InFocus

The Engineering Method

By Jon A. Schmidt, P.E., SECB

Most people with a basic education are familiar with, or at least have heard of, the scientific method. All people with an engineering education had to become proficient at it to some extent in order to meet the minimum requirements for their degrees, since the standard curriculum includes several semesters of chemistry and physics, typically with a laboratory component. Although there is no single accepted definition of the scientific method, most would agree that its basic components are observation, hypothesis, experimentation, and conclusion.

If, on the other hand, you ask the average person on the street, or even the average engineer, to explain what the engineering method is, you will almost certainly be greeted with a blank stare. No dictionary has such an entry, and very few engineering educators have even given much thought to exactly how their students will or should go about applying what they have learned, not only while they are still in the classroom, but also once they have entered the "real world" of professional practice.

Billy Vaughn Koen, a professor of mechanical engineering at the University of Texas at Austin, is one exception to this general rule. For some 40 years now, Dr. Koen has contemplated, researched, and written about the kind of reasoning that is employed by engineers on a daily basis. His most thorough presentation of his findings is the book, *Discussion of the Method: Conducting the Engineer's Approach to Problem Solving* (New York: Oxford University Press, 2003), which begins with the following preliminary definition:

> "I mean by the *engineering method* the strategy for causing the best change in a poorly understood situation within the available resources."

The concepts expressed here will ring true to all engineers, even if they have never considered stating them as the elements of the specific approach that they use to do their jobs. All engineering is about modifying the environment in a way that is considered desirable — paving a road, erecting a frame, cooling a space, powering a light - in a context of uncertainty — soil properties, residual stresses, temperature variations, electrical surges — without exceeding fixed time and money budgets for design and construction.

Dr. Koen goes on to explore the key words *change*, *resources*, *best*, and especially *uncertainty*, focusing on the difficulties inherent in them and how they drive engineers inexorably to the specific *strategy* that is characteristic of them: the use of heuristics. As Dr. Koen states:

> "A *heuristic* is anything that provides a plausible aid or direction in the solution of a problem but is in the final analysis unjustified, incapable of justification, and potentially fallible."

Classic examples of engineering heuristics include rules of thumb and factors of safety. As structural engineers, why do we consider the stress in a material that corresponds to 0.2% strain to be its yield strength and base most of our designs on this value? Why do we then typically divide it by 1.67 to determine a member's capacity to resist service loads? The short answer to both questions is: Because it usually works.

This highlights the critical difference between the scientific and engineering methods. Scientists want to understand the universe better; engineers want to make the universe better. Scientists seek to find out what is; engineers seek to achieve what can be. This does not make the engineering method somehow nobler or more important than the scientific method; in fact, many of the tools now at the engineer's disposal are the results of scientific progress. However, it reflects how the desired ends of scientists and engineers are very different, which in turn compels them to use very different means.

The ultimate irony of Dr. Koen's treatise is that he generalizes the engineering method to what he believes is the universal method by which all persons go through life: *Use heuristics* — which is itself a heuristic. *To be human is to be an engineer*. Most individuals — even engineers — may not necessarily be able to articulate the engineering method, but the reality is that everyone uses it all the time. In fact, it is central to our existence. Perhaps being aware of this truth – I mean, this heuristic — will help us be not only better engineers, but also better people.■

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