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Architects and engineers: What makes the difference?

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Abstract

The historic dispute between architects and engineers, particularly civil engineers, is nonsense. Both professions are prestigious and dedicate themselves to covering separate and distinct aspects of the design of buildings and monuments. Engineers extensively use mathematics, basic sciences and engineering sciences to perform the engineering design of any facility while the architects depend heavily on the liberal arts and the physical models (mock ups) for the architectural design of buildings and monuments. Each covers important, but totally different, aspects of a whole, particularly of a multistory building.

Sinopsis

La disputa histórica entre los ingenieros, particularmente los ingenieros civiles, y los arquitectos, es una ilógica. Aunque son dos profesiones de mucho prestigio, cada una recibe un adiestramiento universitario detallado y específico, en el cual se cultivan destrezas profesionales distintas. El ingeniero usa intensamente las matemáticas, ciencias básicas y ciencias de ingeniería para el diseño de ingeniería de todo proyecto bajo su consideración. Los arquitectos cultivan las artes liberales y los modelos físicos (maquetas) para el diseño arquitectónico de edificios y monumentos. Cada cual cubre aspectos radicalmente distintos de un todo, particularmente de edificios multipisos.

Introduction

In our Puerto Rican professional, social and academic environment three professions intimately related to the construction industry co-exist. The professionals of the three disciplines are licensed by the same board of examiners. For many years the professionals of the three disciplines belonged to the same professional college and during the last two years the three disciplines have been taught on the same campus for the first time in Puerto Rico. Engineers, architects and land surveyors are licensed by the Examining Board of Engineers, Architects and Land Surveyors of the Department of State of Puerto Rico. For many years until 1978 all three belonged to the Professional College of Engineers, Architects and Land Surveyors of Puerto Rico. That year the architects, after a long struggle, acquired their organizational independence.

The Polytechnic University of Puerto Rico (PUPR), which came to life in 1966, initiated its academic activities teaching the technical courses in land surveying and mapping until 1974, when PUPR became a degree granting institution with a bachelor's degree in land surveying and the B.S. in civil engineering, followed later by the B.S. in industrial engineering, electrical engineering and mechanical engineering. In 1995, a program leading to a bachelor degree of architecture was authorized by the Council of Higher Education. Two additional programs leading to a B.S. in chemical engineering and a B.S. in environmental engineering will be initiated during the academic year 1997-98. The Polytechnic University of Puerto Rico is the only institution of higher education housing the three professional curricula on the same campus in Puerto Rico. Since this is a fact, and we are thoroughly familiar with the diverse elements of each program and the criteria to be satisfied in order to achieve accreditation by the corresponding accrediting agencies, we want to compare the engineering and the architecture programs so that the reader may understand the basic academic differences between the two programs.

The internal discrepancies among some of the professionals of engineering and architecture which in the past supplied the energy to separate the architects from the Professional College of Engineers, Architects and Land Surveyors, are evidently still alive. On May 31, 1997, The San Juan Star published, in the Construction section, page C17, an article by Pedro Luis Alfaro and translated to English by Michael A. Marrero, AIA, NCARB, titled "Architecture, Engineering - 2 different professions". On July 5, 1997, The San Juan Star published another article on page C5 by Nancy C. Somerville, Hon AIA titled "Architects, engineers have specific qualifications."

In both articles, some statements are made that may confuse the reader pretending to educate him or her. The statements are made, no doubt, in good faith but may be misleading because the premises are biased and evidently do not correspond with reality.

The first point to clarify in this analysis is that, in PUPR's case, all the undergraduate engineering programs, as well as the one in architecture, are five-year programs. All of them require more than 170 semester credit-hours for graduation to obtain the B.S. in engineering or the B.A. in architecture. The historic discrepancies exist mainly between civil engineers and architects. A comparison of the two programs will help clarify the differences they are underscoring. In some instances, the vocabulary used to support the points made may lead to misunderstanding, anger or wrath in the other group. Design, for example, is a word used extensively by both engineers and architects, but the word has a different meaning in each discipline. Also, architects claim they are better prepared academically; probably that is exactly what they would like to be. But, are they? From the outset, I would like to state flatly, that both professions are highly valued in our society, are both prestigious, well paid, have made a great contribution to society, and must be practiced under the most strict codes of ethics, putting in first place the health, safety and well being of the society.

