

## **AC 2007-926: ENGINEERING CAPACITY BUILDING IN DEVELOPING COUNTRIES**

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# Engineering Capacity Building in Developing Countries

## Abstract

In the pursuit of a more secure, stable and sustainable world, developing countries seek to enhance their human, institutional and infrastructure capacity. To do so they need a solid base of technologically prepared people to effectively improve their economies and quality of life. Such a base will facilitate the infusion of foreign capital through attraction of multinational companies to invest in the developing country, assist in making the most of foreign aid funds, and provide a basis for business development by local entrepreneurs. The World Federation of Engineering Organizations is mounting major efforts at technical capacity building in developing countries.

## Introduction

An old Chinese proverb says:

*“Give a person a fish: you have fed the person for today. Teach a person to fish: you have fed the person for a lifetime.”*

In today’s global economy, one more level needs to be added for developing countries:

*And: teach the person how to process and package fish for export and market it, and you have stimulated economic development.*

Economic development for developing countries can be effectively stimulated by building the technical capacity of their workforce, through quality engineering education programs. A competent technical workforce base can then provide several paths to economic development: attraction of technically oriented multi-national companies, who can invest effectively in the developing country once there is a cadre of qualified local employees available; effective utilization of foreign aid funds, and providing a legacy of appropriate infrastructure projects and technically competent people to operate and maintain them; and small business startups by technically competent entrepreneurs.

Capacity building can be defined as follows:

*Capacity building is a dedication to the strengthening of economies, governments, institutions and individuals through education, training, mentoring, and the infusion of resources. Capacity building aims at developing secure, stable, and sustainable structures, systems and organizations, with a particular emphasis on using motivation and inspiration for people to improve their lives.*

In the global economy of the 21<sup>st</sup> Century, engineers play a key role in overall economic development for countries and regions. In the well developed countries, the role of the engineer is well understood and utilized. In much of the developing world, however, the

available pool of engineering talent is typically below critical mass – and economic development and even important basic societal needs that rely on engineering – such as clean water supply and sanitation – lack the technical talent to address them.

Technical capacity building efforts aim at developing a sufficient pool of well educated and certified engineering graduates in developing countries to effect three desirable outcomes:

- Technical capability is needed for developing countries to engage effectively in the global economy; direct foreign investment, international trade, mobility of engineers, and the flow of work to countries with cost-effective talent will result.
- Indigenous science and technology capacity is needed to insure that international aid funds are utilized effectively and efficiently – for initial project implementation, for long-term operation and maintenance, and for the development of capacity to do future projects. And a sufficient pool of engineers can enable a developing country to address the UN’s Millennium Development Goals effectively, including poverty reduction, safe water and sanitation, etc.
- In order to stimulate job formation in developing countries, a technical workforce pool is needed, made up of people who are specifically educated and prepared to engage in entrepreneurial startup efforts that meet local needs

The World Federation of Engineering Organizations, through its Committee on Capacity Building, is dedicated to assisting developing countries to engage effectively in the global marketplace via technical capacity building.

### **UN mandates**

*“Let me challenge all of you to help mobilize global science and technology to tackle the interlocking crises of hunger, disease, environmental degradation and conflict that are holding back the developing world.”*  
*Kofi Annan, 2002”*

Several of the development goals outlined in the Millennium Declaration<sup>1</sup> amplify this call to action:

Eradicate extreme poverty ... -- reduce by half the number of people living on less than a dollar a day

Ensure environmental sustainability -- reduce by half the proportion of people without sustainable access to safe drinking water

Develop a global partnership for development -- in cooperation with the private sector, make available the benefits of new technologies—especially information and communications technologies.

In his report to the September 2005 summit of world leaders, *In Larger Freedom*, United Nations Secretary General Kofi Annan<sup>2</sup> cited the need for utilization of science and technology for development:

67. To help drive economic development and to enable developing countries to forge solutions to their own problems, a significantly increased global effort is required to support research and development to address the special needs of the poor in the areas of health, agriculture, natural resource and environmental management, energy and climate. Two particular priorities should be to mount a major global initiative on research in tropical diseases and to provide additional support to the Consultative Group on International Agricultural Research (CGIAR) for research on tropical agriculture.

68. Information and communication technologies can significantly contribute to the achievement of the Millennium Development Goals. To fully utilize the potential of information and communication technology (ICT), we need to address the digital divide, including through voluntary financing mechanisms, such as the recently launched Digital Solidarity Fund.

The recommended effort in capacity building by the WFEO capacity building program is addressing these goals directly.

### **UN Millennium Goals and the Millennium Project**

From the Millennium Project<sup>3</sup> Web Site:

“The Millennium Project was commissioned by the United Nations Secretary-General in 2002 to develop a concrete action plan for the world to reverse the grinding poverty, hunger and disease affecting billions of people. Headed by Professor Jeffrey Sachs, the Millennium Project is an independent advisory body and presented its final recommendations, *Investing in Development: A Practical Plan to Achieve the Millennium Development Goals* to the Secretary-General in January 2005. The Millennium Project has been asked to continue operating in an advisory capacity through the end of 2006.”

