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Science, Engineering, and Technology

In exploring the relations among science, engineering, and technology, we are hampered by a vocabulary developed in a less technical age. Terms such as genetic engineering, social engineering, biotechnology, and management technology indicate the magnitude of change in recent years. The manner in which the terms science, engineering, and technology are used influences the course of analysis and the results of the analysis. To think of each as a process is consistent with current activities, and I am strongly attracted to the analyses that flow from this approach. Science is the process of investigation of physical, biological, behavioral, social, economic, and political phenomena. Process is used in a collective sense, encompassing everything the investigator does from the selection of the phenomena to be investigated to the assessment of the validity of the results, and includes the selection of methodology, the selection of instrumentation, the delineation of protocol, the execution of protocol, the reduction of data, the development of constructs, and the assessment of the certainty associated with the results. The details depend upon the relative roles of observation, experimentation, and theoretical modeling. The legacy of investigations of phenomena, the legacy of science, is scientific knowledge consisting of a database, an array of methodologies, and an array of concepts.

Engineering is the process of investigation of how to solve problems. Here again process is used in the collective sense to include everything the investigator does from the acceptance of the problem to the proof of the validity of the solution. The legacy of the investigations, the legacy of engineering, is engineering knowledge consisting of a database, an array of methodologies, and an array of concepts.

Technology is the process of production and the delivery of goods and services, and technological innovation is the process of investigating how to produce and deliver more effectively goods or services, modify significantly their characteristics, or create and deliver new goods or services. Again, process is a collective term and includes everything from the identification of concept to the successful delivery of a product. The legacy, technological knowledge, consists of a database, an array of methodologies, and an array of concepts.

The sum of scientific, engineering, and technological knowledge is a continuously expanding resource of unprecedented richness and value. Without a term for this body of knowledge, it is frequently referred to as scientific knowledge. This has enhanced the arrogance of scientists, demeaned the contributions of engineers and institutions of technology, and confused issues related to national security and international competition.

A conventional wisdom of scientists is that science drives engineering and technology. A strong case can be made that both engineering and technology drive science. (Artifacts of past civilizations attest to the long practice of engineering. Observations made in breweries initiated investigations of both chemical and biological phenomena.) A less prejudicial view is that the three—science, engineering, and technology—are synergistic.

Science and engineering are generic terms—umbrella terms—each encompassing a multiplicity of disciplines. At the same time that scientific disciplines and engineering disciplines are proliferating, the two umbrellas, science and engineering, are moving closer together and may overlap, with scientists increasingly involved in problem-solving and engineers increasingly involved in the investigation of phenomena.

Many endeavors of society such as medicine and education are in part science, in part engineering, and in part technology.—ANNA J. HARRISON, *Mount Holyoke College, South Hadley, Massachusetts 01075.*