

# **Internationalizing the Curriculum at the University of Florida College of Engineering: The Latin America & Caribbean Factor**

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## **ABSTRACT**

Today new engineers must have a broader education/vision of the world. At the University of Florida College of Engineering (UF-COE), we believe that this is strongly bounded to research, development, and the opportunity to participate in international projects..

The UF-COE International Engineering Program (IEP) aims to attract students from Latin America and the Caribbean (LAC), projecting the UF-COE abroad. We recognize the importance of diversity, enhanced by economic initiatives, including NAFTA that have truly brought LAC to the forefront of the international marketplace.

We discuss the concept of internationalization of the curriculum, its importance, and connection with college education in LAC. The effect of Energy use versus development, the limitations it poses to the region and our increasing number of programs from the perspective of our relationship with LAC universities. The IEP effect in our curricula, the program success, accreditation, faculty and students participation are discussed. We show its evolution, results and the metrics used to evaluate our success and growing program, discuss lessons learned, and the future of it. Finally, we emphasize the UF-COE International Engineering Program commitment to play a role by opening doors of opportunities into the world of international engineering, research and education.

## **Keywords**

International Engineering Program, Education, Development, Energy

## **1. INTRODUCTION**

In today's world economy the new player is Energy, whereas in universities programs the new word is "Internationalization". Their impact is becoming more and more an issue over its use, availability and consequences. As a healthy economy certainly relies not only on the abundance of resources but also on their quality for reduced environmental impact, cleanness, and affordability, it is also clear that a countries health and wealth relies on the quality of its education. Much can be said about this, and many are the examples, but they all converge to the same conclusion: without education there is no possibility of sustainable development. This is true for any country.

More than in any other time of human civilization, have we accomplished so much in such short period. From the times of when we controlled fire, the discoveries of the past, the amazing progress of the Greeks and Romans, the Industrial Revolution, until today there is one common denominator: Education. Once societies have pushed it, they unquestionably flourish. The examples given above are clear proof of it. With them it comes the need for better prepared professionals that can now work one to one with their peers abroad. This is particularly stronger of an assessment for future engineers.

Education are not enough anymore? In a way this is part of the new challenges our societies are confronted with. Amazingly, this does not seem to be neither a new nor an un-surmountable challenge. It tells us that we must consider ourselves not restricted to the city or country we live in. In other words, we are being challenged by our own success. We need to work together, to prepare ourselves, especially to the leaders of tomorrow who are the students of today. This is, universities, and even high schools are called today to provide a broader education to our younger citizens, and they must include in their curricula the word "Internationalization". Have we certainly heard all this before, sometime ago [1]:

*"I am not an Athenian or a Greek, but a citizen of the world"* *Socrates*

The need to know, to explore, to see other cultures, the marvels abroad, certainly wakes up in anyone, particularly on our students, that something that has sparked our ancestor's imagination. The need to know, to see, to touch, to manipulate, to control, to have a say, to understand our culture and those of others, to make a contribution to human kind, to help those in need with our own talents here and in any other place in the world. Today an illusion, but tomorrow a reality, these issues, capabilities, will be the corner stone's of our future engineers. They will extend soon beyond the frontiers of our planet, as our civilization is exploring and attempting to colonize other planets and satellites, as is our own moon [2].

The engineers of the future will need to be able to work with engineers and professionals abroad. Internationalization of the curriculum is the natural way in which higher education should prepare the professionals of the future. What mechanisms to put in place, what programs should we seek? At the University of Florida College of Engineering instead of attempting to answer these and other very interesting questions, we have just simply started. Then we can improve upon as we learn from results, see what others are doing, what works and what does not, and of course as good engineers, we optimize our system. One thing is certain though, the meaning of internationalizing the curriculum is a broader concept than usually believed.

