The MISSION Project

Demonstration of Distributed Supply Chain Simulation

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Abstract: Supply chains bring specific tasks to simulation. As long as the simulation is performed at a very high level, the simulation can be done in the traditional way. But, for detailed simulation the competence from the single chain elements has to be incorporated into the models. This can be done best by the local engineers. Up to now, integrating local models into one complete model was time consuming and error-prone. Even more critical, local maintenance of partial models was inhibited. A new approach solves this problem, and furthermore provides encapsulation, if supply chain partners do not wish to publish details of their node to other partners. The interfacing description generates XML files, which provide a specification of each supply chain node and its interfaces, too.

1 INTRODUCTION

Global Enterprises have to face new ways of distributed work. Within this huge field, MISSION focuses on the Manufacturing Engineering process and, furthermore, on simulation. The global approach is enhanced by the integration of three regions from Japan, Europe and USA. The E.U. and U.S. partners have defined a common architecture, called the MISSION General Architecture. The European demonstrator architecture is one instance of the MISSION general architecture (MISSION http://).

The demonstrator illustrates the connection between different simulation models as well as between software tools providing information for the simulation process. The software components can be executed on different computers at different locations.

The demonstrator illustrates how the MMP can be used to bridge the gap between different simulation model islands. In addition, the bridge between

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the simulation and the necessary information available within different software tools is realised. The demonstrator is based on existing tools and methodologies.

The MISSION methods and software have been applied within a supply chain scenario, the "MISSION Enterprise". This enterprise is world-wide distributed. It has a main assembly facility in which electric motors are assembled. The necessary components –housing, rotor, stator, control cards and bearings are supplied by specialised Manufacturing Shops, placed in Spain, Germany, Japan and USA (Rabe, Jaekel, 2000).

2 THE DISTRIBUTED SUPPLY CHAIN ENVIRONMENT

When setting up a supply chain, elements of this chain have to be selected and arranged to achieve both an effective material flow and a smooth organisation. Furthermore, the interfaces regarding material and order flow need to be specified. If enterprises or parts of them are integrated in multiple supply chains, the specification work can be significantly reduced by describing the manufacturing or logistics system by a re-usable template, and store it within a library for later use (Mertins, et al, 2000).

Additionally, manufacturing systems are often similar in various aspects with respect to the supply chains. Therefore, structuring the templates in an object oriented class structure saves modelling effort and at the same time supports additional transparency as well as some standardisation. MISSION includes a template library approach, which allows the design of reusable templates for distributed scenarios. On that base supply chains can be tested applying simulation, which requires simulation models. In total, six major groups of information are necessary for the MISSION templates (Rabe, et al, 2001):

- **Description of the template behaviour.** The template behaviour has to be described in order to get a clear understanding about the template. Obviously, each simulation template connected to this template has to fulfil this description. An informal description is possible but a more formal description in XML is recommended.
- **Referred simulation models.** One or more simulation models can be referred which satisfy the template specification. The simulation model has to be created within a simulator, which has an interface to the MMP.
- **Parameter descriptions of the template.** Each application template has a set of attributes. A subset of these attributes can be directly linked to simulation parameters. Each simulation parameter requires a

link to an attribute but not each attribute does necessarily link to a simulation parameter.

- **Description of exchanged objects.** An important issue is the data exchange between the different components within a distributed scenario. This is described by exchanged objects. Within the supply chain scenario the exchange objects describe the interface between the different companies.
- **Visualisation of the template.** Each application template needs one or more possible representations within graphical views or animations. These representations are used for static or dynamic visualisation of the supply chain.
- **Input and output segments.** The suitable input and output segments need to be connected before an evaluation can be done, E.g., if a container of finished goods leaves a factory and enters a railway system, it is of utmost importance to know at which station this railway system is entered. Furthermore, the container might have to leave the factory at different locations, depending if he will be fetched by railway or by a truck.

