**Three Part Invention, Four Part Revision** **MGMcNally**

*Zeno asks Achilles and Tortoise to consider the status and potential evolution of their undergraduate programs in Civil Engineering and in Environmental Engineering.*

**Zeno:** Are we offering students what they need?

**Achilles:** In general, yes, since our program is ABET accredited (as per ASCE lead input) and most of what we offer is quite similar to most other programs. But there are other considerations. First, our affiliates give direct feedback on whether or not our alumni are prepared, although this is not a random sample. Thus, we should consider other employer and alumni surveys, perhaps as part of accreditation. Second, since the assessment process can't foresee the future, we need to look ahead and see what knowledge and skills are likely to be in demand 10 years down the road. This will depend on the various areas of practice so each of us may wish to draft a list.

**Tortoise:** Prepping students for future needs in industry is important, but if the faculty are mainly focused on prepping students to be researchers, then it is a moot point. Unless we can find ways to intersect research and advanced professional skills, I don't see how we realistically can convince the current faculty to change their mindset.

**Achilles:** This has always been an issue. On one hand, we are a research university so having a bit more of an "exploratory perspective" in our program is as much of a plus as having a bit more hard design or a bit more practical code review. On the other hand, some faculty chant a mantra that specializations are misleading and they also push too much toward preparing students for graduate school when so few go that way. I think it comes down to this: faculty know what they know and that's what they want to teach. They do research but research cannot be taught to UGs, at least not directly. This mindset is supported by faculty growth being defined by research opportunities and not by undergraduate program needs. Hypothetical: if critical structures faculty decided to leave, would we be able to replace them with people that could teach structural and geotechnical engineering, or would we need to deconstruct that portion of our program?

**Zeno:** How can we streamline the courses and coordinate between different areas of focus?

**Achilles:** I don't know if this is something with a real direct benefit. We're covering most but not all areas in sufficient detail but coordinating between areas does not appear promising beyond the methods courses and senior design. We can address some issues via selected tweaks but I think major program changes would be needed if this is indeed to be an objective. Since our program is full unit-wise, we'll need to eliminate some requirements to add others, and we'll need faculty to step up to develop and offer these new or revised courses. I proposed changing the UG program with concurrent courses that could accelerate students into the master's program. Done right, this would allow for more options, but each concurrent course would require some additional faculty input to revising course material.

**Tortoise:** I think this is a nice idea, but I feel that the reality of it is that at the undergraduate level students are likely better served learning the basics of one area rather than trying to weave their experiences together. As hard as it is to conduct multidisciplinary research, it will be even

trickier to offer an effective multidisciplinary undergraduate program. Do we *really think* that's the right thing to do, or is it just a trendy topic in research and we're expanding it to undergrad education?

**Achilles:** Two things. First, those going into practice could still get the same program, but those few going into research would get an earlier introduction to graduate courses. I suspect that there is not a big difference between senior year and the first year of a master's program. Second, I agree that the multi-disciplinary approach can be limited. It will work where it happens naturally but it can't be forced. I think the problem is the silos that exist in basic areas, in both professional practice and in research. Whether this problem will be addressed, I'm not sure. We plan to hire new faculty in Smart Cities with the aim to bring these areas together. However, while all the areas might be working on Smart Cities, they will rarely be doing so on the same or closely related projects. We should take advantage of opportunities but maybe not expect big changes.

**Zeno:** How can we reduce the need for lecturers but still offer the best education that meets the need of the market?

**Achilles:** The total units in our undergraduate program have decreased by four and we're adding more faculty, so this *should not* be an issue. If it is, it's likely that we are addressing the graduate program with these new resources. That is not a bad thing since we're putting our faculty where the cutting edge is and using equally skilled lecturers to teach design components. Whether we consider ourselves a professional program or not, we do place the outstanding majority of our undergraduate alumni directly into professional practice. Also, most of us are *not* skilled in professional practice so judicious use of lecturers is a plus.

