International Technology and Engineering
Educators Association
1914 Association Drive
Suite 201
Reston, VA 20191-1539
Phone (703) 860-2100
Fax (703) 860-0353

KNS 10-12

July 30, 2010

Dr. Thomas E. Keller
Senior Program Officer
National Academy of Sciences
Board on Science Education
Keck Building 1150
500 Fifth Street, NW
Washington, D.C. 20001

Dear Board on Science Education Members:

Thank you for allowing the International Technology and Engineering Educators Association to review your preliminary public draft of *A Framework for Science Education.* It is always beneficial for professions to reevaluate how they are educating the youth of our country. We chose to respond by letter to your preliminary draft, since the evaluation form does not allow for adequate expression of our opinions of your work.

There has been considerable discussion among our constituencies to this proposed body of work. Most question the ability of science education to deliver the study of technology and engineering in classrooms throughout the nation. If science education was excelling at meeting the nation's need for a public that is literate in science, as well as meeting the growing demand for individuals qualified to work in the numerous fields of science, our considerations might be different.

The discipline of technology is placed under the discipline of science in this framework. It is not often that we find such de-emphasis of one discipline within another in our schools, such as has been done in this work. At the same time, engineering is just one of numerous occupations encompassed within the discipline of technology. This framework only looks through the lens of the engineer. Rarely used were words such as technician or architect. We also found that technology and engineering (in the same order as they appear in the STEM acronym) were used interchangeably, leading to the impression that they are one and the same. They are not. We were expecting an explanation of the differences between technology and engineering as well as the difference between science, technology, and engineering. We were extremely disappointed to discover this confusion in the use of the terms.

Technology and engineering are problem solving and "making" subjects in our schools. They are comprised of practices, which are best described as "doing." The framework addresses technology and engineering as design. It does a less than satisfactory job with "doing and making," which, as practices, may even be more essential than designing (producing, manufacturing, constructing). The framework is heavy on products, but does not go into how products are made. At the same time, there is use of terms such as "natural and designed" world, but the designed world is only referenced as meaning "designing," though it is much more.

We noticed a heavy use of the *Standards for Technological Literacy* content in this framework with little reference given. Rather, we found the use of this content under a different name. As noted above, only part of technology

content is covered in this framework. For example, iterations of "Where do the ideas come from and go to?" are not easily found in this framework.

The current framework is void of the laboratory nature of science. This leads us to the assumption that science laboratory work is not valuable. The examples of engineering (technology) are from an STS science and technology studies approach to the topic, covering only rudimentary knowledge without the depth needed to understand and apply the principles and concepts of this vast area of study. We hope that the laboratory nature of technology and engineering are not taken lightly in this framework. If the science community does bring technology and engineering into its curriculum, will students be prepared to use this knowledge to function as citizens of the 21st century, with interested students better prepared to seek further education to enter these professions?

Additionally, Sidawi (2009) examined the literature on studies of science teachers using technology to teach science. The logic of most of these attempts was that a technological problem, solved by using the design process would provide a meaningful context to apply and thus understand science concepts. Despite the apparent logic of the idea, Sidawi found the approaches were not successful because:

> *(1) teachers did not have a grasp of the complex relationship between science and technology and assumed that technology was simply applied science, (2) the students were not able to transfer their learning of science to designing technology, (3) teachers did not have a deep understanding of the design process and tried to teach it as a linear, context-free process without regard to the context of the problem. (Sidawi, 2009)*

Engineers "design and do" within constraints. Your proposed framework talks about technology and engineering, but does not provide avenues for students to work with any depth of content or process. This "doing" causes technologists and engineers to solve problems and extend products for consumer needs and wants, thus improving the economy. The approach used in this framework is devoid of the excitement of this hands-on or doing, thus removing it from the curriculum. Just as science is important to do, so is technology and engineering as a process discipline.

We have noticed that engineers were absent from the writing team. That might explain the rather less-than-complete picture of technology and engineering that was evident in the framework.

The technology and engineering curriculum model is very complex. Therefore, our review team did not feel that many state departments of education or school system curriculum personnel would understand how to integrate core disciplinary ideas and cross-cutting elements of the curriculum. We also felt that it would be very difficult to integrate this framework of science and engineering practices into instructional delivery systems where students would benefit from these connections.

We know that medicine and health care are growing fields of knowledge and study. Science is a foundation for work in these areas, but the writers state that this area is not included in the framework. Why is the science community avoiding this integration into the framework, but including technology and engineering? In real-world practices, science is much closer to medicine than technology. We are reminded of what was learned about the connections between science and technology from Project Hindsight, which reviewed 20 large military projects and found that only two used science as their basis.

Another concern is qualifying teachers to teach technology and engineering. State departments of education have special guidelines pertaining to each. Just as the science community does not want unlicensed people to teach science, the technology and engineering community does not want teachers teaching their school subject without the proper credentials and qualifications. Other professions have seen lower student test scores from unlicensed teachers. States require 30-42 content hours to qualify as a teacher with credentials to teach technology and engineering. A study by Skophammer (2009) revealed that college preparation programs in the U.S. for science teachers (K-12) were almost devoid of course requirements in technological literacy, let alone engineering.

Another point of caution for the science profession moving into engineering is the lack of research on the core standards needed to be mastered to become literate in engineering. The mostly closely aligned standards are *Standards for Technological Literacy* (ITEA [ITEEA], 2000/2002/2007). This profession is currently in the early stages of further refining its standards, so that validated core standards will be available to properly reflect taxonomy for technology and engineering literacy.

The framework goes into great detail in its description of science. However, engineering has not been studied sufficiently for it to become a dimension of science in the public schools. The view of technology and engineering is shallow throughout the framework. We would welcome further conversations, as this letter is inadequate for the amount of detail that needs to be included in such a discussion.

Professionally, we feel strongly that the field of engineering has not been properly analyzed to determine how it should be taught in K-12 education. It is important for these areas of knowledge to be in the curriculum to improve citizenry and the nation as a whole, but the research has not been undertaken to validate what and how we should approach this content for K-12 learning. Yes, it is needed knowledge just as science, mathematics, and language are needed in our schools. However, without the research or the expertise to properly structure it within the science curriculum, we believe that this move may result in an example of where the profession went wrong, such as is associated with the ill-fated implementation of "new math."

The International Technology and Engineering Educators Association offers its assistance to have further discussions on this topic. We feel strongly that the technology discipline and the field of engineering are too important to address in K-12 education without the proper insight and programs of higher education and professional development for the success of this endeavor in our nation's schools.

For the Technology and Engineering Educators Profession, respectfully,

Kendall N. Starkweather
Executive Director/CEO
International Technology and Engineering
Educators Association