"CAPACITY BUILDING FOR SCIENCE, TECHNOLOGY AND INNOVATION IN DEVELOPING COUNTRIES"

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1.0 UN Millennium Project "Science, Technology and Innovation" (STI) Task Force Report, January 2005

The key recommendations of the UN MP STI Task Force Report "Innovation: Applying Knowledge in Development", January 2005 are the following:

- Improving the STI policy environment, including STI advice mechanism.
- Building STI human capacities.
- Promoting entrepreneurial and innovation activities.
- Investing in research and development.
- Technology foresight for developing countries to find niches in the global production chain.
- Forging regional and international STI partnerships.

For me, its key finding remains:

> "For developing countries to lift themselves out of poverty and achieve the MDGs, they need:
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> - Basic infrastructure i.e. roads, schools, water, sanitation, irrigation, clinics, telecommunications, energy etc.
> - Basic industries, namely small and medium enterprises (SMEs) for supply of goods and services to agricultural and natural resources exploitation industries. This means indigenous operational, repair and maintenance expertise and a pool of local technicians.
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> Without the engineering and technology base, indigenous industries cannot upscale and economy cannot uplift and foreign direct investment will not come."

The above is based on the development experiences and successes of Asia Pacific and South East Asia where macroeconomic stability, self-reliance, hard work, thrift and investment in education have transformed the economic landscape in the short span of three to four decades.

In essence, we need to build indigenous STI capacity, both institutional and enterprise-related, and human resource based.

2.0 UN Secretary-General's Report, March 2005; and the UN Summit General Assembly September 2005

The MP reports form the developmental basis of the UN Secretary-General's report "In Larger Freedom: towards development, security and human rights for all", March 2005 to UN member states for the UN Summit General Assembly, September 2005. The following extract emphasizes Kofi Annan's reaffirmation of the key recommendations of the STI Task Force Report on STI for achieving the MDGs in developing countries:

> **"**The unprecedented combination of resources and technology at our disposal today means that we are truly the first generation with the tools, the knowledge and the resources to meet the commitment, given by all States in the Millennium Declaration, "to making the right to development a reality for everyone and to freeing the entire human race from want". Our agenda is still achievable globally and in most or even all countries — but only if we break with business as usual and dramatically accelerate and scale up action until 2015, beginning over the next 12 months. It takes time to train the teachers, nurses and engineers, to build the roads, schools and hospitals, and to grow the small and large businesses able to create the jobs and income needed. Many of the poorest countries will need major capacity-building investments to put in place and maintain the necessary infrastructure and to train and employ qualified personnel. To increase countries' indigenous capacity for science and technology, including information and communications technology, Governments should establish scientific advisory bodies, promote infrastructure as an opportunity for technological learning, expand science and engineering faculties, and stress development and business applications in science and technology curricula."

The UN Summit General Assembly 13-16 September 2005 has endorsed most of the UN Secretary General's recommendations with respect to the MDGs.

The global top science, engineering and technological (S.E.T.) community submitted a joint statement "Science, Technology and Innovation in Achieving the MDGs" to the UN Summit General Assembly dated 13 September 2005. It was issued in the names of the InterAcademy Council (IAC); the InterAcademy Panel on International Issues (IAP); UN Millennium Project (MP); International Council for Science (ICSU); the Academy of Sciences for the Developing World (TWAS); the InterAcademy Medical Panel (IMAP); the International Council of Academies of Engineering and Technological Sciences (CAETS); and the World Federation of Engineering Organizations (WFEO).

> "We state that stronger worldwide capacities in science and technology will greatly enhance humanity's ability to achieve the UN Millennium Development Goals. Sustained progress in reducing poverty and related problems will require strengthened institutions for science, technology, and innovation within the world's developing countries. We call on the national leaders meeting at the United Nations General Assembly in September 2005 to take urgent action

without delay. For our part, we commit ourselves to working with appropriate partners towards these urgent goals."

Since the roadmap for achieving the MDGs has been adopted by the largest gathering of global political leaders and supported by the highest global S.E.T organizations, may I urge everyone to stop talking and start doing. To date, the talking never stops and the doing rarely starts!

3.0 STI Capacity Building for Developing Countries

As stated above, UN MP STI Task Force Report is really about human resource based and institutional and enterprise-related capacity building in developing countries. Since institutions and enterprises are run by human beings, it all boils down to STI human resources capacity building. Priority must be directed to education. In fact, the ongoing initiatives of my UN MP STI Task Force co-coordinator, Professor Calestous Juma and me are focused on the reorientation of universities to development through innovation, entrepreneurship and infrastructure as an opportunity for technological learning.

