

Engineering Program Accreditation in Latin America and the Caribbean

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Abstract

The International Engineering Accreditation Alliance (IEA) is formed by the signatories of the six international agreements governing mutual recognition of qualifications and professional competence of engineers. Washington Accord recognizes substantial equivalence in professional engineering degrees (normally a 4 years degree). The Sydney Accord recognizes substantial equivalence in engineering technology degrees (normally a 3 year). The Dublin Accord provides the same for engineering technician degree (normally 2 years). There are three other agreements that cover competence standards for individual practicing engineers (the APEC Engineer Agreement, the International Professional Engineers Agreement, and the International Engineering Technologist Agreement). This paper will focus on engineering program accreditation, not credentialing of individual engineers.

None of the engineering program accreditation agencies in Latin America and the Caribbean are members of the IEA. There are different strategies used to provide access to engineering program accreditation or quality assurance to universities in the Latin America and Caribbean. These are examined, and a summary of the state of engineering program accreditation in the region will be presented.

Introduction

Engineering program accreditation is the key to a global knowledge economy. Internationally recognized Engineering accreditation establishes programmatic and institutional optimization that provides quality assurance, internationally recognized standards, and a process of continuous improvement. This would bring internationalization to academia, which would in turn build capacity, foster development, enable mobility and move the countries to global competitiveness.

The International Engineering Accreditation Alliance (IEA) [1] groups the agencies that have become signatories of the six international mutual recognition agreements:

- *Washington Accord* for the substantial equivalence of professional engineering degrees (~4 year degree),
- *Sydney Accord* for the substantial equivalence of engineering technology degrees (~3 year degree), and
- *Dublin Accord* for the substantial equivalence of engineering technician degrees (~2 year degree).

Figure 1 shows the Signatories of these accords. Of particular importance is that no Latin American and Caribbean (LAC) country has signed the accords, and only one, from Peru, is a Provisional Signatory. This puts the LAC region in a serious disadvantage, as they need to go through another country's agency to attain substantial equivalence, and translate all accreditation documentation to a language other than their mother tongue. This results in a

more costly accreditation process, and much more effort required from the faculty and administration, yielding a slower process to attain substantial equivalence.

The Ministers of the Science and Technology of the 34 countries members of the Organization of American States (OAS) developed an initiative called *Engineering for the* Americas and one of its first charges in 2005 was to develop a Greater Caribbean Region Engineering Accreditation System (GCREAS), which was funded by the Inter-American Development Bank (IDB), with the intent that the countries in this region would not have to translate their documentation, and that the GCREAS would eventually become a signatory of the IEA. The IDB also funded a second accreditation agency, ACAAI (for its acronym in Spanish: Agencia Centroamericana de Acreditación de Arquitectura e Ingenierías), for Central America. GCREAS was based on the ABET model, while ACAAI was based

Table 1. Signatories and Provisional Signatoriesof the International Engineering AccreditationAlliance

Signatories: Australia - Engineers Australia Canada - Engineers Canada Chinese Taipei - Institute of Engineering Education Taiwan Hong Kong China - The Hong Kong Institution of Engineers India - National Board of Accreditation Ireland - Engineers Ireland Japan - Japan Accreditation Board for Engineering Education Korea - Accreditation Board for Engineering Education of Korea Malaysia - Board of Engineers Malaysia New Zealand - Institution of Professional Engineers NZ Russia - Association for Engineering Education of Russia Singapore - Institution of Engineers Singapore South Africa - Engineering Council of South Africa Sri Lanka - Institution of Engineers Sri Lanka Turkey - MUDEK (2011) United Kingdom - Engineering Council UK United States - ABET **Provisional Signatories** Bangladesh - Board of Accreditation for Engineering and Technical Edu China - China Association for Science and Technology

China - China Association for Science and Technology Pakistan - <u>Pakistan Engineering Council</u> Peru - <u>ICACIT</u> Philippines - Philippine Technological Council

on the Engineers Canada model of accreditation. However, to this date, none have moved to become a Provisional Signatory.

In this paper we review different processes that LAC institutions are undergoing to attain international engineering program accreditation or substantial equivalence.

Regional vs. International Accreditation

LAC institutions need to determine whether they want to pursue regional accreditation, such as that provided by the countries of MercoSur (Argentina, Brazil, Paraguay, Uruguay, Venezuela, and associate countries: Chile, Bolivia, Colombia, Ecuador, Peru), or international accreditation. Regional accreditation brings the immediate benefit that the graduates of accredited programs can practice as professional engineers in the countries that compose the treaty. International accreditation does not bring this benefit, as the credential of the professional engineers is not under the realm of the accreditation agencies and requires treaties or agreements.

