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GUEST EDITORIAL

Special Issue: What is Concurrent Engineering?

WILLIAM P. BIRMINGHAM[1] AND ALLEN WARD
Electrical Engineering and Computer Science Department, The University of Michigan, Ann Arbor, MI 48109, U.S.A.
Mechanical Engineering and Applied Mechanics Department, The University of Michigan, Ann Arbor, MI 48109, U.S.A.

Concurrent engineering (CE) is fundamentally about producing better manufactured things. Initially, most research and implementation concentrated on improving communications within design teams. Research has become more diffuse, and definitions for CE abound. This issue does not attempt to provide a single or unifying definition. Indeed, the whole notion of CE has so imbedded itself in the psyche of both academia and industry that defining it becomes as difficult as defining manufacturing itself. Instead, we have chosen to collect a series of research articles on new directions in CE research that articulate part of a broader vision of what CE is and where it should head, and short essays on the state of CE and how these papers relate to it.

As observed by Tetsuo Tomiyama in the first paper of this issue (which constitutes a second and more eloquent introduction), concurrent engineering can be seen historically as an American attempt to understand, implement, and surpass the best Japanese product-development practices. Alternatively, CE can be seen conceptually as an effort to integrate all aspects of design, marketing, finance, and production, by performing *simultaneously* many activities that used to be done sequentially. In either view, the goal is improved quality, reduced time-to-market, better financial structures (including improved procurement), and a host of other improvements.

Most concurrent engineering efforts focus in one way or another on improving communication. Examples of these efforts include collocating (both physically and electronically) and dedicating development teams; appointing strong, integrating project managers; and constructing procedures, such as Quality Function Deployment, to facilitate joint work among different parts of the team. These efforts have achieved major successes, and encouraged both new research activities and large-scale efforts at radical redesign of manufacturing companies, such as Ford Motor company's new effort toward a worldwide engineering and design group.

Ironically, however, Toyota, which appears to have started modern concurrent engineering, uses neither collocation nor dedicated teams. Furthermore, Toyota suppliers have less frequent communication with the OEM than those of other companies (Ward et al., 1995). (This is not to say that Toyota and its suppliers do not communicate well; merely that communicating more is not synonymous with communicating better.) Communication is not free, with its most important cost being the time of those who must receive and process the communications. This suggests there is more to the issue of concurrent engineering than simply increasing the amount of communication. In particular, CE research may be confronted with a fundamental problem: changes made from one perspective, quickly communicated, may cascade, engendering more changes from other perspectives and burying the organization in change.

Our aim in this special issue is, therefore, to facilitate the emergence of a new generation of concurrent-engineering research that goes beyond facilitating communication to addressing in more detail the content of communication; that work toward a new, general theory of distributed simultaneous decision making.

THE GENERAL THEMES OF THE ISSUE

As one might expect, given this goal, the resulting research is so diverse as to resist simple summary. The issue begins with a Japanese perspective on concurrent engineering by Tetsuo Tomiyama, which serves so well as an introduction that we have shortened our planned comments here.

Next, a paper by Mike Wellman proposes a powerful perspective on distributed optimization: the explicit use

[1] Reprint requests to: William P. Birmingham, Electrical Engineering and Computer Science Department, The University of Michigan, Ann Arbor, MI 48109, U.S.A. Telephone 1-313-936-1590, Fax: 1-313-764-2560, E-mail: wpb@eecs.umich.edu.

of economic models and bidding processes to coordinate the efforts of multiple agents.

Three papers—by Hayes and Sun; by Peña-Mora, Sriram, and Logcher; and by Kuokka, Jefferson, Barford, and Frayman—focus on representing the interactions among agents—the constraints they impose on each other—and the actions that agents should take once they recognize conflicts.

Jin, Christiansen, and Levitt then boldly undertake to create a detailed computational simulation of the communication and decision processes of an entire organization engaged in CE, searching for insights into the costs and benefits of various kinds of communication.

Finally, Finger thoughtfully reviews the experience of perhaps the largest academic group studying concurrent engineering, exposing a number of pitfalls in such research and providing suggestions for the field.

THE FUTURE

The service CE research provides to industry should be increasingly powerful and important. As frequently observed, we face a technological revolution as profound as the industrial revolution itself. The industrial revolution mass-produced farm machinery, transforming the majority of the populations of Europe and North America from agricultural small-holders into urban employees in a generation or two (and in the process throwing a quarter of the population out of work throughout the Great Depression). It thereby created "management science"—the study of how to organize large numbers of people performing repetitive tasks for companies they do not own.

The information revolution is having similar effects, which have not yet peaked. The populations of the advanced countries are again being transformed, from closely supervised wage laborers performing repetitive tasks into quasi-independent agents collaborating with a myriad of other human and computational agents to create new products and processes using approaches, organizations, and technologies that change within a single product cycle. Ultimately, concurrent-engineering research is about how these agents are to work together. It may replace all conventional wisdom about management in a fusion of technology and human aspirations far more intimate and effective than any ever dreamed by the advocates of Taylor's "scientific management."

When manufacturing technology was first developing, the emphasis of a corporation was on producing better manufacturing machines. As the machines got better, and the technology they are based on became more widespread, the use of that technology, in particular processes, became more important [e.g., better control systems, better use of people operating the machines (quality circles), and so forth]. We are now starting to realize, as the airline industry did years ago, that the creation and management of knowledge is the primary competitive advantage of a company. CE is evolving as a primary technology for supporting this process, and thus is a strategic technology.

REFERENCE

Ward, A., Liker, J., Sobek, D., Cristiano, J. (1995). Toyota, concurrent engineering, and set-based design. In Liker, Ettlie, and Campbell, *Engineered in Japan: Japanese Technology Management Practices* (Liker, Ettlie, and Campbell, Eds.). Oxford University Press, Oxford, United Kingdom.

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