Models and Practical Problem Solving: The Question of Disciplinary Integration with Design: An Abstract

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Introduction

The thesis of this paper is that the *nature* of disciplinary learning *per se* needs to be more thoroughly investigated for insights helpful to a proper appreciation of the role that the sciences, humanities, and social sciences play in practical engineering problem solving. An important insight is to realize, as does Cartwright, that these disciplines are, *by their nature, only repositories of models* which describe, at best, *idealizations* of reality (Cartwright, p.4). Also, the context of disciplinary knowledge must be given insightful attention, with particular attention on the *experimental process* through which much of knowledge emerges, be it, for example, in physics, psychology, or economics.

We explore, then, the nature of the disciplines. We first re-visit the *world* (the context) within which disciplines arise. Particular emphasis is on the nature of experimentation. Then we consider the *modeling* of the *world* that goes on within the disciplines. Finally we look at *re-contextualization* - the application of the *modeled* content of the disciplines within the *world*.

This analysis leads to insights which have moment for deliberations about the role that the disciplines play in practical engineering problem solving. There is a *sticky* relationship between context and the disciplines: context consists of *human* activities, values, and the like (related to the development of “theoretical” knowledge through, for example, experimentation); hence, humankind cannot eschew responsibility for disciplinary *content*. Furthermore, our human-produced artifacts (machines, social systems, and the like) are essentially *brittle* when based primarily on disciplinary funds of knowledge: they work well under some but not all *real* conditions. Hence, human security and the quest for control (based on disciplinary knowledge) are misplaced. Finally, emphasis is placed on paying proper attention to the *concrete world of experience* (from whence the disciplines arise).

World

The concrete, so-called *practical* world, forms for Heidegger the background or backdrop or, better yet, the *context* within which disciplinary theories are formed and developed. And this *world* has priority: the disciplines are derived *from* or *out of* it. Perhaps this is why many students, for example, have such a difficult time applying engineering (and basic) science when they design and build working prototypes of a machine. We can build them (an accomplished fact), but we cannot, even after the fact, describe in complete, rational, objective detail how (or why) it is that we did so. If this cannot be done, a conclusion might be that the students could *not* start from the disciplines and proceed directly to something concrete in the *practical world*. Indeed, students start building machines in their world of “everyday experience” and may “look back” at their courses for some guidance but do not find definitive answers as to how to proceed or why. They, in effect, experience the priority of *ontology* over *epistemology*.

Modeling

By modeling I mean the process of *abstraction from reality* that eventuates in a mathematical representation related to some phenomenon of interest within that reality.

Models, laws, and mathematical expressions form the bulk of the information in the disciplinary funds of the natural sciences. The nature of these funds can be characterized then as *artificial* rather than *natural*. In other words, these “funds” describe how it is we have “tackled” the problem of making sense of our world; they do not describe, necessarily, how the world *is*.

Mathematical expressions related to various physical phenomena are intended for (among other things) use in engineering design. Calculations supposedly yield specifications of size, shape, and material for a particular machine. Unfortunately, as mentioned above, many students do not do this. Rather, they proceed “directly” from their “idea” of a machine to the production of a prototype. And they seem to be guided, in large part, by *intuition*. They circumvent the process of developing physical models (of the machine), application of the physical laws, and manipulation of a resultant mathematical equation (or a complex computer model). I suggest this happens because physical laws *only* apply to idealized models, not to *their particular* machine. Often, they just build “it” (intuitionally) and “see” if it works.

Re-contextualization

Internships in many “applied” areas such as engineering, social work, counseling, and business, are fashionable today. They emulate the long established policy of having education students do practice teaching. These experiences make up for the lack of *directly applicable* funds of information within the various disciplines. These funds, when “applied” are not sufficient (and perhaps not even necessary) guides for “action”.

In sum, the disciplinary models (*idealizations*) should not be viewed as adequate guides for “living, moving, and having our being” in the *real* world. These models, often in the form of very generalized rules, do not apply easily to particular cases of living interest. They do not adequately predict performance of, for example, our machines, because they delimit the number of variables and they cannot tell what variables might be of interest and importance for the future being and welfare of these machines (and us). The disciplines, then, yield a *brittle* feeling for the way the actual world is. This *brittleness* or *lack of flexibility* must be compensated for by human intuition in many cases. All this comes to the fore when we attempt *re-contextualization* of our disciplinary funds of information.

Conclusions

Even though our disciplinary fund of models (and laws and mathematical expressions) do not comport with the *world per se* (hence are *brittle*), they cannot be separated or unstuck from the cultural, value laden context within which they emerge. This *stickiness* comports with the thought of Heidegger when he suggests that the content of the disciplines (even the nittiest and the grittiest of detail) arises from our way of getting around in the world and making sense of *our* world.

Perhaps, subconsciously, humankind wishes to *avoid* responsibility. We simply hide our heads in the sands of the disciplines. Indeed, human responsibility not only fades from sight as disciplinary models (supposed actual descriptions of the world) hove into view; it fades an infinite distance away when *reality* is reduced, finally, to a seemingly *deterministic* model - the "superstring." The challenge, however is to recognize *stickiness*, which says that we humans are so *stuck* to what we have developed within the disciplines that individually and societally we are responsible for their content. This content comes about not because that is the way the world is but rather it is how we have managed to develop means to get along in the world. Any attempt at integrating the various disciplines with engineering design and problem solving must argue that, and recognize that, humans cannot disengage themselves (because of *stickiness*) from responsibility for disciplinary content (and its appropriate use in engineering design and problem solving).

Reference

Cartwright, N., 1983. *How the Laws of Physics Lie*, Clarendon Press, Oxford.

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