ABET began in 2007 to accredit international programs instead of granting substantial significant. Ten percent of the programs accredited by ABET are overseas programs. The Middle East requests the largest number of visits, followed by Latin America and Asia. ABET

requires the international program seeking ABET accreditation to coordinate the request with the in-country accrediting agency or overseeing body.

Licensure vs Accreditation

Since 2006 the National Council Examiners for Engineering and Surveying, charged with the Fundamentals in Engineering (FE) and Professional Engineers (PE) Exams that are part of credentialing Professional Engineers in the United States, have offered PE exams in Japan [2]. The NCEES has since signed agreements to offer FE and PE exams in Canada, Saudi Arabia, the united Arab Emirates, Egypt and Turkey; and are in the process of expanding it to countries in Asia and the Middle East. The PE credential is required by many international firms, for others is viewed as an honor or gold-standard. The International Professional Engineers Agreement (IPEA) developed an international standard of competence framework for professional engineering. Those that meet these international standards are credentialed as International Professional Engineer (IntPE), and are registered in the International Register of Professional Engineers (IRoPE). To qualify for a country's register, the engineer must hold a degree accredited or deemed substantially equivalent by a signatory of the Washington Accord, have completed seven years of practice (two in a position of responsibility), and maintain continuing professional development. Licensure in the United States requires, not only passing the PE exam, but additionally application through a State Board, many of which require state residency for licensure.

Several states, such as Oregon, Texas, North Carolina, Washington and Kentucky, which do not require a minimum 6 month residency for Professional Engineers licensure are allowing non-residents to take the PE Exam. Texas has signed agreements with Canada, Mexico and Australia to allow engineers licensed in these countries to apply for a temporary one-year license, renewable for total of three years, in Texas The United States National Society of Professional Engineers (NSPE) has signed agreements with the Japan Society of Professional Engineers, the Society of Professional Engineers in the UK, and the Korean Professional Engineers Association to encourage eligible members (graduates of ABET-accredited or ABET-equivalent programs and those licensed in the U.S. or these countries) to become NSPE members.

Accredited or Substantial Equivalence Programs in Latin America and the Caribbean

Table 1 summarizes a listing of the accredited engineering programs (or deemed substantially equivalent) in Latin America and the Caribbean compiled using the search engines of the different accrediting agencies. As seen from the table, only 9 Latin American and Caribbean countries (Chile, Colombia, Costa Rica, Ecuador, Jamaica, Mexico, Peru, Puerto Rico, and Trinidad Tobago) have sought international accreditation or equivalence. The first accredited program was in Puerto Rico in 1960. This past year, Ecuador accredited its first programs. The majority of programs choose ABET for accreditation. Central America seeks accreditation from the Engineers Canada's Canadian Engineering Accreditation Board (CEAB). English-speaking Caribbean selected Engineering Council UK (UK-EC).

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Monterrey, Campus QueretaroBS, Electronic & Computer Eng.2008BS, Industrial Eng. minor Systems Eng.2008BS, Mechanical Engineering OptA2008		ABET	Instituto Tecnológico de Estudios Superiores de	BS, Computer Engineering	2008
BS, Industrial Eng. minor Systems Eng. 2008 BS, Mechanical Engineering OptA 2008			6 1		
BS, Mechanical Engineering OptA 2008					
BS Mechatronics Engineering 2008				BS, Mechatronics Engineering	2008

 Table 1. Accreditation and Substantial Equivalence in Latin America and the Caribbean

