USING INFORMATION TECHNOLOGY IN MANUFACTURING ENGINEERING

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Abstract: The paper deals with the application of Information Technology (IT) in order to develop the virtual enterprise within the area of Manufacturing Engineering. The research project called Toronto Virtual Enterprise (TOVE) and the generic reference architecture and methodology (GERAM) are presented. Based on the results of these projects a multi-agent oriented networking system for CAD/CAPP/CAM has been defined.

Keywords: CIE, virtual enterprise, DAI, networking system.

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1. INTRODUCTION

The main outcomes of the area of Computer Integrated Enterprise (CIE) are the definition and the development of the virtual enterprise based on information technology. Generally, a virtual organization uses computers to access information, data and knowledge. The evolution of the computer science together with the communication industries allows working more closely each other over massive divides of space and time and brings a new potential to the companies.
The integration can be obtain as follows:

?? The design of a better organization structure that integrates decision-making process;
?? The development of Concurrent Design and Manufacture Environment;
?? The development of an integrated supply chain management system.

The development of Concurrent Engineering Systems implies the following items:

?? Designing of multi-agent systems formed by intelligent agents for concurrent design, process planning and scheduling;
?? Using World Wide Web as communication medium for sharing information and knowledge;
?? Incorporating powerful tools based on the following intelligent computational methods: fuzzy logic, artificial neural networks and genetic algorithms;
?? Integrating the software systems for CAD/CAPP/CAM into an advanced intelligent software system that will support the enterprise engineering functions.

2. THE CURRENT STATE-OF-ART OF CIE

2.1. TOVE – Toronto Virtual Enterprise

Within the Enterprise Integration Laboratory from Department of Mechanical and Industrial Engineering of the University of Toronto, Canada, researches related to enterprise integration have been accomplished. These researches include enterprise modelling, concurrent engineering and integrated supply chain management (Fox, 1996). TOVE research project is described within (Fox, 1992) and at http://www.ie.utoronto.ca/EIL/
The outcome of the project is an environment based on the methods and techniques of Distributed Artificial Intelligence (DAI). DAI deals with the intelligent agents that are basic computational entities implemented as distributed hardware and software systems called multi-agent systems.
Enterprise modelling defines the actions and the constraints for plans and schedules that satisfy the goals of the enterprise. For enterprise modelling the theory of complex actions is used. Within (Gruninger & Pinto, 1995) the theory of complex actions for enterprise modelling is dealt with. TOVE

has been used to model two enterprises: a computer manufacturing enterprise and an aerospace engineering company. The software tools used to develop are as follows: C++ environment and Rock™ knowledge representation tool.

2.2. Generic Reference Architecture of an Enterprise

Based on the results of TOVE project, and CIM-OSA model developed within the ESPRIT program of the European Union, the GERAM (generic enterprise reference architecture and methodology) has been developed. This architecture covers all types of enterprises and it is a framework which incorporates the previously systems (Bernus & Nemes, 1996). The generic reference architecture and methodology contain the following items:

?? The architecture should cover all activities involved directly and/or indirectly in designing of the organization structure of the enterprise;
?? The development of a modelling environment;
?? The existence of a detailed methodology according to the enterprise engineering process;
?? The description of a unifying perspective for designing and manufacturing activities that implies an effective communication mechanism between these activities.

3. APPLYING INFORMATION TECHNOLOGY

3.1. Multi-agent oriented Networking System

The virtual environments can be developed as multi-agent systems because the DAI technology offers the possibility of autonoumous operations.
The multi-agent networking system within the area of manufacturing engineering includes intelligent agents which support the designing and manufacturing activities and communicate.
The intelligent agents area is divided in agent theory, agent architecture and agent languages according to (Wooldridge & Jennings, 1995). Applying this theory in manufacturing engineering, and the practical approach described in (Balasubramanian & Norrie, 1996) the architecture of a manufacturing system that facilitates concurrent engineering has been defined. The architecture is shown in figure 1.

