TECHNICAL CREATIVITY AND THE FUTURE OF ENGINEERING EDUCATION

With the complexity surrounding every engineering project mounting as natural resources dwindle, the world population increases, and the global infrastructure and economy grow ever more intertwined, the creativity and innovation necessary to address the big issues facing civilization - maintaining the infrastructure; providing food, water, shelter, and power to the population; and growing sustainably and safely - will only increase in importance.

The Opportunity for Creativity: Making the Strange Familiar

Creativity helps you see the world in a new way. Creativity helps you consider multiple angles instead of just one, and it helps create bridges between different fields of knowledge and between innovation and the tried-and-true. Quite literally, creativity can make the strange familiar and the familiar strange.

Choosing to embrace creativity is never a zero-sum commitment that will make technical concerns secondary. Rather, creativity can be a powerful tool to enhance technical efforts to solve engineering problems of all kinds. As one professor has stated: "*As educators, we are responsible for stimulating creative thinking among our students . . . Our ultimate goal is to require original creative work as part of every engineering course*" (Richards 1998). Taking a creative look at engineering education does not mean ignoring or choosing to disregard the normal project parameters or technical constraints that must be imparted to the next generation of professionals. Instead, using creativity can mean generating excitement in students as they approach engineering problems in original ways (Raskin 2003).

Classroom Strategies for Creativity

There are many ways to design classroom assignments or teamwork activities to develop creativity. Torrance (1977) recommends several guidelines to promote creativity:

Before a Lesson:

1. Confrontation with ambiguities and uncertainties.
2. Heightened anticipation and expectation.
3. Familiar made strange and strange made familiar.
4. Looking at something from several different psychological, sociological, physical, or emotional points of view.
5. Provocative questions to establish set for examining information in new ways.
6. Predictions from limited information required.
7. Tasks structured only enough to give clues and direction.
8. Encouragement to take next step beyond what is known.

After a Lesson:

1. Ambiguities and uncertainties played with.
2. Constructive responses encouraged.
3. Going beyond the obvious encouraged.
4. Elaborating some element through drawings, dramatics, imaginative stories, etc.
5. Search for elegant (better) solutions.
6. Experimentation and testing of ideas encouraged.
7. Future projection encouraged.
8. Improbabilities encouraged.
9. Multiple hypotheses encouraged.
10. Reorganization or reconceptualization of the information that is required.

In addition, Torrance encourages instructors to develop constructive—as opposed to critical—attitudes in themselves and in their classrooms. In a series of experiments "*students who assumed a constructive rather than a critical attitude toward available information were able to produce a larger number of creative solutions as well as more original ones*" (Torrance 1977).

Torrance's guidelines, as well as the process guidelines presented earlier in the paper, should drive the planning of any (every?) classroom assignment, with the goal of imparting creative mindsets to students. Engineering students must learn to approach problems with an open mind, unconstrained—though certainly influenced—by textbook solutions. They must learn to see the familiar as strange and the strange as familiar on a regular basis, and not rush to spit back a single "*correct*" solution.

If the next generation of engineers is going to tackle the challenges that will inevitably face them on the job and in the field, they must learn to accept multiplicity (looking at something from several different points of view, improbabilities encouraged, multiple hypotheses encouraged, etc.) as they address engineering problems in their courses and, eventually, in their practice.

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