“*Investing in Development* proposes straightforward solutions for meeting the Millennium Development Goals by the 2015 deadline. The world already has the technology and know-how to solve most of the problems faced in the poor countries. To date, however, these solutions have not been implemented at the needed scale. *Investing in Development* presents recommendations for doing so in countries both rich and poor.”

Key recommendations included:

## Recommendation 2

The MDG-based poverty reduction strategies should anchor the scaling up of public investments, capacity building, domestic resource mobilization, and official development assistance. They should also provide a framework for strengthening governance, promoting human rights, engaging civil society, and promoting the private sector.

## Recommendation 6

Developing country governments should align national strategies with such regional initiatives as the New Partnership for Africa's Development and the Caribbean Community (and Common Market), and regional groups should receive increased direct donor support for regional projects.

The Science, Technology and Innovation Task Force of the Millennium Project<sup>4</sup>, in its report *Innovation: applying knowledge in development*, further sharpens the picture with the following conclusion:

“It is more important than ever for developing countries to move ahead in scientific and technological development at an advanced level. Doing so will enable them to build local capacity that can help solve the many science and engineering – related problems they face. It will also position them to take an active part in the global knowledge economy.

Universities are vastly underutilized and potentially powerful vehicles for development in developing countries, particularly with respect to science and technology. If both universities and industry are encouraged to work actively together, universities will be able to assume new roles that could accelerate local and national development. Rendering these institutions more effective as key development partners will require changes at several levels of university administration. It will also require deep changes in enterprise, private as well as public, so that they can become strong demanders of the universities' capabilities, helping transform those capabilities into capacities. Government will need to act as a careful facilitator of interactions between these two actors. If this is achieved, the 'loneliness syndrome' that for so long affected universities in developing countries will be redressed, allowing them to contribute to economic growth and social development.”

The recommended effort in capacity building by the WFEO capacity building program is addressing these recommendations directly.

## Results of previous efforts

In a detailed study of the results of foreign aid to developing countries over the past several decades, William Easterly concludes, in his book “The Elusive Quest for Growth”<sup>5</sup> :

- *Previous efforts have tried to use foreign aid, investment in machines, fostering education at the primary and secondary levels, controlling population growth, and giving loans and debt relief conditional on reforms to stimulate the economic growth that would allow these countries to move toward self sufficiency*
- *all of these efforts over the past few decades have failed to lead to the desired economic growth*
- *these massive and expensive efforts have failed because they did not hit the fundamental human behavioral chord that “people respond to incentives”*

Having concluded that past efforts at stimulating economic growth in developing countries have failed, Easterly outlines what he thinks would work. He argues that there are two areas that can likely lead to the desired economic growth in developing countries, and can lead them toward economic self sufficiency:

- *utilization of advanced technologies, and*
- *education that leads to high skills in technological areas*

While emphasis on health and basic relief needs must continue, there is also a critical need to break the cycles of poverty through development of strong and competitive economies that can relate to world markets. The building of indigenous pools of people with quality educations in science, technology, and engineering can help lead to economic growth and healthy economies.

One need only look at examples from India and South Korea to see the effect of concerted efforts to enhance the education of engineers and technology graduates on the economies of these two countries. At the 2004 meeting of the American Society of Civil Engineers the South Korean delegation to the Capacity Building Forum presented the results of South Korea’s investment over the past three decades in the number and quality of engineering graduates. In 1970 South Korea had about 6,000 engineering graduates. In 1980 these were increased to 14,000. By 1990, the figure had jumped to about 80,000. When plotted against South Korea’s per capita GNP growth, the number of engineering graduates almost directly parallels the growth of the South Korean economy, offset by a few years. This data appears to show a direct cause and effect – investment in building a well qualified and sufficiently large pool of engineers leads to sustainable economic development.

In the case of India there has been a long-term effort to increase the numbers of engineering graduates and the quality of their education. Whereas in the past, many of these graduates sought employment outside the country, now many are returning and

newer graduates are staying to work in India in the software and design industries, often to high-tech cities where well-paying careers and extensive numbers of colleagues await them. The growing number of technically proficient and well-educated specialists also has enabled India to become a prime location for the outsourcing technical support by the world's leading technology firms.

In China, already a major economic power, the proportion of first science and engineering degrees to all bachelors-equivalent degrees was 59%, as compared to about 33% in the US in 2001 (Source: *Science and Engineering Indicators 2004*<sup>6</sup>). The report opens with the statement:

*“Excellence in (science and engineering) higher education helps a country to be technologically innovative and economically competitive.”*

### **What is needed**

First and foremost, a large enough pool of high quality, accredited engineering graduates is needed in developing countries so that the good results listed above can be realized. It must be recognized that there will be some leakage of these graduates to jobs in developed countries, but many will choose to stay where family ties and native country culture provide a comfortable environment.

