



“Organizational culture is an emergent result of continuing negotiations about values, meanings and properties between the members of that organization and with its environment. In other words, culture is the result of all the daily conversations and negotiations between the members of an organization. ...If you want to change a culture you have to change all these conversations—or at least the majority of them.” [Richard Seel, <http://www.new-paradigm.co.uk/culture-complex.htm>]

The Foundation Coalition (FC) is an agent of systemic change in the engineering education community. Systemic change requires systemic learning, so the FC is facilitating many opportunities for engineering educators to learn new assessment instruments and processes, alternative pedagogical approaches, and new conceptual models of engineering education. Learning opportunities are being offered in numerous venues: conferences, interactive workshops, and materials that may be downloaded from the FC web site (<http://www.foundationcoalition.org>).

- ❖ **Developing and field testing concept inventory and other assessment instruments** Since the National Science Foundation (NSF) sponsored the first large curriculum innovation projects in 1998, engineering curricula have undergone many different changes, but the area has changed the least are the engineering science courses. To catalyze new learning about what students are learning in these courses, faculty members across the FC and beyond are developing concept inventory assessment instruments. Currently, twelve concept inventories are in various stages of development across the FC. Development, field testing, and presentations on these instruments is stimulating faculty members to revisit the conceptual understanding that students have when they complete their engineering science courses.
- ❖ **Growing list of resources to encourage adoption of alternative pedagogies and curricula** These resources include one-page introductions, mini-documents, EC 2000 modules, course modules for various engineering courses, and workshops. All these resources are designed to help faculty members become more informed about alternative pedagogies and curricula.
- ❖ **Face-to-face interactions** The FC worked with the SUCCEED, Greenfield, and Gateway Coalitions to offer the Share the Future IV Conference in which over 170 faculty members participated. In addition, FC partners are hosting focused mini-conferences to explore specific issues in greater depth.
- ❖ **Curricular change** The FC qualitative research project on curricular change has published its first conference paper on the processes through which coalition partners have initiated and attempted to sustain curricular change. A meeting in July 2003 will extract guidelines and themes from the case reports that have been generated from over 200 interviews and analysis of documents on curricular change. The goal is to provide knowledge about curricular change processes that will aid other institutions undertaking significant curricular change. In addition to codifying our learning about change across the FC, two departments have volunteered to apply knowledge about change to alter processes and conceptions of curricular change.

Developing and field testing concept inventory assessment instruments

Within the engineering education community, one of the more powerful mechanisms known to stimulate conversations about improvements in engineering education is to ask hard questions about (1) what students should be learning and (2) how well are they performing. Recognizing that the [Force Concept Inventory](http://modeling.la.asu.edu/R&E/FCIforw.html) (FCI, <http://modeling.la.asu.edu/R&E/FCIforw.html>) developed by Hestenes and Halloun has encouraged physicists to re-examine what students are learning in their introductory physics courses and how these courses might be restructured and taught differently, faculty members across the FC have been developing and sharing assessment instruments targeted at areas of interest to engineering educators. In October 2000, FC faculty members began developing four concept inventory assessment instruments. Work on three additional instruments began in October 2001 while testing and refinement of the four original instruments continued. In October 2002, faculty members initiated construction of five more instruments while refining, testing, and dissemination of the first seven instruments was underway.

Report on the two concept inventory workshops held at FIE 2002 and Share the Future IV.

- ❖ [Signals and Systems Concept Inventory](http://fc1.tamu.edu/home/keycomponents/concept/SSCI.html) (SSCI), development started in October 2000, <http://fc1.tamu.edu/home/keycomponents/concept/SSCI.html>
- ❖ [Thermodynamics Concept Inventory](http://fc1.tamu.edu/home/keycomponents/concept/thermodynamics.html) (TCI), development started in October 2000, <http://fc1.tamu.edu/home/keycomponents/concept/thermodynamics.html>
- ❖ [Electromagnetics Concept Inventory](http://fc1.tamu.edu/home/keycomponents/concept/electromagnetics.html) (EMCI), development started in October 2000, <http://fc1.tamu.edu/home/keycomponents/concept/electromagnetics.html>
- ❖ [Strength of Materials Concept Inventory](http://fc1.tamu.edu/home/keycomponents/concept/strength.html) (SoMCI), development started in October 2000, <http://fc1.tamu.edu/home/keycomponents/concept/strength.html>
- ❖ [Materials Concept Inventory](http://fc1.tamu.edu/home/keycomponents/concept/materials.html) (MCI) – development started in October 2001, <http://fc1.tamu.edu/home/keycomponents/concept/materials.html>
- ❖ [Fluid Mechanics Concept Inventory](http://fc1.tamu.edu/home/keycomponents/concept/fluid.html) (FMCI) – development started in October 2001, <http://fc1.tamu.edu/home/keycomponents/concept/fluid.html>
- ❖ [Circuits Concept Inventory](http://fc1.tamu.edu/home/keycomponents/concept/circuits.html) (CCI) – development started in October 2001, <http://fc1.tamu.edu/home/keycomponents/concept/circuits.html>
- ❖ [Chemistry Concept Inventory](http://www.foundationcoalition.org/home/keycomponents/concept/chemistry.html) (ChemCI), development started in October 2002, <http://www.foundationcoalition.org/home/keycomponents/concept/chemistry.html>
- ❖ [Dynamics Concept Inventory](http://www.foundationcoalition.org/home/keycomponents/concept/dynamics.html) (DCI), development started October 2002, <http://www.foundationcoalition.org/home/keycomponents/concept/dynamics.html>
- ❖ [Heat Transfer Concept Inventory](http://www.foundationcoalition.org/home/keycomponents/concept/heat.html) (HTCI), development started in October 2002, <http://www.foundationcoalition.org/home/keycomponents/concept/heat.html>
- ❖ [Electronics Concept Inventory](http://www.foundationcoalition.org/home/keycomponents/concept/electronics.html) (ECI), development started in October 2002, <http://www.foundationcoalition.org/home/keycomponents/concept/electronics.html>
- ❖ [Computer Engineering Concept Inventory](http://www.foundationcoalition.org/home/keycomponents/concept/computer.html) (CPECI), development started in October 2002, <http://www.foundationcoalition.org/home/keycomponents/concept/computer.html>

Each of these field testing instruments is now examined in greater detail.

Signals and Systems Concept Inventory

Linear signals and systems is a core subject in the undergraduate electrical and computer engineering curriculum. The Signals and Systems Concept Inventory (SSCI) is a twenty-five-question, multiple-choice exam designed to assess students' understanding of fundamental concepts in this subject. There are separate versions of the SSCI exam for continuous-time and discrete-time material. John Buck (University of Massachusetts Dartmouth (UMD)) and Kathleen Wage (George Mason University (GMU)) are the principal developers of the SSCI. More information is available on the [SSCI website \(http://ece.gmu.edu/~kwage/research/ssci/\)](http://ece.gmu.edu/~kwage/research/ssci/), which includes password-protected versions of the instruments that are available for distribution, as well as publications about the SSCI.