3.1 Universities for Development

Universities in developing countries must now act as the fount of knowledge that is appropriate for development and competitiveness in the global knowledge economy. For this to happen, policy makers need to realize that knowledge per say does not create wealth. It is the application and commercialization of knowledge, scientific or otherwise, into useful devices, installations, services and systems that create wealth with the final proviso that these find acceptance in the marketplace. Therefore, turning out innovative and entrepreneurial graduates must be the mission of the universities in developing countries.

In my opinion, staffing universities with PhDs is not the route to innovation and competitiveness for the economy. University academics have largely forgotten that they are first and foremost teachers. They must be good communicators. They should not be recruited on PhD degree, research experience and publications only. They should have working experience in industry and in the marketplace if they are to understand the needs of the economy and the community. I would strongly advocate that successful candidates as academics should have demonstrated involvement in community service, especially MDG-based and infrastructure related.

Universities in developing countries must be graduating job creators rather the job seekers. Universities should re-orientate themselves to serve the development needs of their region and their nation. They must establish undergraduate incubators that assist students to venture into knowledge based enterprises suited to the needs of the economy.

In current circumstances, such undergraduate enterprises are easy to set up. With available and affordable computer hardware and software, up-to-date knowledge accessibility through the Internet, robotics and modern instrumentation, some even

remotely located and controlled, device and system design, research and development can be carried out either within the campus, across local campuses or in partnership with overseas campuses. Such undergraduate enterprises will attract industry participation as they are the most fertile recruiting ground for the best and brightest. If such undergraduate enterprises succeed beyond graduation, they will create jobs and add to the successful knowledge enterprises in the country. Even if they fail, the graduates would have been well schooled in the hard knocks of business life and well adapted to the needs of industry.

The UN MP STI Task Force Report reminds readers that the Massachusetts Institute of Technology was set up in the Nineteen Thirties primarily to promote the industrial and economic development of the region of Cambridge, Massachusetts. It points out that the continuing flow of innovations from the Sinchu Technology Park, Taipei, China leading the world in wafer fabrication and other computer devices is supported by two universities in its environ: Our Report highlights 3 case studies of universities in developing countries that fulfill the national development needs through STI, namely the Kigali Institute of Science, Technology and Management (KIST), Rwanda; the University of Campinas (UNICAMP), Sao Paulo, Brazil; and EARTH University, Costa Rica. The Rwanda and Costa Rica examples are prominently featured in the publication "Going for Growth: Science, Technology and Innovation in Africa" www.smithinstitute.org.uk/publications.htm that was launched in the office of the UK Chancellor of the Exchequer on 30 November 2005.

A very positive trend in recent years has been the blossoming of Engineers Without Borders (EWB) in university campuses across North America and Europe. Whilst the bulk of EWB members and volunteers are undergraduate engineering students, many EWBs are supported by their universities and engineering faculty members. EWBs from developed countries partner their counterparts in developing countries in MDG-related and infrastructure-based community projects in the latter. EWB projects won quite a few Mondialogo Engineering Awards in 2005. Mondialogo is a joint UNESCO-DaimlerChrysler cross-cultural project aimed at fostering North-South collaboration amongst university engineering students in MDG and sustainable development projects in developing countries. Inspired by Mondialogo, UN Millennium Project is promoting "A MDG Project for Every University".

3.2 Education for Innovation

Innovation is born of the inquisitive and creative mind. There are mounting scientific evidence that the human child is born inquisitive. The most inquiring, acquiring and creative age is between 3 and 10. It is the traditional education of book and rote learning that dampens and in most cases destroys the creative instinct of the child. If the inquiring spirit is gone from the child in primary school, it will be difficult to restore in secondary and higher education.

The Inter-Academy Panel for International Issues of world science academies (IAP) has made the promotion of hands-on inquiry based primary school science education their top

priority. The most successful is the La Main à la Pâte (LAMAP) program of the French Academy of Sciences (www.lamap.fr). LAMAP re-orientated science education in primary schools, with the aim at promoting a hands-on, inquiry based method for teaching science to young children. LAMAP has since spread to many parts of the world. LAMAP owes much of its worldwide success through this imaginative use of ICT. In my opinion, the most valuable aspect of LAMAP is that children learn to doubt and to query. They are taught not to listen to 'prophets' unless their opinion is verified by experiment. It develops future citizens that are conscious of the importance of evidence based decision making as stakeholders in the political and social life of their countries. Of course, IAP hopes that hands-on inquiry based primary science education will also encourage more children to take up science in later schooling and in their career. LAMAP has since spread to Brazil, Chile, China (www.handsbrain.com), Colombia, Egypt, France, Hungary, Malaysia, Mexico, Morocco, Senegal, and ASEAN. I have so tried to get the UN MP to incorporate elements of the hands-on enquiry-based primary science education into the UNESCO "primary education for all" programme for the MDGs.

