**CORE AND COMPONENT IDEAS IN ENGINEERING, TECHNOLOGY,** **AND APPLICATIONS OF SCIENCE**

**Core Idea ETS1: Engineering Design**

ETS1.A: Defining and Delimiting an Engineering Problem

ETS1.B: Developing Possible Solutions

ETS1.C: Optimizing the Design Solution

**Core Idea ETS2: Links Among Engineering, Technology, Science, and Society**

**ETS2.A: Interdependence of Science, Engineering, and Technology**

**ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World**

**Core Idea ETS2** **Links Among Engineering, Technology, Science, and Society**

*How are engineering, technology, science, and society interconnected?*

New insights from science often catalyze the emergence of new technologies

and their applications, which are developed using engineering design. In turn,

new technologies open opportunities for new scientific investigations. Together,

advances in science, engineering, and technology can have—and indeed have

had—profound effects on human society, in such areas as agriculture, transportation,

health care, and communication, and on the natural environment. Each

system can change significantly when new technologies are introduced, with both

desired effects and unexpected outcomes.

**ETS2.A: INTERDEPENDENCE OF SCIENCE, ENGINEERING, AND TECHNOLOGY**

*What are the relationships among science, engineering, and technology?*

The fields of science and engineering are mutually supportive, and scientists and engineers often work together in teams, especially in fields at the borders of science and

engineering. Advances in science offer new capabilities, new materials, or new understanding

of processes that can be applied through engineering to produce advances in

technology. Advances in technology, in turn, provide scientists with new capabilities

to probe the natural world at larger or smaller scales; to record, manage, and analyze

data; and to model ever more complex systems with greater precision. In addition,

engineers’ efforts to develop or improve technologies often raise new questions for

scientists’ investigation.

*Grade Band Endpoints for ETS2.A*

***By the end of grade 2*.** People encounter questions about the natural world every

day. There are many types of tools produced by engineering that can be used

in science to help answer these questions through observation or measurement.

Observations and measurements are also used in engineering to help test and

refine design ideas.

***By the end of grade 5.*** Tools and instruments (e.g., rulers, balances, thermometers,

graduated cylinders, telescopes, microscopes) are used in scientific exploration

to gather data and help answer questions about the natural world. Engineering

design can develop and improve such technologies. Scientific discoveries about the

natural world can often lead to new and improved technologies, which are developed

through the engineering design process. Knowledge of relevant scientific concepts

and research findings is important in engineering.

***By the end of grade 8.*** Engineering advances have led to important discoveries in

virtually every field of science, and scientific discoveries have led to the development

of entire industries and engineered systems. In order to design better technologies,

new science may need to be explored (e.g., materials research prompted

by desire for better batteries or solar cells, biological questions raised by medical

problems). Technologies in turn extend the measurement, exploration, modeling,

and computational capacity of scientific investigations.

***By the end of grade 12*.** Science and engineering complement each other in the

cycle known as research and development (R&D). Many R&D projects may

involve scientists, engineers, and others with wide ranges of expertise. For example,

developing a means for safely and securely disposing of nuclear waste will

require the participation of engineers with specialties in nuclear engineering, transportation,

construction, and safety; it is likely to require as well the contributions

of scientists and other professionals from such diverse fields as physics, geology,

economics, psychology, and sociology.

**ETS2.B: INFLUENCE OF ENGINEERING, TECHNOLOGY, AND SCIENCE ON**

**SOCIETY AND THE NATURAL WORLD**

*How do science, engineering, and the technologies that result from them affect the*

*ways in which people live? How do they affect the natural world?*

From the earliest forms of agriculture to the latest technologies, all human

activity has drawn on natural resources and has had both short- and long-term

consequences, positive as well as negative, for the health of both people and the

natural environment. These consequences have grown stronger in recent human

history. 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.

Science and engineering affect diverse domains—agriculture, medicine, housing,

transportation, energy production, water availability, and land use, among

others. The results often entail deep impacts on society and the environment,

including some that may not have been anticipated when they were introduced or

that may build up over time to levels that require attention. Decisions about the

use of any new technology thus involve a balancing of costs, benefits, and risks—

aided, at times, by science and engineering. Mathematical modeling, for example,

can help provide insight into the consequences of actions beyond the scale of

place, time, or system complexity that individual human judgments can readily

encompass, thereby informing both personal and societal decision making.

Not only do science and engineering affect society, but society’s decisions

(whether made through market forces or political processes) influence the work of

scientists and engineers. These decisions sometimes establish goals and priorities

for improving or replacing technologies; at other times they set limits, such as in

regulating the extraction of raw materials or in setting allowable levels of pollution

from mining, farming, and industry.

*Grade Band Endpoints for ETS2.B*

***By the end of grade 2*.** People depend on various technologies in their lives;

human life would be very different without technology. Every human-made product

is designed by applying some knowledge of the natural world and is built by

using materials derived from the natural world, even when the materials are not

themselves natural—for example, spoons made from refined metals. Thus, developing

and using technology has impacts on the natural world.

***By the end of grade 5.*** Over time, people’s needs and wants change, as do their demands for new and improved technologies. Engineers improve existing technologies or develop new ones to increase their benefits (e.g., better artificial limbs), to decrease known risks (e.g., seatbelts in cars), and to meet societal demands (e.g., cell phones). When new technologies become available, they can bring about changes in the way people live and interact with one another.

***By the end of grade 8*.** All human activity draws on natural resources and has

both short- and long-term consequences, positive as well as negative, for the

health of both people and the natural environment. The uses of technologies and

any limitations on their use are driven by individual or societal needs, desires, and

values; by the findings of scientific research; and by differences in such factors as

climate, natural resources, and economic conditions. Thus technology use varies

from region to region and over time. Technologies that are beneficial for a certain

purpose may later be seen to have impacts (e.g., health-related, environmental)

that were not foreseen. In such cases, new regulations on use or new technologies

***By the end of grade 12*.** Modern civilization depends on major technological systems,

including those related to agriculture, health, water, energy, transportation,

manufacturing, construction, and communications. Engineers continuously modify

these technological systems by applying scientific knowledge and engineering

design practices to increase benefits while decreasing costs and risks. Widespread

adoption of technological innovations often depends on market forces or other

societal demands, but it may also be subject to evaluation by scientists and engineers

and to eventual government regulation. New technologies can have deep

impacts on society and the environment, including some that were not anticipated

or that may build up over time to a level that requires attention or mitigation.

Analysis of costs, environmental impacts, and risks, as well as of expected benefits,

is a critical aspect of decisions about technology use.