during 1996 to 2007 from SCImago Journal & Country Rank portal. This portal is developed from the information contained in the Scopus database. As shown in this table, Iran with a total number of 50,528 papers, 49,650 citable publication, 180,276 citations, 5.93 citation per paper, and H-index of 73 ranked thirty eight among 233 countries of the world. Table 4 presents Iran's situation in different scientific majors in the country according to ESI. Iran has the most publication in Chemistry with 12,719 papers followed by Engineering with 7447 papers and Clinical Medicine with 6157 papers. On the basis of this report, Economics & Business with 69 papers has the least portion in scientific production. Iran's sharing in 22 scientific majors between other countries of the world are shown in tables 5 to 26. Because of the large numbers of countries, the last reported country of each table is Iran. To see the countries after Iran, referring to ESI website is necessary. In Chemistry with 12719 papers: 21 among 93 countries; in Engineering with 7447 papers: 24 among 94 countries; in Clinical Medicine with 6157 papers: 38 among 107 countries; in Physics with 3908 papers: 36 among 87 countries; in Plant & Animal Sciences with 2829 papers: 36 among 106 countries; in Materials Sciences with 2788 papers: 30 among 78 countries; in Mathematics with 1753 papers: 32 among 82 countries; in Biology & Biochemistry with 1408 papers: 43 among 99 countries; in Pharmacology & Toxicology with 1220 papers: 27 among 88 countries; in Agricultural Sciences with 1202 papers: 36 among 98 countries; in Computer Sciences with 1137 papers: 35 among 79 countries; in Geosciences with 985 papers: 38 among 101 countries; in Environmental/ Ecology with 795 papers: 40 among 100 countries; in Social Science/ General with 749 papers: 40 among 102 countries; in Neurosciences & Behavior with 666 papers: 38 among 82 countries; in Molecular Biology & Genetics with 400 papers: 42 among 82 countries; in Microbiology with 369 papers: 45 among 88 countries; in Immunology with 317 papers: 42 among 91 countries; in Psychiatry/ Psychology with 265 papers: 41 among 84 countries; in Multidisciplinary with 254 papers: 13 among 78 countries; in Space Sciences with 237 papers: 44 among 69 countries; in Economics & Business with 69 papers: 58 among 82 countries

5 DISCUSSION

Iran has had a bright history in science over the many ancient years. It had many famous scientists and a significant number of unique inventions and discoveries brought by Iranian scientists such as Farabi, Toosi, Razi, Bu Ali Sina, Professor Hesabi, and many others. During centuries due to political, cultural circumstances and war, Iran's activities in all aspects of science and art have been changed. Several studies which have been carried out in Iran, confirm the rising growth in scientific production. Osareh and Marefat evaluated Iranian researchers' scientific growth between 1976-2003 in Medline and concluded a significant growth in scientific production especially in 1990-2003. Saboury extracted Iranian articles in three different fields of SCI, SSCI, and A&HSCI form ISI Web of Science between 1993-2002, and reported that Iran has good growth in SCI. Aminpour and Kabiri confirmed the same result in their study which reviewed Iranian science production in medicine (Aminpour and Kabiri 2009; Osareh and Marefat 2005; Saboury 2003). In this study the present findings are very obvious indicating that production of sciences has grown very toughly since 1998.

Iran with the rank of 38 in the world has the second rank after Turkey among its neighbors and the eighth in Asia after Japan, China, India, Korea, Taiwan, Hong Kong, and Singapore. Actually, in Iran, S&T has been subject of adequate attention in the recent years that resulted in the growth of sciences in terms of budget or staff or tools and instruments. Iran's national science budget has been about $900 million until 2005 but has grown since then year by year. It is estimated that presently Iranian government allocates 0.5% of its GDP to research, which still ranks it "far behind industrialized societies" which spend 1.4% of their GDP on average. Of course, there are special huge funds devoted by Iranian government for researches on nanotechnology, biotechnology, stem cell research, and information technology and this is why Iran got a very good rank (13) among the world in the field of multidisciplinary (Figure 24).

Despite limitations in funds or facilities, Iranian scientists have been very productive in several experimental fields such as pharmacology/toxicology, chemistry, physic, computer, engineering, and clinical medicine and Iranian researchers have gained international reputations since the 1990s and some of them are listed among 1% top scientists of the world as reported by ESI. Highly expensive instruments especially for high technology researches have been provided in Iranian universities during the past two decades even greater than those available in some Western countries. According to the State Registration Organization of Deeds and Properties, a total of 9,570 national inventions were registered in Iran during 2008 showing a 38% increase in comparison with 2007 (Wikipedia).

In the field of scientometric studies there are some limitations. For instance, during search and evaluation of the present data we learned that mistaken?? writing of affiliation address by authors is the main source of mistakes found in statistics of the institutes or scientists around the world. Thus all authors are recommending keeping this notice in attention.

Taking collectively all results and regarding the existing scientific background, considering the growth rate of science in Iran, it would not be surprising to see Iran among the top 30 countries of the world in at least 15 ESI categories most probably by 2015.

6 ACKNOWLEDGMENT

The summary of this study was presented as a lecture in 17th IAS Conference in Malaysia 14-17 December 2009 by Mohammad Abdollahi.

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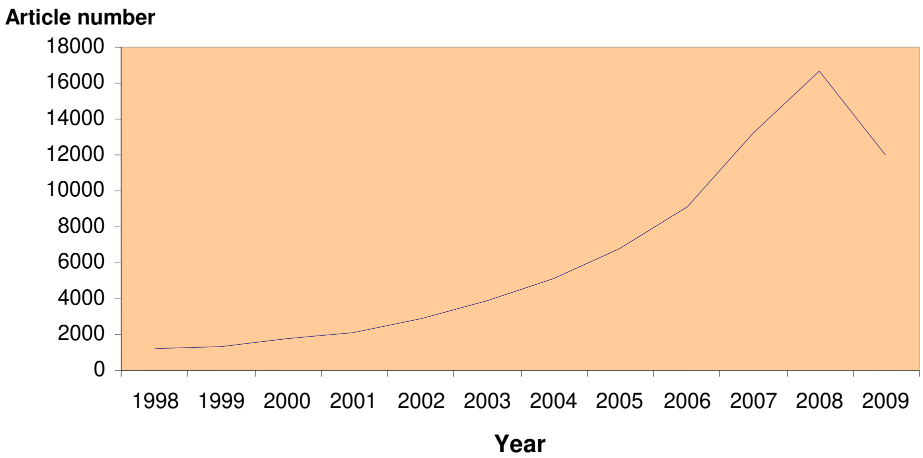


Figure 1. Science Growth Trend of Iran in the last decade according to total publications reported by Thompson Reuter ISI.

Table 1. Iran top 15 universities according to scientific production

Grade	*University*	*Number of Publication*
1	University of Tehran	9175
2	Sharif University of Technology	5852
3	Tehran University of Medical Sciences	5077
4	Islamic Azad University	4558
5	Tarbiat Modarres University	4305
6	Isfahan University of Technology	3920
7	Shiraz University	3616
8	Amirkabir University of Technology	2940
9	Iran University of Science and Technology	2890
10	Shahid Beheshti University of Medical Sciences	2278
11	University of Shahid Beheshti	1897
12	Shiraz University of Medical Sciences	1896
13	Ferdowsi University Mashhad	1821
14	Tabriz University	1309
15	Khajeh Nasir Toosi University of Technology	1250

Table 2. Journals from ISI Web of Knowledge where most of Iranian papers have been published in

Grade	*Journal's title*	*Number of published articles*
1	Asian Journal Of Chemistry	644
2	Applied Mathematics And Computation	639
3	Phosphorus Sulfur And Silicon And The Related Elements	507
4	Iranian Polymer Journal	480
5	Acta Crystallographica Section E-Structure Reports Online	450
6	Synthetic Communications International Journal Of Psychology	435
7	Journal Of Applied Polymer Science Lecture Notes In Computer Science	424
8	Acta Horticulturae	406
9	Iranian Journal Of Science And Technology	383
10	Journal Of Chemical Research-S	365
11	Transplantation Proceedings	355
12	Iranian Journal Of Chemistry & Chemical Engineering-International English Edition	327
13	Tetrahedron Letters	303
14	Iranian Journal Of Public Health	271
15	Archives Of Iranian Medicine	269

Table 3. Place of Iran in the ranking of 233 countries of the world sorted by H-index of Scimago

Grade	*Country*	*Publications*	*Citable Publications*	*Citations*	*Self Citations*	*Citation per Publication*	*H-index*
1	United States	3,916,572	3,731,237	63,589,350	30,540,627	16.62	959
2	Japan	1,117,198	1,097,676	10,495,122	3,384,526	9.71	453
3	United Kingdom	1,114,601	1,032,672	14,946,918	3,794,861	14.22	578
4	Germany	1,023,306	989,796	12,558,132	3,483,370	12.9	506
5	China	984,773	980,298	3,093,755	1,560,726	4.32	215
6	France	739,554	714,426	8,702,631	2,121,758	12.36	465
7	Canada	557,928	536,246	7,250,113	1,507,336	14.26	450
8	Italy	541,016	518,696	5,886,167	1,445,355	11.79	405
9	Spain	393,842	374,080	3,727,404	1,003,865	10.56	312
10	Russian Federation	371,879	369,996	1,546,736	496,504	4.19	222
11	Australia	351,468	333,819	4,049,246	906,964	12.87	341
12	India	340,553	327,821	1,647,043	581,809	5.42	187
13	Netherlands	309,805	297,663	4,638,427	843,892	16.2	392
14	Korea, Republic Of	272,646	269,343	1,721,735	423,751	7.74	204
15	Sweden	226,089	219,210	3,340,199	610,179	15.56	350
16	Switzerland	220,922	212,817	3,629,490	544,970	17.9	392

17	Brazil	201,184	196,781	1,265,605	405,305	7.55	196
18	Taiwan, Province of China	201,048	197,645	1,264,258	332,432	7.45	173
19	Poland	186,718	184,227	1,069,687	317,205	6.33	193
20	Belgium	166,879	160,867	2,122,213	348,904	13.81	298
21	Turkey	146,970	140,069	674,441	205,365	5.68	126
22	Israel	138,881	134,055	1,773,976	289,652	13.51	293
23	Denmark	116,311	112,715	1,803,668	291,500	16.5	280
24	Austria	115,786	111,022	1,371,225	216,361	12.99	259
25	Finland	111,064	108,699	1,498,532	276,525	14.58	254
26	Greece	94,495	90,927	711,248	146,893	8.83	167
27	Hong Kong	91,244	88,186	776,791	150,085	9.69	180
28	Mexico	84,307	82,764	562,949	132,158	7.58	147
29	Norway	83,322	80,905	1,005,656	179,506	13.25	225
30	Czech Republic	82,110	81,087	519,461	137,149	6.97	151
31	New Zealand	70,634	67,326	755,284	135,976	11.81	191
32	Singapore	70,491	68,778	535,390	87,991	8.8	152
33	Ukraine	67,723	67,432	207,465	63,766	3.11	94
34	Argentina	65,335	63,954	502,577	119,081	8.23	143
35	Hungary	64,746	63,287	545,515	105,252	8.91	171
36	South Africa	62,570	59,512	464,233	108,688	8.08	144
37	Portugal	61,466	60,166	490,998	110,026	9.48	147
38	**Iran**	**50,528**	**49,650**	**180,276**	**76,992**	**5.93**	**73**
39	Ireland	50,127	47,659	531,838	67,864	12.69	179
40	Egypt	41,614	41,129	188,598	45,442	4.98	85
41	Romania	34,748	34,448	145,392	36,592	4.8	85
42	Thailand	34,274	33,611	211,028	39,442	7.84	107
43	Chile	31,780	31,177	281,811	56,177	10.31	128
44	Slovakia	31,066	30,594	173,365	42,107	5.84	105
45	Croatia	27,960	27,402	115,365	30,524	4.65	83
46	Bulgaria	26,842	26,517	142,452	29,328	5.6	90
47	Slovenia	25,706	25,315	151,695	36,378	6.64	94
48	Saudi Arabia	23,810	22,870	109,497	16,321	4.79	81
49	Malaysia	22,324	21,843	92,229	16,822	5.57	76
50	Pakistan	19,827	19,003	65,545	19,343	4.02	62

Table 4. Rank of different scientific majors in Iran sorted by total number of publication

Field	*Papers*	*Citations*	*Citations Per Paper*
Chemistry	12719	69453	5.46
Engineering	7447	21527	2.89
Clinical Medicine	6157	18435	2.99
Physics	3908	17008	4.35
Plant & Animal Science	2829	5150	1.82
Materials Science	2788	6972	2.50
Mathematics	1753	2549	1.45
Biology & Biochemistry	1408	5492	3.90
Pharmacology & Toxicology	1220	5717	4.69
Agricultural Sciences	1202	3514	2.92
Computer Science	1137	1511	1.33
Geosciences	985	2956	3.00
Environment/Ecology	795	1881	2.37
Social Sciences, General	749	944	1.26
Neuroscience & Behavior	666	3012	4.52
Molecular Biology & Genetics	400	2155	5.39
Microbiology	369	1192	3.23
Immunology	317	1571	4.96
Psychiatry/Psychology	265	1329	5.02
Multidisciplinary	254	61	0.24
Space Science	237	594	2.51
Economics & Business	69	123	1.78

Table 5. Rank of Iran according to chemistry among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	223,389	3,659,143	16.38
2	Peoples R China	155,421	881,303	5.67
3	Japan	115,485	1,189,369	10.30
4	Germany	94,686	1,150,531	12.15
5	France	65,007	726,271	11.17
6	Russia	60,689	192,661	3.17
7	India	58,342	346,944	5.95
8	England	55,746	739,703	13.27
9	Spain	44,797	477,055	10.65
10	Italy	41,416	457,168	11.04
11	South Korea	33,589	278,871	8.30
12	Canada	32,418	383,598	11.83
13	Poland	28,317	176,058	6.22
14	Taiwan	18,831	150,751	8.01
15	Brazil	18,789	124,440	6.62
16	Netherlands	18,550	296,974	16.01
17	Switzerland	17,986	280,101	15.57
18	Australia	17,971	196,344	10.93
19	Sweden	14,528	197,060	13.56
20	Belgium	12,791	146,049	11.42
21	Iran	12,719	69,453	5.46

Table 6. Rank of Iran according to engineering among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	195,740	1,103,087	5.64
2	Peoples R China	68,187	229,063	3.36
3	Japan	63,432	228,967	3.61
4	England	46,215	225,797	4.89
5	Germany	44,678	227,238	5.09
6	France	37,410	186,268	4.98
7	Canada	33,662	151,518	4.50
8	Italy	32,842	149,417	4.55
9	South Korea	30,949	99,686	3.22
10	Taiwan	28,530	103,417	3.62
11	India	23,596	74,270	3.15
12	Russia	21,561	56,058	2.60
13	Spain	21,287	93,245	4.38
14	Australia	17,162	82,708	4.82
15	Netherlands	13,371	74,396	5.56
16	Turkey	12,600	48,132	3.82
17	Singapore	11,862	54,251	4.57
18	Poland	11,202	35,083	3.13
19	Sweden	10,391	58,523	5.63
20	Switzerland	10,167	67,564	6.65
21	Brazil	9,836	38,035	3.87
22	Belgium	8,852	49,892	5.64
23	Greece	8,262	30,951	3.75
24	Iran	7,447	21,527	2.89

Table 7. Rank of Iran according to clinical medicine among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	704,316	11,709,607	16.63
2	Germany	172,030	2,117,933	12.31
3	England	166,989	2,494,281	14.94
4	Japan	162,513	1,631,297	10.04
5	France	110,297	1,374,403	12.46
6	Italy	99,534	1,350,886	13.57
7	Canada	88,104	1,435,485	16.29
8	Netherlands	66,506	1,139,577	17.13
9	Australia	61,344	830,373	13.54
10	Spain	53,270	612,333	11.49
11	Peoples R China	47,296	361,875	7.65
12	Sweden	45,744	740,555	16.19
13	Turkey	44,100	185,491	4.21
14	Switzerland	40,937	671,693	16.41
15	South Korea	31,950	228,420	7.15
16	Belgium	31,506	526,024	16.70
17	Brazil	29,700	217,528	7.32
18	Taiwan	27,195	209,034	7.69
19	Israel	26,034	297,739	11.44
20	Austria	25,688	338,077	13.16
21	India	23,892	122,938	5.15

22	Denmark	23,645	410,584	17.36
23	Scotland	23,207	391,409	16.87
24	Finland	21,906	388,390	17.73
25	Greece	20,396	174,306	8.55
26	Norway	15,826	253,720	16.03
27	Poland	13,298	130,216	9.79
28	Russia	12,821	47,541	3.71
29	New Zealand	9,639	123,724	12.84
30	Ireland	8,852	109,487	12.37
31	South Africa	8,125	86,663	10.67
32	Singapore	8,045	77,518	9.64
33	Wales	8,002	98,314	12.29
34	Mexico	7,698	69,263	9.00
35	Argentina	7,027	73,818	10.50
36	Hungary	6,490	76,274	11.75
37	Czech Republic	6,447	67,114	10.41
38	Iran	6,157	18,435	2.99

Table 8. Rank of Iran according to physics among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	202,768	2,712,333	13.38
2	Japan	108,609	897,341	8.26
3	Peoples R China	100,608	508,993	5.06
4	Germany	96,475	1,108,815	11.49
5	Russia	74,079	453,953	6.13
6	France	69,476	693,340	9.98
7	England	51,149	597,081	11.67
8	Italy	47,104	457,518	9.71
9	South Korea	34,545	229,326	6.64
10	India	29,167	185,089	6.35
11	Spain	28,003	288,186	10.29
12	Poland	24,272	176,262	7.26
13	Canada	24,030	256,228	10.66
14	Switzerland	20,395	298,485	14.64
15	Brazil	19,620	133,052	6.78
16	Taiwan	18,281	110,677	6.05
17	Netherlands	16,095	210,535	13.08
18	Sweden	14,364	151,835	10.57
19	Australia	14,355	134,273	9.35
20	Ukraine	12,986	53,839	4.15
21	Israel	12,879	146,467	11.37
22	Belgium	11,810	110,500	9.36
23	Mexico	9,317	54,723	5.87
24	Austria	8,621	114,812	13.32
25	Czech Republic	7,953	58,395	7.34
26	Scotland	7,560	91,714	12.13
27	Singapore	7,165	44,871	6.26
28	Denmark	7,089	96,005	13.54
29	Finland	6,841	75,691	11.06
30	Greece	6,750	57,832	8.57
31	Turkey	6,245	34,046	5.45

32	Argentina	5,878	43,756	7.44
33	Hungary	5,657	52,691	9.31
34	Portugal	5,643	51,652	9.15
35	Romania	5,251	32,313	6.15
36	Iran	3,908	17,008	4.35

Table 9. Rank of Iran according to Plant & Animal Sciences among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	150,954	1,391,909	9.22
2	Japan	38,063	266,213	6.99
3	Germany	36,205	326,630	9.02
4	Canada	31,341	260,040	8.30
5	England	30,518	360,375	11.81
6	France	26,496	241,641	9.12
7	Australia	25,871	215,272	8.32
8	Peoples R China	22,566	101,779	4.51
9	Spain	21,187	152,501	7.20
10	Brazil	20,432	67,207	3.29
11	India	19,348	50,510	2.61
12	Italy	16,674	107,534	6.45
13	Netherlands	12,281	126,938	10.34
14	Poland	10,362	31,692	3.06
15	Scotland	9,979	106,077	10.63
16	Sweden	9,489	99,096	10.44
17	Belgium	8,891	73,184	8.23
18	Turkey	8,637	17,912	2.07
19	Switzerland	8,634	89,478	10.36
20	Mexico	8,530	35,757	4.19
21	South Africa	8,114	42,510	5.24
22	New Zealand	7,652	56,588	7.40
23	Denmark	7,279	72,243	9.92
24	South Korea	7,060	40,804	5.78
25	Argentina	6,811	34,751	5.10
26	Russia	6,583	23,826	3.62
27	Norway	6,429	55,186	8.58
28	Czech Republic	5,599	30,952	5.53
29	Finland	5,509	44,254	8.03
30	Austria	5,067	38,284	7.56
31	Israel	5,003	49,750	9.94
32	Taiwan	4,556	27,357	6.00
33	Portugal	4,378	27,734	6.33
34	Greece	3,625	19,838	5.47
35	Hungary	3,534	19,057	5.39
36	Iran	2,829	5,150	1.82

Table 10. Rank of Iran according to Materials Science among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	Peoples R China	73,877	292,615	3.96
2	USA	69,635	717,964	10.31
3	Japan	52,130	322,240	6.18
4	Germany	33,121	242,331	7.32
5	South Korea	23,344	126,252	5.41
6	France	22,706	162,067	7.14
7	England	20,682	170,171	8.23
8	India	19,283	87,697	4.55
9	Russia	16,502	41,801	2.53
10	Spain	11,263	72,871	6.47
11	Canada	11,161	75,115	6.73
12	Taiwan	11,104	61,332	5.52
13	Italy	10,443	67,966	6.51
14	Poland	8,614	28,147	3.27
15	Ukraine	7,413	12,903	1.74
16	Australia	7,397	47,291	6.39
17	Brazil	6,279	27,045	4.31
18	Sweden	6,245	44,587	7.14
19	Turkey	5,500	18,895	3.44
20	Singapore	5,205	43,421	8.34
21	Netherlands	4,956	51,115	10.31
22	Switzerland	4,767	45,332	9.51
23	Romania	4,556	9,443	2.07
24	Portugal	4,147	21,825	5.26
25	Belgium	3,985	30,322	7.61
26	Czech Republic	3,531	15,856	4.49
27	Austria	3,385	24,372	7.20
28	Mexico	3,292	14,899	4.53
29	Egypt	2,810	9,181	3.27
30	Iran	2,788	6,972	2.50

Table 11. Rank of Iran according to Mathematics among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	67,886	299,533	4.41
2	Peoples R China	25,741	65,675	2.55
3	France	23,431	84,554	3.61
4	Germany	19,230	70,858	3.68
5	Italy	13,269	41,599	3.14
6	Japan	12,775	31,184	2.44
7	Russia	12,353	19,039	1.54
8	England	12,115	50,483	4.17
9	Canada	12,036	41,315	3.43
10	Spain	10,974	33,038	3.01
11	Australia	5,842	23,683	4.05
12	Poland	5,397	12,233	2.27
13	South Korea	5,166	11,533	2.23
14	Israel	5,044	18,098	3.59
15	India	4,733	8,551	1.81
16	Brazil	4,068	11,239	2.76
17	Netherlands	3,579	14,487	4.05
18	Taiwan	3,423	9,810	2.87
19	Belgium	3,338	12,914	3.87
20	Sweden	2,868	11,585	4.04
21	Switzerland	2,787	11,567	4.15
22	Hungary	2,689	6,627	2.46
23	Austria	2,530	9,914	3.92
24	Czech Republic	2,412	6,841	2.84
25	Turkey	2,199	4,019	1.83
26	Romania	2,194	4,886	2.23
27	Scotland	2,119	8,899	4.20
28	Mexico	2,060	4,369	2.12
29	Ukraine	2,040	3,753	1.84
30	Greece	2,029	5,822	2.87
31	Portugal	1,947	4,926	2.53
32	Iran	1,753	2,549	1.45

Table 12. Rank of Iran according to Biology & Biochemistry among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	198,379	4,481,303	22.59
2	Japan	60,130	838,770	13.95
3	Germany	43,734	813,605	18.60
4	England	39,439	823,637	20.88
5	France	33,803	532,759	15.76
6	Canada	26,192	469,635	17.93
7	Peoples R China	25,029	161,080	6.44
8	Italy	23,355	307,238	13.16
9	Spain	15,797	204,420	12.94
10	Australia	15,042	254,011	16.89
11	India	13,531	90,121	6.66
12	South Korea	13,498	125,821	9.32
13	Sweden	13,293	239,466	18.01
14	Netherlands	12,040	222,949	18.52
15	Russia	10,984	80,120	7.29
16	Switzerland	10,364	242,644	23.41
17	Brazil	10,137	70,684	6.97
18	Poland	8,667	65,848	7.60
19	Denmark	7,892	146,261	18.53
20	Belgium	7,354	127,084	17.28
21	Scotland	7,344	158,896	21.64
22	Israel	6,555	118,082	18.01
23	Taiwan	5,983	53,187	8.89
24	Austria	5,189	79,764	15.37
25	Finland	5,012	88,062	17.57
26	Turkey	4,705	28,913	6.15
27	Argentina	4,587	37,417	8.16
28	Czech Republic	4,415	36,203	8.20
29	Mexico	3,638	28,424	7.81
30	Hungary	3,628	43,750	12.06
31	Norway	3,315	50,871	15.35
32	Portugal	3,180	35,040	11.02
33	Greece	3,083	29,671	9.62
34	New Zealand	2,726	40,812	14.97
35	Slovakia	2,401	13,946	5.81
36	Singapore	2,270	32,257	14.21
37	South Africa	2,199	21,878	9.95
38	Ireland	2,037	31,418	15.42
39	Chile	1,892	18,605	9.83
40	Wales	1,754	25,383	14.47
41	Bulgaria	1,594	7,096	4.45
42	Thailand	1,435	9,441	6.58
43	Iran	1,408	5,492	3.90

Table 13. Rank of Iran according to Pharmacology & Toxicology among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	50,965	763,285	14.98
2	Japan	20,440	181,781	8.89
3	Germany	11,993	148,567	12.39
4	England	10,985	170,886	15.56
5	Peoples R China	9,715	54,490	5.61
6	Italy	8,547	96,169	11.25
7	France	7,991	102,722	12.85
8	South Korea	6,612	45,113	6.82
9	India	6,590	41,084	6.23
10	Canada	6,202	85,946	13.86
11	Spain	4,837	46,581	9.63
12	Brazil	4,238	27,454	6.48
13	Netherlands	3,956	54,610	13.80
14	Australia	3,787	44,873	11.85
15	Sweden	3,266	47,752	14.62
16	Taiwan	3,102	25,080	8.09
17	Switzerland	2,979	51,451	17.27
18	Poland	2,620	17,755	6.78
19	Belgium	2,565	33,727	13.15
20	Turkey	2,350	16,472	7.01
21	Denmark	1,627	19,450	11.95
22	Scotland	1,525	29,823	19.56
23	Finland	1,520	17,601	11.58
24	Austria	1,453	16,416	11.30
25	New Zealand	1,426	19,553	13.71
26	Egypt	1,295	8,212	6.34
27	Iran	1,220	5,717	4.69

Table 14. Rank of Iran according to Agricultural Science among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	41,362	354,866	8.58
2	Japan	11,868	56,912	4.80
3	Spain	11,825	85,767	7.25
4	Germany	10,835	67,533	6.23
5	India	10,541	27,124	2.57
6	France	8,754	73,756	8.43
7	Brazil	8,658	22,931	2.65
8	Canada	7,810	62,212	7.97
9	England	7,712	77,445	10.04
10	Australia	7,492	52,563	7.02
11	Italy	6,861	50,879	7.42
12	Peoples R China	6,620	28,342	4.28
13	Netherlands	4,343	44,692	10.29
14	Turkey	4,139	19,275	4.66
15	South Korea	4,057	19,401	4.78
16	New Zealand	2,881	20,136	6.99
17	Belgium	2,879	25,553	8.88
18	Denmark	2,765	27,643	10.00
19	Mexico	2,703	12,030	4.45
20	Argentina	2,429	13,819	5.69
21	Switzerland	2,386	20,916	8.77
22	Greece	2,208	15,972	7.23
23	Ireland	2,173	18,427	8.48
24	Sweden	2,155	21,382	9.92
25	Taiwan	2,138	14,437	6.75
26	Poland	2,039	9,906	4.86
27	Hungary	2,017	5,863	2.91
28	Russia	1,905	3,285	1.72
29	Finland	1,829	20,555	11.24
30	Scotland	1,774	20,300	11.44
31	Nigeria	1,737	4,338	2.50
32	Portugal	1,605	11,620	7.24
33	Norway	1,520	14,212	9.35
34	Czech Republic	1,481	4,435	2.99
35	Thailand	1,332	6,357	4.77
36	Iran	1,202	3,514	2.92

Table 15. Rank of Iran according to Computer Science among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	70,638	374,292	5.30
2	Peoples R China	20,609	37,792	1.83
3	Germany	18,982	60,956	3.21
4	England	15,919	62,960	3.96
5	France	14,731	47,469	3.22
6	Japan	14,714	37,958	2.58
7	South Korea	13,265	18,579	1.40
8	Canada	11,584	41,135	3.55
9	Italy	11,531	34,085	2.96
10	Spain	9,444	21,671	2.29
11	Taiwan	8,350	17,946	2.15
12	Australia	6,654	22,763	3.42
13	Netherlands	5,867	19,368	3.30
14	Israel	4,364	20,500	4.70
15	Switzerland	4,006	17,898	4.47
16	India	3,979	9,838	2.47
17	Greece	3,793	8,145	2.15
18	Singapore	3,788	10,649	2.81
19	Belgium	3,344	11,080	3.31
20	Sweden	3,207	21,675	6.76
21	Russia	3,074	3,818	1.24
22	Brazil	3,018	5,811	1.93
23	Poland	2,950	6,535	2.22
24	Austria	2,774	7,625	2.75
25	Finland	2,583	6,783	2.63
26	Turkey	2,289	4,941	2.16
27	Scotland	2,182	8,037	3.68
28	Denmark	2,096	9,510	4.54
29	Portugal	1,808	3,855	2.13
30	Norway	1,542	5,181	3.36
31	Ireland	1,455	3,769	2.59
32	Czech Republic	1,313	2,653	2.02
33	Hungary	1,175	3,401	2.89
34	New Zealand	1,151	3,525	3.06
35	Iran	1,137	1,511	1.33

Table 16. Rank of Iran according to Geosciences among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	86,066	1,104,498	12.83
2	Germany	24,587	290,425	11.81
3	England	24,122	302,768	12.55
4	France	22,136	246,875	11.15
5	Peoples R China	20,656	123,102	5.96
6	Russia	19,310	68,156	3.53
7	Canada	18,198	178,941	9.83
8	Japan	16,006	131,770	8.23
9	Australia	12,953	147,684	11.40
10	Italy	12,812	109,814	8.57
11	India	8,227	35,270	4.29
12	Spain	7,089	55,384	7.81
13	Switzerland	6,742	91,653	13.59
14	Netherlands	6,489	80,021	12.33
15	Sweden	4,860	53,550	11.02
16	Norway	4,772	48,331	10.13
17	Scotland	3,882	38,493	9.92
18	Brazil	3,645	26,257	7.20
19	Denmark	3,291	39,436	11.98
20	New Zealand	3,135	31,271	9.97
21	South Africa	2,936	21,153	7.20
22	Poland	2,935	12,864	4.38
23	Austria	2,859	25,980	9.09
24	Belgium	2,830	29,109	10.29
25	Taiwan	2,734	20,680	7.56
26	Turkey	2,694	16,728	6.21
27	South Korea	2,692	17,734	6.59
28	Argentina	2,525	13,741	5.44
29	Finland	2,369	26,207	11.06
30	Mexico	2,356	14,979	6.36
31	Greece	2,296	19,231	8.38
32	Czech Republic	1,901	11,051	5.81
33	Israel	1,812	20,210	11.15
34	Wales	1,797	19,413	10.80
35	Portugal	1,197	8,466	7.07
36	Chile	1,168	9,756	8.35
37	Hungary	1,053	7,792	7.40
38	Iran	985	2,956	3.00

Table 17. Rank of Iran according to Environment/Ecology among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	82,675	1,058,195	12.80
2	Canada	18,071	207,585	11.49
3	England	17,162	245,588	14.31
4	Germany	14,945	176,516	11.81
5	Peoples R China	13,627	76,363	5.60
6	Australia	12,116	141,691	11.69
7	France	11,586	129,255	11.16
8	Spain	9,946	94,391	9.49
9	Japan	9,490	74,857	7.89
10	Italy	7,604	66,830	8.79
11	Sweden	7,377	108,410	14.70
12	Netherlands	7,102	97,180	13.68
13	India	6,420	31,431	4.90
14	Brazil	5,316	39,845	7.50
15	Switzerland	4,954	74,191	14.98
16	Finland	4,337	54,616	12.59
17	Scotland	4,209	59,748	14.20
18	Denmark	4,067	57,400	14.11
19	Belgium	3,897	45,573	11.69
20	New Zealand	3,760	45,073	11.99
21	Poland	3,710	18,497	4.99
22	Norway	3,647	44,822	12.29
23	Turkey	3,572	14,550	4.07
24	South Korea	3,276	21,038	6.42
25	South Africa	3,218	28,722	8.93
26	Mexico	3,128	23,919	7.65
27	Taiwan	3,049	20,829	6.83
28	Russia	2,668	14,523	5.44
29	Greece	2,388	16,343	6.84
30	Portugal	2,305	18,262	7.92
31	Argentina	2,132	16,735	7.85
32	Austria	2,087	20,823	9.98
33	Israel	2,063	19,337	9.37
34	Chile	1,610	13,729	8.53
35	Czech Republic	1,610	12,552	7.80
36	Wales	1,376	18,269	13.28
37	Thailand	1,057	6,280	5.94
38	Ireland	879	7,160	8.15
39	Hungary	818	5,602	6.85
40	Iran	795	1,881	2.37

Table 18. **Rank of Iran according to Social Science/General among 22 scientific majors of ESI in the world**

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	192,078	1,023,365	5.33
2	England	43,227	213,382	4.94
3	Canada	21,903	99,569	4.55
4	Australia	17,243	71,063	4.12
5	Germany	12,694	38,079	3.00
6	Netherlands	9,946	51,396	5.17
7	Sweden	6,276	32,331	5.15
8	France	6,243	20,596	3.30
9	Peoples R China	5,849	19,492	3.33
10	Scotland	5,709	26,294	4.61
11	Spain	5,313	14,051	2.64
12	Brazil	4,839	9,811	2.03
13	Israel	4,789	16,960	3.54
14	Italy	3,869	15,970	4.13
15	Japan	3,493	10,624	3.04
16	South Africa	3,367	11,446	3.40
17	New Zealand	3,344	13,379	4.00
18	Norway	3,342	15,153	4.53
19	Switzerland	3,162	14,511	4.59
20	Taiwan	3,095	8,997	2.91
21	Belgium	3,052	13,168	4.31
22	Finland	2,870	13,927	4.85
23	Russia	2,807	2,744	0.98
24	Wales	2,792	14,994	5.37
25	South Korea	2,557	6,303	2.46
26	Denmark	2,435	12,045	4.95
27	India	2,426	5,453	2.25
28	Turkey	2,366	4,401	1.86
29	Croatia	2,056	3,086	1.50
30	Mexico	1,858	5,260	2.83
31	Ireland	1,738	6,304	3.63
32	Singapore	1,572	5,309	3.38
33	Austria	1,483	4,739	3.20
34	North Ireland	1,399	5,852	4.18
35	Greece	1,320	4,516	3.42
36	Czech Republic	847	950	1.12
37	Poland	819	1,370	1.67
38	Slovenia	791	854	1.08
39	Thailand	755	2,245	2.97
40	Iran	749	944	1.26

Table 19. Rank of Iran according to Neurosciences & Behavior among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	122,651	2,880,279	23.48
2	Germany	28,167	542,218	19.25
3	Japan	24,961	344,571	13.80
4	England	24,189	571,413	23.62
5	Canada	18,667	363,485	19.47
6	Italy	17,811	264,267	14.84
7	France	16,790	306,721	18.27
8	Netherlands	9,288	160,698	17.30
9	Spain	8,991	128,381	14.28
10	Australia	7,689	120,858	15.72
11	Sweden	7,230	141,398	19.56
12	Peoples R China	6,787	54,430	8.02
13	Switzerland	6,654	142,552	21.42
14	Brazil	6,409	47,877	7.47
15	Israel	4,197	76,636	18.26
16	South Korea	4,069	42,591	10.47
17	Belgium	3,667	68,921	18.79
18	Finland	3,293	59,175	17.97
19	Scotland	3,175	62,698	19.75
20	Denmark	2,983	51,989	17.43
21	Austria	2,959	55,229	18.66
22	Poland	2,672	22,475	8.41
23	India	2,666	15,806	5.93
24	Turkey	2,635	17,038	6.47
25	Hungary	2,497	37,035	14.83
26	Taiwan	2,267	22,222	9.80
27	Russia	2,192	15,958	7.28
28	Norway	1,885	33,847	17.96
29	Mexico	1,756	17,690	10.07
30	Argentina	1,405	17,821	12.68
31	New Zealand	1,283	18,476	14.40
32	Greece	1,248	11,695	9.37
33	Wales	1,176	21,577	18.35
34	Ireland	1,079	18,264	16.93
35	Portugal	1,024	12,859	12.56
36	Singapore	781	8,696	11.13
37	Czech Republic	765	8,671	11.33
38	Iran	666	3,012	4.52

Table 20. Rank of Iran according to Molecular Biology among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	120,394	3,897,399	32.37
2	Germany	26,212	722,978	27.58
3	Japan	25,418	557,085	21.92
4	England	23,988	771,523	32.16
5	France	18,393	477,498	25.96
6	Canada	14,211	363,716	25.59
7	Italy	11,955	244,391	20.44
8	Peoples R China	8,918	85,714	9.61
9	Spain	7,757	153,516	19.79
10	Netherlands	7,569	205,916	27.21
11	Australia	7,071	168,677	23.85
12	Switzerland	6,604	217,666	32.96
13	Russia	5,902	40,831	6.92
14	Sweden	5,510	147,247	26.72
15	Scotland	4,630	149,474	32.28
16	South Korea	4,300	50,951	11.85
17	Brazil	4,294	32,413	7.55
18	Israel	3,746	116,744	31.16
19	Belgium	3,713	89,380	24.07
20	India	3,392	28,125	8.29
21	Denmark	3,028	90,634	29.93
22	Finland	2,717	70,048	25.78
23	Austria	2,688	88,797	33.03
24	Poland	2,503	27,925	11.16
25	Taiwan	2,135	26,696	12.50
26	Norway	1,636	35,194	21.51
27	Argentina	1,521	14,283	9.39
28	Singapore	1,482	29,342	19.80
29	Czech Republic	1,400	19,317	13.80
30	Turkey	1,277	15,673	12.27
31	Hungary	1,274	21,162	16.61
32	Portugal	1,264	20,281	16.05
33	Greece	1,195	22,608	18.92
34	Mexico	1,098	13,325	12.14
35	Wales	1,088	26,074	23.97
36	Ireland	1,013	31,075	30.68
37	New Zealand	1,005	18,355	18.26
38	Chile	655	9,098	13.89
39	South Africa	606	9,785	16.15
40	Ukraine	428	3,087	7.21
41	Slovakia	417	5,163	12.38
42	Iran	400	2,155	5.39

Table 21. Rank of Iran according to Microbiology among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	53,300	1,092,808	20.50
2	Germany	14,816	257,994	17.41
3	Japan	13,638	158,886	11.65
4	England	11,873	236,079	19.88
5	France	11,568	200,919	17.37
6	Spain	7,266	87,463	12.04
7	Canada	6,357	102,201	16.08
8	South Korea	5,560	35,360	6.36
9	Peoples R China	5,429	40,264	7.42
10	Italy	5,274	61,095	11.58
11	Netherlands	4,753	93,530	19.68
12	Australia	4,702	77,559	16.49
13	Brazil	4,348	31,812	7.32
14	India	3,827	23,908	6.25
15	Russia	3,384	20,176	5.96
16	Switzerland	3,152	61,485	19.51
17	Scotland	3,103	57,433	18.51
18	Sweden	3,044	49,632	16.30
19	Belgium	2,978	51,818	17.40
20	Denmark	2,184	42,518	19.47
21	Mexico	1,610	15,929	9.89
22	Taiwan	1,570	16,342	10.41
23	Argentina	1,562	12,828	8.21
24	Austria	1,528	25,804	16.89
25	Finland	1,496	22,937	15.33
26	Israel	1,481	21,434	14.47
27	Czech Republic	1,425	10,931	7.67
28	Poland	1,137	8,025	7.06
29	Portugal	1,114	11,458	10.29
30	Thailand	1,108	10,811	9.76
31	Turkey	1,088	4,815	4.43
32	Ireland	1,024	16,192	15.81
33	South Africa	998	14,039	14.07
34	Norway	933	15,499	16.61
35	New Zealand	867	11,613	13.39
36	Greece	818	7,859	9.61
37	Slovakia	736	4,881	6.63
38	Singapore	689	9,743	14.14
39	Wales	664	10,838	16.32
40	Hungary	650	6,799	10.46
41	Egypt	448	2,595	5.79
42	North Ireland	417	6,772	16.24
43	Malaysia	391	2,739	7.01
44	Chile	378	3,109	8.22
45	Iran	369	1,192	3.23

Table 22. Rank of Iran according to Immunology among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	53,754	1,376,851	25.61
2	England	11,107	247,473	22.28
3	Germany	10,170	224,818	22.11
4	Japan	10,031	222,646	22.20
5	France	8,375	180,471	21.55
6	Italy	6,075	116,119	19.11
7	Canada	5,337	109,155	20.45
8	Netherlands	4,803	98,187	20.44
9	Australia	4,769	98,181	20.59
10	Sweden	4,331	70,463	16.27
11	Switzerland	3,735	102,573	27.46
12	Spain	3,395	52,467	15.45
13	Peoples R China	2,950	20,430	6.93
14	Brazil	2,285	23,805	10.42
15	Belgium	2,075	40,153	19.35
16	Denmark	1,958	33,541	17.13
17	Israel	1,713	32,786	19.14
18	South Korea	1,712	18,783	10.97
19	India	1,637	12,063	7.37
20	Austria	1,618	31,524	19.48
21	Scotland	1,613	34,294	21.26
22	Finland	1,276	22,777	17.85
23	Norway	1,189	19,031	16.01
24	Poland	1,156	10,204	8.83
25	Taiwan	1,014	10,608	10.46
26	South Africa	865	14,747	17.05
27	Mexico	776	8,555	11.02
28	Argentina	756	8,927	11.81
29	Thailand	732	10,109	13.81
30	Greece	692	8,826	12.75
31	Hungary	619	7,572	12.23
32	Turkey	619	3,885	6.28
33	Ireland	569	13,785	24.23
34	Kenya	503	8,716	17.33
35	Czech Republic	492	5,966	12.13
36	Russia	439	4,715	10.74
37	New Zealand	426	6,574	15.43
38	Portugal	416	5,855	14.07
39	Wales	383	6,734	17.58
40	Singapore	375	4,373	11.66
41	Uganda	331	6,371	19.25
42	Iran	317	1,571	4.96

