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PREFACE

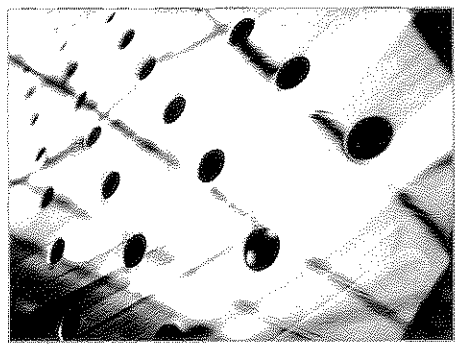
Manufacturing systems of our days work in a fast *changing environment* full of *uncertainties*. Increasing *complexity* is another feature showing up in production processes and systems, furthermore, in enterprise structures as well. One of the recent areas of research is related to the *globalization* of production; *production networks* are formed from independent companies collaborating by shared information, skills, resources, driven by the common goal of exploiting market opportunities.

The scope of the *IFAC Technical Committee (TC 5.2) on Manufacturing Modelling for Management and Control* became of fundamental importance for production enterprises. One of the most vital features of the factories is their ability of cooperation, quick responses to changes and disturbances. These are matters of survival, independent of the size of the firms.

This year topic of the traditional *IFAC Workshop on Manufacturing Modelling, Management and Control (MIM'07)*, i.e. *Real-time Cooperative Enterprises* is really timely. The importance of the field is manifested also in the fact that in the same area an Invited Session is being organised for the *17th IFAC World Congress*, July 6-11, Seoul, Korea.

The Preprints contains 38 accepted papers grouped into the following 8 sessions:

- Modelling,
- Digital Factory,
- Control and Monitoring of Manufacturing Processes,
- Manufacturing Systems,
- Assembly Systems,
- Production Planning, Scheduling & Control,
- Real-time, Cooperative Enterprises,
- Supply Chains & Production Networks.



It is a special pleasure for the organizers that the representatives of two running European research projects took the opportunity of reporting on their main goals and achievements at the Workshop, namely the projects *Digital Factory for Human-Oriented Production System (DIFAC)* and *Automotive Chassis Development for 5-Days Cars (AC-DC)*. At the same time, the Workshop also serves as the closing, international event of the Hungarian National R&D project on *Real-time, Cooperative Enterprises (VITAL)*. The participants of the VITAL project are keen to present their results to the international audience.

We hope that all the participants of MIM'07 coming from diverse scientific and industrial communities will find this event intellectually stimulating offering an opportunity to address the above important challenge of contributing to a coherent framework of real-time, cooperative enterprises.

Special thanks are due to the members of the International Programme Committee of the workshop, particularly to *Professor Francois Vernadat*, Workshop Chair, and *Mr. István Salekovics*, Industrial Chair.

Last but not least, we would like to express our gratitude to *Mrs. Éva Thiry*, Workshop Secretary, for her enthusiastic and unflagging contribution.

Prof. László Monostori
Host-Chairman of MIM'07
Chairman of IFAC TC 5.2

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INTELLIGENT SUPPLY CHAIN CONTROLLING WITH A DATA WAREHOUSE REFERENCE MODEL

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Abstract: In this paper Supply Chain Management for intelligent manufacturing systems with the support of a data warehouse reference model is introduced. A reference model is a tool of knowledge management and a good means to provide supply chain management decision makers with current supply chain management theory. Since controlling systems are based on information technology, it seems to make sense to deliver this knowledge in the form of a data warehousing reference model, to facilitate DWH based controlling solutions right from the beginning.

Keywords: Architectures of intelligent manufacturing systems; Supply Chain Management, Data Warehousing, Controlling, Reference Modelling

1. INTRODUCTION

A data warehousing (DWH) reference model (i.e. a conceptual multidimensional data model) for the problem domain of supply chain controlling has been developed at the Institute of Management Science at Vienna University of Technology. Supply chain controlling supports supply chain management by providing models and information that enables logistics managers to identify, evaluate and monitor decisions in the context of supply chain networks. To develop a state-of-the-art model for intelligent manufacturing systems a literature survey was performed, resulting in a set of management approaches, modelling standards (e.g. SCOR) etc. This provides insight into the management issues that are found in theory and practice and therefore determine the content of the data model.

The introduced reference model has its focus on the data modeling content on the conceptual layer and therefore is constructed according to the multidimensional meta-model. Furthermore, some design guidelines and options for data warehouse architecture are outlined.

2. SUPPLY CHAIN CONTROLLING

Supply Chain Management (SCM) is a still evolving discipline that is under permanent development and in many areas lacks a solid theoretical foundation. According to controlling theory, Supply Chain Controlling (SCC) is put in place to support Supply Chain Management by providing relevant knowledge and information.