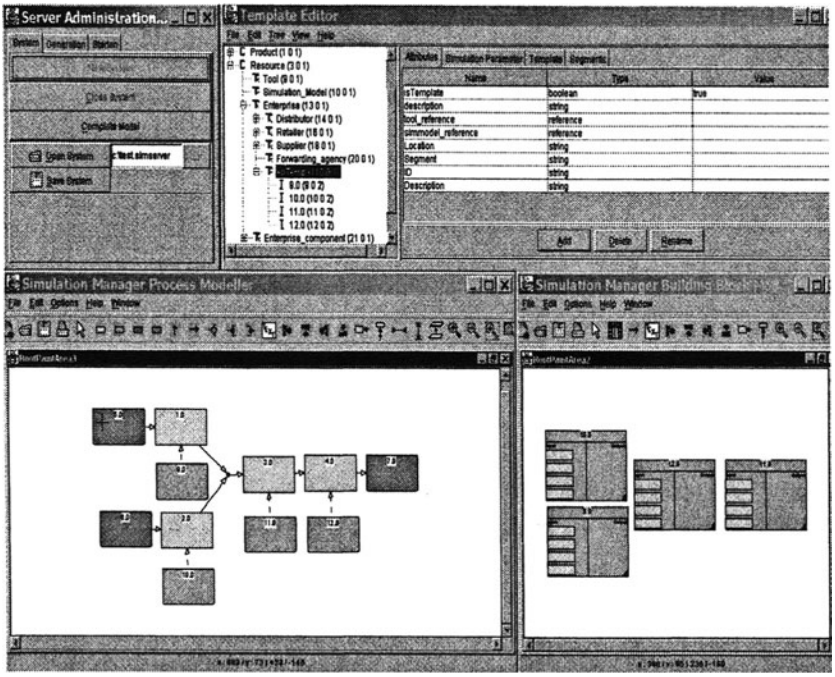

Figure 1: Components of the Simulation Manager

The template library content is not fixed. The user can add classes and attributes at any point of time to fulfil the project requirements for a specific supply chain.

The preparation and application of distributed simulation scenarios are supported by a Simulation Manager (Jaekel, Arroyo Pinedo, 2000) (Fig. 1)

This tool enables the construction of template libraries (predefined simulation models) as well as the graphical modelling of the scenario.

The template library and the graphical representation of the simulation scenario (within the demonstration: Supply Chain scenario) within the simulation manager is the base for the generation of a XML description of each interface between the companies within the supply chain.

During the generation of the interface files the exchange objects play an important role. The exchange objects describe the data which one template exchanges with the other ones. MISSION provides a first reference structure for the se objects. The reference structure includes object definitions as well as the necessary attribute descriptions. E.g. all exchange objects have the attributes about their current position in the scenario. As the demonstration scenario is a Supply Chain, in this case the interface files describe the interfaces between the individual enterprises.

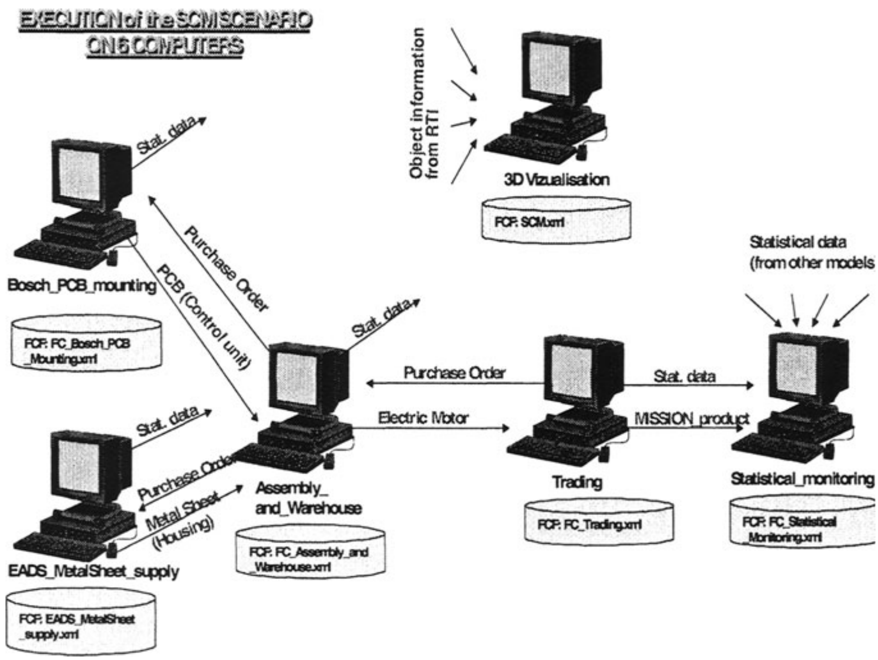

Figure 2: MISSION Supply Chain Scenario on six Computers

The MISSION Supply Chain scenario includes up to 6 personal computers (PCs) with Microsoft Windows NT or 2000 as operation system (Fig. 2). Each computer serves one simulation model. The connections between the simulation models are configured by the interface descriptions generated by the simulation manager.

To achieve the benefit of evaluating the whole supply chain scenario, information has to be gathered from all components, and then evaluated. This is done by the monitoring component (Fig. 3). It collects information about the exchanged objects and processes this information statistically. Results are, e.g., the whole production time, the order time, the manufacturing time and the procurement time.

Similar to the Monitoring component a VR component can be connected within the MISSION scenario, also. It represents online the movements of objects within the supply chain.