During the past year, both the CT-SSCI and DT-SSCI were revised in response to field testing, bringing them to versions 2.2 and 2.1 respectively. Our pool of schools using the exam expanded to six. We continued our four-campus study administering the exams in a pre/post test protocol at the UMD, GMU, the U.S. Air Force Academy, and the U.S. Naval Academy. To date, the four-campus study includes over 300 students. In addition to this study, Old Dominion University and Rose-Hulman Institute of Technology adopted the SSCI for their own internal assessments. MIT also participated in the testing of the DT-SSCI. Kathleen Wage held interviews with GMU students to gather data on their alternate conceptions as revealed by their DT-SSCI answers. The SSCI website was updated to include the new exams and new publications of the past year.

We presented the SSCI and our study results at the Second IEEE Signal Processing Education Workshop and also as part of a Concept Inventory Panel at Frontiers in Education 2002. The publication citations from these conferences are listed below. The IEEE workshop is the primary conference for our target audience of SSCI users: signal processing faculty interested in pedagogical research and reform. We actively recruited several new faculty members to use the SSCI at this workshop.

Statistical analyses of the data from the 174 students who took the CT-SSCI during the 2001-02 academic year found no evidence of gender or racial bias in this pool, as reported in [1]. Motivated by Hake's 1998 survey of the Force Concept Inventory (FCI), the normalized gain was computed for each student, as well as normalized gains for each course (based on the average pre-test and post-test scores for each course). Normalized gain represents the fraction of the available improvement in score that was obtained during the course. In analyzing the FCI, Hake showed that normalized gain is a stable performance measure for courses that have similar pedagogical formats, regardless of variations in student background or instructor experience. Analysis of the 174 CT-SSCI exams revealed a normalized gain between pre- and post-test scores of 0.22 ± 0.07 which is consistent with the results Hake reported for other concept inventory studies of traditional lecture courses. We also analyzed the correlation between CT-SSCI performance and other academic indicators of performance. Only the correlation of normalized gain with GPA was significant on all four campuses. These results are presented in more detail in [1]. During June 2003, we plan to extend these analyses using our expanded pool of students from the 02-03 academic year and prepare a paper for journal publication on our study.

Conference Proceedings Papers

- [1] K. E. Wage, J. R. Buck, T. B. Welch, and C. H. G. Wright, "Testing and Validation of the Signals and Systems Concept Inventory," Proceedings of the Second IEEE Signal Processing Education Workshop, Pine Mountain, GA. October 2002.

Conference Panels

- [1] D. L. Evans, C. Midkiff, R. Miller, J. Morgan, S. Krause, J. Martin, B. M. Notaros, D. Rancour, K. Wage, "Tools for Assessing Conceptual Understanding in the Engineering Sciences," Frontiers in Education, Boston, MA. November 2002.

Thermodynamics Concept Inventory

Thermodynamics is a core discipline for several engineering and science disciplines. The focus of the Thermodynamics Concept Inventory (TCI) activity has been the development of an instrument suitable for pre- and post-course assessment of students taking a first-semester course taught in mechanical engineering (ME). Components of thermodynamics are included in freshman physics and chemistry courses normally required of engineering undergraduates. Additionally, many concepts of thermodynamics, e.g., energy, heat and temperature, are familiar through K-12 schooling and life experiences. Thus, it is important to note that the first engineering course in thermodynamics is *not* a student's first exposure to this material. Dealing with this issue has strongly influenced the development of the TCI. K. Clark Midkiff of the University of Alabama is the principal developer of the TCI and additional information is available from him at cmidkiff@coe.eng.ua.edu.

The TCI is in its third year of development and the instrument is in its fifth version. Noting the pre-existing knowledge and experience of thermodynamics mentioned above, and following the lead of the Force Concepts Inventory, the first four versions of the TCI attempted to test concepts with minimal use of the formal language of thermodynamic that is taught in a first ME course. The third and fourth versions of the instrument were tested on five different campuses in spring and fall 2002. The results of the testing were that the TCI correct response rates were significantly higher-averaging higher than 60 percent, for pre-course testing- than those of most other concept inventories under development in this FC program. The extent of knowledge gained as indicated by comparing pre- and post-test scores of the TCI, i.e., the normalized gain, was similar to that of other concept inventories. Nevertheless, it was decided to drastically revise the TCI to increase its capacity to assess learning of all primary course material, rather than just assess the entering conceptual understanding. This necessitated inclusion of questions using technical terms such as "specific entropy" that a student entering the course would not recognize. The revision also reduces the capacity of the instrument to identify misconceptions from common life experiences, as there are fewer questions of this type. This revision was accomplished in late fall 2002 and tested on a single class in spring 2003. The revision did result in lowering the pre-test score substantially, in line with the other concept inventories developed in this program. In summer 2003, a detailed analysis of the current TCI will be made to identify wording flaws and improve reliability and validity. Further testing will resume in fall 2003.

Conference Panels

- [1] D. L. Evans, C. Midkiff, R. Miller, J. Morgan, S. Krause, J. Martin, B. M. Notaros, D. Rancour, K. Wage, "Tools for Assessing Conceptual Understanding in the Engineering Sciences," Frontiers in Education, Boston, MA. November 2002.

- [2] Evans, D.L., Gray, D., Krause, S., Martin, J., Midkiff, C., Notaros, B.M., Pavelich, M., Rancour, D., Reed-Rhoads, T., Steif, P., Streveler, R., and Wage, K.: "Progress on Concept Inventory Assessment Tools", panel, to be presented at the 33rd ASEE/IEEE Frontiers in Education Conference - FIE 2003, November 5-8, 2003, Boulder, CO, USA.

Electromagnetics Concept Inventory

Electromagnetics Concept Inventory (EMCI) is an assessment tool designed to measure students' understanding of fundamental concepts in electromagnetics. Although primarily intended for junior-level electromagnetics courses in electrical engineering departments, the EMCI can also be used in a variety of undergraduate and graduate electromagnetics-related courses in engineering and physics departments. EMCI Version 1.0 is composed of three exams

Version 1.0 contains three exams:

- ❖ EMCI-Fields (electro and magnetostatic, and time-varying EM fields),
- ❖ EMCI-Waves (uniform plane waves, transmission lines, waveguides, and antennas), and
- ❖ EMCI-Fields & Waves (a combination of the first two exams).

These tests have been broadly disseminated to instructors and electromagnetics and physics education researchers worldwide and are currently being used at more than ten universities and colleges.

Branislav Notaros at the University of Massachusetts Dartmouth, the principal developer of the EMCI, chaired the session on electromagnetics education at the 2002 IEEE Antennas and Propagation Society International Symposium, held 16-21 June, 2002, in San Antonio, Texas.

Since FIE 2002 in Boston, based on discussions at the CI Developer's meeting and at the CI Panel session, as well as on the feedback from instructors using the first version of the tests, development of a new version of the EMCI has been conducted. In addition to improving several parts of the tests, the primary goal is to include many more prerequisite concepts in the EMCI, so that the portion of the instrument devoted to these concepts will be around 40%, while the rest of the questions will test concepts covered in the course.

Future work will include completion of the new version of the EMCI, further dissemination and field testing of the instrument, and validity/reliability evaluation.

