Integrated Enterprise Modeling Method Based on Workflow Model and Multi –Views

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Abstract Many enterprise modeling methods are proposed to model the business process of enterprise and to implement CIM systems. But difficulties are still encountered when these methods are applied to the CIM system design and implementation. This paper proposes a new integrated enterprise modeling methodology based on the workflow model. The system architecture and the integrated modeling environment are described with a new simulation strategy. The modeling process and the relationship between the workflow model and the views are discussed.
Key words CIM; integrated modeling; workflow; simulation; mapping

Introduction

The implementation of a CIM system is a very complex process that needs the guidance and support of enterprise modeling methodology. The development of CIM system theory and methodology has produced many results in the field of system modeling, analysis and design, such as CIM-OSA (CIM Open System Architecture)[1], GRAI-GIM (GRAI Integrated Methodology)[2], PERA (Purdue Enterprise Reference Architecture)[3], ARIS (Architecture of Integrated Information System)[4] and DEM (Dynamic Enterprise Modeling).

The existing major CIM architectures and modeling methods have different characteristics and advantages. But difficulties are still encountered when they are applied to guide CIM system design and implementation. The problems can be summarized as follows:

- The enterprise model is difficult to maintain.
- The enterprise model is difficult to analysis and optimize because of a lack of tools to support the model simulation.
- The systems lack an integrated modeling method and relevant support tools.

This paper proposes an integrated enterprise modeling method based on the workflow model. An integrated modeling and simulation method and associated tools are developed with the support of CORBA and it's ORB service. In our approach, the workflow model is the core model with the organization view, resource view, function view and information view as company views. Model mapping tools accomplish the transformation between the workflow model and the other views. The whole modeling process is led and controlled by the view navigation module. Thus, the workflow model is integrated with other views. Moreover, the performance of the enterprise business can be easily tested through the workflow model simulation.

1 System Architecture

The new CIM system architecture based on requirements collected from application enterprises and a review of current CIM architectures. The architecture is a cube-like architecture

anuscript received: 1999-05-07
Revised: 2000-07-05
Supported by the State High-Tech Developments Plan of China (No. 863-511-944-002)

with three axes: views, implementation life cycle, and instance of building blocks, as shown in Fig.1.

1.1 System views

The new architecture has one model and four views[5]. The workflow model is the core with organization, resource, function, and information views as assistants. The workflow model is used to describe the basic activities, the logic relationship between them, and the flows (such as material flow, information flow, and capital flow) in the enterprise business process. The organization view describes the organization units and their relationship. The resource view describes the resources that are needed by the process, such as equipment, material, software, hardware, and so on. The function view describes the functions that are accomplished in the process. The information view includes all the information related to the process and the characteristics of the information.

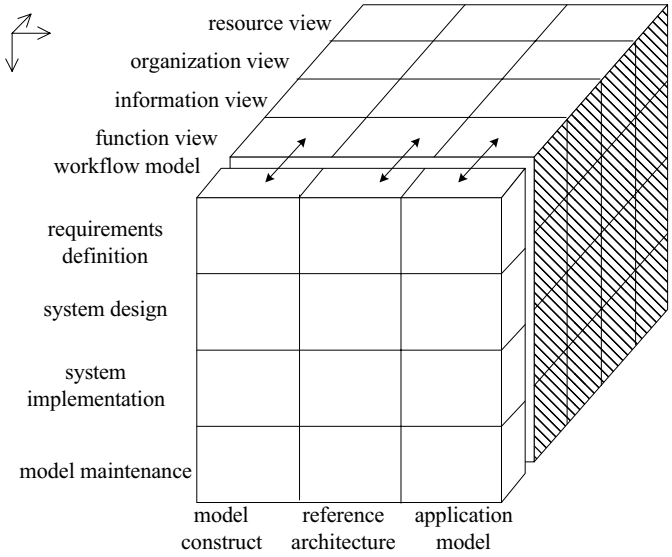


Fig.1 CIM System Architecture

The workflow model is chosen as the core model for several reasons. First, the workflow model covers most of the information included in the other views. The consistency of the whole model can be tested by running the workflow model. Secondly, the simulation of the workflow model gives valuable information for the enterprise BPR. Thirdly, with the rapid development of the workflow technique, more workflow products are available in the market which will help implement the enterprise model.

