Engineering for the Americas: Human Resource for Technology Based Social Development

L. C. Scavarda do Carmo¹, Lueny Morell², Daniel Marcek³, Russel C. Jones⁴, Marcos da Silveira⁵, Jorge Pedro Dalledonne de Barros⁶

Abstract - The Industrial Revolution transformed the productive sector landscape in the last two centuries, wherein productive capabilities resulted in much expanded economic development through advances in various forms of technology. Scientific discoveries accelerated the speed of more sophisticated applications and transformed industrial methods through scientifically based inventions and innovation. The twentieth century witnessed the improvement of social conditions for large numbers of people, but these improvements were neither uniform nor universal.

The torrential development in recent years of information technology – IT – is now making a new revolution in economic and social development possible by empowerment of individuals. This phenomenon underlines the profound need for revised educational objectives and reformed teaching methods, particularly in the areas of technology. Globalization of the productive sector was established by the intrinsically borderless nature of IT and its ability to empower individuals, generate small businesses, and create jobs that mature as enterprises to form the foundation for technology-based development.

Development in Latin America is not following the necessary path toward sustainable, technology-driven growth. It is not planning or investing in the creation of critical human resources necessary to compete in today’s global, knowledge-based world.

The Hemisphere of the Americas has inherent advantages in our common languages and cultural heritage. Despite the extensive asymmetry in social and economic development between North and South Americas, our common historical occidental background combined with a minimal number of distinct languages, geographical alignment and proximity position the Americas as a privileged region, poised and ready for economic and productive integration into the global economy, provided the appropriate workforce exists.

Engineering for the Americas is an initiative targeted at developing essential engineering talent for sustainable local development in the Americas. Through strong partnership among universities, NGO’s, governments, and Industry, EftA aims to establish mechanisms of quality assurance whereby economic opportunities expand due to an enhanced ability of people and work to flow cross-border, an increased, more highly skilled pool of human talent, and an increasingly technology-literate societies in general.

Through an inclusive, broad philosophy, Engineering for the Americas has emerged as a movement for cohesion and action throughout the region. Driven by a Ministerial mandate from the Lima Declaration (November 2004), EftA is gaining momentum and clarity as countries of the Americas move toward action in the effort to harmonize engineering education systems in support of national competitiveness and regional success in the global marketplace.

Index Terms – Economic Development, Engineering Education, Social Development

INTRODUCTION

The dawn of the Industrial Revolution two centuries ago in England began with factories that were nothing more than places where craftsmen could work without changing previous techniques. Slowly new techniques emerged and with the advent of mechanical gadgets and later motors the age of Energy was born. These events corresponded to a moment of immense increase in industrial productivity which drove increases in worker compensation, urban living, and a host of social developments.

By the end of the nineteenth century, improvements in energy creation, management, and distribution meant that the automobile industry could realize the serial method of assembly-line production. The onset of the automotive industry resulted in large scale of production capability. The overnight need to serve a mass market for their new product established market equilibrium with a relatively high salary level to the workers, who then enjoyed higher standards of

¹ L. C. Scavarda do Carmo, PUC-Rio, scavarda@vrad.puc-rio.br
² Lueny Morell, HP University Relations, lueny.morell@hp.com
³ Daniel Marcek, HP University Relations, daniel.marcek@hp.com
⁴ Russel C. Jones, World Expertise LLC, RCJonesPE@aol.com
⁵ Marcos da Silveira, PUC-Rio, marcos@ele.puc-rio.br
⁶ Jorge Pedro Dalledonne de Barros, PUC-Rio, dalle@vrad.puc-rio.br
The knowledge society of the twenty-first century is characterized by the value added by knowledge in the products and services. The unavoidable process of breaking the production process into pieces also generates the need to distribute the process of knowledge creation, moving laboratories and small entrepreneurial opportunities for designing to places where the right kind of expertise and creativity are present.

Countries in the twenty-first century must be able to deal with international production, market limitations, environmental considerations, and inherent difficulties that work dived into pieces imposes. While complexity in the late 50’s or 60’s meant the difficulties of putting together products with technologies coming from distinct areas of technical knowledge, present complexity involves also cultural aspects and respect for the environment. [2]

**Why International Engineering?**

Engineering has a dual role: It is responsible for the basic infra-structure, yet to be completed in the developing world, and is also the basis for building competitiveness and presence in the global market, yet modest in the developing world.