In the next section we present our approach to the situation in the Latin American and Caribbean region as an educational challenge. In the third section we analyze and make the connection between energy development and education. Then we give a glimpse of the UF-COE International Engineering Program with its programs, and show some results of its collaborations. In the fifth section we give an example on how the UF-COE is accommodating and integrating its curricula to account for big problems as is the energy issue that is affecting the world. On this we will show the UF-COE International Energy Management program as an example. Finally, in the sixth section we present our conclusions.

## **2. THE LATIN AMERICA AND CARIBBEAN EDUCATIONAL CHALLENGE**

The Latin American and Caribbean region faces many challenges in five main areas: Education, Social, Economics, Politics, and Ecology. Education is perhaps the most important one from our perspective since without it we will not be able to transform or prepare individuals and their communities. Our region has the highest indices of repetition and school desertion "in the world". To solve this we should start by investing in primary, middle and high schools. With this we will accomplish and provide hopes of success. Education certainly contributes to eliminate the Hyper-Ignorance cancer that affects the region [3].

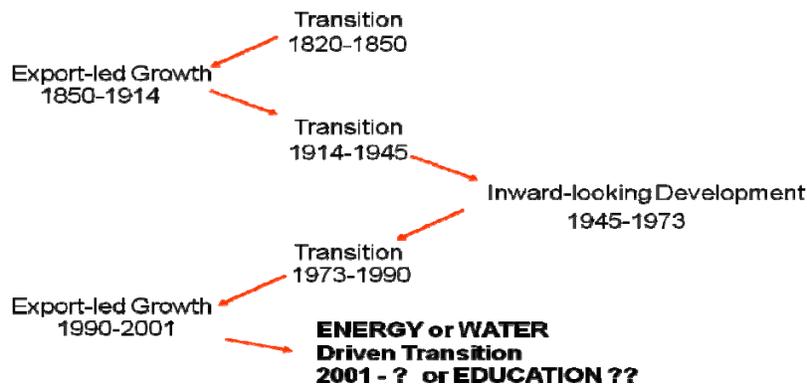
*"A country might have many oil wells, mines with precious metals and jewels, fertile lands, lots of ocean wealth, forests, and many other natural resources, but if the brains of its children are empty, that country has no future"*

We can extend this fact with a dilapidating conclusion, if we don't generate our own strong higher education, and from there our own science, technology and industry, we will be always slaves of developed countries. These countries in turn do invest in education, science, technology, industry, health, etc.

In the Social area, certainly Hyper-Poverty is the main problem. The United Nations, as a result of a world-wide conference on these issues, came up with a set of answers known as the "The Millennium Development Objectives". It considers a set of eight big objectives to improve mankind progress by year 2015. Many countries in Latin America and the Caribbean are not achieving their goals.

On the Economic side, there are problems of Hyper-intervention by the government of each state. Corruption is unfortunately a common factor that enhances the problem. These interventions restricts freedom and economy creating Hyperinflation, that the governments try to suppress through economic, tragic, intervention as is to put money in the streets. The political challenge is certainly a very important one since it affects any short term social and economical decision. We will just mention the issue here and refer the reader to other works [4].

Finally, we have the Ecological and Energy challenge, which is created by our Hyper-indifference. It comes to us from two sources. The first one is the lack of reliable information to the public on the consequences of the environment deterioration. The second one is the levels of poverty that do not allow the provision of resources farther than the satisfaction of the immediate needs of the people. In other words, people get to eat fish, but they are not told how to catch the fish. The Ecological and Energy Hyper-indifference are certainly correlated to the Educational Hyper-Ignorance, and with the social stigma of Hyper-Poverty.



