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Co-operative production planning for small- and medium-sized enterprises

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Abstract

Minimising manufacturing cost and production time parallel to raising the quality and the shipment reliability are important challenges in every production system. In case of distributed production systems the management of the above-mentioned criteria has great significance and needs a complex, co-operative handling of the problems. A new, co-operative manufacturing network model is proposed for co-ordinating the production of Small- and Medium-sized Enterprises (SMEs), based on the holonic paradigm. The paper introduces the main modules of the model succinctly and describes an application under realisation in Hungary, in an agricultural SME network, pointing its economic benefits as well.

Keywords: Co-operative planning; Economic benefits; Network modelling; SME; Virtual enterprise

1. Introduction

On the present level of market competition, enterprises have to organise themselves into effective production system architectures in order to be able to fulfil the market demands. These system architectures can be realised only by using computer networks for production management in order to co-ordinate the production of the distributed manufacturing units.

There are different approaches, different names (agile, biological, fractal [1], holonic, etc.) for production-, or manufacturing systems that basically cover the same idea: a flexible network of co-operating autonomous manufacturing units. The holonic manufacturing system is an approach for a theoretical framework for autonomous and decentralised manufacturing organisations based on the classical holonic theory introduced by Koestler [2].

The holonic production system is a system of co-operating holons that are organised to achieve a production goal. This system integrates the whole range of activities from booking the orders through design, production and marketing to form an autonomous and decentralised production organisation. According to the holonic organisation paradigm the manufacturing environment is going to transform itself into a holonic system as

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openness, flexibility and similarity in building blocks are vital advantages. The virtual enterprise is a practical instantiation of the holonic paradigm in the form of a multilayer, open, flexible (through continuous, dynamic re-configuration) network.

The structure of a virtual enterprise can be seen as a holarchy, i.e. it is a temporary, goal-oriented aggregation of several individual enterprises. Each virtual enterprise is created to pursue a specific business objective, and remains in life as long as this objective can be pursued. After that, the individual nodes resume their independence from each other. The resource of a node that was previously allocated to the expired business is re-directed toward the node's individual goals, or toward other virtual enterprises.

The original virtual enterprise (VE) model has been developed for decomposing large companies that have enough financial, human and organisational resources. The decomposition is based on functions that can result in replications across the network.

In the Planning Small–Medium Enterprise Networks (PLENT) project (ESPRIT Project No. 20723) a more practical, more appropriate approach of the virtual enterprise has to be realised for Small- and Medium-sized Enterprises (SMEs). For the customers the network reflects the framework of a big company, a big economical organisation which can provide complex products associated with bigger capital and professional knowledge, while the basic functions of the SME that are important for their independence remain intact. In such a distributed manufacturing environment the production planning has a key role. The co-ordination of the orders, the optimal assignment of the different resources in a co-operative production of several SMEs is a very difficult task.

The SME network development work is done in the framework of the PLENT project with the participation of firms from Italy, Greece, Hungary and Spain. The main goal of the project is to support organisations that manufacture mechanical parts and products in SME-like production environments.

The paper introduces this management philosophy and the network model briefly then describes a special application of the manufacturing network model for agriculture production (oil and seed production).

2. The SME Network

2.1. "*As-Is*" *characteristics of SMEs*

Several geographic regions can be characterised with special industrial organisational structures called SME. These SMEs are well-known for their dynamic behaviour, but their prosperity, and sometimes their existence, is continuously exposed to risks of the limited investment capability, the difficulty of diverting skilled personnel from day-by-day activities, to undertake process re-engineering initiatives and to the lack of advanced planning support tools specifically conceived for them. Because of these reasons it is really a hard problem for the SMEs to give proper answers to market challenges. The co-ordination of the different SMEs' production in the case of producing a product jointly generates similar problems as in the case of large firms, but the solution is different [3].

SMEs seem to be appropriate units to behave like network nodes because of their lean structure, adaptability to market evolution, active involvement of versatile human resources, ability to establish sub-contracting relations and good technological level of their products. One negative feature of the co-ordination is the traditional individualistic attitude of SMEs. This attitude leaves each enterprise completely alone in facing marketing, purchasing, design, engineering and technological innovation problems. In addition, other problems arise from historical distrust between enterprises traditionally in competition with each other.

These observations are confirmed by the requirements analysis carried out in Task 1.1, and documented by Deliverable D1 of the PLENT project [4]. Some of the examined SMEs are, or have been involved in distributed manufacturing experiences, but their attempts have not until now produced the expected benefits. This is mostly due to the lack of a co-operation model allowing the different nodes to behave as a whole, at the same time preserving their autonomy. Studying and realising this model, along with the software tools required