Conference Papers:

- [1] Evans, D.L., Midkiff, C., Miller, R., Morgan, J., Krause, S., Martin, J., Notaros, B.M., Rancour, D., and Wage, K.: "Tools for Assessing Conceptual Understanding in the Engineering Sciences", panel, *Proceedings of the 32nd ASEE/IEEE Frontiers in Education Conference - FIE 2002*, November 6-9, 2002, Boston, USA, Session.F2B-1.
- [2] Evans, D.L., Gray, D., Krause, S., Martin, J., Midkiff, C., Notaros, B.M., Pavelich, M., Rancour, D., Reed-Rhoads, T., Steif, P., Streveler, R., and Wage, K.: "Progress on Concept Inventory Assessment Tools", panel, to be presented at the 33rd ASEE/IEEE Frontiers in Education Conference - FIE 2003, November 5-8, 2003, Boulder, CO, USA.

Strength of Materials Concept Inventory

Strength of Materials (SoM) Concept Inventory (SoMCI) developers Jim Morgan and Jim Richardson reformed the project team with volunteers attending an engineering mechanics workshop in San Antonio organized by Don Evans in September 2002. The team met again in Boston at the 2002 Frontiers in Education Conference where it picked up two additional members, bringing the total to eight engineering faculty from the following schools

- ❖ - Carnegie Mellon University
- ❖ - Clarkson University
- ❖ - Colorado School of Mines
- ❖ - Purdue University
- ❖ - Rowan University
- ❖ - Texas A&M University
- ❖ - United States Military Academy
- ❖ - University of Alabama

The new team first solicited input from colleagues regarding important SoM concepts students frequently misunderstand. The team met to compile the long list of concepts into a master list and established criteria for writing good concept questions. Next, team members tried drafting example concept questions. It proved surprising difficult--most questions involved more than one concept.

Recognizing the importance of identifying student misconceptions associated with SoM concepts, the team constructed a short "survey" of five open-ended concept questions to give to SoM students at the end of spring semester. We are currently reviewing the results of the survey. We plan to meet again the day before the 2003 ASEE Conference to critique our second round of concept questions.

Materials Concepts Inventory

The goal of the Materials Concept Inventory (MCI) is to measure deep understanding and conceptual knowledge of principles of introductory materials engineering classes. The results of the MCI can then be compared to the student's performance in classes with different teaching methods to determine teaching effectiveness. The thirty-question MCI test that was created had three general categories of questions; background chemistry questions (8), background geometry questions (2), and various materials course questions (20). The topical areas on the materials questions were broken down into the categories of: atomic bonding; electronic structure; atomic arrangement and crystal structure; atomic arrangement and crystal structure; defects and microstructure; phase diagrams and solubility; and macroscopic mechanical properties. Preliminary testing of the MCI indicated that the normalized gain (as defined by Hake) was 15% to 20% in lecture-based courses. This is considered by Hake to be in the lower gain region of knowledge gains, which is typical of lecture-based courses. Details of the MCI development and preliminary testing were reported in 2002 at a materials-oriented National Educators Workshop [1] and at a FIE conference panel [2].

During Year 10 of the Foundation Coalition Project field testing of the MCI began. Analysis of data sets from two early classes showed some interesting trends. One was the fact that average pretest scores ranged between 34% and 39% whereas average posttest scores varied between 55% and 60%. Another was the fact that knowledge gains of 30% to 40% were found in these classes where some active learning strategies were employed. This is considered by Hake to be moderate knowledge gain, typical of teaching found when active learning strategies are employed. Another result showed that there were marked differences in gains in the three general categories. In the 8 chemistry background questions there was only a gain of 13%, indicating that there were misconceptions that persisted from the beginning to the end of the classes. In the 2 geometry background questions there was a gain of 67%, a high knowledge gain, indicating that visualization skills had improved during the classes. It should be noted here that pretest scores on geometry for ASU varied between 60% and 68% whereas those for an earlier TAMU MCI test varied between 79% and 85%. This may be due to the fact that TAMU had CAD activity in the freshman course whereas ASU did not. Finally, a last interesting result was that, for the 20 materials-related questions, there was a gain of 37%. This indicates that medium knowledge gain was achieved with a significant reduction of prior and spontaneous misconceptions related to materials concepts. Details of these and other results are being reported at the 2003 ASEE [3] and FIE [4, 5] conferences. These conference papers will be developed into journal articles.

Currently, the MCI beta version is available through the web site at ASU at the Center for Research on Science, math, Engineering and Technology (CRESMET) at <http://www.eas.asu.edu/~cresmet/> with a solution available through CRESMET by emailing cresmet@asu.edu. Current and future work is going forward to create an improved version of the MCI with the replacement and/or upgrading of 3 or 4 questions under consideration by the end of summer 2003. Field testing will continue to build a strong base of results. Work will also continue exploring and elucidating student misconceptions and approaches to address them.

Conference Papers:

- [1] Krause, S. J., Decker, J.C., Niska, J., Alford, T. and Griffin, R.B. "Materials Concept Inventory for Introductory Materials Engineering Courses", *Proceedings, National Educators Workshop Update 2002: Standard Experiments in Engineering Materials, Science, and Technology*, October 13-16, 2002, San Jose, CA.
- [2] Evans, D.L., Midkiff, C., Miller, R., Morgan, J., Krause, S., Martin, J., Notaros, B.M., Rancour, D., and Wage, K.: "Tools for Assessing Conceptual Understanding in the Engineering Sciences", panel, *Proceedings of the 32nd ASEE/IEEE Frontiers in Education Conference - FIE 2002*, November 6-9, 2002, Boston, USA, Session.F2B-1.
- [3] Krause, S. J., Decker, J.C., Niska, J., Alford, T. and Griffin, R., "Identifying Student Misconceptions in Introductory Materials Engineering Classes", *Proceedings, American Society for Engineering Education Annual Conference*, Nashville, TN, June 2003.
- [4] Krause, S. J., Decker, and Griffin, R.B., "Using a Materials Concept Inventory to Assess Conceptual Gain in Introductory Materials Engineering Courses", *33rd ASEE/IEEE Frontiers in Education Conference - FIE 2003*, November 5-8, 2003, Boulder, CO, USA

- [5] Evans, D.L., Gray, D., Krause, S., Martin, J., Midkiff, C., Notaros, B.M., Pavelich, M., Rancour, D., Reed-Rhoads, T., Steif, P., Streveler, R., and Wage, K.: "Progress on Concept Inventory Assessment Tools", panel, to be presented at the 33rd ASEE/IEEE Frontiers in Education Conference - FIE 2003, November 5-8, 2003, Boulder, CO, USA.

Fluid Mechanics Concept Inventory

Faculty members at the University of Illinois, Champaign-Urbana and the University of Wisconsin-Madison are developing has been aimed at development of a concept inventory in fluid mechanics [1]. The Fluid Mechanics Concept Inventory (FMCI) is intended for use in assessment of Mechanical Engineering students who have or will be taking a course in fluid mechanics. The first step in development of the FMCI was identification of the fluid mechanics concepts that were considered to be essential for mechanical engineering students after completing an undergraduate fluid mechanics course in mechanical engineering. The experienced faculty team identified the essential concepts prior to constructing individual questions. Once the concepts were identified, the team wrote multiple questions for each of the concepts to support validation.

