Editorial

Special issue on multi-agent and holonic systems in manufacturing

The manufacturing sector has been facing major challenges as it undergoes revolutionary changes fuelled by new and sophisticated demands from customers, global competition, distribution of manufacturing and marketing activities, and technological advances. In order to address these challenges, manufacturing enterprises need to change the way they do business and adopt innovative organizational forms, technologies, and solutions to increase their responsiveness and production efficiency.

Current manufacturing systems are complex distributed environments that require collaboration between software, hardware, human, and organizational systems. It is crucial to keep a balance between the technical aspects of automation and the human and social facets when applying information technology in industrial applications; particularly with the rapid advancements in information and communication technologies (particularly Internet- and Web-based technologies) and the wide deployment of automated manufacturing systems. However, creating appropriate frameworks for exploring the best synergies between humans and automated systems represents numerous issues in terms of processes characterization, modeling, and development of adequate support tools.

A series of IFIP sponsored BASYS conferences—International Conferences on Information Technology for Balanced Automation Systems in Manufacturing and Services—have been organized to promote the development of "balanced automation systems" in an attempt to address these issues. BASYS'06 was the 7th edition in its series and was held in Niagara Falls, Ontario, Canada on 4-6 September 2006. Its technical program consisted of three keynote papers and 49 regular papers organized in four focused tracks: multi-agent and holonic systems in manufacturing; networked enterprises; integrated design and assembly; and monitoring and control.

This special issue consists of nine selected and expanded papers from BASYS'06, primarily based on the first track on multi-agent and holonic systems in manufacturing. These papers report on recent research and development efforts concerned with various aspects of implementing multi-agent and holonic systems in manufacturing: from physical device level control, production process planning and scheduling, process execution, to virtual enterprises (VEs) and supply chain management.

Barata et al. present the design and implementation of an agent-based control architecture to support modular reconfigurable production systems. The requirements for plugability of modules (manufacturing components) and product changes are considered and tested against an educational platform that resembles a production system composed of several workstations connected by a crane and conveyors.

Soundararajan and Brennan describe the design and development of a simulation-agent interface for real-time distributed control system benchmarking. Their paper focuses on the development of a hybrid physical/simulation environment that can be used to perform tests at both the physical device level and the planning and scheduling level.

Maturana et al. present their efforts on the development of an agent infrastructure called autonomous cooperative system (ACS) and its evolution into an agent virtual machine by absorbing the agent functionality into the controller's firmware. The proposed agent virtual machine is demonstrated through a shipboard automation example.

Leitão and Restivo present their holonic approach to manufacturing scheduling where the scheduling functions are distributed by several entities, combining their calculation power and local optimization capability. The objective is to achieve fast and dynamic re-scheduling using a scheduling mechanism that evolves dynamically to combine centralized and distributed strategies.

Hao and Shen propose a hybrid simulation approach, using both discrete event simulation and agent-based coordination technologies, to model complex material handling processes in an assembly line. JIT principles are applied to both the production and the material handling processes.

Osomório and Camarinha-Matos discuss a distributed process execution platform for collaborative networked organizations based on requirements of two application projects, proposed a strategy for a supporting technological infrastructure, and present a framework to handle different life cycle phases of collaborative process definitions.

Kaihara applies agent negotiation to VE creation by formulating a VE matchmaking model as a discrete resource allocation problem and propose a market-
oriented programming framework based on the economics of complex systems.

Forget et al. propose a multi-behavior planning agent model using different planning strategies when decisions are supported by a distributed planning system. The proposed solution was implemented through an experimental agent-based platform dedicated to supply chain planning for the lumber industry.

Contreras and Sheremetov present an agent-based service-oriented approach for industrial applications integration in business processes. The proposed framework combines Web services and intelligent agent technologies orchestrated by a business process management system. It is demonstrated through an industrial application scenario from petroleum wells’ drilling.

Intelligent software agents and their applications in manufacturing have been studied for about two decades and holonic manufacturing for about 12 years. Industrial applications are still rare compared with other technologies such as distributed objects and Web-based technologies. This likely due to the fact that the majority of research and development work in this area has been done within the academic community. This situation may change since Foundation for Intelligent Physical Agents (FIPA) joined IEEE as one of its standards committee, which means that the FIPA specifications will be converted to IEEE standards.

However, the future of agent-based and holonic manufacturing is full of challenges. Some difficult problems remain unsolved, e.g., full integration of manufacturing process planning, scheduling, and control, particularly integration with real-time information from data collection systems.

Many researchers working on agent-based and holonic manufacturing are still focusing on the fundamental research to enhance the rationality or intelligence of software agents and develop more efficient and effective coordination and negotiation mechanisms. While this kind of research is important and still needed, we believe that the future R&D work should focus on the integration of agent-based planning and scheduling systems with existing (legacy) systems used in manufacturing enterprises, including the integration with real-time data collection systems and the integration with existing ERP and MRP systems. Furthermore, it is necessary to better integrate human-based and automation-based approaches. Only when such integrations are achieved and validated in industrial settings, will the agent technology be widely applied in manufacturing industry.

(Guest Editors)
Weiming Shen
Integrated Manufacturing Technologies Institute,
National Research Council Canada, 800 Collip Circle,
London, Ontario, Canada N6G 4X8
E-mail address: weiming.shen@nrc.gc.ca

Luis M. Camarinha-Matos
Faculty of Sciences and Technology,
New University of Lisbon,
Monte de Caparica, 2829-516 Caparica, Portugal
E-mail address: cam@uninova.pt

Robert Brennan
Schulich School of Engineering,
University of Calgary,
2500 University Dr. N.W. Calgary,
Alberta, Canada T2N 1N4
E-mail address: rbrennan@ucalgary.ca