**Figure 1: The transitions of Latin American and Caribbean countries growth showing that perhaps neither Water nor Energy are the big players anymore, but perhaps Education.**

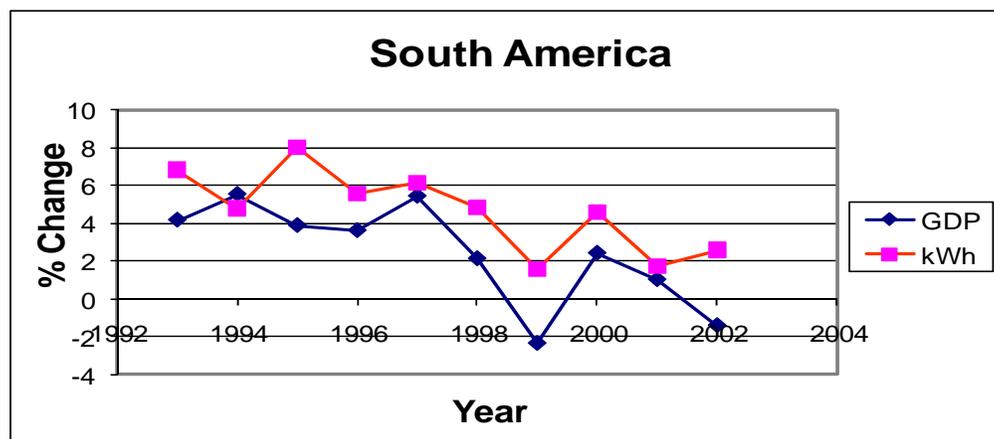
In general, the Latin American and Caribbean economy is improving in comparison with previous years, despite the recession the world is living these days. The main reasons of this growth are the global growth generally led by the United States of America, and that some regions included in the MERCOSUR are stabilizing their political situation and their economies (Brazil and Argentina). As a region with undeveloped countries, many of them move back and forth on their way of growth, like a pendulum [5]. Figure 1 summarizes the issue. As we start the new millennium, we do not know what will drive our transition to it. Energy, Water, or perhaps Education ?

### 3. THE PERSPECTIVE: ENERGY - DEVELOPMENT - EDUCATION

The causal relationship between energy consumption and economic growth is a controversial topic that has been discussed for the past three decades. The current data shows that South America's energy consumption is increasing at very slow rate compared to the 80's. There is a common question about this relationship, if whether energy consumption drives economic growth or economic growth drives energy consumption. This causality runs in two directions, if energy consumption drives economic growth then energy dependent economy exists which tells us that a lack of energy may affect economic growth in a negative way. On the other hand, if economic

growth drives energy, we can see that countries have less energy dependent economy. Furthermore, it is also known that energy is used for the production of goods, transportation and many other activities. Although, many theories exist, one thing is true; energy consumption and economic growth have a strong positive correlation in Central and South America. The most popular studies show that the investigators have used the Engle and Granger test [4] to find co-integration. This test shows the existence of a long run relationship of the time series.

Many countries in South America are rich in natural resources such as natural gas and crude oil. Recently, many stakeholders are very interested in South America due to the nineties significant change in the energy industry. Among these changes, it's important to mention that South America is developing new infrastructure, regional integration, changing their privatization and deregulation system. As a consequence of these changes many companies are largely investing in South America which generates more regional integration, more improvements in infrastructure and also brings education, providing a tremendous potential for development.



**Figure 2. The quantitative correlation between GDP and Energy (kWh) usage in South America.**

It is predicted that the world energy consumption will increase by 60 percent between 1997 and 2020. Furthermore, more of the growth is predicted for Asia and Central and South America, where the energy consumption is anticipated to more than double over the 23 year projection period. Asia and Latin America are expected to maintain energy demand growth of more than 3 percent annually through 2020. It is about more than one half of the world's total increase in energy consumption. The relationship between energy consumption and GDP grows strongly over time, but varies among the stages of economic development and regions. History shows that the relationship between these two factors is relatively weak in industrialized countries, while in developing countries the relationship between these two factors has been more closely correlated. As shown in Figure 2, since the correlation between energy consumption and economic growth is very strong, we foresee that they relate to education on the framework of the issues discussed above. Just as an example, consider that although 90% of the countries in the region have access to electricity, there are tremendous variations: In Uruguay 95% of the population has access to electricity, whereas in Bolivia the figures are as low as 61%. Hence energy is certainly a development indicator as is education, no matter the country and its wealth and natural resources.