Mexico	ABET	Universidad Anahuac	BS, Mechatronics Engineering	2011
Mexico	ABET	Universidad Autónoma de Nuevo León	BS, Civil Engineering	2009
			BS, Food Industry Eng.	2009
			BS, Materials Engineering	2012
Mexico	ABET	Universidad Autónoma de San Luis Potosí	BS, Chemical Engineering	2012
			BS, Civil Engineering	2011
			BS, Electrical Engineering	2014
			BS, ElectroMechanical Engineering	2014
			BS, Food Engineering	2012
			BS, Mechanical-Industrial Mgmt Eng.	2012
			BS, Mechanical Engineering	2014
			BS, Mechatronics Engineering	2012
Peru	ABET	Pontificia Universidad Católica del Perú	BS, Civil Engineering	2008
			BS, Electronic Engineering	2008
			BS, Industrial Engineering	2008
			BS, Informatics Engineering	2008
			BS, Mechanical Engineering	2008
Peru	CEAB	Pontificia Universidad Católica del Perú	BS, Electronic Engineering	2008
			BS, Industrial Engineering	2008
			BS, Informatics Engineering	2008
Peru	EUR-	Pontificia Universidad Católica del Perú	BS, Electronic Engineering	2008
	ACE		BS, Industrial Engineering	2008
			BS, Informatics Engineering	2008
Peru	ABET	TECSUP – Tecnológico Superior, Arequipa	PT(BS), ElectroTechnics Technology	2008
		Campus	BS, Network / Data Comm.Technology	2009
			PT(BS), Plant Machinery Maintenance	2008
Peru	ABET	TECSUP – Tecnológico Superior, Lima Campus	PT(BS), Chem. & Metallurgical Proc. Tech.	2008
			PT(BS), Electro Technics Technology	2008
			PT(BS), Industrial Automation & Electronics	2010
			Technology	
			PT(BS), Network / Data Comm.Technology	2009
			PT(BS), Plant Machinery Maintenance	2008
Peru	ASIIN	TECSUP – Tecnológico Superior	Tech., Chemical & Metallurgical Processes	2008
			Tech., Maintenance of Heavy Machinery	2011
			Tech., Industrial Electro Technical	2008
			Tech., Industrial Electronics & Automation	2008
			Tech., Plant Machinery Maintenance	2008
Peru	ABET	Universidad Nacional de Ingeniería	BSCE, Civil Engineering	2011
Peru	ABET	Universidad Peruana de Ciencias Aplicadas	BS, Electrical Engineering	2008
			BS, Information Systems Engineering	2010
			BS, Software Engineering	2008
Peru	ABET	Universidad Ricardo Palma	BS, Civil Engineering	2008
			BS, Electronics Engineering	2010
			BS, Industrial Engineering	2010
			BS, Informatics Engineering (Software Eng.)	2010
Peru	ABET	Universidad de San Martin de Porres	BS, Electronic Engineering	2008
			BS, Industrial Engineering	2008
			BS, Information Systems	2010
			-	
Peru	ASIIN	Universidad de San Martin de Porres	BS, Computer & Systems Engineering	2009
			BS, Electronic Engineering	2009
			BS, Industrial Engineering	2009
Peru	ABET	Universidad Tecnológica del Peru	BS, Electronics Engineering	2009
	ABET	InterAmerican University of Puerto Rico,	BS, Electrical Engineering	2009
Puerto Rico	TIDDI		BS, Industrial Engineering	2009
Puerto Rico	TIDET	Bayamon Campus	b5, industrial Engineering	2007
Puerto Rico	ADD1	Bayamon Campus	BS, Mechanical Engineering	2009
Puerto Rico Puerto Rico	ABET	Bayamon Campus Polytechnic University of Puerto Rico		
		й I	BS, Mechanical Engineering	2009
		й I	BS, Mechanical Engineering BS, Chemical Engineering	2009 2006
		й I	BS, Mechanical Engineering BS, Chemical Engineering BS, Civil Engineering	2009 2006 1994
		й I	BS, Mechanical Engineering BS, Chemical Engineering BS, Civil Engineering BS, Computer Engineering BS, Electrical Engineering	2009 2006 1994 2006
		й I	BS, Mechanical Engineering BS, Chemical Engineering BS, Civil Engineering BS, Computer Engineering	2009 2006 1994 2006 1994
		й I	BS, Mechanical Engineering BS, Chemical Engineering BS, Civil Engineering BS, Computer Engineering BS, Electrical Engineering BS, Environmental Engineering	2009 2006 1994 2006 1994 2000
		й I	BS, Mechanical EngineeringBS, Chemical EngineeringBS, Civil EngineeringBS, Computer EngineeringBS, Electrical EngineeringBS, Environmental EngineeringBS, Industrial EngineeringBS, Land Surveying and Mapping	2009 2006 1994 2006 1994 2000 1994
	ABET	Polytechnic University of Puerto Rico	BS, Mechanical EngineeringBS, Chemical EngineeringBS, Civil EngineeringBS, Computer EngineeringBS, Electrical EngineeringBS, Environmental EngineeringBS, Industrial EngineeringBS, Land Surveying and MappingBS, Mechanical Engineering	2009 2006 1994 2006 1994 2000 1994 2000
Puerto Rico		й I	BS, Mechanical EngineeringBS, Chemical EngineeringBS, Civil EngineeringBS, Computer EngineeringBS, Electrical EngineeringBS, Environmental EngineeringBS, Industrial EngineeringBS, Land Surveying and Mapping	2009 2006 1994 2006 1994 2000 1994 2006 1994

