Chapter 8.2
Vision, Trends, Gaps and a Broad Roadmap for Future Engineering

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ABSTRACT

New challenges result from the virtualization and distribution of product development activities. This article analyzes problems of cooperative engineering as well as methods and tools for the virtual engineering of extended products. Based on these analyses, a broad road map is proposed that articulates public- and civil-sector roles in coping with future engineering challenges. With a strategic horizon, the public-sector role targets the creation of a knowledge-intensive global business ecosystem conducive to balanced civil-sector innovation and sustainable growth. The civil-sector roles evolve tactics that implement proven cooperative and virtual engineering practices with a focus on value creation.

INTRODUCTION

This road map has been drafted on the basis of gaps identified at two expert workshops organized by the IMS (Intelligent Manufacturing Systems) NoE Special Interest Group 6 on Collaborative Engineering of Virtual Products. A first workshop took place during the IMS Forum held in May 2004 in Como, Italy. A second took place during the Design of Information Infrastructure Systems for Manufacturing (DIISM) Conference in Octo-

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ber 2004 in Toronto, Canada. The input of these workshops have been analyzed and positioned in a strategic research and technology development road map with specific attention to articulating requirements that are aligned to stakeholder needs and opportunities offered by technology.

E-collaboration solutions in product life cycles promise to increase value for stakeholders, to shorten time to market, to handle the increasing complexity of products, and to lower the costs of development and ownership. In cooperative engineering (CE) the focus is on the organizational aspect of product development. In virtual engineering (VE) the focus is on the technological infrastructure that enables and supports CE and the life cycles of extended products.

The three-cycle model of product development (Gausemeier, 2004) identifies the major issues of holistic product development as strategic product planning, virtual product development, and virtual production system development. Both the organizational and technological perspectives matter for all these cycles. Moreover, both perspectives extend into the social domain: Product stakeholders also affect the product life cycle via regulations, transportation, marketing, usage, repair and upgrade, take-back, and recycling and disposal, and there is a need for intimate information sharing among all product and production stakeholders (Kimura, 2005).

Increasingly strong social demands and constraints and environmental considerations direct manufacturing activities and product use to be more resource saving and environmentally benign. Moreover, industry must be globally competitive. Information technology promises to accommodate both requirements (Kimura, 2005).

With a focus on total benefit and cost of ownership, and socioenvironmental impacts, the socioindustrial global community must adopt a practice of collaborative product development, and it must achieve a high maturity level in obtaining and structuring data and knowledge from external and internal sources. A powerful e-collaboration environment bundling VE methods and solutions, tools, and infrastructure must enable advanced practices.

VISION, TRENDS, ENABLERS, AND PRACTICES FOR FUTURE ENGINEERING

A Global Context and its Emerging Vision

Over the past decade, the international community has articulated desirable outcomes, including social and environmental ones. It has achieved consensus about global development goals, such as the Millennium Development Goals[1] (Sachs et al., 2005), and environmental targets, such as the Kyoto Protocol. Reporting frames such as that of the Global Reporting Initiative[2] help organizations to report on environmental and social outcomes in addition to profits or losses. In the new growth paradigm, the precompetitive and postcompetitive phases of the knowledge production process (Yoshikawa, 1994) can be addressed in a more mature manner. The paradigm recognizes the broad context within which products are developed and production capabilities develop. The paradigm also admits ICT's enabling role in achieving development goals such as sustainability and inclusivity. Kimura (2005) lists critical issues for the result-focused management of knowledge in the pre- and postcompetitive phases of product life cycles. Virtual and cooperative engineering require institutions, solutions, and practices regarding knowledge and idea flows that cannot escape the public-civil context.

The emerging vision is to achieve, society-wide, an excellent level of holistic harmonization and fit of technologies, organizational concepts, and company and market culture. The "improvement of the state of manufacturing industries as a whole" envisioned in the IMS[3] program (Yoshikawa, 1994) includes industries' ability to respond