In Table 1, we show data on the capabilities of Latin America and the Caribbean countries in terms of Education, Science and Information Flow. It is revealing to see that there is a clear need for education, which in turn will mitigate the limited educational and scientific capabilities. It is clear that there are a few countries that are at the front pulling these parameters up (Argentina, Brazil, Chile and Mexico). The Information Flows columns shows that the LAC region do not compare to developed/or on the way of development nations.

**Table 1: The lack of economic resources for education and innovation**

	Education		Scientific Capabilities			Information flows	
	School enrollment tertiary (% age group) 2000	School enrollment secondary(% age group) 2000	Scientists in R&D (per million) 2000	Scientific & tech. journal articles 1999	US patents (per million) 2001	Internet users, percent of population 2001	Phone subscribers per 1000 people (fixed and mobile) 2000
Argentina	48.0	96.7	713.4	2361	1.4	8.9%	389
Chile	37.5	75.4	370.1	879	0.8	20.4%	446
Uruguay	36.1	98.1	218.5	144	0.0	12.0%	410
Bolivia	35.7	79.6	98.5	33	0.0	1.8%	135
Panama	34.9	69.2	124.5	37	0.4	3.2%	296
Peru	28.8	80.8	228.8	56	0.2	11.6%	117
Venezuela, RB	28.5	59.3	194.0	448	1.1	5.2%	330
Colombia	23.3	69.8	100.7	207	0.3	2.7%	223
Dominican Republic	23.1	59.5		6	0.2	2.2%	187
Mexico	20.7	75.3	224.7	2291	0.8	3.7%	267
Ecuador	17.6	57.4	83.3	20	0.3	2.6%	138
El Salvador	17.5	54.2	46.7	0	0.5	0.8%	204
Brazil	16.5	108.5	323.4	5144	0.6	4.7%	319
Jamaica	16.4	83.3		44	0.4	3.9%	341
Costa Rica	16.0	60.2		69	0.7	10.1%	274
Honduras	14.7			11	0.0	0.6%	70
Nicaragua	11.8	54.0	72.7	8	0.0	1.0%	49
Paraguay	10.1	59.8		4	0.0	1.1%	204
Guatemala	8.4	37.0		14	0.0	1.8%	134
Trinidad and Tobago	6.5	80.8	144.9	37	3.1	9.2%	334
Haiti	1.2			1	0.0	0.4%	16
<b>Reference Countries</b>							
Korea, Rep.	77.6	94.1	2318.6	6675	74.0	51.9%	1060
United States	72.6	95.2	4099.4	163526	314.4	50.6%	1054
New Zealand	69.2	112.4	2197.2	2375	32.3	28.5%	893
Israel	52.7	93.3	1563.3	5025	163.3	28.9%	1184
Greece	50.5	98.4	1400.1	2241	2.4	13.3%	1097
Ireland	47.5	109.1	2183.7	1237	37.2	23.6%	1077
Singapore	43.8		4139.5	1653	72.1	37.3%	1168
Thailand	35.3	81.9	73.8	470	0.4	5.8%	143
Malaysia	28.2	70.3	159.9	416	1.6	27.9%	412
Hong Kong, China	27.4			1817	34.3	39.0%	1406

Source: World Development Indicators and World Economic Forum.

The table tells us that the distance between developed and undeveloped countries is getting bigger in higher education. In countries with higher income, registration of students has gone up, whereas for everybody else has shown none or little improvement. The number of registered students at some level of education does not indicate the quality of education given, but it just indicates the accomplishments of a country on education [7]. Economic growth sets a high bar to the natural resources of a country, creating environmental problems. Although growth is essential to overcome the fast growing problem in poor countries, it is also true that more income gives room for more investment in education. Should this happen, then the ability of the countries to have capacity to innovate and absorb technology will grow. Other elements that account for growth on education, respect for private property, investment, savings, freedom, etc. are essential.