Engineering design

The Accreditation Board for Engineering and Technology (ABET) defines engineering design as follows:

- "Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision making process (often iterative), in which the basic sciences and mathematics and engineering sciences are applied to convert resources optimally to meet a stated objective. Among the fundamental elements of the design process are the establishment of objectives and criteria, synthesis, analysis, construction, testing, and evaluation. The engineering design component of the curriculum must include most of the following features: development of student creativity, use of open-ended problems, development and use of modern design theory and methodology, formulation of design problem statements and specifications, consideration of alternative solutions, feasibility considerations, production processes, concurrent engineering design, and detailed system descriptions. Further, it is essential to include a variety of realistic constraints, such as economic factors, safety, reliability, aesthetics, ethics and social impact." [1]

"The engineering sciences have their roots in mathematics and basic sciences but carry knowledge further toward creative application. These studies provide a bridge between mathematics and basic sciences on the one hand and engineering practice on the other. Such subjects include mechanics, thermodynamics, electrical and electronic circuits, materials science, transport phenomena, and computer science (other than computer programming skills), along with other subjects depending upon the discipline. Whereas it is recognized that some subject areas may be taught from the standpoint of either the basic sciences or engineering sciences, the ultimate determination of the engineering science content is based upon the extent to which there is extension of knowledge toward creative application. In order to promote breadth, the curriculum must include at least one engineering course outside the major disciplinary area."[2]

Architectural design

Design is defined, on the other hand, by the National Architectural Accrediting Board (NAAB) as the process and product that result from the synthesis of social, environmental, aesthetic, and technical considerations into a cohesive and unified architectural entity.

For the purposes of NAAB accreditation, graduating students must be able to:

- Examine architectural issues rationally, logically and coherently.

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[1] Engineering Times, July, 1996, Volume 18, Number 7, page 1

[2] Engineering Times, July, 1996, Volume 18, Number 7, page 1

- Gather and analyze information about human needs, behavior and aspirations to inform the design process and do basic research as it relates to all aspects of design.

- Use architectural history and theory in the critical observation and discussion of architecture and bring an understanding of history to bear on the design of buildings and communities.

- Integrate natural and imposed site constraints into the development of the program and the design of the project.

- Articulate and clarify basic project goals and objectives and plan appropriate design activities using the techniques of programming, analysis and synthesis applicable to a variety of project types.

- Design both site and building to accommodate people with varying physical abilities.

- Apply the principles that underlie the design and selection of life safety systems in the general design of buildings and their subsystems.

- Assess, select and integrate structural and environmental systems into building design.

- Select building materials and assemblies as an integral part of the design and to satisfy requirements of building programs.

- Develop interior and exteriór building spaces, elements and components using basic principles of architectural form-making.

- Use the interactions between technical, aesthetic, and ethical values in the formation of architectural judgments.

Who does what?

Architecture, being the art and science of designing and erecting buildings and monuments, by definition must depend heavily on mathematics. The basic difference between the two definitions of design is that the engineers employ basic sciences , mathematics and engineering sciences to model mathematically the structure to survive earthquakes, flooding, landslides, tropical storms and any other natural phenomenon that may impair the structure. However, the professionals who are trained and know how to use these magnificent tools are not the architects, but the engineers. On the other hand, the architects are truly experts in modeling physically the structure by developing interior and exterior building spaces, elements, and components using basic principles of architectural form making (mock-ups). These are two very different approaches to the concept of designing a building. The question that may be asked is: Are these two different designs, one by architects and other by engineers? The answer should be *No*. The design of a building does not consist in covering one aspect only but in covering both. The reality dictates that a multistory building, particularly if it is to be built in high seismic risk areas, will never be built without the active participation of the civil engineers, the electrical engineers, the mechanical engineers and the land surveyors. The architect, on the other hand, unless he is also an engineer, will never be able to complete the design of a multistory building without the intervention of engineers. Engineers can do so without any legal constraints.

