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ASPECTS OF AN DIGITAL MASTERED MANUFACTURING SYSTEMS

Project driven manufacturing systems become more and more importance because the customer expects to get tailor-made not uniform solutions. Furthermore increasing automation and computerisation helps to make machines and devices more efficient, safty, ergonomic and human but also more complex. The technical progress and competion reduce the life cycle times. Production processes have to be able to realise this increasing individuality and exibility. Summerised project driven manufacturing systems are charakterised by intensiv design related activities, order based production and high customer specic products.

On the one hand, there is no question, project driven manufacturing systems make special requirements on the organisation of the supply chain networks and costumer relationships, the internal and external information and communication systems, the interfaces between this systems, the production planning and control process and the way of handling uncertain information in every level of planning. On the other hand there are usable methods and technologies as results of resaerch and development, like MAS (Multi Agent Systems), Neural Networks and Fuzzi Logic as methods developed by Articial Intelligence. There are also simulation and virtual reality systems as efficient aswell as effective planning support tools. In addition actual scientific research activities for example in the fields of planning under uncertainty and multi objective production control offers also new posibilitys to solve problems of project driven manufacturing systems.

This paper will give an overview what is the state of the art in project driven and digitally masterd manufacturing systems and will also give an idea what will be done in future.

1. INTRODUCTION

The trend of globalisation brings two challanges for enterprises. On the one hand there are possibilities for using of region-based vantages e.g. cost structures, infrastructure ore human ressources. On the other hand the customer demand and the pressure of competition for a single enterprise loose their regional limitations.

Customer requirements on products and services have to be fullfilled and become more and more individual. To get competition vantages by globalisation requires a cost structure and infrastructural suppositions based specialisation on the core competences. The decrease of the added value of the enterprise at one location or in one enterprise is

direct connected. Therefore the number of involved enterprises for the production of goods increases. The coordination effort for control the process along the supply chain also increases. The information systems are heterogeneous, used in the participating enterprises of the supply chain. Therefore a trubble free information exchange could be handicapped often.

The changing from supplier driven to demand driven markets brought that no longer cost vantages and technology make enterprises mainly competitive but short time-to-market cycles and high quality based on customers requirements. Individualised products indicates, that the economic of scale becomes less importend and short througput cycles in combination with alternate demand requires the ability of enabling flexible manufacturing systems and supply chain networks [1].

2. REQUIREMENTS ON MANUFACTURING SYSTEMS

Short time-to-market cycles as one of the main goals for the manufacturing process make high demand on the planing systems through the whole life cycle of a production system. It beginns with the planning and designing of the manufacturing system. It continues during the using phase of the system. Also the reengineering processes of manufacturing systems are affected.

The more and more establishing supply chain networks have three basic characteristics. They are:

- dynamic,
- complex, and
- intransparent.

To solve the challenge of dynamics, enterprises have to reacting on customer demand in shortest times. Therefore it is nessesary, that both internal and external planning and controll activities are coordinated. The integration of new suppliers has to be realised in shortest times. It has to be possible procuring additional or new manufacturing capacitys with the planning systems.

The complexity depends on the much higher number of participated enterprises and their most different IT infrastructure and systems. In transparency concludes first of all the disability of total deterministic modelling of manufacturing systems. Not all a process influencing factors are known. Some of the relations between the known factors are also not complete describable. Therefore the planning base is mostly uncertain and inaccurate.

3. ENABLING TECHNOLOGIES

There were developed technologies and methodologies, which can adapt for solving the problems of the discribed problems. A selection of important ones will be reflected more detailed. These are multi agent systems, fuzzy logic and neural networks. They were summerised normaly under the term "artificial intelligence".

3.1. Multi agent systems

Intelligent multi agent systems (MAS) are software programes existing on a number of software agents. The MAS is integrated in a defined system environment. Every software agent has one or more objectives, a knowledge base, including rules for

objective oriented behavior, and communication interfaces, enabling them to exchange informations with system users or other software agents. A single agent has the ability to act independently and flexible in the defined environment fulfilling its objectives. (Fig. 1).

