Comparing Mechanical Engineering Programs at University of Los Andes and University of South Florida

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Abstract

There is a recent interest in examining Mechanical Engineering Programs, both, in U.S. and abroad. This paper offers a comparison of the Mechanical Engineering Programs at an U.S. university and a Venezuelan university. Results can contribute to improve the programs that are compared. This article describes and highlights some of the academic differences and similarities of the Mechanical Engineering programs taught in these two universities.

Introduction

Industries such as Petroleum, Steel, Aluminum, and Electric Generation have been a big source of jobs for Mechanical Engineers (ULA, 1993). This fact motivates all universities and technological institutes of Venezuela to improve their mechanical engineering curricula. However, to fulfill this challenge, universities must stay in tune with the industries' needs, and with the advances in technology. Two aspects of the solution universities found can be summarized as follows: First, not to prepare highly specialized engineers for any industry, but with enough background to succeed in their field and second, the constant improvement of their professional staff.

The first part of the solution depends greatly on the second part, and the latter is a demanding program, which involves, among others, cooperation agreements with universities around the world. In 1992, a cooperation agreement between University of South Florida (USF) and University of Los Andes (ULA) began a fruitful partnership. Since then, Engineering Colleges have played an important role finding mutual benefits in both research and academic programs.

The Mechanical Engineering Departments of both universities are representative of small programs of mechanical engineering. The goal in this paper consists in showing to the interested reader, some of the academic differences and similarities of the Mechanical Engineering programs taught in these two universities.

Historic brief

Mechanical Engineering education of ULA began in 1970 (ULA, 1994) when this discipline was introduced as an adjunct department in the Electrical Engineering School by a faculty council's decision. Four years later, in March 1974, it became officially the Mechanical Engineering School of ULA.

In April of 1975, the first class of Mechanical Engineers graduated, followed by 36 commencements with up to 1,250 graduates until the year 1997. ULA has accepted, in the last few years, approximately 30 students per semester and has had an average of 800 regular students.

At the very beginning, the School had ten faculty members and only the Mechanical Engineer degree was offered. Currently, besides the Mechanical Engineer degree, two master degrees (Maintenance, and Thermal Sciences) and the Ph.D. programs are offered. Since Faculty has grown considerably; right now forty-one (41) members absorb the teaching and research tasks. Some of them graduated in the USA from universities such as: University of South Florida, University of Illinois at Urbana-Champaign, University of Iowa, and the University of Pittsburgh. Others come from different universities in England, France, Italy, Spain, the former Soviet Union, Canada, and Mexico.

The Energy Conversion & Mechanical Design Department at USF was born, together with the College of Engineering, in September 1964 when classes officially began (Miller, 1978). It was accredited by the Engineers' Council for Professional Development in September of 1972. The degree of Bachelor of Science in Engineering, with the Mechanical option, was official until the Bachelor Science in Mechanical Engineering (BSME) was institutionalized in 1983.

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At the beginning, the Department was administratively shared by both, Chemical and Mechanical Engineering faculties. From 1980 until 1988, it was defined as the Chemical and Mechanical Engineering Department. After that year, it received its current name of Mechanical Engineering Department (USF 1980, and 1988).

Currently, it has nine full-time faculty members working in teaching and research. The average of graduates per year is near sixty. 787 BSME graduated from 1981 until the summer of 1997 (Howell, 1997).

Organization

A chairman and a school council govern Mechanical Engineering at ULA. It has two departments: Thermal Sciences, and Design and Technology. Each one of these departments is directed by a chief and a department council. The latter composed by its entire faculty and two students representatives. There are also nine technical laboratories included within the departments, each one guided by a coordinator (See Figure 1).