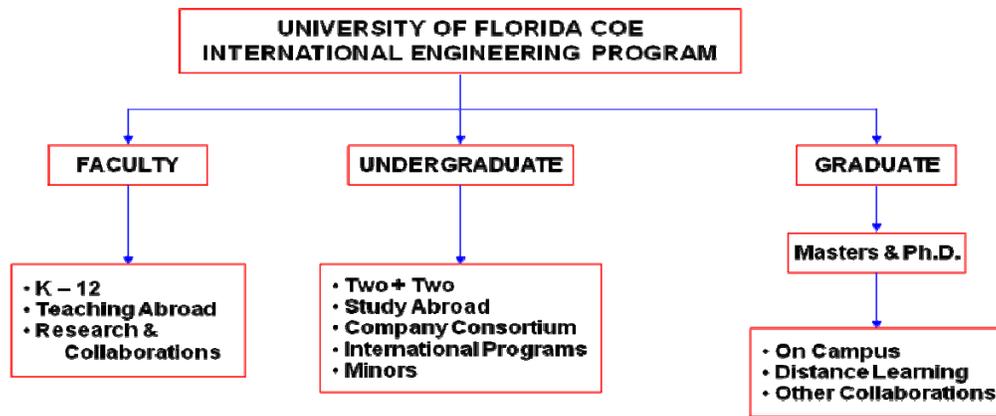
Clearly the countries of the region do not invest enough neither on Education nor in Scientific Capabilities. These are essential components to overcome our limitations as countries and as a region. It is clear that the problems affecting the region do not seem to recognize borders but they do tell us that we should unite to overcome them together. In conclusion, we see that there is a call that it is through international organizations like LACCEI that the University of Florida, particularly its College of Engineering, wants to contribute opening doors and shaping

opportunities for students, faculty and researchers in the region. We introduce the UF-COE International Engineering Program in the next section.

#### 4. THE UF-COE INTERNATIONAL ENGINEERING PROGRAM (IEP)

What is Internationalization of the Curriculum? The concept of Internationalization of the Curriculum at the UF-COE can be described by what is not. Internationalization is not a “measure” of how many foreign faculty or students the college has. It is not also the fact that we have faculty that gives talks or short courses abroad, or spent sabbaticals abroad. Neither is the case when it is argued that our researchers publish or are editors of specialized International Journals. For us, Internationalization of the curriculum is the number of programs that we offer that allows our students to have an international component in their education. This “component” can be any activity that allows them to have an international experience, like study abroad, or to see a study through an international module introduced in a given class, or an international internship, etc.

The University of Florida International Engineering Program (IEP) has three main components [8, 9, 10]: the Faculty, Undergraduate and the Graduate programs. In Faculty we reach for High Schools, teach abroad and establish research collaborations with local research centers.



**Figure 3. The International Engineering Program at the University of Florida College of Engineering.**

At the Undergraduate level, we consider a myriad of possibilities. One of them being the “double degree” or “2 + 2”. In this area the student spends the first 2 years in the university in his home country, and the last 2 years at the University of Florida. At the end he/she obtains both universities Engineering degrees, opening opportunities for later graduate studies at UF. We also have study abroad courses specially designed for engineering students. One is in Chile, and the other one in Germany. In addition we are working on a Company Consortium that looks to attract multinational and international companies to establish some degree of collaboration. One of these is Siemens. Minors are offered over all UF-COE. The ones in more demand are Sales Engineering, Packaging, Statistics, Mathematics, Business, Energy (on the works), etc.

In the Graduate level a Diploma (15 credits after the BS degree), a Masters program (30 credits) with and without thesis, and a Ph.D. (90 credits) are offered. Distance learning is done through our EDGE program (Electronic Delivery of Graduate Engineering Education) which allows us to reach those students that somehow cannot physically attend class on campus because of their work. Other Collaborations include Engineers Without Borders, with projects in Malaysia, Greenempowerment, with projects in northern, central and southern Peru, and the Industrial Energy Management Program, with projects in Peru, Ecuador and Chile. A summary table showing the progress of our young program is shown in Table 2 below.