Puerto Rico	ABET	University of Puerto Rico – Bayamon Campus	A.S., Civil Eng. Technology Construction	2009
			BCS, Computer Science	2011
			BS, Electronics Engineering Technology	2009
			A.S. Industrial Engineering Technology	2009
			BCS, Information Systems	2011
			A.S., Instrumentation Technology	2009
			A.S., Surveying Roads and Structural Civil	2009
			Construction Technology	
Puerto Rico	ABET	University of Puerto Rico – Humacao Campus	A.S., Electronics Technology	2007
Puerto Rico	ABET	University of Puerto Rico – Ponce Campus	A.EngT., Civil Engineering Technology in	2011
			Architectural Drafting	
			A.EngT., Civil Engineering Technology in	2011
			Construction	
			A.Eng.T., Industrial Engineering Technology	2011
Puerto Rico	ABET	University of Puerto Rico – Mayagüez Campus	BS, Chemical Engineering	1970
			BS, Civil Engineering	1960
			BS, Computer Engineering	1992
			BS, Electrical Engineering	1960
			BS, Industrial Engineering	1970
			BS, Mechanical Engineering	1960
Puerto Rico	ABET	University of Puerto Rico – Rio Piedras Campus	BBA, Computer Information Systems	2010
1110 1110			BS, Computer Science	2008
Puerto Rico	ABET	Universidad del Turabo	BS, Computer Engineering	2009
			BS, Electrical Engineering	2007
			BS, Industrial and Management Engineering	2007
			BS, Mechanical Engineering	2003
Trinidad	UK-EC	University of Trinidad and Tobago	BEng, Applied Petroleum Engineering Tech.	2010
and Tobago	en Lo	eniversity of frinduid and foouge	BTech, Electronic Engineering	2002
und Foougo			BTech, Mechanical Engineering	2002
			BEng, Petroleum Engineer	2002
			MSc, Petroleum Engineering	2007
			MEng, Petroleum Engineering	2010
			MSc, Petroleum Technology	2007
			MSc, Reservoir Engineering	2010
Trinidad	UK-EC	University of West Indies	BSc, Agricultural Engineering	1994
and Tobago	en Le	Chiveisity of West Indies	BSc, Chemical and Process Engineering	1967
and Tobago			MSc, Chemical and Process Engineering	2008
			MSc, Chemical and Process Engineering	2008
			with Environmental Engineering	2000
			MSc, Chemical and Process Engineering	2008
			Management	2000
			BSc, Civil and Environmental Engineering	2003
			MSc, Civil with Environmental Engineering	2005
			BSc, Civil Engineering	2005
			MSc, Civil Engineering	2005
			MSc, Construction Management	2003
			BSc, Electrical and Computer Engineering	1988
			BTech, Electronic Engineering	2002
			MSc, Engineering Asset Management	2002 2008
			MSc, Engineering Management	2008
			BSc, Industrial Engineering	1994
			MSc, Manufacturing Engineering	2006
			BSc, Mechanical Engineering	1994
			BTech, Mechanical Engineering	2002
			BSc, Mechanical Engineering with minor in	2000
			Biosystems Engineering BSc, Petroleum Engineering	2009
			MSc, Production Management	2009 2006
l	L		MSC, Production Management	2000

It is curious to note that in Peru, some universities are seeking accreditation from multiple accrediting agencies (ABET, CEAB, ASIIN). This latter strategy is very costly and seems to be motivated for marketing reasons, forcing other universities in Peru to also seek multiple accreditations to remain competitive.

Analyzing the numbers of programs that attained international accreditation in Latin America and the Caribbean, classified by year first attained, yields the chart in Figure 1. A total of one hundred eighty two (182) programs have reached international accreditation. The first programs were accredited in 1960. In the following decade only 3 additional programs attained accreditation. The next 30 years only 10 more were accredited. In the first 5 years of the new millennium emphasis was made by the Ministers of Science and Technology of the 34 countries member of the Organization of American States, 15 additional programs reached accreditation, doubling the number of accredited programs in the region. In the next five years after that, 104 programs sought accreditation successfully. However in the past 5 years, only 47 new accreditation of programs were obtained. This slowdown is a cause for concern.