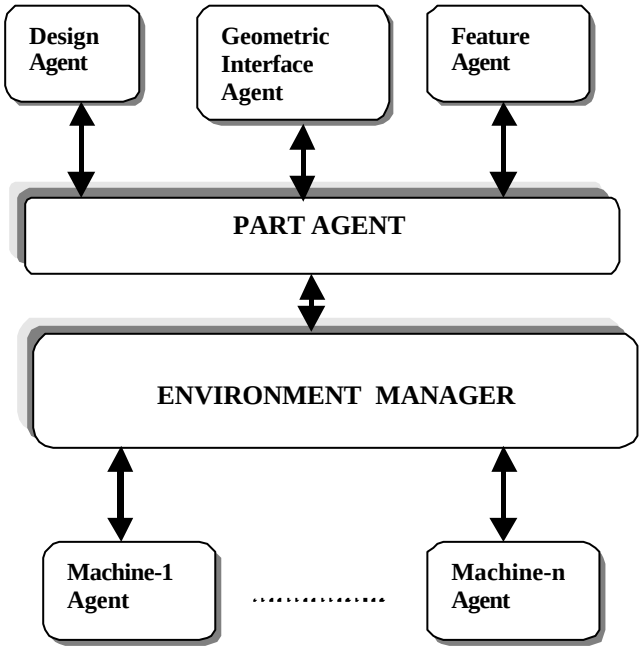

Fig. 1. Architecture of a multi-agent system for manufacturing engineering

The design agent uses a CAD system for geometric part representation. The practical solution could be one of the followings:

?? Autocad that runs on PC;

?? software systems such as Catia, or Pro//Engineer™ that run on graphical workstations.

The geometric agent acts as an intermediary environment for translating information between geometric part representation and the manufacturing features of the part. Feature agent describes the geometric and technological constraints. The feature-based modelling is based on feature extraction or/and design by features.

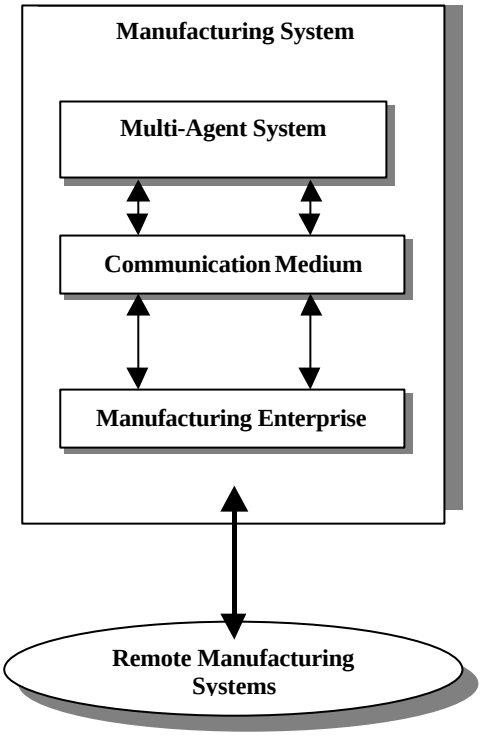

Fig. 2. General organization of a multi-agent networking system

The Part Agent dynamically updates and maintains the information and data converted into knowledge related to the part description. The knowledge representation is dependently by the class of part processed (rotational, prismatic, etc.) and technological constraints. Within an intelligent manufacturing system the knowledge representation methods are the objects or/and the frames which provide an integration of CAD and CAPP systems. This is directed to obtain a concurrent system for design and process planning. The Environment Manager is defined as the co-ordinator agent. The machine agents select, sequence and cluster the operations in order to obtain the process plan of the part. Within the system every agent has an independent function but at the same time communicates with other agents concurently. The communication between intelligent agents is implemented using communication languages (Wooldridge & Jennings, 1995)

The general organization of the multi-agent networking system of a manufacturing enterprise is presented in figure 2.

In order to develop these systems it is possible using the Computer-Assisted System Engineering (CASE) tools based on the object-oriented method of programming. For e.g. the Rational Rose products that use some specific object-oriented modelling techniques. These software products are based on industry open-systems standards and also support the C++, Visual Basic, and Java™. The Rational Rose family product improves the productivity of software developers and provides an integrated standard solution for software changes, and management. They run on Windows or Unix systems.

4. CONCLUSION

The contributions of the paper are related to:

?? the definition of the virtual enterprise in manufacturing engineering;
?? the definition of a multi-agent oriented networking system based on IT as an open medium;
?? dealing with some practical development solutions that could be a basis for the further realization of the manufacturing system as virtual environment.

The future researches will include the complexity of the virtual enterprise defined as dynamic and chaordic system.

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