Table 23. Rank of Iran according to Psychiatry/Psychology among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	120,103	1,440,119	11.99
2	England	24,556	287,874	11.72
3	Canada	16,655	187,077	11.23
4	Germany	16,620	134,982	8.12
5	Australia	10,943	99,110	9.06
6	Netherlands	9,777	105,339	10.77
7	Spain	5,823	31,537	5.42
8	France	5,596	47,320	8.46
9	Italy	4,767	45,912	9.63
10	Japan	4,194	23,246	5.54
11	Israel	4,142	37,663	9.09
12	Sweden	3,344	32,954	9.85
13	Switzerland	3,137	23,910	7.62
14	Belgium	3,051	28,372	9.30
15	Scotland	2,888	31,643	10.96
16	Peoples R China	2,791	19,248	6.90
17	New Zealand	2,339	23,934	10.23
18	Finland	2,163	21,891	10.12
19	Norway	2,080	17,522	8.42
20	Wales	1,933	20,933	10.83
21	Turkey	1,514	6,337	4.19
22	Brazil	1,450	7,673	5.29
23	Austria	1,393	11,322	8.13
24	Denmark	1,390	14,104	10.15
25	Russia	1,301	3,080	2.37
26	Taiwan	1,298	6,802	5.24
27	South Africa	1,221	6,478	5.31
28	Mexico	1,049	3,217	3.07
29	Ireland	1,004	7,940	7.91
30	South Korea	993	6,860	6.91
31	Greece	885	4,566	5.16
32	India	633	4,401	6.95
33	Singapore	578	2,964	5.13
34	Czech Republic	564	1,997	3.54
35	Poland	511	3,253	6.37
36	North Ireland	481	2,641	5.49
37	Portugal	459	2,442	5.32
38	Hungary	423	4,682	11.07
39	Slovakia	374	779	2.08
40	Argentina	273	1,631	5.97
41	Iran	265	1,329	5.02

Table 24. Rank of Iran according to Multidisciplinary among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	5,007	55,115	11.01
2	India	2,131	3,256	1.53
3	Peoples R China	1,698	3,925	2.31
4	Russia	1,246	684	0.55
5	England	1,238	7,839	6.33
6	Germany	717	6,938	9.68
7	France	634	5,039	7.95
8	Japan	483	4,712	9.76
9	South Africa	413	893	2.16
10	Canada	380	3,368	8.86
11	Australia	374	2,170	5.80
12	Italy	325	1,956	6.02
13	Iran	254	61	0.24

Table 25. Rank of Iran according to Space Sciences among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	55,539	1,039,395	18.71
2	Germany	17,572	304,158	17.31
3	England	15,968	293,401	18.37
4	France	13,977	203,653	14.57
5	Italy	11,944	186,411	15.61
6	Japan	8,797	117,883	13.40
7	Russia	8,567	59,669	6.96
8	Spain	7,017	96,634	13.77
9	Peoples R China	6,022	36,777	6.11
10	Netherlands	5,827	108,303	18.59
11	Canada	5,729	111,737	19.50
12	Australia	4,990	89,928	18.02
13	Chile	3,322	62,653	18.86
14	India	3,095	21,500	6.95
15	Switzerland	2,959	51,649	17.45
16	Poland	2,683	35,198	13.12
17	Brazil	2,386	23,382	9.80
18	Mexico	2,376	28,985	12.20
19	Scotland	2,319	52,710	22.73
20	Sweden	2,147	32,765	15.26
21	Belgium	1,940	24,497	12.63
22	Finland	1,584	16,446	10.38
23	Israel	1,570	31,822	20.27
24	Denmark	1,511	27,991	18.52
25	Ukraine	1,473	11,735	7.97
26	South Korea	1,445	14,439	9.99
27	Austria	1,409	13,524	9.60
28	Argentina	1,356	13,770	10.15
29	Greece	1,182	9,957	8.42
30	Czech Republic	1,122	9,684	8.63
31	South Africa	1,105	11,863	10.74
32	Taiwan	921	8,164	8.86
33	North Ireland	836	8,290	9.92
34	Portugal	821	14,770	17.99
35	Hungary	795	18,404	23.15
36	Wales	720	12,527	17.40
37	Ireland	694	8,064	11.62
38	Norway	628	8,330	13.26
39	Turkey	532	2,734	5.14
40	Armenia	515	5,073	9.85
41	Bulgaria	445	2,454	5.51
42	Slovakia	352	1,468	4.17
43	New Zealand	351	4,959	14.13
44	Iran	237	594	2.51

Table 26. Rank of Iran according to Economics & Business among 22 scientific majors of ESI in the world

Grade	*Country/Territory*	*Papers*	*Citations*	*Citations Per Paper*
1	USA	66,168	530,634	8.02
2	England	17,884	101,026	5.65
3	Canada	8,126	43,800	5.39
4	Germany	7,365	27,648	3.75
5	Australia	6,285	24,187	3.85
6	Netherlands	5,511	30,118	5.47
7	France	5,408	27,043	5.00
8	Spain	4,669	17,281	3.70
9	Peoples R China	3,983	19,449	4.88
10	Italy	3,788	15,256	4.03
11	Japan	2,775	7,069	2.55
12	Sweden	2,582	14,813	5.74
13	Taiwan	2,285	5,880	2.57
14	Belgium	2,219	11,613	5.23
15	Switzerland	1,997	12,277	6.15
16	South Korea	1,985	7,296	3.68
17	Scotland	1,883	9,412	5.00
18	Israel	1,773	10,842	6.12
19	Denmark	1,551	7,988	5.15
20	Norway	1,487	6,505	4.37
21	Singapore	1,345	7,099	5.28
22	New Zealand	1,283	4,893	3.81
23	Finland	1,258	5,117	4.07
24	Austria	1,184	4,392	3.71
25	Czech Republic	1,122	1,098	0.98
26	Turkey	1,098	2,897	2.64
27	Greece	1,003	2,899	2.89
28	India	946	2,637	2.79
29	Wales	918	4,163	4.53
30	South Africa	806	1,307	1.62
31	Ireland	767	3,000	3.91
32	Portugal	740	2,162	2.92
33	Brazil	662	1,840	2.78
34	Slovakia	625	376	0.60
35	Mexico	481	1,601	3.33
36	Chile	396	1,555	3.93
37	Russia	361	1,169	3.24
38	Argentina	339	807	2.38
39	North Ireland	331	1,061	3.21
40	Poland	325	693	2.13
41	Hungary	262	896	3.42
42	Slovenia	258	563	2.18
43	Malaysia	198	404	2.04
44	Cyprus	183	856	4.68
45	Lithuania	177	290	1.64
46	Thailand	154	450	2.92
47	Romania	153	246	1.61
48	Philippines	130	485	3.73
49	Indonesia	115	484	4.21
50	U Arab Emirates	108	176	1.63

51	Colombia	106	249	2.35
52	Kenya	105	412	3.92
53	Croatia	77	111	1.44
54	Ethiopia	76	373	4.91
55	Ukraine	76	108	1.42
56	Nigeria	71	123	1.73
57	Luxembourg	70	231	3.30
58	Iran	69	123	1.78

PART TEN

INTERNATIONAL SYMPOSIUM ON KNOWLEDGE SOCIETY FOR THE INNOVATION ECONOMY, SELANGOR, MALAYSIA (8-9 DECEMBER 2010)

Innovations in Postgraduate Research Training within Life Sciences at the University of Manchester

RAY BOOT-HANDFORD
Faculty of Life Sciences
University of Manchester
United Kingdom

ABSTRACT

The Faculty of Life Sciences, with over 250 academic staff and more than 450 postgraduate students, operates as a single department. As a result, we reap the benefits of economy of scale and provide in-house high quality training tailored to the needs of our postgraduate students. PhD training available across the spectrum of Life Sciences is either for a 3 or 4-year period dependent upon the student's previous research experience. The first year of a 4-year programme can be tailored to the needs of a specific cohort of students (*e.g.* taught courses in advanced topics or a series of mini research projects to give the students experience of a number of techniques and approaches). All of our research students undertake our structured Graduate Training Programme which delivers generic skills required by modem bioscientists and exposure to top quality science through an extensive internal and external seminar programme. Progression and achievement is monitored electronically through our 'eProg' system which ensures that at regular meetings of the student and supervisory team, milestones are set and progress effectively monitored throughout their research training. As a result, our submission rates and successful completion rates are amongst the highest in the UK. Research students in the Faculty have direct access to our extensive range of research core facilities including proteomics, bioimaging, bioinformatics, electron microscopy, DNA sequencing, fermentation and genomic technology. All of these facilities are supported by experimental officers and senior technicians who provide training in their use and experimental design guidance. We provide a high quality training for our postgraduates with around 60% of graduates moving on to postdoctoral research in universities or industry both within the UK and around the world.

Figure 1.

Major International Airport

2 hours by train to London

Surrounded by Lake District, Peak District and Snowdonia National Parks

City life
"Sophisticated but homely, cosmopolitan but northern, you cannot deny Manchester's buzz or its unparalleled music scene." Education Guardian.

Figure 2.

MANCHESTER 1824

The University of Manchester

Faculty of Life Sciences

- One of the largest and most successful research and teaching organisations in Europe
- Secured more funding from the Biotechnology and Biological Sciences Research Council (BBSRC) than any other British university
- 1000 staff (including over 250 academic staff and research fellows)
- 495 postgraduate students
- 2000 undergraduate students

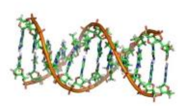


Figure 3. Faculty of Life Sciences.

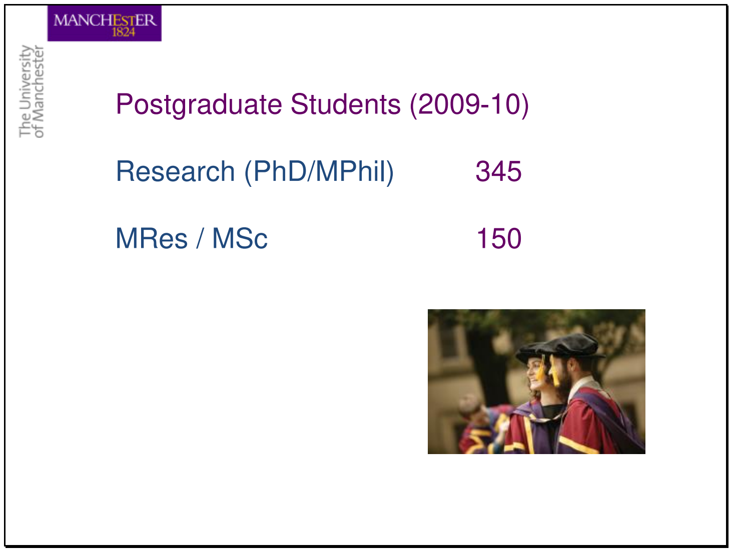


Figure 4. Postgraduate Student (2009-10).

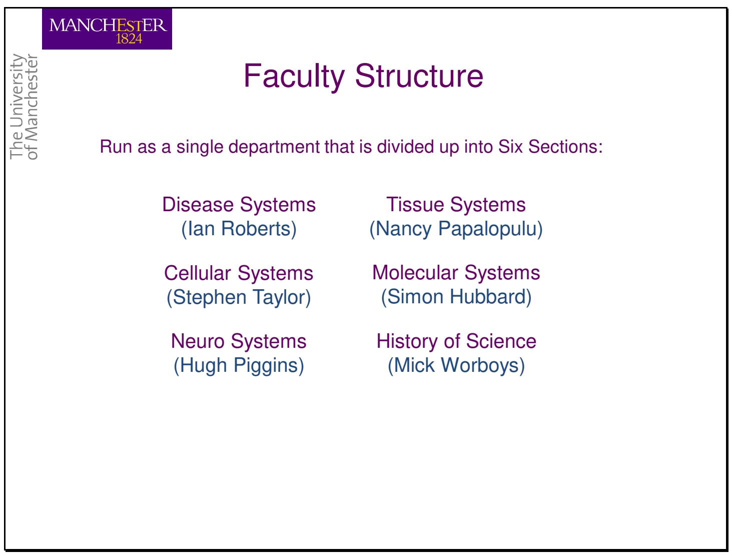
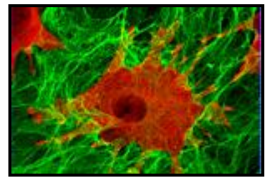


Figure 5. Faculty Structure.

Twelve Research Groups



- •Cell Matrix Research
- •Organelle Function
- •Channels and Transporters
- •Computational and Evolutionary Biology
- •Developmental Biology
- •Eye and Vision Sciences
- •History of Science, Technology and Medicine
- •Immunology and Microbiology
- •Molecular Cancer Studies
- •Neurosciences
- •RNA and Protein Control Systems
- •Structural and Functional Systems

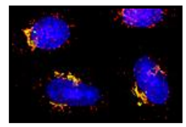


Figure 5. Twelve Research Groups.

Major Research Equipment/Facilities

- BSU including transgenic animal facility
- Electron microscopy suite/Histology
- Flow cytometry
- Confocal microscopy/Bioimaging
- Molecular analysis (X-ray crystallography, NMR)
- Genomics/Proteomics/Microarray
- Bioinformatics
- Biomolecular analysis
- Greenhouses/Plant growth facilities
- Fermentation

Figure 6. Major Research Equipment/ Facilities.

Figure 7. Analytical Research Facilities.

Figure 8. FLS Research Buildings.

Figure 9. What is Special About Manchester?

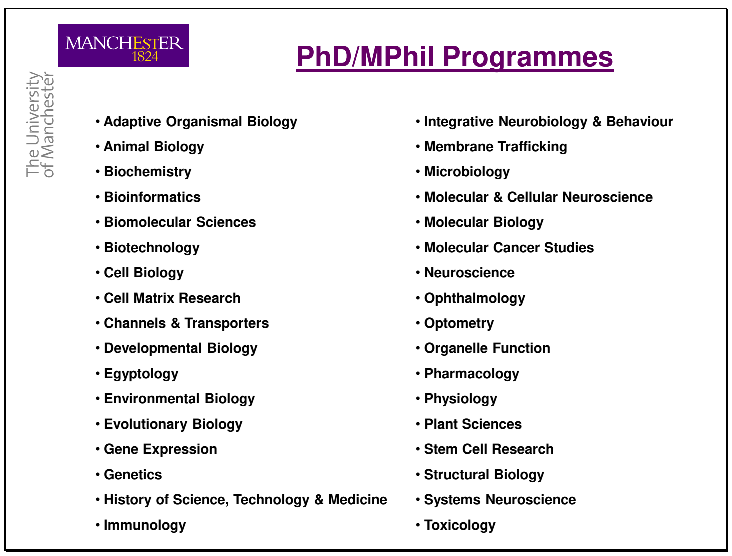


Figure 10. PhD/ MP hil Programmes.

Flexible 3 or 4 year programme

3 year programme for individuals with significant research experience and advanced knowledge

4 year programme for those with little research experience and/or a need for training in advanced knowledge

1st year can be training in research or advanced topics in the form of a formal MSc

Figure 10. Flexible 3 or 4 Year Programme.

For example:
1st year could be an MSc such as 'Biotechnology with Enterprise'

Including modules such as:
Advanced Biotechnology, Shaping Ideas for the Market, Knowledge Transfer, Commercialisation in the Life Sciences

The associated research project could be tailored to meet the research interests of the sponsor

Followed by a 3 year PhD a relevant, related topic, perhaps involving joint supervision with sponsor.

Figure 11.

MANCHESTER 1824

The University of Manchester

The Graduate Student Experience

- Supervisor and student
- Research project
- Research Environment
  (lab, Research Group, & Faculty)

• Formal training for students and supervisors
• Formal independent monitoring of progress

• Graduate Training Programme online – eProg

Figure 12. The Graduate Student Experience.

MANCHESTER 1824

The University of Manchester

Graduate Training Programme

The GTP is a structured framework of training activities designed to complement your research activity.

GTP includes report writing, presentations, career guidance, interview skills, public engagement etc.

Features

➢Research Progress – visual timeline of your study - eProg
➢Research Skills Training – Optional & Compulsory
➢Annual Workshops – generic skills training
➢Personal development planning – documents all achievements
➢Help & Advice - useful links and information

Figure 13. Graduate Training Programme.

MANCHESTER 1824

The University of Manchester

The Supervisory Team

- Supervisor
- (Co-supervisor/s)
- Adviser
- Section Postgraduate Tutor

- Prof Ray Boot-Handford – Admissions
- Dr Dave Thornton – Progression
- Dr Jason Bruce – GTP
- Prof Cathy McCrohan – Associate Dean

- Graduate Office staff

Figure 14. The Supervisory Team.

MANCHESTER 1824

The University of Manchester

Manchester Life Science PhD Student Achievements

Publications - linked to the student's PhD

	Calendar Year (Jan - Dec)		
	2008	2009	2010
Number of students with at least one publication	44	53	68
Number of unique publications	49	60	76
Number with student as first author	23	41	53
% first author	47%	59%	69%

Awards

	% successful first submissions (Ai and Aii)		
	PhD	MPhil	
2004-05	91	71	
2005-06	78	100	
2006-07	78	93	
2007-08	82	67	
2008-09	87	91	
2009-10	92	100	to date

Alternative Format

	Number	% total submissions
2004-05	0	0
2005-06	2	2
2006-07	4	4
2007-08	13	12
2008-09	17	16
2009-10	24	32

3 & 4 Yr Programme Data

a) Awards

Programme		%	
length	Ai	Aii	R
4yr (n=50)	12	84	4
3yr (n=269)	5.6	87	7.8

Figure 15. Manchester Life Science PhD Student Achievements.

Figure 16.

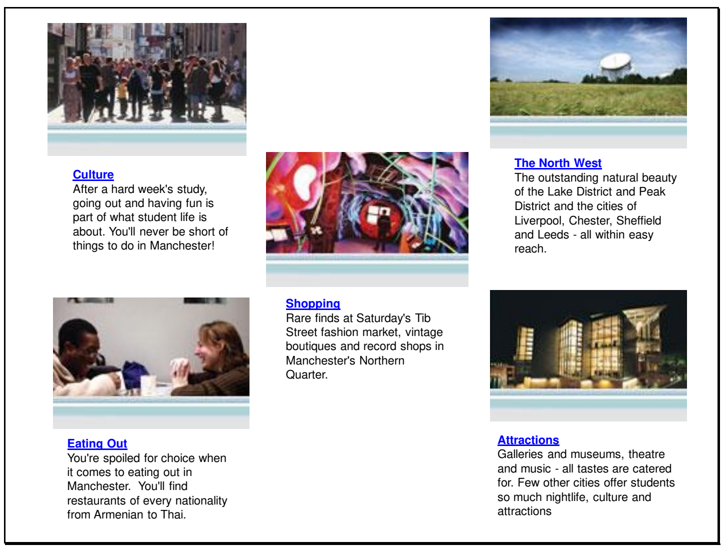


Figure 17.

Capturing Innovation – The Imperial College Model

DAVID LEAK
Department of Life Science
Faulty of Natural Sciences
Imperial College
London, United Kingdom

ABSTRACT

Imperial College has developed multiple routes for capitalising on the knowledge and inventiveness of its academic staff. Business Development looks to develop large and long term corporate partnerships often involving more than one academic department. Imperial Consultants coordinates consultancy at a range of levels, from one to one advisory relationship to managed research programmes. Imperial Innovations strives to develop and commercialise ideas arising from academic research, mainly but not exclusively done at Imperial College. In this presentation I will concentrate on the activities of Imperial Innovations from both the company perspective and a personal perspective as an academician. This will follow the route from idea through evaluation to exploitation, with a particular focus on criteria for success.

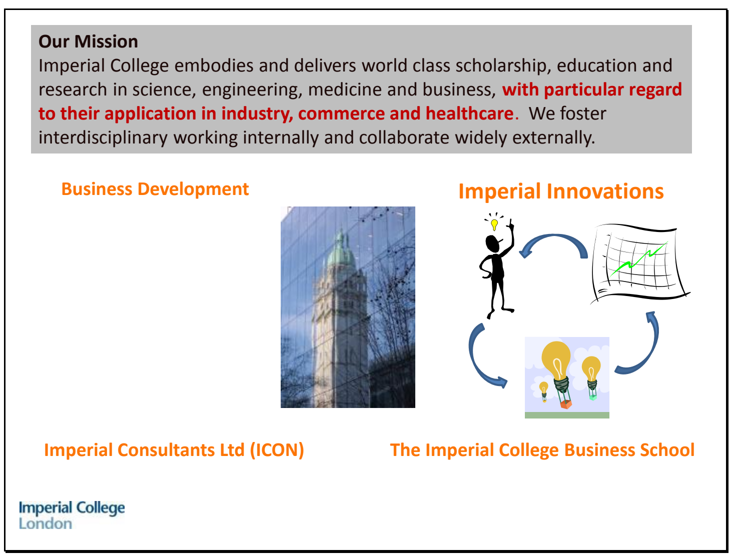


Figure 1. Our Mission.

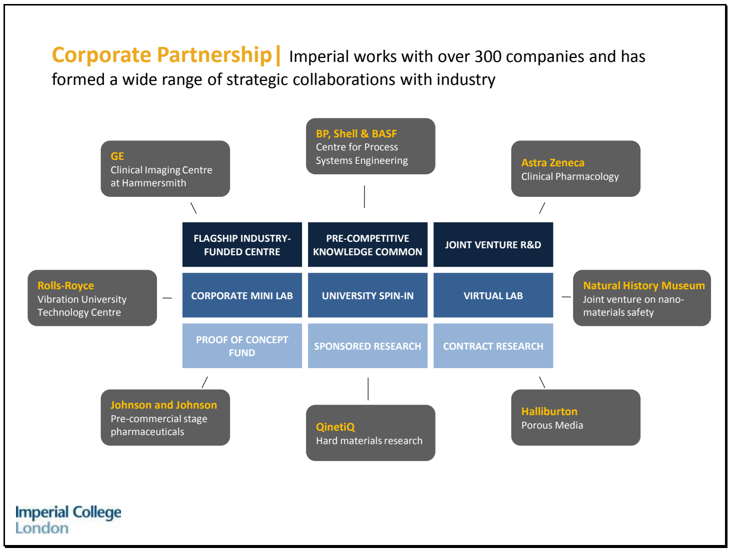


Figure 2. Corporate Partnership.

Figure 3. Imperial Consultants Ltd.

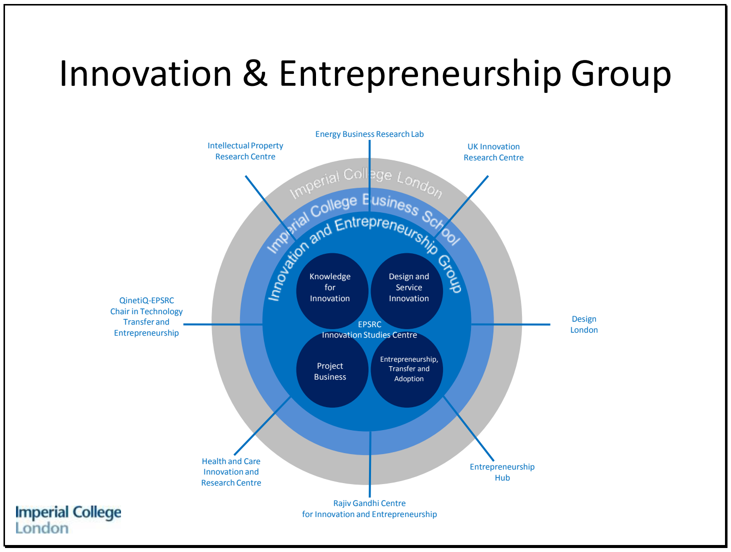


Figure 4. Innovation & Entrepreneurship Group.

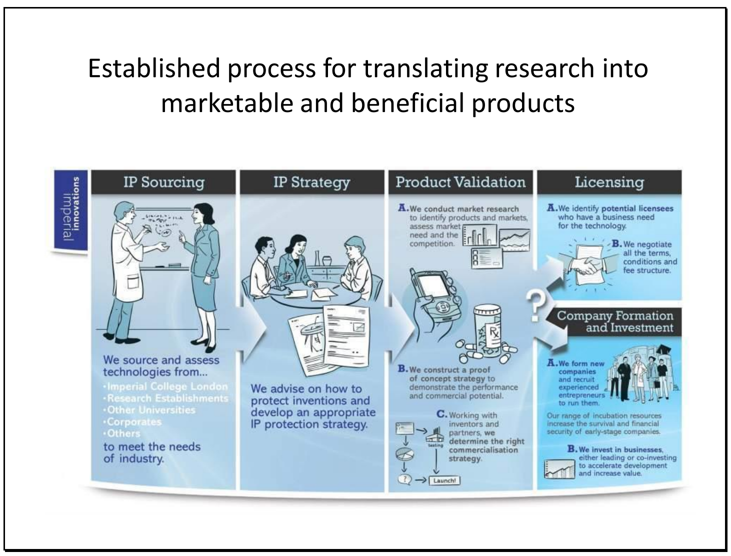


Figure 5. Established Process for Translating Research Into Marketable and Beneficial Products.

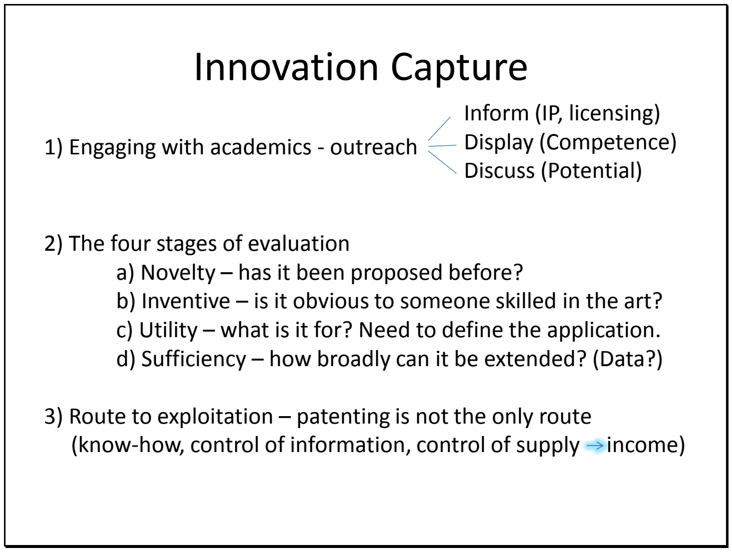


Figure 6. Innovation Capture.

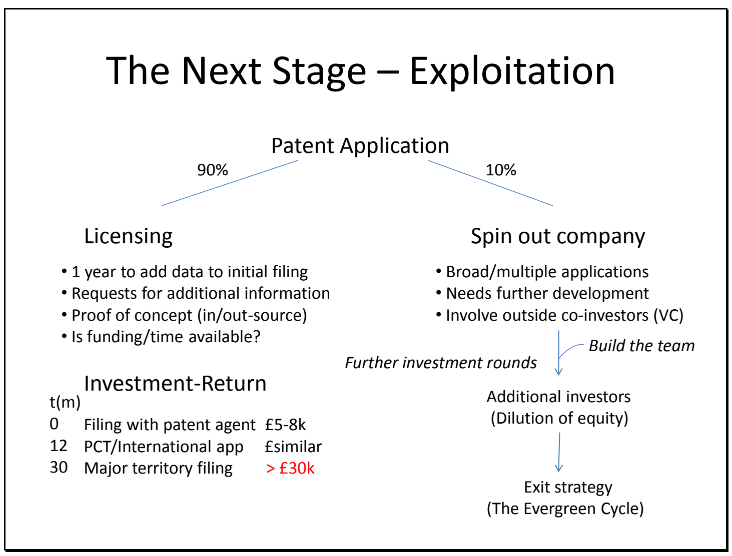
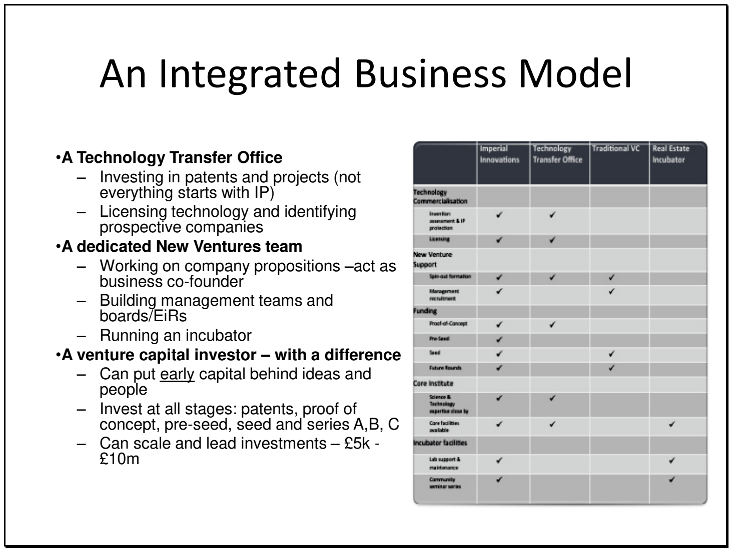


Figure 7. The Next Stage – Exploitation.



	Imperial Innovations	Technology Transfer Office	Traditional VC	Real Estate Incubator
Technology Commercialisation				
Invention assessment & IP protection	✓	✓		
Licensing	✓	✓		
New Venture Support				
Spin-out formation	✓	✓	✓	
Management recruitment	✓		✓	
Funding				
Proof-of-Concept	✓	✓		
Pre-Seed	✓			
Seed	✓		✓	
Future Rounds	✓		✓	
Core Institute				
Science & Technology expertise close by	✓	✓		
Core facilities available	✓	✓		✓
Incubator facilities				
Lab support & maintenance	✓			✓
Community seminar series	✓			✓

Figure 8. An Integrated Business Model.

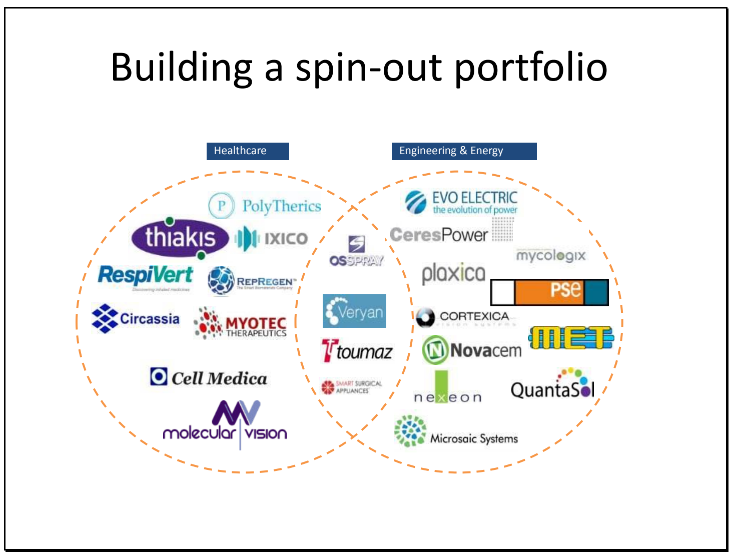


Figure 9. Building a Spin-Out Portfolio.

Figure 10. Successful Realisations.

Figure 11. Acknowledgements.

From Research to Innovation Routes to Exploiting the Intellectual Capital in Universities

TONY CASS
Department of Chemistry & Institute of Biomedical Engineering
Imperial Collage
London, UK

ABSTRACT

Universities are at the forefront of discovery in all disciplines but it is in the sciences, engineering and medicine that such discoveries can lead directly to an economic return. Given the sums involved it is not surprising that governments (the major source of funding) and universities themselves seek to efficiently translate this research to directly societal benefit. A recent study by Imperial College business school showed that the £3bn spent on university research generated £45bn worth of economic growth. Perhaps for this audience a more telling figure is that each pound spent on university research in the UK in the biomedical sciences generated 3Op each year thereafter in economic growth. Even with these rates of return, governments and funding agencies are seeking better mechanisms to harness the productivity of their universities and the academics who work in them. In this lecture I will compare three mechanisms to translate university research; two of these, licensing and spin-outs, are quite familiar. The third, problem-solving consultancy is less established. I will highlight the strengths and limitations of each with reference to my own commercialization experiences.

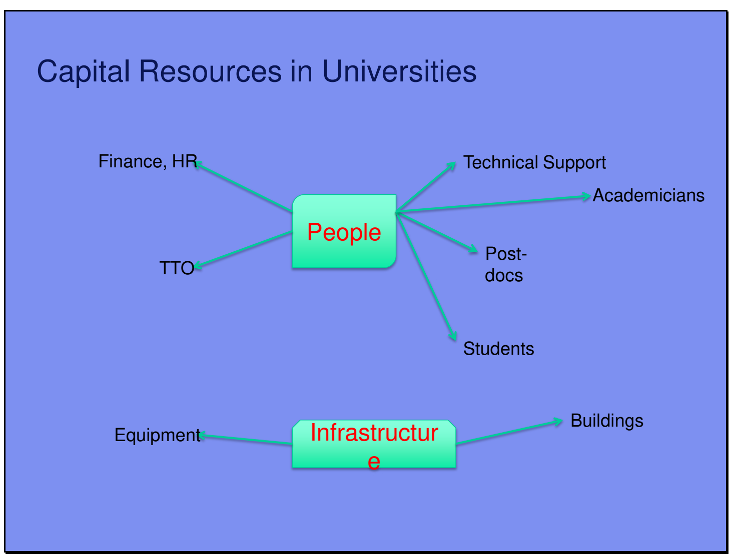


Figure 1. Capital Resources in Universities.

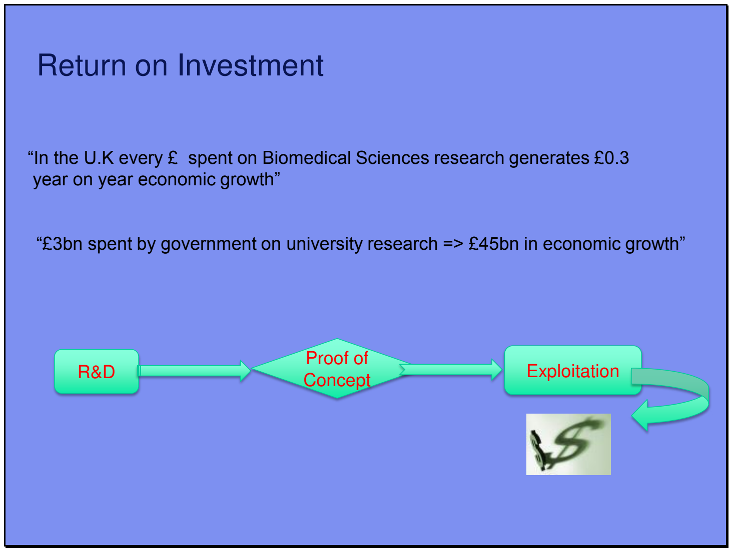


Figure 2. Return on Investment.

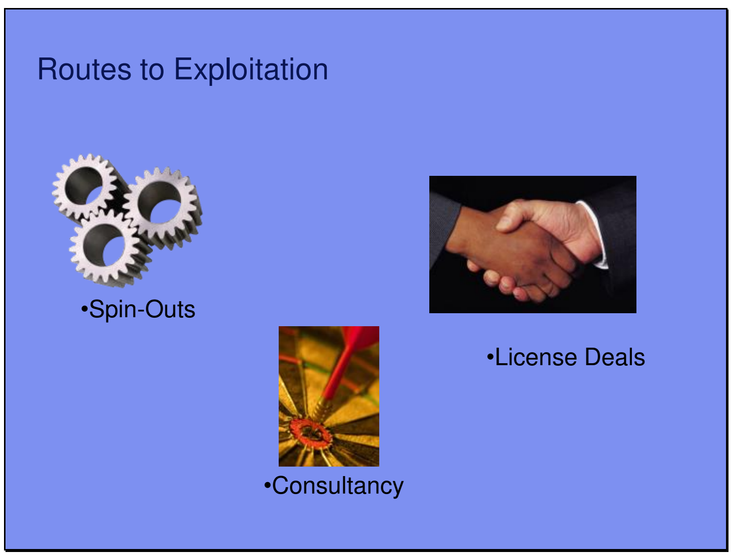


Figure 3. Routes to Exploitation.

Figure 4. License Deals.

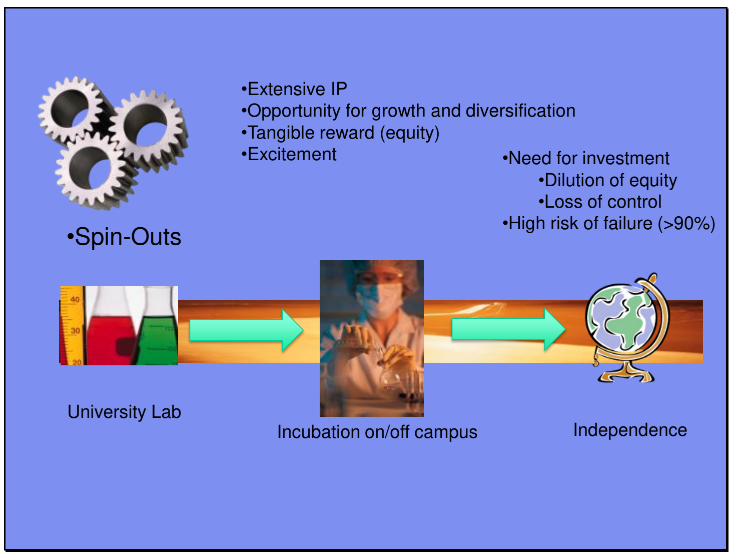


Figure 5. Spin-Outs.

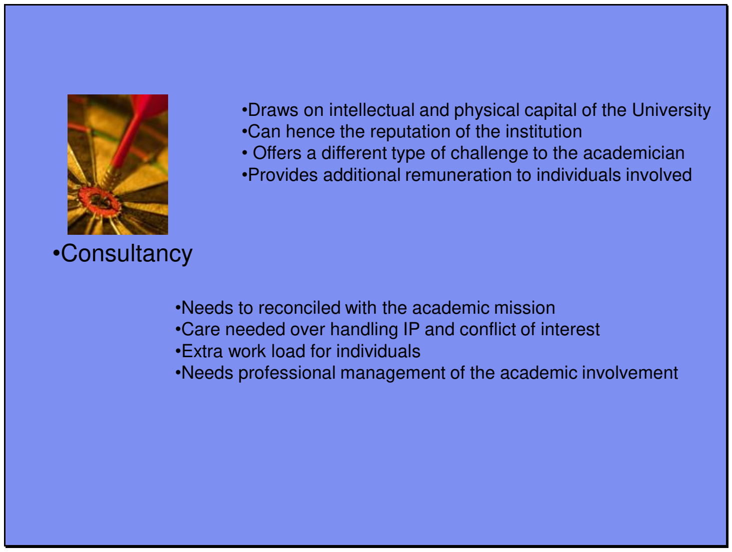


Figure 6. Consultancy.

Figure 7. Bio Nano Consulting.

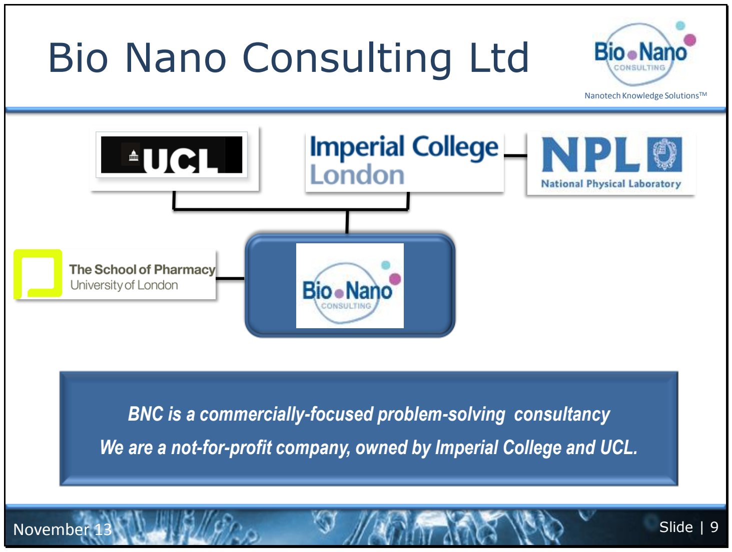


Figure 8. Bio Nano Consulting Ltd.

Figure 9. Bio Nano Consulting.

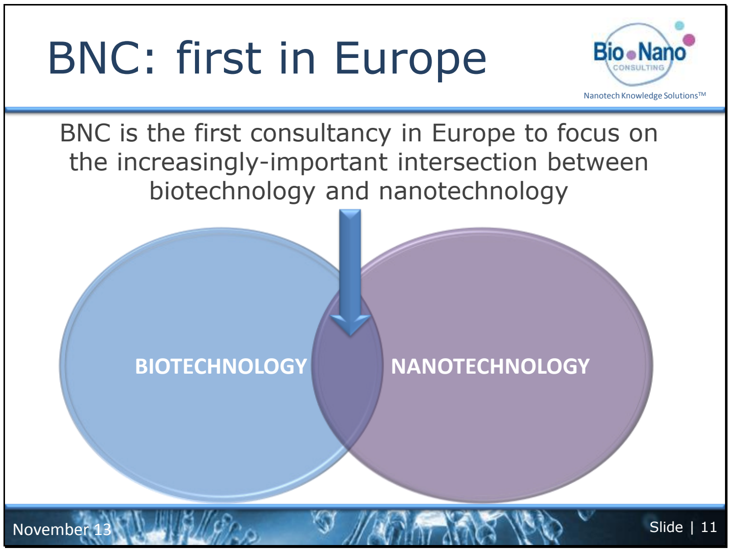


Figure 10. BNC: First in Europe.

Figure 11. Partnering Institutions.