Today, in this world where the human being uses for his benefit so many diverse mechanical artifacts and systems, it can be easily understood that the intervention of engineers in all of them is much greater than that of architects. This is why engineers outnumber architects by millions and millions. Some examples may prove the case: the engineering design, manufacturing, construction, testing, operation and maintenance of electric power generation equipment, step up transformers, switch yards, and power transmission lines; rockets and spacecraft; computers and communication systems of all kinds; all the machinery and processes employed in the manufacturing of pharmaceuticals; food processing; production of potable water and used water treatment plants; land, water, air transportation systems and many others.

There are thousands of artifacts and systems made by engineers which do not require the intervention of architects; the opposite is not true. Table 1 shows a comparison of the two curricula. It is easily observable that the intellectual strength that qualifies an engineering to perform engineering design is the depth in mathematics, basic sciences and engineering sciences. Spatial studies constitute the strength of the architect.

Table 1: Semester credit hours required by the PUPR programs

Component	Civil engineering	Architecture
Mathematics	24	6
Basic sciences	19	3
Socio-humanistic and languages	27	30
Engineering sciences	33	---
Engineering technology	---	27
Concentration	56	66
Capstone	4	12
Computer algorithms	6	---
Computer skills	---	9
Electives	6	27
Practicum	---	3
Total	175	183

Program of architecture at PUPR

The program of architecture provides students an opportunity to aquire knowledge in the theoretical, technical and practical aspects of the profession, and thus be able to enter and excel in this highly competitive field. Towards such end, our well-balanced curriculum is both structured and open. It includes core professional courses, liberal arts, social and natural sciences, and mathematical skills at the precalculus level, focusing on both representational and language abilities. The student's understanding of architecture, upon completion of the minimum graduation requirements, is one of a jointly broad social, cultural and technical base.

Architecture requires the command of architectural design, history, technology, structures, theory, and pragmatic aspects related to practice. Our program prepares students to face situations of considerable complexity and comprehensiveness and social responsibility, at the same time allowing for personal interests to mature in related fields. Graduates of the program are thus expected to generate an effective, forceful and spirited architecture.

Architects engage in diverse interrelated branches: architectural design, management, administration and construction. They work for the public sector, private enterprise and as individuals. Some architects specialize, for example, in preservation, residential work, housing interior architecture, environmentalism, landscape or specific building types. The majority, however, keep a varied practice, simultaneously engaging in projects addressing diverse uses, scales and costs.

The Polytechnic University's program of architecture offers a five-year bachelor of architecture professional degree program. The school opened in the fall 1995 and enjoys candidacy status by National Architectural and Accrediting Board (NAAB), the only accrediting agency for architecture in the USA.

Candidacy is a status granted by board action to new programs which intend to seek initial accreditation. Candidacy status is intended to define, as early in a program's development as possible, the necessary components of an accredited professional program in architecture. The conditions for accreditation define the minimum standards which form the basis for initial accreditation and a foundation for the program's future development and enrichment. Acceptance of a program's candidacy status by NAAB indicates only that the plan proposed by the applicant institution, if properly implemented, should enable the program's subsequent accreditation.

Most states require that an individual intending to become an architect hold an accredited degree. There are two types of degrees that are accredited by the National Architectural Accrediting Board: (1) The bachelor of architecture, and (2) the master of architecture. These professional degrees are structured to educate those who aspire to registration and licensing as architects.

The four-year, pre-professional degree, where offered, is not accredited by NAAB. The pre-professional degree is useful for those wishing a foundation in the field of architecture, as preparation for either continued education in a professional degree program or for employment options in fields related to architecture.