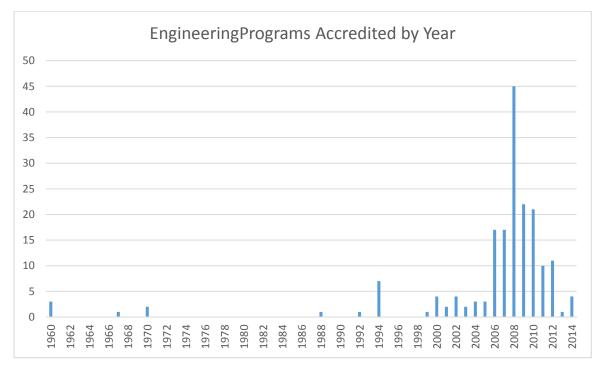


Figure 1. Number of engineering programs internationally accredited by year in Latin America and the Caribbean.

Strategies to increase accredited engineering programs in Latin America and the Caribbean

There is a need for a multipronged strategies to substantially increase the number of accredited programs in the Americas.

Strategy #1: Increase signatories of the IEA Accords

The Engineering for the Americas (EftA) initiative of the Ministers of Science and Technology of the countries of members of the OAS developed the strategy to create new accrediting agencies committed to signing the mutual recognition accords that form part of the International Engineering Agreements Alliance (IEA). With funding from Hewlett Packard and others to write the proposal, the Interamerican Development Bank (IDB) funded the creation of two accrediting agencies:

- 1. ACAAI: Central American Accrediting Agency for Architecture and Engineering, was designed based on Engineers Canada's Canadian Engineering Accreditation Board (CEUB) model, which was the preferred model of Central American institutions.
- 2. GCREAS: Greater Caribbean Region Engineering Accreditation System, was designed based on ABET, but soon was determined by the English-speaking Caribbean not to meet their needs,

A third new accrediting agency was created by IEEE and the University of West Indies:

3. CACET: Caribbean Accreditation Council for Engineering and Technology. This was deemed to fit closer to the model for developing Chartered Engineers

However, looking at Table 1, ten years later none of the three have moved to become a provisional signatory of the Washington, Dublin, and Sydney accords. This has led to some frustration and more agencies that are accrediting in this region:

4. CFIA: Colegio Federado de Ingenieros y Arquitectos in Costa Rica is accrediting Engineering programs in Costa Rica and is seeking support from Engineers Canada to become a provisional signatory and join the IEA.

Increasing the number of signatories of the IEA would permit larger numbers of institutions to seek internationally recognized accreditation at a lower effort and cost than seeking accreditation outside of their nation/region. Hopefully other countries will join the signing, such as Mexico, Brasil, Argentina, Chile and Colombia that have mature accrediting agencies.

Strategy #2: Sign a regional accord towards mutual recognition and mobility within the LAC region

In 2010, the ALAI Latin American Engineering Accreditation Accord was signed by national and regional accrediting agencies and engineering education associations in the LAC region. Argentina (CONFEDI), Bolivia (CEUB), Brasil (ABENGE and CONFE), Central America (ACAAI), Chile (Acredita and CONFEDI), Colombia (ACOFI), Mexico (CACEI) and Paraguay (CPI). Institutions with internationally-recognized accredited programs are being asked to join the MercoSur Treaty to expand mobility to countries outside of MercoSur (Argentina, Brazil, Paraguay, Uruguay, and Venezuela; and associate countries: Chile, Bolivia, Colombia, Ecuador, and Peru).

Strategy #3: Professional societies assist national accreditation agencies to align their process to comply with the IEA Accords

The IEEE (Insittute of Electrical and Electronic Engineers) is working with the Peruvian accrediting agency, ICACIT (for its acronym in Spanish, meaning: Institute of Quality and Accreditation of Engineering Career and Technology Education), which was founded in 2001. It translated the ABET materials into Spanish, trained evaluators, and assisted in ICACIT-

ABET simultaneous accreditation visits since 2007, and ICACIT accreditation visits starting in 2009. This effort has been successful and has resulted in ICACIT being admitted as a provisional signatory.

