

## ON MECHANICS/ENGINEERING SCIENCE EDUCATION

Carl T. Herakovich

University of Virginia, Charlottesville, VA, 22904-4742, USA

### EXTENDED SUMMARY

It seems that just about everything under the sun has been re-engineered in the past quarter-century except that which may need it the most – engineering education. In fact, it's hard to say that engineering education has ever been re-engineered. In the management field, re-engineering is defined as “the fundamental rethinking and radical redesign of ... processes to achieve dramatic improvements in critical, contemporary measures of performance...”. It is further stated that “re-engineering seeks to change a broader span of the process, it questions fundamental assumptions”, and “re-engineering tends to be riskier”.

At a time when the world is going through dramatic changes with intense engineering activity in such diverse fields as biology, medicine, environmental science, computer science, information technology, space exploration, development and efficient use of energy, and materials science, to name some fields, it is imperative that engineers be equipped not only to actively contribute to these fields, but to assume leadership roles. Many share the view that engineering education needs an overhaul. Professor Sheila Widnall of MIT (and former Secretary of the U. S. Air Force) has said “I believe that a revolution in undergraduate engineering education is required not just for women but to improve the effectiveness of engineering in this country. Unless we develop more of a holistic approach to problem solving, we will become a niche profession.” And Dr. William Wulf, President of the U. S. National Academy of Engineering has spoken of “The Urgency of Engineering Education Reform”.

As the knowledge base has exploded, engineering education has actually retrenched. Whereas fifty years ago, essentially all undergraduate engineering students took a wide variety of courses in diverse fields including statics, dynamics, fluid mechanics, solid mechanics, materials science, chemistry, electricity and electronics, heat transfer and thermodynamics, today's curricula are very narrow with the great majority of all engineering courses in the field of the student's major department. Breadth and diversity have been further restricted by the addition of new majors such as bioengineering, computer engineering and materials engineering, again with most engineering courses limited to the departmental major. As a result of this narrowing of the curricula, engineering graduates have a very limited specialty with little appreciation for the broader picture of how their discipline integrates with other engineering fields and society at large. In Widnall's words, we are becoming a niche profession. Indeed, engineers with only an undergraduate degree border on being limited to activities typically associated with a technician.

One answer to this problem is a complete re-engineering of undergraduate engineering education. To use the management approach, “a fundamental rethinking and radical redesign of the process”. A single undergraduate curriculum in Engineering Science would go a long way toward producing an engineer who is better equipped to actively contribute and lead in the 21<sup>st</sup> Century. By concentrating on the fundamental science of engineering, the curriculum can be subjected to a radical redesign with the potential to achieve dramatic improvements in the ability of engineers to lead in the solution of societal problems. To be sure, engineers actively engaged in the practice of engineering will require further study in a specialty. However, all engineering undergraduates would be prepared to actively participate in the societal decision making processes that are so dependent on engineering knowledge.

Mechanicians can, and should, play an important, critical, leadership role in the redesign to a broadly based engineering science curriculum. By efficiently integrating mechanics with engineering science, the curriculum can be streamlined to provide sufficient coverage of the engineering sciences as well as the important fields of biology, computing, human interactions and societal problems.

The presentation will more fully explore these ideas.