

Mecesup Project Report

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This report encompasses my review of the engineering programs at Pontificia Universidad Católica de Chile (PUC) and Universidad de Chile (UC) as part of the cross-school mecesup project. This review is based on visits to both universities during the period June 15-22, 2007. The visit involved meeting with faculty in the Departamento de Ingeniería Hidráulica y Ambiental at PUC, and the División de Recursos Hídricos y Medio Ambiente at UC, as well as members of the mecesup committee from both universities. The meeting format involved presentations at both PUC and UC on the structure of the Civil and Environmental Engineering degree programs at Northwestern University (NU), further presentations on NU's approach to ABET accreditation in Civil Engineering (BSCE) and Environmental Engineering (BSEnE), presentations by PUC and UC faculty on the Ingeniero Civil degree programs at both universities, and discussion of curricular development, specific engineering courses, and the ABET accreditation process. Herein I summarize the major topics of discussion and provide recommendations for further development of the engineering curricula in Ingeniero Civil, Hidráulica, y Ambiental, as well as for approaches to ABET accreditation.

Overall comments: I was impressed with the depth and breadth of education that students receive at both PUC and UC. Relative to the U.S., the basic Civil and Environmental Engineering programs at PUC and UC require much more rigorous training in mathematics and basic engineering sciences, as well as more in depth study of advanced topics in both civil and environmental engineering. This largely reflects the differences in the overall professional preparation and licensure between Chile and the U.S. Specifically, in the U.S. the four-year engineering degree is not intended as a terminal degree for advanced engineering work, and professional licensure is certified independently of the universities, whereas in Chile practicing engineers normally have specifically the Ingeniero Civil degree and this carries with it the professional engineering license. Both systems have their advantages. The U.S. system retains greater flexibility and often results in students obtaining some work experience before completing advanced study (M.S. or M.Eng.) and requires such experience before being provided with a professional license (P.E.), whereas engineers are much more uniformly educated in the Chilean system. The curricula at PUC and UC generally instill a high level of technical competence, but at the cost of requiring two additional years of coursework and also of requiring students to make a commitment on their entire professional training at a young age and normally without the benefit of any professional experience. Opportunities appear to exist to streamline the engineering curricula by seeking better integration of lower-level science courses with engineering courses and by better defining the core competency for the Ing. Civil Licenciatura so as to allow students greater flexibility in pursuing their selected specialization at the Ingeniero degree level or at a more advanced degree level (M.S.)

Specific Points of Discussion:

Issue 1: Teaching broad introductory courses in environmental engineering

The difficulty in teaching broad, introductory courses in environmental engineering at the Ingeniera Civil Licenciatura level was discussed extensively at both UC and PUC. This is a common challenge for engineering programs in the U.S. as well. In general, this type of course is difficult to teach because there is great disparity in the degree of student interest in and preparation for the material. These challenges can be overcome by improving sequencing of the course, i.e., by requiring all students to take it at a similar level in their degree program, and by improving integration of the course within the overall Ingeniera Civil program. Essentially, if knowledge of environmental processes and/or environmental impacts of engineering activity is viewed as a core competency within the Ingeniera Civil program, then this material should not be considered as a “stand-alone” or “one-off” course, but instead the first course should really serve as an introduction to environmental systems and then be reinforced through other courses in the program. This can best be achieved by providing the foundation for this material in the Ciencias Básicas program and then by addressing the natural systems / environmental impacts aspects in multiple courses in the Programa Común de Ingeniera Civil.

In terms of the instruction, my recommendation is that both UC and PUC take advantage of their strong laboratories and the local setting in the city of Santiago to provide more “hands-on” and practical experience for students taking this course. Laboratories offer the opportunity to demonstrate key concepts to students, and are feasible even for relatively large courses provided that teaching assistant support is available, time is provided in the course schedule for laboratory periods, and laboratory activities are restricted to demonstrations with limited data acquisition. With regard to opportunities in Santiago, numerous examples of natural environmental phenomena and environmental impacts of municipal and industrial development can be found in the local area. Extensive use of case studies based on local sites and concerns can be an effective tool in providing context for education in environmental engineering, demonstrating the relevance of class material to students, and illustrating the importance of interdisciplinary, systems-level approaches to environmental problems.

Issue 2: Breadth of training in basic engineering sciences

The Ciencias Básicas program at both PUC and UC is very strong in mathematics and physics, but does not include breadth in chemistry and biology. In this sense, the programs are strong, but traditional. Modern engineering practice is interdisciplinary, and future engineering efforts are likely to require even greater flexibility and trans-disciplinary cooperation. Therefore I recommend that the engineering faculties reconsider if the current Ciencias Básicas program provides students with sufficient breadth of natural sciences to support the expected high degree of technical diversity of efforts that engineering graduates will need throughout their careers.

Issue 3: ABET process

The engineering programs at UC and PUC will face the normal challenges of the ABET process – such as documenting that desired educational outcomes are achieved – but also face particular challenges because of the different academic structure in Chile compared to the U.S. I have several recommendations that can be helpful in negotiating this process:

1. Program objectives should be defined at both the level of the overall Ingeniero Civil program and also at the level of each department/specialization. This does not translate directly to the U.S. undergraduate degree program, but encompasses the same sort of breadth that would normally be found in ABET-accredited programs in the U.S. This effort will also help the faculties of Ingeniero Civil and the various component departments to better define the competencies they wish students to develop at the Licenciatura level vs. the departmental specialization level.
2. When evaluating program outcomes, it is easiest to directly follow the ABET a-k outcome criteria. If other outcome criteria are adopted, then it is necessary to “map” the program outcome criteria on the ABET outcome criteria, which is always a cumbersome process.
3. Once program objectives and outcomes are set, it would be very useful to develop a matrix indicating which program objectives and outcomes are addressed in each course at both the Licenciatura and Ingeniero/specialization levels. In this manner, the overall coverage of each objective and outcome can readily be evaluated. Most importantly, it can readily be seen which courses might be redundant and which objectives/outcomes might not receive sufficient attention in the curriculum. Typically it is important for each key objective to be addressed in multiple courses in order to ensure that desired outcomes are achieved. Where only a small number of course(s) are relied upon to achieve a particular program objective or outcome, then those course(s) must receive particular attention in order to ensure that they always achieve the desired outcomes.