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Abstract

Engineering is key to economic growth for developed as well as developing countries. Engineering education and capacity building is a critical pillar in developing knowledge-based economies. Science, technology, engineering and innovation play a fundamental role in the creation of wealth and economic development and in the improvement of the quality of life for all citizens globally. This paper describes the role that HP University Relations is playing in the Latin America region in building engineering/science human capacity and infrastructure; from engineering education activities, sponsored research, and infrastructure projects; to student and faculty internships and the development of new technology communities. The paper will describe specific examples and the role of academia, government; non-governmental organizations as well as HP and other partners are playing.

I. Introduction – on capacity building, technology infrastructure and innovation

Recent research by ECLAC (UN Economic Commission for Latin America and the Caribbean) [1] on the contribution of investment and other sources of funding to Latin America’s growth during 1960-2002, describes four broad periods in Latin America’s growth experience:

1. The 1960s, representing the last “gold decade” of the import substitution industrialization (ISI) strategy combined with mixed external conditions;
2. the 1970s, representing the accelerated decay of the ISI model and mixed external conditions (improved terms of trade for oil exporters but falling terms of trade for non-oil exporters, and low real external interest rates);
3. The 1980s, representing the debt crisis and lost “decade”, which marks the accelerated transition from the ISI to a new export-led development strategy, a period of stabilization and reforms combined with deteriorated external conditions; and
4. the 1990s and early 2000s, associated with the gradual insertion of Latin America into the new globalization era: growth recovers but modestly compared to the 1960s and 1970s.

The research [1] found that secondary education was an important force contributing to per capita GDP growth during the 1960s and 1970s but its role declined in the 1980s and further in the 1990s and 2000s, as coverage of secondary education increased. The evidence suggests that education policies should incorporate new forms of expanding the base of human capital, mainly through efforts to improve the quality of all types of education and other training that facilitates a dynamic adoption of new technologies.

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1 The research combined growth accounting and regression analysis, and is based on a sample of the six largest Latin American countries (Argentina, Brazil, Chile, Colombia, Mexico, and Venezuela) which produce nearly 90 per cent of Latin America’s GDP.
In addition, the World Bank recommends that nations who wish to develop knowledge-based economies should concentrate their efforts on four major areas [2]:

- education and training
- communication and information infrastructures
- economic incentives and institutional regime, and
- innovation systems

The basic premise is that knowledge is becoming a primary factor of production, in addition to capital, labor and land. In fact, many economists now argue that knowledge has become the most important component of production. The belief is that a knowledge economy will lead to improved quality, reduced costs, better response to consumer needs, and innovative products.

It is widely accepted nowadays that globalization is radically accelerating the pace of change and raising the long-term stakes for all geographies. We also see both technology and knowledge playing an important foundation for meaningful economic development across the globe. Success in knowledge-based economies depends largely on the capabilities of people: countries that focus on education and training have experienced, and will continue to experience, tremendous growth. Thus, education and training, capacity building, is the most important foundation for developing economies.

According to Russel C. Jones, Chair of the World Federation of Engineering Organizations Capacity Building Committee:

“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, including societal development and poverty reduction. It has a particular emphasis on using motivation and inspiration for people to improve their lives. Capacity building efforts must be responsive to expressed needs of those to be served.”

Take, for example, Ireland. This country has experienced an extraordinary transformation in recent years. From a poor, largely agricultural country whose young people were leaving by the thousands each year to seek opportunities elsewhere, Ireland has become in the last two decades one of the most dynamic knowledge-based economies in Europe. Its GDP per capita has risen in 15 years from less than 60% of the EU average to slightly better than the EU average in 2002, overtaking its neighbor the United Kingdom. Its real GDP growth rate has averaged 6.5% over the past decade, during which it created 4 times as many net jobs as the UK. It has become a high-technology powerhouse within Europe, and the largest exporter of software in the region [2].