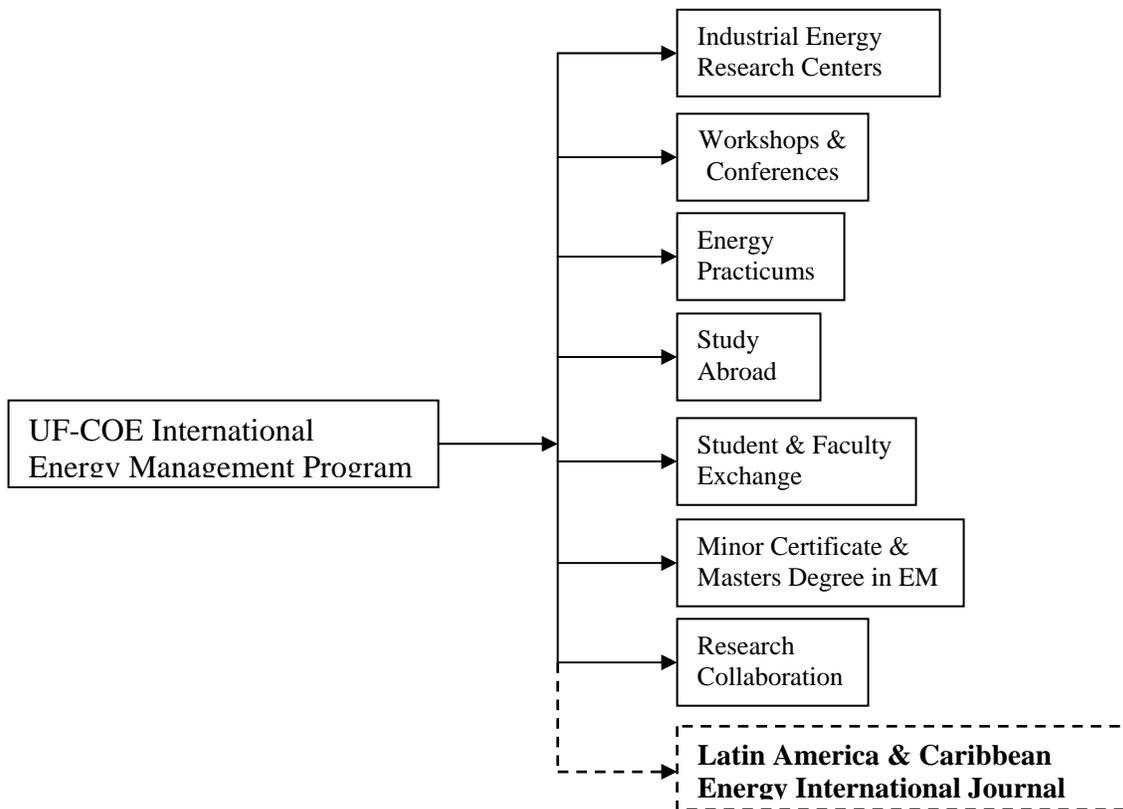
**Table 2: Preliminary results of the UF-COE IEP after 3 years of existence (incoming or outgoing students).**

Country/University	3 + 2	UG	GRAD	Faculty Exchange	UF at LU	EDGE
<b><u>JAMAICA</u></b>						
University of Technology Kingston					2	
<b><u>VENEZUELA</u></b>						
Universidad Catolica Andres Bello - Caracas		5	3	3	3	2
<b><u>COLOMBIA</u></b>						
Pontificia Universidad Bolivariana - Medellin		1	1	2	1	
Universidad del Norte Barranquilla	2	2	1	1	1	
<b><u>ECUADOR</u></b>						
Escuela Superior Politecnica del Litoral (ESPOL) – Guayaquil	7		15	2	3	
<b><u>PERU</u></b>						
Universidad Privada del Norte Trujillo, Lima, Cajamarca	1	1	1	3	2	
Universidad Ricardo Palma Lima	2			4	4	
Universidad Nacional Ingenieria Lima						
<b><u>CHILE</u></b>						
Universidad de Viña del Mar Valparaiso		1		2	40	
Universidad del Bio-Bio Concepcion		8	5	3	12	
Pontificia Universidad Catolica de Valparaiso - Valparaiso					1	