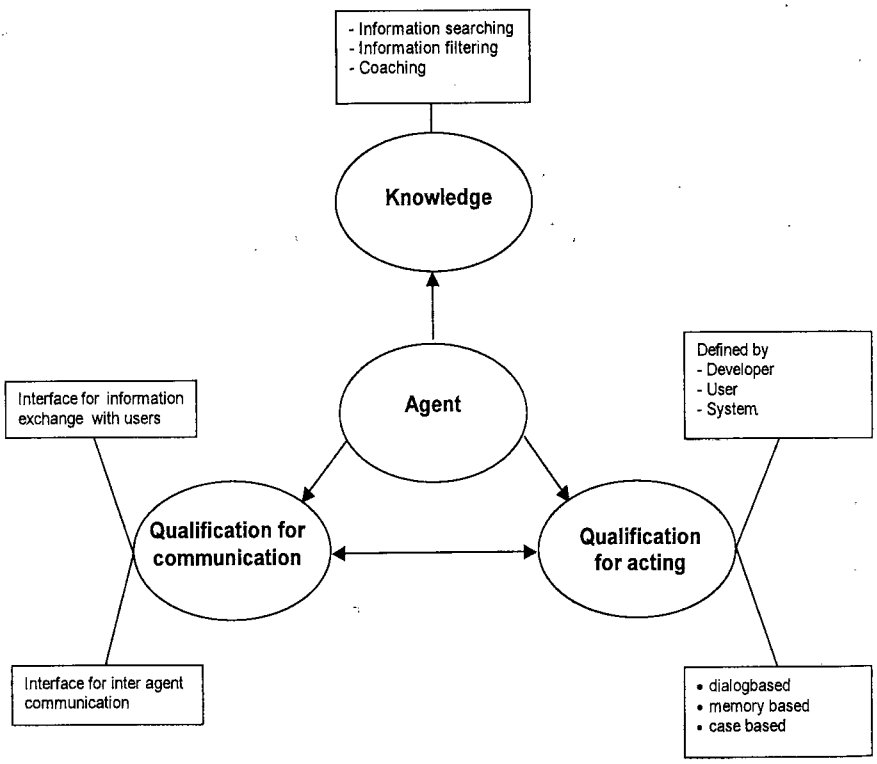

Fig. 1: Agent model

The agent can get his knowledge base from the developer of the MAS, from the user or from the system, e. g. by heredity. Furthermore an agent can get additional knowledge during his existence by sensing the environment or communicating with other agents [3].

Independency means, that an agent is able to act for fulfilling his objectives without direct intervention from the user or other agents. Flexibility summarises the three characteristics reactivity, proactivity and social. [7]

- *Reactivity* includes the capability of sensing the environment for objectiv oriented reacting.
- *Proaktivity* means beyond it the capability of acting punctual and purposeful if the situation it requires in the course of fulfilling their tasks.
- A software agent behaves *socia,l* if he goes in contact with other software agents or system users independently, when the fulfilling of its tasks it requires.

Multi agent systems gives the possibility, fulfilling tasks independent and purposeful in complex and distributed information systems on bahalf of their characteristics. Additional they can relieve the users from regular control and supervision of systems by their ability of autonomous acting.

The service grade of such systems arises because:

- The error rate goes down,
- The availability of functions arises and additional
- Individualised services can be delivered.

Multi agent systems can be used in several levels of information systems for coordination and control [7]:

- System or terminal level
- Internal networks
- Networks between enterprises

At the system level agent systems can be used for administrate and maintain interfaces to internal and external systems. The interfaces can be permanent supervised and in the case of failure the agents initiate alternatives. Additional agents can serve as „sub contractor" for agents of higher levels

Agents in internal networks can be used for automating of business processes. They can process direct in workflows, e. g. generating manufacturing orders based on customer oders. Otherwise agent systems at this level can used for production planning by negotiating machine capacities and resource demand [8]. Other approach is the usage of agent systems for regulating resources for the network administration.

At the level of external networks agents are useful for maintain relationships between enterprises and for external ressources procurement. For this solution agent systems will become in future basic for the network architecture.

3.1.2. Neural networks

Artificial neural networks are software programmes, simulating in a similar way biological nerve systems. existing of a large scale of connected single components, called processors, simulating artificial neurons. The processors receive signals throug the connections from other processors. The incoming signal will be modified inside this neuron and after then sended out. The ratio between incoming and outgoing signal is called "weight". Artificial neural networks have the ability of changing this ratio. By doing this in a senseful way, it is called learning [5].

