

EC2000: Lessons learned during review of a biomedical engineering undergraduate program

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Abstract

The Biomedical Engineering Undergraduate Program at Northwestern University experienced its first review under EC2000 in this academic year. The campus visit by the evaluation team took place in October 1999. Preparations for the accreditation review had been underway obviously for a number of years and were stepped into high gear for the final twenty-four months preceding the visit. This is my eleventh year as chairman of the undergraduate program in biomedical engineering at Northwestern University, and I have experience of shepherding my department through accreditation reviews of our undergraduate program under both the old ABET criteria and now under EC2000. In this report I provide an account of how we at Northwestern University prepared for the accreditation review, what we learnt through the process and how we plan to use these lessons to improve our program. Recognizing that there will be much interest among our sister programs in how we navigated the uncharted sea of EC2000, I hope that our experience will prove useful to them as they equip their ships for this exciting new voyage.

1. Introduction

In this paper I seek to provide a brief account of our experiences during the review of Northwestern University's undergraduate program under EC2000. The objective is to provide some ideas that might prove useful to our colleagues at other institutions as they prepare their biomedical engineering programs to face the new process of accreditation.

2. Preparations for the review

The Robert R. McCormick School of Engineering and Applied Sciences at Northwestern University has a long history of surveying its constituents and using the results of these surveys to improve its educational programs. Hence, as we migrated from accreditation under the old ABET rules to accreditation under EC2000, we had a number of mechanisms in place and examples to cite for how feedback from constituents had been used to improve the educational outcomes of our program. This made the transition from the old ABET practices to EC2000 relatively easy.

Significantly, we had made a revolutionary change in our curriculum at the school-wide level since our previous ABET review, and this change was motivated by feedback received from some of our constituents. The change entailed a new sequence of courses for first year engineering students where engineering analysis and design were integrated with math, physics

and written communication. Hence, from day one now, engineering students at Northwestern are introduced to engineering methods of analysis, and a foundation in engineering design starts in their second quarter at the university. The full integrated package of six new courses runs from the fall quarter of the first year to the fall quarter of the second year. Importantly, from the perspective of ABET review, this sequence of courses had been in place long enough by the fall quarter of 1999 that we were able to present data to our program evaluators that demonstrated the effectiveness of these courses in meeting the educational objectives we had set for them, and to show how the courses were continuing to evolve through constituent feedback. As these courses were offered first as pilot versions and introduced next only to 50% of our first year students, those students following the traditional curriculum were able to serve as control groups against which the effectiveness of the new curriculum could be measured. In summary, a major school-wide initiative provided us with a firm bedrock upon which to support our claim for accreditation under EC2000. Credit for this major curricular innovation resides with retired Dean Jerome Cohen and Associate Dean Stephen Carr who showed great vision in leading this revolution in our educational process. Sadly, retired Dean Cohen died of a heart attack barely one month after our campus EC2000 visit.

To help us prepare for the EC2000 review, Associate Dean Stephen Carr instituted a Process 2000 committee. This committee was constituted from representatives of all the Engineering School's academic programs that were seeking accreditation and all of those that serviced these programs. I served as the representative for biomedical engineering. In hindsight, we met too frequently and obsessed too much about minor details. Our Process 2000 committee was not an efficient body. However, I believe that a committee of this general nature is essential. The kinds of material that must be gathered to support one's claim for accreditation under EC2000 cannot be gathered overnight. Education is a slow process with the main unit of time being years. Hence, there must be much forward planning, if one hopes to have useful data to present to the ABET evaluators. It became clear in the Process 2000 committee that in relation to most of our sister departments in the Engineering School, Biomedical Engineering had a less advanced system for gathering constituent feedback. Consequently, we benefited greatly from the experience of our colleagues in these other departments. The Process 2000 committee was also generally useful in that we were able to share ideas and it permitted us to gather data about outcomes more efficiently. We were able to eliminate unnecessary duplication of effort.

One of the main challenges in undergraduate engineering education for an institution such as Northwestern University, where faculty are conflicted over how much of their effort should be spent in research and how much in teaching, is to build awareness of and adherence to the principles of EC2000. We had two strategies to tackle this problem. Firstly, we held a number of workshops at the school-wide and at the department levels. One quite useful workshop involved bringing in a faculty member from another institution which had recently tested the waters of accreditation under EC2000. Attendance was semi-mandatory. Although those faculty who attended the workshops came away with a clearer understanding of the nature of EC2000, they were not especially good at getting faculty to buy into the process. A more useful strategy for this objective, which we instituted rather late in the process, was to form teams of faculty to mock review our own programs. This was an extremely effective mechanism for vesting the faculty in EC2000. It forced a number of them to immerse themselves in the system and also provided our academic programs seeking accreditation with useful feedback on their Self-Study reports ahead of the campus visit by ABET program evaluators. In the future

we plan to carry out these self-reviews much earlier than we did this time.

