The Link between Academic and Industrial Engineering R&D[1]

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We are at a crossroads in Engineering, both in its academic manifestation and in industrial practice. This essay focuses primarily on the latter. I am writing this after having spent almost ten years in academe, with eight years prior in engineering practice. I am certain that much of what I will write will draw opposition since it runs counter to what exists, which I maintain is ineffective. Perhaps open minds will use these ideas as a basis for discussion and evolution.

Engineering is an applied field. This is true although academic Engineering is largely involved with many theoretical issues that surround state-of-the-art applications[2]. Just like other academicians, most academic Engineers perform *reductionist* research, thus exposing a narrow part of a discipline to exhaustive study and further understanding. The work can span the spectrum of possible activity, from very theoretical to very applied, as academic freedom permits. The research draws on many other disciplines, such as economics, sociology, public planning, and of course computer science, physics and mathematics. But this is the nature of Engineering, to be eclectic in its tools as it solves the complex multi-disciplinary problems society has to offer. The theoretical Engineer looks to physics and mathematics for new tools that may be useful in advanced applications or possible future anticipated applications, while the applied Engineer looks to current knowledge to solve current needs. All this activity serves a useful purpose and each as much reflects the interests and temperament of the individual as the needs of the times. Then, this is also part of the academic system, where an extreme level of personal choice exists within the framework of the excellence we are trying to build.

[2] Some justifiably argue that Engineering departments have become the haven of those who prefer doing mathematics or computer science, but would never be accepted in those disciplines because of their lack of rigor in those fields.

Yet, a purpose of the academic Engineering scholar is to *populate* or to *seed* the Engineering journals with specific results that answer specific narrow problems. This is the **primary** research responsibility of academic Engineering. It is **not** to solve an industrial problem, except by personal choice under academic freedom, or as a consultant.

This brings us to the proper role of the industrial R&D Engineer (generally also a Ph.D.). Suppose a particular industry has a specific problem to solve. Such a problem is almost by definition multi-disciplinary and requires Engineers of many backgrounds for its successful solution. How does the industrial Engineering team begin to address the difficult problem at hand? It begins to **search** the literature for all that had been **sewn** by their academic colleagues in order to **reap** relevant papers across disciplines which address all the aspects of the larger problem. These industrial Engineers must now *synthesize* the disparate products that came from the *deconstructive* academic research. This is a reason why the industrial R&D Engineer needs a Ph.D., in order to understand and be able to utilize the archival literature created, primarily, by their academic colleagues.

To summarize, the academic Engineer deconstructs complex problems into very narrowly focused problems that are analyzed and results published. The industrial Engineers cultivate specific solutions from a broad base of journals to solve their multi-disciplinary problem. This synthesis is unique to the problem that must be solved. This process can be very effective, but is rarely so today because of the decimation of industrial R&D during the past decade of mergers and downsizing. The current mismatch between academic and industrial Engineering has led to complaints by industry that academic Engineering research is not *responsive* to the *real* needs of industry. Funding agencies that have taken up this call are in reality dooming future generations to a lack of the kind of intellectual resources described above.

That is not the role of academic Engineering, as previously detailed. The problem lies with the scarcity of industrial Ph.D. Engineers, who are needed to *translate* academic work and synthesize it to solve the larger industrial problem.