Besides these results, we have had experience on inserting an International Module in the Industrial Energy Management class (EIN 4321), a senior engineering course, through an International Case Study. The results were very encouraging from the comments of the students stating that they could see how they can apply what they learn in class to other countries. These were enhanced by the results of the class and instructor evaluation. In previous years the average evaluation for this class was 3.7. However, when this International Module was introduced, the evaluation rose to 4.7, a full point representing an increase of more than 27%.

## 5. CURRICULA INTEGRATION OF WORLD PROBLEMS: ENERGY

To bring focus to these issues, a new International Industrial Energy Management (IIEM) program is currently being developed at the University of Florida College of Engineering (UF-COE). The main goals of IIEM are to help manufacturing facilities to become more energy efficient, to prepare energy engineers, to educate the society on energy issues, to promote the exchange of ideas and technology on energy conservation and environmental impact issues. Currently, this program considers: implementation of Industrial Energy Assessments Centers in Engineering Colleges in Universities in LAC, Summer Workshops, Conferences, New Degrees in Energy Management at both the Undergraduate and Graduate levels, Collaborative Research, Software Development, Energy Practicum's, Students and Faculty Exchange, etc. The program addresses a myriad of areas and levels of interest so as to connect the LAC region through this new engineering initiative for the Americas.



**Figure 4. The UF International Industrial Energy Management (IIEM) program structure. The dashed line box shows the proposed Latin American and Caribbean Energy International (LACEI) journal [8].**

Recently, the University of Florida created the Florida Institute of Sustainable Energy (FISE), to provide leadership to achieve sustainable energy generation, distribution, and usage and become the external gateway for energy research in the state of Florida and at UF. This considers research at an interdisciplinary level, education programs, marketing of new UF technology, etc. The objective is to identify later on, areas of strength, gaps, new areas of research, collaboration opportunities, etc. We consider that UF has these strengths in place, and is in a position to share them through the creation of this *International Industrial Energy Management (IIEM) program*.

In this context communication and exchange of ideas is a main issue, and consequently we hereby propose the creation of a Latin American and Caribbean Energy International (LACEI) journal. It will address topics of interest in the region, and the world, such as Energy Education, Renewable Energy Sources, Biomass, Ethanol, Hydrogen, Industrial Efficiency, Case Studies, Solar, Eolic, Geothermal, Fuel Cells, Cogeneration, HVAC, Policies, Economics, Global Warming, etc. In summary, it will consider all those topics that are related and of interest that comes out of the LAC community research, under the umbrella of LACCEI. We are aware of the fact that these goals involve collaborative projects that will require our ability to attract research funding in an international and multidisciplinary fashion. This is precisely the challenge we are confronted with today, to work together. For this, we believe that LACCEI and the IIEM program are a good start and should be a good umbrella and a vehicle for use to develop and catapult the energy management issues of the region in a collaborative fashion. The proposed program structure is shown in Figure 4, and each activity is described below.

The University of Florida College of Engineering is a strong educational institution, with great tradition for excellence in higher education. We have a wealth of experience with international students, and our faculty conducts ground breaking research. Our IEP is taking us to work with partner institutions around the globe. In Latin America and the Caribbean we are looking for the same partnership, to open possibilities of collaboration, to upgrade degrees, exchange students and faculty, establish collaboration programs, etc. We have distance

education at the Masters Degree level with excellent faculty on-line support to students, at very highly competitive costs. In addition we are seeking to establish through LACCEI, a collaboration network with universities in the region.