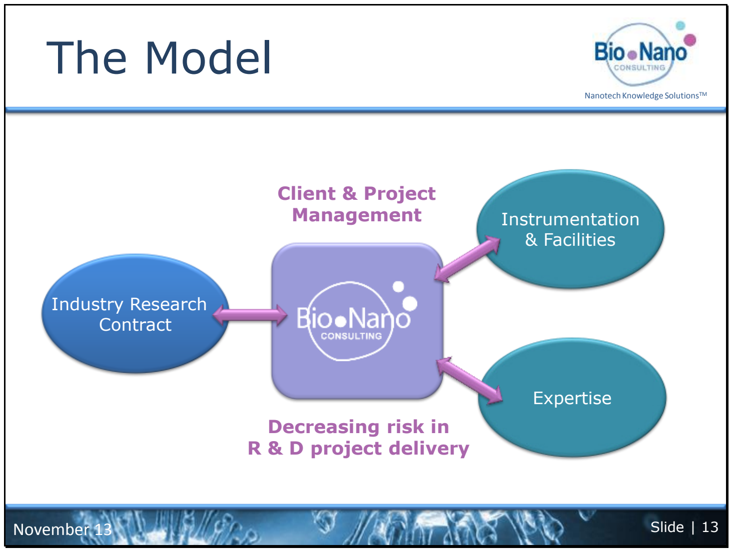


Figure 12. The Model.

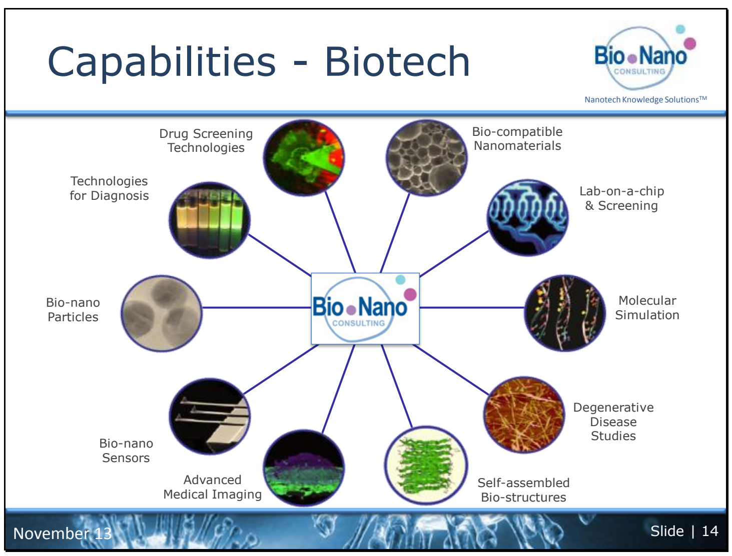


Figure 13. Capabilities – Biotech.

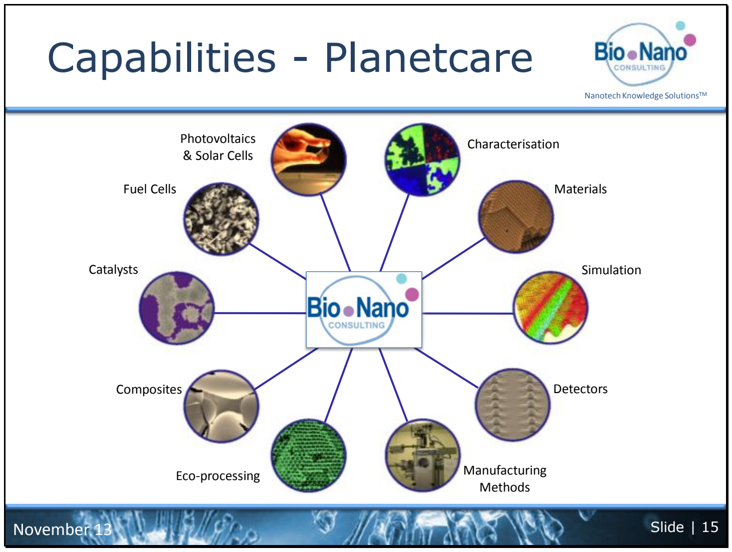


Figure 14. Capabilities – Planetcare.

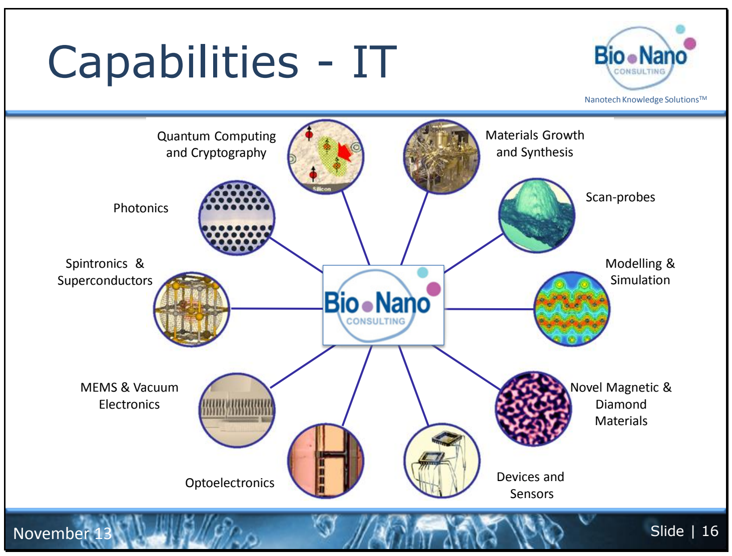


Figure 15. Capabilities – IT.

Figure 16. Non-Executive Directors.

Figure 17. Industrial Advisory Board.

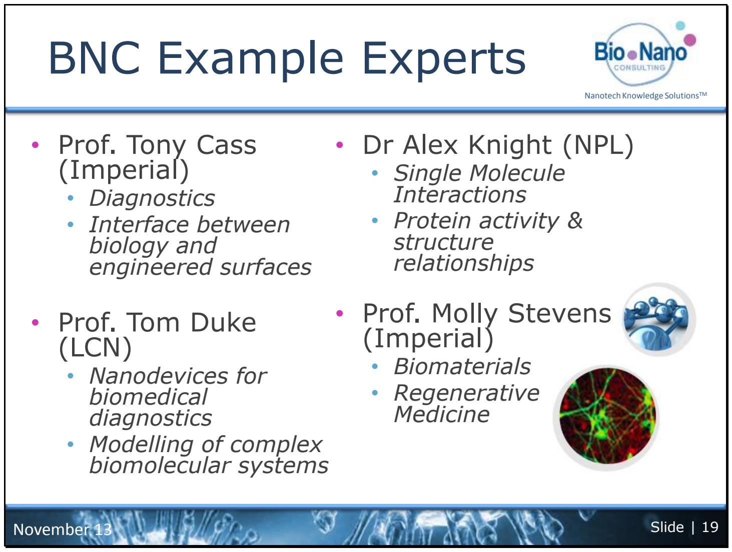


Figure 18. BNC Example Experts.

Figure 19. Portfolio of Clients.

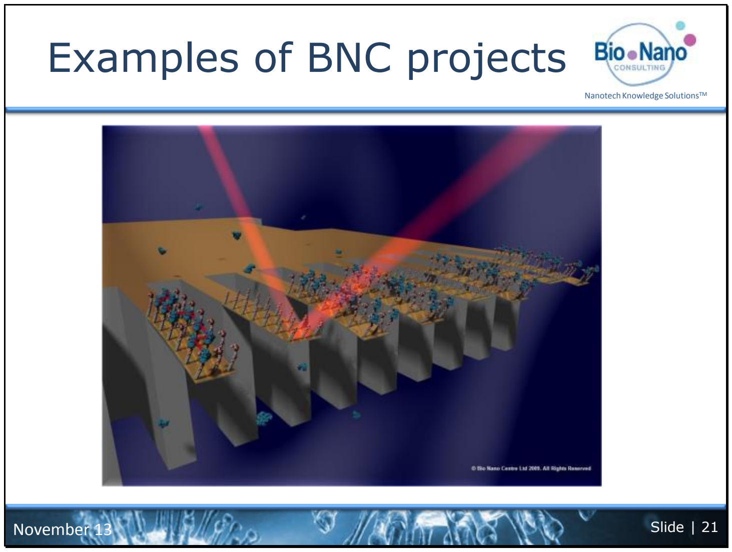


Figure 20. Examples of BNC Projects.

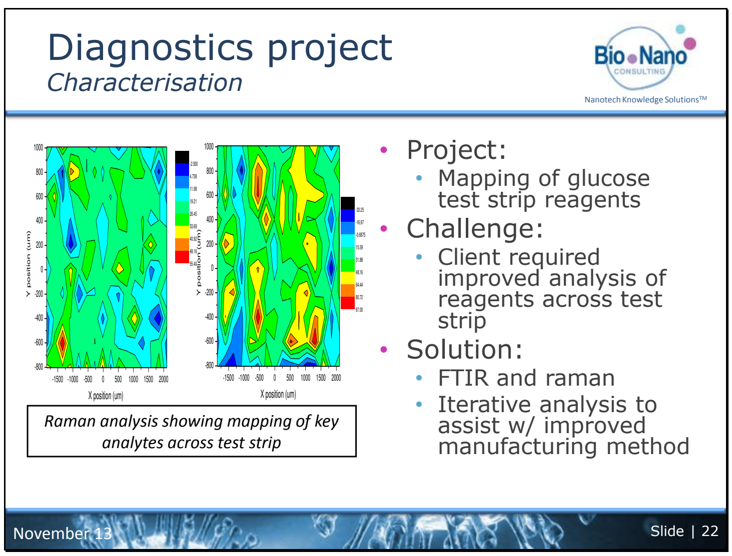


Figure 21. Diagnostics Project.

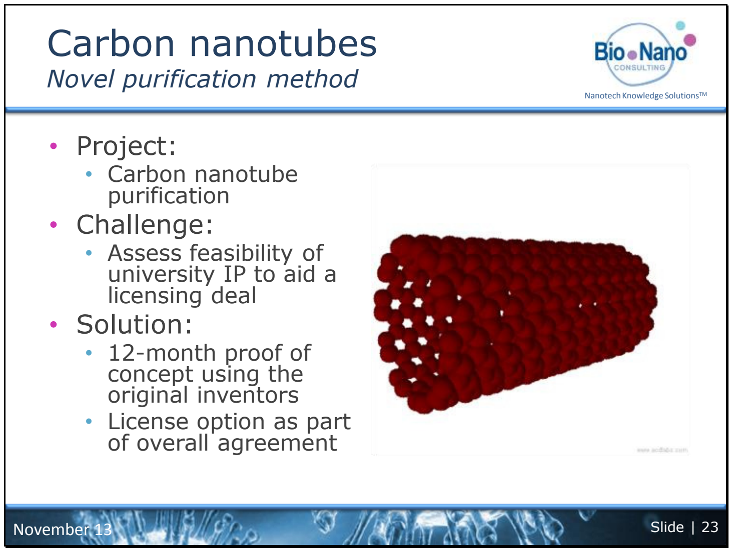


Figure 22. Carbon Nanotubes.

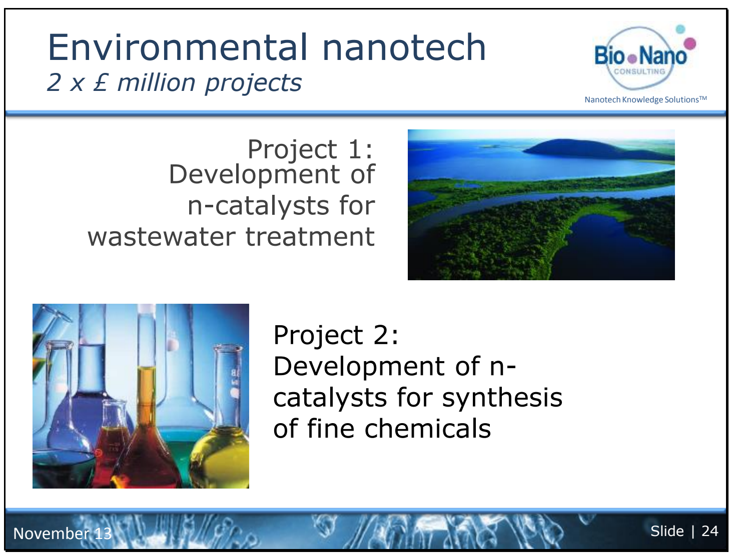


Figure 23. Environmental Nanotech.

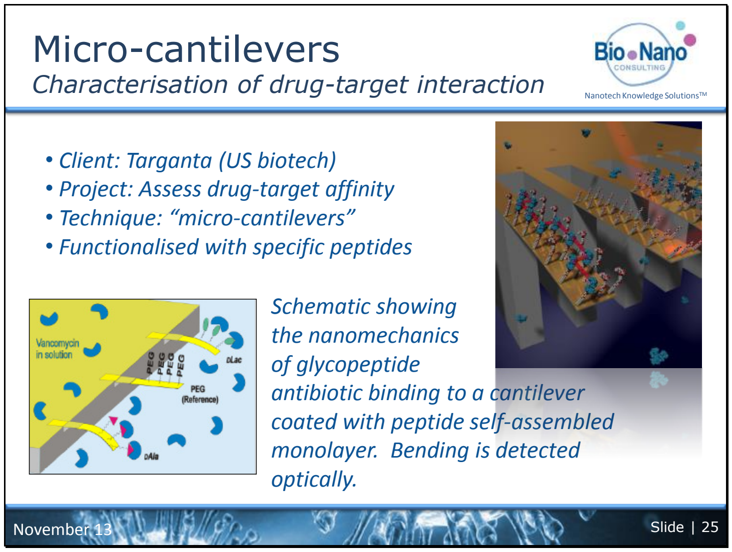


Figure 24. Micro-Cantilevers.

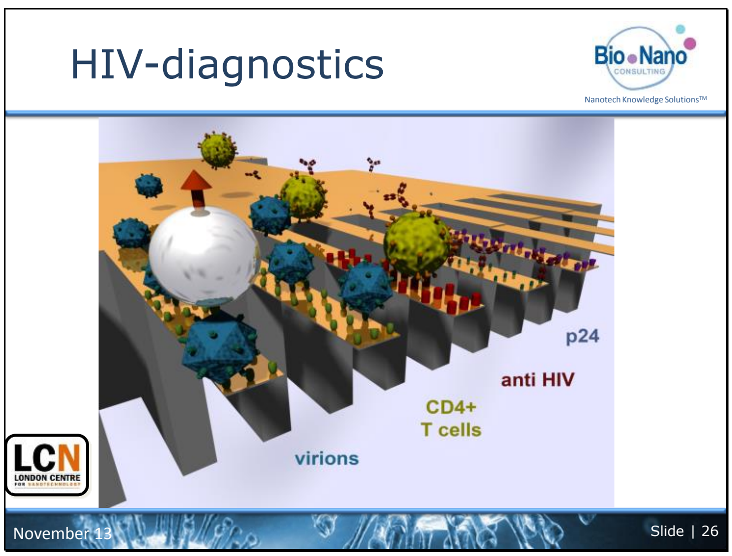


Figure 25. HIV-Diagnostics.

S & T Landscape in the OIC: Role of the Islamic World Academy of Sciences (IAS)

MONEEF R. ZOU'BI

Director General

Islamic World Academy of Sciences (IAS)

Amman, Jordan

ABSTRACT

Launched in 1986, the IAS was the brainchild of a handful of scientists who persuaded the Organisation of the Islamic Conference (OIC) (as it was called back then) to establish an academy of sciences to serve the S&T community in OIC countries and the developing world. The IAS was born in Amman (Jordan) as an independent non-political, non-governmental organization, during October of that year. IAS combines three different functions. Firstly, it is a learned society that promotes the values of modern science and identifies and honours high achievement and disseminates the latest scientific achievements internationally through meetings and publications. A second function of IAS —still to be realised- is that of a funding agency that supports the best individuals to undertake imaginative and far-reaching research. Thirdly, the IAS leads the scientific community of the OIC in its relations with societies, governments and academies of sciences worldwide.

This presentation is a modest attempt to talk about the significance of this multifaceted role of the IAS in boosting the STI landscape in the OIC.

Figure 1. The Rise of the science divide!

Figure 2. A proposed S&T 'Divide' timeline.

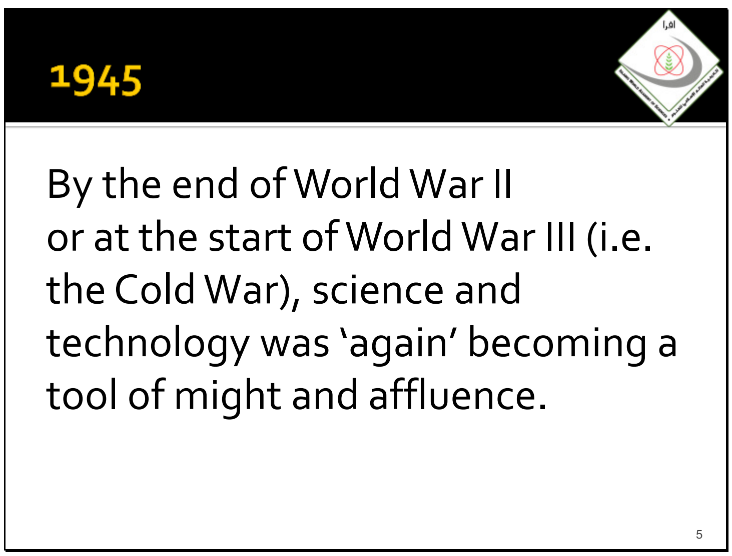


Figure 3. 1945: Rediscovering the value of science.

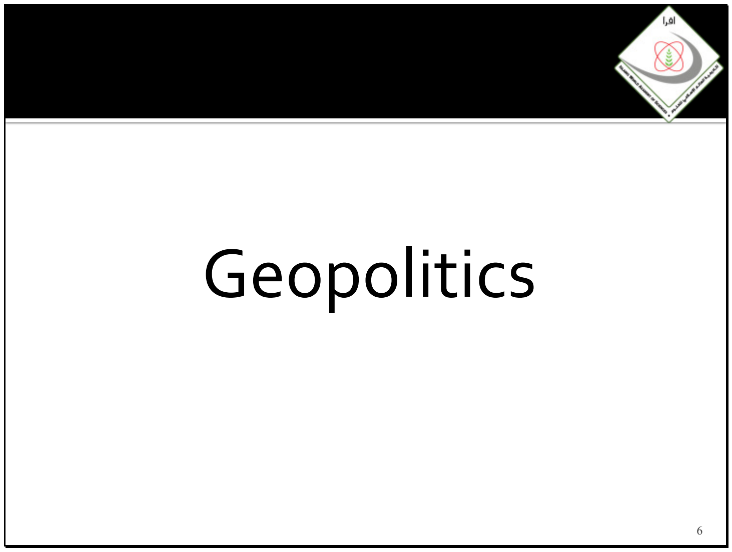


Figure 4. Geopolitics.

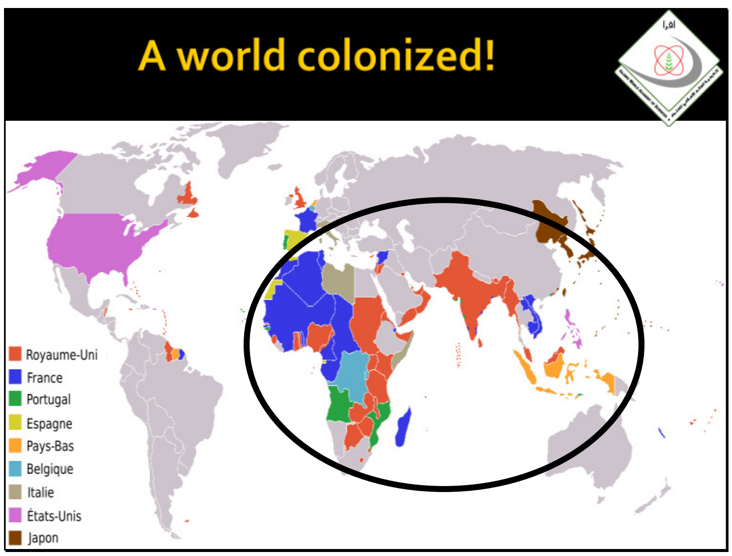


Figure 5. A world colonized!

Figure 6. 1969: Arson at the Aqsa and the birth of the OIC.

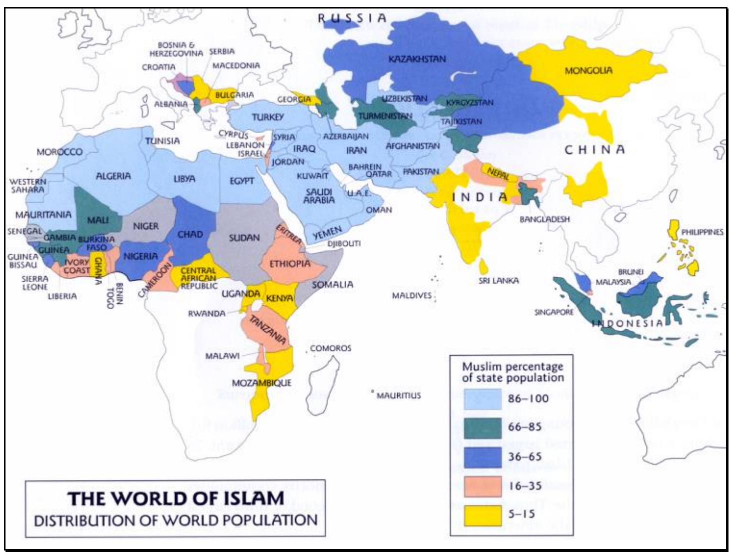


Figure 7. The world of Islam, today.

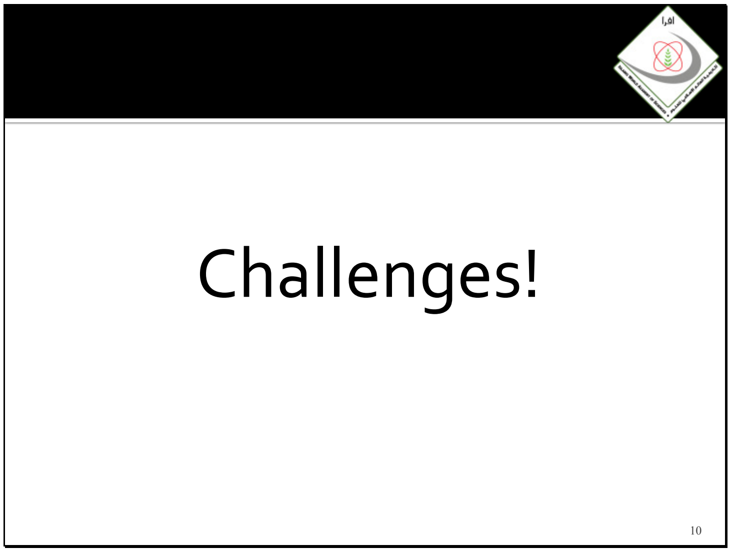


Figure 8. Challenges.

Figure 9. Why do we need science? Do we need STI policies?

Figure 10. Water crises in pictures I.

Figure 11. Water crises in pictures II.

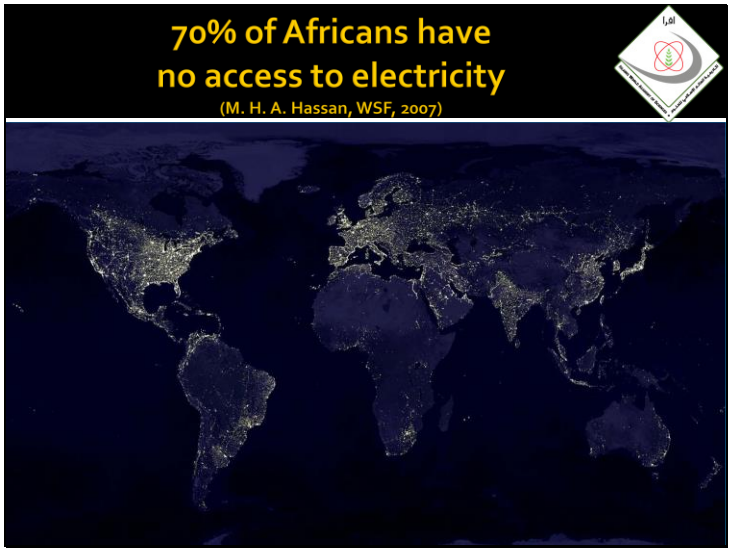


Figure 12. 70% of Africans have no access to electricity.

Figure 13. The energy crises.

Figure 14. Global health care is a must.

Figure 15. Agriculture and food security.

Figure 16. Biodiversity in pictures.

Figure 17. Wealth creation.

Figure 18. Climate change.

Figure 19. The first bottom line.

Figure 20. The future.

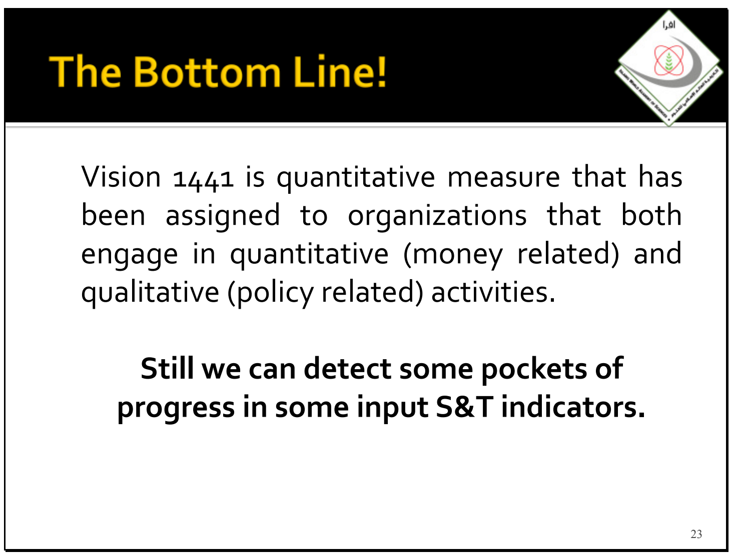


Figure 21. The second bottom Line!

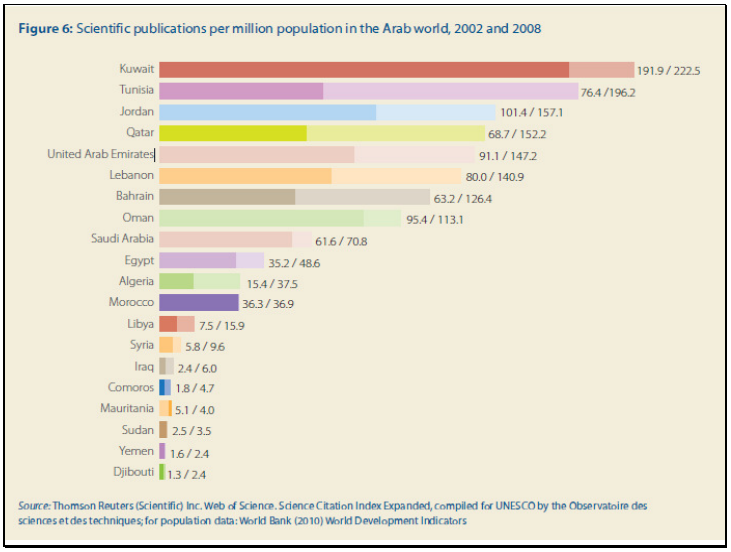


Figure 22. Scientific publications per million population in the Arab world, 2002 and 2008.

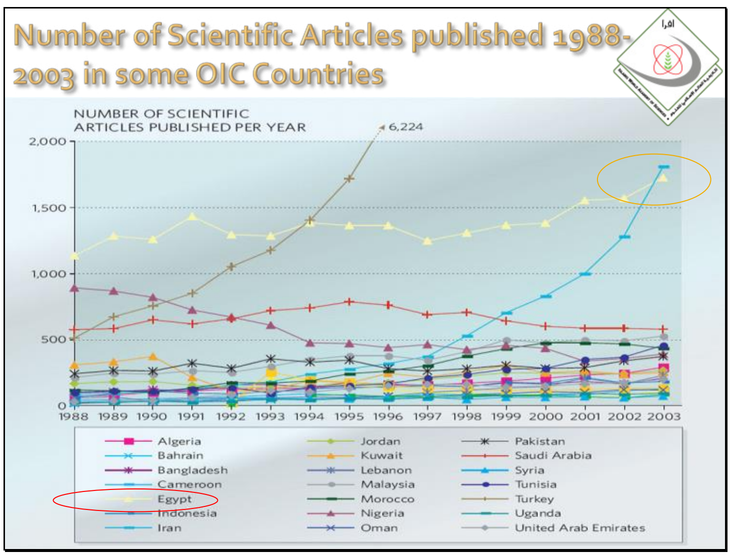


Figure 23. Number of scientific articles published 1988-2003 in some OIC countries.

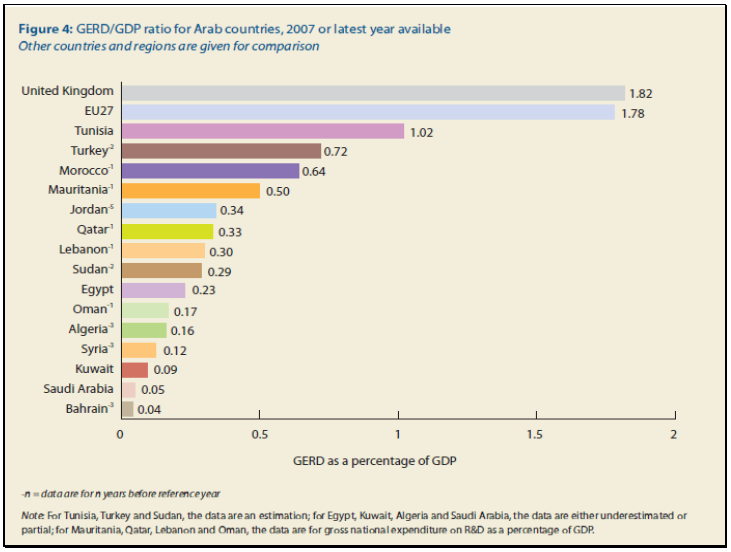


Figure 24. GERD/ GDP ratio for Arab countries.

FTE researchers per million population is some selected Arab countries, 2007; *Badran & Zou'bi (2009)*

Country	FTE Researchers /Million population 2007
Jordan	588
Qatar	588
Tunisia	555
Egypt	451
Libya	361[b]
Oman	252
Sudan	252[c]
Kuwait	240
Morocco	186
Algeria	179
Mauritania	156
Yemen	23

27

Figure 25. FTE Researchers per million population is some selected Arab countries, 2007.

Figure 26. Successes.

Figure 27. Saudi Gazette.

Figure 28. King Saud University.

Figure 29. SESAME in Jordan.

Figure 30. Success stories in the making.

Figure 31. MASDAR in Abu Dhabi.

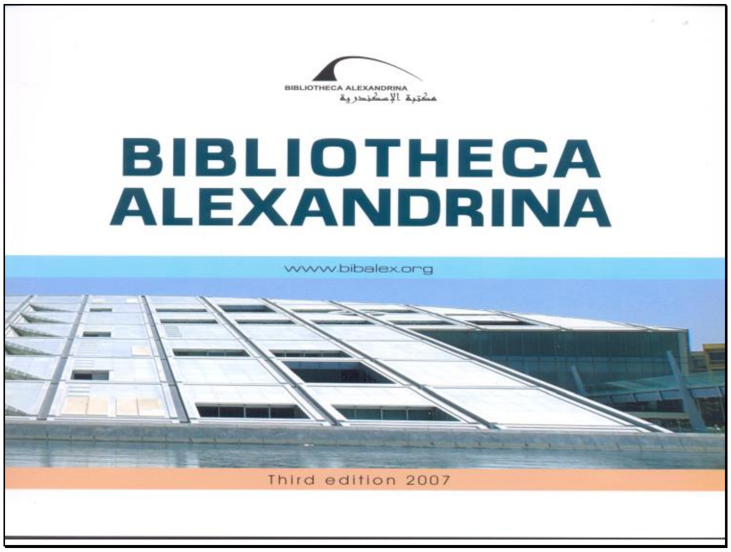


Figure 32. Bibliotheca Alexandrina.

Figure 33. SciDev Net.

Figure 33. Education City in Qatar.

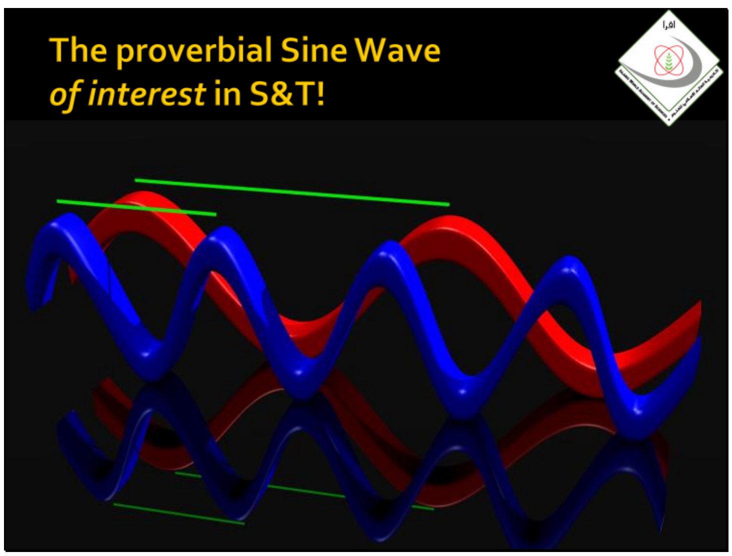


Figure 34. The proverbial sine wave of interest in S&T!

Figure 35. The way forward!

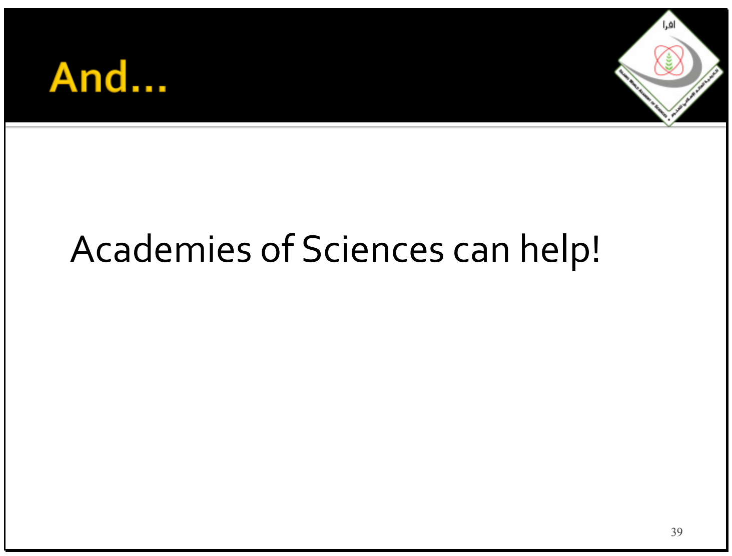


Figure 36. Academies of sciences can help!

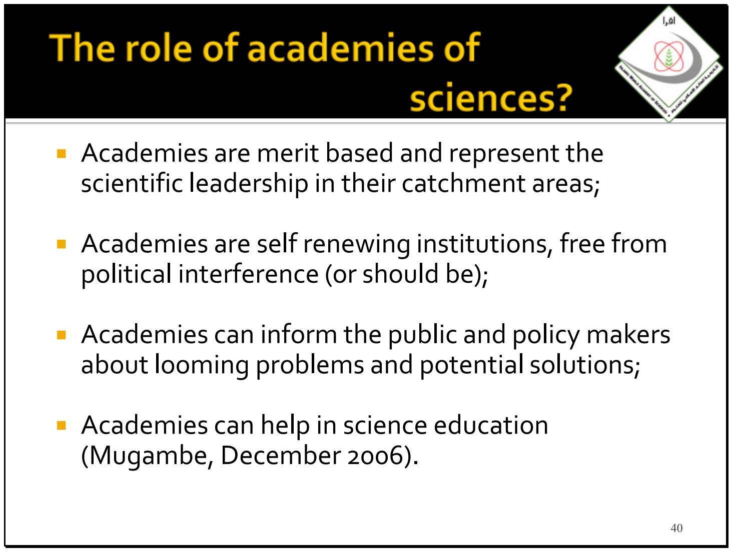


Figure 37. The role of academies of sciences?

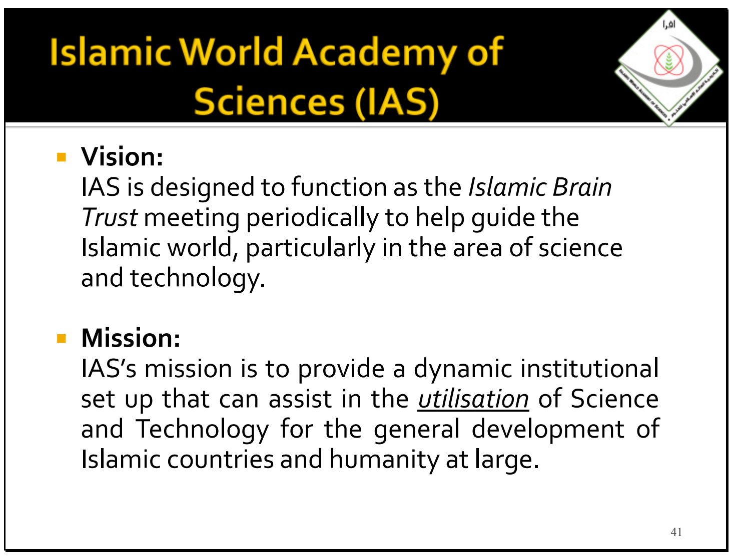


Figure 38. Islamic World Academy of Sciences (IAS).

Figure 39. IAS headquarters in Amman in winter.

Figure 40. In terms of independent policy advise.

Figure 41. IAS Activities at a glance I.

Figure 42. IAS activities.

Figure 43. IAS activities.

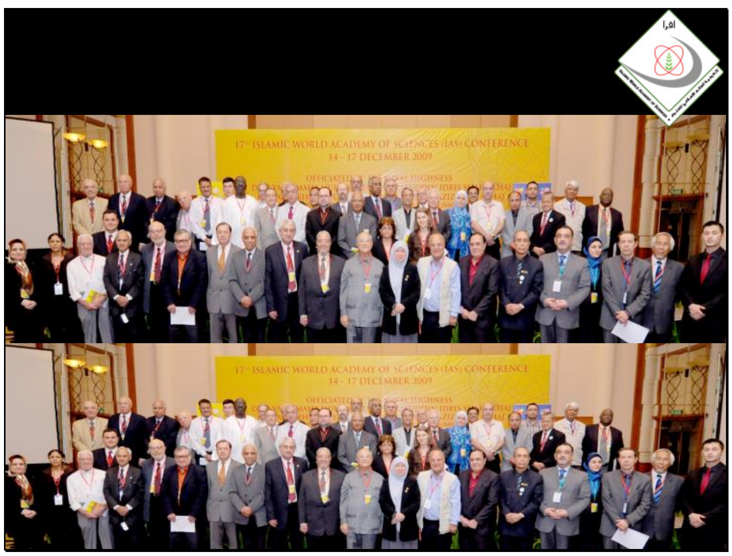


Figure 44. IAS activities.

Figure 45. IAS activities.

Figure 46. IAS activities at a glance.

Figure 47. IAS activities at a glance.

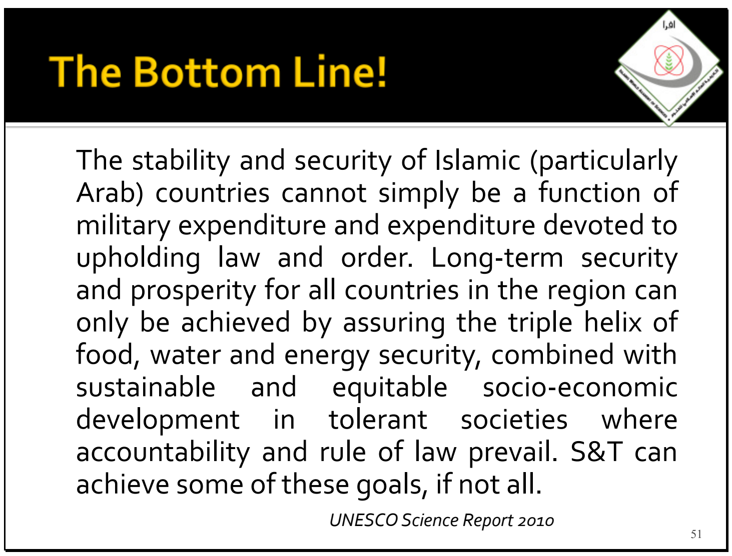


Figure 48. The bottom line.

Building Scientific Capacity and Increasing Innovation in Developing Countries

ABDALLAH S DAAR
Professor of Public Health Sciences and Professor of Surgery, University of Toronto
Senior Scientist, McLaughlin-Rotman Centre for Global Health, University Health Network and University of Toronto
Chief Scientific and Ethics Officer and Chair of the Scientific Advisory Board, Grand Challenges Canada
Chair of the Advisory Board, United Nations University International Institute of Global Health, Kuala Lumpur, Malaysia
Chair of the Board, Global Alliance for Chronic Diseases

ABSTRACT

I will describe our work at the McLaughlin-Rotman Centre for Global Health (University of Toronto and University Health Network, Toronto, Canada), and my own experience in helping to build capacity and increase innovation in various emerging economies and developing countries. The work is based on three major approaches: 1) Identifying major challenges in global health and building collaborative research and capacity-building funding communities around those priorities; 2) Working with governments and the scientific communities of sub-Saharan African countries to build infrastructure and identify creative mechanisms of bringing together, and aligning, science, business and capital with a view to harnessing and releasing the enormous local life sciences innovative capacity and help move knowledge towards product development and commercialization, especially in health and agriculture; and 3) helping educational and research institutions identify and implement long-term priorities in global health.

Figure 1. Ethical Context of Global Health.

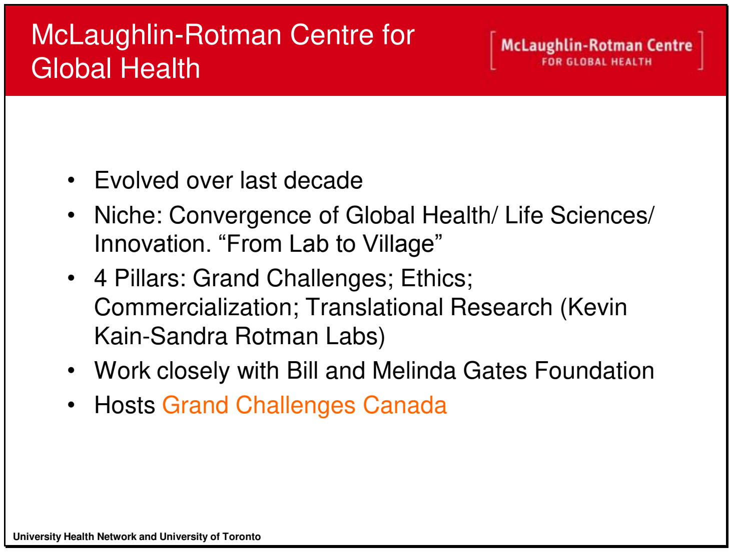


Figure 2. Mclaughlin-Rotman Centre for Global Health.

