

Cultural Change at Texas A&M: From the Engineering Science Core to the Foundation Coalition

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Abstract

This paper describes a curriculum innovation process at Texas A&M - College Station (TAMU) with emphasis on the Foundation Coalition project. Lessons learned from the Engineering Science Core project - a predecessor to the Foundation Coalition (FC) at Texas A&M funded under the NSF Undergraduate Curriculum Program - will be presented. The paper looks at faculty, administrator and student "buy-in" to the program and at curriculum development strategies that have been implemented on the TAMU campus. The processes developed for successful institutionalization of the Foundation Coalition programs will be presented.

The Texas A&M Integrated Engineering Science Core

The *integrated engineering science core* program at Texas A&M was funded under a project titled "A Restructured Engineering Science Core with a Design Component." It was one of the three projects funded under the rejuvenated NSF engineering curriculum program. The other two grants went to Drexel University (E⁴) and Rose-Hulman Institute of Technology (IFYICSEM).

The primary objective of the *integrated engineering science core* program was to produce fundamental changes in the nature of the traditionally fragmented undergraduate engineering science core. The approach utilized addressed two critical curriculum issues:

- how to encourage more breadth of coverage in the engineering sciences to enable students to better understand interdisciplinary concepts, and
- how to increase understanding of fundamental concepts by introducing a consistent framework for presenting the engineering sciences in relation to each other and the upper-level disciplinary curriculum.

Engineering science courses such as statics, dynamics, thermodynamics, fluids mechanics, materials, and circuits were broken down and reassembled into four core courses. The resulting new sequence of engineering science courses was a set of "first courses" in the engineering disciplines, cutting across the traditional disciplinary boundaries. As such, the program sought to provide students with an understanding of the fundamental scientific principles which govern our world and the role they play in determining the structure of engineering, problem solving, and design.

The four courses and associated text books (multiple editions of all) focuses on the framework and unity of the engineering sciences and on applications to traditional topics. The framework evolved around the conservation laws, the second law of thermodynamics, and the accompanying accounting statements of mechanical energy, thermal energy, electrical energy, species mass, etc. Each course conferred four semester-hours credit, taught as a 3-hour lecture and 1-hour of recitation/problem solving/lab.

The program was offered in the fall of 1989 to a group of honors student volunteers. The students substituted the core courses for required courses on a departmental basis. After the first offering, the courses were not restricted to honors students again.

Now all of TAMU's engineering degree programs allow these courses to be used for a set of engineering science and elective courses in the curriculum. Moreover, civil, aerospace, and agriculture engineering have adopted the four core courses as a requirement. In total, about 250 students currently participate in this program every year.

Faculty members that initially participated in the program were those that taught, on a regular basis, in the traditional engineering science courses. The faculty's home departments were compensated from the College with salary support for participating faculty. Support for teaching assistants was also provided. When the program was expanded, new faculty members interested in teaching the courses were required to first teach a

section of the course recitation. The objective was to make sure that teachers were exposed to the conservation and accounting methodology before teaching the full course. The faculty participating in the program worked to get new faculty involved in the department when they could not teach a course or when expansion of the program deemed it necessary.

Much effort was put into reporting the success of the four courses at national conferences and professional organizations' meetings. The local effort to disseminate results happened in low key or a "grass roots" manner, and no systemic or broad based approach to reach all faculty in the College was made.

Lessons Learned

It is our belief that the *engineering science core* project was extremely successful in achieving its goals. In fact, our current plan is to "merge" the four engineering science core courses with the Foundation Coalition sophomore integrated curriculum. The goals of the *engineering science core* have never raised significant objection from the faculty. In spite of this, the level of commitment of various departments has failed to lead to true institutionalization of the program within the college. After critically assessing the situation, we believe that the reasons for this lack of total acceptance are as follows:

1. The faculty in the *engineering science core* focused intently on preparing new courses and texts and did not continuously work to keep other faculty informed. The demand to show deliverables in a program such as this are very intense.
2. The faculty in the *engineering science core* did not gather much input from departments other than their home departments; thus to some it was viewed as a program for some majors but not all.
3. Because so much energy was put into textbooks, the *engineering science core* became rigid in resisting the incorporation of changes from faculty when they disseminated the materials.
4. Trade offs on how the *engineering science core* program could be readily and economically implemented were not evaluated until after the courses were developed.
5. Because honor students were used in the first pilots, the *engineering science core* never lost the reputation of being an honors program.
6. The leader of the program was a high level administrator in the College, thus many faculty did not believe the value of the *engineering science core* to the College was evaluated without bias.

The Texas A&M Foundation Coalition Program

With the lessons learned from the *engineering science core* program in mind, the Foundation Coalition at TAMU, which was initiated in the fall of 1993, has worked from the beginning on issues of institutionalization. The *Foundation Coalition*, supported by the National Science Foundation Engineering Education Coalitions Program, is a collaborative endeavor among seven institutions (Arizona State University, Rose-Hulman Institute of Technology, Maricopa Community College District, Texas A&M University, Texas A&M University at Kingsville, Texas Woman's University, and the University of Alabama) focusing on the creation of an enduring *foundation* for student development and life-long learning. The member institutions are developing learning environment and curriculum models based on four primary thrusts:

- integration of subject matter within the curriculum,
- improvement of human interactions through the use of teaming and collaborative learning,
- utilization of technology-enabled learning, and
- continuous assessment and evaluation of methods and outcomes.