The “Millennium Objectives” were set by the United Nations. Every single issue associated to these goals (water, energy, health, agriculture, biodiversity, etc.) depends on good engineering for sustainable solutions. To help the developing world reach the goals set by the UN, the World Federation of Engineering Organizations (WFEO) organized a committee on Capacity Building, chaired by one of the authors (R.C. Jones) that is now devising mechanisms and actions that could improve the quality of Engineering by developing the related human resources. [3]

The new production methods moved toward to apparently distinct poles: from one side, a move to the large scale, the total globalization of markets and the production chain, and from another side, to the small scale, by empowering the individual, either the consumer as the entrepreneur. [4] These distinct poles reflect in the relevance of an Engineer that is able to work with a local eye, but also able to respond to global opportunities. Today’s engineers are both problem hunters and problem solvers. To effectively deliver on these responsibilities, engineers must now be educated to work in teams, have market awareness, understand business considerations, and deal with project members teams now composed of non-engineers and professionals from a variety of distinct cultures.

The international engineer differs from the local one in the need to be culturally and environmentally aware. [5]

**Regionalization**

Two areas in the world are developing as Regions with specific increase in internal trade agreements. One is the European Union, where more than commercial agreements a political integration is in process and a common currency is the most obvious example of unity. A less known example is

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the EUR-ACE (EUropean Acredited Engineer), that aims to establish a pan-European system of engineering accreditation educational programs. [6]

Another region is the Asiatic Pacific area. After the financial crisis in Asia that started in Thailand in 1997, several agreements were established in the Pacific Asia, most of them of bilateral character, and some involving also the United States or Europe. Commercial liberalization is very difficult to reach, mostly when non competitive agricultural groups need strong local subsidies and historical differences still persist. [7]

Regions are formed with two main objectives: to increase the overall competitiveness of the region and also to contribute to local development under the regional protection.

The United States, being a strong economy, practically of the size of each of the two above mentioned regions, is facing the necessity to cope with the increasing costs of production, including the cost of new knowledge development, which in turn generates the need to understand, engage, and support other areas in the world.

Latin America did not engage in a process of technology driven development, as did several developing countries in Asia, at least until the present moment. Like these oriental countries, Latin American and African countries are motivated to associate with a developed area in the world. The association with Europe or the United States does not exclude each other, since a set of agreements mostly of bi-lateral nature do not mean that kind of integration that Eastern Europe is now engaging with Western Europe. Nevertheless, the degree of commerce of Latin American countries with the United States, the presence of large industrial enterprises with interest in the Hemisphere of the Americas, combined with the trend in the United States toward mechanisms of production with a largely distributed chain of production strongly suggests the benefits in terms of both economic and social development of industrial integration within the Hemisphere of the Americas.

At the same time that this theme is discussed in ICEE-06, the second meeting of Ministers of Education of Latin America, the Caribbean and the European Union presents the Mexico Declaration proposing quality of higher education as a process to create a Common Area for Higher Education – ALCUE. [8] To be successful, both informal and formal initiatives are needed as the basis for increasing overall hemispheric competitiveness of the Americas in today’s global economy.

**Technology Driven Development**

Examples of India, China, Korea and Taiwan can be used to show the advantages of education, particularly modern technical education, as a serious mechanism of social development [1]. Nevertheless, the development in these countries was connected with nationals returning from the United States, already seasoned in their experiences in large international corporations. Moreover, only recently the facilities provided by communication and information technologies allowed the distribution of work and opportunities, including high end jobs.

These models from the Orient cannot be completely adopted in Latin America. This is a unique area in the world. The cultural ties can be underlined by a common history and similarities may be exemplified by the use of practically two very similar languages: Spanish and Portuguese. Although the area is very diverse, commonalities are unique as compared with other areas in the world.

By comparing the economic success in the last two or three decades, it is important to realize that the developing countries of the Orient and Latin America had a similar total gross domestic product as a share of the world 1980, and now the developing orient has share that is almost 4 times that of the Latin America. This “fading fortune”, as stated by the Wall Street Journal (see figure 1) must be compared with the South Korean effort to increase the number of graduations in Engineering in the same period (see figure 2).