How did they do this? As in every case of dramatic and sustained economic growth, the reasons for Ireland's boom are complex. However, there is broad consensus that two factors in particular fueled Irish growth: education and foreign direct investment, the former being a precondition for
the latter. Most analysts agree that Ireland's failure to invest significantly in education for its first 50 years of independence was a major cause of its economic backwardness during those years. Beginning in the 60s and increasingly in the 70s, however, successive Irish governments made a major commitment to expanding educational opportunities, by extending free secondary education to all (eliminating fees in secondary schools) and by an increased effort to upgrade tertiary and technical education.

There is broad agreement that key factors in Ireland’s economic achievements in the 1990’s included the following [7]:

- A youthful population and rapidly expanding labor supply
- Substantial inward investment inflows
- The strategic deployment of EU Structural and Cohesion Funds
- Pursuit of pragmatic and innovative government policies
- A Social Partnership approach to economic development
- An openness to international trade in goods and services, and to new ideas; and,
- An emphasis on education and technological innovation.

These factors remain substantially in place. Without a doubt, the emphasis on educational and technological innovation has paid back with great return to the country’s economic development. Technology investments also catalyze economic growth. Economic studies conducted before the information-technology revolution show that as much as 85 percent of measured growth in U.S. income per capita was due to technological change [4].

In the case of another economic miracle in the Asian region, we find Singapore’s commitment to innovation infrastructure investments. The Government created an iN2015 vision, based on anticipated social needs, as well as the economic goals of Singapore’s key economic sectors. The objective is to bridge the computing, storage and bandwidth divide, making these affordable to Singapore’s citizens. The Government proposes four thrusts to realize this vision [8]:

- Spearhead the transformation of key economic sectors, government and society through more sophisticated and innovative use of infocomm;
- Establish ultra-high speed, pervasive, intelligent and trusted infocomm infrastructure;
- Develop a globally competitive infocomm industry; and
- Develop an infocomm-savvy workforce and globally competitive infocomm manpower.

By establishing an ultra-high speed information communication (“infocomm”) infrastructure and developing a globally competitive ICT-savvy workforce, Singapore aims to create and funnel more jobs into knowledge service oriented activities which will serve to fuel a vibrant information and telecommunication cluster to support the country’s economic development.

Thus, a strong case can be made for viewing engineers as the key knowledge workers for capacity building and sustainable economic growth in developed and emerging economies. Sustained investment in R&D to fuel innovation also plays an important role in economic development.
A well-known example of these investments is Finland [2]. In the 1960s, wood, pulp and paper products accounted for over 60% of Finnish exports. Even in 1990, this sector still accounted for 40% of exports, slightly above the share of metal and machinery products at 31%. Yet the figures for 1990 also showed the beginning of a trend that would confirm itself dramatically in the 90s: the emergence of Finland as a major exporter of electronic and high-technology products. By 2000, this sector had grown to over 30% of exports, and Finland had become a world leader in the production of cellular telephones and related equipment.

How did Finland, a small country with limited natural resources other than its forests, become a leading competitor in the "new economy"? Two factors in particular seem to have played a vital role: a sustained investment in research and development, to fuel innovation, and a coherent and forward-looking response to economic crisis. The foundations for Finnish success had been laid over several decades. Since the early 1980s, Finland consistently increased investment in R&D, and expanded public finance of business R&D in the late 80s and early 90s, at a time when OECD countries were dramatically reducing government R&D support.

