Engineering and Technology in Tomorrow's Science Classroom

By the end of 2012, states will be considering a final draft of *Next Generation Science Standards* (NGSS) in an effort to develop common core educational standards to complement those in English language arts and mathematics that have already been adopted by 46 states. Although the public release of the NGSS is not due for a few months, a preview can be seen in *A Framework for K–12 Science Education: Practices, Core Ideas, and Crosscutting Concepts,* published by the National Research Council in July 2011. The *Framework* is intended to serve as the blueprint for the *Next Generation Science Standards*. I have had the good fortune to serve as a consultant on *Framework* with the charge of assisting the study committee in deciding how best to include engineering and technology as an integral part of science. The results of that effort appear in Chapter 3 and Chapter 8.I am also a member of the writing committee working on the *Next Generation Science Standards*, and although I can't discuss details yet, I can say that we are following the *Framework* very closely.

In brief, Chapter 3 of the *Framework* describes the practices of science and engineering that students are expected to develop during 13 years of schooling, and emphasizes the similarities between science and engineering. Chapter 8 of the *Framework* presents core ideas in technology and engineering at the same level as core ideas in the traditional science fields, such as Newton's laws of motion and the theory of biological evolution. Although prior standards documents included references to engineering and technology, they tended to be separate from the "core content" of science, so they were often overlooked.

An important contribution of the *Framework* is to provide a clear definition of technology and engineering as they relate to science:

> *In the K–12 context, "**science**" is generally taken to mean the traditional natural sciences: physics, chemistry, biology, and (more recently) earth, space, and environmental sciences. . . . We use the term "**engineering**" in a very broad sense to mean any engagement in a systematic practice of design to achieve solutions to particular human problems. Likewise, we broadly use the term "***technology***" to include all types of human-made systems and processes—not in the limited sense often used in schools that equates technology with modern computational and communications devices. Technologies result when engineers apply their understanding of the natural world and of human behavior to design ways to satisfy human needs and wants.* (NRC 2011, pages 1–3,4)

Notice that engineering is *not* defined as applied science. Although the practices of engineering have much in common with the practices of science, engineering is a distinct field and has certain core ideas that are different from those of science.

Chapter 3 of the *Framework* describes the practices of science and engineering, pointing out where they are similar and where they are different. Unlike previous standards documents, which focused on scientific inquiry, the new document gives equal attention and status to engineering design as both a means for teaching science and a set of abilities that all students should master.

Chapter 8 of the *Framework* describes three core ideas that all students should learn. As core ideas, these have the same status as core ideas in the traditional science disciplines of physical science, life science, and earth and space science. Each idea is developed in some detail, and recommendations are given about what students should learn about these ideas in successive grade bands. The core ideas are as follows:

> ***Core Idea 1: Engineering design.*** *From a teaching and learning point of view, it is the iterative cycle of design that offers the greatest potential for applying science knowledge in the classroom and engaging in engineering practices. The components of this core idea include understanding how engineering problems are defined and delimited, how models can be used to develop and refine possible solutions to a design problem, and what methods can be employed to optimize a*

design.(NRC 2011, page 8-1)

Core Idea 2A: Interdependence of science, engineering, and technology. *The fields of science and engineering are mutually supportive. New technologies expand the reach of science, allowing the study of realms previously inaccessible to investigation; scientists depend on the work of engineers to produce the instruments and computational tools they need to conduct research. Engineers in turn depend on the work of scientists to understand how different technologies work so they can be improved; scientific discoveries are exploited to create new technologies in the first place. Scientists and engineers often work together in teams, especially in new fields, such as nanotechnology or synthetic biology that blur the lines between science and engineering.* (NRC 2011, page 8-7)

Core Idea 2B: Science, engineering, and society. *Society has changed dramatically, and human populations and longevity have increased, as advances in science and engineering have influenced the ways in which people interact with one another and with their surrounding natural environment. Not only do science and engineering affect society; society's decisions (whether made through market forces or political processes) influence the work of scientists and engineers.* (NRC 2011, page 8-8)

For Discussion

Giving equal status to engineering and technology raises a number of important issues for curriculum developers and teachers, a few of which we can discuss during our breakout session. For example:

- Why is there increased emphasis on engineering and technology?
- Is it redundant to have engineering practices *and* core ideas?
- Do we need to have special courses to teach these core ideas?
- What will it look like in the classroom?

References

Achieve, Inc. (in press). *Next generation science standards*, a project of the National Governors Association, and Council of Chief State School Officers, managed by Achieve, Inc. http://www.nextgenscience.org/

National Research Council (2011). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Committee on New Science Education Standards, Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: National Academy Press.http://www.nap.edu/catalog.php?record_id=13165