Conference Papers:

- [1] Martin, J.K., Mitchell, J., Newell, T., "Development of a Concept Inventory for Fluid Mechanics," to be presented at the 33rd ASEE/IEEE Frontiers in Education Conference - FIE 2003, November 5-8, 2003, Boulder, CO, USA.

Circuits Concept Inventory

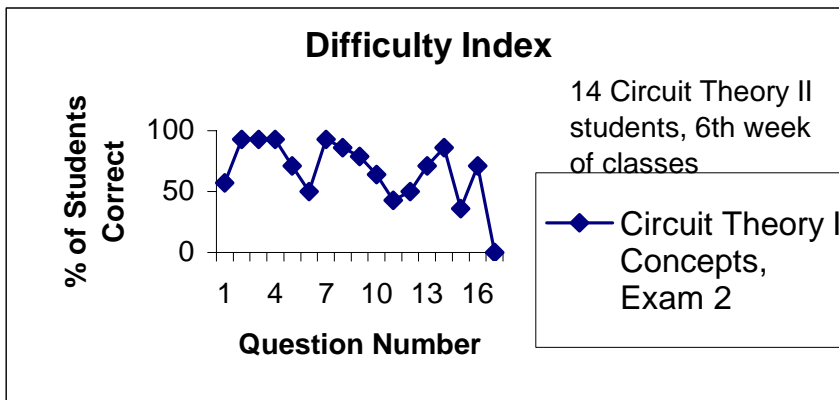
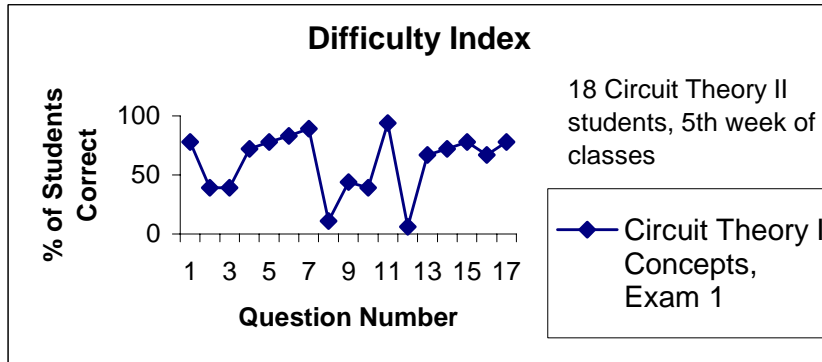
Circuits is the initial subject in most electrical and computer engineering curricula. Version 1.0 of the Circuits Concept Inventory (CCI) is a thirty-four-question, multiple-choice exam created by Bob Helgeland and Dave Rancour at the University of Massachusetts Dartmouth. As of January 2003 the concepts addressed by the CCI exams include:

- Basic switch connections (1 question)
- Series/parallel equivalent components (6 questions)
- Current and voltage conservation laws (4 questions)
- Voltage and current dividers (4 questions)
- Response of first-order circuits (8 questions)
- Characteristic parameters of ac signals (10 questions)
- Dependent sources (2 questions)
- Impulse response (1 question)
- Time domain and s-domain signals (1 question)
- Frequency response (2 questions)
- Resonance (2 questions)
- Fourier series. (2 questions)

(43 questions total)

Thirty-four questions were selected for version 1.0 that was given to 101 students enrolled in circuit theory classes at UMD during the summer and fall 2002 terms. CCI test data was presented at FIE

2002. Sample data is shown below.



Upon analyzing the results we discovered some flaws in version 1.0. Four different authors wrote the questions, so the format varied. Some questions contained multiple correct answers and the total number of choices per question ranged from 3 to 6. This made statistical analysis of the data more challenging because of the large assortment of partially correct responses. Furthermore, a 25% score could not be interpreted as being equivalent to random guessing, which

would be the case if all questions had exactly four choices. Revised versions of the CCI, to be given at UMD in the spring and summer 2003 terms, will have exactly four choices per question with only one of the choices being correct.

The original pool of 43 questions will be increased to over 90, largely by including topics that were not covered in the prototype exams. New topics will include:

- Thevenin/Norton equivalents
- Superposition
- Node and Mesh analysis
- Complex numbers
- Coupled inductors
- Phasors
- Poles and zeros

- Response of second-order circuits
- Convolution
- Three-phase Power.

Some new questions will use reverse reasoning, e.g., find the correct input given a system and an output. The prototype exams were given once per term whereas the revised exams are administered at the beginning and end of the term, as pre-test and post-test, in order to measure student gains. Construct validity and possible gender and race bias will be examined using ANOVA tests to verify construct validity. Peer review will be used to determine content validity.

Chemistry Concept Inventory

A Chemistry Concept Inventory (ChCI) was created utilizing an expansive literature review of chemistry related misconceptions and utilizing the general principles of the [Force Concept Inventory](#). The incorrect choices (distracters) for the multiple choice questions were generated from open-ended quizzes administered during general chemistry classes at ASU. Sixty questions were developed of which thirty are suitable for the first semester of a two-semester chemistry course while the other thirty are suitable for the second semester of the two-semester course. A fraction of the questions are tied to questions on the MCI to allow comparison of results of knowledge gain between a basic science course and an introductory engineering science course. The two thirty -question sets will begin field testing this summer at chemistry classes at ASU and at a local community college to compare results from different sites. The questions will be improved based upon the results obtained during this summer and new tests will be administered to large chemistry sections this fall. Progress on the ChCI has been reported at a panel session at the Share the Future Conference IV panel in March 2003 and will also be reported at a FIE conference panel [1] this fall.

Conference Papers:

- [1] Evans, D.L., Gray, D., Krause, S., Martin, J., Midkiff, C., Notaros, B.M., Pavelich, M., Rancour, D., Reed-Rhoads, T., Steif, P., Streveler, R., and Wage, K.: "Progress on Concept Inventory Assessment Tools", panel, to be presented at the 33rd ASEE/IEEE Frontiers in Education Conference - FIE 2003, November 5-8, 2003, Boulder, CO, USA.

Dynamics Concept Inventory

The Dynamics Concept Inventory (DCI) team is developing a CI for sophomore-level dynamics. Dynamics is generally taken by mechanics, aerospace, civil, and industrial engineers and the pre-requisite is usually statics and two semesters of calculus. The efforts of this team are focused on the second half of the dynamics course, that is, rigid body dynamics, since the [Force Concept Inventory](#) (FCI) sufficiently covers particle dynamics. The DCI team grew out a meeting held in San Antonio, Texas in September of 2002. This meeting, attended by 14 mechanics faculty from an equal number of universities, was instrumental in encouraging work on a Dynamics CI and on reinvigorating the work on the Strength of Materials CI. For more information on the development of the DCI, please contact D. L. Evans (devans@asu.edu), Arizona State University, leader; Gary Gray (gray@engr.psu.edu), Pennsylvania State University; Phillip Cornwell (Phillip.J.Cornwell@rose-hulman.edu), Rose-Hulman Institute of Technology; Francesco Costanzo (costanzo@engr.psu.edu), Pennsylvania State University and Brian Self (Brian.Self@usafa.af.mil),

US Air Force Academy. This team has worked closely together since the San Antonio meeting to begin to assemble a CI that addresses the commonly held alternate conceptions in rigid body mechanics.