![Fading Fortunes](figure1.png)

**FIGURE 1**

**WALL STREET JOURNAL, JULY 11TH, 2005**

![Engineering Graduation Rate in South Korea](figure2.png)

**FIGURE 2**

**ENGINEERING GRADUATION RATE IN SOUTH KOREA**

Careful analysis of the efforts on Engineering Education done by countries in the Orient show that the South Korean case is a typical example of efforts in the developing Asia to educate large amounts of high quality Engineers. [9]-[11].

**Engineering Mobility and Brain Drain**

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Technology driven development depends on a complex set of National programs and several actions of political, social and economic flavor. It also corresponds to a clear political decision of the civil society. The basic educational infrastructure to foster these actions will always be dependent on the existence of a sizeable technical workforce. National technical education consists of efforts to improve the population overall technical literacy in their scientific and technical aspects of the pre-university education (K-12) and Engineering Education.

Modern Engineering Education will create professionals able to deal with the basic-infrastructure of the country yet to be completed in developing countries, and always under reconstruction and improvement in developed countries. Moreover, modern engineers must be the professionals that will improve the industrial competitiveness of the industry. These professionals, if correctly educated in the developing countries, will be highly internationalized in their mentality, able to respond with a high level of mobility. Developed countries are unable to produce the necessary numbers of such professionals and will inevitably look to meet unfulfilled needs in the developing world. This process, known as brain drain, has been a significant deterrent to national programs for engineering education development and international cooperation in this field, mostly in Latin America. Nationals of this region fear to invest in highly skilled professionals only to loose them to the hunger for talent in international markets.

Recent studies performed by the National Academy of Engineering, in the US, points to the intrinsic ambiguity of objectives in the North American policies for foreign engineers.[9] On one hand, a strong workforce of foreign engineers is an unquestionable source for talented professionals, ready to move to the US, as far as present visa restrictions are simplified. On another hand, an important source of talented professionals may be the base for off-shoring (offshore out-sourcing) of jobs, with the double advantage of lower wages, with consequent increase in the overall productivity to the US and increase of opportunities and jobs in the developing countries. Besides, off-shoring mechanisms enlarge the internal markets of developing countries, particularly with sophisticated newcomers, with obvious mutual advantage to developing and developed countries.

The sixties produced a large movement of industrial plants to the developing countries. By that time, although many workers immigrated to developed countries, the overall increase of opportunities of jobs in the developing countries by far offset the workforce drain. The present situation differs from that started in the 50’s and 60’s since now high end jobs are being discussed when the overall production of wealth based on knowledge could be off-shored.

The next stage of further development in the developed world is now dependent of the effective development of the developing world. Difficult political decisions must now be taken in the developed world as well as in the developing countries.

The Engineering for the Americas initiative originated from a group of volunteers involved in Engineering Education, from Schools of Engineering and Industry, with particular interest in the Hemisphere of the Americas. Since its inception, Engineering for the Americas has evolved into a broad partnership of academics from throughout the Americas, Industry, Governments, NGO’s, Professional Societies, Accreditation Agencies, Banks, and inter-governmental agencies.

The Engineering for the Americas initiative is now a central component of an OAS-sponsored program that envisions engineering professionals able to be a fundamental resource for improvements in Hemispheric competitiveness in the global market, but also actors in local development by providing attractive opportunities forouthbound job mobility, expanded small business formation, and new job creation.

A critical mass of local qualified, credentialed engineering talent cohered by national direction, investment, and commitment to compete is the only mechanism to offset the unavoidable pressures of global competition. Engineering for the Americas seeks, through engineering education reform, modernization of curriculum, creation of competitive computing infrastructure, and application of quality assurance, to stimulate broad workforce creation and regional center of excellence that drive an enhanced ability for the Americas to compete and win.

The mission of the Engineer for the Americas strives:
- To work with the government, the industry, schools of engineering and civil society in order to foster hemispheric political decisions in support of technological-based development as a vehicle to gain hemispheric economic advantage
- To expand this community through inclusive opportunities for local indigenous industries as well as for the multi-national companies seeking to increase their presence in Latin America
- To devise and implement a form of hemispheric professional quality assurance across engineering disciplines
- To guarantee appropriate and relevant education throughout the Schools of Engineering of the Hemisphere
- To keep present and alive the good examples of Engineering best practice and good education in other regions of the world, as well as their mechanisms to improve regional competitiveness with local development
- To associate the several stakeholders like Schools of Engineering, Industry, professional associations, K-12 Schools, Government, and Engineering students around common goals
- To improve the quality of the pre-university technical education, aiming at reduction of technical illiteracy, but also to evangelize and enhance the image of today’s engineering professional their impact on local social and economic development
• To build a robust community aiming to attract the many stakeholders in order to maximize opportunity and minimize delay.

