





*“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 core of education is conversation. Whether face-to-face in classrooms across the country, via electronic channels opened by telecommunication technologies, or via the written word in papers and books, communication between individuals is where learning truly takes place. Similarly, improvements in the education process occur through conversations about what changes might and should be brought about and how these changes might happen. Recognizing that these conversations hold the key to systemic improvement in engineering education, faculty members across the Foundation Coalition (FC) are engaging faculty members in other schools in conversations, dialogues, discussions, and meetings regarding innovations and improvements in engineering education. Mechanisms through which these exchanges occur are manifold, but most can be placed into one of four categories.

- ❖ **Developing and field testing assessment instruments** Ascertaining what students know, what skills they have gained, and what they think about their competence and the instruction they have received have been long-time catalysts in promoting improvements in teaching. Therefore, the FC is constructing a variety of instructional assessment instruments and inviting faculty members at institutions throughout the country to work with these instruments, providing data and feedback through which the instruments can be enhanced. Conversations stimulated by these instruments are raising interest in FC activities and results.
- ❖ **Developing resources to encourage adoption of alternative pedagogies and curricula** These resources include one-page handouts (introductions), targeted summaries, more detailed documents on educational pedagogies, EC 2000 modules, the FC web site (<http://www.foundationcoalition.org>), and workshops. All these resources are designed to help faculty members become more informed about alternative pedagogies and curricula.
- ❖ **Continuing partnerships** The FC is working with the other engineering education coalitions in offering an annual Share the Future Conference as well as regional workshops. FC partners are also hosting small, focused conferences to explore specific issues in greater depth. These partnerships are intended to help change conversations across the engineering education community.
- ❖ **Curricular change** The FC has undertaken a qualitative research project that examines the **processes** through which coalition partners have initiated and attempted to sustain curricular change. Documenting curricular change *processes* on a given campus is intriguing to the rest of the engineering education community. The goal is to provide knowledge about curricular change processes that will aid other institutions undertaking significant curricular change.

## Developing and field testing 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. Work began on four concept inventory assessment instruments in October 2000 while work on three others began in October 2001. In addition, work continues on instruments designed to explore students' perceptions and attitudes and on a self-assessment instrument for teams.

- ❖ [Signal and Systems Concept Inventory](http://fc1.tamu.edu/home/keycomponents/concept/SSCI.html) (SSCI),  
<http://fc1.tamu.edu/home/keycomponents/concept/SSCI.html>
- ❖ [Thermodynamics Concept Inventory](http://fc1.tamu.edu/home/keycomponents/concept/thermodynamics.html) (TCI),  
<http://fc1.tamu.edu/home/keycomponents/concept/thermodynamics.html>
- ❖ [Electromagnetics Concept Inventory](http://fc1.tamu.edu/home/keycomponents/concept/electromagnetics.html) (EMCI),  
<http://fc1.tamu.edu/home/keycomponents/concept/electromagnetics.html>
- ❖ [Strength of Materials Concept Inventory](http://fc1.tamu.edu/home/keycomponents/concept/strength.html) (SoMCI),  
<http://fc1.tamu.edu/home/keycomponents/concept/strength.html>
- ❖ [Student Perceptions and Attitudes](http://fc1.tamu.edu/home/keycomponents/assessment_eval/attitude_test.html),  
[http://fc1.tamu.edu/home/keycomponents/assessment\\_eval/attitude\\_test.html](http://fc1.tamu.edu/home/keycomponents/assessment_eval/attitude_test.html)
- ❖ [Self-Assessment Instrument for Teams](http://fc1.tamu.edu/home/keycomponents/assessment_eval/teaming_skills.html),  
[http://fc1.tamu.edu/home/keycomponents/assessment\\_eval/teaming\\_skills.html](http://fc1.tamu.edu/home/keycomponents/assessment_eval/teaming_skills.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>

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) and Kathleen Wage (George Mason University) 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.

The continuous-time SSCI (CT-SSCI) is currently at version 2.0, and faculty members at University of Massachusetts Dartmouth, George Mason University, the U.S. Air Force Academy, and the U.S.