The FC curriculum at Texas A&M consists of the following elements:

- The integrated freshman curriculum - a total of 29 credit hours (13 in the fall and 16 in the spring) consisting of calculus, physics, chemistry, English, engineering problem solving, programming, and engineering design graphics.
- The integrated sophomore curriculum - a total of 16 credit hours consisting of a "modified" version of the engineering science core with five courses instead of four, technical writing, calculus, and differential equations.
- The upper-division curriculum - a total of 10 upper-division courses in mechanical, civil, aerospace, industrial, and chemical engineering that have adopted one or more of the four thrusts of the FC. All these courses are junior level. Senior level courses will be developed this year and taught a year from now.

The FC program started in the fall of 1993 and the first pilot was delivered in the fall of 1994 with a group of 100 volunteer students participating. The only requirement was that students needed to be ready for calculus since the integrated freshman curriculum did not

have a pre-calculus track. All academic departments were invited to participate if they were willing and able to do the following three things:

- commit enough students to justify future changes to the upper division courses,
- provide released time for teachers participating in the program, and
- have enough faculty committed to the FC “ideas” to support future changes to upper division courses.

The departments of mechanical, electrical, aerospace, and civil engineering participated the first year. In the fall of 1995 all academic departments participated in the freshman integrated curriculum. The program was scaled-up to 200 students. In the 1996 academic year the program will be expanded to 400 students with 200 calculus-ready students starting in the fall and 200 students that were in pre-calculus in the fall starting in the spring semester. Students will still be self-selected but it is our hope that at least one academic department will make the freshman integrated curriculum a requirement for all students.

Faculty members participating in the FC were recruited based on recommendations by department heads and the engineering program office. Summer support was provided and release time was obtained for several of the participants. In contrast with the *engineering science core*, no compensation was given to any engineering department. Teaching FC courses was considered as a “regular” teaching load for faculty.

Support for most of the teaching assistants and graders was provided by the academic departments as part of the matching commitments to the project. The recruitment of new faculty has been done by the teachers currently involved in the program.

One of the most effective components of the dissemination activities at the TAMU campus is the constant communication with department heads, curriculum committees, and undergraduate advisors. The FC team consults with these three groups on a regular basis.

Process For Institutionalizing Change

From the beginning institutionalization has been part of the 7-goal strategic plan of the FC. Four of the goals relate to product development: 1) the lower level curricula, 2) the upper level curricula, 3) the bridge programs for students into the curricula, and 4) the activities to improve access and retention of a more demographically diverse student body. The remaining three goals are focused upon functions crucial to marketing the program: 1) the assessment and evaluation of effects of curricula changes, 2) the dissemination, on and off campus, of the program activities, and 3) the process for institutionalization of the FC and future curricula innovations.

Table 1 lists several activities that the FC management team will conduct to obtain the sustained support of the university administration.

Table 1. Activities Planned with Administration by FC

Administration Level	Action
Provost or Academic VP	Each PIC, and appropriate FC team members, will meet with Provost office at least once per semester or quarter.
	Each campus will provide the Provost's office with written materials on the FC efforts across all campuses.
	The FC will convene a meeting of all of the campuses provosts, in Fall 1996 if possible.
Engineering Deans	PICs will strive to arrange at least monthly meetings with the Dean's office to keep information flowing and to prioritize the needs of the FC with those of the College.
	Each campus will provide the Deans office with written materials on the FC efforts across all campuses.
	Governing Board (Deans from all institutions) shall convene at least bi-annually.
Other Deans	Each local FC team will meet with the other deans involved in the FC at least once annually.
Department Heads	Local FC teams shall meet with all department heads and departmental faculty at least once per year.
	FC will convene or attend at least one meeting with all department heads in engineering at least one per semester.
	Each campus will provide the department heads with written materials on the FC efforts across all campuses.

Even with support from administration, the only way for the FC vision of a new culture of engineering education to become a reality is for the campus faculty to understand and value the FC curricula and programs and to foster transition on a broad scale.

To accomplish this, a continuous two-way flow of information, written, oral, and electronic, must exist between the FC teams and the non-FC faculty members. Table 2 lists numerous activities planned by the FC institutions in seeking to reach the faculty.

Table 2. Activities Planned with Faculty by FC

Faculty	Activities
FC Faculty	Regularly scheduled meetings on the campus at each curricula level
	Once per semester meeting of local FC management and all of the FC teaching faculty members
	Video conferences among faculty at various curricula level across the FC institutions
	Annual faculty retreats for sharing outcomes and ideas for continuous improvements in the curricula
	Workshops for enhancing FC thrusts in the curricula
	Workshops for enhancing student access and retention in the engineering programs
Non-FC Faculty members	Departmental faculty meetings
	Workshops for enhancing FC thrusts in the curricula
	Workshops for enhancing student access and retention in the engineering programs
	Provide opportunities for faculty to independently evaluate components of the FC programs
Non-FC Institution Faculty	Interaction at regional, national and international conferences
	WWW information on FC activities and outcomes will be available
	Workshops for FC innovations

Industry input and support is also crucial for the success of the institutionalization of the FC best practices on the FC campuses and other campuses. The National Advisory Board (NAB) has provided important input and ideas on the curricula. They are providing opportunities for the students and the faculty to get more exposure to the expectations and practices commonly found in the work environment. They have done this through visits to campus and by offering visits or internships at their facilities.

- increase the number of internships available to FC students, particularly lower level students;
- initiate recognition and award activities for FC faculty;
- conduct industry visits to FC courses multiple times each semester;
- disseminate public information about the accomplishments and plans of the FC; and
- gather, filter, and report input on industry needs with respect to higher education and graduates.

The FC Management Team and the NAB will expand these activities on all of the campuses. Some of the goals are: