

Mecesup UCH0403:
***Renewal of Civil Engineering Programs at Universidad Catolica de Chile
and Universidad de Chile***

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Activities

In March 2007 I visited the University of Chile and the Catholic University of Chile for approximately one week. Activities included:

- Meetings with a number of faculty members from both institutions to discuss curriculum redesign issues. Meetings included relatively high level discussions of broad curricular design at both schools, discussions focused on first-year curricula with the faculty responsible for first-year programs at both schools, and both electrical and mechanical engineering faculty engaging in curricular re-design activities in the third through sixth years of the curriculum.
- A one day workshop on user-oriented curriculum design. This workshop was attended by approximately 12 faculty members. The workshop included an introduction to two major ideas in user-oriented curriculum design: synthesis of information about users through the use of affinity diagramming and persona creation; and identification of raw ideas for innovation through brainwriting and idea shaping.
- Presentation of a talk, titled “The Olin Experiment,” which highlighted some of the features of the Olin College curriculum, and emphasized some of the lessons learned in the process of building the Olin curriculum.
- Attendance at a conference titled *The Imperative for Curriculum Innovation and Quality Assurance in Engineering Education*, which was hosted in Vina del Mar by the Catholic University of Valpariso. At this conference I presented a shorter version of “The Olin Experiment,” and met with leaders from other engineering programs in Chile and Argentina.

Lessons Learned at Olin

“The Olin Experiment” concludes with a number of observations based on our experiences at Olin. While these observations may not be directly portable to other institutions, I believe they are broadly applicable. I summarize these lessons below.

- *Faculty engagement matters as much as pedagogical approach.* The literature clearly indicates that some pedagogies are, in general, more effective than others. Faculty should clearly be aware of this literature, and should modify their approaches accordingly. Having said this, faculty engagement has a very strong influence on student experience – so as an institution thinks about modifying

pedagogies, it must do so in a way that engages faculty. For example, a bottom-up, incentive-based approach may be more effective than a decree-based approach.

- *The union of all faculty members' "minimum" knowledge set is an eight year undergraduate program.* It is tempting to begin a curricular design process by asking "what material should we teach students?" This approach inevitably yields a set of topics that is far too large. The design process then becomes an exercise in cutting material and in "squeezing more in." In the end, this will result in a curriculum that has too much emphasis on specific topics, little philosophical framework, and little emphasis on student development. Based on our experience at Olin, I suggest that it makes more sense (1) to establish a philosophical framework and associated broad learning objectives (e.g., "We want our students to be strong in design"; (2) to decide how you will divide the available curricular space among these broad objectives (e.g., "We will devote 1/8th of the curriculum explicitly to courses that emphasize design over any specific engineering science topics"; and (3) only discuss particular topics when the curriculum is sufficiently granular that the time constraints are obvious.
- *Be explicit about resource allocation, particularly with respect to first year students.* The typical resource allocation model for engineering programs makes relatively little investment in first year students (e.g., class sizes in the first year are often very large – 100-300 students), and a large investment in final year students (e.g., final year classes often have only 10-20 students in them). Such a model makes sense from an "efficiency" perspective – "all students have to take calculus, so why not teach it to all of them at once?" – but do not make sense from a *student experience* perspective. Indeed, the first year plays an enormous role in determining student attitudes and success in future years, and first year students have less experience than final year students, so one could argue that it makes more sense to invest in students early.
- *Rethink classroom use.* We have found that innovative pedagogies do not require innovative space, and particularly do not necessarily require investments in technology. By thinking innovatively about *use* of space (e.g., by adopting a studio model rather than a lecture model), one can make substantial changes without substantial investment.
- *Be explicit about the pedagogical goals of projects.* Often projects are seen as a fun "antidote" to more formal lecture-based learning. As a result, projects are sometimes not structured around particular learning goals. It is possible to design projects that are both fun and that have specific learning outcomes – both with respect to particular topics and with respect to broad competencies – but one must design the project to accomplish these goals.
- *Students don't need to learn everything before they can do engineering.* We have found that it is possible to have first year students doing things that involve relatively advanced topics (e.g., control, mechanical design). Indeed, provided the opportunity, students will do very impressive work that they, in theory, "shouldn't be able to do". While these early experiences do not lead to students having deep knowledge of the topic, they do introduce students to the topics,

provide students with a context for their learning in later experiences, and motivate students for future work.

Observations and Recommendations

Caveat: I was of course in Chile for only one week; the observations and suggestions outlined below are based on this relatively short interaction, and should be therefore read with appropriate skepticism.