The program of architecture includes a computer laboratory and a photographic darkroom for student use. They complement the architectural representation component of the program. In addition, the school benefits from the availability of the following laboratories on campus in the Civil Engineering Department: Soils Mechanics Laboratory; Materials Laboratory and Mechanics of Materials Laboratory. These complement the technology and structure components.

All students that request admission and are admitted to the architecture program must show evidence that they have acquired the academic abilities and skills necessary to progress through this major. Those not demonstrating the complete acquisition of these abilities and skills (as reflected by the results of their College Entrance Examination Board test; P.U.P.R.'s placement test; previous university experience; or other tests or criteria) will be required to take preparatory courses to overcome deficiencies in languages, mathematics and science. These remedial courses are in addition to the 183 credits of the architecture program. The courses are awarded their corresponding credits according to contact hours.

Developmental studies component
(24 credit-hours)

Course		Title	Credit-hours
MATH	100	Preparatory mathematics	3
MATH	110	Algebra	3
SPAN	100	Preparatory Spanish	3
SPAN	110	Spanish grammar	3
ENGL	100	Preparatory English	3
ENGL	110	English grammar	3
ATUL	100	Adjustment to university life	3
SCIE	110	Introduction to physics	3

The curriculum structure of the Program of Architecture consists of the following components:

Socio-humanistic studies and languages
(30 credit-hours)

Course		Title	Credit-hours
SPAN	111	Spanish reading and writing	3
SPAN	251	Hispanic literature	3
ENGL	111	English reading and writing	3
ENGL	251	Analysis of world literature	3
HIST	351	History of Puerto Rico	3
SOHU	251	Socio-humanistic studies I	3

SOHU	252	Socio-humanistic studies II	3
ARPP	101	Ethics	3
****	***	Elective	3
****	***	Elective	3

Basic sciences and mathematics (9 credits)

Course		Title	Credit-hours
MATH	111	Precalculus I	3
MATH	122	Precalculus II	3
SCIE	211	General physics I	3

Professional core (63 credits)

Course		Title	Credit-hours
ARCH	101	Basic design I	4
ARCH	102	Basic design II	4
ARCH	103	Basic design III	4
ARCH	201	Design fundamentals I	4
ARCH	202	Design fundamentals II	4
ARCH	203	Design fundamentals III	4
ARCH	301	Intermediate design I	4
ARCH	302	Intermediate design II	4
ARCH	401	Advanced design I	4
ARCH	402	Advanced design II	4
ARCH	403	Advanced design III	4
ARHH	101	Introduction to architecture	3
ARHH	201	Caribbean architecture	3
ARHH	301	Historiography	3
ARCT	101	Introduction to architectural theory	3
ARCT	201	Mid-career research	4
ARPP	501	Practice construction documents	3
ARPP	502	Practice management and finances	3

Technology (27 credits)

Course		Title	Credit-hours
ARST	101	Structures I: Concepts	3
ARST	201	Structures II: Steel	3
ARST	301	Structures III: Concrete	3
ARST	401	Structures IV: Wood	3
ARTE	101	Introduction to technology	3
ARTE	201	Technology: Materials and methods	3
ARTE	301	Technology: Site	3
ARTE	401	Technology: Environmental systems	3
		Elective in technology	3

Computer science (9 credits)

Course		Title	Credit-hours
ARCC	101	Architectural representation I	3
ARCC	201	Architectural representation II	3
ARCC	301	Architectural representation III	3

Electives (27 credits)

Credit-hours in history	3
Credit-hours in theory	3
Credit-hours in architectural representation	3
Credit-hours free electives	18

Laboratory experiences and practice (3 credits)

ARPP	100	Practice/Experience	3

Capstone design (12 credits)

Course		Title	Credit-hours
ARCH	501	Capstone design I	4
ARCH	502	Capstone design II	4
ARCH	503	Capstone design III	4