At the Concept Developers Meeting held at FIE 2002 in Boston, the DCI team agreed to use the Delphi process, patterned after that used for the Colorado School of Mines-led CI team^{1,2,3} to determine a list of the important concepts, as well as misconceptions, in dynamics. We began the process by recruiting 25 seasoned faculty members from a diversity of institutional types ranging from community colleges to research universities, and including minority and women faculty. We asked them to describe those concepts in rigid body dynamics that their students have difficulty understanding. The team told the Delphi participants to focus on areas in which students often display insufficient conceptual understanding rather than focusing on student difficulties with analysis skills. Once the raw data was collected from the Delphi participants, it was categorized, summarized, and final statements for each of the 24 important concepts (and alternate misconceptions) were developed. In Round 2 of the Delphi process, we asked each of the participants to estimate the proportion of their students who understand the issue or concept at an acceptable level at the end of dynamics, and to describe how important they believe it is for students to understand the concept. From the collected data, the team has identified eleven concepts from rigid body dynamics that should be covered on the DCI. Student focus groups have also been used to address alternate conceptions that involve the concepts identified by the Delphi process. More information will be presented at the 2003 Frontiers in Education Conference.⁴

The DCI team has created concept questions for each of the 11 concepts and refined those questions for inclusion on the first draft of the DCI, which we plan to have completed by the end of 2003. The DCI will then be tested at several institutions during the spring 2004 semester.

Heat Transfer Concept Inventory

In contrast to the approach followed for the FMCI, and following the lead of Krause and other faculty members working on various concept inventories, development of a Heat Transfer Concept Inventory (HTCI) began with students. Faculty members at the University of Illinois, Champaign-Urbana and the University of Wisconsin-Madison worked with students to identify essential concepts and alternate conceptions. Faculty members also worked with students in the development and evaluation of questions used on the HTCI, and in the answers to the questions as students assisted in the identification of key false positive answers. This is being done through focus group activities including videotaping of student discussion of concepts and questions, and guided reflection on concepts led by faculty. The HTCI is not yet complete; but the completed inventory is expected to be available for testing and validation by the end of summer 2003.

¹ Linstone, H.A., and Turoff, M. (1975) *The Delphi Method: Techniques and Applications*. Reading, MA: Addison-Wesley

² Clayton, M. J. (1997). Delphi: a technique to harness expert opinion for critical decision-making tasks in education. *Educational Psychology*, 17 (4), 373-386.

³ Miller, Ronald, Olds, Barbara, Streveler, Ruth. Developing an Outcomes Assessment Instrument for Identifying Engineering Student Misconceptions in Thermal and Transport Sciences (NSF ASA grant DUE-0127806)

⁴ Gray, G., Evans, D., Cornwell, P., Costanzo, and M., Self, B., (2003) Toward a nationwide dynamics concept inventory assessment test. *Proceedings, 2003 ASEE Annual Conference*, Nashville, TN

Conference Papers:

- [1] Jacobi, T., Martin, J.K., Mitchell, J., Newell, T., "A Concept Inventory for Heat Transfer," to be presented at the 33rd ASEE/IEEE Frontiers in Education Conference - FIE 2003, November 5-8, 2003, Boulder, CO, USA.

Electronics Concept Inventory

Analog and digital electronics are core components of electrical engineering curricula. The project goal is to develop assessment instrument(s) that measure change in the conceptual understanding of electronics by students. Development of the Electronics Concepts Inventory (ECI) began in October 2002. As is the case for several other concept inventories, the concept inventory consists of multiple parts. For the ECI, there will be an ECI-Analog that will focus on analog electronics and an ECI-Digital for digital electronics. During the 2002-2003 academic year, developers at UMD developed fifty multiple-choice questions in analog electronics. During the summer of 2003, developers will develop a second set of multiple-choice questions for digital electronics. Both digital and analog parts will be ready for testing during the 2003-04 academic year.

Computer Engineering Concept Inventory

Computer hardware and software concepts are core components in computer engineering curricula throughout the country. The goal is to develop assessment instruments to measure change in the conceptual understanding of Computer Engineering by students who have completed sophomore level courses such as digital logic and computer design, data structures or introduction to computer organization. The first version of the Computer Engineering Concept Inventory (CPECI) is presently under development. For more information on the development of the CPECI, please contact Paul Fortier (pfortier@umassd.edu), Howard Michel (hmichel@umassd.edu), or Hong Liu (hliu@umassd.edu) of the Electrical Engineering Department, University of Massachusetts Dartmouth (UMD), or Jeff Jackson (jjackson@coe.eng.ua.edu), Department of Electrical and Computer Engineering, University of Alabama (UA).

Three areas listed below show the initial core concepts to be covered by the first version. The initial CEI will be distributed to other academic institutions in summer 2003 for review and comment. Additional topics and questions will be developed and existing questions refined or dropped during the summer based on these reviews.

- Digital Logic
- Computer Architecture and Organization
- Programming Fundamentals

Developing resources to encourage adoption of alternative pedagogies and curricula

- ❖ Facilitating adoption of alternative pedagogies and curricula recognizes that faculty members and institutions change their courses and curricula in stages. Although there are a wide variety of staged change models, the Foundation Coalition has tried to focus on the following six-stage model.
- ❖ **Pre-awareness** In pre-awareness, faculty members know little or nothing about a pedagogical or curricular project or innovation. At this stage they will invest only a small amount of time—say, at most, twenty minutes—to become more familiar with the nature of the project.
- ❖ **Awareness** At this stage, a faculty member associates the name of an innovation or project with a brief description of its nature. They may need repeated exposures to information before they reach this stage. Faculty members in the awareness stage may be willing to invest more time to learn about the project, perhaps up to an hour.
- ❖ **Interest** Now, faculty members may be willing to read articles about the project or innovation. They will invest more time and may initiate scans for additional information.
- ❖ **Search** In search, faculty members will actively seek more information about the project or innovation.
- ❖ **Decision** At this stage, faculty members are actively seeking information that will help them make a decision on whether to adopt the innovation or use the results of the project.
- ❖ **Action** Now, a faculty member has decided to adopt the innovation or use the results of a project in her/his own courses.
- ❖ Using the above model, the Foundation Coalition has prepared resources that will assist faculty members in the transition at each stage of the change process.

One-page introductions One-page introductions have been prepared to raise the level of **awareness** of FC core competencies and curricular innovations. Topics for the one-page introductions include active/cooperative learning, student teams in engineering, technology-enabled learning, FC first-year curricula, and assessment and evaluation. Here is a listing of the one-page introductions and mini-documents that have been developed to date.

