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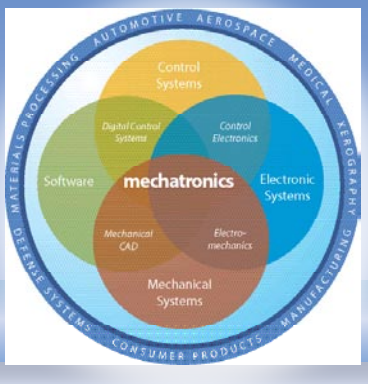
MECHATRONICS IN DESIGN

FRESH IDEAS ON INTEGRATING MECHANICAL SYSTEMS, ELECTRONICS, CONTROL SYSTEMS AND SOFTWARE IN DESIGN



Complexity Demands a New Engineering Mindset

Engineering education is a great example of a complex system that must be transformed.

In mechatronic system design, we integrate. From the very start of the design process, we combine the physical system with sensors, actuators, computer control and human interfaces to give it some intelligence and decision-making capability.

At its very heart, system complexity is synonymous with power. However, this power can be good or bad. If the complexity in any system is not tamed, the consequences can be devastating. We have witnessed some of the consequences of untamed complexity in the Chernobyl nuclear plant accident in 1986, the recent world financial meltdown, and now the Gulf of Mexico oil spill. All are examples of systems of unimaginable complexity – intended or not – that were left unmanaged without common-sense, human-centered checks and balances, which resulted in catastrophes of immense scope.

In a complex system, learning how all the pieces – constant and variable – interact gives a depth of understanding that averts catastrophe. That is what we mean by human-centered design – understanding the interfaces among technology, people, communities, governments and nature. This is what makes complexity manageable.

All complex systems have, as a foundation, fundamental principles or core knowledge that cannot be ignored. However, there must also be a flexibility from the engineering perspective to respond to problems which inevitably arise. Clearly, the typical discipline-specific engineer is not well-equipped to manage such complexity; not even an engineer with multidisciplinary engineering breadth can do an effective job.

Complexity demands an engineering skill set with technology depth and also non-technical breadth—specifically, human-centered design expertise capable of managing complexity. This concept received wide acceptance at the IBM/IEEE Conference on Transforming Engineering Education, held April 6-9 in Dublin. Jim Spohrer, director of IBM University Programs, saw it as essential to IBM's focus on service activities worldwide because every product has a service associated with it. The questions that arose at this conference were: "Why are these engineers not being created?" and "How do we ensure that they will be?"

The urgent problems society faces are multidisciplinary in nature, complex, and ever-changing. Engineering graduates need to be able to adapt and apply technology that is human-centered, desirable, feasible, viable, sustainable, usable and manageable. Incoming students need to experience a culture change. They need to transform from the world of memorizing, test-taking and focusing on grades, to the world of critical-thinking problem solving, turning easily accessible information into insight and understanding, and taking responsibility to become an engineer.

BY KEVIN CRAIG

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So if we all know what should happen in engineering education, why is it not happening?

As I see it, there are two main impediments to engineering education reform. First, the silo structure in a typical engineering college does not foster reform. Engineering departments typically don't collaborate or interact in a multidisciplinary way and fail to realize that doing so would enhance, not diminish, what they do. Second, there is a failure of faculty to get out of their comfort zone, become involved in real-world problem solving, and respond to the challenges of teaching multidisciplinary engineering problem solving in a discovery learning mode, as opposed to a lecture mode.

Knowledge needs to be unbundled and rebundled in engineering education to give it balance between theory and practice and relevance to the solution of the multidisciplinary problems society faces. Engineering education done in this manner can mitigate catastrophe!

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