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The Foundation Coalition Newsletter

....an agent of change

http://www.foundationcoalition.org

From Jeff Froyd, Project Director

As I stated in the last issue of the newsletter, one of the intriguing lessons than can be drawn from the Engineering Education Coalitions program is greater understanding into the process of curricular change. Based on the experience of the partner institutions in the Foundation Coalition (FC), some insights have been gained about curricular change processes. Over the next several issues, I plan to share insights, in the hope that future curriculum innovators will find a slightly less bumpy path. The first insight is the **inevitability of resistance**.

As Senge and others describe in their book, *The Dance of Change: The Challenges to Sustaining Momentum in Learning Organizations*, resistance is inevitable for any change at either the natural or human level. Since resistance is inevitable, its occurrence should not be regarded as a sign that the change will be unsuccessful or as a negative force pushing against the change. Instead, change agents should anticipate resistance and be prepared. As part of that preparation, change agents can select among general strategies for responding to resistance. At least four different general strategies might be mentioned.

- The first is to ignore resistance in the hope that it will dissipate. Ignoring resistance fails for several reasons, including the fact that people resent being ignored. As a result, they tend to generate more resistance.
- A second general strategy is to try to steamroll the resistance by bringing out all the arguments for the importance of the change, including assessment data that demonstrate success of the change. Steamrolling almost always generates more resistance because resisters again feel that they are not being heard.
- The third general strategy is to listen and address the resistance. Often resisters can offer ideas that will improve the final result. Even if the change cannot be altered to accommodate the issue being raised, resistance often decreases when resisters feel that they have been heard.
- The fourth general strategy is to anticipate resistance and prepare appropriate strategies. Sources of resistance can often be anticipated, and potential resisters can be either sought for counsel or invited to join the change process almost before it begins. More in-depth analysis of resistance and potential responses can be found in *Beyond the Wall of Resistance: Unconventional Strategies That Build Support for Change Beyond Resistance* by Rick Mauer (<http://www.beyondresistance.com>).

The FC asked a qualitative research to study processes of curricular changes across the FC. One result of the three-year study is a paper in the January 2004 issue of the *Journal of Engineering Education* entitled “The Evolution of Curricular Change Models within the Foundation Coalition.” Hopefully, these resources will assist your change initiatives.

Upcoming Events

29 Feb—2 Mar	Best Assessment Processes VI Symposium Rose-Hulman Institute of Technology, Terre Haute IN
Spring 2004	Energy Stem Miniconference. Contact John Mitchell.
17 May	Concept Inventories Seminar, Ohio State University. Contact Jeff Froyd.
17–19 May	Innovations in First-year Engineering Curricula Miniconference Ohio State University. Contact John Merrill.
20–23 June	ASEE 2004 Annual Conference and Exposition: Engineering Education Reaches New Heights, Salt Lake City UT

Electronics Concept Inventory

Marc Herniter **Mario Simoni** **Bruce Ferguson**
Rose-Hulman Institute of Technology

Dan Moore
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Concept inventory exams are standardized tests designed to identify mastered concepts and common misconceptions that students have in a specific body of knowledge. These have been used extensively for Newtonian mechanics, generating significant interest in physics education research. Concept inventories, accepted as valid data for the ABET accreditation process, have been developed for other subjects, too: <http://www.foundationcoalition.org/home/keycomponents/concept/index.html>.

Marc Herniter, Mario Simoni, and Bruce Ferguson (with input from Dan Moore) from Rose-Hulman Institute of Technology are developing (in conjunction with faculty members at other institutions) the electronics concept inventory (ECI). The ECI will assess student understanding of introductory electronics concepts that would typically be covered in the first course of a two-course sequence. Specific topics include semiconductor physics, diode circuits, single transistor amplifier circuits, and device modeling. In addition to the electronics concepts, a small set of questions on basic circuit analysis are included, to help remove ambiguity from the statistics of the exam's results.

A challenge in creating a concept inventory is identifying the core concepts of a subject and then common misconceptions about those concepts. Questions pertaining to each concept must not be based on definitions or rely on extensive computation to get the correct answer. Developers of the ECI have selected the core concepts and then created and revised questions. A concept is a fundamental idea used to understand electronics. Performance is the ability to actually solve problems involving electronics. Calculations, procedures, and definitions do not constitute a concept, but all are involved in problem-solving performance. Mastery of concepts is a necessary but not sufficient condition for mastery of electronics. As such, the creators differentiate between this ECI and a final examination given in a course.

To determine which concepts have been mastered, the ECI developers measure students' performances on questions centered only on basic understanding of concepts. The questions do not require a calculator, and each can be answered in a couple of minutes. When dealing with diodes, a fundamental concept is the notion of the operation of a device in forward bias. They evaluate the understanding of the forward bias concept on the ECI by presenting, for example, a rectifier circuit and asking a question having four possible choices for an answer. One response is correct. The others represent incorrect conclusions arrived at because of common misconceptions, such as confusing forward and reverse bias or incorrectly determining what portion of the voltage waveform produced forward bias. By evaluating wrong answers, not only are the concepts on which students are weak revealed, but students' misconceptions are identified. Gross trends in mastered concepts and common misconceptions indicate learning successes and shortcomings.

Hopefully, the ECI will be developed until it becomes accepted as a standard across the country since (1) one purpose of a concept inventory is to collect and combine data from as large a sample as possible, which can only happen if the exam is standardized, and (2) the ECI data provide better data for ABET accreditation if the ECI is accepted as a national standard. To promote national recognition, a number of electrical and computer engineering faculty members from various universities were invited to participate in construction and evaluation of the ECI. External faculty members critique the present exam and comment on the questions' validity. The wording of questions is analyzed; any ambiguities are addressed. Confusion in terminology is identified and removed from the problem. In addition, each external faculty member generates one new question and suggests one question that should be removed from the exam.

Several revisions to the 31-question exam have been made and information from external feedback has been incorporated. The ECI has been used in beta testing on (i) two student focus groups, with which Don Evans from Arizona State University was involved, (ii) several sections of the basic electronics course at Rose-Hulman, and (iii) three sections of electronics courses from other universities. The exam is being modified, based on the discussion from the focus groups and the resulting statistics from the beta testing. This summer the ECI will be finally revised and released to the public in the fall of 2004. For detailed information on the ECI, contact Mario Simoni or go to <http://www.foundationcoalition.org/home/keycomponents/concept/electronics.html>.