Introduction to the Foundation Coalition	Foundation Coalition Partners	Active/Cooperative Learning
Assessment and Evaluation	Assessment Tools for Attitudes and Skills	Concept Inventory Assessment Tools
Technology-enabled Learning	Electronic Response Systems	Technology Usage Patterns in First-year Engineering
EC 2000 a–k Instructional Modules	Conservation and Accounting Framework	Sophomore Engineering Science Curriculum at Rose-Hulman Institute of Technology
First-year Engineering at the University of Alabama	First-year Engineering at Texas A&M University	First-year Engineering at Arizona State University

First-year Engineering at the University of Massachusetts–Dartmouth Student Teams in Engineering Curriculum Integration

Copies of the one-page introductions are available at <http://fc1.tamu.edu/publications/brochures/>.

- ❖ **Mini-documents** Once faculty members become aware of a specific innovation, they have additional questions about the innovation. Based on experience in offering workshops on several different innovations, FC faculty members have identified questions that are asked repeatedly and prepared targeted summaries to address these questions and help catalyze the transition from awareness to interest. For teams, these mini-documents address questions such as “How do I form teams?”, “How do I assign individual grades for team assignments?”, “How do I facilitate dysfunctional teams?” For active/cooperative learning, these mini-documents address the five elements of cooperative learning: positive interdependence, individual accountability, group processing, social skills, and face-to-face interaction.

Mini-Documents on Student Teams in Engineering

- Forming Teams
- Getting Student Engineering Teams Off to a Good Start
- Peer Assessment and Peer Evaluation
- Facilitating Dysfunctional Teams
- Monitoring Progress of Student
- Improving Conflict Management Skills in Student Teams
- Improving Intrateam/Interteam Communication Skills
- Improving Decision Making Skills in Student Teams (expected completion date: 31 July 2003)

Mini-Documents on Active/Cooperative Learning

- Positive Interdependence, Promotive Interaction, and Individual Accountability (expected completion date: 30 September 2003)
- Interactive Lectures and Class Sessions (expected completion date: 30 September 2003)
- Building Team Skills for Active/Cooperative Learning (expected completion date: 30 September 2003)
- Problem-Based Learning (expected completion date: 30 September 2003)
- Virtual Teams or Computer Supported Cooperative Learning (expected completion date: 30 September 2003)
- Using Active/Cooperative Learning in a Digital Design Course (expected completion date: 30 September 2003)

- ❖ **Web site and publications** As interested faculty members begin to search for materials, the FC has expanded its Web site (<http://www.foundationcoalition.org>) to include the one-page introductions, the targeted summaries, success stories, copies of FC papers, and additional

material to help faculty members find more information about the innovations in which they are interested. In addition, the FC has constructed a web site focused on active/cooperative learning (ACL, <http://clte.asu.edu/active/main.htm>). It includes interviews with 21 engineering faculty on 8 different campuses faculty members who have incorporated ACL into their classes and course modules that illustrate the application of ACL in engineering classes. . Through the interviews, our faculty offer suggestions for preparing students for teamwork, developing instructional materials, and implementing and assessing cooperative learning lessons and activities. The site also contains content-specific engineering lessons, activities, and projects.

❖ **Workshops** As faculty members **decide** whether to adopt the innovations and **act** to apply them in their courses or on their campuses, FC workshops provide an effective tool to help faculty members acquire in-depth knowledge and initial experience with using the innovation. The workshops range in length from two hours to two days, depending on the objectives of the campus that is hosting the workshop.

- Principles for Classroom and Curricular Innovation
- Active/Cooperative Learning: Introduction and Applications
- Active/Cooperative Learning: After the Basics
- Active/Cooperative Learning in Capstone Design Courses
- Student Teams in Engineering: Introduction and Applications
- Converting Group Projects into Team Projects
- Concept Inventory Assessment Instruments for Engineering Science
- Developing an Assessment and Evaluation Plan
- Developing Measurable Objectives and Outcomes for Programs and Courses
- Course Objectives and Classroom Assessment
- Technology-enabled Learning in Engineering: Taxonomy and Applications
- Designing Innovative Classrooms for Education in Science, Engineering, and Mathematics
- Curriculum Integration: Why and How
- Curricular Change, Resistance, and Leadership
- Process of Curricular Change: Case Studies Across the Foundation Coalition
- How Do We Learn?
- Inclusive Learning Communities: Lessons from Foundation Coalition Experiences
- Faculty Learning Communities
- Retention of Undergraduate Students in Engineering
- First-year Curricula and Programs across the Foundation Coalition
- Conservation and Accounting Framework: A Unified Approach to Engineering Science
- Teaching EC 2000: Integrating Student Outcomes "a-k" into Engineering Courses

- Writing More Effective Engineering Education Proposals

The list of available FC workshops can be found at

<http://fc1.tamu.edu/events/workshops/index.html>. Information about FC workshops that have been offered can be found at <http://fc1.tamu.edu/events/workshops/pastworkshops.html>.

- ❖ **EC 2000 Course Modules** Another tool to encourage faculty members to consider integrating material on one or more of the non-technical EC 2000 “a–k” student outcomes into their classes is a set of fifteen course **modules**. Modules are designed to enhance students’ skills in four general areas: technical skills, communication skills, professional skills, and ethical-societal skills. They are designed to fit into any upper-level engineering course that needs to deal explicitly with one or more of the EC 2000 student outcomes. Each module contains material for three fifty-minute lectures and makes use of active/cooperative learning methods. Each contains a justification for the material, learning objectives, an assessment process, multiple student assignments, activities to build the skill and bridge it into the discipline-specific course content, and an instructor's guide. More information about the modules can be found at <http://www.foundationcoalition.org/home/FCVersion2/ec2000.html>.

Journal Papers

- [1] Pimmel, R. L., “Student Learning of Criterion 3 (a)-(k) Outcomes with Short Instructional Modules and the Relationship to Bloom’s Taxonomy,” *Journal of Engineering Education* (Accepted pending Revision), 2003.

Conference Papers

- [1] Stern, H. P. E. and R.L. Pimmel, “Instructional Module for Engineering Ethics,” *Proceedings, 2002 Frontiers In Engineering Conference*

- ❖ **Surveys on EC 2000 Instructional and Assessment Material** A project team has completed a systematic, comprehensive search for instructional and assessment materials dealing with Criteria 3 (a)-(k) outcomes that are available on the Web. We have characterized the content and availability of each item. We are creating a Web-accessible database containing this information and we are analyzing it patterns of availability. In addition, we have initiated a survey to identify instructional and assessment material dealing with these outcomes. In this survey, we are contacting deans and program heads of each ABET-accredited program to identify instructors who have responsibility for teaching specific Criteria 3 (a)-(k) outcomes. We then survey these instructors on the nature of their instructional material. We have obtained some information and anticipate much more. We are in the process of creating a searchable database that will be accessible through the Internet.

Conference Papers

- [1] Haag, S, & Caso, R. (2003). Assessment Materials Addressing EC 2000 Program Outcomes. Accepted International Conference on Engineering Education (ICEE) July 21-25, 2003, Valencia, Spain.
- [2] Pimmel, R., Caso, R., Haag, S., and Fowler, E., (2003). A Structured Survey to Inventory EC 2000 Instructional Materials. Accepted 2003 Frontiers in Education (Paper #1390), November 2003, Boulder, Colorado.