### 5.1. Program Goals and Essentials

Essentially this program is designed to be bi-directional in all of its components, not an easy task as the main barriers are commitment and funding. The goal is to attract potential future graduate students, and build research infrastructure. The time of participation may vary according to the program and partner universities. The time abroad should be fully integrated in the curriculum, and participation should not delay the time of graduation. Some programs offer, or should offer, participation certificates: this increases our curriculum and is good for our students' resumes. Instead of bringing foreign students to UF, we recognize the possibility that a number of courses could be offered at the local University by UF faculty, and vice-versa. This has proven to work excellent for the University of Florida Institute of Food and Agricultural Sciences (IFAS) faculty teaching in universities as ESPOL (Guayaquil, Ecuador), and vice-versa.

- **LAC Industrial Energy Research Centers:** We establish these centers in local universities, providing a better relationship university-industry, energy assessments to industry, strong collaboration with the UF-COE, with exchange of students and faculty.
- **Workshops and Conferences:** We provide workshops and courses at UF designed for Latin American Researchers, students, and industry professionals. We look for an increasing collaboration in the field among institutions and their researchers.
- **Energy Practicum:** We are developing new courses and experimental energy management laboratories that will start this year in the format of Industrial Energy Management Practicum's. These are nothing but laboratories in the subject, with the corresponding theoretical background, special industrial guests, and tours to selected manufacturing facilities.
- **The Study Abroad Program:** We are currently seeking Universities, hopefully with the equivalent of ABET certified programs to establish programs of mutual interest. We have a program in Chile performing energy assessments at Chilean manufacturing facilities. We have collaborations with projects with a few universities abroad: Chile, Ecuador, Venezuela, Spain, etc.
- **Students and Faculty Exchange:** As a result of our efforts and the establishment of the programs mentioned above, we have received visits from faculty and students from several LAC countries, and established collaborations in some programs.
- **Minor Certificate and Masters Degree in Energy Management:** The Minor in Industrial Energy Management requires 16 to 19 credit hours, depending on the electives chosen. It is designed such that students can work towards, and suggest solutions to, the ever increasing energy problems in the world. The Masters degree in Energy Management, currently under review, is designed to incorporate engineering courses being offered in all UF-COE departments. To obtain this degree, students will be required to successfully complete 30 credit hours, all from a list of courses that provide a focus on a variety of applied energy topics. New course are being developed, including the course: *New Trends and Advances in Energy*. Both programs are considered to be multidisciplinary,

## 11. Conclusions

We have presented and shown the results of our efforts to establish collaborative agreements, at both university and college of engineering levels, with universities in Jamaica, Venezuela, Colombia, Ecuador, Peru, and Chile. In addition, we discussed how our efforts have been successful through funding the establishment of an Industrial Energy Research Center at Universidad Privada del Norte, in Perú, an International Industrial Energy Management Consulting course in Chile with Universidad de Viña del Mar in Chile, preparation of international

meetings and courses. Internationalization, globalization, collaboration, students, faculty, researchers, programs, exchange, conferences, ideas, development, etc. incorporate the possibilities which exist for meaningful interactions with focus on engineering education for the Americas. We are not only a university that does some work with this focus, but we have certainly made some progress, and developed programs and expertise that we are willing to share. We believe that these programs, even if they are not the final solution, can contribute to the solutions of many of our society problems. In these context, better prepared engineers to solve many problems, and to be the solution for the serious engineering problems the LAC region is confronted with.

Finally, it is conferences like the International Latin American and Caribbean Conference for Engineering and Technology, organized by LACCEI that sets the stage and open more possibilities of collaboration, for the benefit of our students and our society as a whole. In summary, “Developing Entrepreneurial Engineers for the Sustainable Growth of Latin America and the Caribbean: Education, Innovation, Technology and Practice”, is not a cliché, but it rather reflects the spirit and concerns of today for the engineers of tomorrow.

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