Civil engineering program at PUPR

Civil engineers are responsible forf providing the engineering design, the construction and maintenance of the world's infrastructure facilities, which are basic to the existence of modern society. These facilities can be large and complex, thus requiring the civil engineers to be broadly trained and able to deal with the latest technologies. The goal of the civil engineering program at the Polytechnic University of Puerto Rico is to develop in the students a professional knowledge of the technology needed to enter into these highly competitive fields; and to prepare the graduates to pursue a productive civil engineering career that is characterized by continued professional growth. The student develops the ability to apply pertinent knowledge to the practice of engineering design in the major discipline areas of civil engineering: structural engineering, geotechnical engineering, hydraulics and environmental engineering, transportation engineering, and construction management. This engineering design experience is built upon the fundamental concepts of mathematics, basic sciences, engineering sciences, and the humanistic and social sciences. This will provide civil engineers a healthy self image, a well rounded knowledge of their role in society, the ability to communicate and to develop their creativity by applying engineering design with originality.

Civil engineers are involved in almost all aspects of public works and utility infrastructure development. They provide the engineering design of a multistory building, a highway, a bridge to span a river, a retaining wall to support soil pressure, a water treatment plant, a dam, among other things. They may analyze the hydrologic conditions of a particular area, the mechanical properties of soils, or the expected behavior of a structure under the most adverse natural forces such as earthquakes, tropical storms and flooding. They may also plan, supervise and manage the execution of the jobs previously mentioned.

The program of civil engineering offers undergraduate instruction leading to the degree of Bachelor of Science in Civil Engineering (B.S.C.E.). The following laboratories are an integral part of the program: Geotechnical Engineering Laboratory, Construction Materials Laboratory, Mechanics of Materials Laboratory, Environmental Engineering Laboratory, Structural Engineering Laboratory and Civil Engineering Simulation Laboratory. These laboratories have been designed to perform a wide range of experiments in each one of the five areas of specialization. Although all laboratory facilities are meant for academic tasks only, they are fully equipped to provide service to the industry.

All students admitted to the civil engineering program must show evidence that they have acquired the academic abilities and skills necessary to progress through this major. Those not demonstrating the complete acquisition of these abilities and skills (as reflected by the results of their College Entrance Examination Board test, results in P.U.P.R.'s placement test, previous university experience, or other tests or criteria) will be required to pass preparatory courses. These courses are designed to help them overcome deficiencies in languages, mathematics and science. These remedial courses are in addition to the 175 credits of the civil engineering program. The corresponding course credits are awarded according to contact hours. These courses are the following:

Developmental studies component
(Maximum of 24 credit-hours)

Course	Title	Credit-hours
ATUL 100	Adjustment to university life	3

ENGL 100	Preparatory English	3
ENGL 110	English grammar	3
SPAN 100	Preparatory Spanish	3
SPAN 110	Spanish grammar	3
MATH 100	Preparatory mathematics	3
MATH 110	Algebra	3
SCIE 110	Introduction to physics	3

The Civil Engineering Curriculum structure consists of the following components:

Mathematics component (21 credit-hours)

Course	Title	Credit-hours
MATH 111	Precalculus I	3
MATH 122	Precalculus II	3
MATH 133	Calculus I	3
MATH 144	Calculus II	3
MATH 215	Calculus III	3
MATH 226	Calculus IV	3
MATH 237	Differential equations	3

Basic sciences component (16 credit-hours)

Course	Title	Credit-hours
SCIE 111	General chemistry I	4
SCIE 112	General chemistry I, laboratory	0
SCIE 213	Physics I, mechanics	3
SCIE 214	Physics I, laboratory	1
SCIE 235	Physics II, heat, light and sound	3
SCIE 236	Physics II, laboratory	1
SCIE 249	Physics III, electricity and magnetism	3
SCIE 250	Physics III, laboratory	1

Socio-humanistic and language component
(27 credit-hours)

Course	Title	Credit-hours
ENGL 111	English reading and writing	3
SPAN 111	Spanish reading and writing	3
ENGL 251	Analysis of world literature	3
SPAN 251	Hispanic literature	3
SOHU 251	Socio-humanistic studies I	3
SOHU 252	Socio-humanistic studies II	3
PHIL 441	Professional ethics in engineering	3
SOHU	Socio-humanistic elective I	3
SOHU	Socio-humanistic elective II	3

