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Demand and Supply Chain Simulation in Telecommunication Industry by Multi-Rate Expert Systems

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***Abstract*—**In modern telecommunications industry, demand & supply chain management (DSCM) needs reliable design and versatile tools to control the material flow. The objective for efficient DSCM is reducing inventory, lead times and related costs in order to assure reliable and on-time deliveries from manufacturing units towards customers. In this paper the multi-rate expert system based methodology for developing simulation tools that would enable optimal DSCM for multi region, high volume and high complexity manufacturing environment was proposed.

***Keywords*—**Demand & supply chain management, expert systems, inventory control, multi-rate control, performance metrics.

I. Introduction

SUPPLY chain management (SCM) [1] is the combination of art and science that goes into improving the way your company finds the raw components it needs to make a product or service and deliver it to customers.

A supply chain is a coordinated network of entities that transforms raw goods into finished products. The entities that make up a supply chain are typically producers, manufacturers, distribution centers, and customers. The overarching goal of demand & supply chain management (DSCM) is to produce the right products, in the right quantities, at the right time, at minimal cost. DSCM is the process of planning, implementing, and controlling the operations of the supply chain with the purpose to satisfy customer requirements and internal targets as efficiently as possible. DSCM in telecommunication industry connects component suppliers, inbound logistics, manufacturing and work-in-process, finished goods and outbound logistics to customers.

In this paper an approach to use multi-rate expert systems in supporting decision making in inbound logistics and production planning was analyzed and discussed. The resulting effects are visible thru improved key performance indicators (KPIs) in related DSCM phases.

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II. Inbound Material Flow

Modern telecommunication assembly manufacturing plant is continuously working with 30 to 50 component suppliers and 300 to 400 different components.

Component lead times could vary from few hours to several weeks.

To minimize component buffers and tied-up capital in supply chain, planning and timing the components availability plays significant role (see Fig. 1).

Practical actions to improve efficiency in SCM are as follows.

- Set up continuous visibility to channel inventory and sell through.
- Share the demand information in the whole chain continuously.
- Plan and execute based on end user demand.

Difference between gross and net demand requirements are illustrated in Fig. 2. To minimize the risk for components availability in case of demand fluctuations, supplier managed inventory (SMI) is often used. Through SMI the focus is shifted from monitoring single deliveries to monitoring stock levels. SMI component buffers will be kept near to manufacturing unit, providing necessary flexibility. Against forecasted demand, suppliers follow gross requirements and keep the component levels between agreed minimum and maximum levels. Traditional min & max levels are between 7 to 14 days.

Keeping 14 days components in buffer ties-up lot of capital. Our intention with current paper is to prove that multi-rate expert systems could help big manufacturing units release the capital from unnecessary component buffers by increased efficiency in demand-supply planning and demand-supply network (DSN) management.