**Tortoise:** I can see this being a concern for accreditation. Regardless of faculty perception or ideals, over 80 percent of our undergraduate alumni go into industry. Some of our faculty are not engineers, and that can be a disconnect. In the sciences it might be a little more reasonable to gear undergraduate students towards research, but engineering is considered by many students to be a profession first and a research field second.

**Achilles:** Actually, it's both a dessert topping and a floor wax. It's one of the reasons why I've been pushing on the master's level. The bachelor's program leans toward professional practice while the doctoral program leans toward research and teaching, but what should the orientation be of a master's program? It can serve as a step toward the PhD or a terminal degree toward professional practice. We need to resolve this paradox so we can get buy-in on the undergraduate programs being more oriented toward practice.

**Tortoise:** How many lecturers are we using, really? If not that many, why try to reduce it? Maybe I'm ignorant of the issues at hand. Are we getting pressure from above, or does their use stress our budget?

**Achilles:** Budget pressures are constant. I don't think that senior administrators and faculty understand that new faculty in cutting edge research areas likely lack the ability to teach courses oriented toward professional practice. This is particularly true in our area of engineering. Faculty numbers are growing, as are student numbers, but so are lecturer demands.

**Zeno:** Doesn't much of this reflect resource concerns? Options will have benefits and costs.

**Achilles:** Professional master's programs will require a real effort on our part to develop and maintain, but these can generate revenue (a big initial cost, but subsequent cash flow). Selected concurrent courses require additional effort with little faculty benefit but with program benefits (some upfront costs, some subsequent benefits). Re-design of our program could reflect the research interests of faculty that we are able to hire. This new model may be that faculty are determining the curriculum rather than the curriculum determining the faculty. We are not hiring conventional transportation and structural engineers, but we're still offering the standard courses, and practice still demands some of these courses. New courses can be introduced as electives and eventually used to replace conventional courses.

**Tortoise:** Don't forget that the Dean plans to hire more full-time lecturers (LSOEs or Professors of Teaching) within the next few years. We could have one in transportation and in water soon.

**Achilles:** This may be a good thing, at least in the short term, since the university will fund slots to teach the needed courses (likely multiple times per year as we grow) and we will not need to allocate school and department funds to lecturers. But we have to ensure that we do not have a department with two different type of faculty.

**Zeno:** Can recommendations be made for revising current courses, if not current programs?

**Achilles:** Well, do our undergrads need two Matlab courses? Almost certainly not. We could make one an upper division specialization elective oriented toward those moving to graduate school and/or research.

**Tortoise:** Yes, I think this is out of touch. Civil engineers do not use Matlab and they do not program. Rarely, some may work for a highly specialized company or work in a niche, but two programming courses focused on solving nonlinear problems and differential equations, well, this is just not needed at the undergrad level. And we need room for other innovations.

**Achilles:** Do we need two CAD/GIS courses? Probably not the way we're currently teaching them. We could replace CAD with an industry-based on-line course for a price equivalent to a lab fee and combine the remaining material into one course. It not only reduces program units, which can be re-allocated, but also would free faculty for other teaching opportunities.

**Tortoise:** I agree that the CAD/GIS courses need an overhaul. This should be pretty easy to implement with instructor buy in. It may be a chance to increase our industry involvement even more. Maybe we can blend the senior design client consultant model into these courses?

**Achilles:** We've been trying to go in that direction for years, with little success. We also require three professional topics courses. The topics (economics and environmental issues) are valid but *may* restrict choices for our undergraduates and delay graduation. Developing an *Economics for STEM* option may not only cover needed program material and ease the jam in subsequent methods courses but would also generate unit revenue by having our students enrolled in our courses rather than courses from other schools. This course needs to qualify as a General Education course and not an engineering course, *per se*. This also holds for our Introduction to Environmental Issues course. A current proposal to change this would probably cost us General

Education approval. Without this approval, far fewer students would likely enroll. These all look like tweaks but they can have real benefits to the department and its programs.