Naval Academy are doing pre/post testing surveys in undergraduate signals and systems classes. Preliminary statistical analysis of the results obtained to date has been initiated to determine if scores can be correlated with gender, race, grade-point average, and common prerequisite courses. The analyses will look for race or gender biases and also will try to characterize which prior academic measures are the best predictors of exam performance and normalized gain.

The discrete-time SSCI (DT-SSCI) is in "beta" and undergoing preliminary testing at University of Massachusetts Dartmouth, George Mason University, and Massachusetts Institute of Technology. Based on the results of this testing, the DT-SSCI will be revised this summer for broader testing beginning in the fall of 2002.

In fall 2001, 97 students at GMU, UMD, and the USNA took the CT-SSCI as a pre-test and a post-test. Motivated by Hake's survey of the FCI (Hake, 1998), 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 97 SSCI exams revealed a normalized gain between pre- and post- test scores of  $0.24 \pm 0.08$  which is consistent with the results Hake reported for other concept inventory studies of traditional lecture courses.

#### Conference Proceedings Papers

1. Wage, K.E., and Buck, J.R., "Development of the Signals and Systems Concept Inventory (SSCI) Assessment Instrument," *Proceedings, 2001 Frontiers in Education Conference*, Reno, NV, October 2001.
2. Wage, K.E., Buck, J.R., Welch, T.B., and Wright, C.H.G. (2002), "The Continuous-time Signals and Systems Concept Inventory," *Proceedings, International Conference on Acoustics Speech and Signal Processing*, Orlando, FL, May 2002.
3. Wage, K.E., Buck, J.R., Welch, T.B., and Wright, C.H.G. (2002), "The Signals and Systems Concept Inventory," *Proceedings, American Society of Engineering Education Annual Conference*, Montreal, Quebec, June 2002.

#### *Thermodynamics Concept Inventory*

The Thermodynamics Concept Inventory (TCI) was developed by Donovan Evans (Arizona State University), Clark Midkiff (University of Alabama), and Thomas Litzinger (Pennsylvania State University) and has been modified through two semesters of testing. The thirty-three-question inventory requires approximately thirty minutes to complete. The first complete cycle of pre- and post-testing of the concept inventory will conclude at the end of the spring 2002 semester. Faculty members at the University of Alabama, Pennsylvania State University, Baylor University and San Jose State University have agreed to test the instrument in spring 2002. Faculty members at the Franklin W. Olin College of Engineering in Massachusetts and the Colorado School of Mines have evaluated or considered using the instrument. Highlights from early testing are that beginning students often fail to recognize or exploit situations of constant volume or constant pressure, and that students have a rudimentary grasp of First Law of Thermodynamics concepts but perform poorly when Second Law concepts are tested.

Thermodynamics concept testing was studied by a team at the University of Wisconsin Madison. The evaluation team consisted of Sandy Klein, Jay Martin, and John Mitchell. This team made

slight modifications to the original and then gave the modified version to two thermodynamics classes (taught by Klein and Sanders) in the first two weeks of class. The TCI was given as a homework assignment, collected, and graded. The TCI was neither returned nor discussed. Evaluation of the pretest results follows.

Students took less than an hour to complete the inventory. Their performance shows that they do bring some knowledge of thermodynamics into the course. However, results also indicate that they do not fully grasp the concepts of energy balances and entropy (Second Law of Thermodynamics) at the beginning of the course. These results are not surprising. Student performance on the thermodynamics of chemical reactions was poor, however, and this result was surprising, since they have worked on these concepts in previous chemistry courses.

#### Conference Proceedings Papers

1. Midkiff, K.C., Litzinger, T.A., and Evans, D.L., "Development of Thermodynamics Concept Inventory Instruments," *Proceedings, Frontiers in Education Conference*, Reno, NV, October 2001.