1.2 Implementation life cycle

Unlike the architecture of CIM-OSA, we divided the whole implementation life cycle into four stages: requirements definition, system design, system implementation, and model maintenance. Each stage has its own emphasis.

(1) Requirements Definition

During this period, the requirements definition model will be built on the basis of the business process survey. This model begins with the organization view, a simplified resource view, and the workflow model, which includes the organizational structure and the main process in the enterprise. Then, the major information needed by function view and information view is retrieved from workflow model through the model mapping mechanism.

(2) System Design

In the system design period, concepts related to the requirements definition, such as the

enterprise data model, the module and transaction definition, and network topologies, are transferred to information technology interface. The emphasis is on adapting information and resource views. The system design will also optimize the model using information technique. The requirements definition and system design are loosely linked which means the system design can be changed without modifying the requirements definition model. But these two stages can not be developed in isolation. The content determined in the system design period should not conflict with that of the requirements definition period.

(3) System Implementation

In the system implementation, the workflow model is transferred to a model that can be understand and used by the computer by establishing the physical link between the original model and the information system. Material flow, information flow and capital flow are used to initialize the workflow model.

(4) Model maintenance

A series of well-formed model document modification files are used to facilitate model maintenance. The main work of this stage is to record and maintain the model documents.

1.3 Instance of building blocks

General model blocks are suitable for all enterprises. Enterprise reference architectures contain a set of templates required to describe the model for each kind of manufacturing enterprise. The application model is specific for each particular enterprise, which is formed by the general building block and other components according to the relevant reference model.

2 Integrated Modeling and Simulation Environment

In our approach, several views and models exist at the same time in one level. Furthermore, different levels have different models. These views and model are so tightly related that a change in one view or model will modify the others. The use of the traditional series modeling method could not provide efficient modeling, nor could it make model maintenance easy. So CORBA based soft-bus was developed to provide an integrated modeling and simulation environment. The ORB service was used to set up the dynamic link between the different distributed objects. Usually, the link between the application objects follows a Client/Server pattern.

With the CORBA technique, modeling and simulation tools can be integrated into one environment. The output of the modeling tool, which is an enterprise model, will be sent to the simulating tool as the input, as shown in Fig.2. The key techniques in integrating the modeling and simulation are.

(1) The mapping from the organization view and the resource view to the workflow model and from the workflow model to the function view and information view. This will be discussed in Section 3.

(2) The simulation of the workflow model. The discrete event simulation method was used for the workflow simulation. Simulation is carried out by simulation engine, which impels workflow instance, allocating the resource to activities, and dealing with semi-automatic or manual task automatically.

(3) Heterogeneous model data transformation based on CORBA. As stated before, the different enterprise views, the workflow model exist in the modeling process at the same time. Thus data transformation is complex and difficult. Coincident data formalism was considered as one solution.

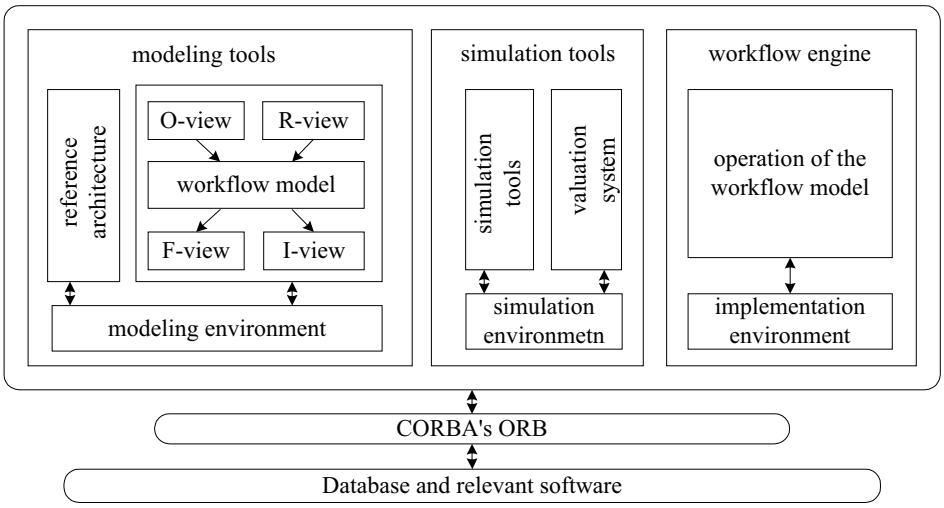


Fig.2 The structure of the integrated modeling environment

Note: F—Function I—Information O—Organization R—Resource

3 Integrated Modeling Process

With the support of the integrated modeling environment, view navigation is introduced to lead and control the whole modeling process.

