Session 2793

Preparing Non-traditional Engineering Programs For a Successful ABET/EAC Visit Under EC2000

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Abstract

George Mason University, located in the Northern Virginia high technology community, offers engineering programs in Civil and Infrastructure Engineering, Computer Engineering, Electrical Engineering, and Systems Engineering to a diverse student body. In this paper, we discuss the challenges we faced, lessons learned, and opportunities that we seized while preparing for a successful ABET/EAC visit under EC2000. In addition, we share how the insights gained will be used for continuous improvement of our engineering programs.

I. Important Differences Between Mason Engineering Programs and Traditional Schools

The undergraduate engineering degree programs in the School of Information Technology and Engineering of George Mason University recently underwent an ABET visit under the EC2000 criteria. The four undergraduate degree programs that were assessed were: civil and infrastructure engineering, computer engineering, electrical engineering, and systems engineering. George Mason's engineering program is non-traditional in several important ways that influence the preparation for and compliance with the new ABET criteria. In this section, three of these differences are highlighted: a focus on information technology, programs with 120 credit hours, and IT-based labs.

1. Information Technology and the Mason degree programs

George Mason is located in Northern Virginia, a hotbed of information technology commercial and academic activity. It is second only to Silicon Valley in the number of IT companies and employees, and approximately 60% of US Internet traffic is routed through Northern Virginia. In the 1980s, industry in the region lobbied for a new school to serve the unmet educational needs of Northern Virginia. This resulted in the founding of a unique engineering school in 1985 at Mason with a focus on information technology as a fundamental component of engineering in the 21st century. IT is sufficiently important that the school's name includes it: School of Information Technology and Engineering.

This focus on IT within engineering has many positive consequences. First, all students on graduation are facile with IT concepts and applications. This is evident even in degree programs that appear to be more traditional, such as Civil and Infrastructure Engineering, where approximately 25% of the graduates directly enter the IT industry. In many cases these students'

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engineering backgrounds are considered highly beneficial in their work in the IT fields because the students have learned to solve complex problems, involving multiple decision makers, with multiple objectives.

For those graduates who enter the engineering profession, employers also view their background in IT positively. These graduates are prepared to use and support the computer infrastructure that engineering companies rely on heavily. In addition, because they are engineers, they appreciate why the IT infrastructure is needed and what it has to be and do to support the engineering firm or agency.

A second positive consequence of a focus on IT within the engineering degree programs is the effect this has on learning. Every school of engineering uses computer-based instructional techniques. Mason just does this a bit more than others. In classrooms, starting with the freshmen engineering class through the senior design class, the use of computing to demonstrate concepts, techniques, and applications is apparent. Students are also required to use IT applications as a regular part of their class work and presentations. One comment from a member of the School's Advisory Board, who is the Chairman of the Board of a national engineering company and who has hired many Mason graduates, illustrates this point: A Mason graduate is prepared to work on day one while graduates of other Virginia schools of engineering often take six months or longer to become productive. This comment was focused on the current high use of IT within the engineering business.

Of course there are some downsides to this focus on IT. By increasing exposure to IT concepts and applications, time is taken away from other domain knowledge. In addition, because the computer is viewed as the principal experimental device, there is a reduction in hands-on physical experimentation. These are important with regard to ABET because, in general, knowledge of IT has not typically been included as a fundamental part of the knowledge base for most programs. This of course is changing with the EC2000 criteria, wherein degree programs can define their objectives. A reduction in hands-on physical experimentation is also problematic because, regardless of how a program defines its objectives, most Visitors have strong, positive memories of physical experimentation in their undergraduate education. Many have difficulty understanding how this can be replaced with computer-based techniques.

2. Degree programs with 120 credit hours

In the mid 1990's, the Governor of Virginia, through a task force on higher education, proposed that all degree programs in the Commonwealth should contain 120 credit hours. George Mason's administration adopted this proposal and as a result all engineering degree programs were redesigned in 1996 to contain 120 credits.

There are positive effects from this move. There is a trend of reducing engineering curricula to 120 credit hours through the country. In the metropolitan DC area, in addition to Mason, the University of Maryland at College Park (the main campus) has reduced its engineering curricula to 120 credit hours. In addition, it should be easier for students to graduate in four years, which was the original motivation of the Governor's proposal. The early data indicate that indeed this has resulted.

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Negative consequences may be significant. Clearly, with a drop from 135 credits for the Civil and Infrastructure Engineering program or from 129 credits for the Electrical Engineering program to 120 credits, some material is either now ignored or covered less well. Because university-mandated general education requirements must still be satisfied, there is necessarily a reduction in the coverage of engineering domain knowledge. It is too early to tell whether this places new Mason graduates at a disadvantage relative to earlier Mason graduates or other univeristies' graduates. However, data thus far on employment of our graduates and employer satisfaction is positive. It appears that graduates are most competent, still in high demand, and well compensated.