Faculty Commitment to Reform

During my visit I was extremely impressed with the level of energy at both universities around curricular innovation and reform. At both schools multiple faculty members have done a great deal of work to add engineering experiences early in the curriculum. In addition, I saw several examples of commitment to authentic engineering experiences in the upper levels of the curriculum. I recognize that the faculty members I met, and the kinds of experiences I was shown, are likely not representative of the entire population of faculty, or the entire student experience. Nonetheless, I believe both universities have a significant resource in the energy and creativity of their faculty. I encourage the leadership of both schools to continue to empower reform-minded faculty, and to reward them appropriately.

First Year Experiences

Many of our conversations focused on first year engineering experiences. The Catholic University has been running a first year engineering experience for all its students for several years; the University of Chile has been running a pilot for several years, and has recently begun to ramp this pilot up to a full-scale implementation. I was impressed at both universities with the commitment to give all first year students a motivating “taste” of engineering. I was also impressed with the creativity of some of the project ideas we discussed, and with the desire to make the projects connect to real-world problems.

First year experiences are critical from a number of perspectives. First, they heavily influence student attitudes, as they constitute students’ “first impressions” of engineering. A positive first year experience can have long-lasting benefits – but just as importantly, a negative first year experience can influence student thinking for years to come. They also can provide excellent learning opportunities in both the technical realm and in “soft” competencies (e.g., communication, team work, etc.), and they can serve to motivate and reinforce subjects the student has learned, is learning, or will learn.

Given the importance of these first year experiences, I have a number of suggestions, based on our experiences at Olin. These suggestions are probably unrealistic, given resource constraints, etc., but I think they at least provide a sense of the direction in which one might try to push these experiences over a several year period.

Teaching Resources: At both the University of Chile and at the Catholic University, a small team of faculty members is responsible for delivering the first year engineering experience to a large number of students – student:faculty ratios for these experiences appear to be on the order of 100:1 or 200:1. Faculty members teaching these courses are

also assisted by some upper-level students (e.g., 1 teaching assistant per 15 students). On the other hand, upper-level courses appeared to have smaller numbers of students in them (e.g., student:faculty ratios of between 40:1 and 10:1).

If indeed first year experiences have long-term impact on student attitudes, it is very important to invest in them appropriately. I am concerned that a student:faculty ratio above 100:1 may not be consistent, in the long term, with the goal of giving students a positive initial experience. Given the dedication and energy of the faculty working on the first year experiences at both schools, I am confident that the experiences are positive for students, and will be positive in the short term. However, I believe that the *sustainability* of these programs will ultimately require a greater investment in the form of additional support. This could be in the form of additional faculty resources, but might also be in the form of increased training of student assistance, reformulation of the course structure, etc.

Fabrication and Material Selection: I observed that relatively little is available to first-year students in the way of fabrication facilities – students are expected in some cases to do their projects “at home”— and that students are often free to choose materials for their projects (e.g., using whatever materials are available). At Olin we used a similar approach initially, but with experience we have found that a focused approach to fabrication and materials in first-year experiences is very helpful, for it allows the experiences to emphasize learning objectives rather than the details of tracking down material, figuring out how to fabricate, etc. For example, first semester students doing a mechanical design project are provided with a limited kit of materials (e.g., a certain amount of Delrin plastic, a certain length of latex tubing, etc.), and are provided with a limited, but advanced, range of fabrication options (e.g., laser cutting and hot staking). These limitations have two advantages: first, they greatly reduce student time spent on identifying materials and fabrication (and consequently allow students to spend more time on design processes, teamwork, etc.), and they greatly enhance the professionalism and quality of the final product.

Learning Objectives: The first learning objective identified for these first year experiences is typically “fun”, or “motivation.” Other learning objectives (around teamwork, project management, etc.) seem to be addressed in a lecture setting, but appeared to be less emphasized in the project component. I believe there may be an opportunity to increase the structure and learning objectives of the project component (see my comments above about pedagogical goals of projects). This could in part be achieved by simply changing the fraction of the experience that is lecture-based and the fraction that is project-based, but also would require some re-thinking of the project component.

Conclusion

I very much enjoyed my visit to Chile, and was very impressed with what I saw. Many people I spoke to expressed the opinion that Chile’s engineering programs are somehow behind typical US programs with respect to curricular innovation; based on what I saw, both the University of Chile and the Catholic University of Chile have already done some very good things in the area of curricular innovation, and more importantly, are devoting

impressive energy and enthusiasm to future curricular innovation. I wish you continued success in this endeavor!