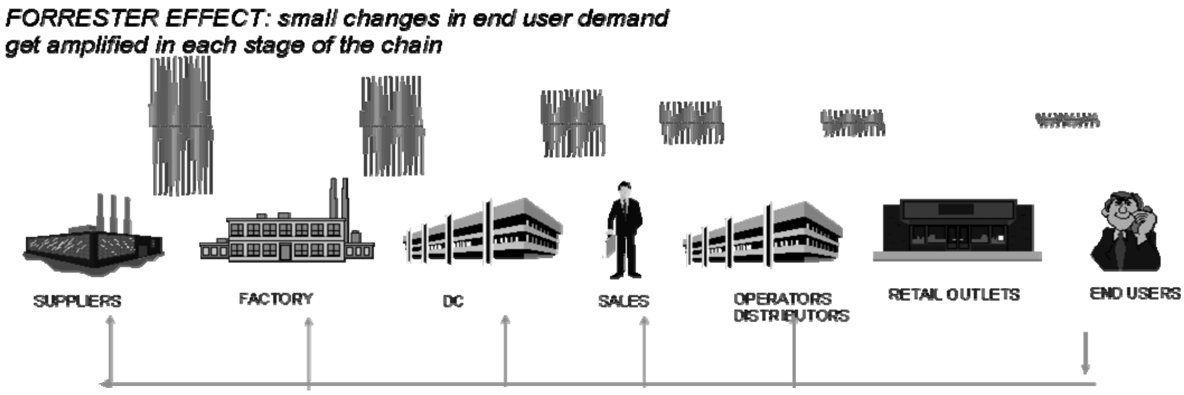

Fig. 1 Forrester effect

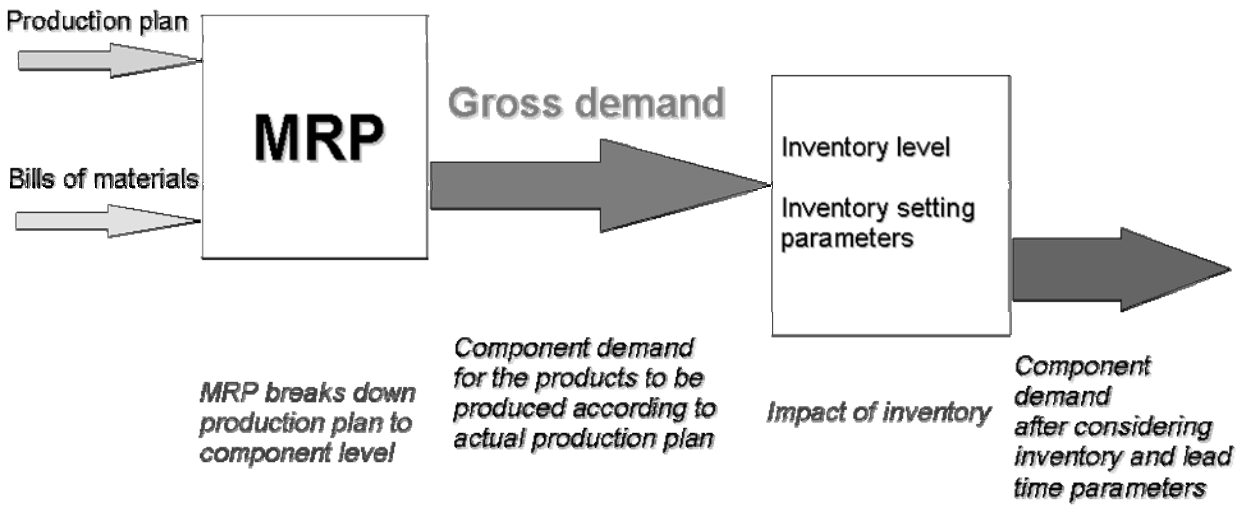

Fig. 2 SMI achievable by gross requirements

III. Expert Systems for Supporting DSN

This chapter gives a short overview of the different applicable techniques and methods which could be useful for self-optimizing concepts and structures for supporting expert systems in DSCM. They can be divided into sub-symbolic and symbolic methods [2].

A. Sub-Symbolic Methods

Well known methods are based on neural net approaches. They are influenced by the brain and today there are many different kinds of nets explored. The greatest property of neural nets is the learn ability [3]. The net can be trained by different training methods like supervised learning, unsupervised learning and reinforcement learning. Different algorithms are considered and the downside of neural nets is also focused.

B. Symbolic Methods

Representing knowledge in a concrete form is the goal of symbolic methods. They are influenced mainly by artificial intelligence (AI) approaches [4]. The AI starts with symbols which represents parts of the world. These approaches lead to the so called symbol grounding problem of AI. The problem is the linking of real world properties to symbols. Such applications as fuzzy systems [5]-[6] and expert systems [7] were chosen from practical effectiveness.

C. Multi-Rate and Hybrid Systems

The basic methods mentioned above have their advantages and disadvantages. There exist different approaches to combine them to get synergy effects. Here optimizing methods similar to neural nets optimization and fuzzy logic will be focused. Some existing systems are evaluated for the purpose of self-optimizing systems.