Strategy #4: Bridge knowledge and experience gap in accreditation through capacity building

The Ministers of Science and Technology of the OAS have identified the need for bridging the knowledge and experience gap and building a culture of accreditation and quality assurance as one of 3 priority focus areas of the Engineering for the Americas initiative. Since 2006, the OAS has charged LACCEI (Latin American and Caribbean Consortium of Engineering Institutions) to lead accreditation strategies. LACCEI is a non-profit consortium of 150+ universities with interest in academic and research collaborations with Latin American and Caribbean engineering programs. Surveying its members, LACCEI found that the institutions wanted workshops to bridge the gap from deciding to explore accreditation to determining the accreditation agency, and they wanted access to a pool of trained experts in accreditation that could answer questions and assist in the accreditation process. LACCEI developed workshops under an initiative called Par Amigo (Friendly Peer). The objectives were

- Assist engineering programs with the selection of accrediting method and agency
- Assist engineering programs through the accreditation process and the preparation of the self-study
- Serve as a multilingual and multicultural resource of information, practical assistance and mentors for engineering programs considering or seeking accreditation
- Develop faculty leaders in program accreditation and assessment for accrediting agencies in the Americas
- Certify and maintain a Par Amigo registry who are familiar with and current in accreditation processes and provide cost effective assistance to engineering programs seeking accreditation by requiring each Par Amigo to donate one week a year of free training, consulting and advice.

The Engineering Education Capability Maturity Model [3] was developed for the training program for the Par Amigo initiative based on the Capability Maturity Model [4], see Figure 2, an extension of an integrated process improvement model with the goal to increase the process capability of an institution's educational processes. The *process capability* is the inherent ability of a process to produce planned results. This engineering model was used to map the activities required to complete accreditation to an appropriate level of capability of the accreditation team. Everyone starts at Level 1, where the process are adhoc and results depend on the individuals involved. By applying Project Management techniques a Disciplined Process is developed, leading to Level 2, where the results are repeatable. At Level 2, Engineering Management principles are applied to the academic process to yield a Standard, Consistent Process. At Level 3, everything is documented, defined and measured, and Quantitative Management principles are followed to yield a Predictable Process. In Level 4, the process is Managed. Change Management principles are followed to yield a Continuously Improving Process. Finally the Optimizing Level is reached, and this is where the program is deemed to be

ready for accreditation. By making the tasks and activities required for accreditation to the appropriate capability level, the team is organized to complete tasks for which they are ready. Tasks of higher level can be tackled but the program remains classified as being in the lowest level where there are tasks remaining to be completed. This model gives an efficient structure to the process of seeking accreditation, and mentally "chunks" the process into levels, allowing the faculty and administration to buy into the effort and cost of progressing one level at a time. Checklists have been developed for completing tasks at each level. This model was utilized in the development of the LACCEI Par Amigo workshop, ABCs of Accreditation, designed to bridge the gap to develop a culture of accreditation and an overview of the different accreditation systems. These and more advanced workshops are offered at the LACCEI Conference by the different accreditation agencies. Last year LACCEI collaborated with ABET to offer its members the advanced certificate workshops required for ABET Ideal Scholar certification, translating all materials and offering the workshops to its members with simultaneous translation and bilingual facilitators. It is hoped that this mixture of workshop would train the cadre of Ideal Par Amigo individuals willing to volunteer one week a year to help the LAC region successfully international accreditation of their engineering programs.

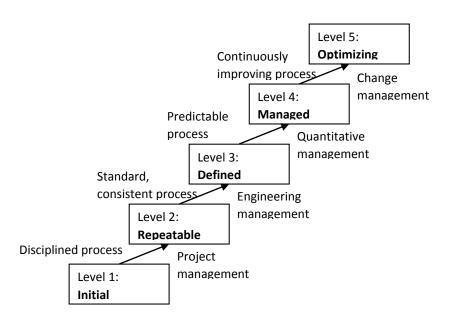


Figure 2: The Five Levels of the Capability Maturity Model

Conclusion

Much remains to be done to obtain adequate advances in engineering program accreditation in the Latin American and Caribbean region. A multipronged approach was described that involved national and regional accrediting agencies in region pursuing becoming signatories of the mutual-recognition accords that form part of the International Engineering Accreditation Alliance, expanding the regional accords to include engineering professional mobility across more nations, professional societies assisting the LAC accrediting agencies in aligning their processes to comply with the accords, and much capacity building to help the region acquire a culture of accreditation and quality assurance while identifying and developing accreditation experts with affinity to the region.

References

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