Secondary school science education is much more structured with science graduates as teachers guiding students through well prescribed curriculum. However, the secondary education system in the developing world suffers from excessive book and rote learning for prescribed examinations. The alarming fact is that enrolment in science in secondary schools is dropping everywhere. The ongoing challenge is to pervade the curriculum with evidenced based inquery type learning by more technological content.

3.3 STI Research Institutions

The high end of the STI human resource development is the staffing of R&D institutions in developing countries. However, there exists an almost universal misconception that the necessary path to economic development in developing countries is through more emphasis and investment in science and scientific research. This view has consistently been championed by development banks and by the scientific communities in developing countries themselves. Postgraduate research departments of universities and basic research institutes have been set up prematurely in the least developing countries with their graduates and researchers finding no local gainful employment and migrating to the developed world, aggravating the brain drain. Yet more of the same are being advocated. What an irony it is that developing countries are training highly skilled manpower for the developed world, whilst insufficient resources are devoted to lift the countries out of poverty!

3.4 Military Engineers

In any developing country, the military engineering divisions and units are amongst the best equipped for basic infrastructure construction and rehabilitation. Yet, such invaluable capacity remains idle in the sea of need in developing countries. We forget that there was a fine tradition of Caesar's legions, which built roads, aqueducts, baths and sewers. In more recent decades, military engineering units in China, Taiwan, China and

Korea, have contributed significantly to the construction of infrastructure and laid the foundation of their bludgeoning construction industry.

In Kenya, there is a worsening famine due to drought. Yet, the 2004 budget allocation for capital projects of water storage for irrigation was under spent due to lack of indigenous implementation capacity. The situation in 2005 was no better. I have been to Washington DC to meet the US Army Corps of Engineers to consider assisting in capacity building of Kenyan military engineering units in water storage projects. The response has been very positive from the US Army Corps of Engineers and the Kenyan government and military top brass.

4.0 STI Brain Drain from Developing Countries

STI human resource capacity building in developing countries faces the critical problem of brain drain.

Currently, there is a disturbing worldwide trend that enrolment in engineering courses in universities is declining. This has been particularly evident in developed countries with the related phenomenon of closure of engineering departments in universities and institutions of higher learning. The situation of science courses is no better. As a result, developed countries have been exercising the prerogative of the rich by recruiting scientists, engineers and technologists from the developing countries. Most developing countries thus suffer on three counts. First, they do not produce enough scientists, engineers and technologists for their own requirement as their education and training infrastructure is inadequate to cope with the growing demand. Secondly, they expend scarce hard foreign currency in sending their students for expensive S.E.T courses in developed countries. Thirdly, there is the constant S.E.T drain, usually the best and the brightest, to the developed countries.

In my opinion, solutions to overcome this critical shortage of S.E.T in the developing world cannot be North-South but must be South-South. However the professional accreditation and certification barriers in developing countries against S.E.T professionals from fellow developing countries are formidable. Nevertheless, it is the only practical and pragmatic solution to offset the brain drain in the short span of a decade to 2015. In engineering, we must achieve this South-South mobility for the sake of the MDGs, tapping from those countries where large population and large geographical spread or both require the production of large number of engineers and technologists to satisfy their own development needs. Such countries are South Africa, India, China, Mexico and Brazil to name but a few.

As an example, there are more than 1.5 million engineering students in universities in China with some 350,000 graduating as engineers each year. To increase this number by 10% would not strain the engineering educational resources of China but would be of great help to other developing countries. In point of fact, the US National Academies published in October 2005 a report that the US edge in science and technology competitiveness is slipping. It cites as evidence that China is graduating some 600,000

engineers a year, India some 300,000 engineers a year whereas USA is graduating only some 60,000 engineers a year! When the engineering qualifications from the above-mentioned major producers of engineers and technologists are accepted first regionally and then worldwide, these countries will provide accessible and affordable engineering education and training facilities for students from other developing countries. It is thus very much a win-win situation for the whole developing world.