The combination of neural nets and fuzzy logic has different goals. First of all the ability to learn of neural nets and the white box behavior of fuzzy systems should be combined to get a learnable and symbolic interpretable overall system. Introducing multi-rate control will enable us to define component level decision making priorities that are necessary for the tied-up capital and on-time deliveries management. Further more the knowledge should be readable for a human and the usage of a priori knowledge like mentioned in the introduction. These approaches are distinguished into multi-rate neuro-fuzzy systems and hybrid neuro-fuzzy systems.

IV. UCM Structuring

The information processing of a self-optimizing DSN management system has to implement a lot of functions: quasi-continuous code has to control the physical motions of the material flow, fault-detection software has to monitor the demand balancing, adaptation algorithms fit control parameters to altered demand fluctuations, etc.

To structure the complex information processing the user-controller-module (UCM) has been designed [2]. The UCM consists of three parts: the controller module, the reflective operator, and the cognitive operator.

In this structure of information processing of DSN systems the practical application of neuro-fuzzy algorithms onto the three different level of the UCM was evaluated. Fig. 3 demonstratively shows a localization example of a neuro-fuzzy optimization process in the more cognitive user part, and an adoption of the optimization process to the reflective user part.

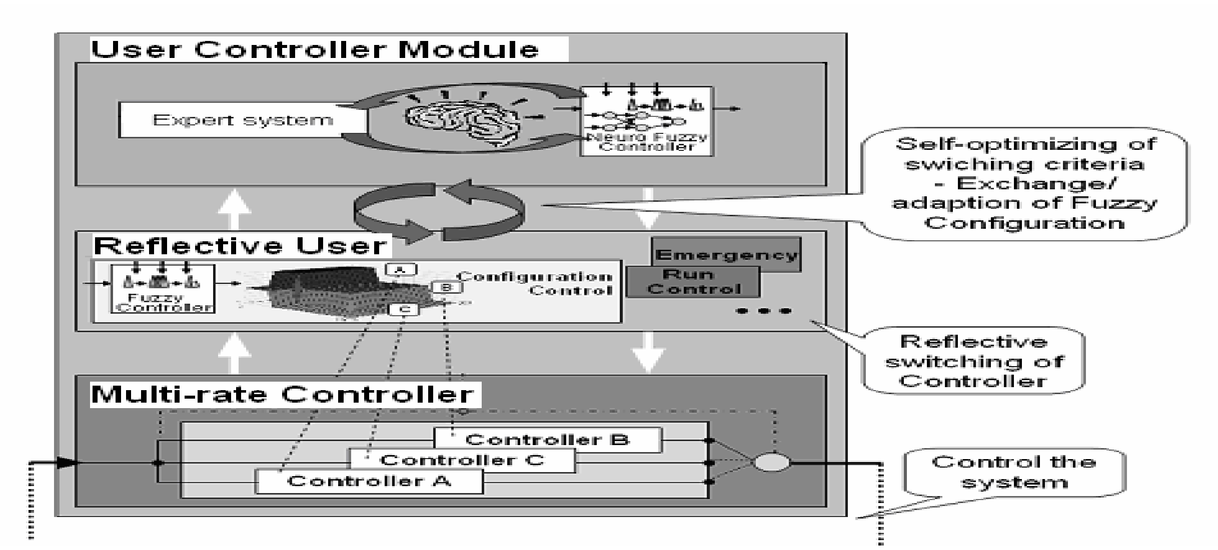

Fig. 3 Example for localization of fuzzy approaches

The different fuzzy configurations can be extracted and stored in an expert system. The expert system itself can restore configurations optimized before. So a next step should be to extend the expert system with case-based reasoning capabilities to make use of existing cases in mind of alikeness to the actual problem and to adopt the original case solution to the new situation.

Also it is possible to extend the expert system with the opportunity to communicate with other UCMs and exchange configuration information [8]. So a hierarchy of UCM can communicate and exchange fuzzy models.

V. Conclusion

In this paper the approach for the integration of a multi-rate expert system into a DSCM in the modern telecommunications manufacturing environment was presented. The background information for the demand and supply network and practical approach for the expert system set-up and implementation were proposed.

This approach enables the expert systems development and specific simulations to evaluate new possibilities for future DSN enhancements.

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