Peer Review and Scientific Assessment

A Handbook for Funding Organizations, Regulatory Agencies, and Editors

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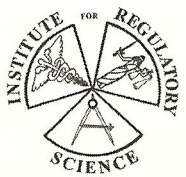

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scientific information; its classification based on the level of maturity and reproducibility; and information outside the purview of science.

3. Reconciliation of information described as sound science, best available data, best available information, or best available science with BAS/MESC.

Scientific Method

The objective of this part is to briefly describe the evolution of science to indicate its distinction from the BAS concept described in the next section rather than a comprehensive review of evolution of science from antiquity to today. The process started by reviewing the evolution of science, also known as "scientific method". We recognized that any fundamental and generic discussion about science should start with the definition of science. The English word "science" is derived from the Latin word *scienta* meaning knowledge. The equivalent word in French: *science*; German *Wissenschaft*; Spanish *ciencias*; Italian *Sienza* have the same meaning as in English. A definition reflecting the views of a purist is provided by Einstein (1938), who stated that science consists of an "endeavor to bring together by means of systematic thought the perceptible phenomena of this world into as thorough-going an association as possible. To put it boldly, it is the attempt of the posterior reconstruction of existence by the process of conceptualization."

There is an exceptionally large volume of literature describing the history of science; the evolution of science from antiquity to today; the classification of scientific disciplines into "hard" versus "soft" sciences; and the distinction between science and engineering. Sarton (1948) provided a useful and comprehensive review of the history of science. Blake et al. (1960) described the scientific method during the very active period of the 17th to 19th centuries. Carpaldi (1966) addressed various theories and provided comments on their status in view of 20th century science.

From the beginning of human history, evolution of science starts with what Popper (1979) calls deductive method. From a review of the extensive literature on the development of science, one can identify a four-step process for validation of scientific endeavors.

- *Step I:* This step consists of an observation; an experience; *Gedankenexperiment* (literally, "thought experiment" meaning intellectual rather than physical experiment); thought; curiosity; intuition; or other processes that typically impact an individual. The observation is not limited to visual but may also include other senses such as smell, sound, taste, or the impact of acceleration or inertia. For the sake of simplicity, we will refer to this step as "intellectual struggle," which constitutes the first step in scientific endeavor.
- *Step II:* The second step in evolution of science is a hypothesis, a rationalized and formalized expression of the intellectual struggle. For obvious reasons there have been a large number of hypotheses that were proven to be wrong. Conversely, there have been many hypotheses that were proven to be right and have led to the third step in the scientific evolution.
- *Step III:* The third step in the scientific process consists of the formulation of a "theory." A theory includes proven scientific principles; various degrees of assumption; and other reasoning that attempts to explain a wide range of circumstances. In the classical system, the applicability of a theory to the asserted range of science requires proof. Some of the literature on classical science stops at this level and suggests that the objective of scientific investigation is to formulate a theory.
- *Step IV:* The ultimate objective of scientific investigation is the conversion of a theory into a "scientific law" sometimes called scientific principle. Whereas theories include assumptions and unproven parts, scientific laws or principles have neither.

Although the scope of a law may be limited, it must be able to predict all events that are within its applicability. The process described here is referred to sometimes as the hypothesis-theory-law (HTL) process. We will use HTL process henceforth when referring to the traditional scientific process.