An example particular to Latin America around capacity building as a base for economic development can be found in Chile. Through a World Bank program called “Mecesup”, Chile has strengthened tertiary education, supporting the development of doctoral programs. This, in turn, has led to significant growth in scientific capacity. From 80 doctoral programs in 1999, the figure rose to 126 in 2004; likewise, from 1,144 doctoral students enrolled in 1999, the figure jumped to 2,237 students in 2004. Doctoral degrees granted increased from 75 per year in 1999 to 238 in 2004, which translates into 15 PhDs per million inhabitants. Through this targeted program, Chile seeks to continue to develop a unique competitive advantage in the harvesting of its natural resources through technology, rather than simply trying to develop its manufacturing sector. [3]

Therefore, if technology and knowledge form the basis for meaningful economic development, given that globalization is radically accelerating the pace of change and raising the long-term stakes, it is clear that success in knowledge-based economies depends largely on the capabilities of people who are credentialed in meaningful and consistent ways. Engineers, then, are key to a country/region’s economic development and to grow knowledge-based economies. Further, the particular kind of knowledge countries need to develop is also key: first, literacy of the general population, and then educating problem-solvers who can build the technical infrastructure for sustainable change.

II. HP University Relations

Hewlett-Packard Company engages with the higher education community and leading academic institutions in many ways. From research interaction and student recruitment, to customer relationships and policy advocacy - numerous HP organizations and hundreds of HP employees advance the company's interests with higher education globally.

As a unit of HP Labs, University Relations (UR) extends the reach of Labs through programs that organize engagement with the external research community in alignment with HP technology strategies. As an HP corporate function, it broadens funding opportunities through
public/private partnerships, participates in major sales efforts to build the HP business and brand, and facilitates access to top talent in key growth areas. As a global team, University Relations staff partner with industry, government and academia to improve collaboration, accelerate knowledge transfer, and foster capacity-building -- through education, job creation, entrepreneurship and IT infrastructure -- in support of economic development. And finally, as thought leaders, the University Relations team works with leading research institutions and education organizations around the world to drive the higher education change agenda focused on innovation, quality assurance and diversity in engineering and science education.

“Through its global network of relationships with academic, governmental and industrial entities, University Relations increases HP’s capacity for innovation, expands business opportunities and contributes to global market development. UR works to align the technology interests and talent needs of HP with those of leading research institutions around the world. This activity not only extends HP’s knowledge supply chain, it also serves to shape and improve educational programs globally. HP receives financial, technological and human-resource returns through public/private partnerships, sales support efforts and community-building that the UR team drives.”

Wayne C. Johnson, Vice President HP University Relations Worldwide
2006 Annual Report

University Relations manages several strategic technology initiatives for HP Labs and fosters HP relationships with approximately 75 leading universities around the world. Program Managers are responsible for growing the relationships between HP and universities and capitalizing on the wide variety of interactions. Cross-functional planning, executive contact, strategic initiative generation and early trend identification are University Relations roles in HP engagement with partner institutions. In the U.S., over 40 Partner Universities are supported through aligned activity among College Recruiting Programs, Public Sector Sales/Higher Education Marketing, Corporate Philanthropy & Education, Government & Public Affairs, together with University Relations. University Relations facilitates similar integrated engagement with some 30 institutions in Europe, Latin America and Asia.

Technology Programs focus on accelerating the research and development of technologies of strategic importance to HP with collaborations in the academic research community. In the process, the promotion and adoption of these technologies is also accelerated. The programs are developed and led by University Relations with the support of HP Labs, HP businesses and HP corporate functions. Current programs focus on Linux-Itanium platform development; grid/utility computing; R&D investments in China and Singapore; mobility and rich media; digital printing, and cyber security.

Other important HP relationships touch dozens of universities and have their basis in HP Philanthropy programs, HP customer relationships, other research collaborations and recruiting activity.

III. HP efforts to build Capacity in Latin America and the Caribbean
In Latin America, HP University Relations works with a small network of leading research institutions and thought leaders whose strengths and interests are closely aligned with HP’s research and social goals. Currently, this group includes universities and researchers in Argentina, Brazil, Chile, Colombia, Costa Rica, Mexico, Panama, Peru, Puerto Rico, and Uruguay. Partnerships are built in collaboration with business units in the region. For example, in Brazil and Puerto Rico, University Relations partners with HP’s R&D groups.