The Self-Study Report assembled for the biomedical engineering program was approximately 400 pages in length. In addition, the evaluation team requested further information (e.g., transcripts of a handful of recent graduates) and faced a further onslaught of data (course books, summaries of survey instruments, etc.) when it arrived on campus. While I was extremely impressed by the diligence of our program evaluator in wading through the mass of materials assembled for review, one must question if this is an efficient way to survey an educational program. How is a program evaluator to handle this overload of information and how is one best able to present a faithful image of one's program? We took two steps that we felt lessened the evaluator's burden. Firstly, we attempted in the opening 40-50 pages of the Self-Study Report to provide a comprehensive, honest, but comparatively succinct, account of our program and how it adheres to the philosophy underlying EC2000. We believed that these initial pages of the document provided the best opportunity for us to bring our evaluator into the educational culture of our program. We sought to provide a clear sense of what we hope to accomplish with our curriculum, why we have our educational objectives and how we ensure they are met. The second method we employed to lessen the data-processing burden of our evaluator was to ensure that all additional materials assembled for or provided to him were explained carefully before they were thrust upon him. Our objective was to anticipate potential areas of confusion and address them before they arose. For example, our program has evolved significantly during the past four years and the transcripts of the graduating class of 1999, requested for review, did not fully match the one outlined in our Self-Study Report. Specifically, none of these graduates had benefited from our new sequence of engineering courses for first years. We needed to explain this to avoid confusion. Similarly, we felt that it was vital that the evaluator be guided through the assembly of materials presented for review during the campus visit. There is simply too much material to process fully in the few hours an evaluator has for this task and he or she needs to be given a road-map so that he or she can choose to review the data that he or she considers of key importance. Obviously, one must strike a balance between clearing the evaluator's path and appearing to orchestrate the review process, but provided one limits oneself to activities that are plainly intended to ease the evaluator's load, there should not be a problem.

3. The visit

We were aware that our program has strengths and weaknesses and it was very impressive to me how well our program evaluator discovered them. One problem that we face, and this is probably one that most biomedical engineering programs face also, is that we have a relatively high student to paid faculty ratio. Our ratio is ~30, while for the ratio at Northwestern for the Engineering School, considered as a whole, the average is <10. This could be viewed by an evaluator as a lack of commitment on the part of the university to biomedical engineering. However, we were able to demonstrate that our relatively low number of faculty did not adversely affect our educational mission. We are able to maintain a good selection of courses with reasonably low enrollments, and provide reasonable student access to faculty members, by the volunteer teaching service we obtain from faculty who are not salaried through the department. There are many faculty members at our medical school involved in biomedical engineering research and many of these are keen to participate in teaching our courses. We were able to demonstrate to the satisfaction of our evaluator that our educational outcomes are not

compromised but rather enhanced by this approach. There was also ample evidence to demonstrate the commitment of the university to biomedical engineering and we anticipate a significant increase in paid faculty number over the near term.

A second problem that we faced in the evaluation process was with regard to the definition of an engineering topic. In emerging areas of biomedical engineering, the distinction between biology and engineering can become blurred. A course in molecular and cell biology taught by a biology professor would be considered 100% science by an ABET evaluator, while a similar course taught by an engineering professor could be considered as much as 100% engineering topics. While I would certainly accept that the two courses would in all probability have a quite different emphasis, it seems likely that some significant fraction of the content would be common. It is difficult therefore to decide what is an engineering topic in this context, and this is a problem common to many sub-fields of biomedical engineering. ABET requires one and one half years of engineering topics for an accredited program. This would not seem to be an unreasonable demand, but it does seem to depart from the philosophy of EC2000, and reminds one of a major point of dissatisfaction with the old accreditation process. Simple numerical accounting of course credits, when the assignment of credit according to category is somewhat subjective, seems to be out of line with the EC2000 revolution. It seemed to us therefore that the evaluators would not concern themselves much with counting course credits, since the differentiation between engineering and science in advanced courses can be quite difficult, perhaps intractable. We had expected them therefore to focus primarily on whether our graduates are trained well in the fashion advertised by our program objectives. This was indeed one of their primary foci, but after having steeped ourselves so thoroughly in the philosophy of EC2000, we were surprised by the extent to which counting of course credits remained a part of the evaluation process. Our program was not found to be deficient, but we are now alerted to pay more attention to this aspect of accreditation in the future.

The one area where we feel that we continue to have need to improve our processes is in the measurement of program outcomes. We have gathered over the years a large body of data that we use to tell us how well we are doing in meeting our educational objectives. Our evaluator was given access to both our raw data and a condensation of them. The latter should not be difficult if processes are actually in place that use the data, because there will be reports on hand resulting from them and evidence that these reports were used to assess and at times modify program practices. If such reports do not exist, the evaluator can reasonably question what point there is in collecting the data. We had a number of examples to show our evaluator of where the data we had collected had been fed back and used to improve our program. Nonetheless, we believe that assessment of program outcomes is an area in which we can improve our practices significantly between now and our next ABET review. I believe that some of the data we collect are flawed and, hence, of somewhat limited utility. We need to improve these measures or develop new ones. Sometimes it is difficult to improve existing instruments. Powerful interests can be vested in flawed measures. For example, we have a university-wide mechanism for course evaluation. I believe that the data gathered through this process has many flaws and is of rather limited use in evaluating educational performance. Others in the university community, even within my department, would vehemently disagree with this opinion. So we must continue to experiment and find better and more efficient ways to measure outcomes. A few good measures are better than a wide array of critically flawed ones.

4. Concluding remarks

EC2000 is in some sense a frightening process. It is a new model for how engineering educational programs should operate. However, it is generally a sound model and one that encourages curricular innovation, high standards and accountability. It will likely lead to a significant improvement in educational practice. To prepare our program for evaluation under the new criteria was a lot of work, but afterwards it seems well worth the effort. We look forward now to new improvements in our program that will follow as we feed back the assessment measures EC2000 has forced us to upgrade and monitor closely.

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