

# **Tools for Assessing Conceptual Understanding in the Engineering Sciences**

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## TOOLS FOR ASSESSING CONCEPTUAL UNDERSTANDING IN THE ENGINEERING SCIENCES

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**Abstract**  $\frac{3}{4}$  One of the hindrances to reform in science, technology, engineering and mathematics (STEM) education is the absence of good assessment instruments that can measure the value added to student learning by new ways of teaching important material. The well-known Force Concept Inventory (FCI) assessment instrument is a good model of an instrument that can be used to check on student's understanding of basic concepts in a discipline. This panel will discuss work in progress by the panel members and their co-developers to construct FCI-like Concept Inventories in each of the disciplines of thermodynamics, systems and signals, strength of materials, electromagnetics, circuits, materials, fluid mechanics, and transport processes.

**Index Terms**  $\frac{3}{4}$  assessment, continuous improvement, concepts, engineering sciences, evaluation

### PANEL SUMMARY

One of the hindrances to reform in science, technology, engineering and mathematics (STEM) education is the absence of good assessment instruments that can measure the value added to student learning by new ways of teaching important material. As pointed out by several studies, including the three video case studies, *Lessons from Thin Air*, *Private Universe*, and, particularly, *Can We Believe Our Eyes?*[1], students subjected to traditional instruction and assessment often do not adequately resolve the misconceptions that they either bring to a subject or gain while studying a subject. These misconceptions, sometimes referred to as alternative views or student views of basic concepts because they make sense to the student, block the establishment of connections between basic concepts, connections which are necessary for understanding the macroconceptions developed in further work.

The mechanics part of physics education is probably farther along the reform path than other disciplines due to

the existence of an assessment instrument that tests basic concepts. The well-known Force Concept Inventory (FCI)[2] assessment instrument of Hestenes, et al. has been in use for over 15 years and is now credited with stimulating reform of physics education. Such assessment inventories can play an important part in relating teaching techniques to student learning. The design of these instruments relies on the designer(s) knowing the misconceptions commonly held by students in a discipline. The instruments use these misconceptions as distractors to see if a student can pick out a correct concept from among the common misconceptions.

This panel session will briefly review the FCI and discuss the engineering science Concept Inventories that are currently being developed and tested for common engineering subjects. Some of the instruments to be discussed will be available for wide distribution while some will still be in the design stages. Somewhat mature instruments are available in thermodynamics; signals and systems; strength of materials; and electromagnetics. Instruments are just being prepared in circuits, materials, fluid mechanics and transport processes.

Panelists in this session will discuss the challenges that they have had in developing their instruments and give an array of misconceptions they have found. The status and availability of their instruments will also be covered. Audience participation will be involved.

### ACKNOWLEDGMENT

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### REFERENCES

- [1] All available from the Annenberg/CPB Math and Science Collection, P.O.Box 2345, South Burlington, VT 05407-2345.
- [2] Hestenes, D., Wells, M. and Swackhamer, G., "Force Concept Inventory," *The Physics Teacher* 30, 141 (1992)

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