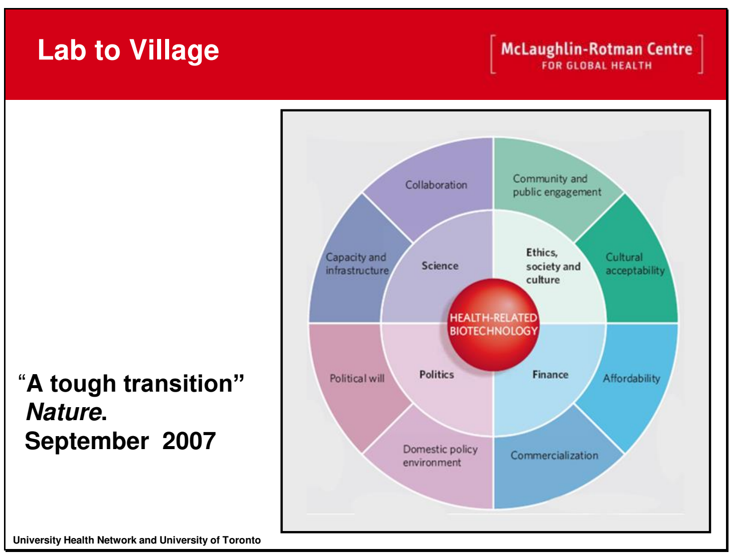


Figure 3. Lab to Village.

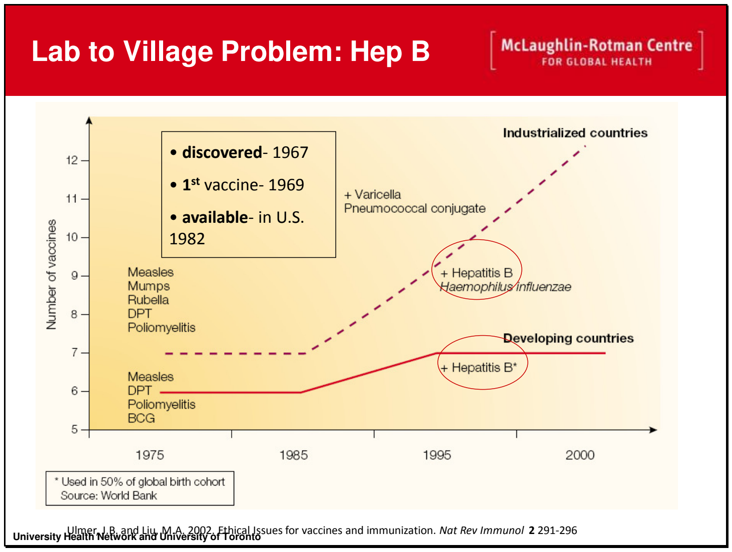


Figure 4. Lab to Village Problem: Hep B.

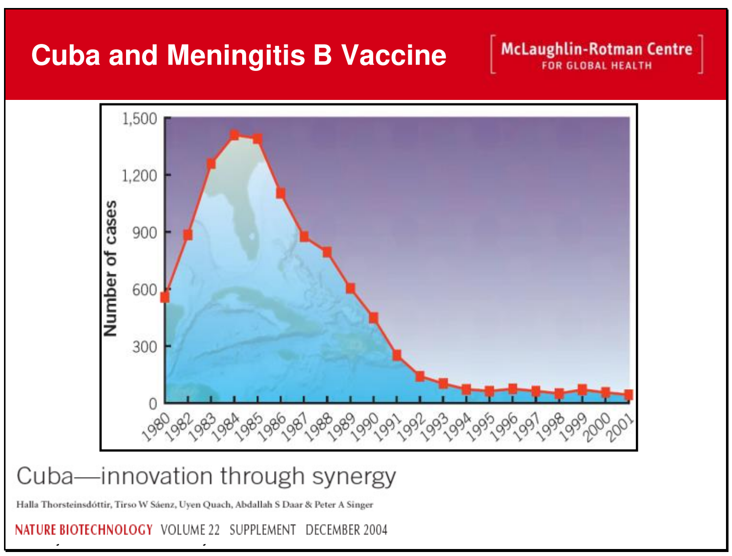


Figure 5. Cuba and Meningitis B Vaccine.

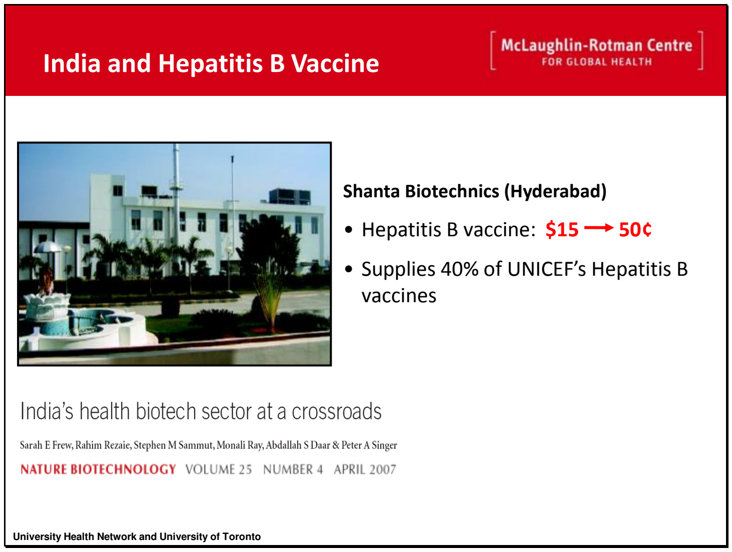


Figure 6. India and Hepatitis B Vaccine.

Figure 7.

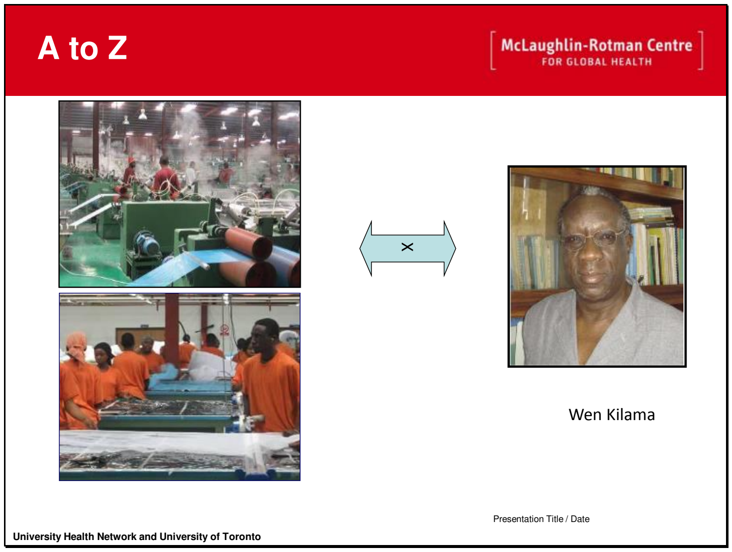


Figure 8. A to Z.

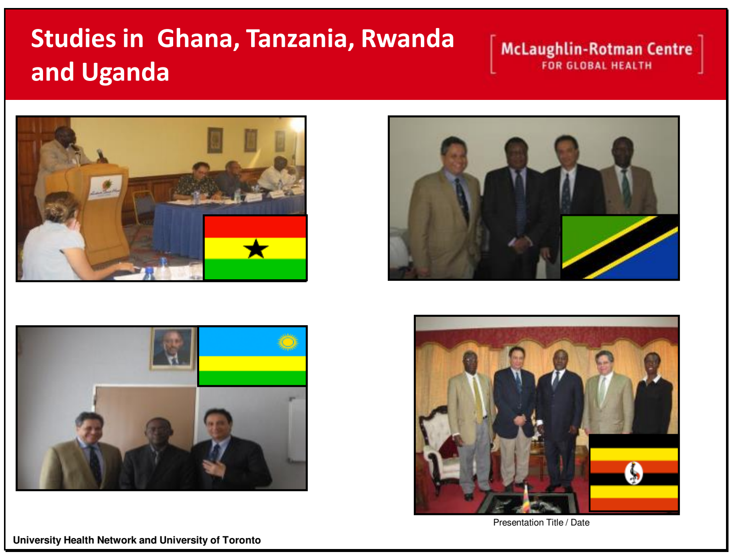


Figure 9. Studies in Ghana, Tanzania, Rwanda and Uganda.

Findings based on studies in Ghana, Tanzania, Rwanda and Uganda

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1. Lack of synergy and knowledge flows between various stakeholders
2. Inadequate financial incentives/resources for commercialization
3. Unexploited potential to commercialize innovative products (Stagnant Technologies)

University Health Network and University of Toronto

Figure 10. Findings based on Studies in Ghana, Tanzania, Rwanda and Uganda.

We …

McLaughlin-Rotman Centre FOR GLOBAL HEALTH

1. Held stakeholder workshops in Ghana, Tanzania Rwanda and Uganda
2. Our findings were validated and the concept of ***Convergence Innovation*** resonated with all stakeholders
3. Developed business plans and presented them to Science Ministers
4. Identified and mentored "local champions" to implement Convergence Platforms
5. Met with AfDB and World Bank officials to prepare the ground work for financial requests from countries.

University Health Network and University of Toronto

Figure 11. We….

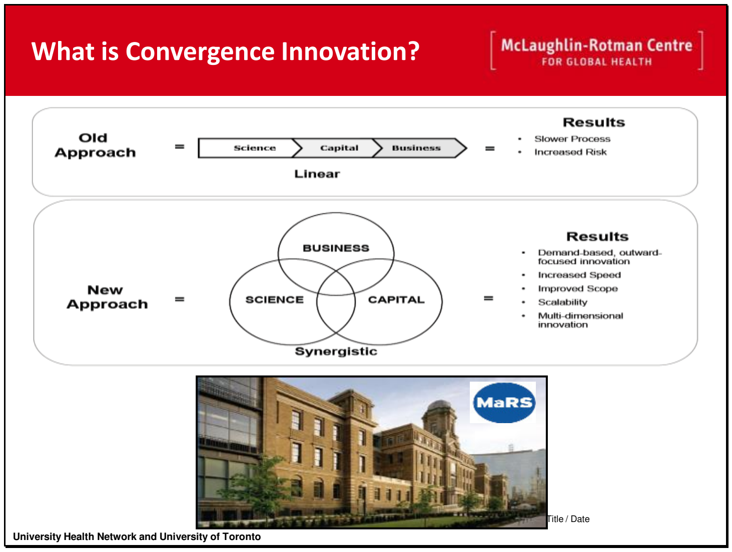


Figure 12. What is Convergence Innovation?

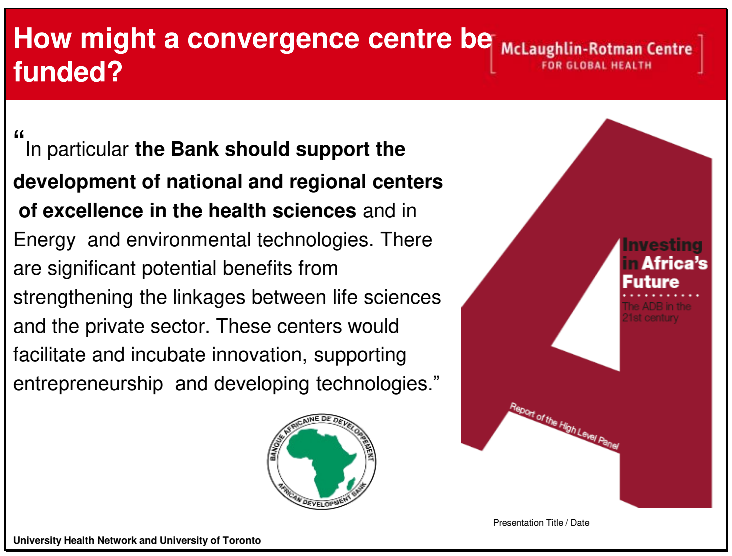


Figure 13. How Might a Convergence Center be Funded?

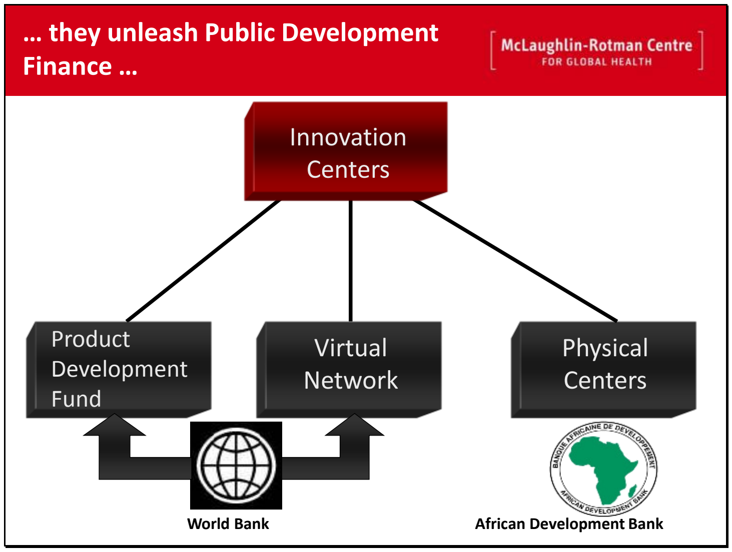


Figure 14. … They unleash Public Development Finance.

Figure 15. Key Benefits of Life Science Convergence Platforms in Africa.

Figure 16. Practical Steps Forward.

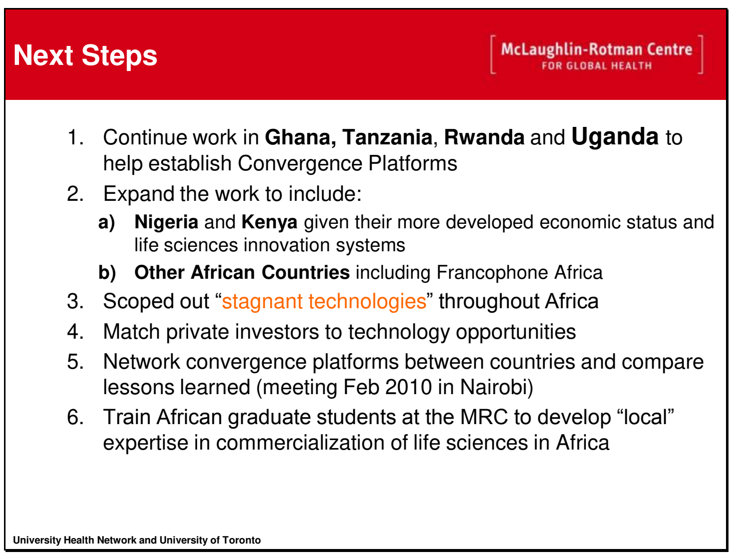
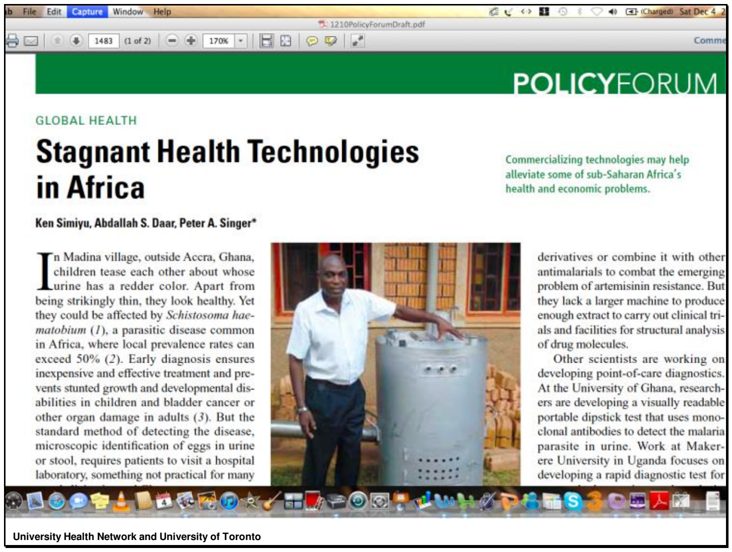


Figure 17. Next Steps.


POLICYFORUM

GLOBAL HEALTH

Stagnant Health Technologies in Africa

Commercializing technologies may help alleviate some of sub-Saharan Africa's health and economic problems.

Ken Simiyu, Abdallah S. Daar, Peter A. Singer*

In Madina village, outside Accra, Ghana, children tease each other about whose urine has a redder color. Apart from being strikingly thin, they look healthy. Yet they could be affected by *Schistosoma haematobium* (*1*), a parasitic disease common in Africa, where local prevalence rates can exceed 50% (*2*). Early diagnosis ensures inexpensive and effective treatment and prevents stunted growth and developmental disabilities in children and bladder cancer or other organ damage in adults (*3*). But the standard method of detecting the disease, microscopic identification of eggs in urine or stool, requires patients to visit a hospital laboratory, something not practical for many

derivatives or combine it with other antimalarials to combat the emerging problem of artemisinin resistance. But they lack a larger machine to produce enough extract to carry out clinical trials and facilities for structural analysis of drug molecules.

Other scientists are working on developing point-of-care diagnostics. At the University of Ghana, researchers are developing a visually readable portable dipstick test that uses monoclonal antibodies to detect the malaria parasite in urine. Work at Makerere University in Uganda focuses on developing a rapid diagnostic test for

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Figure 18. Stagnant Health Technologies in Africa.

Case Studies

McLaughlin-Rotman Centre FOR GLOBAL HEALTH

- In East Africa the largest long-lasting insecticide-treated bed nets manufacturer in Africa
- In East Africa bio-prospecting to develop traditional medicines in a quality-controlled manner
- In S. Africa a rare life sciences venture capital firm
- In East Africa, a full-scale manufacturing facility which is experimenting with commercialization
- In S. Africa an initiative that provides virtual incubation and management expertise
- In West Africa, a preparation that works to manage sickle cell disease

University Health Network and University of Toronto

Figure 19. Case Studies.

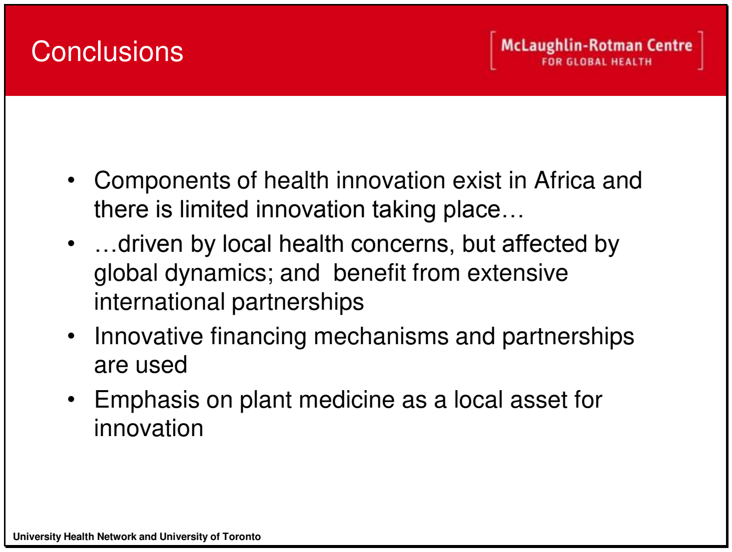

Figure 20. Conclusions.

Figure 21. Needed.

Figure 22. Grand Challenges Canada.

Figure 23. Grand Challenges Canada.

Grand Challenges Canada: Mission

McLaughlin-Rotman Centre FOR GLOBAL HEALTH

- Identify global grand challenges to health
- Fund a global community of researchers and related institutions on a competitive basis to address the grand challenges
- Support the implementation and commercialization of solutions that emerge

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Figure 24. Grand Challenges Canada: Mission.

Grand Challenges Canada: Funding

McLaughlin-Rotman Centre FOR GLOBAL HEALTH

- $225m over 5 years
- Development Innovation Fund:

"…support the best minds in the world as they search for breakthroughs in global health and other areas that have the potential to bring about enduring changes in the lives of millions of people in poor countries."

2008 Federal Budget

University Health Network and University of Toronto

Figure 25. Grand Challenges Canada: Funding.

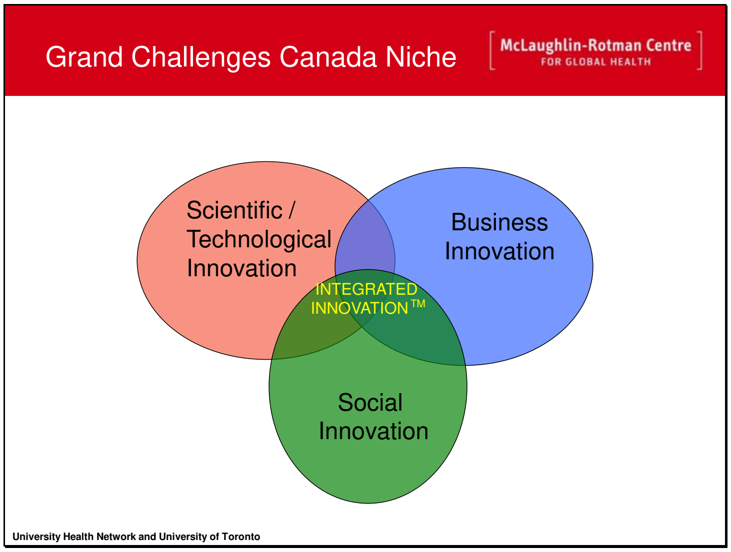


Figure 26. Grand Challenges Canada Niche.

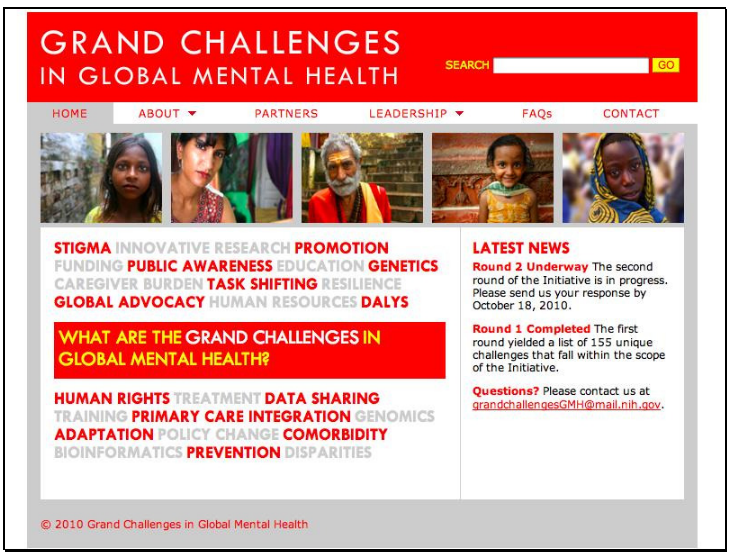


Figure 27. Grand Challenges in Global Mental Health.

Figure 28. Thank you.

Innovation in Traditional Milieus — Medicinal Plants of Mauritius 'From Academic Research to a Business Model'

AMEENAH GURIB-FAKIM
University of Mauritius
Reduit, Mauritius

ABSTRACT

The African continent is blessed with a unique biodiversity accounting for almost 25% of the global pool of genetic resources. Paradoxically, this continent is experiencing the highest rate of destruction. The conservation of plant genetic resources, the documentation and validation of the traditional knowledge are key issues that will need to be addressed. The industrial potential of these plants is to be demonstrated especially as medicinal plants have not only the potential of addressing the Millenium. Development Goals (MdGs) but also provide to Mankind cheap and efficacious remedies. In Mauritius, the publications on medicinal plants dated back to 1888 with the work of Doctors Daruty and Bouton. My work has been initially focused on producing a database on all the medicinal and aromatic plants of Mauritius but also for the Indian Ocean region. After documentation, the research work has been focussed on the validation of the traditional data with a view of developing cheaper alternative to standard allopathic medicine. The joint publication of the African Pharmacopeia will impact African farmers willing to export their products in international market as they will fulfil the needs of industry. As for many African farm products, women are the prime agriculturalists and this project is likely to have a direct impact on livelihoods. At the local level, many small 'Women Association' have started using my publications to set up small business and the Government of Mauritius has funded a business plan for this project. This presentation will show case this work.

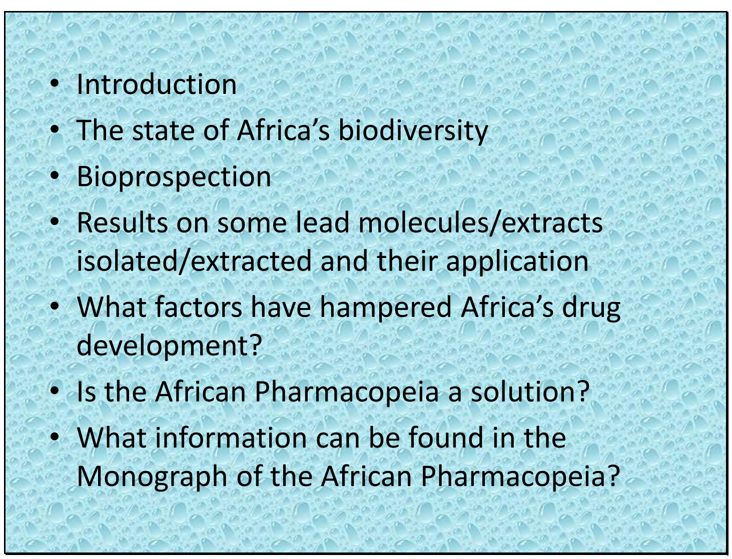


Figure 1.

WHO: (*More than*) 80% of the world's population depend on medicinal plants for their primary health care

Evolution of drug industry: 2nd World war to date ~ 60% of drugs sold in the chemist shop are of natural origin (including antibiotics) and 25% come directly from medicinal plants.

In the Plant Kingdom: Medicinal plants form the largest single grouping of plants. It is estimated that 30,000 species world-wide fall in this group, of which around 33% are trees.

Tropical & Subtropical Africa has 40-45.000 higher plant species that potentially hold considerable industrial value. This represents ***at least 25% of the global pool of plant genetic resources and has contributed significantly to the world's trade in genetic material***.

Figure 2.

Challenges facing the African biodiversity

Estimate show that the continent has 216 634 000 ha of closed forest areas.

- Calculated loss of 1% (Global rate is 0.6%) due to deforestation – direct implication is that Many Medicinal Plants will become extinct even before they are documented!

This makes Africa as having the HIGHEST rate of deforestation in the world.

- Documentation of TK is therefore one of the priority especially when conservation is also becoming an issue.

Figure 3. Challenges Facing the African Biodiversity.

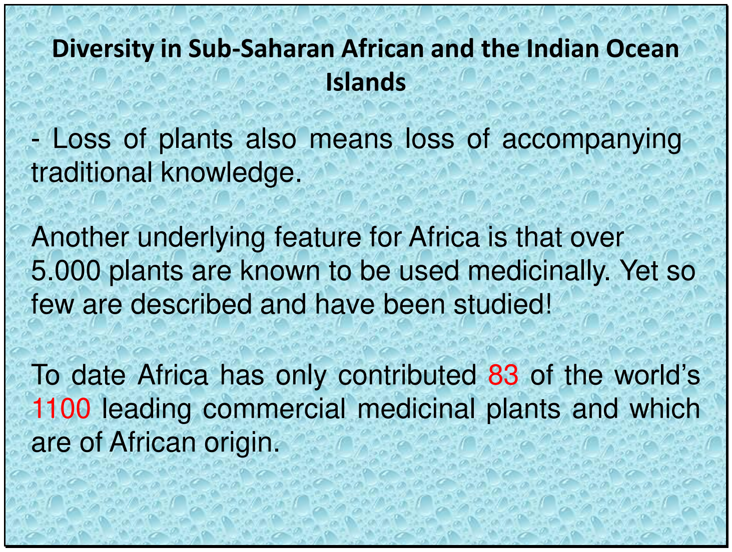


Figure 4. Diversity in Sub-Saharan African and the Indian Ocean Islands.

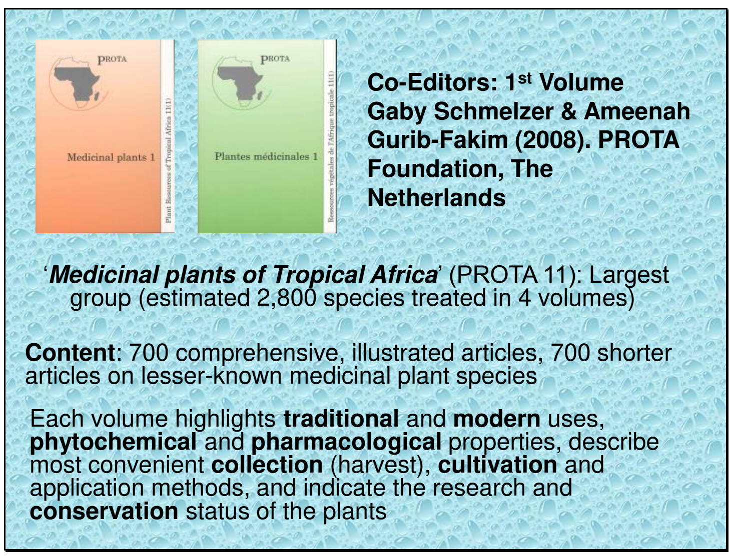


Figure 5. Co-Editors: 1st Volume Gaby Schmelzer & Ameenah Gurib-Fakim (2008).

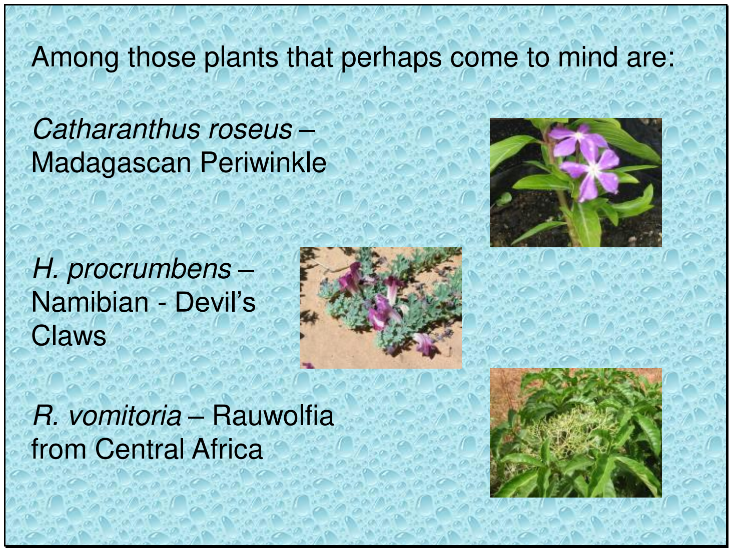


Figure 6. Among those plants that perhaps come to mind.

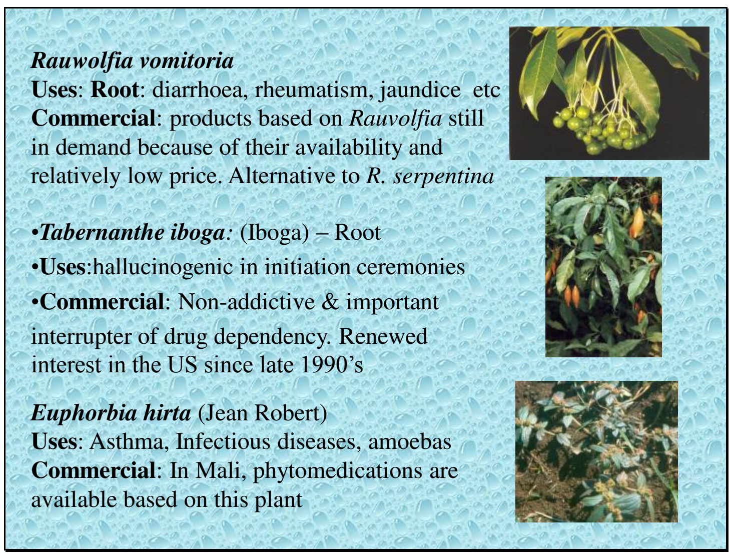
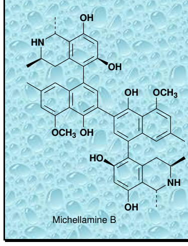


Figure 7.

Bioprospection - African medicinal plants – addressing the research agenda

In the course of bioprospection carried out on African biodiversity for potential cure for HIV-AIDs in Western Africa…

Ancistrocladus korupensis was discovered in the Korup forest of Cameroon. Since then, the Korup forest has become one of West Africa's largest conservation projects.



Michellamine: Went through advanced pre-clinical development, but continuous infusion studies in dogs indicated that *in vivo* effective anti-HIV concentrations could only be achieved close to neuro-toxic dose levels.

Figure 8. Bioprospection – African Medicinal Plants – Addressing the research Agenda.

•Thus, despite *in vitro* activity against an impressive range of HIV-1 and HIV-2 strains, the difference between the toxic dose level and the anticipated level required for effective antiviral activity was small, and NCI decided to discontinue further studies aimed at clinical development.

•**Korupensamines**: the discovery of novel anti-malarial agents, the korupensamines, from the same species, adds further promise for this species.

Figure 9.

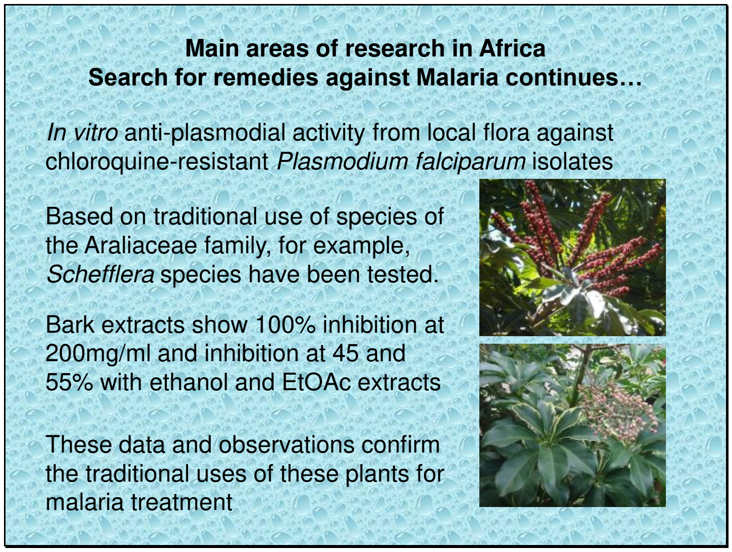


Figure 10. Main Areas of Research in Africa.

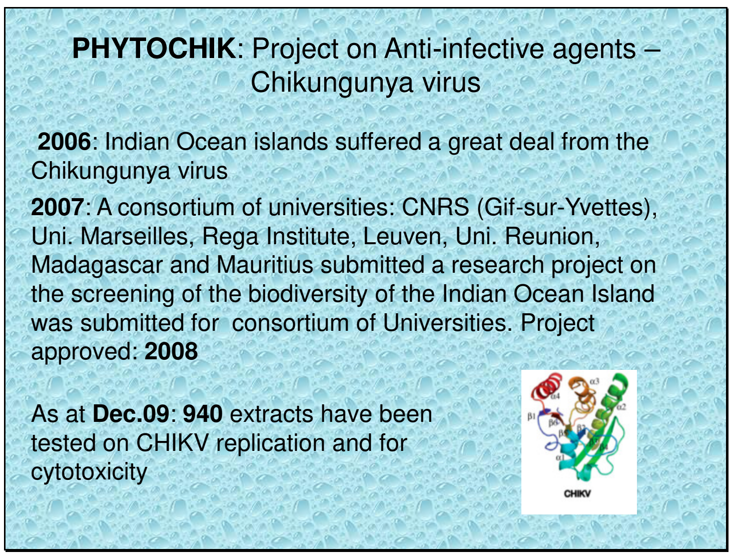


Figure 11. Phytochik: Project on Anti-infective Agents – Chikungunya Virus.

Dec 09: 33 hits were obtained and they are being fractionated as per usual protocols

Results on these fractions indicated that true antiviral effects were confirmed for 12 species from 2 main families

What is also very interesting is that medicinal plants used traditionally to treat malaria, have shown activity *in vivo*, in rodent malaria and have also shown activity against the Chikungunya virus!

These plants are being priority for further screening and fractionation work!

Figure 12.

Plants from Mauritius with promising biological activities

Asteraceae family

Psiadia lithospermifolia

Trad. Uses: Leaf infusion of both plants are used against asthma & respiratory ailments. **Leaf poultice**: wounds

Plant: endemic to Mauritius and Reunion Islands of the Mascarenes

Endemic plants pose some problems vis a vis the identification of new molecules

Figure 13. Plants from Mauritius with Promising Biological Activities.

Psiadia lithospermifolia

Leaf extracts: Tannins, Coumarins and flavones

Leaf Oil: (E)-Asarone (51.5%); other sesquiterpenes: (E)-β-farnesene, d-elemene

Anti-microbial activity

Essential Oil: (0.03% v/v) showed significant activity against assayed microorganisms – *Bacillus cereus*, *Staphylococcus aureus*, *Pseudomonas aureofaciens*; *Aspergillus ochraceus*, *Fusarium moniliforme*, *Candida pseudotropicalis*, *Kluveromyces lactis*.

Figure 14. Psiadia Lithospemifolia.

Antimicrobial profile better positive controls such as Chloramphenicol and Nystatin

Leaf extracts: Significant inhibitory activities against *S. aureus*, *Bacillus subtilis* and *Pseudomonas aureofasciens* 0.03% (v/v).

- Leaf extract more effective than the antibiotic – Chloramphenicol at the recommended concentrations of 0-250mm/ml

NO fungitoxic properties observed for the leaf extracts

Figure 15.

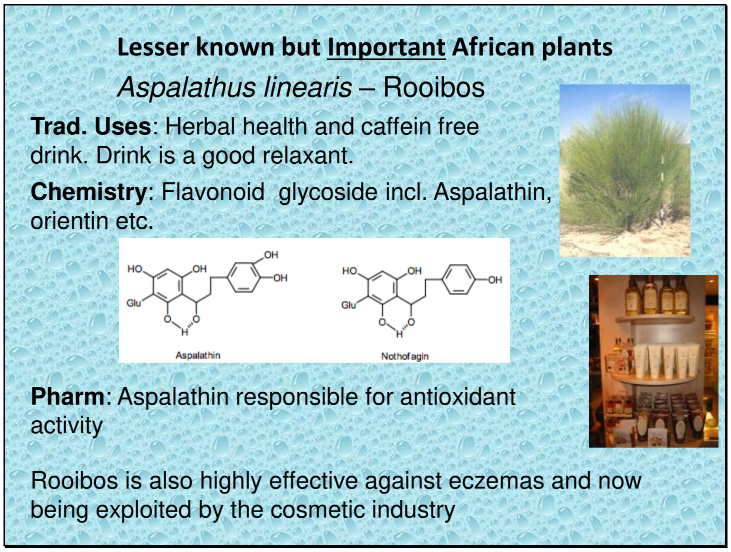


Figure 16. Lesser Known but Important African Plants.

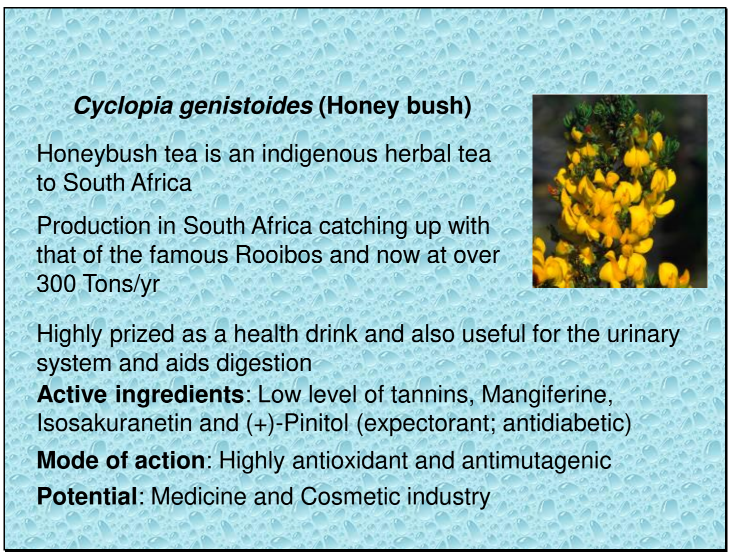


Figure 17. Cyclpia Genistoides (Honey Bush).

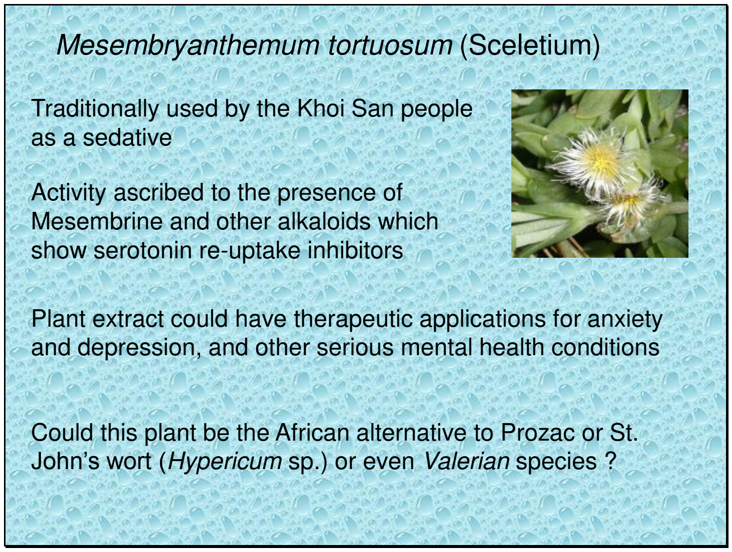


Figure 18. Mesembryanthemum Tortuosum (Sceletium).