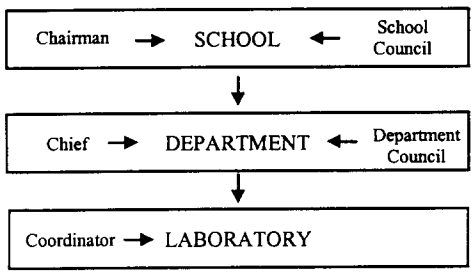

Figure 1 ULA's Mechanical Engineering School hierarchical organization

The Mechanical Engineering Department governance at USF differs from that of ULA because USF has no subdivisions such as sections or grouped areas. For technical laboratories (research, and instructional), the difference is a matter of numbers. There are ten labs at USF: Computer-Aided Design, Wind Tunnel, Dynamics Systems, Data-Acquisition, Computational Fluid Dynamics, Computational Solid Mechanics, Numerical Heat Transfer, Thermal Science, Mechanical Lab I, and Mechanical Lab II.

Curriculum and Study Plan

The Mechanical Engineering study plan in ULA requires at least 194 credit hours (ULA, 1993), and should be completed in ten (10) semesters of sixteen (16) weeks each. The studies are grouped in two levels: Basic, and Professional. Students obtain the degree of Mechanical Engineer. At USF, the plan requires 136 credit hours (USF, 1997) and the students obtain a Bachelor of Science in Mechanical Engineering (BSME) in eight (8) semesters of fifteen (15) weeks each. There is a year of difference between both plans; however, these two specific degrees are considered equivalents.

Basic level

Here, the student gets the necessary knowledge about basic sciences: physics, chemistry, and mathematics. In addition to Humanities, Graphic Representation, Statistics, and computer programming. Four (4) semesters are required to complete this part of the program.

The basic level is almost the same in both universities and is designed to endow students with a general background in mathematics, science, and humanities (see Tables 1 and 2).

The first three semesters are typical for any engineering program. Within this interval, students can change their minds with respect to the program they are registered to. Two courses from Humanities electives (Sociology, Anthropology, Culture's History, and Study Techniques) are required to fulfill the program.

	SEMESTERS			
	I	II	III	IV
C	Calculus 10	Calculus 20	Calculus 30	Math. 40
O	Chemistry 11	Physics 11	Physics 21	Phy. 21 Lab.
U	Represen. Systems 1	Represen. Systems 2	Phy. 11 Lab.	Mechanical Drawing
R	Elective 1	Elective 2	Rational	Rational
S	(Humanities)	(Humanities)	Mechanics 10	Mechanics 20
E			Statistics	Resistance of Materials
S				
H	18 hours	18 hours	21 hours	21 hours

Table 1: Mechanical Engineering Basic Level at ULA

The fourth semester is designed with the first specific courses to the Mechanical area (see Table 1); therefore, it is considered as the transition semester between basic and professional levels.

One important area to compare is mathematics, where both -ULA and USF- have four courses (see Tables 1 and 2), but they are more extensive at ULA. The entire calculus courses at USF have an equivalent syllabus identified with the first two at ULA. The third calculus course at ULA (Cálculo 30) is related with multivariative calculus, which is not required at USF.

	SEMESTERS			
	Fall (I)	Spring (II)	Summer	Fall (III)
C	Calculus I	Calculus II	Calculus III	Diff. Equations
O	Chemistry I	Chemistry II	Physics II	Statics
U	Freshman English I	Freshman English II	Physics II Lab.	Engineering Statistics
R	Design Graphics	Chemistry I Lab.	Chemistry II Lab.	Engineering Orientation
S	Social Scie. Elective	Humanities Elective	FORTRAN for Engineers	Intro. Electrical Systems I
E		Physics I		Thermodynamics I
S		Physics I Lab.		
H	15 hours	17 hours	11 hours	15 hours

Table 2: Mechanical Engineering Basic Level at USF

The content of the fourth course at ULA is: Series, Ordinary Differential Equations, and Introduction to Partial Differential Equations, which has more topics than the Differential Equation course at USF. Comparison results showed that mathematics at ULA is more extensive, and introduce some of the topics that students at USF will see at the graduate level (Carreras, 1997).