General engineering sciences component
(39 credit-hours)

Course	Title	Credit-hours
ENGI 131	Engineering graphics	2
ENGI 142	Descriptive geometry	2
ENGI 146	Freshman engineering design	3
ENGI 220	Computer programming and algorithms	3
ENGI 235	Probability and statistics for engineers	3
ENGI 246	Earth sciences	3
ENGI 322	Applied mechanics-statics	3
ENGI 324	Mechanics of materials I	3
ENGI 325	Engineering mechanics-dynamics	3
ENGI 327	Fluid mechanics	3
ENGI 328	Fluid mechanics laboratory	1
ENGI 335	Mechanics of materials II	3
ENGI 340	Mechanics of materials laboratory	1
ENGI 449	Engineering economics	3
EE 3800	Principles of electrical engineering.	3

Civil engineering component (66 credit-hours)

Course	Title	Credit-hours
SURV 191	Surveying instruments laboratory	1
CE 246	Applied software for civil engineering	3
CE 247	Applied numerical analysis	3
CE 318	Water resources engineering	3
CE 321	Highway design I	3
CE 322	Highway design II	3
CE 330	Construction materials	3
CE 331	Laboratory of construction materials	1
CE 410	Construction management	3
CE 412	Theory of structures I	3
CE 413	Water supply engineering	3
CE 415	Steel structures design	3
CE 416	Environmental engineering	3
CE 420	Concrete structures design	3
CE 424	Theory of structures II	3
CE 425	Advanced structural design	3
CE 437	Geotechnical engineering I	3
CE 438	Geotechnical engineering laboratory I	1
CE 439	Geotechnical engineering II	3
CE 440	Geotechnical engineering laboratory II	1
CE 441	Foundation engineering	3
CE 446	Wastewater engineering	3
CE 447	Transportation engineering	3
CE 514	Environmental engineering laboratory	1
CE 540	Civil engineering capstone design I	2
CE 550	Civil engineering capstone design II	2

Elective component	6
Minimum total program credits	175

Civil engineering elective courses

Course	Title	Credit-hours
CE 445	Civil engineering practice	3
CE 455	Cost estimates	3
CE 500	Matrix computer analysis of structures	3
CE 501	Dynamics of structures	3
CE 502	Structural optimization	3
CE 503	Prestressed concrete design	3
CE 504	Earthquake engineering	3
CE 505	Bridge design	3
CE 506	Advanced steel structures design	3
CE 507	Computer analysis and design of structural systems	3
CE 508	Design of wood structures	3
CE 509	Structural engineering laboratory	1
CE 510	Open channel engineering	3
CE 511	Environmental improvement	3
CE 512	Advanced topics in water resources engineering	3
CE 515	Computer aided design in hydraulic and environmental engineering	3
CE 516	Fundamentals of ground-water hydrology	3
CE 520	Geometric design of highways	3
CE 522	Transportation facility design and planning	3
CE 523	Computer aided design in transportation and highway engineering	3
CE 528	Deep foundations	3
CE 529	Design with geosynthetics	3
CE 530	Geotechnical engineering III	3
CE 531	Advanced soil mechanics	3
CE 532	Soil dynamics	3
CE 533	Advanced foundations	3
CE 534	Computer aided design in geotechnical engineering	3

CE 535	Monitoring of construction projects	3
CE 536	Soil improvement	3
CE 538	Inspection of projects	3