Led by the Director for Latin America, HP’s UR Latin America team works to integrate all aspects of the relationship with these partner universities, from collaborative research to infrastructure development and support. In order to best illustrate this multi-stakeholder, multi-disciplinary approach, we have described some example initiatives and programs below.

A. Technology Programs – from worldwide strategy to local implementation

HP’s University Technology Programs respond to a particular focus area in HP’s research agenda, and seek to create linkages with the higher education community in order to advance the state of technology in this area and develop relationships with thought leaders. These company-level strategies, however, must be examined in the context of the region’s own capabilities and experience. UR Program Managers in Latin America regularly visit partner universities to understand their needs and skills, and create links to the right HP technology programs. At the same time, these relationships offer an opportunity to share best practices and contribute to aligning universities’ research capabilities to industry-specific challenges, acting as a bridge between academia and industry.

In the case of Linux-Itanium platform development, HP was co-founder of the Gelato Federation, the global technical community dedicated to advancing Linux on the Intel Itanium platform through collaboration, education, and leadership. This community, which began with just 7 members, has now grown to over 60 leading universities and research institutes, and comprises over 25% of the worldwide installed base of Itanium-based systems. In seeking new members from Latin America, the UR team found a significant hurdle in the low adoption rate of Itanium systems in the academic community.

UR’s approach, in the case of Latin America, is to partner with thought leaders who are interested in developing research on Linux-Itanium, and to help them develop the necessary technical infrastructure for research. UR also works to link scientists from Latin America to more experienced researchers from other areas, to support the new lines of work being developed by Latin American professors. Today, Gelato boasts 9 members from Latin America, who are active contributors to the technical research community and thought leaders in their own countries. Table 1 shows Gelato and PlanetLab current and future members in Latin America and the Caribbean.
HP is recognized around the world as a leader in imaging and printing research and development. For the past several years, scientists at HP Labs have been researching innovative ways to automate and streamline the production of variable content workflows in the commercial printing arena, known as Digital Publishing. In 2003, HP began to build collaborative research programs with a few universities in order to begin to expand the scientific community working in this burgeoning field. Having begun with two small projects, the work has now expanded to a community of over 20 universities around the world, collaborating with each other and with HP Labs to advance the state of Digital Publishing science through research and teaching. Working in collaboration with HP Corporate Philanthropy, HP University Relations has worked to identify the needs of these university partners to enable them to effectively conduct research. In 2006, 15 grants were awarded to universities around the world (including 3 in Latin America, to schools in Brazil and Mexico), allowing them to integrate digital printing and publishing into their curricula in innovative ways, and also providing them with the means to build new research efforts.

B. Collaborative Research and Development

While HP Labs is charged with the task of developing HP’s medium- and long-term research agenda, HP actually invests the majority of its R&D spending through other R&D units who focus on short-term R&D to bring the next generation of HP technologies to market. In Latin America, HP operates several of these centers, including a major manufacturing and R&D hub in Aguadilla, Puerto Rico, a strong R&D group in southern Brazil, as well as a manufacturing and
logistics R&D site in Guadalajara, Mexico. These sites have taken advantage of and also helped develop the knowledge ecosystem in their own regions, including close collaborations with university partners.

In the case of Puerto Rico, the University of Puerto Rico at Mayagüez’ (UPRM) strong engineering school has long been a source from which to recruit top engineering graduates and with whom HP’s R&D teams in Aguadilla have collaborated on many key technical challenges. For example, when HP Labs was seeking to develop a Technology Program around Digital Printing and Publishing in 2003, researchers from HP Puerto Rico and UPRM worked together to develop their skills and competencies in this new area, each creating strong research teams who are now leaders in their field.