Professional level

Appendixes 1 and 2 show tables of the curricula, and part of the Electives courses of the program's professional level at universities USF and ULA.

At ULA, this level of the program requires six (6) semesters to be fulfilled. It can be considered in sections as follows:

a) The first one focuses in teaching the career's basis, it means in a broad view, materials science, mechanics of fluids, dynamics, fundaments of machine design, and thermal sciences. All students must complete this section. Approximately, this part matches semesters V-VII at ULA, and semesters IV-VI at USF.

At USF, the above section is equivalent to the Basic Engineering Science courses. Additionally, a significant number of non-engineering electives courses, five (5), from the General Education requirement are needed in this period of three semesters. Meanwhile, in ULA the only courses outside the school are Digital Programming, and Elements of Electric Engineering I, which are also engineering related courses.

b) The second section takes in more advance knowledge, for instance: turbomachines, control theory, instrumentation, manufacturing processes, economic engineering, and energy conversion. It is in this period when the student has the right to select his/her professional electives, at least twenty (20) hours, equivalent to a minimum of five courses from thirty available (see Appendix 2). These electives courses will determine the field of preparation of the student as a professional.

At USF, the Electives courses of the department, six (6) in total, cover most of last two semesters of the program (see Appendix 2). In addition, Capstone Design, and Mechanical Engineering Labs I and II are mandatory.

c) An interesting alternative, but not obligatory, is an industrial training program (Pasantias) in a company for either eight or sixteen weeks as part of the required credits in electives courses. This program is called Cooperative Education in the USA, and it has been a bridge between industry and the university in both countries.

d) The final section is a requirement for graduation called Project in Mechanical Engineering. Using the skills and tools gained during the entire plan of studies, it is time to bring it together in a project, which has the same significance of a thesis. The project is offered in such a manner that students beyond the seventh semester can get register it. Students defend their project before a three-member committee as a public oral defense.

The Mechanical Engineering Project is of major importance for ULA students for two reasons. One, many students depend on his/her project to be hired. Second, it is demanding and time consuming (Marín, 1996). Consequently, the average time to complete the project is about two semesters in ULA.

The USF Capstone Design course taken in the seventh semester could be identified with this requirement of ULA. One difference is in the grading policy, at USF it is evaluated by its professor as a regular course, while at ULA it is a committee decision. In most cases one semester is enough to complete this course at USF.

Educational facilities

One of the main concerns of ULA faculties is that the industrial equipment installed for teaching purposes is old and the instrumentation presents contrasts with a mix of modern and old devices. The positive hidden part of that mixture is that the student will be prepared for dramatic changes in equipment or instrumentation.

On the other side, at USF, each department has several well-equipped laboratories that are used for undergraduate teaching.

Buildings

Currently, the community of the Engineering College at ULA has exceeded the capacity of its buildings. Soon all of

the Engineering College will be using new installations, when the Hechicera's buildings get ready for moving; an improvement long awaited.

As an answer to the growing demand for research and educational facilities, the Engineering College at USF has plans to construct a new building in a few years. The Mechanical engineering department will receive the benefits of new research and educational labs, as well as new classrooms.

Computer Labs

The Engineering College has an internal network, and it is connected to the main ULA's network. Most of the forty-one professors of the department have computers in their offices. Additionally, there are three computer labs allowed for all engineering students, two for graduate students, and one for professors, the latter is a group of twenty SUN work-stations. Researchers of the Mechanical Engineering School have access to the two supercomputers that ULA acquired recently.

At USF (1997), the College of Engineering operates a cluster of file and computer servers for students and faculty within the college. These consist of SUN servers and four Ardent multiprocessors mini-supercomputers. The networks provide access from offices and laboratories, computer rooms and dial-in facilities. All machines are configured for E-mail and access to Internet. In addition, the College operates open access P.C. labs. Two are available for undergraduate students. One is reserved for graduate students and faculty. Another open access lab is operated in conjunction with the Technology program. The network provides access either via Ethernet or the ISDN.