First, the organization view and a rough resource view were built. The organization view describes the organization objects and structure. The organization object includes the organizational unit, either individuals or teams. Teams, which are formed temporarily for some project and goal, describe the dynamic characteristic of the enterprise organization. The organizational units and relationships between them form the organizational structure tree.

The organization view is tightly connected with the role defined in the workflow model. The role refers to the individual or organizational unit who carries out the activity. The organization view allocates the individuals or teams when the workflow model operates. All the information about roles comes from the organization view. Once the workflow model occupies some unit from the organization view, it will dynamically modify the data (but not the structure), and release the unit after operation.

The mapping between the resource view and the workflow model is also formed in the same way. The resource view provides the necessary resources such as manufacturing equipment and raw material for the workflow model definition and operation.

Then the workflow model is built by abstracting the main activities from the business process. When describing the detailed information of each activity, such as who execute the activity and what is used during the operation, the information of the organization view and resource view is needed. Once the role and resource are introduced into the workflow model, the information is put into the organizational unit-activity matrix and resource-activity matrix separately. And supplementary statements can be added to the resource view if necessary.

The function and information views are built by abstracting the relevant information from the workflow model. All the information for building the function view and the information view is included in the workflow model.

The view navigation not only guides the modeling process but also controls it. To make the model more flexible as well as easily modified, our modeling method prescribes that one kind of information can enter the model from only one definite entrance and can be spread to the whole model by model mapping. Therefore, in the whole modeling process, the information relevant to

the organization/resource can only enter the model from the organization/resource view; while information about processes, functions and information can only enter the model from the workflow model. For example, if a new machine is needed during the operation of the workflow model, the workflow modeling tool can not add the machine directly. Instead, the machine must be added to the resource view through the resource view modeling tool first. Then the workflow model can use it. The modeling process is shown in Fig.3.

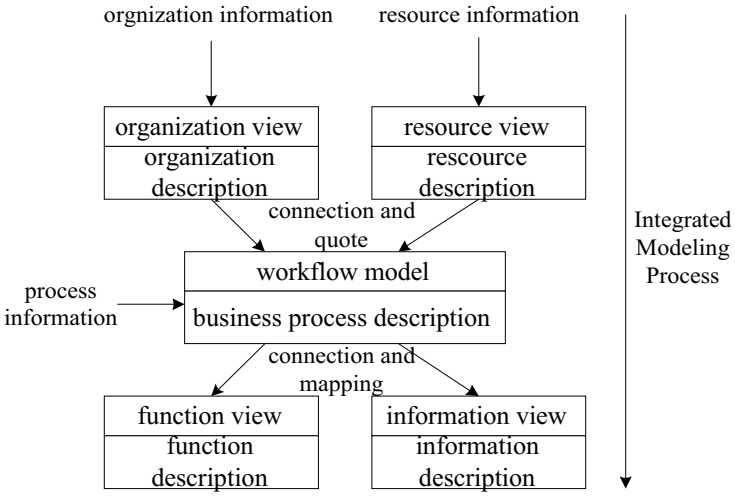


Fig.3 The modeling process

4 Simulation Strategy

The workflow model is one means to present an enterprise business process. It should be critically analyzed and optimized before it is executed. Workflow simulation plays an important role in the analysis of the workflow model and can provide useful evidence for process optimization and enterprise BPR. A new simulation strategy based on high-level Petri net is proposed to integrate the modeling and simulation process. The output of the modeling tools, which is the workflow model, serves as the input to the simulation tool. The simulation tool is composed of a workflow mapping tool, a Petri net simulation tool, and a simulation visualizing tool. The workflow mapping tool establishes some connections directly to the workflow model database and the user interface. It will transfer the initialized workflow model to a Petri Net model either automatically or half-automatically with the help of a library of reference templates. Each reference template is a typical constructor of a workflow model with its corresponding Petri net model. It should be pointed that at this step, only the structure of the workflow model is mapped to the Petri net model; therefore, the structure and data of the Petri net model are separated first here.