Licensing

It has been correctly stated, although in a derogatory tone or as a criticism, that under the law in Puerto Rico, engineers are awarded a generic license, with no distinction among electrical, mechanical, civil, chemical, industrial, agricultural, petroleum, nuclear, or aeronautical engineering disciplines. Two arguments clarify this point. First of all, no matter what discipline the engineering student may choose, ABET requires that all of them take a minimum of 32 semester credit hours of basic sciences and mathematics, 32 semester credit hours of engineering sciences, 16 semester credit hours of humanistic and social sciences and about 16 semester credit hours of engineering design in the discipline chosen, for a total of 96 semester credit hours minimum. Nonetheless, no institution grants the student a degree after passing only 96 credits. Normally the degrees are granted depending upon the specific institution and its programs, with a number of credits that may fluctuate between 128 and 180 semester credit hours depending on whether it is a four- or a five-year program. This is a professional degree. The bachelor's degree really provides basic training in engineering and does not have the intention or purpose of a specialized degree. Secondly, the specialization is achieved only with the master's and doctoral degrees in engineering - the second argument in favor of the generic license.

In the United States of America almost all ABET-accredited programs are described as four-year programs. The students admitted to these four-year programs must be prepared to start directly with differential and integral calculus, and physics and computer courses based on calculus. This requirement implies that an engineering student in the USA starts at a considerably higher level of education in science and mathematics than a student admitted to the programs in architecture, a difference that may well represent 20 to 30 credit hours. That is, the level of academic preparation required at the moment of admission of the student to the program is much higher for engineering than for architecture in these fundamental disciplines.

When the programs are compared, it is easily observed that no fewer than 6 credits in the program of architecture are in history courses - that in essence are in socio-humanistic sciences, thus the science and mathematics contents in architecture are hereby limited.

Undoubtedly, the 128-credit-hour program acreditted by ABET is rightly comparable to the 183-credit-hour acreditted by NAAB program for a bachelor's degree. Much more, the 175-credit-hour acreditted by ABET programs, such as the PUPR's or those of UPR, Mayagüez Campus, exceed the requirements for basic sciences, mathematics, engineering sciences by far and socio-humanistic contents compare favorably with the programs accredited by NAAB.

Representatives from the National Society of Professional Engineers (NSPE), the Accreditation Board for Engineering and Technology (ABET), the National Council of Examiners for Engineering and Surveying (NCEES), the Engineering Deans Council, and the American Society of Engineering Education (ASEE) have proposed a model to revise the present licensing scheme. The new model calls for graduates of an ABET/EAC accredited engineering program who pass the Engineering Registration Examination (ER) to be designated "registered engineers" (REs). Registered engineers would not be able to sign and seal engineering design drawings. The model also incorporates the new format of the engineering registration examination which tests the fundamentals offered during the first three years of engineering school, as well as the discipline specific engineering knowledge from the full five-year curriculum.

With technical engineering principles covered by the ER exam, the proposed model recommends that the second licensing exam cover only nontechnical issues such as ethics, codes, standards and government policies.

As for practice experience, the model would maintain the current standard of four years of experience, including such activities as professional practice under a licensed professional engineer (LPE).

One addition to the model is the call for mandatory, periodic proof of continuing professional competency for maintaining the LPE status. One of the most important factors related to excellence in engineering service and the protection of the public is to provide a means of assuring that all licensed professional engineers continue to update their credentials throughout their professional lives (fig. 1).

It is sometimes pointed out that the training required for an intern architect is prescribed, and translates knowledge acquired at the university into a wide range of professional scenarios. In contrast, it is said, an engineer's education and training is focused solely on his specific discipline, as is the state board licensing exam that he takes. Locally, it is said that it is required by law for architects to have fulfilled a minimum of a two-year internship before the individual can become licensed, even if he or she has successfully passed the state board exam. This is not the case for engineers, they say, who, once having passed the exam can become licensed, even without any work experience.

Regarding the licensing process for both professions, nothing has been divinely prescribed. All the licensing processes are absolutely controlled by those professionals who are personally interested in participating in them, who lobby with the legislature. It may well happen that the situation described and the limitations imposed or requirements established concerning the licensing of architects are the product of the hidden interest of a small group of their professionals in limiting the number of practicing professional architects, having nothing to do with the complexity or the diversity of the subjects made part of the curriculum.