3. Focus on IT-based labs

Most laboratories in the engineering curricula are IT- or computer-based. Students do participate in physical laboratory experimentation in the basic sciences (e.g. chemistry and physics). They also perform physical experimentation in formal labs in some degree programs, but typically less than if they were attending a more traditional engineering school.

There are numerous positive benefits from the focus on computer-based labs. It is now possible (and reasonable) to simulate physical and other phenomena using mathematical models in ways that are faster, more easily visualized, and wider in scope and complexity than can be done in a physical teaching lab. Thus, students can learn about more complex problems and their solution through interactions that are computer-based. IT-based labs allow students to gain knowledge and intuition more quickly in many cases because of the ability to test many alternatives rapidly, especially relative to physical laboratory experimentation.

Clearly, high-end, multipurpose computer labs are cheaper than traditional physical laboratories. Within a highly constrained university budget, computer-based laboratories in engineering are becoming more routine. Mason is just ahead of the trend in this regard.

Negative consequences from the almost exclusive use of computer-based labs in the engineering curricula are important. ABET Visitors, employers, and students expect that graduates of engineering programs will have a substantial base of experimentation in physical laboratories. This expectation must be addressed if a program is to succeed. Thus far, Mason's programs have been able to demonstrate that our graduates are prepared for the work place and for graduate school. Our graduates are highly sought after by industry. Most of our graduates continue with graduate studies within a year of a bachelor's degree, and they are prepared for this next step of education. Our graduates who proceed to full-time graduate study have been highly successful at a variety of strong universities, including George Mason, University of Virginia, Virginia Tech, University of California, and Stanford.

II. Preparing Mason for ABET Visit Under EC2000

In the previous section, we pointed out some important differences between engineering programs here at George Mason University and engineering programs at universities that have more traditional student bodies and/or curricula. In this section, we provide additional

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discussion of the challenges we faced, lessons learned, and opportunities that we seized while preparing for a successful ABET/EAC visit under EC2000. We offer the following advice for engineering programs that are preparing for their first ABET/EAC visit under EC2000: get started early; understand the new EC2000; focus on constituency needs; and document outcome assessment and continuous improvement processes.

1. Get started early

To prepare for the ABET/EAC EC2000 review, the dean of the School of Information Technology and Engineering, instituted an ABET working group. It is never too early to assembly the ABET working group. This group was constituted by the associate dean for undergraduate studies and with representatives from all of the engineering school's programs that were seeking accreditation. George Mason University has only four undergraduate engineering degree programs (Civil and Infrastructure Engineering, Computer Engineering, Electrical Engineering, and Systems Engineering). Fortunately, partially due to the small number of engineering programs, no situations arose that could not be resolved within the informal structure that existed within this group. For schools offering the full range of engineering programs, much more thought needs to given early on to the process of structuring the ABET working group(s).

The ABET working group began by examining the mission statement for George Mason University, then refining the mission statement of the School of IT and Engineering as well as for each of its engineering programs. It was apparent early on during the working sessions that, even though there were some differences among the four engineering programs, there were many similarities as well. Consequently, representatives from each program benefited greatly from the experience of their colleagues, and there was lots of sharing of valuable information across programs. Additionally, working together as a small cohesive group eliminated or minimized unnecessary duplication of effort.

Within the School of IT and Engineering, academic departments provide oversight for the engineering programs. Since individual programs (not the School nor Department) must seek accreditation, the Dean required that each individual engineering program assume the major responsibility for preparing for the ABET/EAC visit. Because of the small number of programs and the cooperative nature of the ABET working group, it turns out that this decision by the Dean was not a bad one. However, even for our small number of programs, there were problems scheduling mutually convenient meeting times and sharing information, partially because ABET was an add-on responsibility for many of the representatives. For schools with larger numbers of programs, a more formally structured process for managing the working group as well as having representatives dedicated to the ABET preparation efforts might be required.

2. Understand the new EC2000

Because EC2000 was not well understood, it was perceived by many to be a scary and unwieldy process. The judgment for opting for review under EC2000 instead of the traditional familiar criteria was questioned periodically, even up to the week of the scheduled ABET/EAC visit. Having each member of the ABET working group attend an ABET training session offered by

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ABET had tremendous payoffs. Only after we gained a better understanding of the EC2000 as a replacement for the traditional prescriptive accreditation criteria and process with a set of outcome based assessment-driven objectives defined by the constituency could we begin to identify and seize the opportunities afforded to our non-traditional engineering programs by an ABET/EAC visit under EC2000. For example, the smallness of our Civil Engineering faculty and student body as well as the virtually non-existence of physical labs for this program was initially perceived to be problematic. Under the traditional ABET/EAC criteria this could certainly be viewed as deficiencies by an evaluator who comes from a much larger program with many faculty, students, and physical labs. This is just one of several instances where we thought, even though we were being evaluated under EC2000, that the ABET evaluators might resort to the traditional bean counting process. However, we were able to demonstrate under EC2000 that our relatively low number of faculty and students, and our heavy reliance on modern IT-based labs, did not adversely affect our educational mission. In fact, the EC2000 philosophy provided the needed flexibility for our non-traditional programs.