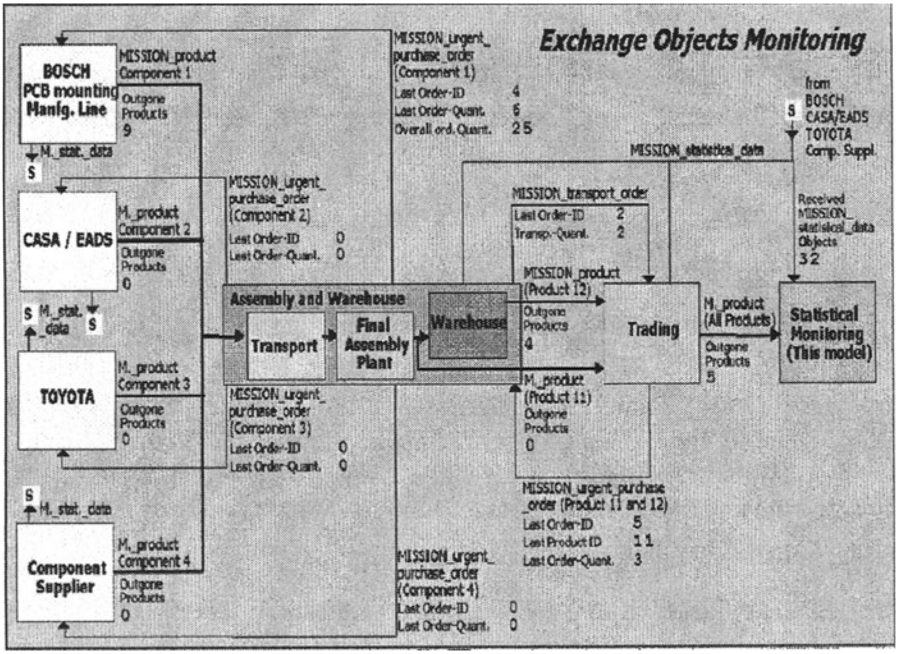

Figure 3: Monitoring Component (Overview Screen)

3 BENEFITS OF A DISTRIBUTED SIMULATION ENVIRONMENT

Among the most important issues, which need to be tackled when modelling supply chains, the followings are addressed by the MISSION project:

- Knowledge is distributed, as local engineers know the local rules and environment best. Therefore, best modelling results are expected with decentralised models, which are built and maintained locally.

- Simulation models, which are needed for dynamic evaluation, contain detailed rules and strategies of the company. Engineers might not wish to make these known to others, especially not outside of the enterprise. Therefore, mechanisms for information hiding are required.
- Complex enterprise software systems like control systems are a critical factor within the enterprise processes. It is necessary to get a test environment to check the software before it will be really installed. Moreover the number of parameters of such tools is very high and has to be calibrated within an experimental environment before they are used within the daily work.

Separate distributed models are adequate to fulfil these requirements. They are built and maintained locally, and joined for evaluation purposes, only. The interface description, which is necessary to evaluate the complete supply chain, can be used for purposes of process engineering, evaluation by simulation and specification of the supply chain control system.

4 TECHNICAL BASE

The project MISSION develops an environment for integrated applications of simulation and non-simulation tools from different vendors. Three years ago the High Level Architecture (HLA) (IEEE, 2000, Kuhl, et al, 1999) was selected as the base for the MISSION architecture. The HLA satisfied many requirements for distributed simulations. Within military applications of the HLA, for each new model a new simulator will be programmed, typically. Therefore, a flexible interface for simulation models is not required for military applications. This is completely different within civil domains, where the total effort spent to one simulation study is extremely low, compared to defence applications. The dependency of the interface description to the HLA-RTI from the specific simulation model is a critical disadvantage for regular civil applications of HLA.

Within MISSION an approach has been established that allows flexible configuration of interfaces of tools within a simulation scenario. This approach is based on a template library approach and the generation of a federate configuration file for each simulation interface as well as the generation of the federation execution file for the HLA-RTI in parallel. The major advantage of this approach is that changing simulation models or adding completely new ones requires only changes of the configuration, but no reprogramming. Of course, those interfaces need to be related to a specific application field then, which is manufacturing systems (including virtual enterprises and logistics) within the MISSION project.

5 CONCLUSION

An environment has been developed to combine different simulation models and real systems. This combination can be done on „engineering level", i.e. by building blocks, business-process models and graphical editors.

There is a predefined Template Library, which includes simulation elements as well as exchanged objects. This library is object oriented and may be enriched by the end user.

There is a ready-to-use supply chain model as a building-block system. Any building block may be replaced by another (newly created or existing) model to achieve very detailed results.

The MISSION project was completed in December 2001. All components of the project were successful. New technologies were discovered. Some components, in particular the Supply-Chain-models, are applicable in the present status immediately.

Corresponding discussions with interested industrial companies have been initialised. During the project additional research activities were discovered for further research activities. Corresponding projects are expected to start in Winter 2002/03.

6 ACKNOWLEDGEMENT

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