- [3] Haag, S., Caso, R., Fowler, E., and Pimmel, R. (2003). A systematic web and literature search for instructional and assessment materials addressing EC 2000 Program Outcomes. Accepted 2003 Frontiers in Education (Paper #1418), November 2003, Boulder Colorado.
- [4] Caso, R. & Froyd, J. (2031). Preliminary Results of a Search for Assessment Materials Addressing EC 2000 Program Outcomes from Secondary and First-hand Sources, Proceedings 2003 Best Assessment Processes V Symposium, April 2003, session 33-O203
- [5] Pimmel, R. I., P. Morley, S Haag, R. Caso, and E. Fowler, "A Structured Survey to Inventory EC 2000 Instructional Materials," Proceedings of the 2003 FIE (in press)

Face-to-Face Interactions

Changing all or most of the conversations that occur across the engineering education community requires face-to-face interactions between faculty members who are interested in improving engineering education. Face-to-face interactions during the past year have taken two forms.

- ❖ **Share the Future Conferences** The FC has worked with the other existing engineering education coalitions—SUCCEED, Greenfield, and Gateway—to sponsor an annual Share the Future Conference. The heart of each Share the Future Conference is two-hour workshops during which participants have opportunities to interact with the facilitators and each other to acquire a more in-depth knowledge of the workshop topic. Gateway and SUCCEED led the way and offered the first Share the Future Conference in 2000. Foundation joined in offering the second conference in 2001, and the third conference was presented by all four coalitions as Greenfield contributed in 2002. Share the Future IV was held on 16-18 March 2003 in Tempe, Arizona. More information on the Share the Future Conferences can be found at <http://fc1.tamu.edu/events/conferences/index.html>.
- ❖ **Focused dissemination** FC partner institutions have hosted small, focused conferences (colloquially referred to as miniconferences) at which participants interested in a narrow set of issues and innovations meet to describe what they have done, what they would like to learn, and what they plan to do before the next conference. These miniconferences offer an excellent opportunity for participants to learn about the accomplishments of the FC partners because the conversations occur in an environment in which participants are trying to learn how they might improve programs that are offered on their campuses. Specifics about past miniconferences and planned mini-conferences are provided in the following paragraphs.

Third Mini-conference on First-year Innovations

The third annual Mini-conference Innovations sponsored by NSF through the Foundation Coalition was held May 13- 14, 2003 on the Purdue University campus. Invited participants came from large public Midwestern universities: Universities of Illinois, Iowa State, Michigan, Ohio State, Pennsylvania State, Purdue, Minnesota, and Wisconsin. The focus of the conference was on the innovations on campuses, in engineering colleges, and in departments that help students adapt to university life and learn about engineering. The intended outcomes of the conference were:

- ❖ To obtain a greater understanding of what works well and not so well in the freshman year,
- ❖ To develop/revise plans for improving the freshman year program on individual campuses
- ❖ To determine whether to continue the conference without NSF support.

Each institution presented some aspects of their freshman year. Schools that participated in previous years (Iowa State, Michigan, Purdue, and Wisconsin) gave an update on their programs and the progress that they are making. Schools new to the Mini-conference (Illinois, Penn State, and Minnesota) made a summary of their freshman year program. At the conclusion of the Mini-conference, participants considered whether to continue to hold such a Mini-conference without FC funding. There was overwhelming support to continue holding a Mini-conference.

A number of issues were raised and discussed during the breakout sessions and general discussions. None were “resolved” in the traditional sense, but they served as points for further discussion. Each school has taken a somewhat different approach for the first year, and all of the

programs work to some extent. The issues raised will serve to stimulate further improvements in the first year programs, and that they may be topics to discuss in future conferences.

Common ideas that emerged from the discussions are:

- ❖ The Freshman Year doesn't lead well into departmental curriculum
- ❖ Faculty in departments don't value the first-year programs
- ❖ Faculty in departments don't know how to teach freshman
- ❖ Integration of design throughout the curriculum is valuable
- ❖ First-year engineering curricula have little real engineering content. They are is mostly mathematics, chemistry, physics, and social sciences
- ❖ There are many different approaches to a first-year engineering program.

Second Annual SEC Engineering Schools Meeting

Schools in the Southeastern Conference (SEC), which offer engineering, met at Vanderbilt University in Nashville, Tennessee, on 19-20 May 2003. The conference focused on three issues (diversity, first-year engineering curricula, and student outcomes in EC 200x) with the following goals:

- ❖ Establish a dialogue among SEC engineering schools
- ❖ Share experience and concerns regarding the three issues
- ❖ Identify important, common, unresolved questions
- ❖ Identify specific collaborative efforts for resolving these questions and the "deliverables" resulting from these efforts (perhaps involving proposals for external funding)
- ❖ Share conclusions with the deans
- ❖ Plan a follow-up meeting to report progress and to explore additional issues

More information about the SEC Engineering Schools Meeting can be found at <http://fc1.tamu.edu/events/news/undergraded.html>.

Miniconference on the Energy Stem in Mechanical Engineering

The second mini-conference on the energy stem in Mechanical Engineering, sponsored by the Foundation Coalition, was held May 28 and 29, 2003 at the University of Wisconsin. There were 20 participants from 14 different universities. The focus of the conference was on the role of concepts in learning and teaching.

Presentations were made by those involved with developing concept inventories and concept-based teaching methods and materials. Small groups were formed based on their interest in thermodynamics, fluid mechanics, or heat transfer. At the end of the mini-conference, several action items were developed:

- ❖ Develop a concept question data bank: Pool questions so that instructors have a resource and develop a misconception data bank. A review process for questions needs to be

developed. The University of Wisconsin and University of Illinois will serve to collect questions

- ❖ Need to quantify the results of concept questions: Need to increase the number of faculty who understand and use concept questions. Several individual action items were accepted in connection with this action item.
- ❖ Hold sessions at ASME, ASHRAE, and other professional technical societies

The participants overwhelmed agreed that this mini-conference was worthwhile. Networking provided by meeting others interested in improving the quality of teaching is invaluable. The participants agreed to support the development of a data base. There was general agreement to hold the conference next year, even without Foundation Coalition support.

Ways of Knowing and Ways of Practice

"Ways of Knowing and Ways of Practice" was an on-line, distance learning experience for faculty and instructional staff during Spring Semester, 2003. Enrollment was limited to twenty participants; preference was for teams of two from participating institution such that one faculty person was from engineering and one from another science, math, or computer science discipline. Specifically, the professional development opportunity explored *ways of knowing* including theories of learning, learning styles, disciplinary and cultural perspectives and how they inform *ways of practice* including both teaching practice and engineering practice. The professional development experience involved an orientation in Madison, Wisconsin, weekly on-line discussions based on readings, a personalized curriculum project, and approximately two to three hours per week commitment on the part of each participant.