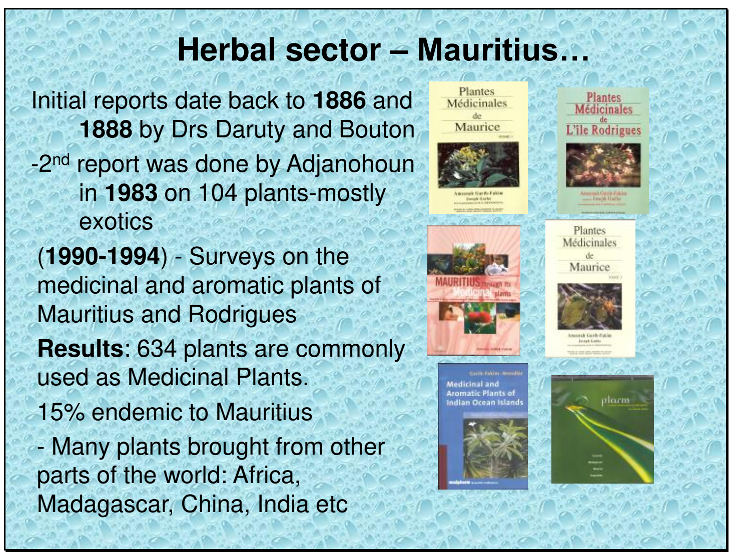


Figure 19. Hebal Sector – Mauritius.

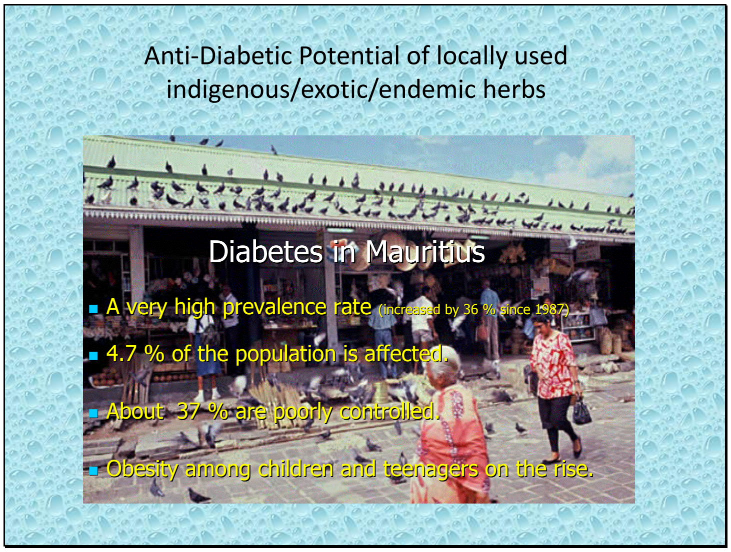


Figure 20. Anti-Diabetic Potential of Locally Used in Digenous/ exotic/ endemicherbs.

Figure 21. Medicinal Plants of Mauritius & Indian Ocean Islands Commonly used Against Diabetes.

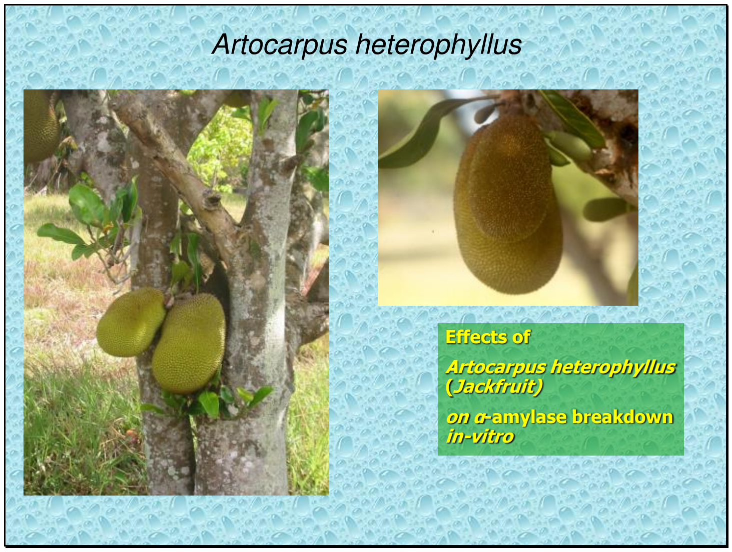


Figure 22. Artocarpus Heterophyllus.

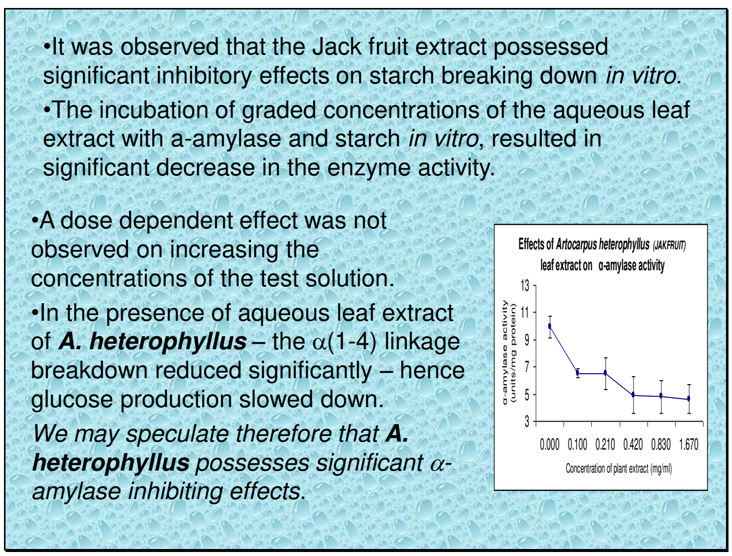


Figure 23.

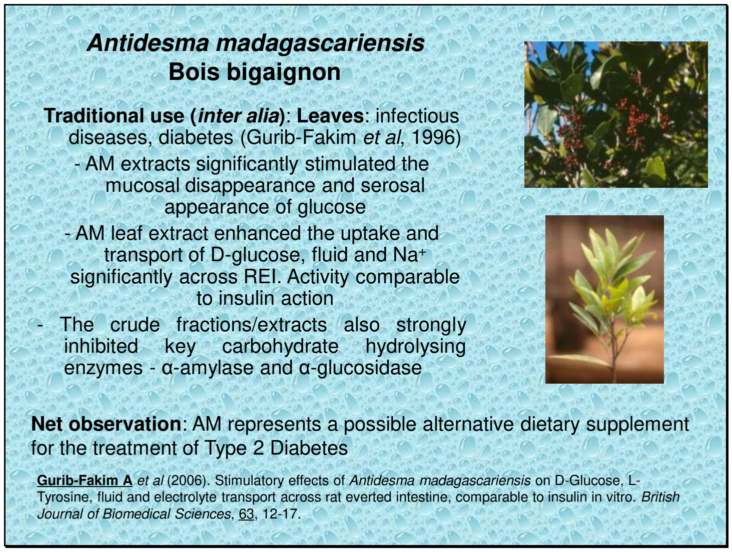


Figure 24. Antidesma Madagascariensis Bois Bigaignon.

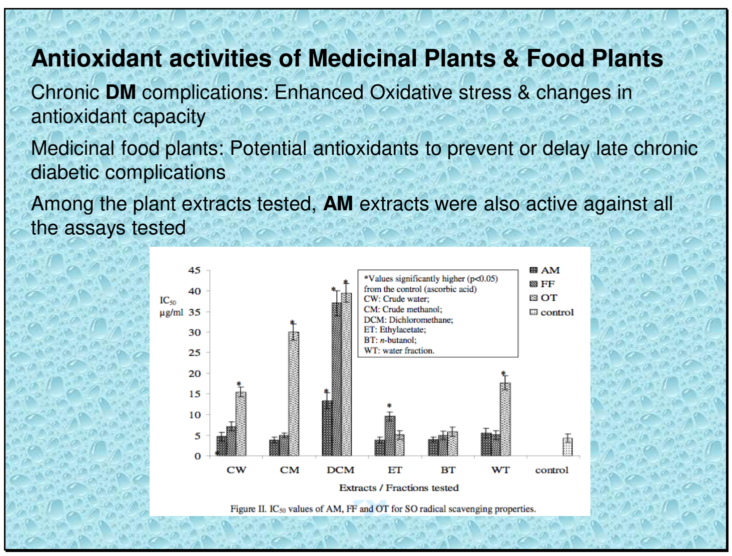


Figure 25. Antioxidant Activities of Medicinal Plants & Food Plants.

Yet with so much potential and diversity – why is Africa '*absent*' from the international scene?

However, is the absence of African Medicinal Plants on the market ONLY due lack of detailed study?

The answer lies elsewhere

The potential for the business and agricultural sectors is enormous but Africa will lag behind unless African countries prepare internationally recognised medicinal plant standards.

Figure 26.

Major lacunas

The Medicinal Plants Forum for Commonwealth Africa, Cape Town (2000), has shown that

Lack of suitable technical specifications and quality control standards for African Medicinal Plants and herbal medicines.

Lack of standards considered to be a major barrier to regional and international trade and an important reason why traditional medicine has not been widely integrated into the the African primary health care.

Lack of official recognition from governments generally have been the major handicap to what can be an important business for the continent.

Figure 27. Major Lacunas.

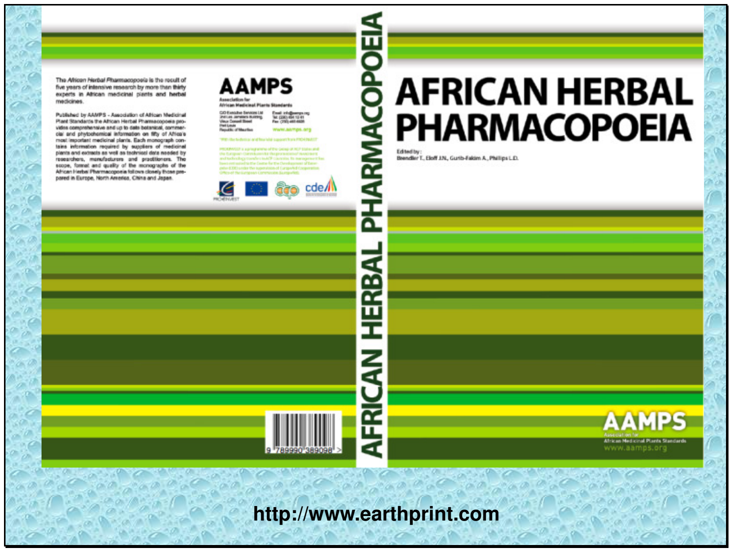


Figure 28. African Herbal Pharmacopoeia.

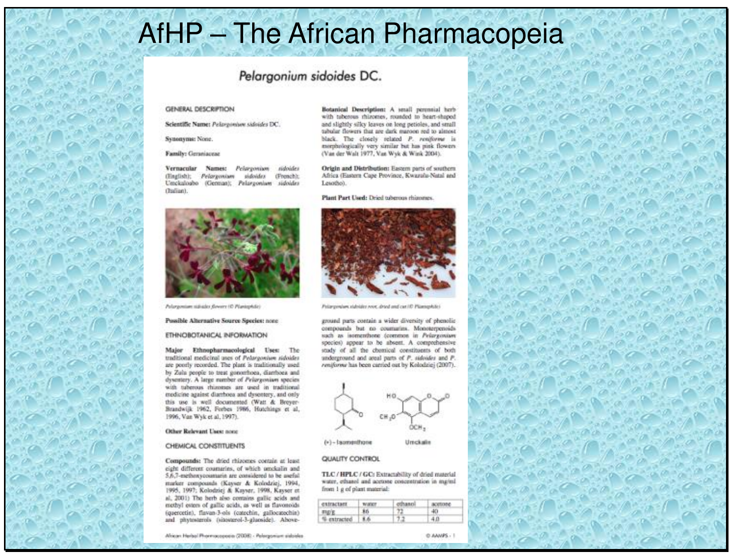
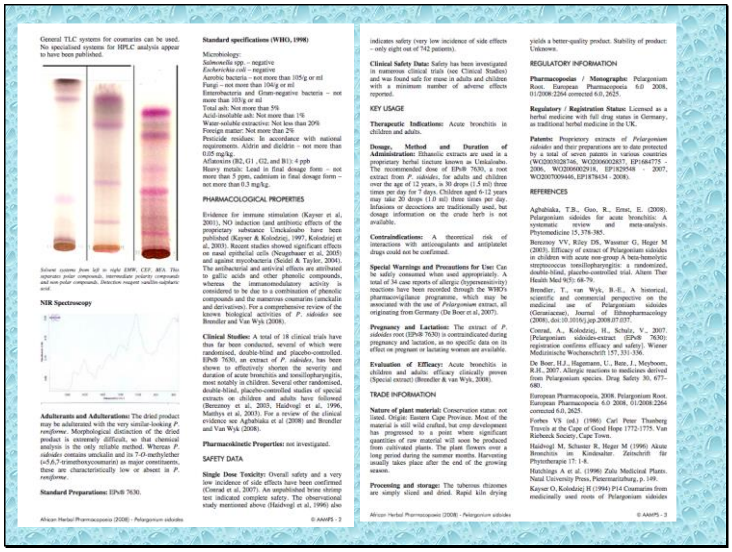


Figure 29. AfHP – African Pharmacopeia.



General TLC systems for coumarins can be used. No specialised systems for HPLC analysis appear to have been published.

Solvent systems from left to right EMW, CEF, BEA. This separates polar compounds, intermediate polarity compounds and non-polar compounds. Detection reagent vanillin-sulphuric acid.

NIR Spectroscopy

Adulterants and Adulterations: The dried product may be adulterated with the very similar-looking *P. reniforme*. Morphological distinction of the dried product is extremely difficult, so that chemical analysis is the only reliable method. Whereas *P. sidoides* contains umckalin and its 7-*O*-methylether (=5,6,7-trimethoxycoumarin) as major constituents, these are characteristically low or absent in *P. reniforme*.

Standard Preparations: EPs® 7630.

Standard specifications (WHO, 1998)

Microbiology:
Salmonella spp. – negative
Escherichia coli – negative
Aerobic bacteria – not more than 105/g or ml
Fungi – not more than 104/g or ml
Enterobacteria and Gram-negative bacteria – not more than 103/g or ml
Total ash: Not more than 5%
Acid-insoluble ash: Not more than 1%
Water-soluble extractive: Not less than 20%
Foreign matter: Not more than 2%
Pesticide residues: In accordance with national requirements. Aldrin and dieldrin – not more than 0.05 mg/kg.
Aflatoxins (B2, G1 , G2, and B1): 4 ppb
Heavy metals: Lead in final dosage form – not more than 5 ppm, cadmium in final dosage form – not more than 0.3 mg/kg.

PHARMACOLOGICAL PROPERTIES

Evidence for immune stimulation (Kayser et al, 2001), NO induction (and antibiotic effects of the proprietary substance Umckaloabo have been published (Kayser & Kolodziej, 1997, Kolodziej et al, 2003). Recent studies showed significant effects on nasal epithelial cells (Neugebauer et al, 2005) and against mycobacteria (Seidel & Taylor, 2004). The antibacterial and antiviral effects are attributed to gallic acids and other phenolic compounds, whereas the immunomodulatory activity is considered to be due to a combination of phenolic compounds and the numerous coumarins (umckalin and derivatives). For a comprehensive review of the known biological activities of *P. sidoides* see Brendler and Van Wyk (2008).

Clinical Studies: A total of 18 clinical trials have thus far been conducted, several of which were randomised, double-blind and placebo-controlled. EPs® 7630, an extract of *P. sidoides*, has been shown to effectively shorten the severity and duration of acute bronchitis and tonsillopharyngitis, most notably in children. Several other randomised, double-blind, placebo-controlled studies of special extracts on children and adults have followed (Bereznoy et al, 2003, Haidvogl et al, 1996, Matthys et al, 2003). For a review of the clinical evidence see Agbabiaka et al (2008) and Brendler and Van Wyk (2008).

Pharmacokinetic Properties: not investigated.

SAFETY DATA

Single Dose Toxicity: Overall safety and a very low incidence of side effects have been confirmed (Conrad et al, 2007). An unpublished brine shrimp test indicated complete safety. The observational study mentioned above (Haidvogl et al, 1996) also

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indicates safety (very low incidence of side effects – only eight out of 742 patients).

Clinical Safety Data: Safety has been investigated in numerous clinical trials (see Clinical Studies) and was found safe for muse in adults and children with a minimum number of adverse effects reported.

KEY USAGE

Therapeutic Indications: Acute bronchitis in children and adults.

Dosage, Method and Duration of Administration: Ethanolic extracts are used in a proprietary herbal tincture known as Umkaloabo. The recommended dose of EPs® 7630, a root extract from *P. sidoides*, for adults and children over the age of 12 years, is 30 drops (1.5 ml) three times per day for 7 days. Children aged 6-12 years may take 20 drops (1.0 ml) three times per day. Infusions or decoctions are traditionally used, but dosage information on the crude herb is not available.

Contraindications: A theoretical risk of interactions with anticoagulants and antiplatelet drugs could not be confirmed.

Special Warnings and Precautions for Use: Can be safely consumed when used appropriately. A total of 34 case reports of allergic (hypersensitivity) reactions have been recorded through the WHO's pharmacovigilance programme, which may be associated with the use of *Pelargonium* extract, all originating from Germany (De Boer et al, 2007).

Pregnancy and Lactation: The extract of *P. sidoides* root (EPs® 7630) is contraindicated during pregnancy and lactation, as no specific data on its effect on pregnant or lactating women are available.

Evaluation of Efficacy: Acute bronchitis in children and adults: efficacy clinically proven (Special extract) (Brendler & van Wyk, 2008).

TRADE INFORMATION

Nature of plant material: Conservation status: not listed. Origin: Eastern Cape Province. Most of the material is still wild crafted, but crop development has progressed to a point where significant quantities of raw material will soon be produced from cultivated plants. The plant flowers over a long period during the summer months. Harvesting usually takes place after the end of the growing season.

Processing and storage: The tuberous rhizomes are simply sliced and dried. Rapid kiln drying yields a better-quality product. Stability of product: Unknown.

REGULATORY INFORMATION

Pharmacopoeias / Monographs: Pelargonium Root. European Pharmacopoeia 6.0 2008, 01/2008:2264 corrected 6.0, 2625.

Regulatory / Registration Status: Licensed as a herbal medicine with full drug status in Germany, as traditional herbal medicine in the UK.

Patents: Proprietory extracts of *Pelargonium sidoides* and their preparations are to date protected by a total of seven patents in various countries (WO2003028746, WO2006002837, EP1684775 - 2006, WO2006002918, EP1829548 - 2007, WO2007009446, EP1878434 - 2008).

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Conrad, A., Kolodziej, H., Schulz, V., 2007. [Pelargonium sidoides-extract (EPs® 7630): registration confirms efficacy and safety]. Wiener Medizinische Wochenschrift 157, 331-336.

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Forbes VS (ed.) (1986) Carl Peter Thunberg Travels at the Cape of Good Hope 1772-1775. Van Riebeeck Society, Cape Town.

Haidvogl M, Schuster R, Heger M (1996) Akute Bronchitis im Kindesalter. Zeitschrift für Phytotherapie 17: 1-8.

Hutchings A et al. (1996) Zulu Medicinal Plants. Natal University Press, Pietermaritzburg, p. 149.

Kayser O, Kolodziej H (1994) P14 Coumarins from medicinally used roots of Pelargonium sidoides

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Figure 30.

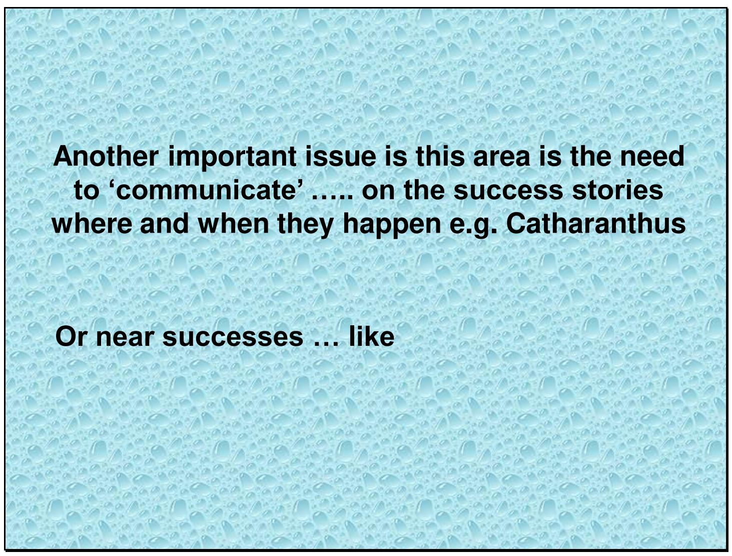

Figure 31.

Figure 32. Near Successes from Africa – Hoodia.

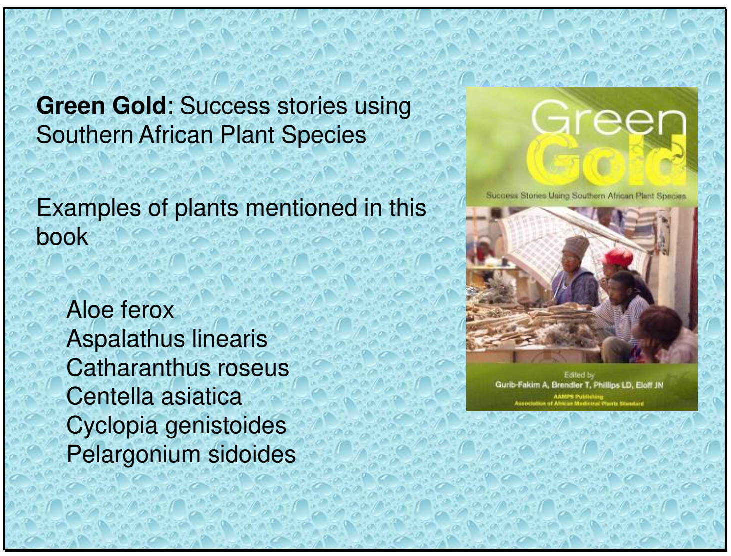

Figure 33. Green Gold.

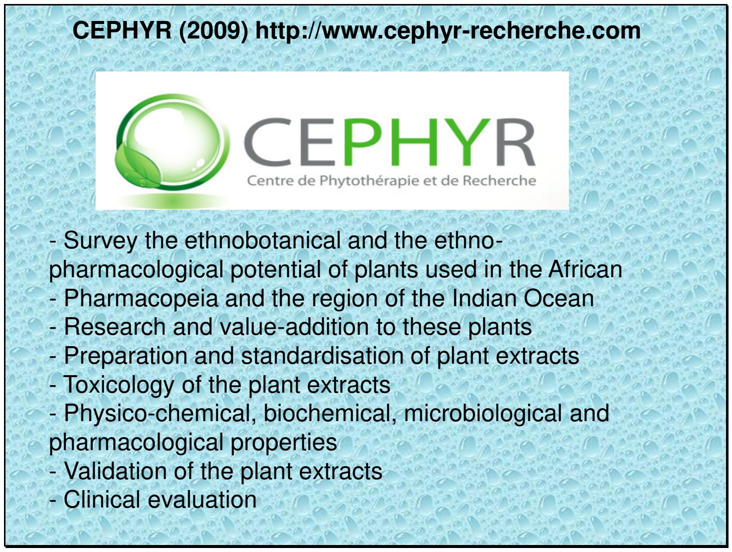

Figure 34. CEPHYR.

Figure 35.

Nano innovation: Innovation in Nanotechnology
Where is it taking us?

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Department of Physics
University of Illinois at Urbana-Champaign
Urbana, USA.

ABSTRACT

Nanotechnology, coined the technology of this century and the meeting ground of all fields, attracted billions of funding dollars, and thousands of scientists and engineers. It is exciting, novel, and ventures into areas of S&T beyond nature where we never been. It is simply synonymous with innovation and captures the imagination of all, and affords us to dream to solve the problems facing the human race, such as acute disease, energy, lighting and food crunch. Its importance is highlighted by the billions spent and by market size projection of $1Trillion in 10 years. Western countries established national initiatives, and Asian countries followed suit and Saudi Arabia entered the race.

It works at the limit of size, on a scale no bigger than 100 nanometers (billionths of a meter). The basic principle is that due to miniaturization, surface phenomena become the dominant factor. Often materials acquire much improved or even novel properties not found in bulk. Nanostructured materials have improved mechanical, electrical, optical, and chemical properties, and are lighter, stronger and cheaper. Prospective applications include energy storage, production & conversion; agricultural productivity & food management; water treatment & remediation; health monitoring & disease diagnosis & drug-delivery; air-pollution; skin care and advanced paints; defense, and communication

In this talk, I will present the basic premises and innovative nature of the technology, drawing examples from my own research and commercialization activities at the University of Illinois. I will then briefly turn to the Muslim World and touch on the state of the technology, how to create a nano culture, and how to enable innovative applications that could slow down the "nano-divide". I will end with raising the issue of potential effects on the environment and health as well as the need for a code of ethics.

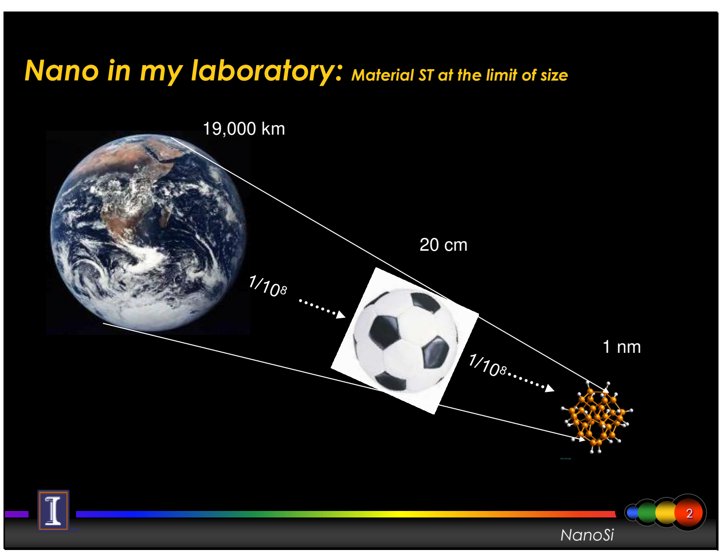


Figure 1. Nano in my Laboratory: Material ST at the limit of size.

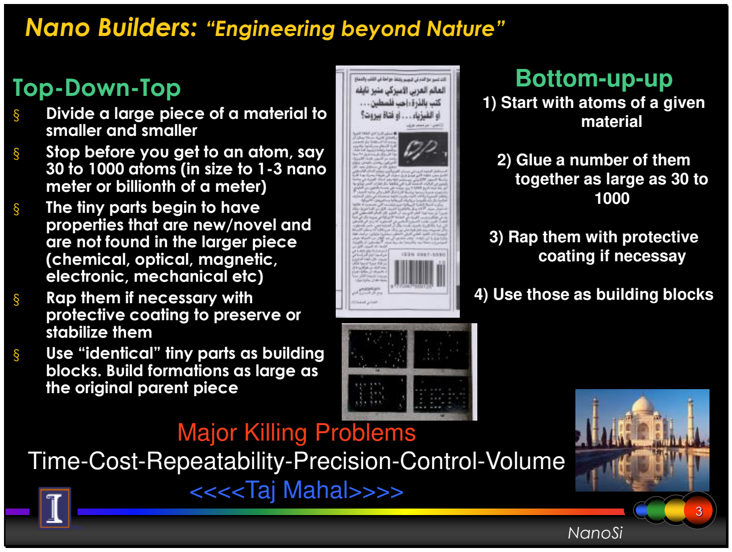


Figure 2. Nano Builders: "Engineering Beyond Nature."

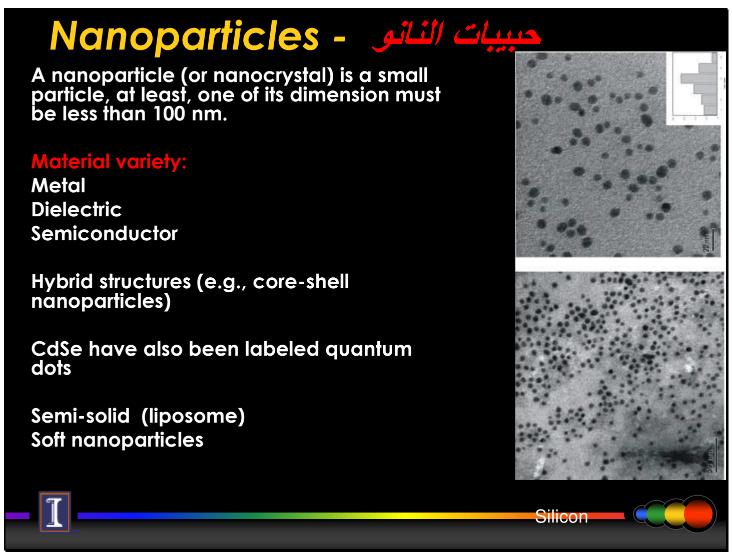


Figure 3. Nanop Articles.

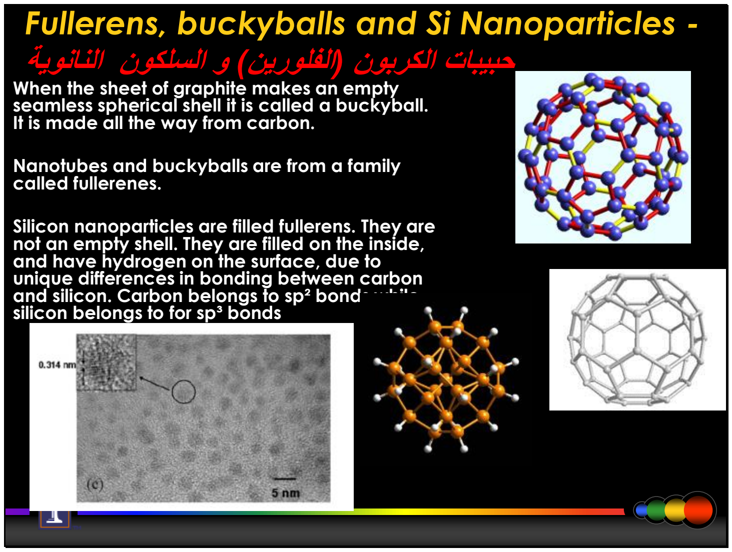


Figure 4. Fullerens, Buckyballs and Si Nanoparticles.

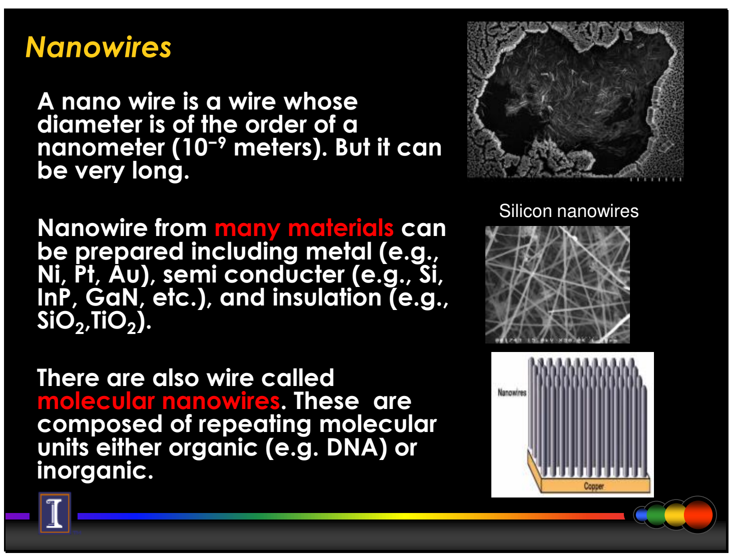


Figure 5. Nanowires.

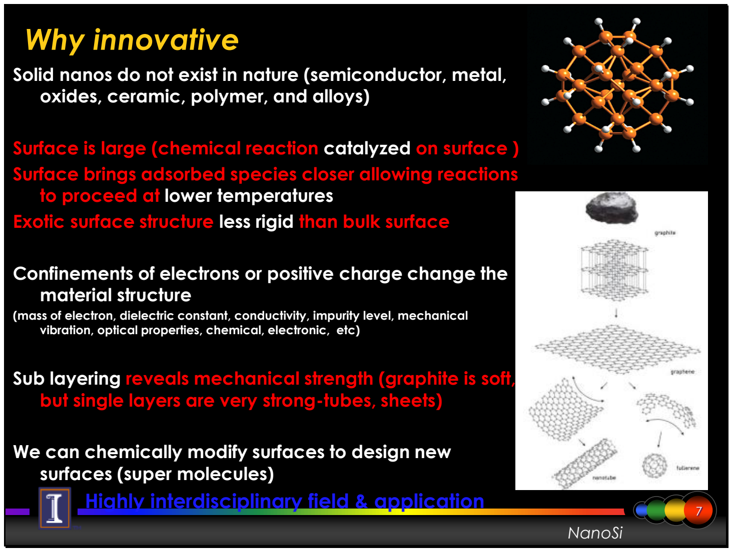


Figure 6. Why Innovative.

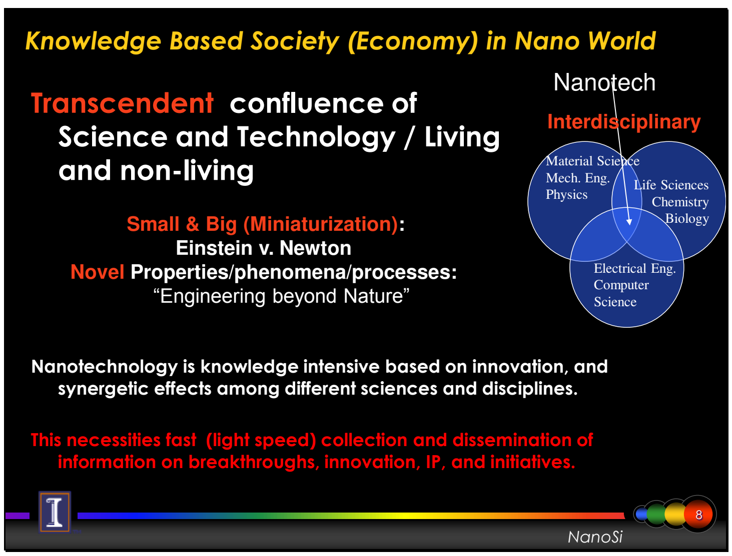


Figure 7. Knowledge Based Society (Economy) in Nano World.

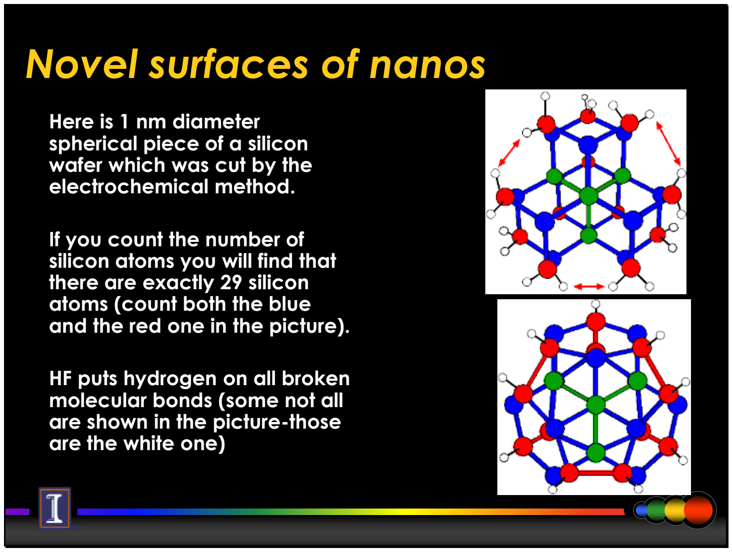


Figure 8. Novel Surfaces of Nanos.

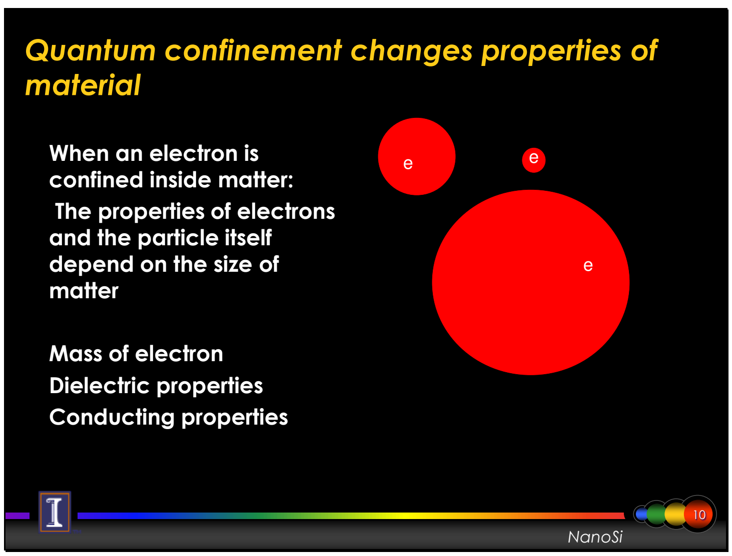


Figure 9. Quantum Confinement Changes Properties of Material.

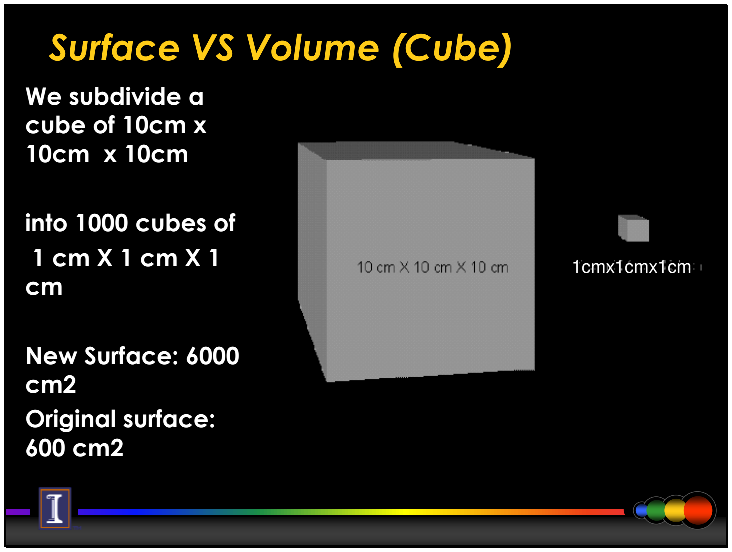


Figure 10. Surface VS Volume (Cube).

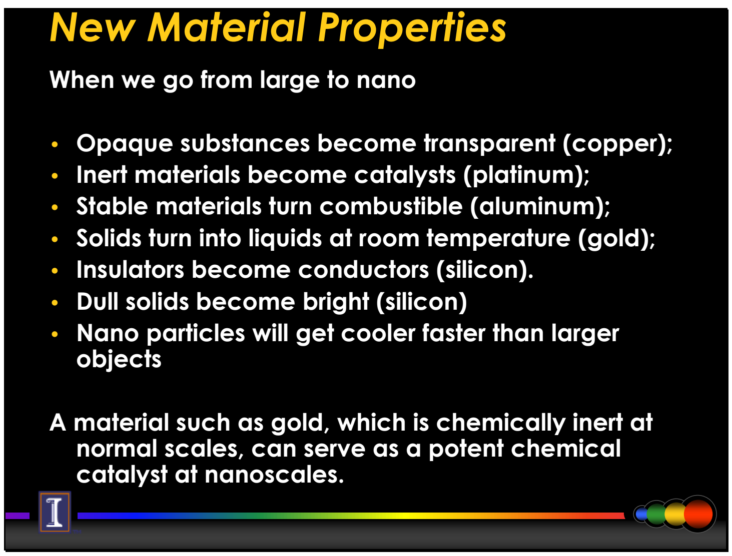


Figure 11. New Material Properties.

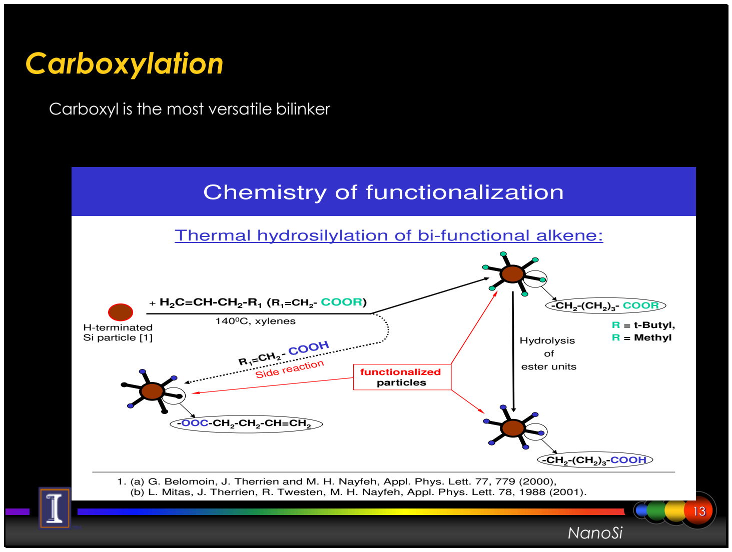


Figure 12. Carboxylation.

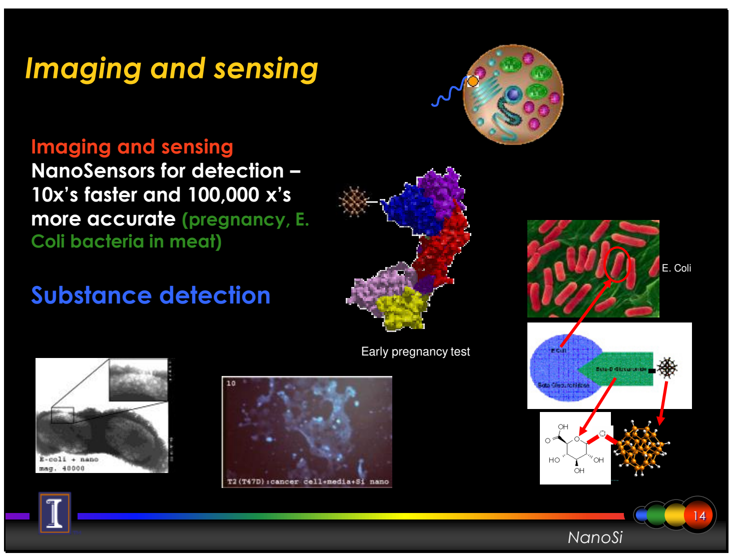


Figure 13. Imaging and Sensing.

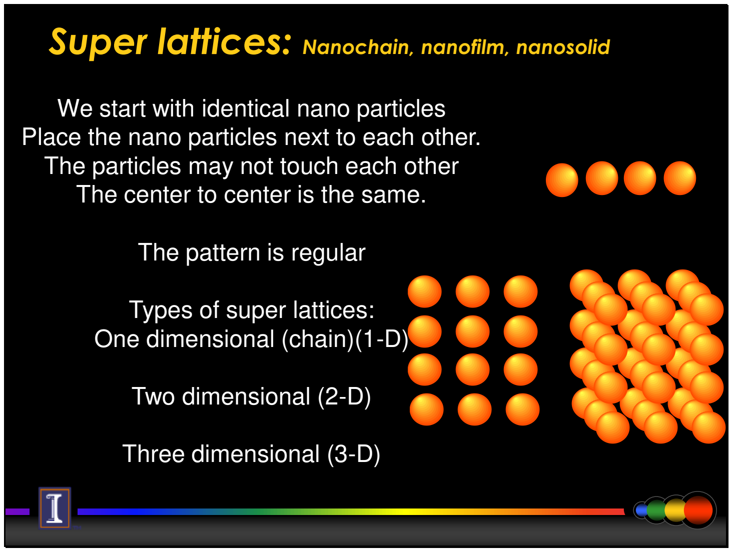


Figure 14. Super Lattices: Nanochain, Nanofilm, Nanosolid.

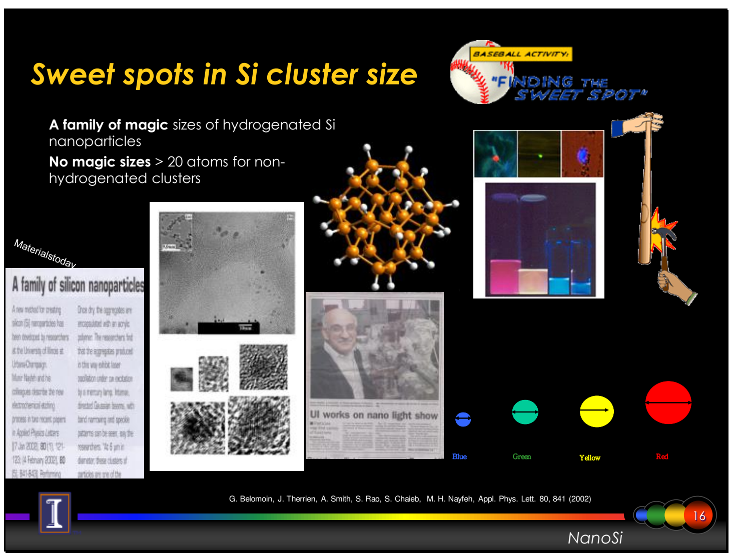


Figure 15. Sweet Spots in Si Cluster Size.

Figure 16. Nano Si Let there be Light.

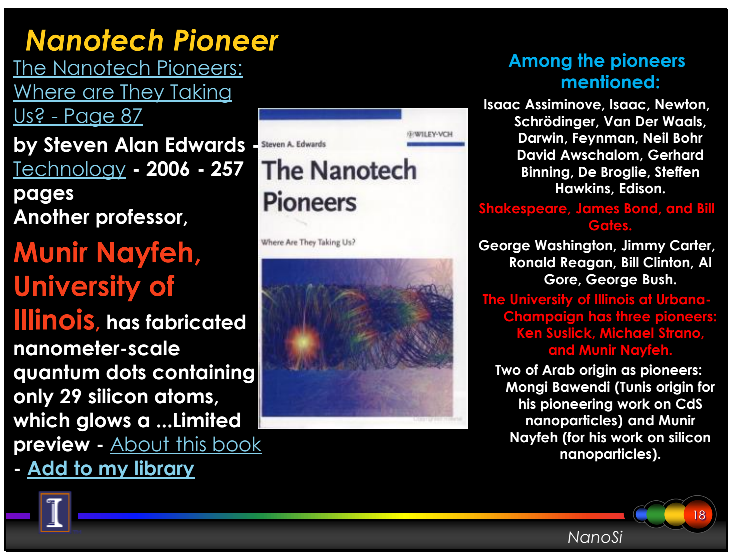


Figure 17. Nanotech Pioneer.

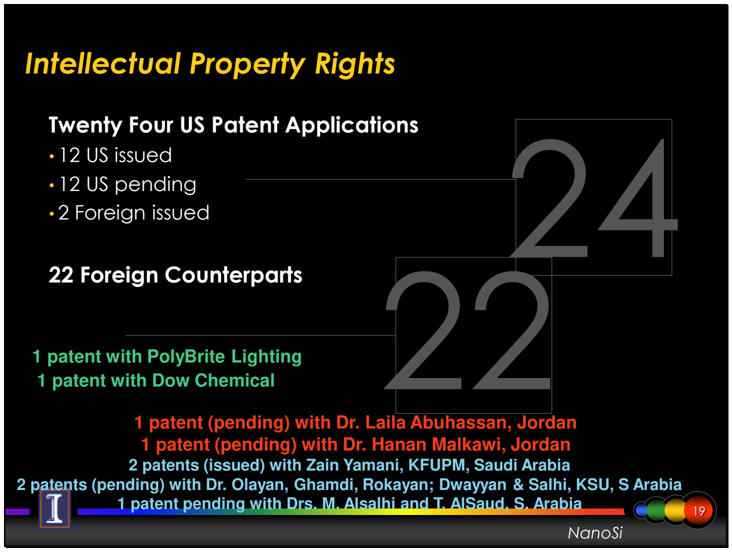


Figure 18. Intellectual Property Rights.

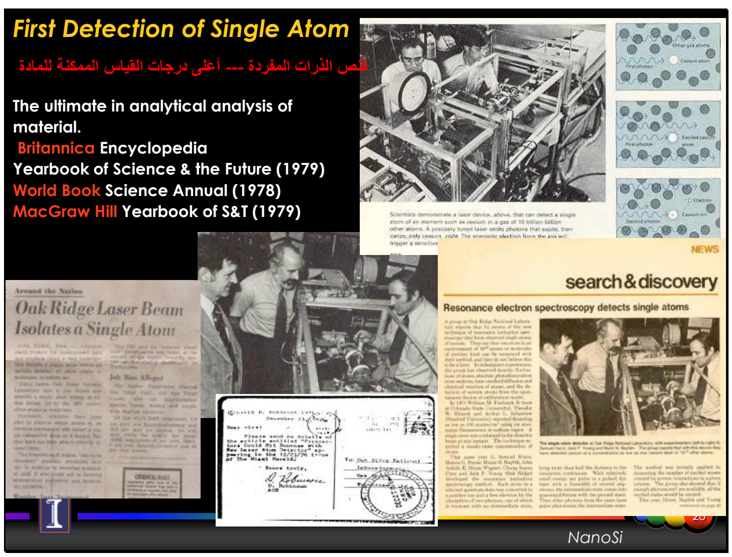


Figure 19. First Detection of Single Atom.

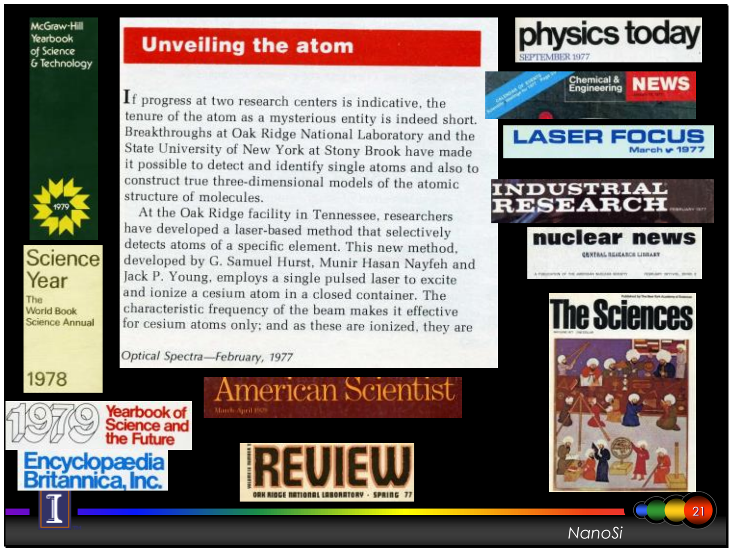


Figure 20. Unveiling the Atom.

Figure 21. Nanotechnology Rules: Moving and Organizing Atoms – The Smallest Writing in the World Writing with Atoms – March 1992.

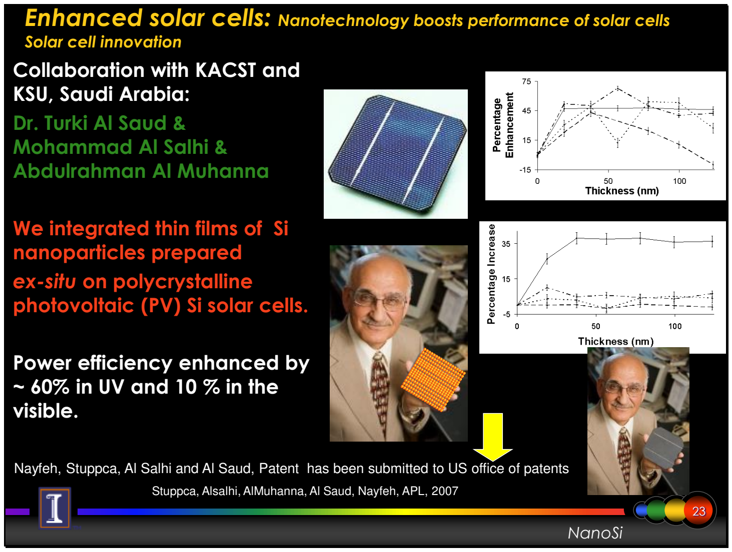


Figure 22. Enhanced Solar Cell: Nanotechnology Boosts Performance of Solar Cells.

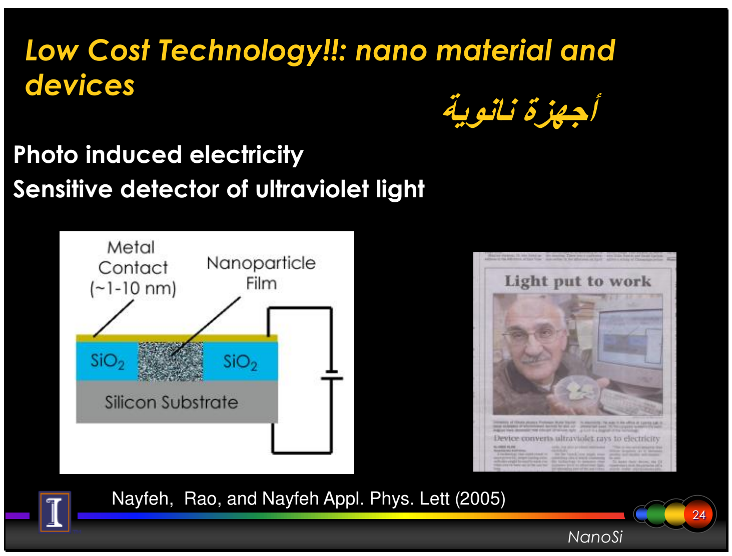


Figure 23. Low Cost Technology!!: Nano material and Devices.

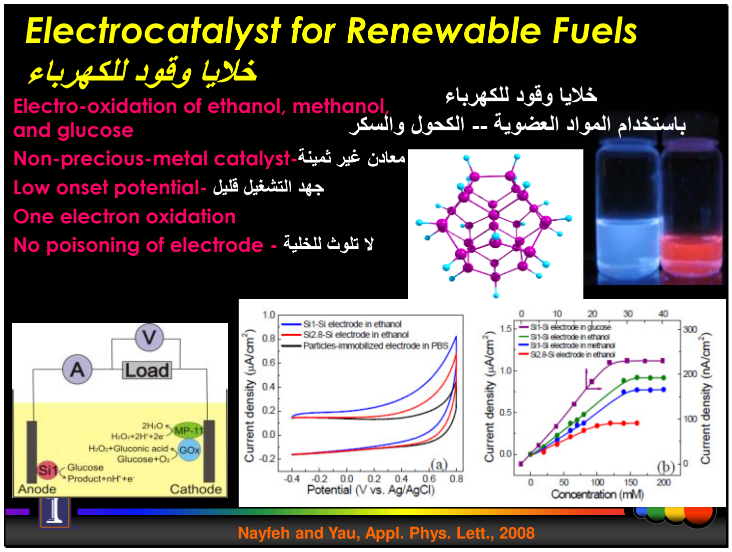


Figure 24. Electrocatalyst for Renewable Fuels.

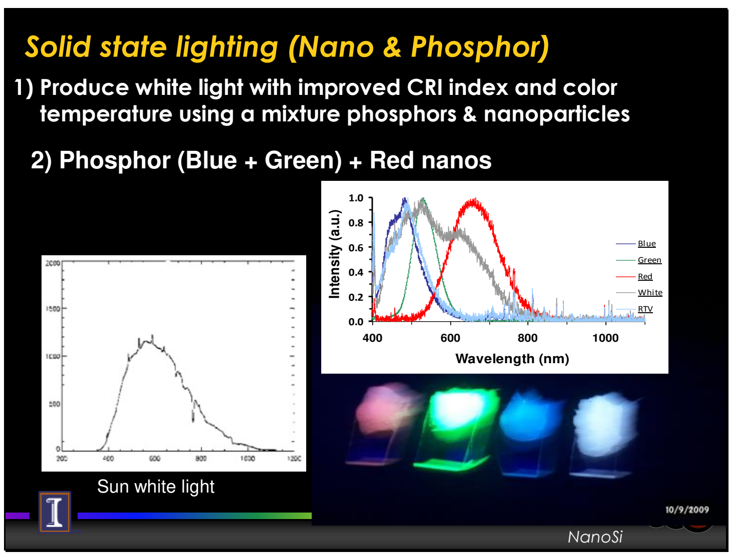


Figure 25. Solid State Lighting (Nano & Phosphor).

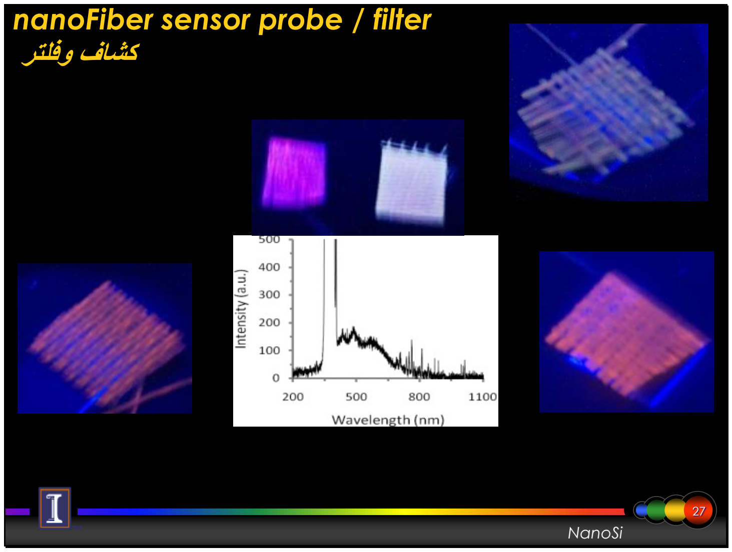


Figure 26. Nano Fiber Sensor Probe/ Fitter.

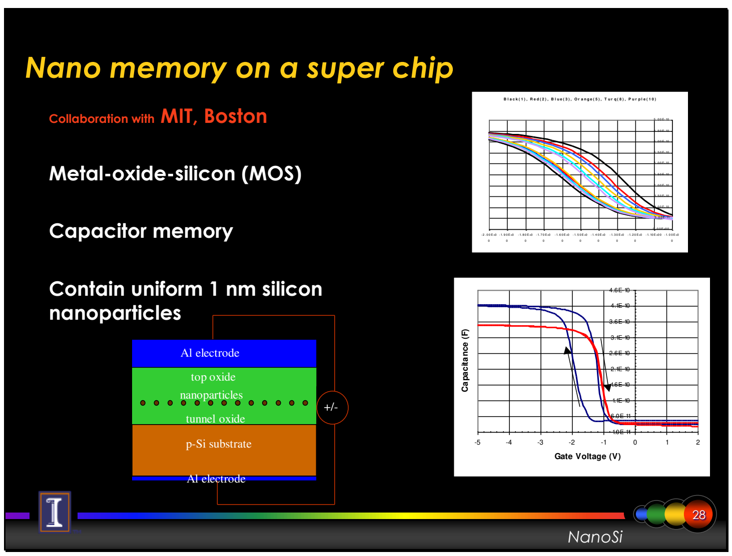


Figure 27. Nano Memory on a super Chip.

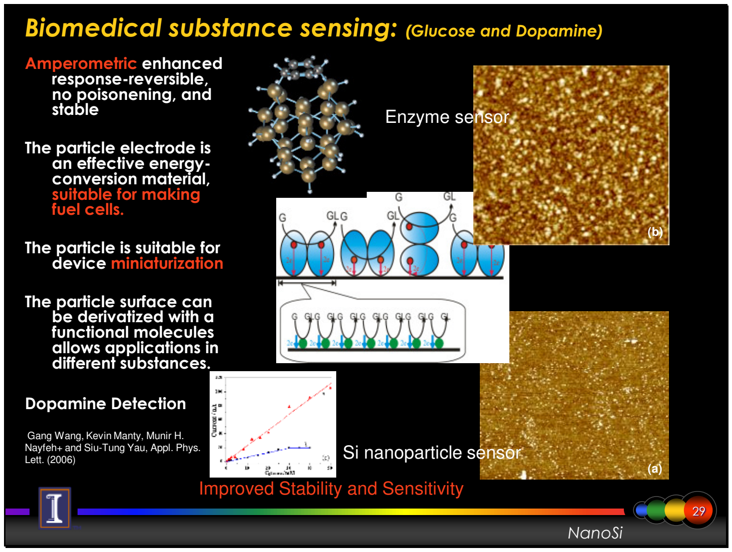


Figure 28. Biomedical Substance Sensing: (Glucose and Dopamine).

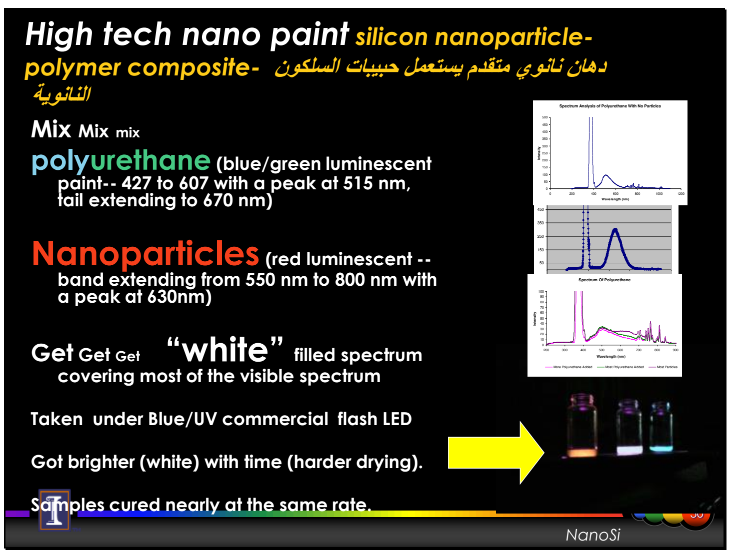


Figure 29. High Tech Nano Point – Silicon Nanoparticle.

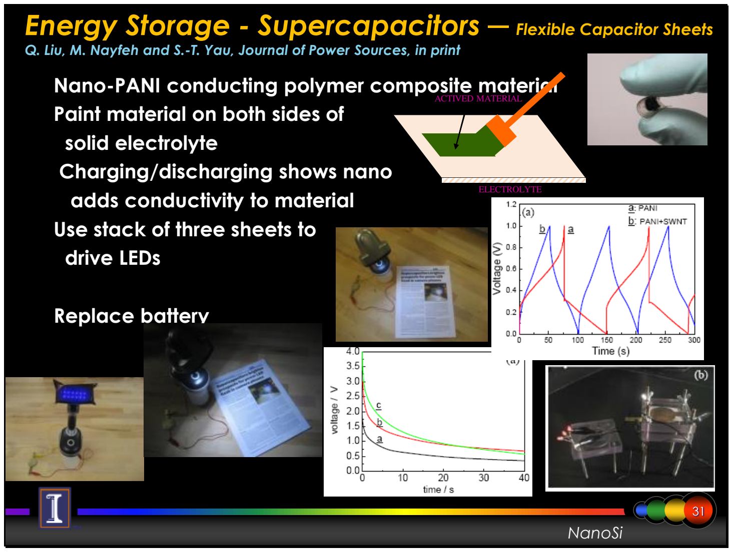


Figure 30. Energy Storage – Supercapacitors – Flexible Capacitor Sheets.

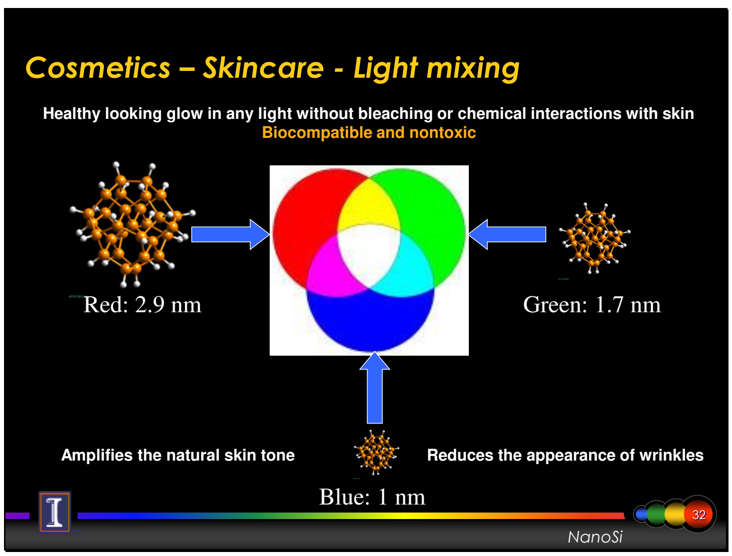


Figure 31. Cosmetics – Skincare – Light Mixing.

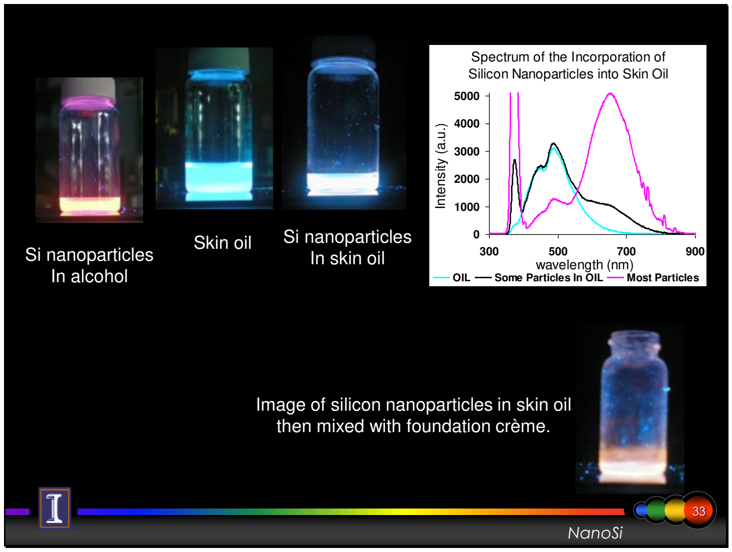


Figure 32.

Figure 33. Nanotechnology For You.

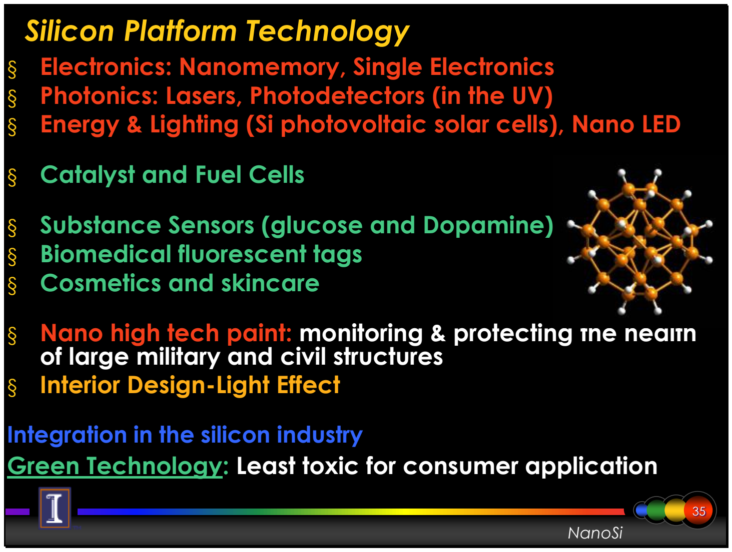


Figure 34. Silicon Platform Technology.

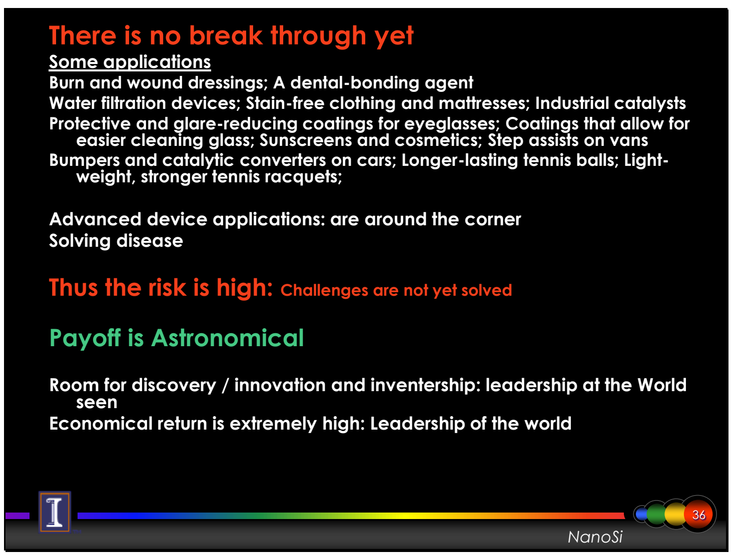


Figure 35. There is no Break through yet.

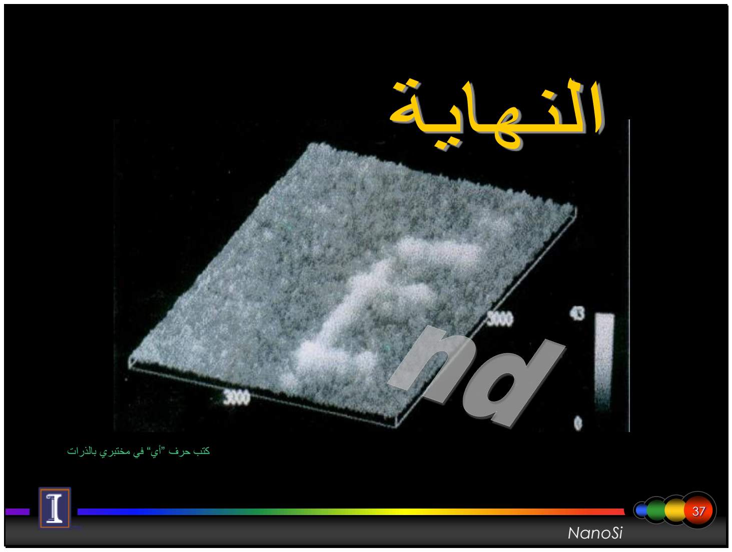


Figure 36.

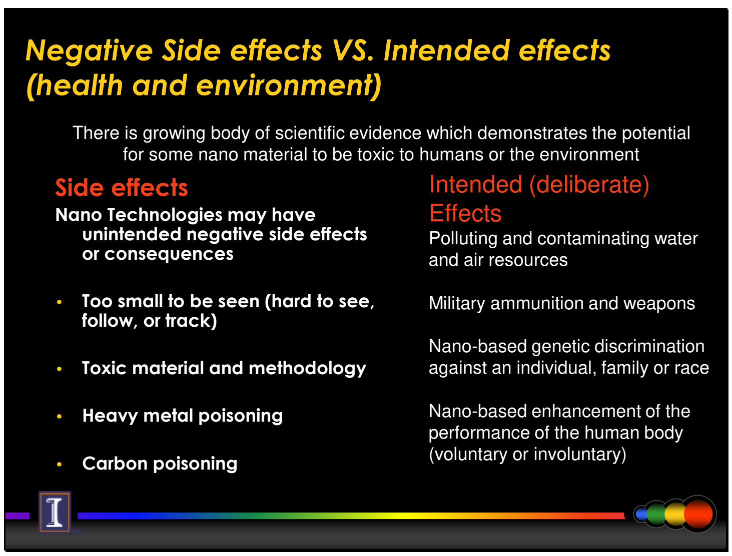


Figure 37. Negative Side Effects VS. Intended Effects (Health and Environment).

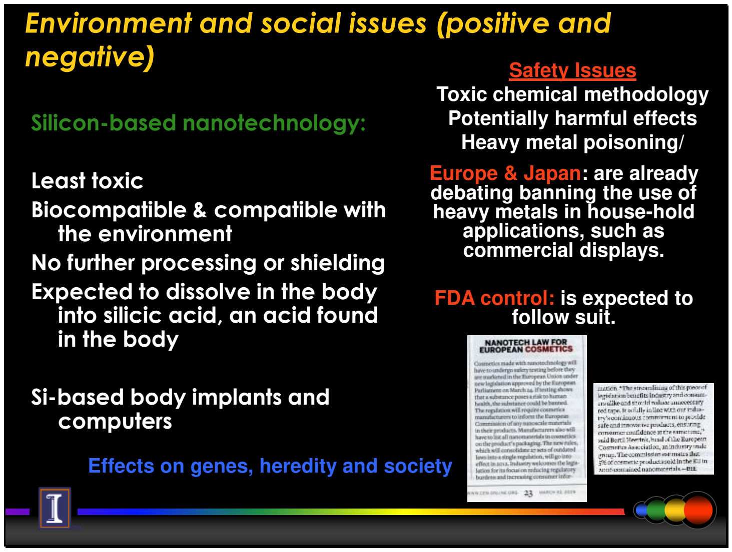


Figure 38. Environment and Social Issues (Positive and Negative).

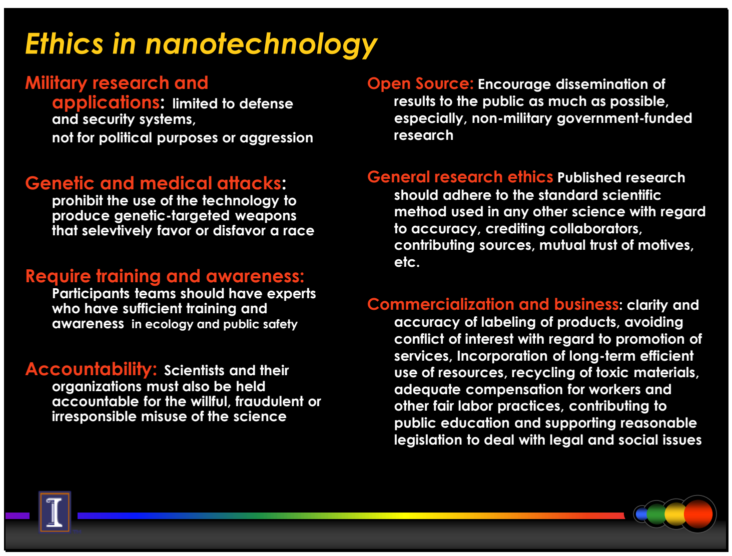


Figure 39. Ethics in Nanotechnology.

Women in Life Sciences at the University of Manchester

ALISON GURNEY
Professor of Pharmacology
Faculty of Life Sciences
University of Manchester

ABSTRACT

A Life Science subjects are studied as much by women as men and, on average, women achieve higher grades. Among our postgraduate research student population almost 60% are female, but many more of the men are appointed to academic positions. The gap between men and women widens with increasing seniority, such that only 26% of our lecturers and 7% of professors are female. The reasons for this are complex, but it means the possible loss of some of our best scientists and this has implications for the success of the university as well as wider scientific progress. As the university wishes to employ the best scientists available, it has been working to identify and address the barriers that women face in following an academic career in the life sciences. In this presentation I will discuss some of these barriers, how we went about identifying them, what we are doing now to address them and our action plan for the future.

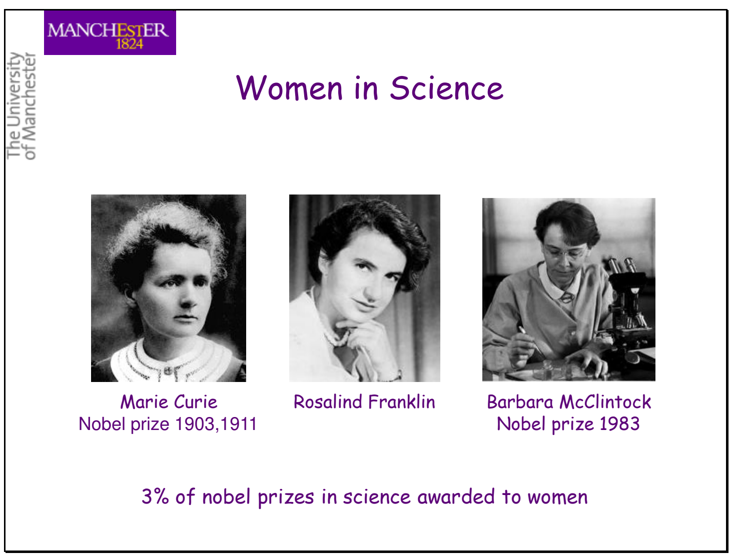


Figure 1. Women in Science.

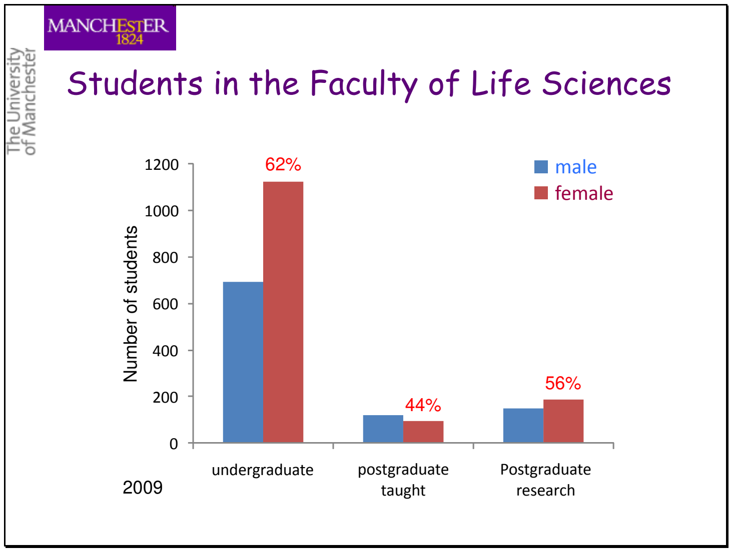


Figure 2. Students in the Faculty of Life Sciences.

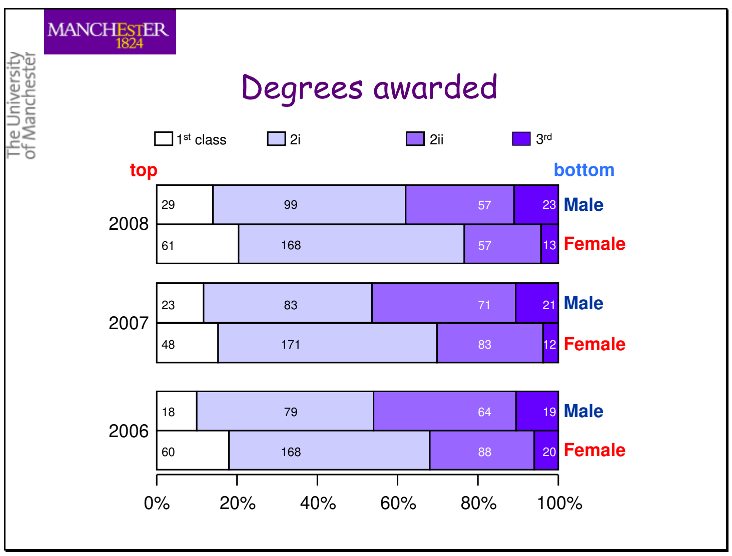


Figure 3. Degrees Awarded.

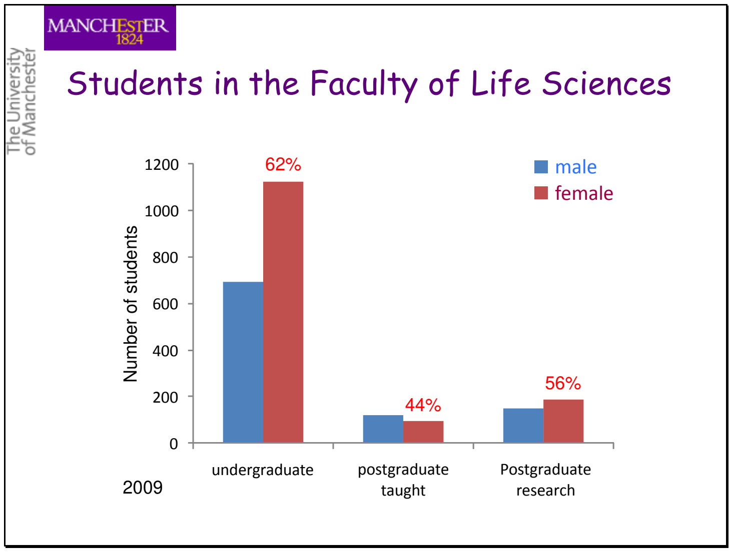


Figure 4. Students in the Faculty of Life Sciences.

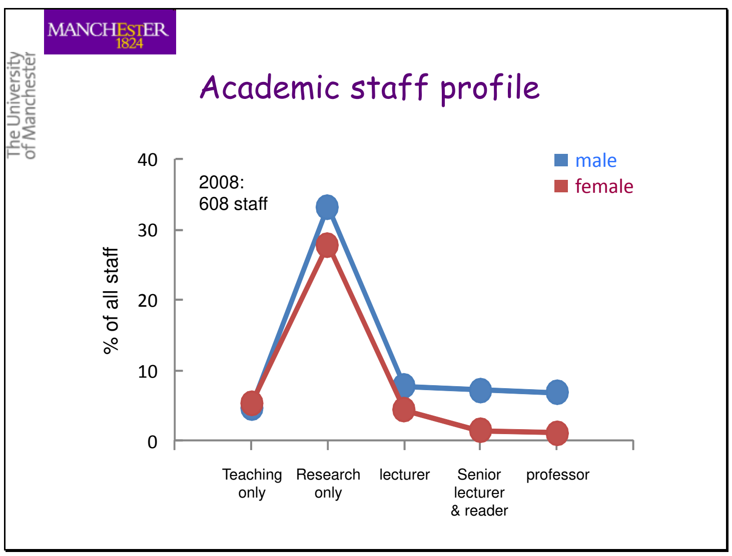


Figure 5. Academic Staff Profile.

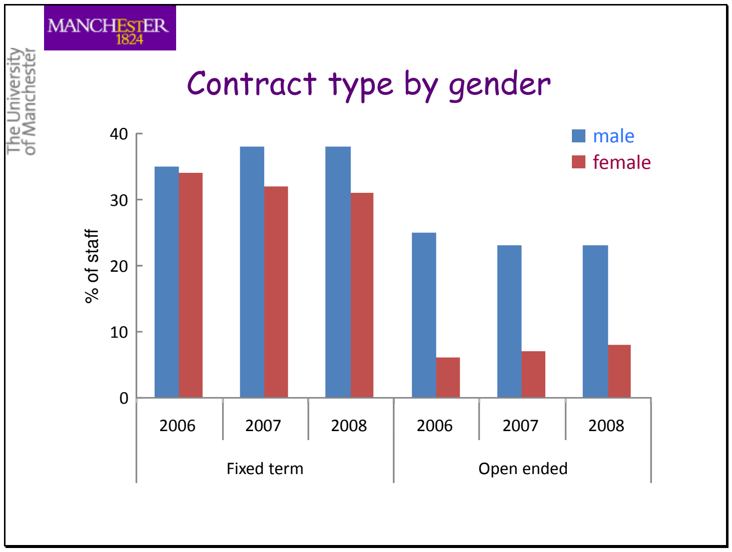


Figure 6. Contract Type by Gender.

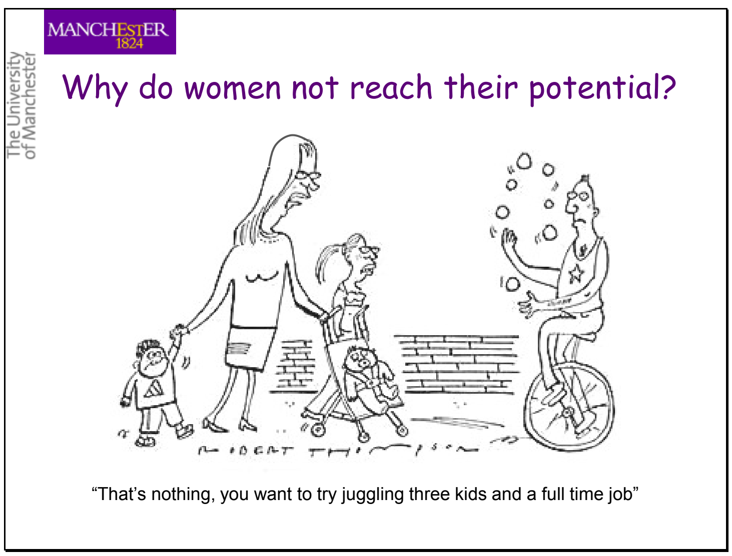


Figure 7. Why do Women not Reach their Potential?

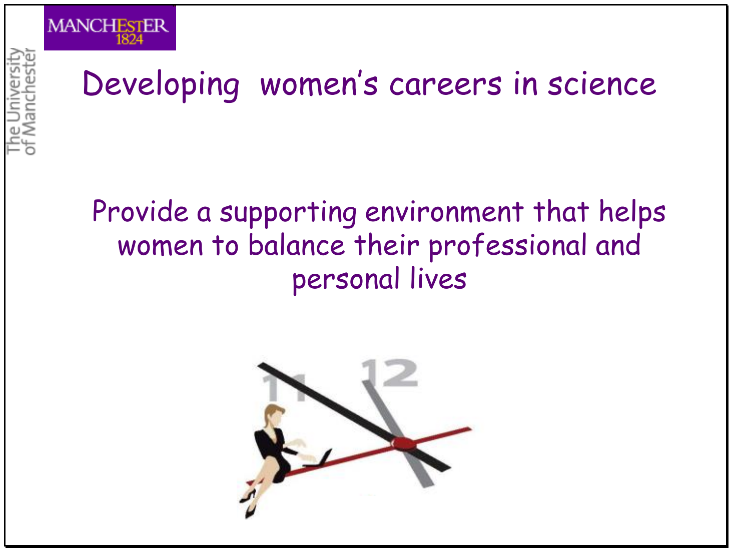


Figure 8. Developing Women's Careers in Science.

Figure 9. Women in Leadership Project, 2004-6.

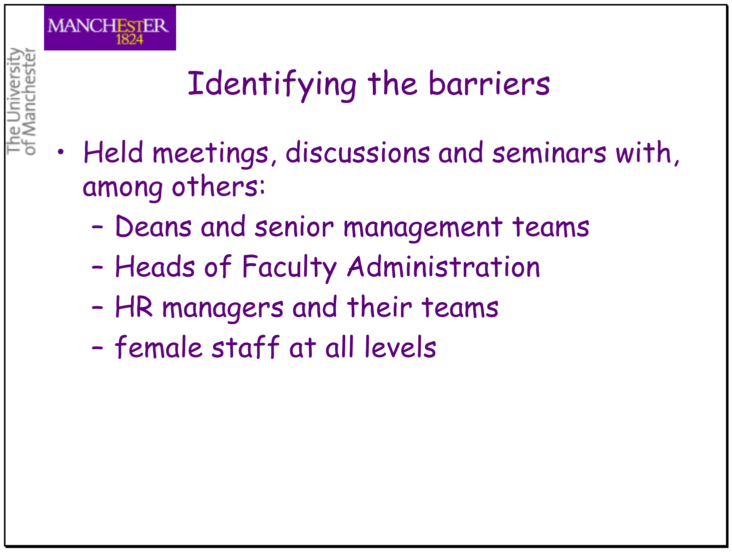


Figure 10. Identifying the Barriers.

Figure 11. Issues Identified.

MANCHESTER 1824

The University of Manchester

General measures to address barriers

- Local child care facilities
- Encourage flexible working
- Assign teaching to avoid beginning/end of day
- Timing of committee meetings etc.
- Allow part-time working for a period
- Job share to cover teaching commitments
- Bespoke mentoring
  - role models very important
  - multiple mentors

Figure 12. General Measures to Address Barriers.

MANCHESTER 1824

The University of Manchester

Helping new staff

- Reduced teaching and administrative loads for first 6 months after maternity break
  - Re-establish research programme
- Enhance technical support
  - during maternity leave to maintain momentum
  - For year after maternity leave to improve research output
- Allow extra probationary period if required.

Figure 13. Helping New Staff.

Figure 14. Changing the Culture.

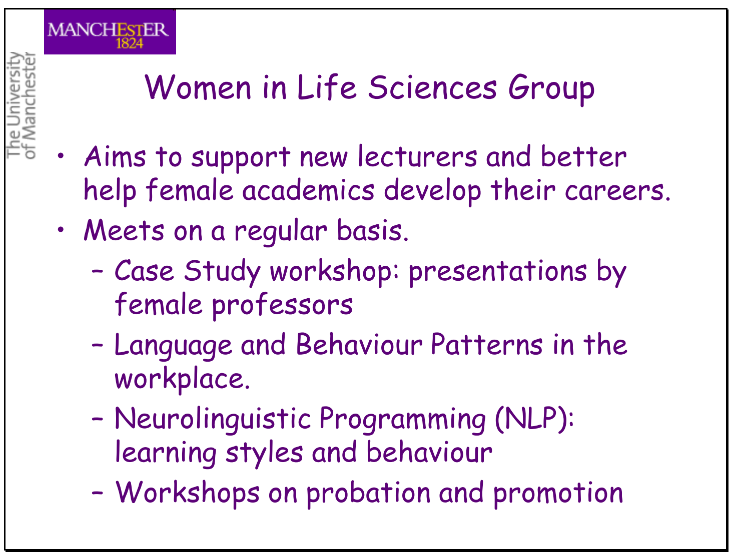


Figure 15. Women in Life Sciences Group.

Figure 16. WiLS Website.

Figure 17. Resources on the Intranet.

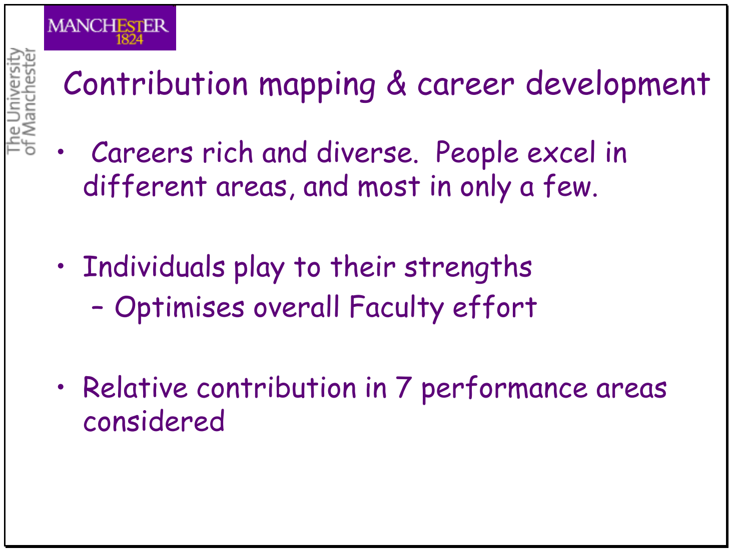


Figure 18. Contribution Mapping & Career Development.

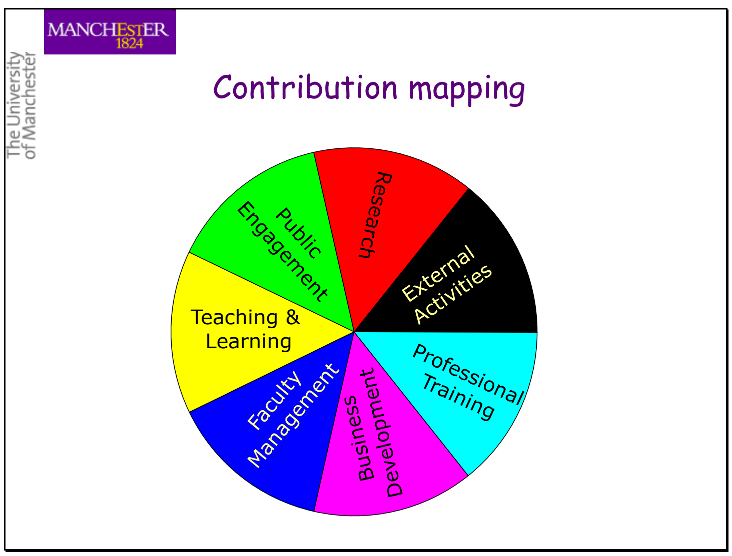


Figure 19. Contribution Mapping.

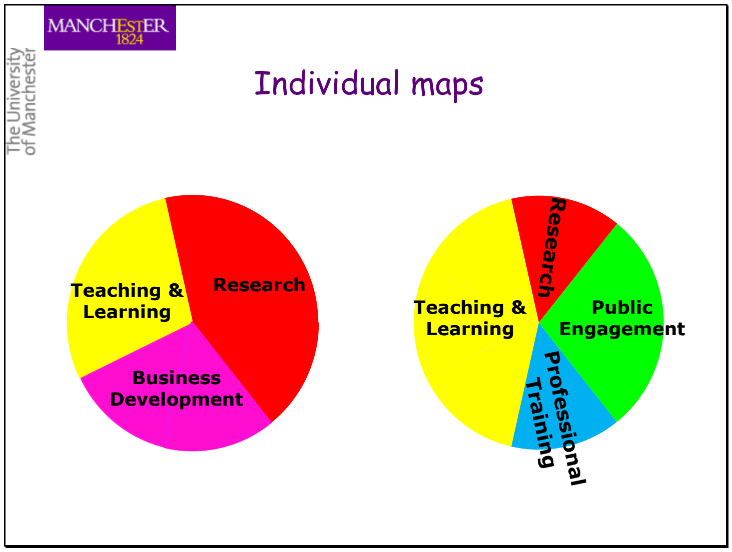


Figure 20. Individual Maps.

Figure 21. Athena SWAN Charter.

Figure 22. SWAN Awards.

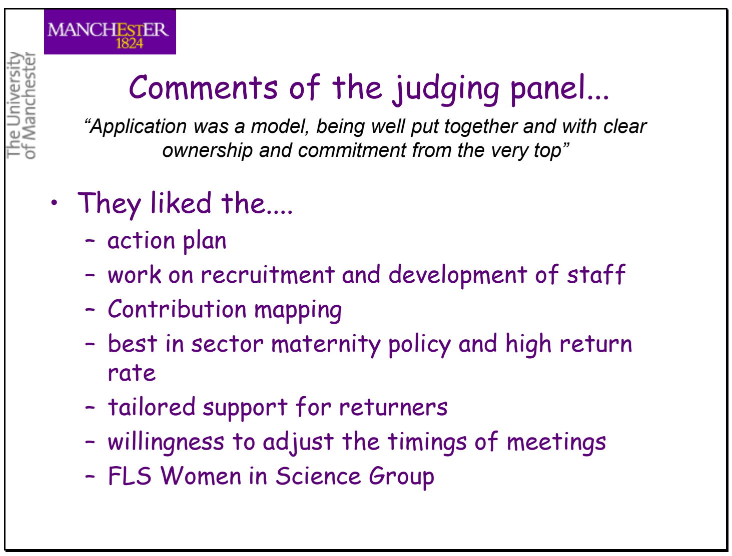


Figure 23. Comments of the Judging Panel.

Figure 24. Silber SWAN Award.

Figure 25.

Developing Genuinely Innovative People

JIM PLATTS
Manufacturing Engineering Group
University of Cambridge

ABSTRACT

How does one trigger, encourage, support and develop creative "knowledge economy" companies? Drawing on Cambridge's experience, this paper will be emphasizing the human, "friendly family" dimensions of fruitful networks and the importance of having all the relevant technical, managerial, legal and financial dimensions working together and being collectively creative, in the network. For Cambridge, the world has been a small place for a long time, and nowhere is far away. So many places, seemingly distant, are in fact already part of the Cambridge network and provide avenues into it for others, and Selangor is one such example.

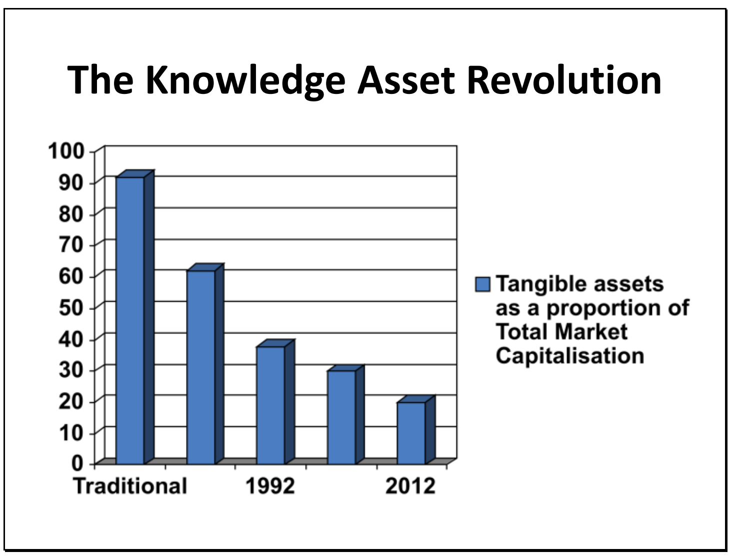


Figure 1. The Knowledge Asset Revolution.

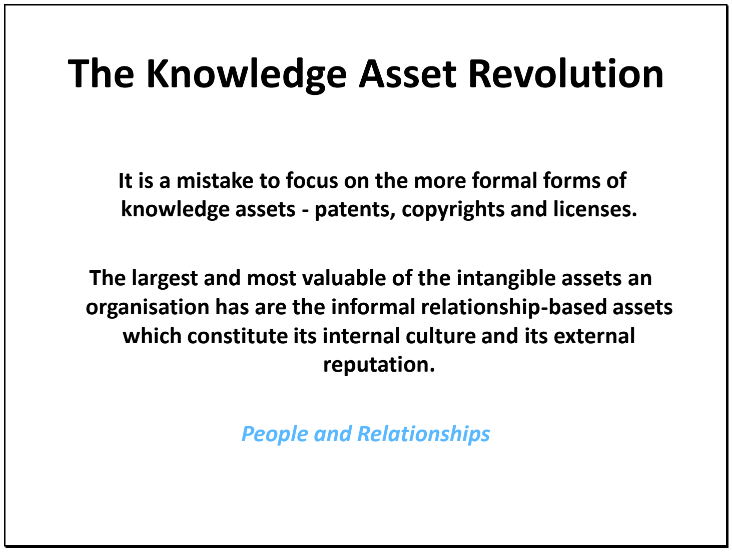


Figure 2. The Knowledge Asset Revolution.

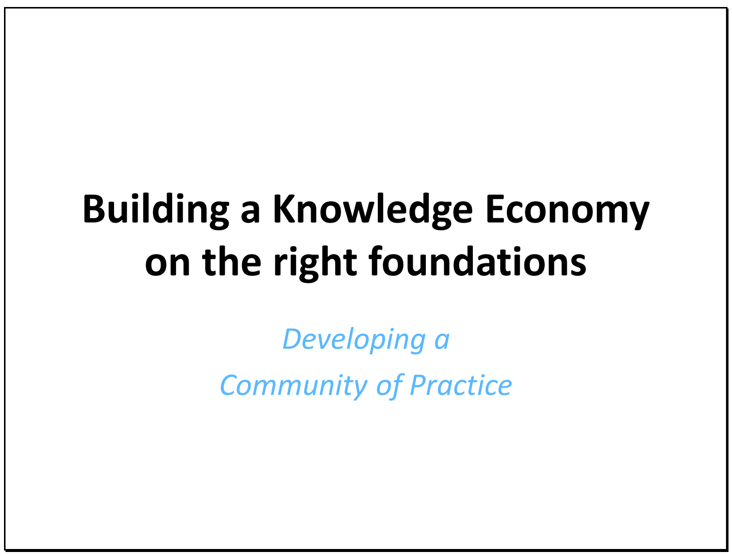


Figure 3. Building a Knowledge Economy on the Right Foundation.

Figure 4. Unlike Most Universities.

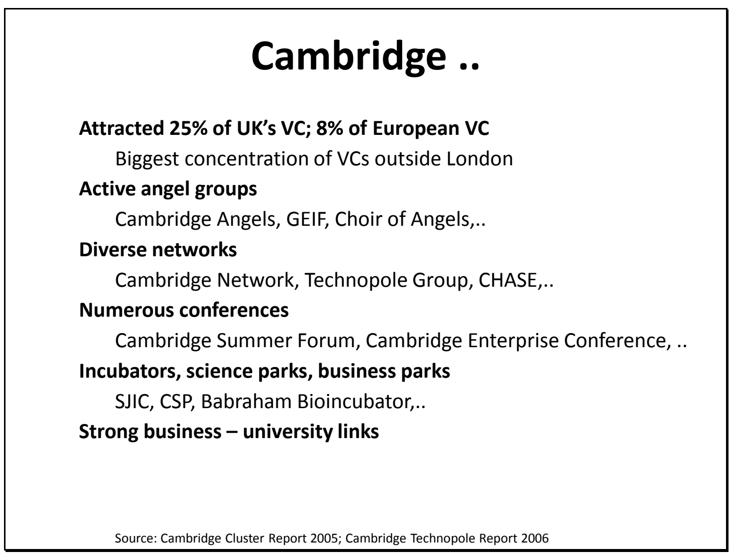


Figure 5. Cambridge.

How it happened (1)

1209: Formation of University of Cambridge
1534: Cambridge University Press established
1881: Horace Darwin establishes 'Cambridge Instruments'
1960: Cambridge Consultants established
1970: Trinity College establishes Cambridge Science Park
1970s: Acorn Computers & Sinclair established in Cambridge
1978: Barclays Bank begins supporting new technology firms
1985: 'Cambridge Phenomenon' report published by SQW
1987: St. John's Innovation Centre established

Figure 6. How it Happened (1).

How it happened (2)

1997: Ionica plc first Cambridge firm with US$bn valuation
1997: Eastern Region Biotechnology Initiative established
1998: Cambridge Network formed
1999: University of Cambridge pushes entrepreneurship
1999: East of England Development Agency established
1999: ARM, Autonomy *et al.* reach multiple billion US$ valuations
2000: Cambridge 'excellent for support of startups' - EC
2000: Dotcom bubble bursts
2002: Cambridge continues to grow – slower but stronger (?)
2004: CSR floats on LSE; Artimi raised $14m; biotech strengthe
2005: Cambridge receives 8% of all European VC money
2006: Biggest European VC investment goes to Plastic Logic

Figure 7. How it Happened (2).

Figure 8. Acorn.

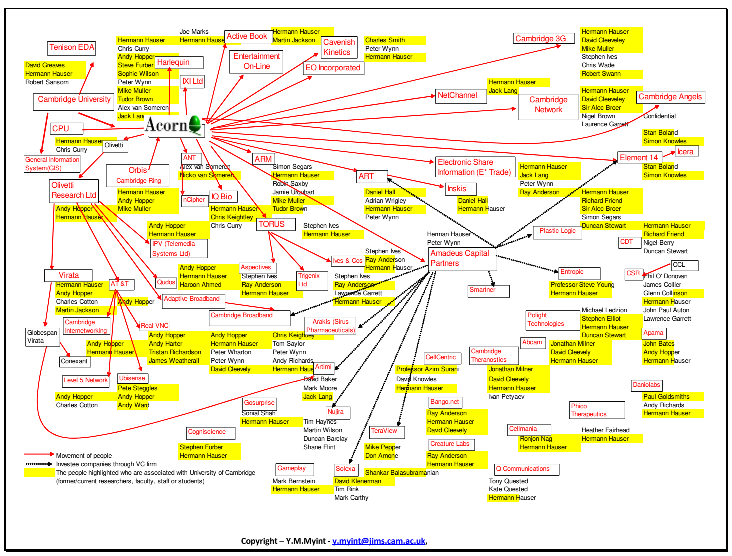


Figure 9.

That was outside the University

Meanwhile, INSIDE the University…

Figure 10. That Was Outside the University.

Figure 11. MET Major Project.

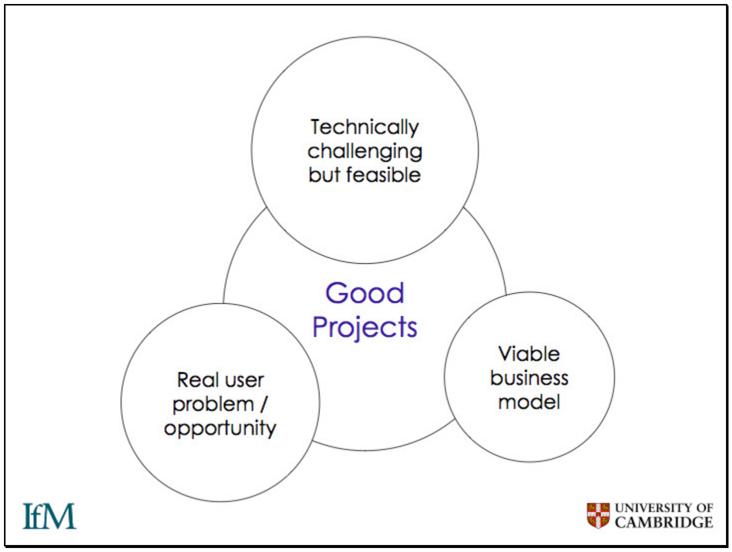


Figure 12.

Figure 13.

Figure 14. Managing Your Team.

Figure 15.

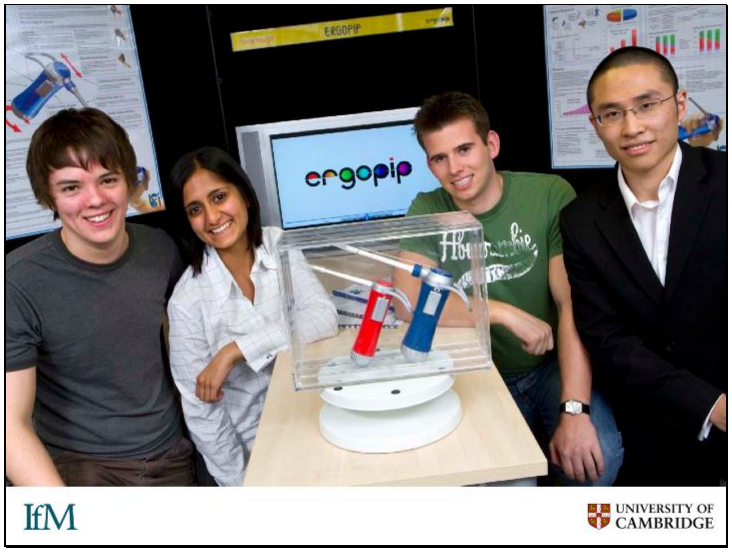


Figure 16.

Figure 17.

Figure 18.

Figure 19.

Figure 20.

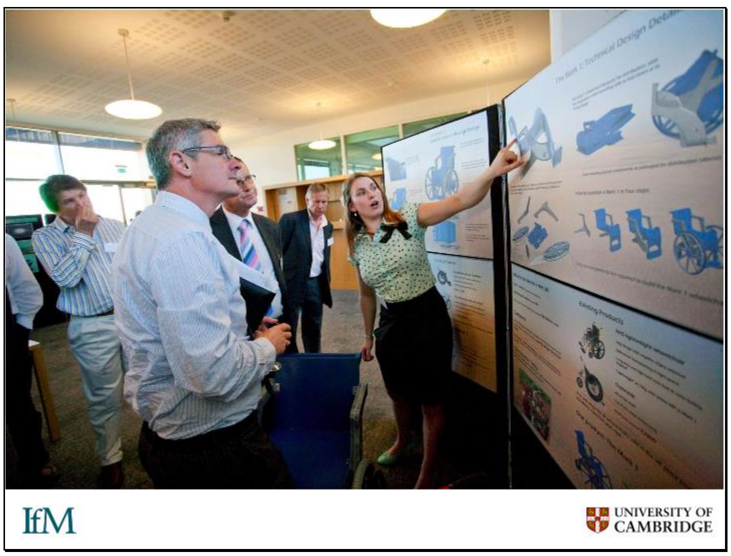


Figure 21.

Meanwhile in Malaysia…

Figure 22.

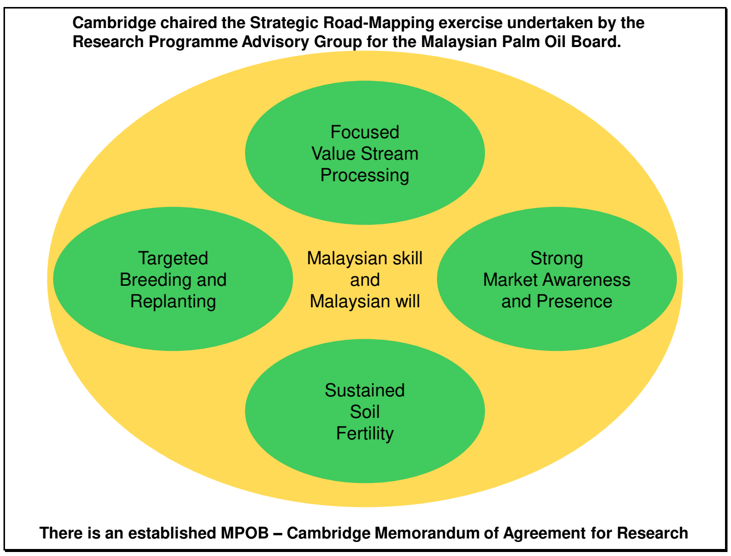
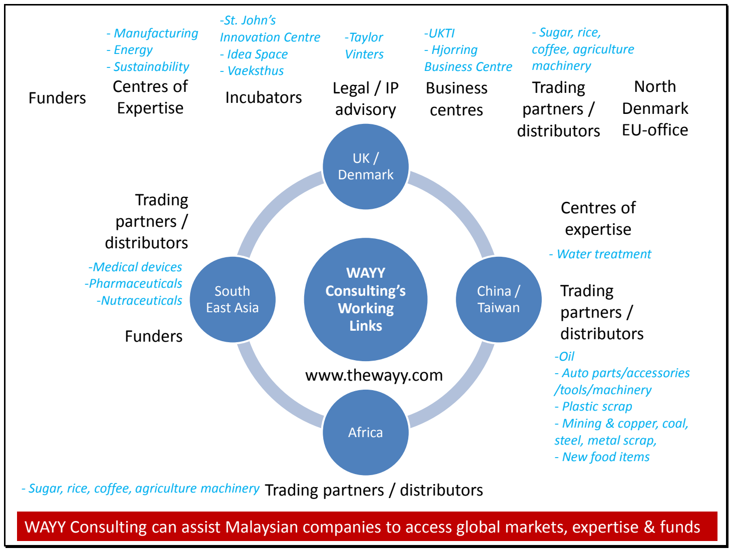


Figure 23.



Funders
- Manufacturing
- Energy
- Sustainability
Centres of Expertise
-St. John's Innovation Centre
- Idea Space
- Vaeksthus
Incubators
-Taylor Vinters
Legal / IP advisory
-UKTI
- Hjorring Business Centre
Business centres
- Sugar, rice, coffee, agriculture machinery
Trading partners / distributors
North Denmark EU-office
UK / Denmark
Trading partners / distributors
-Medical devices
-Pharmaceuticals
-Nutroceuticals
Funders
South East Asia
WAYY Consulting's Working Links
www.thewayy.com
China / Taiwan
Centres of expertise
- Water treatment
Trading partners / distributors
-Oil
- Auto parts/accessories /tools/machinery
- Plastic scrap
- Mining & copper, coal, steel, metal scrap,
- New food items
Africa
- Sugar, rice, coffee, agriculture machinery
Trading partners / distributors
WAYY Consulting can assist Malaysian companies to access global markets, expertise & funds

Figure 24.

Managing a Commercial Oil Palm Tissue Culture Laboratory: Past Reminders and Future Challenges

SHARIFAH SHAHRUL RABIAH SYED ALWEE
Biotechnology Centre
PT 23417 Lengkuk Technology

ABSTRACT

FASSB has been increasing its clonal production from 250,000 annually in 2007 to one million in 2010. With this increase, many challenges have to be overcome to ensure the success of scale up. However, the lessons that have been learnt from the past should be our constant reminder on how to proceed towards the future for a competitive and high quality clonal oil palm production program. One of the main issues is ortet selection and availability. As the production figure increase, so does the requirement for ortets. In order to meet this requirement, there might be a tendency to reduce the selection standards and increase production of ramets per clone. This will lead to lower clonal quality with a high possibility of somaclonal variation in the form of loral abnormality. As such, a research programme on increasing the cloning efficiency through improvement in embryogeneiss rate or adoption of new technologies for improving the tissue culture process itself is of utmost importance. One such programme is the development of suspension culture technology for oil palm. With this technology, production can be increased from 1,000 — 3,000 clonal plantlets per ortet to 50,000 clonal plantlets production per ortet with a 30% reduction in cost of production. Beyond the laboratory, managing the delivery of 1 million ramets pose several challenges. Efficient customer service programme ensures smooth progression of ramets from weaning to field planting.

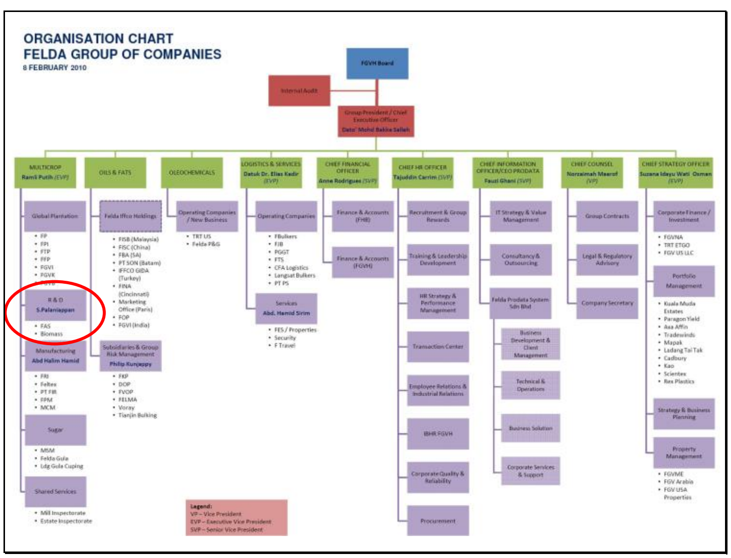


Figure 1. Organisation Chart – FELDA Group of Companies.

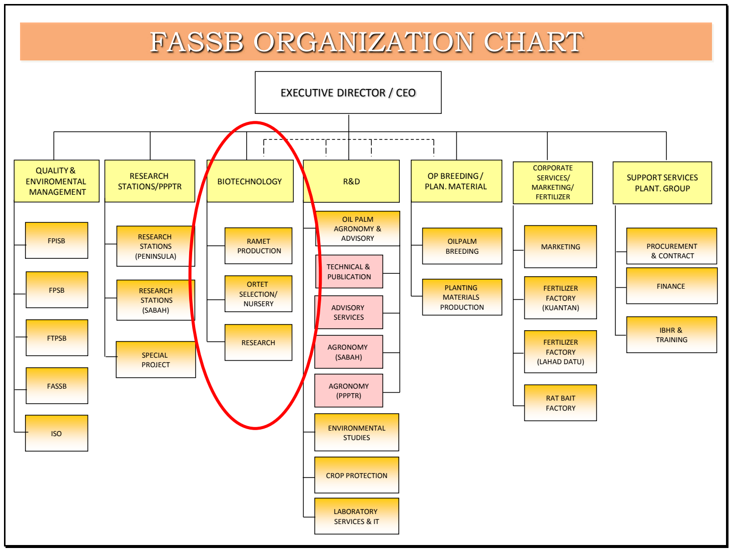


Figure 2. FASSB Oranization Chart.

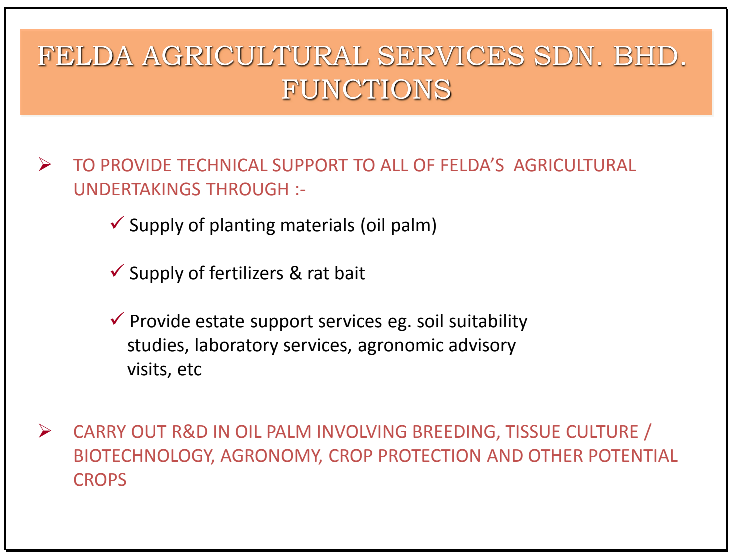


Figure 3. FELDA Agricultural Services SDN. BHD. Functions.

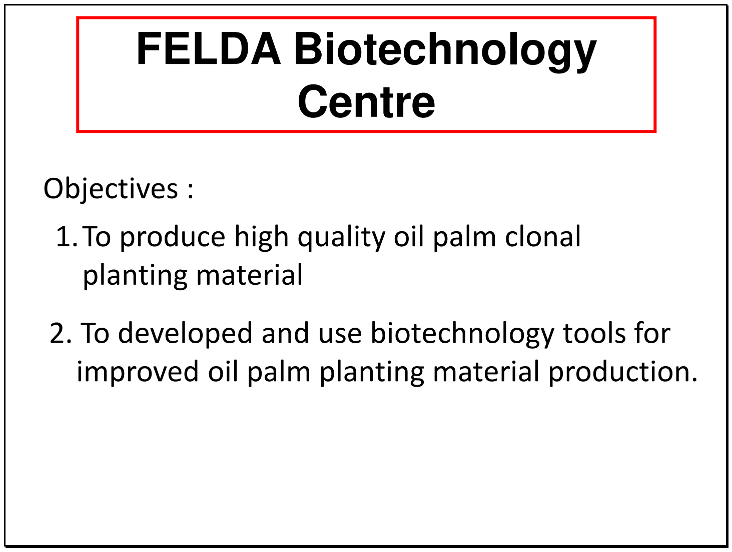


Figure 4. FELDA Biotechnology Centre.

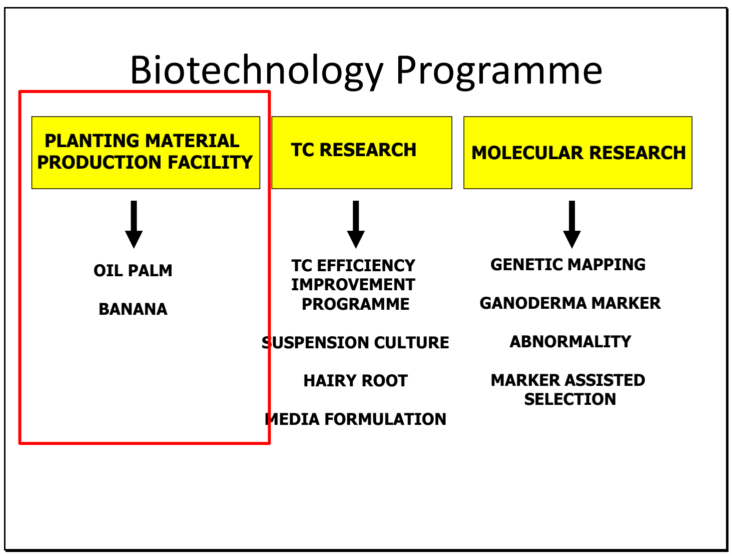


Figure 5. Biotechnology Programme.

Figure 6. FBC Tissue Culture Laboratory.

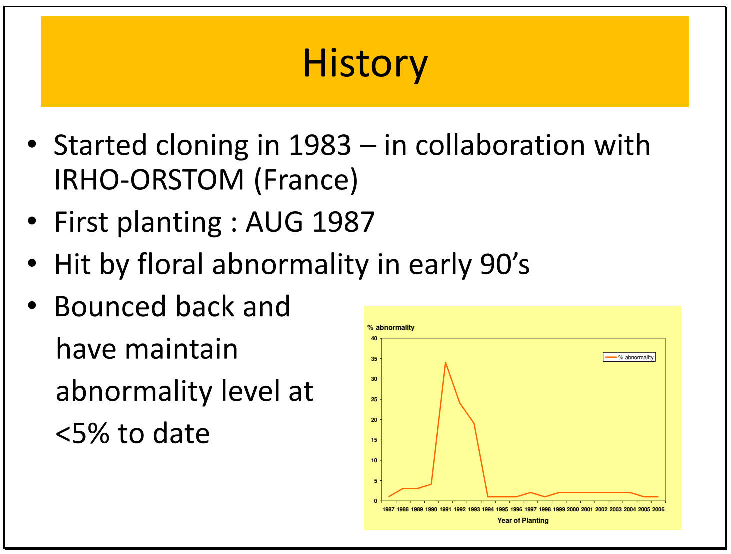


Figure 7. History.

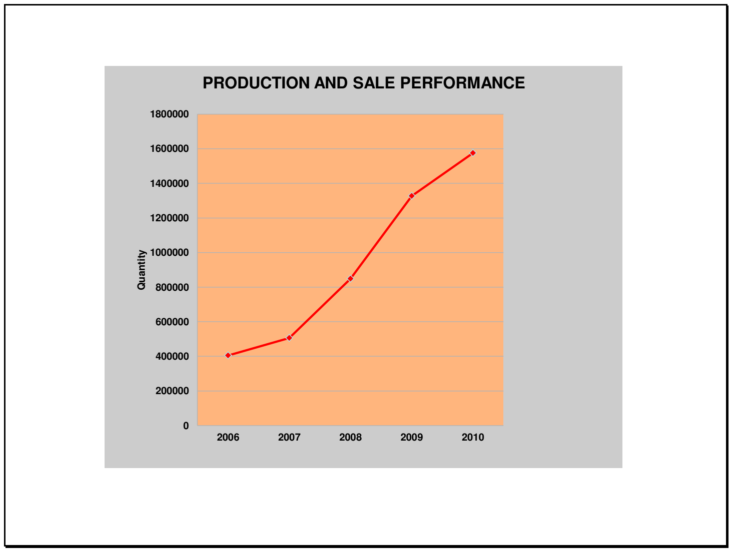


Figure 8. Production and Sale Performance.

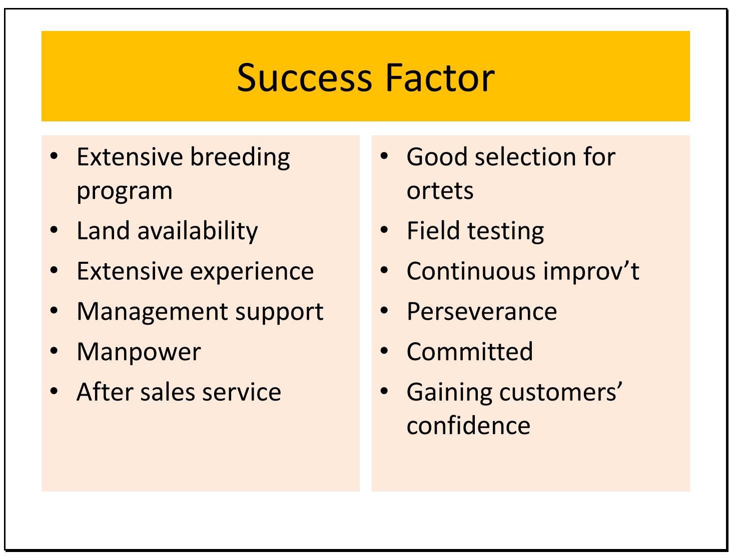


Figure 9. Success Factor.

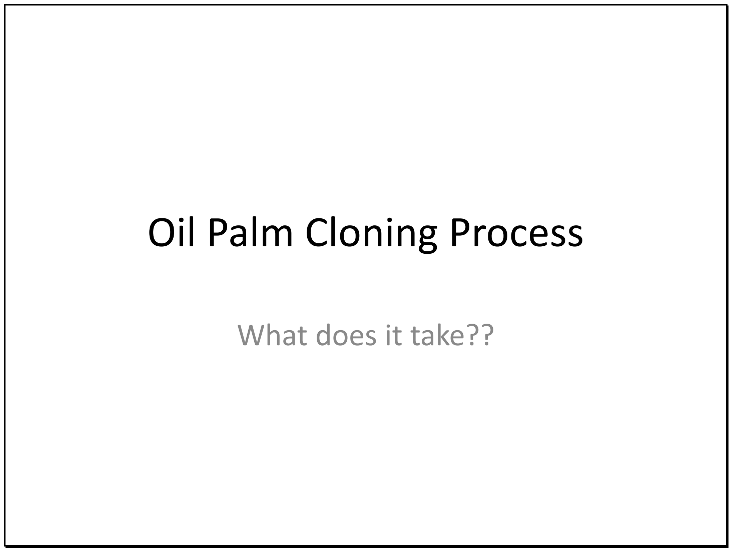


Figure 10. Oil Palm Cloning Process.

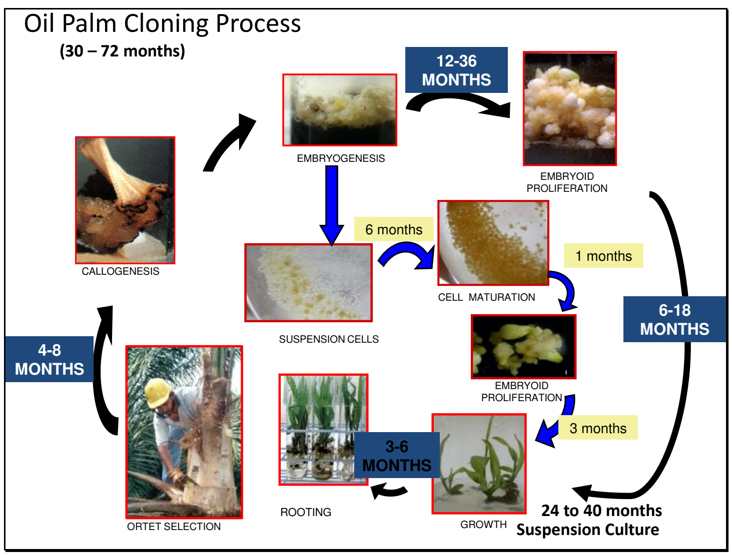


Figure 11. Oil Palm Cloning Process (30-72 months).

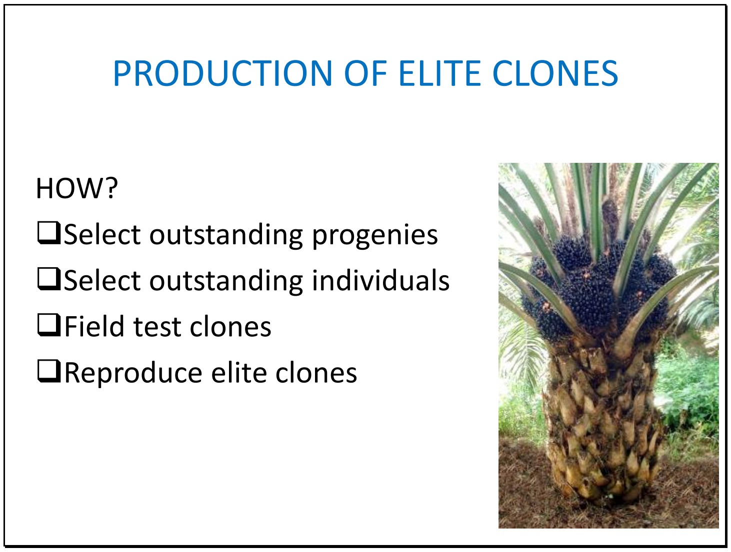


Figure 12. Production of Elite Clones.

