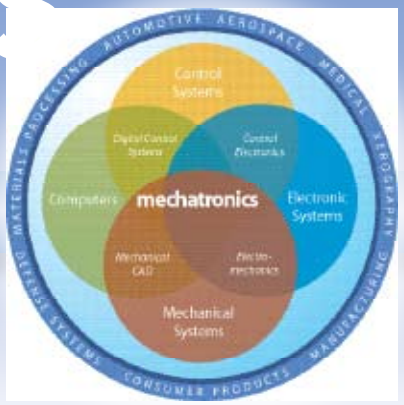
MECHATRONICS IN DESIGN

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



No Design 'After-thoughts' ALLOWED

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BY KEVIN CRAIG

To really achieve success in mechatronics' design, it's important to understand how the mechatronics' approach differs from conventional design approaches.

The conventional design process includes several steps: (1) need or opportunity recognition, (2) concept generation, (3) detailed design and (4) manufacture. Need is simply the set of attributes the product must fulfill. Engineering must design a product to meet that need, so concept generation is the next step. Here is where you develop a solution-independent problem statement, as well as clarify your goals and quantifiable performance objectives. You also need to identify the functions or tasks required to achieve a given outcome. Often, an innovation at a function level leads to an innovation at the full concept level, since it may open up new ways to understand problems and new avenues for pursuing solutions.

The alternatives engineers consider should cover a broad range of possibilities. To choose an alternative, you must establish your requirements — measures of performance the design must meet. Requirements can be thought of as falling into three areas: product characteristics, product life and customer use. An engineer selects the most attractive path from many concepts. Picking the first solution that comes to mind may lead you off a cliff or into a worse problem than you started with. Once you decide on the concept, you are ready to turn that concept into a set of specifications, a detailed design manufacturing can use to produce the final product.

Any design that adheres to these steps will meet your needs, but there are other design methods you can use to develop a high-performance, low-cost, quality product. For example, parameter design concepts move quality control from the manufacturing stage to the detailed-design stage. Many engineers are embracing DFX (Design for Excellence) concepts, which stress the importance of taking into account at the design stage such aspects as manufacturing and assembling, testing and safety, and environmental and recycling considerations.

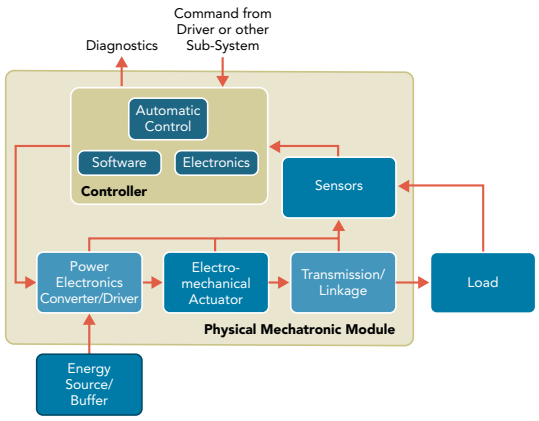
So how does mechatronic system design differ from these conventional approaches? First, remember that mechatronics is the synergistic integration of physical systems, electronics, controls and computers throughout the design process. The difference lies in the conceptual design step where an integrated system emerges rather than a conglomeration of add-on parts.

This integration embraces both hardware components and information processing. In evaluating design concepts, you need to substitute a modeling-and-analysis approach for the conventional design-build-and-test approach. In addition, your modeling must be multidisciplinary and cut across domain boundaries. For a specific conceptual design, optimization must be performed with respect to defined criteria.

The payoffs can be enormous. With the mechatronics design approach, you can replace bulky, complex mechanisms featuring cable-connected components with simple, compact mechanisms with bus or wireless communication. Instead of massive, slow-moving, stiff constructions, mechatronics gives you light-weight, electronically-damped, fast-moving, elastic systems. And you achieve accuracy through measurement and feedback control rather than through narrow tolerances.

The mechatronics' design approach is becoming increasingly responsible for some of industry's most impressive innovations. Imagine being able to store the uncompressed contents of the Library of Congress on a single standard computer hard disk. That is where Seagate's heat-assisted magnetic recording technology is headed. Disk drive manufacturers are striving for higher data-storage density and higher data-transfer rates. However, they'll achieve those goals at lower cost only through an integrated mechatronic system design, with innovative control schemes and additional sensors and actuators.

Similarly, the automotive industry is developing mechatronic modules, smart actuators that can be optimally combined to form mechatronic systems. We'll explore such case studies, and the potential benefits of mechatronics, in future columns.



System diagram for an automotive mechatronic module featuring a smart actuator.

Watch the new Mechatronics' webcast, "Unleashing the Internal Combustion Engine through Mechatronics": http://rbi.ims.ca/5384-506