Actions fall in two categories: Top down actions of political players and bottom-up actions of good examples of successful activities involving distinct inter-institutional stakeholders.

Examples of successful top-down actions to date are the political efforts, led by the OAS, which prepared the Lima Declaration. In this document, signed in Lima, Peru, in November 2004 by Ministers of Science and Technology or corresponding high authorities, the relevance of science, technology and Engineering as important mechanisms for National development is strongly endorsed. These authorities also reaffirmed their willingness to foster interactions of the State members in programs of international cooperation in the area of Engineering and Engineering Education. This document was ratified by the American Heads of States in a declaration signed in Mar del Plata, Argentina, in December 2005.

Several meetings involving Schools of Engineering, industry and government representatives were prepared in the Hemisphere of the Americas. In November 2005, about 250 representatives of the stakeholders of the Engineering for the Americas program met in Lima, Peru to reaffirm their interest in developing either deeper top-down actions as well as bottom-up actions. A plan for these actions was sketched, particularly a plan per country. A new program for Engineering Education reform in Brazil is being prepared and a program to approximate Schools of Engineering in the Southern Countries of the Continent (Brazil, Argentina, Uruguay and Chile) is also in its way.

The International Conference on Engineering Education, ICEE-06, will also be a moment for further discussions and definition of actions.

The American Society for Engineering Education – ASEE organizes an annual international colloquium, this time in connection with its Brazilian counterpart, the “Associação Brasileira de Ensino de Engenharia – ABENGE”. [12] The 2006 issue of this colloquium will be held in October 9-12, 2006 in Rio de Janeiro. The three main themes of this colloquium are aligned with the main objectives of the Engineer for the Americas program. The themes are:

• Curriculum for the global Engineer
• The Primary and Secondary (K-12) Education
• Engineering for the Americas

CONCLUSIONS

Developed countries face a difficult dilemma. Further development cannot be reached without new markets in the developing countries. New markets may be built as part of a complex process of off-shoring part of the knowledge chain of production. The new markets will be made of entrepreneurs and well qualified engineers, with the real risk of reducing, at least in a first moment, the availability of high end jobs in the already developed countries.

The other mechanism of attraction of talented professionals, with facilitation of working visas, keeps the production of knowledge in the developed countries, with a dramatic cost of losses of talented professionals form developing countries, but without further growth of the available market or increase in the global competitiveness.

This dilemma was already faced by the industries in the late 50’s, 60’s and 70’s with the clear decision of off-shoring whole factories to the developing countries. The losses in blue collar jobs in the developed world were offset by the increase of the industrial competitiveness and the drain of talented personnel from the developing world was offset by the creation of new job opportunities.

Social and economic development in the twenty-first century is deeply dependent on science, technology and engineering. A relevant workforce of engineers and a scientifically literate population are necessary conditions for development.

The Engineering for the Americas initiative must implement a set of actions in a cooperative way to reach social and economic development based on technological infrastructure, including professional development and regional competitiveness. It is necessary to foster local industries that already reached global competence, help the emergence of new local industries, create international attractiveness for international industries with knowledge creation platforms, increase cooperation among the several stakeholders, generate interest in a deeper involvement in the K-12 stage of education, and finally structure modern and adequate schools of engineering. All these actions aim a new breed of professionals with strong analytical skills, but culturally connected, aware, and engaged in today’s global engineering practice.

The Engineering for the Americas initiative proposes to harness the intellectual capital of the nations of the Americas, create systems of education and quality designed to enable trade, and enable social and economic progress through understanding, participation, and mastery of all that the Digital Age has to offer. The competitiveness of the Americas depends on the development of our people – engineers are the foundation of change.

Only mutual understanding could make wisdom and mutual confidence win over fear and past disillusions.

REFERENCES

[11] A thorough study of Engineering Education needs for Brazil and Latin America is under way by the auspices of the National (Brazilian) Confederation of Industries. Preliminary results are due on May 2006.
[12] Visit the ASEE site for events, in http://www.asee.org