### *Electromagnetics Concept Inventory*

The Electromagnetics Concept Inventory (EMCI) is best suited for junior-level undergraduate electromagnetics (EM) courses in electrical engineering departments. It can be applied in a variety of undergraduate and graduate EM-related courses in engineering and physics departments. EMCI 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).

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

#### Conference Proceedings Papers

1. Notaros, B.M., "Concept Inventory Assessment Instruments for Electromagnetics Education," *Proceedings, IEEE Antennas and Propagation Society International Symposium*, San Antonio, Texas, 16–21 June 2002.

### *Strength of Materials Concept Inventory*

The Strength of Materials Concept Inventory (SoMCI) assesses students' mastery of fundamental concepts in a sophomore mechanics of solids or strength-of-materials course. Concepts examined include stress, strain and deformations due to axial, bending, and torsional loads; failure of ductile and brittle materials, stress transformation, and axial buckling. Follow-on courses such as structural analysis (in civil engineering) or machine design (in mechanical engineering) build directly upon these concepts. Many students typically do not master some of the more abstract strength of materials concepts until completion of these follow-on courses. The principal developers are Jim Richardson (University of Alabama [UA]) and Jim Morgan (Texas A&M University [TAMU]). Testing began at UA and TAMU in summer 2001, and the SoMCI was available to other schools beginning in spring 2002.

## Conference Proceedings Papers

1. Richardson, J., and Morgan, J., "Development of an Engineering Strength of Material Concept Inventory Assessment Instrument," *Proceedings, Frontiers in Education Conference, Reno, Nevada, 10–13 October 2001*.

## *Student Perceptions and Attitudes*

Student perceptions and attitudes regarding educational experiences have been shown to contribute significantly to the retention of students in undergraduate science, math, engineering, and technology (SMET) programs. For example, studies conducted at Texas A&M suggested that female students as a group had lower retention, despite higher incoming preparation and higher performance, when compared to male students. Findings of this nature have also been reported elsewhere, supporting the assumption that student perceptions do help drive persistence and may be based upon issues independent of a student's academic preparation and grade performance.

Student persistence in SMET disciplines is a matter of national concern in the context of contemporary life, which is increasingly affected by scientific, mathematical, and technological innovations. Hence, generating and sustaining positive attitudes and appropriate perceptions about SMET disciplines and about learning experiences in SMET programs has become a matter of great importance among academicians. The measurement of student perceptions and attitudes has therefore become a focus of research in a variety of academic programs.

## *Self Assessment Instrument for Teams*

The assessment team at University of Massachusetts Dartmouth revised and tested the FC [team process check](#) (TPC) and developed a [team knowledge test](#) (TKT), both of which can be administered either on paper or on-line.

The TPC provides a self-report assessment of a team's functioning and is intended to be administered periodically during the life of a team. The measure has demonstrated good internal consistency and has also yielded two meaningful factors. The first factor appears to assess what may be termed the team's sense of agency or ability to get the job done well. The second factor is an affiliative or interpersonal factor, including communication and conflict resolution. The TPC was found to be correlated with faculty ratings of the teams, and partial support was found for its capacity to predict outcome as measured by team project scores.

The TKT is the first draft of a measure intended to assess individual team members' general knowledge of team issues and concepts. The development team has used it as a pre/post measure of team knowledge over a semester's team experience as well as before and after the use of the team training material that was posted on the Web site and was assigned by faculty members as part of their courses. Additional revision will be required to improve the scale and to establish its reliability and validity. The group also developed two Web sites, a [faculty guide](#) ([http://www.fcae.umassd.edu/fcteam/teamfacultyguide/frames\\_index.html](http://www.fcae.umassd.edu/fcteam/teamfacultyguide/frames_index.html)) and a [student team training site](#), ([http://www.fcae.umassd.edu/fcteam/teamtraining/frames\\_index.html](http://www.fcae.umassd.edu/fcteam/teamtraining/frames_index.html)) to facilitate the assessments that were performed and the studies that were conducted. Ultimately, these Web sites will be incorporated into an ongoing continuous improvement process of team assessment and training. The team has also begun to disseminate the tools and the assessment process by reaching out to several other campuses within the FC to examine the materials and consider their use.