A state-of-the-art model has been developed to increase the understanding of supply chains and to integrate current management concepts and instruments bringing the following results:

- Structure and elements of modern supply chains are directly built into the new developed data model that is presented in the paper.
- Management and modeling approaches for supply chains such as Efficient Consumer Response (ECR), Collaborative Planning Forecasting and Replenishment (CPFR), Supply Chain Operations Reference Model (SCOR) and so on, that again provide the basis for the model content.

Further subjects that have been addressed were the information technology building blocks found in current supply chains (such as Enterprise Resource Planning and Advanced Planning and Scheduling software) and the changing role of logistics service providers in supply chain management to develop architectural guidelines for the data warehouse.

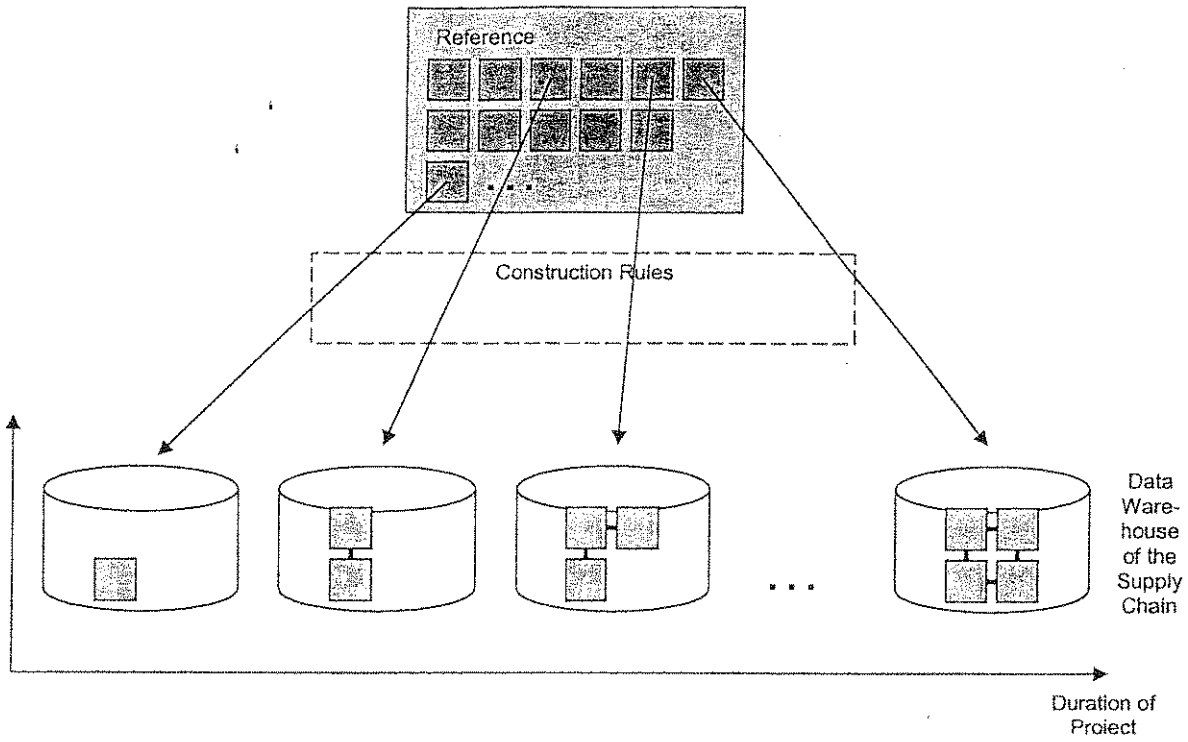

Fig. 1: Construction of a data warehouse using a reference model

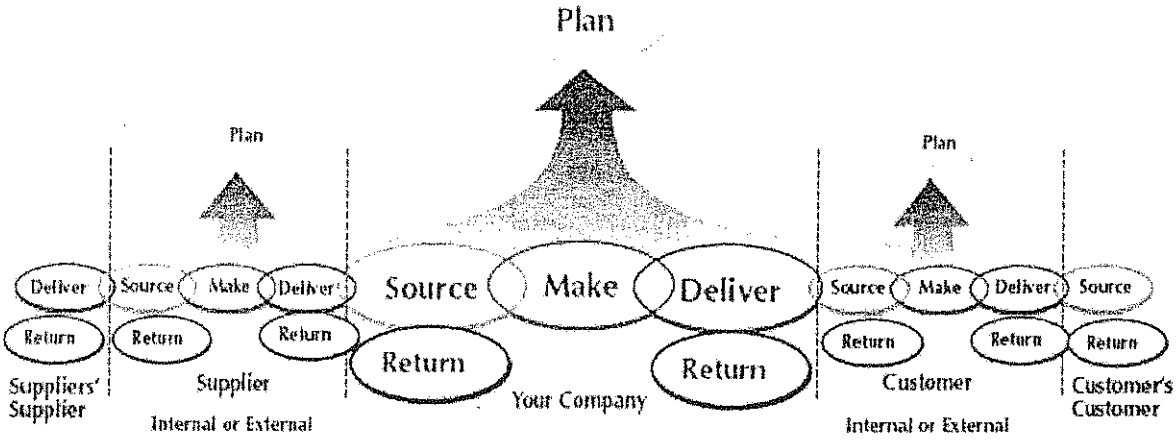

Fig. 1: Structure of the SCOR model

Within supply chain controlling, some specific approaches and instruments have emerged, whose examination constitutes the second part of the chapter on supply chain controlling.

3. DATA WAREHOUSING

There is some recent development in data warehouse development processes and requirements analysis in data warehousing that influence the overall structure of the reference model to be created:

- The long lifetime and broad scope of a data warehouse makes specifically designed development processes necessary which are highly iterative.
- The process of identifying information needs of the data warehouse customers needs to be analyzed to define those phases and activities that are supported by a DWH reference model.
- There are many approaches for actually creating a multidimensional data warehouse data model (ADAPT, DFM, UML dialects, etc.) These have been examined to decide which to use for modeling.

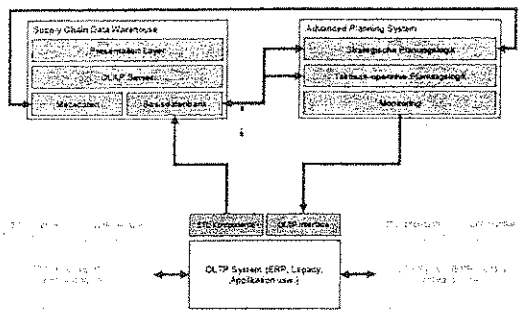

Fig. 2: Architecture Model for the support of operative functions