Technical Labs

As mentioned before, there are nine (9) laboratories at ULA: Vibrations, Mechanical Technology, Instrumentation, Experimental Stress Analysis, Mechanical Testing, Metallurgy and Thermal Treatments, Refrigeration and Air Conditioning, Turbomachines, and Energy Conversion (See Fig. 2). All these laboratories are used for research and educational objectives. They have computers with Internet access. The computers are 486 or higher, which are good enough for common work.

The Mechanical Engineering department at USF groups ten laboratories (See Fig. 3). They are utilized for undergraduate instruction and for research. They are part of the computer network.

	DEPARTMENT	
	DESIGN and TECHNOLOGY	**THERMAL SCIENCES**
L	Vibrations	Instrumentation
	Mechanical Technology	Refrigeration and Air Conditioning
A	Experimental Stress Analysis	Turbomachines
B	Mechanical Testing	Energy Conversion
S	Metallurgy and Thermal Treatments	

Figure 2 ULA Labs, grouped by department.

	RESEARCH	**INSTRUCTIONAL**
L	Dynamics Systems	CAD
	Thermal Science	Data Acquisition
A	Computational Fluid Dynamics	Mechanical Engineering Lab I
B	Computational Solid Materials	Mechanical Engineering Lab
S	Wind Tunnel	
	Numerical Heat Transfer	

Figure 3 USF Research and Instructional Labs.

Libraries

In ULA, each college has a library. There are two of them able to provide service to the engineering community; one in the actual engineering building and the other that will centralize all the materials and publications for science and technology in the Hechicera's buildings. The service is already on line for students. ULA libraries use the so-called system of closed shelves for undergraduate students. In other words, library clerks bring requested books to students. About collections, they have yearly subscriptions to some important journals related to engineering.

The USF main library provides services to the Engineering community. The system of open shelves allows users direct access to books and journals. This library is superior to ULA libraries in collections. In addition, the interlibrary loan service regularly used in the USA, is almost absent in Venezuela (Rosales, 1997).

Contributions and Influences

Research and academic tasks are usually the natural sources of projects. Students who already had completed all the mandatory and electives courses are allowed to develop these projects as a special work in a company. Some of these companies (Petroleum, Iron and Steel, and Aluminum industries) are the most important providers in this aspect. There is an office specially created in ULA to maintain permanent contact with industry. Through this office, the Mechanical Engineering School and other schools of ULA have been increasing its influence across the nation for about ten years. The contribution of the Mechanical Engineering School can be generalized as follows:

First, ULA covers most of the need for new mechanical engineers in Los Andes region. ULA's engineers are welcomed most everywhere in Venezuela (ULA, 1994). And second, engineering related industries and services are now part of the former agricultural economy of the region.

The influence of the USF Mechanical Engineering Department in the region is demonstrated by the increased number of funded research projects and for the recognition that several of its faculty members have received lately, in the form of regional and national awards.

Final Comments

This general comparison circumscribes only two Mechanical Engineering Programs, one in Venezuela, and the other in the USA. Nonetheless, the findings it provides can be of interest for other universities with similar programs. This final comments highlight some important differences according to the authors' criteria.

One important difference is about the length of the curriculum. In ULA, Mechanical Engineers are prepared in five years, a whole year longer than in USF. This is a significant difference with a variety of consequences. On one side, ULA has more time to prepare its students. On the other side, USF students can enter to the industry and get one year of experience while ULA students are just graduating.

The number of class hours per week is another difference observed. At ULA, 17 to 22 hours/week is the regular load per semester. The typical weekly schedule for an USF student varies from 13 to 18 hours. Moreover, regular semesters at USF are 15 weeks long versus semesters of 16 weeks at ULA.