Participants represented the following institutions: Milwaukee School of Engineering, Michigan State University, Southern Illinois University-Edwardsville, University of Wisconsin-Platteville, North Dakota State University, Tarleton State University, Dordt College, Southeast Missouri State University, University of Minnesota-Duluth, and the University of Wisconsin-Madison. Participants facilitated weekly on-line discussions based on their specific projects. Topics included problem solving with computers, visualization techniques, simulations, situated learning, freshmen retention, on-line learning, active classrooms, conceptual learning, time-effective lab report grading, and evaluating and improving teaching.

Special features included a conversation with Ted Marchese from Washington DC and John Heywood from University of Dublin, Ireland. Marchese is former chair of AAHE and currently a consultant with Academic Search. Participants had discussed his article, "New Conversations about Learning Insights from Neuroscience and Anthropology, Cognitive Science, and Workplace Studies." Heywood is an engineering education consultant who is completing a manuscript titled, "Curriculum Leadership in Engineering Education." Technology features included a web-based teleconference and WebCT.

Several participants plan to meet in Nashville at the ASEE Annual Conference; one is presenting a paper based on their project. Formative assessments indicate that the experience has played a significant role in terms of reflection and space for individual professional development. An overall evaluation is in progress. Sandra Courter, project director, plans to submit a paper for 2004 ASEE Annual Conference based on the experience. Details on the project can be found at <http://www.engr.wisc.edu/elc>.

Curricular change

The culture of engineering education encompasses not only the structure of an engineering curriculum and how students and faculty members interact with it, but also the processes through which engineering curricula grow and improve. Therefore, the FC is continuing a qualitative research project that examines **processes** through which coalition partners have initiated and attempted to sustain curricular change. It is important to emphasize that the focus of the study is the process of curricular change is the process of curricular change, non content of new of curricula. The project is organized as a series of qualitative case studies that examine curricular change at each of the partner institutions. Data for each case study has collected through interviews of approximately twenty-five key faculty and administrators, as well as review of relevant documents. Each case study identifies critical events and salient issues involved in that process, as well as valuable lessons learned by each institution from experience.

To date, several themes have emerged from analysis of the data.

- ❖ The study shows that assessment data gathered during the piloting of the new curriculum were necessary to engage and sustain conversations about the possibilities of adopting the curriculum for all engineering majors. However, at no FC partner institution were the assessment data **alone** sufficient to move the non-FC faculty to adopt a new curriculum. The initial change model that the FC leaders were using, with its emphasis on the pilot curriculum, was problematic.
- ❖ In the second-generation change model, the emphasis shifts away from pilot curriculum development and assessment, and instead the design of an institutional curriculum system that accommodates all students is given more attention. So the project focus is both on developing a pilot curriculum and carefully assessing student performance as well as attributes that will be useful in designing a curriculum structure for all students. Developers can learn from pilot curricula to see how college-wide curriculum might be designed, but they must use a process that involves all faculty members as well as student advisors to craft a college-wide curriculum.
- ❖ Curricular innovation projects will include developing, implementing, and carefully assessing a pilot curriculum for student performance and learning required to design college-wide curriculum. Next, developers will use knowledge gained from pilot curriculum efforts to design a college-wide curriculum system with high faculty and administrative involvement. Finally, the innovation effort will consider developing new administrative structures within the college that will support the new curriculum.

Conference Papers

- [1] Clark, M. C., Froyd, J., Merton, P., and Richardson, J. (2003) Evolving Models of Curricular Change: The Experience of the Foundation Coalition", *Proceedings, American Society for Engineering Education Annual Conference*, Nashville, TN, June 2003

Department Change Project at UWM

The focus of the department change project at UWM is the Department of Mechanical Engineering, which has worked on developing and implementing a process for regular and systematic curricular review and revision. In Year 10, there were two parts to the activities. The first part involved activities designed to move the department towards becoming a learning community, an

organization in which continuous review and reflection on curricular content became a regular part of department activities. The key component of this was an off-campus gathering of the faculty and their families. On a Friday in the fall, faculty and teaching staff cancelled classes (with the approval of the Dean and the Department Chair) to travel to a nearby spot for a day-and-a-half gathering. Spouses and families were included to begin to foster the kind of learning community we know makes for an environment where members are free to discuss, disagree and find common ground on their beliefs about teaching and learning. The time was structured with time for readings, time for reflection, and group work in summarizing readings. The process used was based on the work of Cooperrider and Hammond, called Appreciative Inquiry. © Building on the memories of positive and collegial experiences in the history of the department set the tone for further successes. The group left with a list of statements in answer to the question "What are our responsibilities teaching undergraduates at a Research I institution?"

The second part of the effort was the establishment of a model that the department could follow in developing a process for continuous improvement of the Mechanical Engineering Curriculum. For example, at a winter gathering, the faculty revisited the belief statements from the fall work and integrated them with the department's 1999-2000 ABET review documents. From this, the curriculum committee consolidated the belief statements from the fall with the materials from the ABET review into a ten-point philosophy for the department.

Currently, groups of faculty are working on aligning course outcomes and objectives with the philosophy statements. When completed, these, along with the process instruments will be available for other departments wishing to embark on significant, long-lasting and on-going change at the departmental level.

Conference Proceedings and Workshops

- [1] Haglund, D., Kushner, J. & Martin J. "Developing a Philosophy of Practice: A New Approach to Curricular Evolution in Engineering Education at the University of Wisconsin," *Proceedings, American Society for Engineering Education Annual Conference*, Nashville, TN, June 2003.
- [2] Haglund, D, Martin, J., & Mitchell, J. "An Approach to curricular Evolution at the University of Wisconsin-Madison." Share the Future Conference: Tempe, AZ, February 2003.

Department Change Project at UMD

The focus of the department change project at UMD is the Department of Electrical and Computer Engineering, which is restructuring its computer engineering curricula using knowledge about computer engineering curricula across the nation and the practices gained from FC participation. In year 10, department pursued several activities to engage department faculty in reflection on and discussion about their curriculum. One important activity was to gather information from faculty regarding the department's history, current perspectives on the curriculum and change as well as past assessment and evaluation activities. From this information, the department discovered many misconceptions that existed within our own faculty regarding what should be in a computer engineering curriculum. To illuminate and clarify some of these misconceptions and to foster more faculty engagement in the process, the department surveyed curricula at small, medium and large institutions in an effort to determine national norms and how the UMD curriculum compared with these norms. The output of this effort of year 10 is a draft technical paper entitled "A Survey of US Computer Engineering Curricula in 2003." This draft paper served as a focal point of discussion

in a series of faculty workshops held in October and November 2002. Of particular interest was in how departmental faculty felt their curriculum compared to those of other similar and dissimilar institutions. These discussions led to the initiation of a another workshop held in January 2003 which focused on development of department strengths and weaknesses as well as a request to delve deeper into the curriculum of other institutions defined in our draft paper of October. The focus shifted to more detailed analysis of course contents to see what was different and similar in each of the surveyed curricula. As the project continues, course pedagogy, teacher and teaching methods, and assessment will be discussed. The project deliverables will be the paper defined above and another detailing the processes used in facilitating department change. Both papers will be submitted to national conferences in the coming year.

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"It is not the strongest of the species that survives,
nor the most intelligent,
but the one most responsive to change."

Charles Darwin