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Holonic and Multi-Agent Systems for Manufacturing

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Preface

The increasing complexity of manufacturing systems as well as the overall demands for flexible and fault-tolerant control of production processes stimulates (among many others) two key emerging technologies that are already making an important breakthrough in the field of intelligent manufacturing, control, and diagnostics. These two paradigms are:

- the **holonic approach** based on the event-driven control strategy, usually aimed at modular control systems that are directly physically linked with the manufacturing hardware equipment, and
- the multi-agent approach developed in the area of distributed information processing.

The research communities working in both these fields are approaching the problem of intelligent manufacturing from different viewpoints and, until recently, to a certain extent, in an independent way. We can however observe quite a clear convergence of these fields in the last few years: the communities have started to cooperate, joining efforts to solve the painful problems involved in achieving effective industrial practice. We can see convergence in the terminology, standards and methods being applied.

The shift in the focus of holonic research over the last five years is significant: Whereas Phase I of the HMS (Holonic Manufacturing Systems) Consortium project was aimed primarily at low-level real-time control and resulted, for example, in the IEC 61499 standard for real-time function-block oriented holonic control, the proposals for Phase II of this consortium are much more concentrated on agent-based control solutions, including knowledge management methods, simulation tools and standards developed by the multi-agent community within the framework of the FIPA consortium activities. The best evidence of this trend is the title and contents of the recently published book

M.S. Deen (ed.): *Agent-Based Manufacturing –Advances in the Holonic Approach,* Springer-Verlag, Heidelberg, 2003

On the other hand, the multi-agent community realizes to a much wider extent than before that one of the most challenging areas for the application of the agent-based information and decision-making systems is the field of intelligent manufacturing. More and more agent-based systems have started to appear in the manufacturing domain, for simulation, production planning and scheduling goals, and for reconfiguration purposes. In the latter, coalition formation and teamwork planning methods are often applied for this purpose. This trend is strongly supported by the challenging visions of virtual manufacturing and virtual enterprises. The other important emerging challenge is the opportunity to consider each product or semiproduct as an agent/holon – this vision is supported by, for example, the recent results of the AUTO-ID initiative aimed at integrating RFID tagging technology with a global information network.

We should stress that the convergence mentioned above is catalyzed mainly by real industrial needs: a very high flexibility in changing production plans and schedules, real-time fault detection and reconfiguration capabilities, as well as allowing

autonomous subsystems to be easily integrated with various kinds of communication networks are stressed more and more. Satisfying these more complex and demanding requirements needs an exploration of knowledge-intensive solutions as well as the leveraging of the current communication and database technologies. The holonic and multi-agent ideas support trends towards higher degrees of local autonomy connected with larger volumes of knowledge "owned" locally in the control elements, and towards more powerful processors (capable of running real-time, ladder-logic types of code as well as higher-level code written, for example, in C++ or Java in parallel) and Web-enabled devices.

Many topics important for agent-based manufacturing are still in the early stages of their research. This is the case in, for example, semantics and ontologies (it would be desirable to use technologies similar or compatible to those in the Semantic Web area, but this seems to be currently more than difficult), or applying holarchy principles in the agent-oriented solutions.

We hope that the first three HoloMAS workshops held under the DEXA-event umbrella (HoloMAS 2000 in Greenwich, HoloMAS 2001 in Munich and HoloMAS 2002 in Aix-en-Provence) helped to bridge the gap between the holonic and multi-agent communities. The interest of both the camps has been increasing and because we have seen there is a chance to cover the whole scene, we decided to transform the HoloMAS workshop into a conference, the **1st International Conference HoloMAS 2003** within the framework of the DEXA 2003 event. We are very thankful to the DEXA Association (Linz, Austria) for supporting the conference idea from the very beginning and to the EU Centre of Excellence MIRACLE at the Czech Technical University of Prague for general support.

We are very glad to declare that 43 papers were submitted, prepared by the most important research bodies engaged in holonic and agent-based manufacturing world-wide to HoloMAS 2003. The PC chose 29 papers to be presented and included in this volume. They contain the most representative results of the corresponding research inside and outside the HMS consortium and provide an excellent overview of the current situation in this subject's research field.

The HoloMAS 2003 conference created an excellent, highly motivating environment, and helped to integrate the community. We believe that it contributed to a better clarification of the goals and to a more efficient coordination of the research in this subject field. The conference also aimed to serve as a display window of holonic and agent-based manufacturing research, offering information about the state-of-the-art to specialists in neighbouring, knowledge-processing research fields covered by the DEXA multi-conference event.

Prague, Cambridge, Leuven
June 2003

Vladimir Mařík
Duncan McFarlane
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HoloMAS 2003

1st International Conference on Industrial Applications of Holonic and Multi-agent Systems, HoloMAS 2003

Applications of Holonic and Multi-agent Systems

Prague, Czech Republic, September 1–3, 2003

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