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SIMCHRONIZATION: A METHOD SUPPORTING THE SYNCHRONISATION OF INFORMATION AND MATERIAL FLOWS

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ABSTRACT

Highly productive and fast reacting supply chain networks require a tight and instantaneous coupling of their information and material flows. The application of the presented approach *SIMchronization* reveals these complex and highly dynamic interactions by using a domain-specific graphical modeling language and behavior-describing rule sets in combination with a discrete simulation algorithm. One output of the simulation's animation component is a set of automatically generated models, so-called 'State Flow Diagrams.' A 'State Flow Diagram' shows information flows, like sent messages, and corresponding material flows, like processed parts, numbered according to their occurrence in the respective period. A comparison of two diagrams from different periods illustrates the development of stock levels and helps synchronize the supply chain. The diagrams are an easily comprehensible and appropriate means to communicate operative implementation concepts of newly designed or modified supply chains.

1 THE STATIC SUPPLY CHAIN MODEL

The *SIMchronization* method helps analyze and synchronize the chronological sequence of material and information flows in a supply chain. The approach was initially developed to study various effects on e-maintenance supply chains, but it is applicable in nearly any logistic related environment.

The analytical part of the method is based on a combination of a graphical model depicting the supply chain's structure with behavior-describing rules of its objects and involved partners. To describe the static model of a supply chain network we developed a domain-specific graphical modeling language. The names and basic semantics of some of the modeling classes are adopted from the SCOR (Supply Chain Council Inc. 2010) model's process structure. To model the material flow and describe the processing of logistic parts the following modeling symbols are provided: 'Source,' 'Store,' 'Make,' 'Transport,' 'Deliver,' 'Reader' and 'Switch.' The class 'Plan' is used to describe both production planning and centralized supply chain control processes. Material and information flow channels connect interacting objects in the network. These channels are used to transfer parts from one object to another or to communicate via messages or calls.

Some supply chains are implemented by using Auto-ID solutions as radio-frequency identification (RFID), optical character recognition (OCR) or barcode technologies. A 'Reader' object in cooperation with a 'Plan' object is able to transfer specific data to and from a logistic part or its attached tag. As a consequence, the analysis of autonomously controlled logistic processes is supported by the method.

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2 THE RULE SETS

The behavior of different supply chain partners, especially in case of changing system conditions, is a complex and highly dynamic interplay of actions and reactions. A graphical modeling language alone is not appropriate to model all possible alternatives. Therefore, the static graphical model of the supply chain structure was combined with formal rules, which describe the resulting behavior of supply chain elements in certain situations. We developed a textual rules language that provides useful commands to affect the information and material flow of a supply chain model. For example, in a centralized control scenario a rule set of a 'Plan' object monitors sales volumes of a 'Deliver' object, and sends out corresponding order messages to a 'Source' object via an information flow channel.

3 THE SIMULATION

To reveal the dynamics of a supply chain network a discrete simulation algorithm is applied to the static model and the behavior-describing rules. The simulation algorithm considers a priority and event sequence, periodically reads out the rule set of an object and forwards it to a rule engine. The rule engine evaluates the rule set immediately and returns the output to the simulation algorithm. As a result message-like production orders, or inquiries, are created and corresponding parts are moved by the simulation. During the simulation the flow of parts through the supply chain is animated. After a simulation run the report generator provides quantitative data, like lead time and activity based costs. To support the understanding and the communication of newly designed or modified supply chains, the simulation's model generator creates a state flow diagram for each individual period. Figure 1 shows a small state flow diagram including information flows (messages and calls are depicted in red) and material flows (parts are depicted in beige) numbered according their occurrence in the respective period.

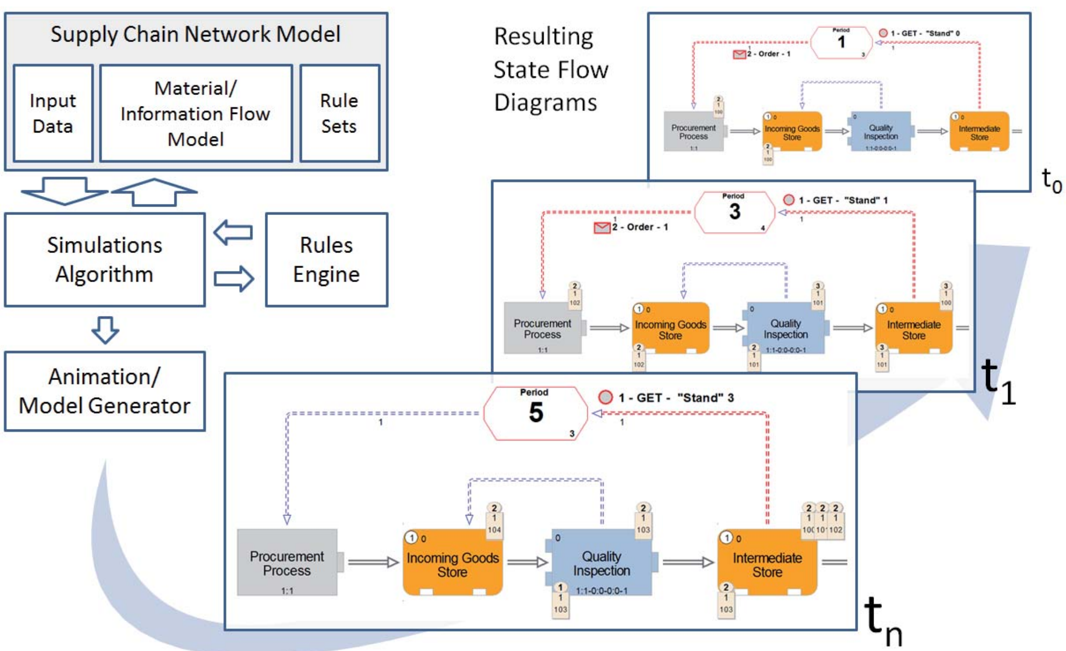

Figure 1: The *SIMchronization* method

REFERENCES

Supply Chain Council Inc. (2010). Supply Chain Operations Reference (SCOR®) model; Overview - Version 10.0.