The Role of the Humanities in Distinguishing Science from Engineering Design in the Minds of Engineering Students

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Abstract

Engineering problems differ from scientific problems. Therefore the proper identification, formulation, and solving of engineering problems require an understanding of the distinction between engineering and science. In this paper it is argued that the humanities and social sciences (H&SS) play a major role both in the distinction between engineering and science, and in clarifying that distinction in the minds of engineering students.

Modern engineering is a human cultural activity that involves an interplay between theory, experiment, and imagination, in which human beings form and transform nature, for practical ends and purposes, with the aid of tools and procedures.[1] Those "practical ends and purposes" involve human society in all its multifaceted complexity. Thus engineering design requires a holistic and integrated perspective on reality before engineering problems can be properly formulated and solved. The first two sections of this paper discuss that distinction between engineering (or technology) and science, and examine the difficulties that ensue when that distinction is not made. To demonstrate the integrative character of engineering design, the next section looks at the kind of expertise required by a design team that sets out to solve the problem of transporting humans over long distances. Then four basic principles for guiding curricular and pedagogical reform are identified and discussed. Finally, a number of specific examples of integration of the H&SS in the engineering classroom are considered. Throughout, an attempt is made to show that (i) the identification, formulation, and solving of engineering problems demand a holistic perspective that considers far more than just the narrow, "technical," dimensions of a problem, and (ii) the H&SS can play a major role in developing that holistic perspective in the minds of engineering students, even–and perhaps especially–in the engineering classroom.

If engineering design requires a holistic and integrated perspective on reality, why is it that the tendency in modern technology seems to be in the opposite direction? That is, why is it easy for engineers to have their perspectives so narrowed that important aspects of design problems are overlooked? Dams that disrupt the ecological balance of a region, VCRs that are too difficult for the average person to program, and the addressing of age old medical problems with genetic engineering solutions that raise even greater ethical problems are just three kinds of design failures that result from what has been called the *narrowness tendency in design* (Van Poolen, 1987, p. 785). Schuurman (1980) blames this narrowness on the confusion of technology with science and the tendency for the methodology of science to be employed in situations where what is needed is not science but technology.

It may be argued that the two-cultures problem[2] in undergraduate engineering (UE) education is an inherited one. That is, the *original* two-cultures problem, as articulated by C.P. Snow (1964), is between the culture of science and the culture of the humanities (literature in Snow's

[1] This definition is informed by the definition of technology given in Monsma (1986, p. 19) and by the definition of engineering given in Dordt College (1993, p. I-13).

[2] The two-culture problem is exemplified by the general antipathy of engineering students for the H&SS.

discussion). Because of the fundamental role of natural science in technology, and in engineering education in particular, the two-cultures chasm has split technology and the humanities just as it has science and the humanities.

To overcome the two-cultures problem, clarify the distinction between science and engineering design for engineering students, and facilitate a holistic approach to engineering problem solving, engineering educators must be guided by four general principles: (i) holism, (ii) multidimensionality, (iii) the integrative character of design, and (iv) harmonizing of abstraction and integration. These are developed in this paper.

The most effective vehicle for overcoming the two-cultures problem in UE education and for enabling students to properly distinguish science from engineering design, is for UE professors to convey to their students a positive attitude with regard to the H&SS and teach their particular subjects holistically. In this paper consideration is given to how that positive attitude may be conveyed inside the classroom: the kinds of incidental or planned activities will effectuate that conveyance.

The humanities and social sciences play an important role in undergraduate engineering education. That role is not limited to providing "well-roundedness" in individual engineers, but is also a fundamental part of identifying, formulating, and solving engineering (design) problems. This is so because engineering problems are, by their very nature, holistic, in contradistinction to natural scientific problems, which are, by their nature, abstract. Thus the humanities and social science component of undergraduate engineering education ought not be limited to courses taken outside the school of engineering, but ought also be integral with engineering courses—particularly upper level design courses.

References

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