The learning process depends on exercised examples. The aim of this process is building up a function represented by only a limited number of points in each example. Every example has to depend on the same rules. The learning process ends when the founded functions are quit equal.

The essential advantage of this software technology is the posibility of relativly reliable progoses, based on limited, incomplete and uncertain information without the knowledge of the real rules of the analysed system.

As noticed ahead nowadays enterprises have to make decisions in a dynamic changeable environment represented by incomplete an uncertain information about it. Therefore the senseful integration of artificial neural networks can deliver more reliable information for decision-making.

3.1.3. Fuzzi logic

Under the term "fuzzy logic" were different concepts summarised. Fuzzy logic is indicating in a narrower sense as a specific application of blurred sets, an extension of the classical boolean logic. The aim is representing uncertain information and deriving conclusions on blurred coherences.

In a wider sense under the term "fuzzy logic" are summerised all on blurred sets based fundamental concepts, e.g,. fuzzy control or fuzzy linear programming. In this way fuzzy logic is a methodology to generalize any specific theory from a discrete to a continuous form [6], [9].

On the one hand, there is with fuzzy logic the possibility of creating decisions with information systems in a human like way. On the other hand, fuzzy logic enables users to build complex coherences in an easy way without the knowledge of the concrete deterministic rules. Therefore fuzzy logic is an usefull methodology to solve problems of handling blurred and uncertain information.

3.3. Digital factory

The digital factory is a concept of virtual modelling and simulation of manufacturing systems with a focus on technological aspects. It depends on three levels:

- Geometrical model of the manufacturing system within all its components,
- Dynamik model of the manufacturing systems,
- Modeling and simulation of the process technologie of the manufacturing system.

It enables planner and decision makers planning the optimisation of a manufacturing system without an real changing in this system. Futhermore the involved planners, developers or machine and tool suppliers don't have to be at one place during the whole planning process. With it changing processes can be realised faster.

Main problem of this concept is the collection of the needed informations from each system component. In furture it will be possible, that special devices at the machines, e. g. an embedded systems, will deliver this system data in the requested form.

The models used for virtual modeling and simulation is not only usable for the planning process for which they were built up. The concept of digitaly factory make sense if the used models are regulary updated in the case of changings in the system and reuseable for every planning or changing process during the whole life cycle of the system [2]. The consequent and general utilisation of simulation for product development and process design make it possible to minimise the risks of planning and the period of development.

Today the focus of the digital factory is the graphical demonstration in virtual reality. There can be observed the movements and courses, sometimes in a way it is not possible in real systems.

4. OUTLOOK

Information and decision support systems are aimed to support decision makers by detecting deviations from a pre defined model. The model was developed based on the goals of the enterprise. The ranking, imortances and dependences of the goals are related to the environment of the enterprise. Changings in the environment requires

proving the goal system and the related system models. Now a day the reaction time span between a change in the environment and the implementation of a modified system model is even long. Permanent watching of the environment combined with the possibility of automatical prooving on the related models for required changings will become more and more essantial, because of the high dynamic environment.

Planning of manufacturing systems is often processed sequencly. At first different version of systems are assessed from the technical side. After then a small number of the technical senseful solutions will be assessed from the economical side. The risk of these procedure is that economic senseful solutions could be eliminated in the first step. The risk of inaccurate planning results arises, if the used informations for planning are uncertain because in general uncertain information will be made certain befor using.

A way out is a parallel planning procedure were every version of a plan will be assessed technically and economically by using uncertain information as certain ones. This requires that systems processing economical data, e. g, ERP.systems, have to be integrated in the systems of the digital factory for technical modelling and simulation in the planning process. In addition methods for handling uncertian or inaccurate information have to be used.

5. CONCLUSION

The trend of project driven manufacturing systems brings several new challenges. Multi agent systems bring advantages for the integration of heterogeneous and distributed information systems and make planning and control processes in supply chain networks more efficient.

Neural network support the handling of uncertain und inaccurate data or informations. Fuzzy logic make it possible to support decision making based on inaccurate data and rules.

The virtual modeling and simulation can rationalise the planning of manufacturing systems basicly. It would become more efficient by using systems supported remodeling and parallel planning procedures.

If the integration of the introduced methodologies and technologies will succeed in a senseful kind, a large step on the way to a digitally mastered manufacturing system will be done.

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