But the basic need is the creation of good jobs in the home country. This is a chicken-and-egg issue. Increased demand for engineers will result only when there is a sufficient pool of well qualified graduates to attract direct foreign investment, multinational corporation operations, offshore outsourcing from developed countries, and entrepreneurial startups. Developing country planners and government officials must pursue effective economic development and job generation strategies in parallel with making the needed investments to enhance the quality and quantity of engineering graduates.

Engineering education in developing countries should include significant coverage of entrepreneurship – how to start, operate, and grow a small business. Note that US companies such as Hewlett-Packard, Microsoft, and Yahoo all were started in garages by enterprising young people with a technical bent. Engineering graduates should be equipped to take a path of creating jobs rather than seeking one if they wish to do so.

As technology based economies grow in developing countries, one important source of top talent – in addition to new engineering graduates – is the return of previous emigrants from the diaspora. Several countries that are developing well have benefited from the return of former citizens who see new opportunities in their home countries, and bring back foreign experience and network contacts to the benefit of their home countries.

In addition to increasing the number and quality of engineering graduates, and pursuing strategies to have good local jobs available, developing countries need mechanisms to

apply research and development results from local universities and companies for economic gain. Such mechanisms as incubators and small business development financing are needed in the mix.

### **Capacity building and the World Federation of Engineering Organizations**

Given the strong relation between creation of a critical mass of educated and skilled engineering and science graduates, shouldn't efforts be made to build these capacities in Sub-Saharan African countries? This is one of the conclusions reached by both UNESCO and the World Federation of Engineers (WFEO). The World Federation of Engineering Organizations was founded in 1968 under the auspices of the UNESCO in Paris and is a non-governmental international organization that brings together national engineering organizations from over 90 nations and represents some 8,000,000 engineers from around the world. WFEO is the worldwide leader of the engineering profession and co-operates with national and other international professional institutions in developing and applying engineering to the benefit of humanity.

In keeping with its mission, WFEO created its Standing Committee on Capacity Building at the WFEO General Assembly in Tunis in 2003. The Committee on Capacity Building held its first organizational meeting in Washington, DC in June 2004; this meeting was supported by the U.S. National Science Foundation. The Committee currently includes 44 members from 29 countries.

For the first several years of its activity, the WFEO Committee on Capacity Building concentrated its efforts in Latin America and the Caribbean, in a project labeled "Engineering for the Americas". This project, being carried out in conjunction with the Organization of American States, is focused on developing plans for enhancing engineering education and practice throughout Latin American and the Caribbean. The OAS Ministers of Science and Technology issued a major declaration in support of this capacity building effort at their meeting in Lima, Peru in 2004. A subsequent meeting held in Lima at the end of November 2005 attracted over 200 participants from the corporate sector, universities, national governments, and NGOs from throughout the hemisphere. Funding was provided by the U.S. Trade and Development Agency and several corporations, and was used to support attendance by over 100 of the participants. Results included defining the needs of the sector, steps necessary to enhance and ensure the quality of engineering education, and country-level financing and planning of capacity building efforts. A follow up meeting was held in Puerto Rico in January of 2006 and a steering committee and several action oriented sub-committees have been set up to pursue the recommendations from the November 2005 conference. This effort clearly demonstrates that cooperative efforts can successfully address issues of capacity building and how the profession can share common concerns and develop effective solutions to these concerns.

The WFEO Committee on Capacity Building, while continuing its Engineering for the Americas thrust, is now applying the successful model developed in Latin America to



sub-Saharan Africa. Many of the societal, human and economic needs identified in the Millennium Development Goals and other similar descriptions of the situation in developing countries are present in sub-Saharan Africa. The WFEO Committee on Capacity Building is developing programs to address a significant subset of those needs, in areas of its expertise. Activities will include: engineering education workshops; development of accreditation systems; entrepreneurial training, particularly for women; stimulation of internship programs; electronic delivery of courses; formation of Engineers Without Borders cells; and faculty and student exchanges.

A third major project where the Capacity Building Committee is taking the lead for WFEO is a major international colloquium on Women in Engineering and Technology, scheduled for June 2007 in Tunis. Keynote presentations will feature women leaders in engineering and technology, and four breakout tracks will focus detailed discussion: girls and women in engineering education; women as entrepreneurs of small and medium enterprises; women enabling technology in communities; and women in the engineering and technology workforce.

## **Conclusion**

Technical capacity building in developing countries as a lever for economic and social development is currently recognized as an important priority in the global engineering community. World leaders, including those in the United Nations system, have recognized and highlighted this priority. The WFEO Committee on Capacity Building is pursuing this priority on several fronts – with particular emphasis in Latin America and the Caribbean and in sub-Saharan Africa.

## **Bibliography**

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