**Tortoise:** They seem more than tweaks to me. Barring a total redesign, I think it's smart to change things in increments like this. Over the last year, I have not sensed that this department has the motivation to undergo a big curriculum overhaul. Maybe my read is wrong! I'd be happy to learn that I am wrong.

**Achilles:** Thus far, the only faculty whom are prepared to do this are the same ones whom are not willing to do so since those who call for wholesale re-development don't really understand that even if faculty were all willing to consider change, most will not willingly accept or implement it. We've been tweaking this for most of the 20 years it's been in place. There have been both positive changes as well as minor step-backs, such as the removal of a programming class eventually producing two Matlab courses. Sometimes, the more we try to tweak things, the more it's resisted.

*At this point, several of Zeno's lyceum faculty wander in.*

**Zeno:** Welcome, colleagues. As you know, we've been holding fairly constant in the size of our undergraduate programs (about 120 annually) but we're faced with pressure to offer some courses multiple times per year. Courses that are the primary roadblocks toward progress to degree include introductory courses in statics, mechanics, fluids, and project management. If these are offered more than once, teaching loads would be affected. Colleagues, how do each of you feel about these and other such changes?

**Chorus:** Changes? We're just here for the race between Achilles and Tortoise.

*A short while later, Achilles and Tortoise, who had left to prepare for the race, returned only to notice that Zeno and the other lyceum faculty had wandered off. Committed to completing the race, Tortoise moves ahead to position himself at the agreed upon head start location while Achilles waits for his friend at the starting line. While waiting, he notices Crab, a senior faculty member whom he thought had retired from the lyceum, sitting under a nearby tree.*

**Achilles:** Why, good day, Crab. What brings you here today?

**Crab:** Oh, I have been here all along, listening to your discussion with Zeno. It was a very creative, thoughtful, and comprehensive examination of the main challenges and dichotomies that we face as a lyceum. I don't think that the faculty have yet taken the time to fully understand the points raised in your dialogue. They may well perceive it less as a call to action than as the philosophical musings of a certain contrarian colleague.

**Achilles:** I thought that you and the faculty really just came here for the race?

**Crab:** Oh, don't misunderstood me. They discussed the race while you and Tortoise were preparing for the contest. Zeno explained his theory to the faculty then all of them decided that

your race was already resolved theoretically, that any practical outcome was of little relevance, and that they each had other matters that required their attention.

**Achilles:** I think it was the faculty who misunderstood which race was the important one.

**Crab:** Of course, that may well be the case. However, I too have been thinking about the very topic of your dialogue with Tortoise. I see that he is still moving toward his starting point so we have a moment to discuss this further. I think the arguments expressed can be used effectively as justification for some needed structural changes to our programs, some of which are in concert with things that I have also been proposing. I think that we need to accept, if not embrace as immutable, one of the key principles that you identify: "Faculty know what they know and that's what they want to teach."

**Achilles:** That was just a practical conclusion made without too much thought. In theory, faculty are expanding their knowledge base and we are always bringing new faculty to the lyceum.

**Crab:** Then more of a prescient conclusion, perhaps? Nonetheless, this implies that feasible revisions to the program must involve repackaging existing courses and requirements rather than creating new courses to satisfy new demands. Many of the ideas expressed by you and Tortoise are actually consistent with this approach. For example, the idea of on-line and canned practical courses for gaining specific skills may be a way to balance professional practice and engineering fundamentals. My suggestion is that those of us who feel more engaged should get together and map out some specific changes to the curriculum that do not involve large scale revisions to what is currently being taught. This will give us a head start in formally proposing program changes.

**Achilles:** A head start is an excellent idea. And it seems that Tortoise has reached his starting point so our race may begin. However, you now have me wondering whether it makes sense to rely more on the theory or more on the practice?

**Crab:** Why don't we start the race and see?