The Mechanical Engineer from ULA is graduated with little non-engineering knowledge. In fact, only two humanities electives are present in that extensive program. On the other side, in the program at USF, the non-engineering electives were included in order to provide a wider educational background.

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APPENDIX 1

Professional Level courses of the Mechanical Engineering Programs at University of South Florida and at University of Los Andes.

USF

SEM.	COURSES	HOURS
IV	- Dynamics	3
	- Intro. Electrical Sys. III	3
	- Materials Engineering I	3
	- Thermal Sys. & Economics	3
	- Intro. to Linear Systems	2
	- Social Science Elective	3
		17
V	- System Dynamics	3
	- Computer Methods	3
	- Kinematics & Dynamics of Machinery	3
	- Mach. Anal. and Des. I	3
	- Historical Perspect. Elective	3
	- ALAMEA Perspect. Elective	3
		18
VI	- Machine Design	3
	- Fluid Systems	3
	- Engineering Communications	3
	- Fine Arts Elective	3
	- MW/MI (Non-engineering)	3
		15
VII	- Heat Transfer I	3
	- Mechanical Engineering Lab I	3
	- Capstone Design (MW/MI)	3
	- Approved Technical Elective	3
	- Approved Technical Elective	3
		15
VIII	- Mechanical Eng. Lab II	3
	- Controls Elective	3
	- Approved Design Elective	3
	- Approved Technical Elective	3
	- Approved Technical Elective	1
		13

ULA

SEM.	COURSES	HOURS
V	- Digital Programming	3
	- Fluids Mechanics	4
	- Mechanics of Materials	5
	- Thermodynamics I	4
	- Metallurgy I	3
		19
VI	- Mechanical Technology I	3
	- Metallurgy II	4
	- Machines Elements I	4
	- Thermodynamics II	4
	- Elements of Electric Engineering I	5
		20
VII	- Mechanical Technology II	4
	- Machine Elements II	6
	- Production I	3
	- Heat Transfer	3
	- Energy Conversion	5
		21
VIII	- Mechanical Technology III	4
	- Turbomachines	5
	- Mechanical Engineering Project	3
	- Engineering Economics	3
	- Control Theory	3
		18
IX	- Production II	3
	- Seminar in Mechanical Eng.	2
	- Refrigeration and Air Cond.	3
	- Approved Electives	14
		22
X	- Instrumentation	3
	- Thermal Power Stations	3
	- Approved Electives	16
		22

APPENDIX 2

Professional Level Electives Courses of the Mechanical Engineering Programs at University of South Florida and at University of Los Andes.

USF

AREA	COURSES	
DESIGN	- Senior Mechanical Design	3
	- Air Conditioning Design	3
	- Propulsion	3
TECNICAL	- Vibrations	3
	- Hydro and Aerodynamics	3
	- Mechanical Manufacturing Processes	3
	- Power Plant Engineering	3
	- Tribology	3
	- Compressible Flow	3
	- Introduction to Advanced Composites	3
	- Robotics	3
	- Independent Study	variable

ULA

DEPT.	COURSES	
THERMAL	- Gas Turbines	4
	- Compressors	4
	- Pumps and Fans	4
	- Thermal Installations	3
	- Thermal Systems	3
	- Two Phases Flow	4
	- Diesel Engines	4
	- Automobile Engineering	4
SCIENCES	- Aerodynamics	3
	- Refrigeration and Advanced Air Conditioning	3
	- Special Topics	4
	- Independent Study	4
DESIGN & TECH	- Vibrations	3
	- Industrial Maintenance	3
	- Mechanical Technology IV	4
	- Lifting & Transportation Machines	4
	- Experimental Stress Analysis	4
	- Thermal Treatments	4
	- Iron and Steel Industry	3
	- Special Topics	4
	- Independent study	4
	- Pasantias (8 or 16 weeks)	variable

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