In partnership with the Puerto Rican government and thanks to government incentives, HP Puerto Rico is successfully responding to the challenges and opportunities of the global economy. An important example is the establishment of the HP Technology Center. In 2001, HP Puerto Rico decided to approach the government of Puerto Rico to partner on a new economic development strategy. Through the government’s Industrial Development Company, HP received a five-year grant to establish the first bona-fide R&D operation in Puerto Rico: the HP Technology Center. The main goals of the center are to enhance HP’s value, enhance Puerto Rico’s economy, focus on R&D of new technologies, and leverage and enhance HP’s and partners’ human capital and resource capabilities.

During its first two years, the technology center built an R&D organization of nearly 60 people and now has three research teams: software and hardware, e-services, and an Imaging and Printing Excellence Center. Invention disclosures currently range in the thousands, more than 85 patents have been issued, and about 40 new products or processes enabling almost a billion dollars of manufacturing revenue have been developed.

In addition to the R&D outcomes, HP Puerto Rico leaders are participating in the government of Puerto Rico’s Science and Technology Roadmaps: Communications and Information Technology (C&IT) and Life Sciences (the most important technology cluster in Puerto Rico’s economy); providing new opportunities for HP and Puerto Rico. Evidence of this is the end-to-end product tracking and authentication solution the technology center has developed for the pharma/biotech industry, a technology to track and authenticate products across the whole pharma value chain. The solution is a breakthrough for the industry as well as potentially Federal Drug Administration standards, capabilities and policies.

The technology center also has developed strategic alliances with HP Labs and with labs in other HP business units. HP University Relations has assisted in developing these as well as collaborative initiatives with academia and other partners. This offers Puerto Rico’s scientists and engineers the opportunity to partner with top research, development and manufacturing groups around the world. The center can most certainly help move Puerto Rico into a knowledge-based economy, and it is becoming a showcase that can attract further investments in Puerto Rico and other developing economies.
HP Brazil’s R&D operation is located in Porto Alegre, in the campus technology park of the Pontifical Catholic University of Rio Grande do Sul (PUCRS). PUCRS researchers have worked with HP Brazil in areas such as Parallel and Distributed Computing, Digital Printing and Publishing research, Imaging and Display technology and software development and testing. And while this location allows for a particularly close working relationship with PUCRS researchers in many areas, the HP Brazil team has not limited itself to working with PUCRS, but rather works with nearly 20 universities and research centers throughout Brazil. The results continue to shine, with a growing number of technical papers published by HP-University teams in international conferences each year.

HP Mexico’s Guadalajara operation covers a range of activities, from printer manufacturing to Business Process Outsourcing (BPO), and R&D teams are working to improve each of these areas and advance HP’s ability to serve its customers. For example, the manufacturing logistics team has partnered with a team of 3 local universities to develop research projects around RFID in HP’s own facilities. The universities, who did not have formal RFID research before being approached by HP, developed their competencies by working side-by-side with HP engineers and have since integrated RFID into their curricula. Several students have completed theses in this area, and the university and HP are continuing to collaborate on R&D projects in this area. This pioneering work has led UR to expand the work to other countries, with the recent creation of an RFID Technology Program, led by top Latin American institutions.

HP Guadalajara has also begun to replicate the effort undertaken by HP Puerto Rico to change from an operations site to an intelligent-operations center, developing their knowledge capabilities in RFID and supply chain optimization areas, enabling them to provide high-level technical services to other areas of the company.

One way of catalyzing research collaboration is through conferences and workshops. University Relations not only supports several technical and education-related conferences in the region, facilitating faculty attendance, but also organizes events to bring together scientists from HP and universities to share and discuss innovations in technology. In May 2006, and co-hosted by UPRM, the First Latin America Utility & Grid Computing Workshop was held in San Juan, Puerto Rico. The goals were to understand the state of Grid/Utility Computing R&D and applications in Latin America, share HP’s technology roadmap in these areas and foster a sense of community. More than 65 scientists from HP and universities and research institutes attended, stimulating collaboration throughout the region.