### Conference Proceedings Papers

1. Powers, T.A., Sims-Knight, J., Topciu, R.A., Haden, S.C., "Assessing Team Functioning in Engineering Education," *Proceedings, American Society of Engineering Education Annual Conference*, Montreal, Quebec, June 2002
2. Sims-Knight, J., Upchurch, R.L., Powers, T.A., Haden, S.C. and Topciu, R.A., "Teams in Software Engineering Education." submitted to the 2002 Frontiers In Engineering Conference

### *Materials Concepts Inventory*

Stephen Krause (Arizona State University) and Richard Griffin (Texas A&M University) have been developing a Materials Concepts Inventory (MCI) during the past six months. Graduate and undergraduate students majoring in materials have been employed in developing questions and identifying misconceptions. Undergraduate engineering students from many disciplines who are taking an Introductory Materials Science and Engineering course have answered both open-ended and multiple-choice questions to probe their understanding of fundamental materials concepts. They have also been interviewed to gain insight on their background so gaps in knowledge and the origin of misconceptions can be identified. Basic concepts utilized in developing the questions include bonding, band structure, crystal structure, defects, atomic motion, microstructure, solutions, simple thermodynamics, deformation, and the nature of metals, polymers, ceramics, and semiconductors. The MCI will be field tested this summer and fall to refine, enhance, expand, and further understand the nature of misconceptions and interventions in engineering materials.

Some surprising results have emerged on students' preparation coming into the class. A few examples are that less than 10% of the students had heard of simple band theory to explain electrical and electronic properties of materials, less than 10% realized that biological and botanical materials (e.g., plants, animals, humans) have much material composed of the same long-chain structure of molecules as synthetic polymers have, and less than 20% had a knowledge or understanding of simple concepts of solubility that are important in the topic of phase diagrams (e.g., if excess saturated salt sits at the bottom of a glass of salt-saturated water, the students thought that adding more salt would increase the concentration of salt in the solution—it does not). Appropriate interventions using active learning techniques are being developed to address misconceptions and gaps in background. Also, discussions will be initiated with introductory physics and chemistry instructors to see if gaps in background can be addressed in those courses.

### *Fluid Mechanics Concept Inventory*

Ty Newell (University of Illinois), Jay Martin (University of Wisconsin), and John Mitchell (University of Wisconsin) met in February 2002 at the University of Wisconsin to develop a taxonomy of fluid mechanics concepts as the first step in developing the Fluid Mechanics Concept Inventory (FMCI). Taxonomy has three broad categories: basic concepts, fundamental fluid relationships, and special cases that may be of special interest to particular disciplines and could form the basis for optional sections of the instrument. Basic concepts encompassed four areas: properties, boundaries, dimensional analysis, and similarity. Fundamental fluid relationships included two areas: continuity and momentum. Under continuity three sub areas were outlined: steady/unsteady fluid flow, compressible/incompressible fluid flow, and the dimensionality of the physical situation to be analyzed. For momentum the following outline was developed

- 1) Ideal (reversible) flow (variations of terms 1, 2, and 3)

- a. Bernoulli flows (terms 1, 2, and 3)
  - b. Dynamic pressure (terms 1 and 2)
  - c. Momentum/reaction (terms 1 and 2)
  - d. Hydrostatics/manometry (terms 2 and 3)
- 2) Viscous flow (variation of terms 1, 2, 3, and 4)
- a. Pure viscous (term 4)
  - b. Low momentum, no gravity (terms 2 and 4)
  - c. All effects (terms 1, 2, 3, and 4) – various flow characterizations
    - i. Parallel flow
    - ii. Elliptical flow

where 1-terms are momentum terms, 2-terms are pressure gradient terms, 3-terms are gravity terms, and 4-terms are viscous terms. Special cases included bluff bodies, airfoils, pipe networks, turbomachinery, compressible flow, and channel flow.