The content of the data base should be prepared in such a way that it can be used for Advanced Planning Systems (APS)

The architecture model should provide all the master data (e.g. product and material informations, parts lists, supplier data or customer data) and transaction data (material stock, lead time) for the Advanced Planning System.

4. THE REFERENCE MODEL

The main idea behind the DWH based supply chain controlling approach presented here, is to initially provide a generic supply chain model and product component model template that can be incrementally augmented with additional model content (like finance or warehousing) that consistently integrates with the previous as well as the future model content because it builds on a common supply chain topology model. For example, the DWH development can focus on process modeling in early phases of the project and then put an emphasis on information about stocks of physical goods in subsequent phases. This allows for better integration of information on different management domains and better creation of new domain knowledge by using interactive Online Analytical Processing (OLAP). The core reference model includes a supply chain network, a product component tree and a set of views containing problem-subdomains (like process management or finance).

Data are depicted as cubes – so called „data cubes". These „data cubes" contain key figures that represent events, activities, or other facts of interest. To categorize and organize the central facts, they are allocated to dimensions e.g. geographical regions, product groups etc.

This is due to the fact that the DWH modeller does not constraint the data warehouse model, because the reference model structure allows for making less assumptions and premises about the object under examination – that is, the supply chain. Furthermore, the supply chain model has to be built using the multidimensional model structure to consistently embed it into the multidimensional DWH model.

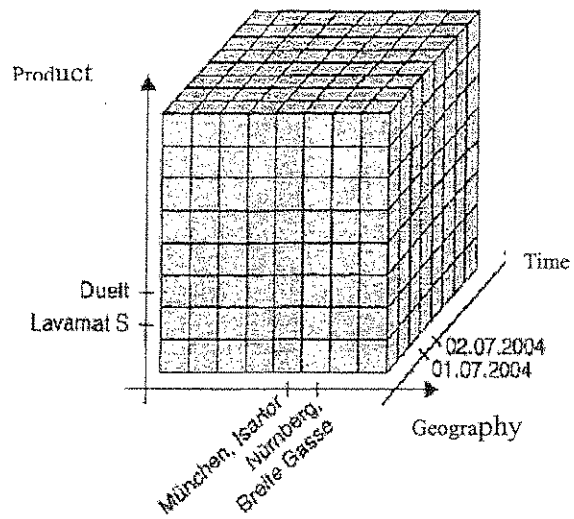

Fig 3: Online analytical processing (OLAP)

The reference model consists of several parts:

- Supply Chain Network: the supply chain network describes the topology of the supply chain and – in its initial form - is simply constructed from edges and vertices (i.e. a graph) that show peers (organizational units within the supply chain of a certain granularity and abstraction level) and interactions between them.
- Product Component Tree: this model basically is a gozinto-graph showing how the components that are flowing through the supply chain are eventually combined into the finished product. The combination of components in order to produce a component of higher value is performed within certain peers within the supply chain network. These links between components and peers have to be explicitly modelled.
- Views: views group model elements of a certain subject (processes, material flow, finance etc.). The idea is to analyze and model a certain subject as isolated as possible during the development of the DWH. A view consists of dimension hierarchies and facts (a defined by the multidimensional metamodel). Elements of different views may be connected among each other to make it possible to extend an existing data warehouse data model using content from a new (i.e. previously unused) view and to perform OLAP operations on facts based on these extended dimension hierarchies.

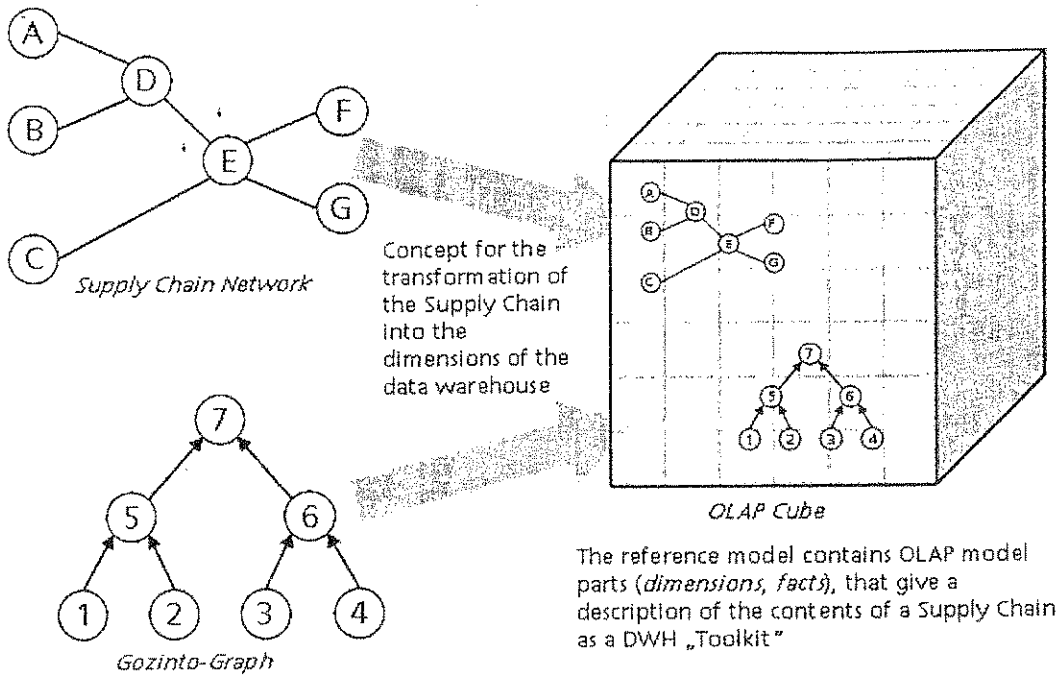

Fig. 4: Elements and structure of the Data Warehouse Reference Model

CONCLUSION

This paper describes a conceptual, multidimensional data warehousing reference (DWH) model that is intended to be used for supply chain controlling (SCC). To accomplish this, the reference model content contains concepts to represent modern supply chain networks and production processes in order to make this domain knowledge applicable for logistics and supply chain experts in a well defined and technology based fashion.

The main areas of analysis are supply chain management and supply chain controlling, data warehousing and the methodology of reference modelling. Starting from a review of generic approaches to controlling and a system theoretical analysis of company networks, supply chains as company networks in production and logistics as well as current supply chain management and modelling (e.g. SCOR) approaches are examined. Another section is dedicated to data warehousing (DWH) as the underlying technology. Besides a review of DWH development processes, DWH requirements analysis methods and DWH architectures, an evaluation of data warehouse modeling standards (e.g. ADAPT, UML dialects, DFM) is a key part. A section on reference modeling methodologies provides the actual procedures to develop the reference model.

The development of the DWH reference model is performed in several steps. Supply chain controlling and the institutionalization of supply chain controlling within company networks as well as architectural guidelines to integrate a data warehouse with the distributed IT landscape of the supply chain constitute the first step. Then the key parts of the reference model are specified: the supply chain network model, the product component tree and the six views for processes, information flows, material management, cooperation interrelations, finance and time measurement.

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