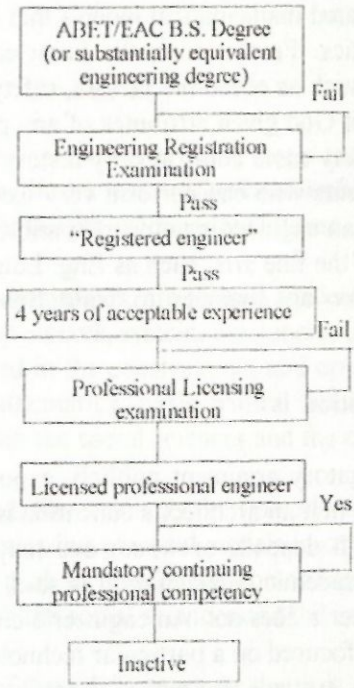

Figure 1. Licensure model

Practicing architecture

Another argument frequently presented states that many times engineers in the electrical, mechanical, structural or civil engineering disciplines attribute themselves the privilege of practicing architecture, simply because their work involves one component of a building's design. Once again, it is mandatory to come to the definition of the word "design" as used by the engineers or the architects. No one architect, unless he or she is also an engineer, will be able or capable of performing the engineering design of the electrical system, the water supply system, the structural system, the sewage system or any other system of a multistory building which requires lengthy and complicated mathematical models that demand the application of higher mathematics. Furthermore, the knowledge and application of realistic constraints, such as economic factors, safety, aesthetics, ethics and social impact are not God given attributes of any profession in particular. Today, similar to many cases confirmed by history, there are many people with exceptional talents who can perform very well in several fields. The same way that being an engineer is not incompatible with being a pianist or an active promoter of the fine arts, such as Eng. Luis A. Ferré Aguayo, it is not incompatible for an engineer to train himself to perform some architectural designs.

More diverse education

Another derogatory argument publicly exposed by some people in favor of architects is that an architect's education is more diverse than that of an engineer. It all depends of whom one may be talking about. An architect's typical academic curriculum, it is said, covers a wide range of topics, and an engineer's does not. An engineer's curriculum, continues the argument, is mostly focused on a particular technology that corresponds to only one of the many systems that make up, say, a building. To respond to this argument it would suffice to look closely at the curriculum of each one of the PUPR's bachelor's degree programs. Furthermore, generalizations, such as the aforementioned, are always dangerous. Comparisons, to be fair, should be made among people having obtained equivalent degrees, say, architects and engineers of any discipline with a bachelor's degree; architects and engineers of any discipline with a master's degree; and architects and engineers of any discipline with doctoral degrees. It would not be difficult to find out what the truth is. What really happens is that when the criteria put out by NAAB to evaluate programs in architecture are carefully analyzed, it is made evident that architecture is limited to buildings and their surroundings. Engineering embraces many other components, processes and systems besides buildings and their environment. It is true that there are some subjects the architects take and the engineers do not, but on the other hand, there are many subjects that the engineers are required to take that the architects are not.

Conclusion

Although this analysis will not bring to an end the historic dispute between professional engineers and professional architects, it does pretend to illustrate to the reader the main educational thrust of each profession.

Engineers, of all disciplines, are trained academically to perform the engineering design of any process, system, machinery, instrumentation, tools and whatever is required in the construction, and operation of any facility applying advanced mathematics, basic natural sciences and engineering sciences in harmony with the social sciences and the environment.

On the other hand, the architects are trained academically to depend heavily not on mathematics but physical models (mock-ups) and the liberal arts to model the spatial analysis and distribution of any and all architectural designs in harmony with the social sciences and the environment.

The implications of these differences are that it is relatively easy for an engineer, independently of one's discipline but particularly for a civil engineer, to embark on architectural design and the construction of highly complicated structures such as multistory buildings particularly in high seismic risk areas. The architects, on the contrary, can not perform the engineering design of any process, component or system associated with buildings and monuments by themselves. The only way they can do it is by contracting the respective engineers to perform the engineering design for the contracting architects.

The depth in advanced mathematics makes the big difference between the two curricula.