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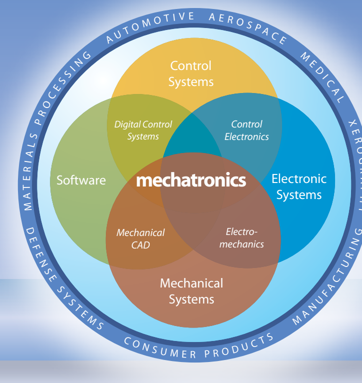
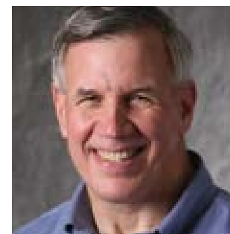
MECHATRONICS IN DESIGN

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



Handling the World Wide Web

Before the WWW, engineers were handling webs at astonishing speeds



BY KEVIN CRAIG

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The word *web* means different things to different people. To some, *web* conjures up images of Spider Man with his astonishing web, while for most others, it is the pervasive World Wide Web. However, for many engineers, the word *web* brings to mind the pervasive and astonishing material web used in many processes that make the majority of the products we all use. Let's explore this overlooked material-handling application that is indispensible in so many diverse industries. And while we are doing that, let's ask the question why there is a gap and time lag between the latest technological advances in web handling and actual industrial practice, an observation not unique to this application.

Web-handling machines are universal and operate with incredible speed and accuracy.

The economic advantage of manufacturing a material continuously instead of in batches is clear. The inputs and throughputs to continuous manufacturing processes are usually webs. A web is defined as a long, thin, flexible material with negligible bending stiffness about two of its three axes. Major classes of web materials include film, foil, food, paper, nonwovens, rubber, textiles and composites of these. Materials range from centimeter-thick metals to micron-thick plastics, widths range from single thin strands to more than 10m, and line speeds range from mm/min to more than 2,500 m/min. The goal of web handling is getting a web through a machine as fast as possible with minimum damage and waste, while preserving the web's properties. Web manufacturing forms the raw-material web (e.g., paper making, film extrusion, textile spinning), while web converting (e.g., coating, laminating, printing, sheeting) takes one or more web materials and permanently alters them in some fashion either by changing material properties or causing geometrical/physical changes. Web manufacturing and converting are often done by a combination of mostly art (trial and error) and a little bit of science, depending on the industry. However, all webs follow the same laws of physics — if we know the physics, we know the behavior! Web handling is an exact science with model-based design rules; all webs behave fundamentally the same way when pulled through a machine under tension. There even exists a wealth of literature and experts (e.g., D.H. Carlson, 3M Corp. P.R. Pagilla, Oklahoma State University, and M.D. Weaver, Rockwell Automation) in this area. Monitoring and controlling web velocity and tension is a common web-handling challenge.

The use of a model-based design approach, rather than a trial-and-error design approach, is fundamental in modern mechatronic system design. Why is this approach not more widespread when applied to webs? There is a gap, and time lag, between the academic/research world and the world of industrial practice. More than 10 years ago, Dennis Bernstein wrote an article in the IEEE Control Systems Magazine entitled "On Bridging the Theory/Practice Gap." It was timely then and even more so now. In this article, he outlines that both sides contribute to the problem.

So what needs to happen to bridge this gap? Academic rigor and the best practices of industry need to be merged in an understandable, usable way for innovation to occur and result in tangible advances. On the academic side, professors need to get out of their comfort zone and make each course — from freshman year through the graduate programs — not just a textbook course but an up-to-date fusing of academic rigor and best industrial practice with actual industry case studies as examples. Too hard, too challenging? This is what transformational engineering education is all about. On the industrial side, companies need to recognize that their competitive advantage comes from an inspired, educated workforce and that should be their primary concern. Too often the training budget is the first to be cut with the view that technological advances somehow arrive with the morning newspaper. Too harsh an assessment? I do not think so and I do not believe the rest of the world thinks so either.

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