C. Capacity Building
As HP has continued to cultivate relationships with leading universities in Latin America, much of this work has taken place in partnership not only with faculty, but also with students, both at the undergraduate and graduate levels. These talented students have often integrated research topics into their theses or senior design projects, and have also had the opportunity to work alongside industry representatives, gaining a better understanding of the skills expected of them when they enter the professional world.

In addition to working with their professors as part of their studies, some students also have the opportunity to work directly for HP. HP Labs seeks to hire talented students every year as research interns in a variety of project areas, offering real-world, complex technical challenges to the brightest individuals from around the world. In the past 2 years, several HP Labs researchers have begun to actively recruit from partner universities in Latin America to meet their research needs. These students typically will spend anywhere from 3-6 months at HP Labs, and in some cases, up to 1 year. They can then return home to continue their education (pursuing Master’s or Doctoral degrees, in key research areas, contributing to the development of their own university’s research portfolio) or seek employment in their home country armed with real-world experience. The idea is to enhance the student’s skill set and knowledge, and allow him to return to his own country to pass-on this knowledge to create a strong knowledge ecosystem, avoiding a “brain drain” situation.

To further support the return of the student to his country’s knowledge ecosystem, HP is currently working with government economic development agencies or science and technology ministries in several Latin American countries to support a longer length research experience for students. The student would spend a 6-month internship at an HP Labs site, and then return to his home country to continue work on the research project for an additional 6-18 months, depending on the topic and need. Governmental agencies can assist in creating a “brain gain” by providing stipends to students as they continue work on their research problems from home, for example.

Another dimension of capacity building that HP University Relations is facilitating in the region is engineering curriculum innovation/reform and quality assurance/accreditation initiatives. Numerous workshops on these topics have been delivered to institutions in Mexico, Argentina, Brazil, Peru and Chile, seeding important developments, as the following comment from the Director of the University of Chile states:

“This workshop turned out to be the seed of a continuing effort to change our teaching methods... our school has started work on a deep review of our curriculum and our approaches to teaching and learning. Many of the professors involved recognize that experience as a turning point in their careers. Our school is strongly research-oriented and teaching often tends to be seen as a lower priority activity. The workshop changed this for many people, and this lasting effect is proof of the value of the methodology developed by the Learning Factory.”

Patricio Poblete Olivares  
Director of the School of Engineering and Science  
University of Chile
Other support includes active participation in country/regional advisory boards like ANIEI (National Association of IT Education Institutions) in Mexico, or as an advisor to specific engineering programs (such as the advisory council for UPRM’s doctoral program in Computer Science Engineering).

IV. Achieving Better Results Through Partnering with Multiple Stakeholders

In order to achieve sustainable capacity building, one cannot act alone. HP University Relations believes that effect real change among engineering graduates, industry, university and government need to be aligned to provide the right conditions.

Industry must be willing to articulate its needs from engineering graduates and provide practical experience to students; Universities must be able to listen and respond to industry needs in adapting the curricula their students follow, as well as working to ensure quality is maintained and accreditation standards and developed and met; finally, Government agencies should ensure that they create the right economic conditions to foster the development of knowledge workers, and that these new graduates have a place to contribute to their country’s development.

For this reason, HP has been a strong supporter of the Engineering for the Americas (EftA) initiative, which seeks to bring together these multiple stakeholder groups across the entire region of the Americas, providing global leadership and achieving economic impact through development of the hemisphere’s engineers. EftA comprises industry and university representatives; and governmental and non-governmental agencies (such as engineering education and accreditation agencies), working together to address engineering education, quality assurance, and professional mobility [5,6].

V. Conclusions

Capacity building and economic development projects are complex undertakings, with many factors influencing their success. And while many of these factors can be out of our hands, there are areas where industry, universities and governments can act in order to effect real change. HP University Relations is working towards making a difference in Latin America through strong partnerships with multiple stakeholders. HP works to regionally implement technology programs and infrastructure grants to support HP’s research objectives and goals for improvements in engineering education. In taking multiple approaches, HP has begun to make tangible strides in building human capacity in Latin America.

References


