

The Engineering Method and the Heuristic: A Personal History

By
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The identification of engineering heuristics with engineering method and the generalization of engineering method to universal method was published in a book by Oxford University Press in early 2003. I have often been asked for a history of this nexus by students, colleagues, and practicing engineers.

From the genesis of the idea in the spring, 1965 to this new book at Oxford, I have sought the natures of engineering, method, and the heuristic in over half a century of research. The following chronology with relevant comments responds to this request I have often received.

1965 My initial idea of linking engineering method and the heuristic was made in this year. As told in the Oxford book [Part II],

While I was learning chess and studying artificial intelligence in the spring of 1965, my major professor* tossed a little, buff-colored book** by Nagel and Newman describing this proof [Gödel's Proof] across the desk and suggested that I look it over. My first reading ended at 1:30 a.m.; my second, at 5:30 a.m. I was astonished. Montaigne may have had his Sextus Empiricus and Kant his Hume to usher in their skeptical crises, but I had Gödel to usher in mine. . . .

With a bit of serendipity, within the week, I, along with the other students in my artificial intelligence class, was required to program a computer to demonstrate a portion of Gödel's Proof, and my crisis deepened. Imagine how unnerved an apprentice engineer becomes as he sees, both theoretically and computationally, the certainty of mathematics dissolve before his eyes. Still, I knew I had to complete my engineering homework for the next day, and I badly needed mathematics to do so. Fortunately at the time, the same course in artificial intelligence was developing a peculiar, non-algorithmic way to program a computer called heuristic programming. I had my answer: arithmetic was an heuristic! Arithmetic might only be an heuristic, but clearly it was a good and very necessary one. All the while I could not help wondering—"If arithmetic is in doubt, what is not?" Slowly, the phrase All is heuristic was born, and this discussion some thirty-six years later is the result.

This was the beginning of the quest to find one thing that was not an heuristic.

*Dr. Kent Hansen

***Gödel's Proof*, by Nagel and Newman

1969 I joined the faculty of The University of Texas in January, 1968 and soon afterwards began teaching a small freshman tutorial (TC 301.1) in engineering method to a class consisting of one-half liberal arts students and one-half engineers. Although not politically correct by today's standards, it was entitled "The Man-made World" after a series of books by Dr. John Truxal. Unsatisfied with yet another traditional course in the history of technology, survey of engineering accomplishments, or random musings of a resident engineer for the un-washed, I immediately developed a theory of what an engineer really does based on my study of the heuristic. This course soon became a General Studies course and later a University Course taught in a large auditorium on the university campus. The thrust of the course was that engineering design was identical to the use of engineering heuristics.

- 1970 The first public disclosure of this view was in a presentation entitled, "Description of an Engineering Course for Liberal Arts Honor Students," Gulf-Southwest Section Meeting, American Society for Engineering Education, 1970.
- 1980-81 I received a grant for \$20,000 called "Discussion of Method: The Theory of Engineering Design," Alfred P. Sloan Foundation Grant, 5/21/80-8/31/81, \$20,000. Dr. James Koerner had somehow heard about my course and wanted to ensure that the theory contained in my class was committed to paper.
- 1981-82 A second grant likewise entitled "Discussion of Method: The Theory of Engineering Design," Alfred P. Sloan Foundation Grant followed the next year, again for \$20,000. The final report was submitted soon afterwards. The Sloan Foundation was the essential ingredient that allowed this theory to see the light of day.
- 1985 In this year, a small monograph entitled "Definition of the Engineering Method" was extracted from the first section of the Sloan report and published by the American Society for Engineering Education (ASEE). This monograph has gone through an estimated six printings and has been used in introductory courses in engineering throughout the U.S..
- 2003 Koen, Billy Vaughn, *Discussion of the Method: Conducting the Engineer's Approach to Problem Solving*, Oxford University Press, March, 2003.

Representative Invited Lectures:

- "Description of an Engineering Course for Liberal Arts Honor Students," ASEE Gulf Southwest Section Meeting, 1970.
- "The Teaching of the Methodology of Engineering to Large Groups of Non-Engineering Students," ASEE Gulf Southwest Section, 1971.
- "Engineering: A Man-Made World," Gulf Coast Chapter of Texas Society of Professional Engineers, Freeport, Texas, Nov. 19, 1974.
- "Les Nouvelles Techniques d'Ingénierie dans les Ecoles aux U.S.A., Ecole Centrale, Paris, France, December, 1976.
- "Technological Illiteracy," Austin Rotary Club, 1980.
- "The Theory of Engineering Design," Clemson University, Sept. 1983.
- "The Theory of Engineering Design," Colorado School of Mines, April 1984.
- "Engineering Method: Its Definition, Implementation, and Rule of Judgment," International Seminar on Modern Design Principles, Trondheim, Norway, June 13-15, 1988.