WFEO national member engineering institutions have been pioneers in promoting cross border mobility of professional engineers for several decades. The outstanding examples are the Washington Accord, the FEANI EurIng, the APEC Engineers Register and the Engineers Mobility Forum. However, accreditation and certification remain very much within the purview of government in developing countries. In my opinion, South-South and global mobility of engineers and technologists can only be achieved through the World Trade Organisation (WTO), as WTO decisions are binding on member nations. WFEO has approached WTO offering to work with WTO for worldwide mobility of professional engineers in relation to agreements on trade in engineering and construction services, as the General Agreements on Trade in Services (GATS) are very much part and parcel of the WTO Doha Trade for Development Agenda 2003-2006. Surprisingly this WFEO offer has not received any response from WTO. Neither has it been received positively by those leading the Washington Accord and EMF within the global engineering fraternity. We urgently need WTO member nations to put STI human resource mobility on the negotiating table.

4.0 Conference on the History of Islamic S.E.T. as Heritage of Humankind

The serious problem of declining enrolment in science in secondary schools and universities in developing countries need to be addressed. Why is there an aversion to STI amongst the youth in developing countries, especially Islamic countries?

Currently, UNESCO is mounting an impressive exhibition "Golden Age of the Arabic Sciences" in Paris 29 October 2005-19 March 2006. (www.unesco.org/pao/exhib/islam.htm).The exhibition has been widely praised, including a special article in the Time magazine. In conjunction with the Exhibition, UNESCO has been organizing a series of workshops on Islamic Science and Technology. Independently, as WFEO President, I wrote in 2005 to the UNESCO Deputy Director General, Dr. M. Barbosa , on my long cherished proposal for an International Conference on History of Islamic Science, Engineering and Technology. My rationale is as follows:

> "There is a general aversion to S.E.T amongst male Islamic youth in developing countries. S.E.T. is perceived by them as Western and Islamic youth in developing world in general are rather anti anything Western. Yet, the developing world had a glorious history and heritage in S.E.T, be it China, India, Egyptian or the Incas etc. Indeed, it was Islamic S.E.T. with its algebra, astronomy, architecture and medicine etc that sparked the European Renaissance through Islamic Spain. We therefore need to acquaint our male Islamic youth of this glorious S.E.T heritage to revitalize their interest in STI as important tools for

poverty reduction, economic development and competitiveness.

History is most useful when we can use it to point the way to the future. In STI, it is important to also highlight the eminent Islamic scientists, engineers and technological industrialists that are carrying on the glorious Islamic S.E.T. tradition. The Conference should feature eminent Islamic scientists as role models to Islamic youth. The deliverable outcome from the Conference should be directed to incorporate the rich Islamic S.E.T heritage and the present day role models into the textbooks and curricula both in the developed world and the developing world so that the impression is not sustained that science, engineering and technological giants are all Western. Another important deliverable could be to encourage developing countries to nominate their significant S.E.T installations for UNESCO heritage listing. A third outcome could be the incorporation of historic Islamic S.E.T experiments in the IAP hands-on primary science education programme.

If the Islamic S.E.T Heritage Conference is successful, it should be followed by subsequent conferences on North East Asian (Chinese, Japanese, and Korean), Indian, African and Latin American S.E.T. heritage during the UNESCO's Decade of Education for Sustainable Development (2005-2014)."

There is also the UNESCO proposal to have a traveling exhibition from the Paris Exhibition to Islamic countries. Already Malaysia through the enthusiastic support of the Honourable STI Minister is committed to host the exhibition in Kuala Lumpur and Abu Dhabi, the venue of the last Nobel Centennial Exhibition, 2007 has shown keen interest.

I am pleased to announce that the Conference on the History of Islamic Science, Engineering and Technology as Heritage of Humankind will be held in UNESCO, Paris 15-17 March 2006, during the closing week of the Paris Exhibition.

5.0 Conclusion

In view of the global support for the MDGs, I am optimistic that poverty reduction through economic development will be achieved, especially if the S.E.T. communities in developing countries work to build up their STI human resource and institutional and enterprise-related capacity and make STI innovation as the pathway to achieve the MDGs.

As a professional engineer from industry, I regard the existing 4.0 billion poor and the prospective 3-4 billion poor as potential consumers in huge markets. We have only to look at Korea; Taiwan, China; Malaysia and South-East Asia in the past thirty years, China in the past ten years and India, Brazil and Mexico now. It is in everyone enlightened self interest to work for the success of the poverty reduction and economic uplift through the MDGs in developing countries..