

## Engineering Design: A Foundation for a 21st Century Renaissance

Engineers understand well the importance of design as the culmination of the engineering process, the ultimate application of science and technology to meet the needs of society. As such, engineering design is an intellectual endeavor very similar to that encountered in the creative arts, but distinguished by its rigor and use of scientific and technological tools. Unlike research, which attempts to induce general conclusions from specific experiences, engineering design is a rigorous deductive process that develops a specific solution to meet a specific need from a general set of principles. Engineering design is a far more general, powerful, and disciplined approach than mere invention. In addition to innovation, ingenuity, and creativity, design requires great skill and training. It is not an activity left to happenstance, to accidental discovery. Rather, engineering design is approached with the disciplined methodology of engineering problem solving.

Ironically, the immense importance of design in addressing the myriad needs of a rapidly changing world has not received the visibility and priority of other activities such as “creativity,” “innovation,” and “entrepreneurship” that are clearly dependent upon it. Design frequently seems overlooked in the priorities expressed by industry leaders, as articulated by the Council on Competitiveness: “American’s challenge is to unleash its innovation capacity to drive productivity, standard of living, and leadership in global markets. For the past 25 years, we have optimized our organizations for efficiency and quality. Over the next quarter century, we must optimize our entire society for innovation.” Design has also not captured the attention of business scholars such as Clayton Christenson, who instead places a priority on “disruptive innovation” that creates the paradigm shifts that triggers economic change. The priority given innovation is also evidenced by major federal initiatives such as the America COMPETES Act, aimed at doubling the research budgets of NSF, DOE Science, and NIST; new research programs launched by DOE such as ARPA-E and Energy Innovation Hubs; the American Competitiveness Initiative launched by industry, and, of course, numerous efforts by state and local governments to stimulate innovation and entrepreneurial efforts as key to economic growth.

In part, this may be language. Today “innovation” and “entrepreneurship” are portrayed as key to economic growth. What are our images of “design”? Ralph Lauren? The exterior of a new car? Designing widgets? Or machines that make widgets? Or business plans to sell widgets and make money? The public tends to think of “design” as something very routine, perhaps with images such as huge rooms full of hundreds of engineers at drafting tables (or now computer workstations) or young designers with art backgrounds trying to develop the next “cool” car design that young people will buy, but with little understanding of the technology that can manufacture or make it work.

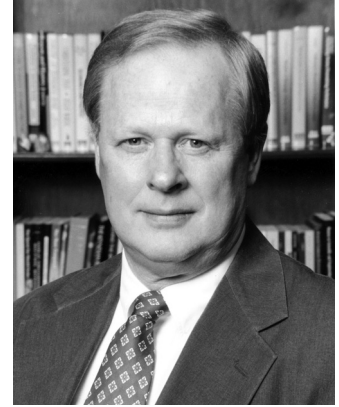
Perhaps, from only a slightly more sophisticated viewpoint, people view design as an activity that rearranges existing items in a more attractive or functional way, rather than “creating” something that is completely new and original. Put another way, “design” is viewed as “sustaining innovation,” e.g., a more routine engineering activity or an artistic embellishment, but NOT viewed as “disruptive innovation” to exploit new paradigms based on new knowledge.

So, what to do to provide this rigorous intellectual skill, so critical to innovation, entrepreneurship, and economic growth, with the priority and support that it requires? One approach is an effort to re-educate leaders, particularly in the scientific and technology communities where federal policy is developed, about the importance of design, linking it in their minds to R&D (the discovery of new knowledge), disruptive innovation (paradigm breaking), entrepreneurship (creating value and wealth through new applications), and commercialization and deployment!!! Here, particular targets are federal agencies such as NSF, DOE, NASA, DOD, and DOC, as well as advisory bodies such as the National Academies, the National Science Board, and, in particular, the President’s Council of Advisors in Science and Technology. A similar educational effort should be directed at industry through organizations such as the National Business Roundtable and the Council on Competitiveness.

Of course, many of us have been trying to do this for years, but it is very hard to get traction because of the breadth of “design” activities, spanning not only rigorous engineering design but also art and fashion. Perhaps we should give up on the world “design” and try to capture both its creative and rigorous character in other ways, with other language. Rather than a direct marketing effort for “design,” it might be more effective to take a broader approach that merges the concepts of “design,” “creativity,” and “innovation,” and “paradigm breaking” into a new framework. Let me suggest a possibility.

The professions that dominated the late 20th century were those that managed knowledge and wealth, professions such as law, business, and politics. Today, our world is increasingly valuing those activities that actually create new knowledge and wealth, professions such as art, music, architecture, and engineering in what could become a *renaissance* in the 21st century. After all, the tools of creation are expanding rapidly in both scope and power, to generating new knowledge. Today, we have the capacity to create objects atom by atom, new life-forms through the tools of molecular biology and genetic engineering, and new social institutions through computer networking and communications. Our civilization is refocusing its intellectual activities and priorities from the preservation or transmission of knowledge to the process of knowledge creation itself—to research, innovation, entrepreneurship, and, of course, DESIGN!

*A 21st century renaissance!* Perhaps that is the best language in which to convey the importance, the excitement, and the priority that should be given the intellectual discipline of design! Engineering design will be—indeed, must be—a foundation for the renaissance that will characterize a 21st century world driven by new knowledge, learning, and innovation!



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