- "The Philosophy of Technology: Generalization of Engineering Method To Universal Method," local Mensa Group, January 20, 1989.
- "Quo Vadis Design - An American Council on Engineering Design?", NSF Engineering Design Conference, Amherst, Massachusetts, June 13, 1989.
- "Noses and Thumbs: An Engineer Looks At His Role in Society or A Theoretical Analysis of the Interaction Between The Engineer and Society," Tri-State University, October 15, 1989.
- "The Theory of Engineering Design," University of New Mexico, Chemical and Nuclear Engineering Department, Albuquerque, NM, April 10, 1990.
- "Definition of the Engineering Method," talked to an ME Design class taught by Professor Alice Agogino, The University of California by speaker phone, September 10, 1991.
- "Teaching Engineering Design," 1992-93 Effective Teaching Luncheon and Seminar, The Bureau of Engineering Teaching, College of Engineering, The University of Texas at Austin, Austin, TX, March 23, 1993.
- "Teaching Engineering Design: A Case Study in Behavior Modification," ASEE Gulf Southwest Section Annual Meeting, The University of Texas at Austin, Austin, TX, April 1, 1993.
- "Design is Behavior," presented to the Faculty of Colorado School of Mines, Golden, CO, April 13, 1994.
- "A Definition of the Engineering Method", Honors Symposium, Colorado School of Mines, Golden, CO, April 13, 1994.
- "In Search of Universal Method: An Engineer's Journey", Society of Plan II Engineers, The University of Texas at Austin, April 11, 2001.
- Generalization of the Engineering Method, The Association of Professional Engineers and Geoscientists (APEGM) of the Province of Manitoba, Winnipeg, Canada, October 13, 2001, Keynote Speaker
- Generalization of the Engineering Method, Design Colloquium and Seminar, Engineering Talk #10, The Association of Professional Engineers and Geoscientists (APEGM) of the Province of Manitoba, Winnipeg, Canada, October 15, 2001
- Koen, B. V., "An Engineer's Quest for Universal Method," Keynote Address, Norms, Knowledge, and Reasoning in Technology Conference, Boxmeer, The Netherlands, sponsored by the Philosophy and Ethics of Technology Department, Technical University of Eindhoven, Netherlands, June 3-4, 2005
- Koen, B. V., "The Definition of Engineering Method and Its Implications for the Liberal Arts, Ethics, and Religion," Role of Engineering at Catholic Universities (RECU), Keynote Speech, University of Dayton, Dayton, OH. September 22, 2005.
- Koen, B. V., "In Search of a Philosophy of Engineering," Philosophy and Engineering Planning Group, Massachusetts Institute of Technology, October 19-20, 2006.

- Koen, B. V., "An Engineer's Search for Universal Method," Engineering and Technology Studies at Illinois, Engineering, Technology, & Culture, An Interdisciplinary Lecture Series, University of Illinois at Urbana-Champaign, January 24, 2007.
- Koen, B. V., "Philosophy of Technology and/or Philosophy of Engineering," Globalization and Technology, Biennial Meeting, Charleston, S.C., Society for Philosophy and Technology, July 10, 2007.
- Koen, B. V., "Quo Vadis, Humans? Engineering the Survival of the Human Species," Workshop for Philosophy and Engineering, Technical University of Delft, Delft, The Netherlands, Oct. 29-31, 2007
- Koen, B. V., "Towards a Philosophy of Engineering," Workshop on Philosophy and Engineering Conference, Keynote speech, Royal Academy of Engineering, London, England, November, 2008
- Koen, B. V. "What Should Everyone Know about Technology," panelist session 2588, sponsored by Technological Literacy Constituent Committee, ASEE National Conference, Austin, Texas, June 16, 2009
- Koen, B. V., "Debunking Contemporary Myths Concerning Engineering," Forum for Philosophy, Engineering, and Technology Conference, Colorado School of Mines, Golden, CO, May 9-10, 2010
- Koen, B. V., "Defining and Distinguishing Engineering as a Unique Intellectual Discipline," Texas Academy of Science Symposium, St. Edwards University, Austin, Texas, March 4, 2011
- Koen, B.V., "An Engineer's Search for Universal Method," keynote speech (by video) with Q. and A. (by Skype), Solution Engineering Seminar, 12th Annual Invitation Gilb Seminar, Deutsche Bank, London, June 20-24, 2011

Representative Articles:

- B. V. Koen, "Toward a Definition of the Engineering Method," Proceedings of the ASEE-IEEE Frontiers in Education Conference, Oct. 3-5, 1984, Philadelphia, Pa., pp. 544-549. (Won the Ben Dasher Best Paper Award for 1984.)
- B. V. Koen, "Toward a Definition of the Engineering Method," *Eng. Ed.*, December, 1984, pp. 150-155. (Reprint of #63 above.) (Won the William Elgin Wickenden Best Paper Award for 1986).
- B. V. Koen, "Toward a Definition of the Engineering Method," *The Bent of Tau Beta Pi*, Spring, 1985, pp. 28-33. (Reprint of #63 above.)
- B. V. Koen, "Alternate Definitions of Engineering," ASEE 1986 Annual Conference Proceedings, Atlanta, Georgia, June 16-20, 1985.