A draft version of the FMCI will be developed during the summer. This will then be given as a pretest in the fall semester to classes at UW and University of Illinois. The results will be evaluated and the FMCI modified. The FMCI will then be given at the end of the semester. The cycle will continue until the team judges that the FMCI is satisfactory; it will then be tested and evaluated at other schools.

### *Circuits Concept Inventory*

David Rancour (University of Massachusetts Dartmouth), Robert Helgeland (University of Massachusetts Dartmouth), and Harold Stern (University of Alabama) are developing the Circuits Concept Inventory (CCI). Question topics addressed to date include voltage and current dividers, time constants, dependent sources, bandwidth and quality factor, resonance, and Bode plots and impulse response. The first draft of the CCI will be tested on the summer class of 2002, so assessment data is unavailable at this time.

## 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. Copies of the one-page introductions are available at <http://fc1.tamu.edu/publications/brochures/>.
- ❖ **Targeted summaries** 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 targeted summaries 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 targeted summaries address the five elements of cooperative learning: positive interdependence, individual accountability, group processing, social skills, and face-to-face interaction.
- ❖ **Web site and papers** 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.

❖ **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

The list of available FC workshops can be found at

<http://fc1.tamu.edu/events/workshops/index.html>. During the past year, FC faculty members have offered thirty-five workshops at thirteen different locations. Information about FC workshops that have been offered during the past year 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://fc1.tamu.edu/home/keycomponents/ec2000.html>.

### Conference Proceedings Papers

1. Pimmel, R.L., Karr, C., and Todd, B.A., "Instructional Modules for Teaching Written, Oral, and Graphical Communication Skills to Engineering Students," *Proceedings, 2002 ASEE Southeastern Section Conference, Gainesville, FL, April, 2002*
2. Todd, B. A., Brown, M.A., Pimmel, R.L., and Richardson, J., "Short Instructional Modules for Lifelong Learning, Project Management, Teaming, and Time Management," *Proceedings, 2002 ASEE Southeastern Section Conference, Gainesville, FL, April, 2002*
3. Leland, R., Wiest, J., and Arnold, D., "Teaching Modules for the Technical Skills Component of ABET 2000," *Proceedings, 2002 ASEE Southeastern Section Conference, Gainesville, FL, April, 2002*
4. Stern, H. P. E, and Brown, M.A., "Short Instructional Modules for Teaching Ethical and Societal Issues Within an Engineering Curriculum," *Proceedings, 2002 ASEE Southeastern Section Conference, Gainesville, FL, April, 2002*
5. Pimmel, R.L., Leland, R., and Stern, H. P. E, "Student Evaluation of Instructional Modules on EC 2000 Criteria 3 (a) – (k) Skills," *Proceedings, 2002 ASEE Annual Conference, Montreal, Canada, June, 2002*
6. Pimmel, R., R. Leland, and H. Stern, "Changes in Student Confidence Resulting from Instruction with Modules on EC 2000 Skills" *Proceedings, 2002 ASEE Annual Conference, Montreal, Canada, June, 2002*
7. Todd, B. A., "Short, Instructional Module to Address Lifelong Learning Skills," *Proceedings, 2002 ASEE Annual Conference, Montreal, Canada, June, 2002*
8. Stern, H. P. E. and R.L. Pimmel, "Instructional Module for Engineering Ethics," submitted to the 2002 Frontiers In Engineering Conference

## Continuing partnerships

Changing all or most of the conversations that take place across the engineering education community cannot be accomplished by a single engineering education coalition or even by all of the engineering education coalitions acting together. Therefore, the FC has sought to form partnerships with many different allies who are interested in improving engineering education. Primarily, the partnerships take one of 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 will be held in Tempe, Arizona, in February or March 2003. 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.

### *First Miniconference on Freshman-year Innovations*

The University of Wisconsin Madison (UW) hosted the first miniconference on Freshman-year Innovations. It was held on the UW campus on 14–15 May 2001. Representatives from the University of Michigan, Purdue University, Smith College, the University of Wisconsin Madison, and the Foundation Coalition participated. Each campus shared innovations that they have implemented and solicited ideas for making further improvements. Participants were encouraged by the results of sharing information and agreed that another conference should be held. More information about the miniconference can be found at [http://fc1.tamu.edu/events/news/miniconference2001\\_uw.html](http://fc1.tamu.edu/events/news/miniconference2001_uw.html).