Fifure 13. ORTET Selection

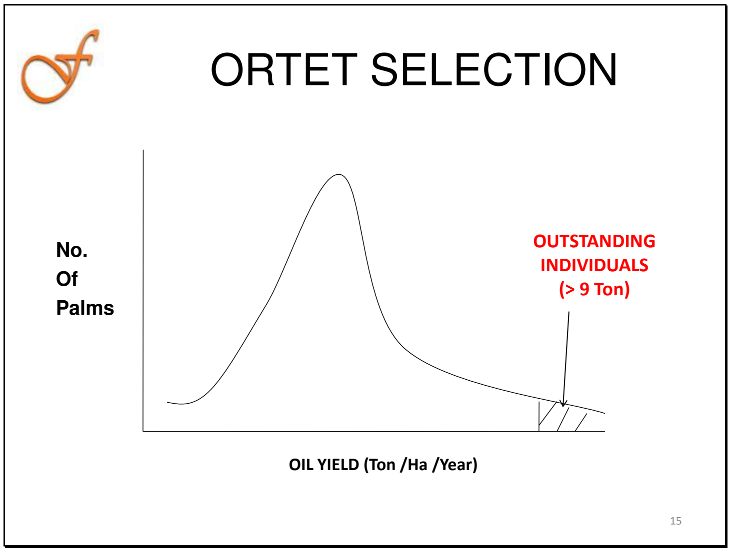


Figure 14. ORTET Selection.

Ortet selection criteria

1. High O/B

   1982 – 1990: 27%

   1991 – 1995: 28%

   1996 – 2004: 30%

   2005 – now: 32%

2. Slow height increment: <0.5m/year

3. High BNO

Figure 15. ORTET Selection Criteria.

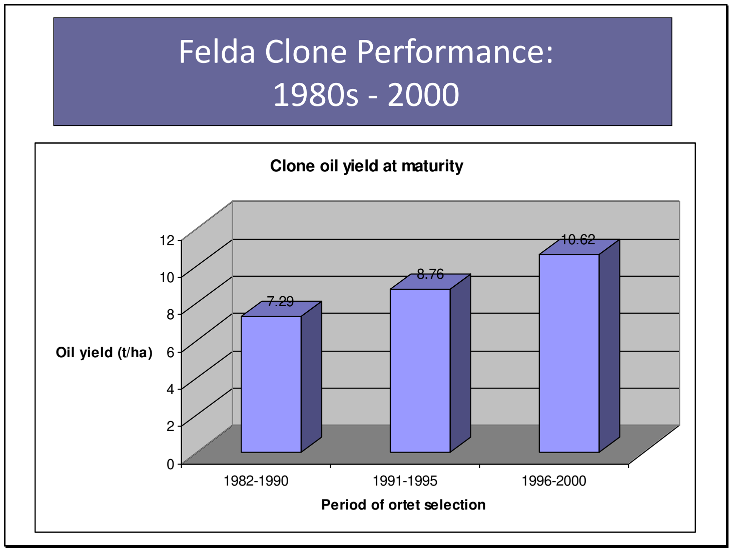


Figure 16. Felda Clone Performance: 1980s-2000.

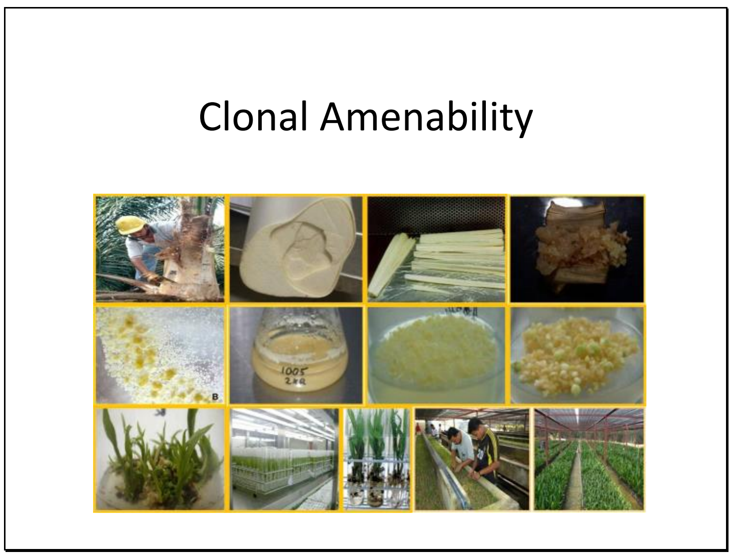


Figure 17. Clonal Amenability.

TC Amenability

- Amenability is genotype dependent
  - Predictable with known genotypes
  - Guesswork with new genotypes
- Information on clonable ortets
  - Embryogenic and proliferative
  - Saves time and resources

Figure 18. TC Amenability.

TC Amenability:
Genotype Dependent

Background	Mean (% of ortet amenable)
La Me	72
NIFOR	54
Yangambi	52
NPM	77
AVROS	55

Figure 19. TC Amenability: Genotype Dependent.

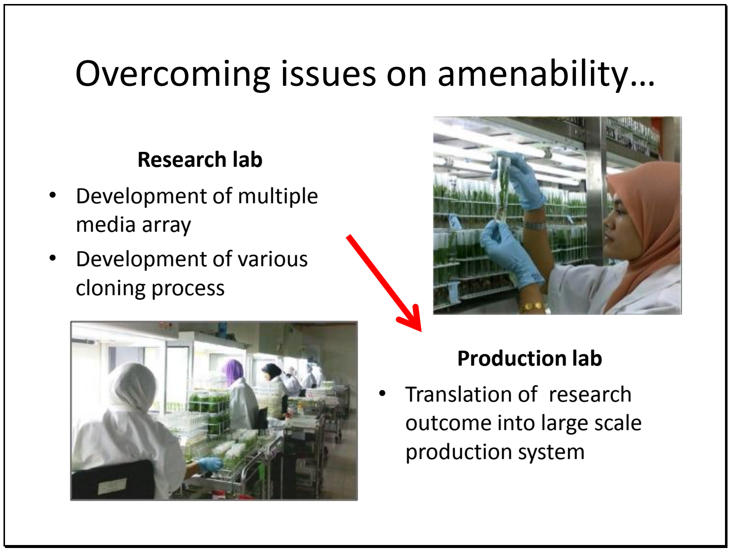


Figure 20. Overcoming Issues on Amenability.

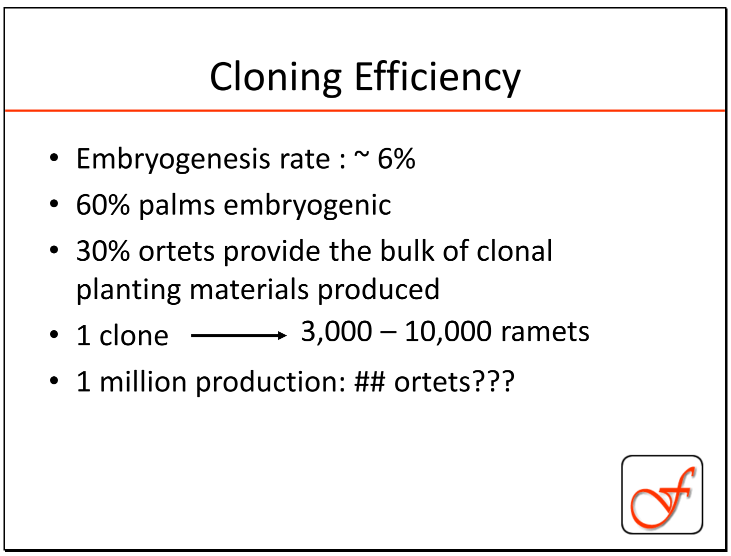


Figure 21. Cloning Efficiency.

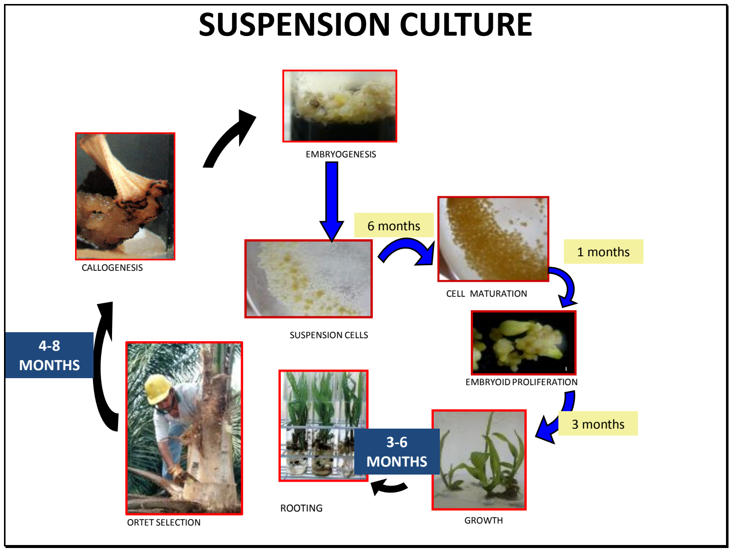


Figure 22. Suspension Culture.

Figure 23. Shortened Timeframe.

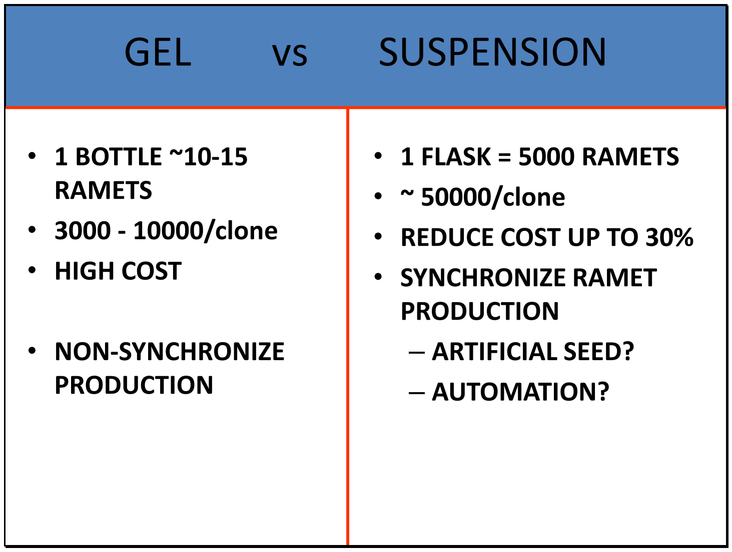


Figure 24. GEL vs Suspension.

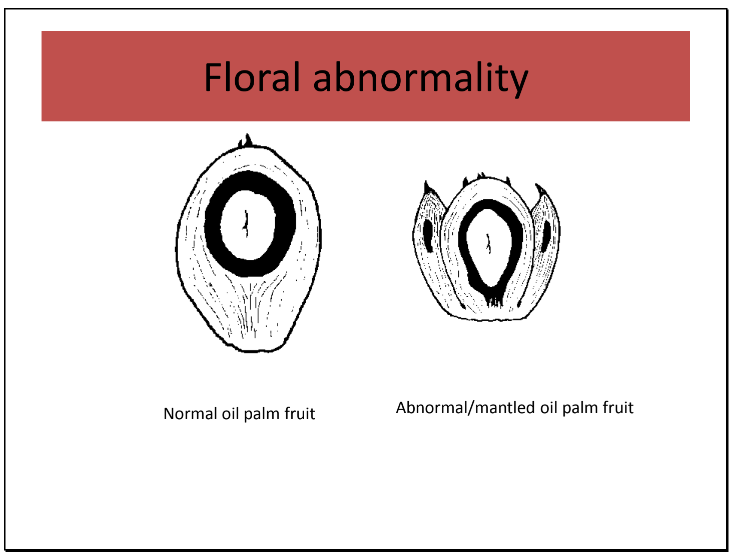


Figure 25. Floral Abnormality.

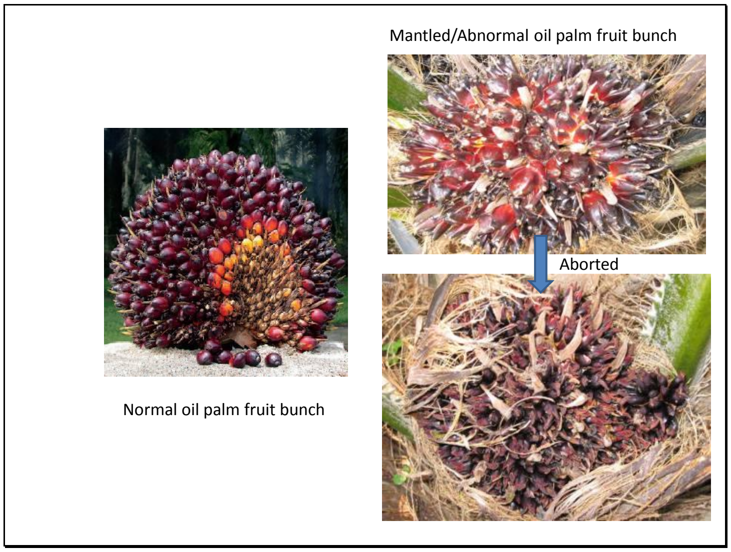


Figure 26.

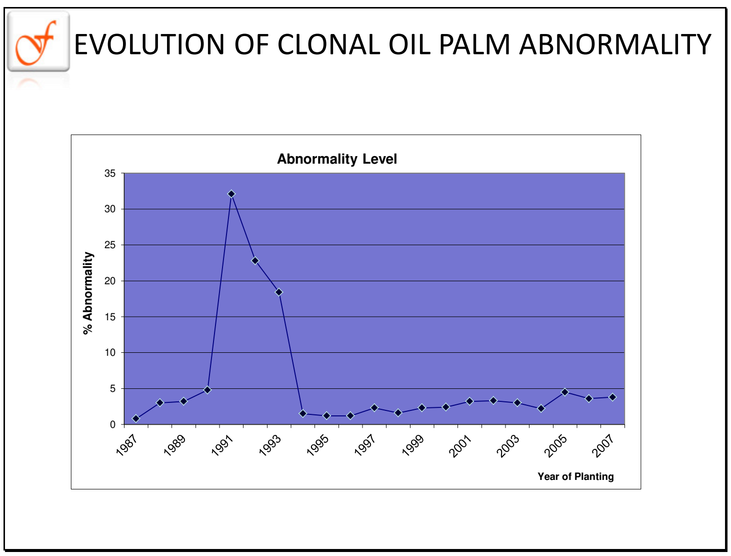


Figure 27. Evolution of Clonal Oil Palm Abnormality.

Abnormality

- Limits the number of ramets produced per ortet

  20 – 30% more production per ortet

- In absence of molecular markers:
  - Limit no. of subculture/proliferation
  - Reduce stress in culture
- Delayed introduction of plants for commercial planting

Figure 28. Abnormality.

Mitigation Strategy

- Stringent selection and close observation of cultures
- Establish selection criteria
- Establish checkpoint throughout cloning process
- Know limit of each clone
- Discard/test when in doubt
- Don’t be greedy!!

Figure 29. Mitigation Strategy.

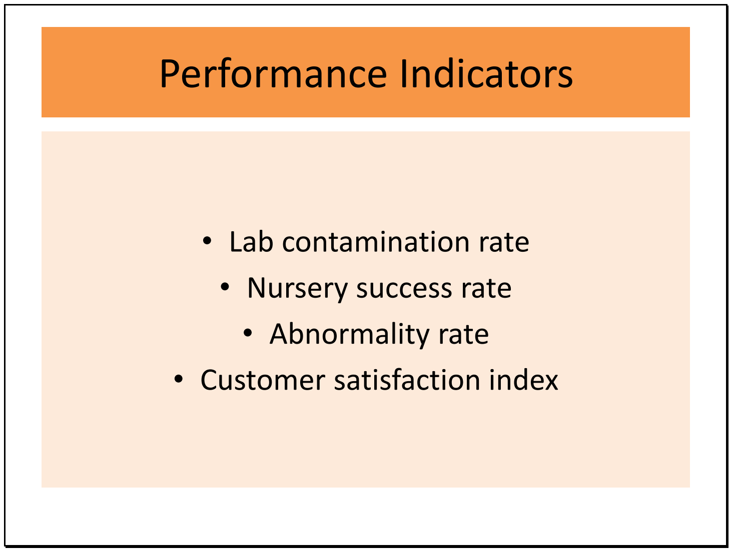


Figure 30. Performance Indicators.

Figure 31. Quality Management.

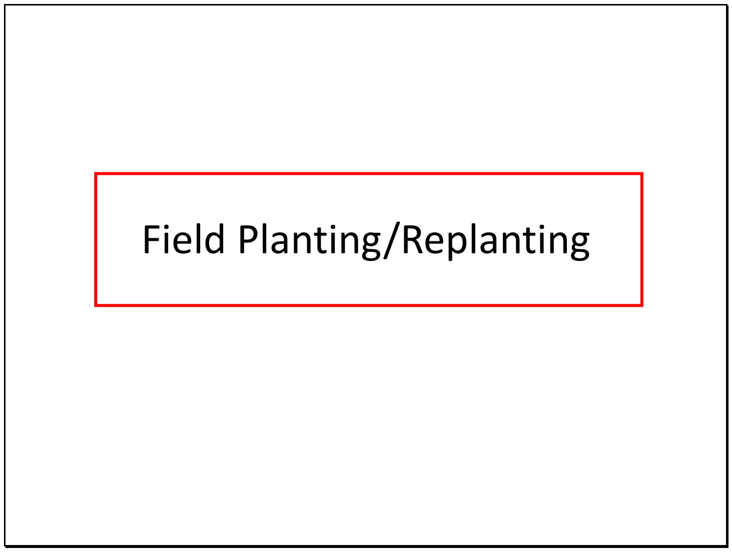


Figure 32. Field Planting/ Replanting.

Figure 33. Achieving High Yield Potential.

PRE-REQUISITES FOR PRODUCING HIGH YIELDING CLONE

- SUITABLE PLANTING AREA
  - TERRAIN
  - SOIL TYPE
  - RAINFALL/IRRIGATION
- AGRONOMIC INPUT
  - NURSERY
  - TIME AND TECHNIQUE OF PLANTING
  - FERTILIZER
  - MOISTURE CONSERVATION
  - PEST AND DISEASE
  - WEED CONTROL
  - ABLATION

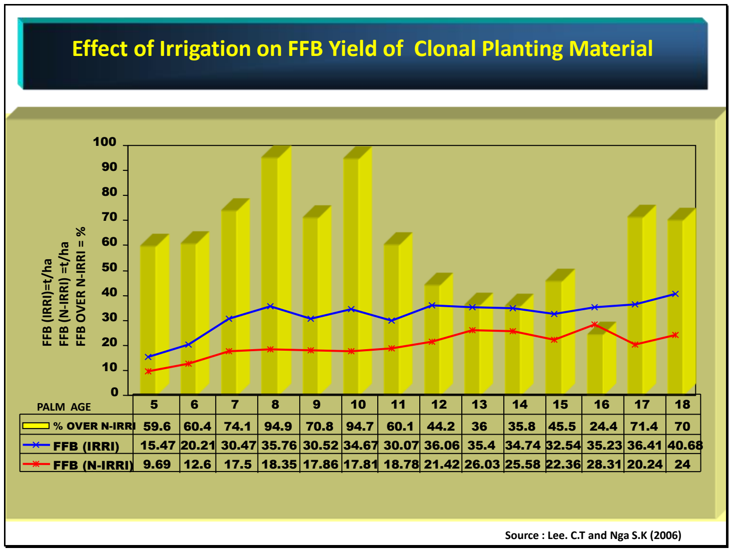
Figure 34. Pre-Requisites for Producing High Yielding Clone.

Oil Yield of Oil Palm Clones on Different Soil Series

Soil type	Planting material	25 - 36	37 - 48	49 - 60	61 - 72	73 - 84	85 - 96
Carey Series	AGK1*	20.4	31.6	40.2	43.9	40.6	-
	AGK6	20.6	32.0	40.1	40.0	50.2	-
	AGK8	17.8	27.3	39.0	37.5	39.5	-
	DxP control	11.3	24.0	30.4	34.6	34.5	-
Bukit Lunchu Series	AGK1	5.5	21.8	28.9	28.1	30.7	26.3
	AGK8	2.2	18.9	26.1	36.1	24.9	21.0
	DxP control	4.6	12.5	23.0	23.9	22.2	21.0
Bungor Series	AGK1	17.1	28.7	36.4	28.9	27.0	-
	AGK6	20.5	21.5	34.8	34.8	28.7	-
	AGK8	18.7	24.8	34.8	35.8	33.0	-
	DxP control	10.2	18.5	24.2	26.5	24.6	-

(Khaw and Ng, 1998)

Figure 35. Oil Yield of Oil Palm Clones on Different.

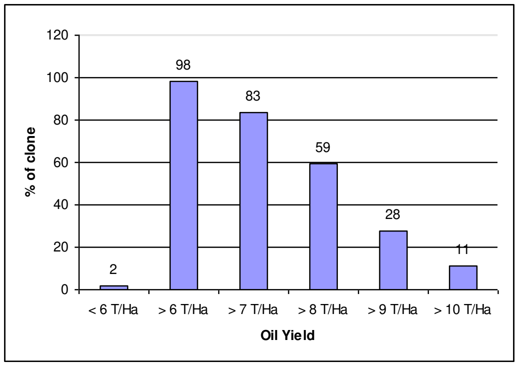


PALM AGE	5	6	7	8	9	10	11	12	13	14	15	16	17	18
% OVER N-IRRI	59.6	60.4	74.1	94.9	70.8	94.7	60.1	44.2	36	35.8	45.5	24.4	71.4	70
FFB (IRRI)	15.47	20.21	30.47	35.76	30.52	34.67	30.07	36.06	35.4	34.74	32.54	35.23	36.41	40.68
FFB (N-IRRI)	9.69	12.6	17.5	18.35	17.86	17.81	18.78	21.42	26.03	25.58	22.36	28.31	20.24	24

Figure 36. Effect of Irrigation on FFB Yield of Clonal Planting Material.

Figure 37.

Clone Performance over D x P



39

Figure 38. Clone Performance Over D x P.

CLONAL PERFORMANCE IN TRIAL PLANTING

TRIAL CODE	DATE PLANTED	LOCATION	NUMBER OF		YEARS OF RECORDING	% OVER D x P	
			CLONE	D x P		FFB	OIL
C 3	8/87	PPPTR	7	2	10.4	118	121
C 7	10/89	TELANG	11	2	8.7	103	116
C 10	6/90	PPPTR	11	2	8.0	116	128
C 12	12/90	KG5	18	2	7.5	103	125
C 13	12/90	KG5	13	2	7.5	104	108
C 20	5/93	KG5	6	1	5.0	105	115
C 26	11/95	KG5	3	2	8.8	110	118
C 29	11/96	PPPTR	4	2	6.6	98	129
MEAN						107	120

40

Figure 39. Clonal Performance in Trial Planting.

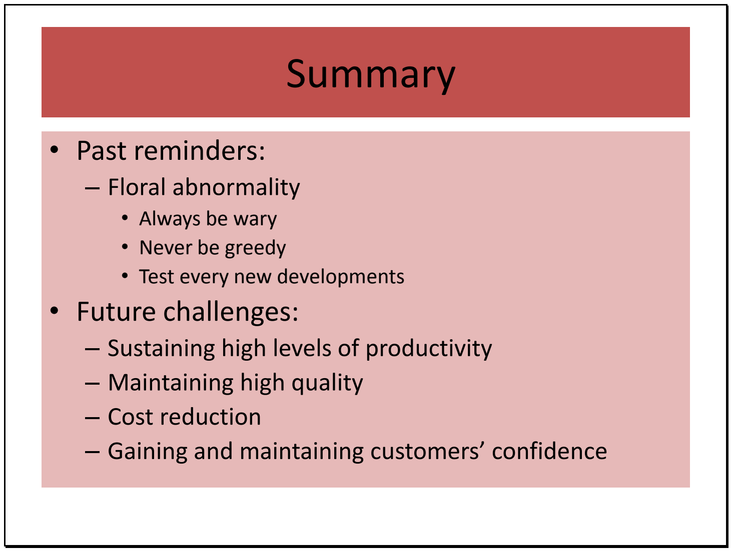


Figure 40. Summary.

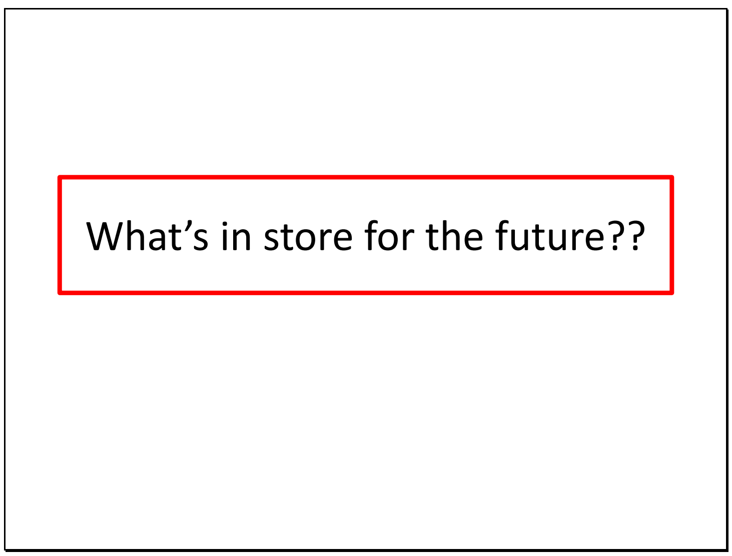


Figure 41.


THANK YOU

PART ELEVEN
APPENDIXES

APPENDIX A

2009 CONFERENCE COMMITTEES

Advisory Science Committee

Prof. Abdel Salam **Majali** (Chairman)
Tan Sri Datuk Dr Omar **Abdul Rahman** FIAS
Prof. Ahmed **Marrakchi** FIAS
Prof. Mehmet **Ergin** FIAS
Dr Moneef R **Zou'bi** DG-IAS

IAS Organising Committee

Dr Moneef R **Zou'bi** DG-IAS
Ms Lina **Dadan**, IAS
Ms Taghreed **Saqer**, IAS
Mr Abdel Hamed **Shams Eldeen**, IAS

Local Committee

Hon. Dr. Halimah **Ali (Chairperson).**
Datuk Dr. Rosti **Saruwono (Deputy Chairperson).**
Prof. Dr. Abdul Latif **Ibrahim FIAS (Secretary General).**
Prof. Zainal Abidin **Kidam (Treasurer).**

APPENDIX B

CHAIRPERSONS OF THE 2009 CONFERENCE SESSIONS

Session 1:	Prof. Abdel Salam Majali FIAS	Jordan.
Session 2:	Hon. Dr Halima Ali	Malaysia.
Session 3:	Prof. Iqbal Parker FIAS	South Africa.
Session 4:	Tan Sri Dato Abdul Khalid Ibrahim	Malaysia.
Session 5:	Tan Sri Prof. Omar Abdul Rahman FIAS	Malaysia.
Session 6A:	Prof. Ahmed Marrakchi FIAS	Tunisia.
Session 6B :	Prof. Ahmed Azad FIAS	Australia.
Session 7:	Prof. Hamid A. Zakri FIAS	Malaysia.
Session 8:	Prof. Amdullah Mehrabov FIAS	Azerbaijan.

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Sheikh **Hamad Al-Zamil**, Chairman, Al-Zamil Group, Saudi Arabia.
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APPENDIX E

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Prof. Ugur **Dilmen**	1996	Turkey.
Prof. Mohammad **Abdollahi**	2005	Iran.
Prof. Mohammed Manna **Al-Qattan**	2007	Saudi Arabia.
Dr Faris **Gavrankapetanovic**	2009	Bosnia.
Dr Saima **Riazuddin**	2011	Pakistan.
Prof. Liaquat **Ali**	2013	Bangladesh.
Professor Jackie **Ying**	2015	Singapore.

APPENDIX F

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Habes Majali	*Public Relations Officer.*
Saleh As'ad.	*Office Manager.*
Hamdi Bader	*Driver.*

APPENDIX G

DECEASED IAS FELLOWS

Prof. Mohammad **Ibrahim**	(1911-1988)	Bangladesh.
Prof. Djibril **Fall**	(1930-1992)	Senegal.
Prof. Salimuzzaman **Siddiqui**	(1897-1994)	Pakistan.
Prof. Abdus Salam **Mia**	(1925-1995)	Bangladesh/USA.
Prof. Suleiman Gabir **Hamad**	(1937-1996)	Sudan.
Prof. Mohammad R **Siddiqi**	(1908-1998)	Pakistan.
Prof. Abdullah M **Sharafuddin**	(1930-1998)	Bangladesh.
Prof. Achmad **Baiquni**	(1923-1998)	Indonesia.
Prof. Mumtaz Ali **Kazi**	(1928-1999)	Pakistan.
Prof. Faramaz G **Maksudov**	(1930-2000)	Azerbaijan
Prof. Ali **Kettani**	(1941-2001)	Morocco.
Prof. Mohamed Kamel **Mahmoud**	(1926-2003)	Egypt.
Prof. Samaun **Samadikun**	(1931-2006)	Indonesia.
Prof. Iftikhar Ahmad **Malik**	(1936-2008)	Pakistan.
Prof. J (Younis) Ario **Katili**	(1929-2008)	Indonesia.
Prof. Ibrahima Mar **Diop**	(1921-2008)	Senegal.
Prof. Syed Zahir **Haider**	(1927-2008)	Bangladesh.
Prof. Muhammad Ilyas **Burney**	(1922-2008)	Pakistan.
Prof. Badri **Muhammad**	(1943-2009)	Malaysia.
Prof. Pulat **Khabibullaev**	(1936-2010)	Uzbekistan.
Prof. Mohammed A **Waqar**	(1941-2010)	Pakistan.
Prof. Souleymane **Niang**	(1929-2010)	Senegal.
Prof. Ahmad Nawawi **Ayoub**	(1937-2010)	Malaysia.
Prof. Kamal H. **Batanouny**	(1936-2011)	Egypt.
Prof. Mohamed B E **Fayez**	(1927-2011)	Egypt.
Prof. Mazhar M **Qurashi**	(1925-2011)	Pakistan.
Prof. Mahmoud **Hafez**	(1912-2012)	Egypt.
Prof. Jamal **Nazrul-Islam**	(1939-2013)	Bangladesh.
Prof. **Riazuddin**	(1930-2013)	Pakistan.
Prof. Naeem Ahmad **Khan**	(1928-2013)	Pakistan.
Prof. Mehmet Nimet **Ozdas**	(1921-2014)	Turkey.
Prof. Ugur **Dilmen**	(1955-2015)	Turkey.
Prof. Ibrahim Gamil **Badran**	(1924-2015)	Egypt.
Prof. Fakhruddin **Daghestani**	(1936-2016)	Jordan.
Prof. Ibrahima **Wone**	(1926-2016)	Senegal
Prof. Syed Qasim **Mehdi**	(1941-2016)	Pakistan.
Prof. Korkut **Ozal**	(1929-2016)	Turkey.

APPENDIX H

PUBLICATIONS OF THE ISLAMIC WORLD ACADEMY OF SCIENCES

CONFERENCE PROCEEDINGS

- *The Islamic Academy of Sciences.* Proceedings of the Founding Conference (1986). Published by the Islamic Academy of Sciences, **Editor: A. Kettani (Morocco).**
- *Food Security in the Muslim World.* Proceedings of the first international conference, Amman (Jordan) (1987). Published by the Islamic World Academy of Sciences, **Editor: S. Qasem (Jordan).**
- *Science and Technology Policy for Self-Reliance in the Muslim World.* Proceedings of the second international conference, Islamabad (Pakistan) (1988). Published by the Islamic World Academy of Sciences, **Editors: F. Daghestani (Jordan), H. El-Mulki (Jordan), and M. Al-Halaiqa (Jordan).**
- *New Technologies and Development of the Muslim World.* Proceedings of the third international conference, (Kuwait) (1989). Published by the Islamic World Academy of Sciences, **Editors: F. Daghestani (Jordan), and S. Qasem (Jordan).**
- *Technology Transfer for Development in the Muslim World.* Proceedings of the fourth international conference, Antalya (Turkey) (1990). Published by the Islamic World Academy of Sciences, **Editors: F. Daghestani (Jordan), A. Altamemi (Jordan), and M. Ergin (Turkey).**
- *Science and Technology Manpower Development in the Islamic World.* Proceedings of the fifth international conference, Amman (Jordan) (1991). Published by the Islamic World Academy of Sciences, **Editors: F. Daghestani (Jordan), A. Altamemi (Jordan), and H. El-Mulki (Jordan).**
- *Environment and Development in the Islamic World.* Proceedings of the sixth international conference, Kuala Lumpur (Malaysia) (1992). Published by the Islamic World Academy of Sciences, **Editors: S. Al-Athel (Saudi Arabia), and F. Daghestani (Jordan).**
- *Health, Nutrition and Development in the Islamic World.* Proceedings of the seventh international conference, Dakar (Senegal) (1993). Published by the Islamic World Academy of Sciences, **Editors: N. Bor (Turkey), A. Kettani (Morocco), and Moneef R. Zou'bi (Jordan).**
- *Water in the Islamic World: An Imminent Crisis.* Proceedings of the eighth international conference, Khartoum (Sudan) (1994). Published by the Islamic

World Academy of Sciences, **Editors: M. Ergin (Turkey), H. Dogan Altinbilek (Turkey), and Moneef R. Zou'bi (Jordan).**

- *Science and Technology Education for Development in the Islamic World.* Proceedings of the ninth international conference, Tehran (Iran) (1999). Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), M. Doruk (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 9957-412-7).**
- *Information Technology for Development in the Islamic World.* Proceeding of the tenth international conference, Tunis (Tunisia) (2000). Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), M. Doruk (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 9957-412-03-5).**
- *Biotechnology and Genetic Engineering for Development in the Islamic World.* Proceedings of the eleventh international conference, Rabat (Morocco) (2001). Published by the Islamic World Academy of Sciences, **Editors: A. S. Majali (Jordan), M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 9957-412-07-8).**
- *Materials Science and Technology and Culture of Science.* Proceedings of the twelfth international conference, Islamabad (Pakistan), (2002). Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 9957-412-06-x).**
- *Energy for Sustainable Development and Science for the Future of the Islamic World and Humanity.* Proceedings of the thirteenth international conference, Kuching, Sarawak (Malaysia), (2003). Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 9957-412-08-6).**
- *Science Technology and Innovation for Socioeconomic Development of OIC-Member Countries Towards Vision 1441.* Proceeding of the fourteenth international conference, Kuala Lumpur (Malaysia), (2005). Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 9957-412-11-6).**
- *Higher Education Excellence for Development in the Islamic World.* Proceeding of the fifteenth international conference, Ankara (Turkey), (2006). Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 978-9957-412-18-0).**
- *Science and Technology and Innovation for Sustainable Development in the Islamic World: Policies and Politics Rapprochement*, Proceeding of the sixteenth international conference, Kazan (Tatarstan), (2008) – Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 978-9957-412-19-7).**
- *Towards the Knowledge Society in the Islamic World: Knowledge Production, Application and Dissemination,* Proceeding of the seventeenth international conference, Shah Alam, *Selangor (Malaysia); 2009* - Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 978-9957-412-22-7).**

- *The Islamic World and the West: Rebuilding Bridges through Science and Technology,* Doha (Qatar), 2011 **-** Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan). In press.**
- *Achieving Socioeconomic Development in the Islamic World through Science, Technology and Innovation*, Dhaka (Bangladesh), 2013 – Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan). In press.**

BOOKS

- *Islamic Thought and Modern Science.* Published by the Islamic World Academy of Sciences (1997) - **Author: Mumtaz A. Kazi**.
- *Qur'anic Concepts and Scientific Theories.* Published by the Islamic World Academy of Sciences (1999) – **Author: Mumtaz A. Kazi.**
- *Personalities Noble* **Editor: Hakim Mohammed Said**, Second Revised Edition. Published by the Islamic World Academy of Sciences (2000), **Editor: Moneef R. Zou'bi** (Arabic-English). **(ISBN: 9957-412-01-6).**
- *Declarations of the Islamic World Academy of Sciences.* Published by the Islamic World Academy of Sciences (2005), **Editor: Moneef. R. Zou'bi (ISBN: 9957-412-09-4)**.
- *Islamic World Academy of Sciences Outreach.* Published by the Islamic World Academy of Sciences (2005), **Editor: Moneef R. Zou'bi (ISBN: 9957-412-10-8)**.
- *Intellectual Property Rights: An Introduction for Scientists and Technologists.* Published by the Islamic World Academy of Sciences (2006), **Author: Mohamed B. E. Fayez (ISBN: 978-9957-412-18-0)**.
- *Reverse Engineering: The Permissible but not Well-Recognized* -Published by the Islamic World Academy of Sciences (2010), **Author: Mohamed B. E. Fayez (ISBN: 978-9957-412-20-3)**.
- *The Discoveries in the Islamic Countries* – Arabic Edition Published by the Islamic World Academy of Sciences (2013), **Author: Ahmed Djebbar (ISBN: 978-9957-412-23-4)**.
- *The Essentials of Science, Technology and Innovation Policy* – Published by the Islamic World Academy of Sciences (2013), **Author: Tan Sri Dr Omar Abdel Rahman (ISBN: 978-983-9445-95-4).**

PERIODICALS

- *Medical Journal of the Islamic World Academy of Sciences* (ISSN 1016-3360) – quarterly. Chief Editor: **Prof. Naci Bor FIAS**, Mithatpasa Cad. No. 66/5, Ankara, Turkey.

- *Newsletter of the Islamic World Academy of Sciences* – quarterly. Chief Editor: **Moneef R. Zou'bi**.
- *Islamic Thought and Scientific Creativity* (in Arabic) - quarterly Journal of the Organisation of the Islamic Conference (OIC) Standing Committee on Scientific and Technological Co-operation (COMSTECH). Arabicised version published by IAS with the support of the Royal Academy for Islamic Civilisation Research (Al-Albait Foundation) (publication ceased in 1996).

OTHER PUBLICATIONS

- An *Overview* of the IAS, Chief Editor: **M. R. Zou'bi.**

- IAS Postcards.

APPENDIX I

IAS SUPPORTERS

The Hashemite Kingdom of Jordan
The Islamic Republic of Pakistan
The State of Kuwait
The Republic of Turkey
Malaysia
The Republic of Senegal
The Republic of Sudan
The Islamic Republic of Iran
The State of Qatar
The Republic of Tunisia
The Kingdom of Morocco
The State of Sarawak/Malaysia
The Republic of Indonesia
The Republic of Tatarstan/ Russian Federation
The State of Selangor/Malaysia
The Sultanate of Oman
The State of Selangor/ Malaysia
The Republic of Kazakhstan
The People's Republic of Bangladesh

The OIC Standing Committee on Scientific and Technological Co-operation (COMSTECH), Pakistan.
The Islamic Development Bank (IDB), Saudi Arabia.
The OPEC Fund for International Development, Vienna, Austria.
Arab Potash Company, Jordan.
United Nations Educational Scientific and Cultural Organisation (UNESCO), France.
Islamic Educational Scientific and Cultural Organisation (ISESCO), Morocco.
The World Bank, USA.
The United Nations Environment Programme (UNEP), Kenya.
Kuwait Foundation for the Advancement of Sciences (KFAS).
Turkish Scientific and Technical Research Council (TUBITAK).
The Royal Scientific Society (RSS), Jordan.
Pakistan Ministry of Science and Technology.
Ministry of Science, Technology and the Environment, Malaysia.
University Cheikh Anta Diop, Dakar, Senegal.
Ministry of Higher Education and Scientific Research, Sudan.
National Centre for Research, Sudan.
Ministry of Culture and Higher Education, Iran.

Iranian Research Organisation for Science and Technology (IROST).
The Academy of Sciences, Tehran, Iran.
The Academy of Medical Sciences, Tehran, Iran.
Saudi Arabian Oil Company, Saudi Arabia (ARAMCO).
Ihlas Holding, Turkey.
Arab Bank, Jordan.
Jordan Kuwait Bank, Jordan.
Rafia Industrial Company, Jordan.
Secretariat of State for Scientific Research and Technology, Tunisia.
Academy of the Kingdom of Morocco.
Petra Private University, Jordan.
Higher Council of Science and Technology (HCST), Jordan.
Pakistan Academy of Sciences.
Majlis Islam Sarawak, Malaysia.
Tabung Baitulmal Sarawak, Malaysia.
Sasakawa Peace Foundation, Japan.
Perdana Leadership Foundation, Putrajaya, Malaysia.
Royal Jordanian Airlines, Jordan.
Arab Jordan Investment Bank, Jordan.
National Centre for Human Resources Development, Jordan.
Al Bukhary Foundation, Malaysia.
Bilkent University, Turkey.
US National Academy of Sciences, USA.
International Islamic Charity Organisation, Kuwait.
Islamic Organisation of Medical Sciences, Kuwait.
Arab Gulf Programme for Development (AGFUND), Saudi Arabia.
Fouad Alghanim & Sons Group of Companies, Kuwait.
Saudi Basic Industries Corporation (SABIC), Riyadh, Saudi Arabia.
Tatarstan Academy of Sciences, Tatarstan, Russian Federation.
World Islamic Call Society, Tripoli, Libya.
Jordan Phosphate Mines Company, Amman, Jordan.
International Islamic Academy of Science and Biotechnology (IAB), Malaysia.
University of Industry of Selangor (UNISEL), Malaysia.
Ministry of Foreign Affairs of Qatar: The Permanent Committee for Organizing Conference, Qatar.
Doha International Centre for Interfaith Dialogue (DICID), Qatar.
R.B. Suleimenov Institute of Oriental Studies, Kazakhstan.
Prime Ministry of Bangladesh, Bangladesh.
Foreign Ministry of Bangladesh; Bangladesh.
University Grants Commission of Bangladesh, Bangladesh.
Bangladesh Academy of Sciences, Bangladesh.
Sheikh Mohammed bin Hamad Al Thani, Qatar.
Eng. Awni Shaker Al Aseer, Saudi Arabia.
Eng. Amjad Abu Aisheh, Jordan.

APPENDIX J

IAS Waqf	IAS Endowment Fund
Islamic World Academy of Sciences Jordan Islamic Bank Shemeisani Branch Account No.: 809/$91 Telephone : +962 6 5677107 Facsimile: +962 6 5691700 PO Box 925997 Amman 11110 Jordan.	Islamic World Academy of Sciences Arab Bank Fifth Circle Branch Account No : 0134-32907-711 Telephone : +962 6 5526870 Facsimile: +962 6 5526874 PO Box 141107 Amman Jordan.

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http://www.iasworld.org

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http://www.medicaljournal-ias.org