- B. V. Koen, "Engineering Method and the State-of-the-Art," *Proceedings of 1985 Frontiers in Education Conference*, Golden, Colorado, October 20-22, 1985.
- B. V. Koen, "Engineering Method and the State-of-the Art," *Eng. Ed.*, April 1986. (Reprint of #69 above.)
- B. V. Koen, "A Theoretical Basis for Judging the Engineer," ASEE 1986 Annual Conference Proceedings, Cincinnati, Ohio, June 22-26, 1986.
- B. V. Koen, "Generalization of Engineering Method to Universal Method," *Proceedings of 1986 Frontiers in Education Conference*, Arlington, Texas, October 12-15, 1986, pp. 265-270.
- B. V. Koen, "The Theory of Engineering Design: A Strategy for Cross-Cultural Analysis," International Congress on Planning & Design Theory Proceedings, August 1987, Boston, MA, pp. 11-13.
- B.V. Koen, "Engineering Method: Its Definition, Implementation, and Rule of Judgment," Proceedings of 14th International Conference on Improving University Teaching, June 20-23, 1988, Umea, Sweden (invited speaker).
- B.V. Koen, "Engineering Method: Its Definition, Implementation, and Rule of Judgment," Modern Design Principles in View of Information Technology, K. Jakobsen (ed.), Tapir Publishers, 1988, pp. 27-40.
- B.V. Koen, "Toward A Definition Of The Engineering Method," European Journal of Engineering Education, Vol. 13, No. 3, 1988, pp. 307-315.
- B.V. Koen, "An Heuristic Look at the Difference in Engineering Design in The United States and Japan," Proceedings from 19th International Symposium of the Frontiers in Education (ASEE), Institute for Electrical and Electronics Engineers (IEEE) and International Society for Engineering Education (IGIP), Vienna, Austria, July 2-4, 1990, pp. 534-536.
- B.V. Koen, "A Heuristic Look at the Differences in Engineering Design," *The Intl. Journal of Engineering Education*, Vol. 7, #6, pp. 487-489, 1992.
- C.A. Fisher, T. Cochrane, B.V. Koen, J.D. Lang, R.V. Pieri, H.J. Sneek, J.R. Dixon, J.F. Lardner, H.R. MacKenzie, F.B. Prinz, and D.S. Ullman, "Design Methodology and New Paradigms for Design," *Innovations in Engineering Design Education, A Compendium to the 1993 ASME Design Education Conference*, March 24-26, 1993, Orlando, Florida, ASME 1993, pp. 81-84.
- B.V. Koen, "Teaching Engineering Design: A Case Study in Behavior Modification," Proceedings of ASEE Gulf-South Section Annual Meeting, The University of Texas at Austin, Austin, TX, Vol. 1, pp. 17-21, April 1-2, 1993.
- B.V. Koen, "Toward a Strategy for Teaching Engineering Design," *Journal of Engineering Education*, Vol. 83, #3, pp. 193-201, July 1994.
- Billy Vaughn Koen and Yasutaka Shimizu, "Heuristics for Internationally Distributed Collaboration (IDC) between Japan and the United States," ASEE/IEEE Frontiers in Education Conference, San Juan,

Puerto Rico, August 10-13, 1999, Proceedings.

Representative Books, Monographs, and Chapters in books:

- Koen, B. V., Definition of the Engineering Method, monograph of the American Society for Engineering Education, 1985.
- Koen, B. V., "Engineering Method: Its Definition, Implementation, and of Judgment," *Modern Design Principles in View of Information Technology*, K. Jakobsen (ed.), Tapir Publishers, 1988, pp.27-40.
- Koen, B.V., "The Engineering Method," Critical Perspectives on Nonacademic Science and Engineering, Paul T. Durbin (Ed.), Associated University Presses, Inc. 1991, pp. 33-59.
- Koen, Billy V. and Shimizu, Yasutaka, Heuristics for Internationally Distributed Collaboration Between Japan and the U.S.: A User's Manual, Japan Industry and Management of Technology Program, The University of Texas at Austin, 2001.
- Koen, Billy V., El Metodo De Ingenieria, monograph, Universidad del Valle, Colombia, Presentacion a la Edicion Especial de ACOFI, September 19-22,2000, Cartagena, Colombia.
- Koen, Billy Vaughn, *Discussion of the Method: Conducting the Engineer's Approach to Problem Solving*, Oxford University Press, March, 2003.
- Koen, Billy Vaughn, "Engineering Method," contribution to *Encyclopedia of Science, Technology, and Ethics*, Carl Mitcham, Editor, MacMillan Reference Books, August, 2005.
- Koen, B.V., "The Engineering Method and its Implications for Scientific, Philosophical, and Universal Methods," *The Monist*, vol. 92, no. 3, essay 3, July 2009.
- Koen, B.V., "Quo Vadis, Humans? Engineering the Survival of the Human Species," Vol. 2, *Philosophy of Engineering and Technology: Philosophy and Engineering: An Emerging Agenda*, Van de Poel and Goldberg editors, Davis, Koen, Mitcham, Vesilind, assoc. editors, Springer, 2010, pp. 313-341

Rev. 09/01/2011