Special Skills Workshops # 2: *Engineering Research and Education*

Speaker: Dr. Richard A. Miller, Professor, School of Advanced Structures, College of Engineering and Applied Science, University of Cincinnati
Date: June 23, 2011
Time: 10:00 – 11:30 AM
Venue: University of Cincinnati, 615A Old Chemistry

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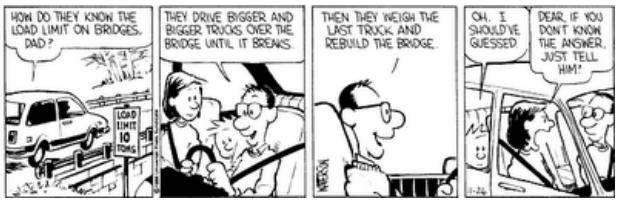
This workshop was presented by Dr. Richard Miller, Professor of Civil Engineering in the School of Advanced Structures of the University of Cincinnati. Dr. Miller earned his Ph.D. in Civil Engineering from Northwestern University in 1989, and has been a professor at the University of Cincinnati since his graduation. Dr. Miller holds the following positions and awards: Faculty Chair, CEAS Master Educator (2010), Prestressed/Precast Concrete Institute Student Education Committee Chair, and Prestressed/Precast Concrete Institute Research and Development Committee Chair. Dr. Miller's research interests include prestressed concrete structures, concrete bridges, concrete materials, large scale structural testing and structural monitoring.

Dr. Miller Speaking (left) and Engineering Research & Education Seminar in Session (right)

Dr. Miller's presentation was geared more toward enlightening teachers as to how to teach Engineering. The participants were the 12 RET teachers, who come from various backgrounds and teaching positions around the tri-state area, each bringing their own knowledge, experience, and teaching expertise to the table. Dr. Miller used many various and sundry examples to illustrate teaching design process to students and answering the timeless question "Why are we doing this?" Dr. Miller began by discussing his own research interests, particularly relating to his work with testing bridges to determine their limits before they are rebuilt. Dr. Miller mentioned the Calvin and Hobbes cartoon, posted below by courtesy of www.aplaceofsense.com, which pokes fun at the exact procedure used by structural engineers to test the load limits of bridges.



The scope of Dr. Miller's seminar was not limited to a small span of information. He discussed how he encourages out-of-the-box thinking with Freshman Engineering students in his courses at UC by introducing an experiment conducted to determine the speed at which a golf ball must enter the hole on the green in order to not bounce out. The technical information associated with this experiment can be found on the website www.leaderboard.com. Without providing any information about the methods used or results obtained by the Engineering students, the RET participants were charged with the task of designing the same experiment to determine mathematical results.

Dr. Miller truly adhered to the inquiry based learning technique of letting seminar participants work through the information presented and arrive at their own conclusions about the best method by which to conduct this experiment. As the brainstorming process transpired, he encouraged participants to consider all the information presented and the purpose of the experiment without actually providing much specific information on the best way to accomplish the hypothetical task. Over the course of this workshop, a number of interesting experimental designs were created, modified, and discarded. Laser sensors, photo gates, individuals with stopwatches and meter sticks were all suggested as possible tools to accomplish the task at hand to solve the problem. We discussed what some of the outside factors of conducting the experiment would be, including: height of the grass, slope of the green, quality of the hole, friction, uphill versus downhill puts, and the variation in human reaction time which has been measured to be as much as 1/10 of a second.

As RET participants were wrestling with the problem at hand, some important questions came to light. How much accuracy is necessary in this experiment? Why is this experiment important? Why are we doing this? Dr. Miller revealed that this was one of the goals of this assignment; to illustrate that work should always be done for the purpose of getting something useful out of it. As we were discussing the topic of design process, Dr. Miller cited specific examples for how the design process must work, keeping in mind that there is always a definition or purpose to the action.

Dr. Miller discussed that as people are conducting experiments or designing technology, there are 3 schools of thought. Liars are those who know the truth but choose not to tell it. There are also those who seek only to serve their own agenda – the truth and lies are irrelevant to them (BSers). Finally there are design thinkers, who adhere to the idea that necessity is the mother of invention, most especially when you make a mistake. Dr. Miller showed a clip from the iconic TV show Green acres (Feb 9, 1966), where the main characters find themselves involved in a caper where a head gasket is needed for their vehicle, and through an unusual way of making pancakes, it is discovered that an oddly shaped pancake can be used as a head gasket in a pinch.

Design thinkers are always questioning. They wonder what will happen if something is done this way, or that way, and how can it help to accomplish the goal. Design thinkers also consider why it can be done differently, as opposed to only how it can be done differently. These individuals even can suspend the truth momentarily to ask why. Dr. Miller spoke of Albert Einstein often when discussing examples of design thinkers, saying that good researchers always possess the ability to suspend belief in the truth. Dr. Miller discussed the way in which engineers think, and how to recognize and encourage this thought process in future engineering students as they pass through middle or high school classrooms. The best advice he could offer was to help and encourage students to answer the question "Why?" in order to foster both their critical and creative thinking. He also cited specific examples of ways to tie the field of Engineering to other skills or interests that students may have, such as pattern recognition, variation, and desire to help humanity.

In conclusion, what was learned over the course of this lecture was not limited to a specific topic or content area. Dr. Miller included a wide array of information and examples that each individual could interpret in their own way to take back to their classrooms. Probably the most important overarching

theme for this group of middle and high school teachers was to always be willing to ask the difficult questions, and to design lessons that do have a purpose and end goal. Dr. Miller also gave us the tools to recognize and encourage those students who may succeed in a career in Engineering at some time in the future.