As a result of the ABET EC2000 related training that we received, as we approached our ABET/EAC visit date, we were able to focus almost exclusively on ensuring that the large body of data that we had gathered could be clearly tied to our mission, program outcomes, and a continuous improvement process. In the end, all of the hard work required by EC2000 was felt to be well worth the effort.

3. Focus on constituency needs

Because of the excellent job market, most of our graduates and students are able to find jobs without going through traditional channels such as University Career Services offices. Consequently, collecting complete and accurate data on where our students work is challenging. It was to our advantage that George Mason University is located in the Northern Virginia high technology community where the demand for our engineering graduates exceeds the supply.

Each engineering program had its own set of goals as well as outcome measures for those goals and objectives. Even though some of the objectives were unique to specific programs, all programs shared a set of common objectives, many of which were measurable, to some extent, through surveys done by the University. One problem that we, like other universities, will continue to experience is that realistic outcome measures are not always easily identifiable. The understanding of constituency requirements that can be translated into quantifiable goals and objectives demanded much of our time and attention. The focus on our constituency, which is shown in Figure 1, is integral to the success of a continuous improvement program, and it is essential for a successful ABET/EAC visit under EC2000.

Because of the practice-oriented mission of our engineering programs, the role played by Industry Advisory Councils has been especially important. The formation of industry advisory councils, which are composed of industry professionals, alumni, etc., has been an effective way to identify industry's needs. These councils serve an important function in advising our academic programs, ensuring that the curricula are current, relevant, and in line with the demands of the workplace. Additionally, they provide reassurance to the high tech industry that the University is really concerned with meeting the community's educational needs. This

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provides for improved relationship with the industry constituency. We were pleased when the formal documentation confirmed that our engineering programs were completely an out growth of our mission, which were completely supported by our constituency.

4. Document outcome assessment and continuous improvement processes

Our success in documenting the assessment and continuous improvement process was the result of the willingness of the engineering faculty, staff, students, and dean of the School of IT&E to work as a team. At the beginning, it was hoped that some commercially available assessment tools could be used. The Educational Benchmark, Inc. (EBI) survey provided some valuable feedback on our engineering program; however, it became apparent rather quickly that additional assessment data were necessary.

The ABET working group decided on several assessment tools that would become a component of their quality assurance processes. Table 1 shows an example of the quality assurance process that was implemented for each of our engineering programs.

To document the outcome assessment and continuous improvement process in preparation for the visit of ABET evaluators, each engineering program prepared notebooks for each outcome and each course in the major. Each notebook contained an executive summary of the assessment methodology, raw data and data resulting from the analyses as well as specific activities that demonstrate the program changes resulted directly from the feedback. In addition to the detailed notebooks for each outcome, each engineering program prepared a single document that contained only executive summary information on the continuous improvement processes for each program outcome. This allowed the ABET/EAC evaluators to use their time more effectively, and the evaluators were able to provide a broader and in-depth review of our engineering programs.

One of the greatest challenges that we faced was providing a paper trail (e.g., on minutes of faculty meetings, meetings with student groups, meetings with industry advisory councils) that could clearly show, conclusively, that the program changes (and there had been many since our last ABET/EAC visit) were the result of feedback from the engineering program constituency. To help alleviate these types of problems, the ABET working groups are strongly encouraged to implement formal methods for tracking feedback to program changes. Additionally, the proper use of these types of tracking procedures would facilitate communication of important information among IT and engineering programs within the engineering school, as well as among other departments that provide support courses for the engineering programs.

It should be pointed out, however, that even though the processes that have been implemented for documenting our continuous improvement processes are well structured, we must monitor these processes carefully and make any necessary adjustments so that the overall workload does not become unwieldy.

5. Summary

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The School of IT&E's faculty appreciates the intense level of scrutiny by the ABET/EAC evaluators, and this feedback will greatly assist us in maintaining continuous improvement processes for our engineering programs. Assessment of our engineering programs is clearly very important to us and we view it as a collection of essential on-going activities.

We have implemented processes suitable for assessing outcomes for all of our engineering programs and these processes are both comprehensible and controllable. In addition, the assessment outcomes are clearly tied to our mission, program objectives, and constituent needs. As a result of our experiences with EC2000, we are capable of communicating more clearly to our constituency groups how the feedback that we receive drives the continuous improvement processes for our programs. This new level of awareness of the mission of our engineering programs can result in improved relationships and stronger support from our constituency here within the Northern Virginia high technology community.