### *Planning for the Southeastern Engineering Schools Conference*

The associate deans for undergraduate programs from the schools in the Southeastern Conference (SEC) that offer engineering met in Atlanta on Thursday, 21 February 2002. They identified three issues that would be the common foci for the larger meeting to be held in May 2002. The three issues were diversity, foundation/first year in engineering curricula, and information technology.

### *Second Miniconference on Freshman-year Innovations*

The University of Michigan will host the second miniconference on Freshman-year Innovations on 9–10 May 2002. The focal topics will be learning communities, freshman design/introductory courses, faculty development, integration with curriculum, and integration with writing and engineering. The agenda will cover the following issues:

- ❖ Progress since the last meeting
- ❖ Evaluation of proposed changes that were implemented
- ❖ Review and discussion of common problems and successes
- ❖ Awareness of freshman initiatives in other schools and coalitions

More information about the second miniconference can be found at [http://fc1.tamu.edu/events/news/freshman\\_innovations\\_conf.html](http://fc1.tamu.edu/events/news/freshman_innovations_conf.html).

### *Undergraduate Educational Issues in SEC Engineering Schools Meeting*

The schools in the Southeastern Conference (SEC) that offer engineering will meet at Vanderbilt University in Nashville, Tennessee, on 13–14 May 2002. The conference will focus on three issues (diversity, foundation/first year, and information technology) and has 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*

On 16–17 May 2002, the University of Wisconsin will host a miniconference to bring together some of the schools that have been involved in experimenting with mechanical engineering curricula, particularly the energy stem. There are many new ideas surfacing in this area, and bringing together selected faculty from schools that have been involved in making changes would be valuable. The goal is to provide a forum for an interchange of ideas that would then foster change on the campuses. The miniconference will focus on two major issues:

- ❖ Integration of courses across the energy curriculum (including the conservation approach)
- ❖ Concept inventories for thermodynamics, fluid mechanics, heat transfer

More information about the conference can be found at [http://fc1.tamu.edu/events/news/miniconference\\_uw.html](http://fc1.tamu.edu/events/news/miniconference_uw.html).

## 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 has undertaken 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 is 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.

- ❖ Each of the institutions initiated curricular improvement by developing a pilot program and offering it to a relatively small number of students. Initiating improvement via pilot programs is a well-accepted developmental strategy for engineering artificial systems. While offering some obvious evaluation benefits, it presents challenges in an educational environment. Expanding from a pilot program to a curriculum for an entire student body presents major challenges to faculty development, facility and technology costs, and management systems. Pilots should be planned both to study the proposed improvements, as well as to support eventual adoption.
- ❖ Building support for curricular improvement within and beyond the college of engineering requires significantly more planning, effort, and time than anticipated by the change leaders. Building support requires insight into the processes of change.
- ❖ Soliciting support beyond the college of engineering requires interaction with faculty members and administrators. Such interaction is outside normal communication lines.
- ❖ New curricula that integrate content from disciplines inside and outside engineering as well as introducing new pedagogies and classroom technologies requires ongoing faculty preparation and training.
- ❖ Processing for implementing curricular change and sustaining those changes differ among institutions, and even within departments of a college. Planning for how changes will be adopted needs to be part of the early development process.

To date the project has prepared four case reports that describe the process of curricular change on partner institution campuses. Data from the four case reports have been used to prepare short case studies that can be used in workshops on curricular change across the Foundation Coalition. Two workshops based on the case studies have been offered. The first was offered at the 2001 Implementing Curricular Change in Engineering Education (ICCEE) Conference that was held at Union College in Schenectady, New York, on 19–20 October 2001. The second was offered at the Share the Future III Conference.

Five more case reports are being prepared and will be finished by 30 September 2002.

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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