DISCUSSION OF THE METHOD: Conducting the Engineer's Approach to Problem Solving

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This monograph changes one's views about the engineering process. More importantly, the thesis of the monograph is all-encompassing—the engineering process is normally applied by everyone in our everyday life.

In 1637, Rene Descartes' book with a similar title effectively began modern philosophy. *Discours de la Methode* was one of the first statements of the scientific method, where the last three steps (analysis, synthesis, and evaluation) recur in the modern higher-order thinking skills of Bloom's pedagogical taxonomy.[1] Descartes suggested that his method could be applied to an individual's life perspective. Potentially, Koen's book could have a comparable impact.

Discussion of the Method: Conducting the Engineer's Approach to Problem Solving has six chapters:

1. Situations calling for engineering talents are described in this chapter.
2. In this chapter the engineering method is defined as the use of heuristics to bring about the best change in a poorly understood situation within the available resources. A heuristic, sometimes called a rule-of-thumb, is defined as a guide to action that has four characteristics
   a) It does not guarantee a solution
   b) It may contradict other heuristics
   c) It reduces the search time to solve a problem
   d) Its acceptance depends on the immediate context rather than on an absolute standard.
3. Examples of heuristics the engineer uses are given in this chapter. While there are 59 heuristics in Koen's book, four from engineering design are
   a) Allocate resources as long as the cost of not knowing exceeds the cost of finding out
   b) Allocate resources to the weak link
   c) Work at the margin of solvable problems
   d) Make small changes in the state of the art

   Chapter three also provides examples from general engineering practice related to heuristics, such as the Embarcadero Freeway, the Tacoma Narrows Bridge, and the Golden Gate Bridge. Chemical engineering heuristic examples, mostly from Austin professors like John McKetta or Matthew van Winkle, include "Engineers always give an answer," or "In the absence of other information, a distillation column should have 20 stages."
4. In chapter four, the engineering method is generalized to the universal method for causing any change under uncertainty.
5. A summary of the engineering method is given in this chapter.
6. In Chapter 6 an application of the method to construct a new society of learning or "Eutopia" is found.

The book is as interesting as it is challenging. After reading a draft in 1982, and rereading it several times since, I recommend that Koen's book be read in two parts. The first part (Chapters 1, 2, and 3) defines the engineer and the engineering method, illustrating the concepts of heuristics and state-of-the-art, and how they distinguish engineers. This first part can be read at a single sitting in a few hours, to get the central concept of Koen's definition of the engineering method.

This first part of Koen's book was published by ASEE in 1985 as *Definition of the Engineering Method*. It relies upon and enhances our engineering education background. For this first part alone, the book is valuable. It provides an educational guide to engineering students who want to understand what it means to be an engineer.

The second part of the book (Chapters 4, 5, and 6) extends the engineering method to a universal method, to be used by everyone (including scientists) in all aspects of life. Compared to a definition of engineering, this second part is a much more daunting challenge. The author rightly feels the need to briefly compare this method to all preceding Western (and some Eastern) thinkers who proposed a universal method, beginning with the pre-Socratic Ionians and proceeding through modern authors such as Goodman, Kuhn, Popper, and Wittgenstein.

In his second part, Koen departs from Descartes, who used reason alone, without citations or footnotes, because Descartes

Continued on page 211.

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Book Review: *Discussion of the Method*

Continued from page 203.

did not wish to appeal to Greek authority. Readers must either accept Koen's synopsis of such major thinkers as Kant, Gödel, and Wittgenstein, or they must be conversant with the history of Western thought, principally in philosophy. This requires either an abstraction of the thinkers cited, or many years of reading.

William Perry[2] suggested that the intellectual development of college students consists of stages that progress from authoritarian dualism (Stages 1 through 3) through the slough of relativism (Stages 4 through 6) to committed action (Stages 7 through 9), and indicated that relativism is where many college students get stuck. The relative equality of opinion and the absence of authority lead to the lack of commitment that is sometimes predominant in education today.

As applied to pedagogy, Koen's book also suggests that a departure from authority (dualism) is good, but going beyond relativism is better. Koen's method for doing so is through heuristics. Heuristics, or general rules-of-thumb, are particularly important guides in the absence of absolutes.

Koen's book provides some guidance in dealing with ambivalence of contrasting heuristics, often incorporated in society's aphorisms. How does one balance the contrasting heuristics of "Look before you leap," with "He who hesitates is lost"? It is clear that the triage advice, "When you hear hoofbeats, think horses not zebras," has a geographic limitation—it applies more in the Western world than Africa. According to Koen, contradictions require judgment to obtain a basis for action, to get beyond relativism.

In the score of years since its original publication, Koen's ASEE book has been used in a freshman honors seminar "Paradoxes of the Human Condition," with between 12 and 15 students per year, in an effort to find a way beyond Relativism in the Absolute versus Relative paradox. One week the students discuss the Absolute through Descartes' effort to break from Greek authority. The following week the students discuss Koen's *Definition of the Engineering Method* in parallel with Perry's model of intellectual development.

Our students' essays indicate that a study of Koen's heuristics initiates progress away from a Relativistic position. In other words, even though an absolute is not known, heuristics show the way to take appropriate action, or to choose between two actions. As such, the students readily embrace Koen's perspective of heuristics, and their combination into a state-of-the-art, or paradigm.

Professor Koen's book suggests a startling, explicit statement of a new way to think about engineering and life, but a method which may already be implicit in the subconscious of most practicing engineers. If we, as educators, wish to prepare our students for engineering practice, the techniques indicated in this book provide a philosophical underpinning for dealing with risks associated with engineering actions and designs, when there is insufficient applicable science. The interesting extension of Koen's engineering philosophy to life is, at a minimum, worthy of our consideration.

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