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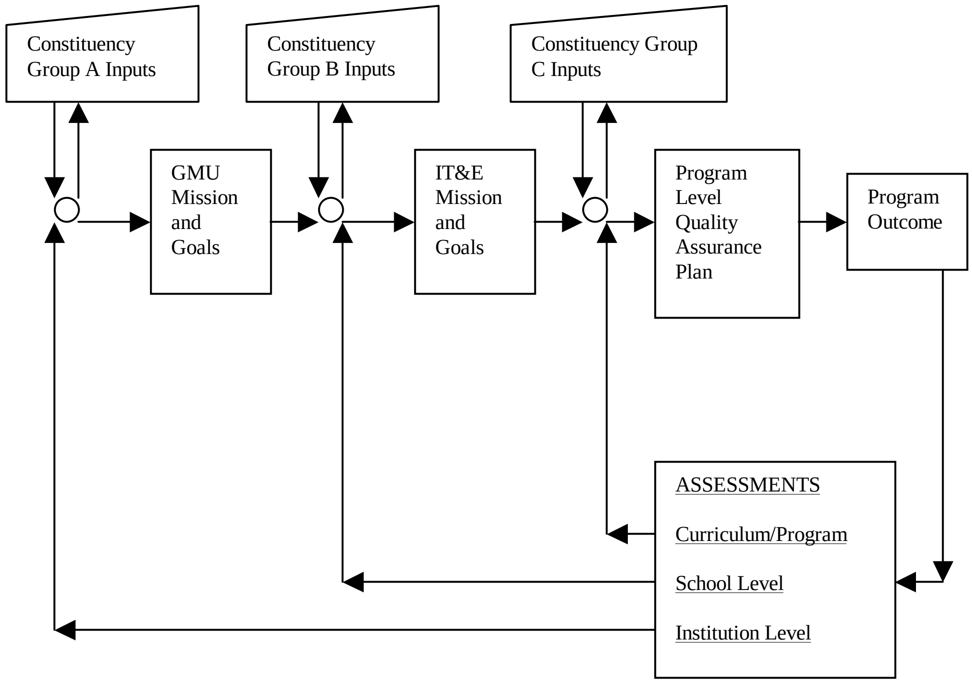

Constituency Group A: State; SCHEV; BoV; Other

Constituency Group B: IT&E Advisory Board; Employers; NVTC; Administrative Council; Alumni; Student Leaders; Student Advisory Group; Other

Constituency Group C: Students; Graduates; ABET; Program Advisory Council; Student Advisory Group; IT&E Undergraduate Studies Committee; Other

Figure 1
System Level Quality Assurance Process

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TABLE 1

Outcome Assessment Plan for Continuous Improvement
Civil Environmental & Infrastructure Engineering Department

Process Steps	**Done**	**Fall 00**	**Spring**	**Fall 01**	**Spring**	**Fall 02**	**Spring**	**Fall 03**	***Comments***
Review mission of GMU and Undergrad IT&E	☑					☑			Every 2 years or whenever GMU or IT&E specifically announce a change.
Determine/Review Program Objectives	☑					☑			Approved by Industrial Advisory and Student Committees in 2000. Every 2 years
Determine/Review Program Outcomes	☑					☑			Every 2 years
Conduct Alumni Survey in coordination with CEIE Alumni Chapter	☑					☑			Every 2 years, including survey instrument review to ensure relevance of data gathering effort
Educational Benchmarking, Inc. Survey	☑		☑		☑		☑		Performed by IT&E every spring with graduating class
Conduct Course assessments by collecting, analyzing, and interpreting data	☑	☑	☑	☑	☑	☑	☑	☑	Every semester a course is offered. By instructor.
Accomplish other non-course assessment instruments - OIA	☑	☑	☑	☑	☑	☑	☑	☑	Each semester: Graduating seniors will complete OIA Survey
Senior Project Self-Evaluations	☑		☑		☑		☑		Each spring, at the completion of Senior Design capstone course
Assess Program Outcomes A-F	☑					☑			Each year ½ of the Outcomes will be Assessed and appropriate Reviews conducted by each Outcome Faculty Team
Assess Program Outcomes G-K	☑			☑				☑	
Use assessment results in curriculum revision process	☑	☑	☑	☑	☑	☑	☑	☑	Course Assessments will be reviewed by instructor or Full time Faculty Course Mentor (for those courses taught by Adjunct faculty). . Major recommendations will be passed to Outcome Assessments (½ each year) and to subsequent course instructor.
Conduct Objectives assessments	☑					☑			Every two years in light of assessments of all Outcomes. By entire faculty, industry advisors, and student advisory committee.

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