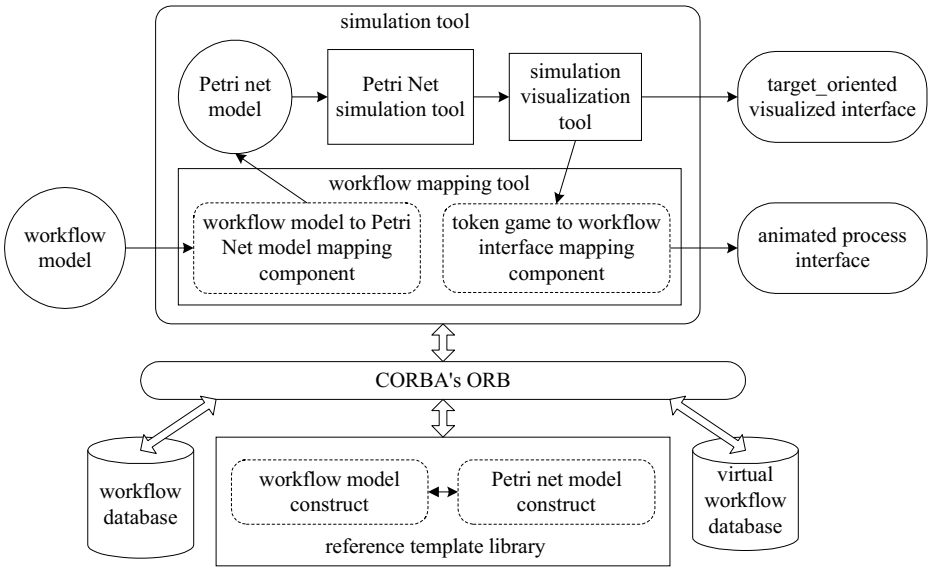
Then, the Petri net model with colored tokens and the transition enabling condition is executed by the Petri net simulation tool. A virtual workflow database is established to use the information existing in the resource view and organization view without affect in the state of the real workflow model. The virtual workflow database provides the necessary enabling conditions for the transition and can be reinitialized or deleted after the simulation.

The simulation visualization tool is used to visualize the process and the simulation result. One of the visualization goals is to show the running state of the workflow model with animations. The token games of the Petri net model will be mapped to the workflow interface by the workflow mapping tool to show the user which activity is being executed now, and which have already being executed or will be executed. The other goal of the visualization is to show the changes of the

performance indicators, which is called target-oriented visualization. This will directly show the user how the indicators, for example, time, activity cost, and utilization of the resources, change during the simulation process.

The structure of the simulation tools is shown in Fig. 4.

Fig.4 Simulation tools structure



5 Conclusions

This paper presents an integrated enterprise modeling method based on the workflow model. An integrated modeling environment integrates the modeling and simulation processes with the workflow model as the core model. Model mapping functions transfer the information between the different views and the workflow model. The whole modeling process is led and controlled by the view navigation systems. A new simulation strategy introduced to integrate the modeling and simulation processes has several advantages. First, the consistency and performance of the model can be tested easily by the integrated simulation tool. Second, the model can be easily modified with the model mapping mechanism. Third, the CORBA technique improves the efficiency of the modeling process.

Process modeling is the basis for process integration, which is a higher level of enterprise integration. Using the workflow model as the core model makes the whole model more flexible which is the key characteristic of future enterprise models needed to meet the demands of the rapid changing market. Moreover, the integrated modeling process with view navigation presents a new modeling concept that changes the traditional series modeling process to a more centralized, controllable and cooperative modeling process.

The methodology is well developed, but some key problems still need further research. For example, using the CORBA technique to form the integrated modeling environment; efficiently using view navigation technology; and method to transfer the organization and resource part of the workflow model to Petri Net model.

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