A Hypertext-based Integrated Modeling Environment(HIME)

Sung Joo Park, Hyung Do Kim,
Jong Woo Kim, Chang Hee Lee

Department of Management Science
Korea Advanced Institute of Science and Technology
373-1 Kuseong-dong, Yuseong-gu, Taejon 305-701, Korea

Abstract

This paper describes the design and implementation of a prototype modeling environment, Hypertext-based Integrated Modeling Environment(HIME). It implements a modeling framework, call Integrated Modeling Framework(IMF), which has been developed to increase model-related productivity and to integrate modeling knowledge and various information resources.

I. Introduction

Computerized manufacturing planning and control is an essential component of CIM as well as CAD/CAM. Since CIM systems are confronted with rapid environment changes, they should reflect the changes into their control strategies and corresponding hardware/software components in response to the changes. To cope with these changes, heterogeneous models should be consistently represented and managed. Furthermore, information systems need to be (automatically) developed based on the exact definition of their requirements.

Integrated Modeling Framework(IMF) is a representation formalism for specification and integration of diverse elements in complex information systems. The objectives of the framework is to integrate various elements which include analytic models and heuristic knowledge. HIME(Hypertext-based Integrated Modeling Environment) is an integrated modeling environment providing comprehensive support for model related works based on IMF. The purpose of this paper is to introduce the motivation, the structure of IMF and HIME.

II. Integrated Modeling Framework: IMF

IMF is proposed to represent diverse aspects of a system which includes mathematical knowledge. *Object blackboard* and *multi-facetted* concepts have major roles to the integration of diverse aspects. Object-oriented framework provides a natural way to view the "real world" in terms of objects. Object blackboard provides central place to connect diverse knowledge. Multi-facetted concept is useful to include different view of users and to integrate models.

Integrated Modeling Framework consists of three submodels; object model, mathematical knowledge model, and event/process model. Facet concept integrates the three submodels. That is, facet concept makes it possible to support different users' perspectives, communication, model sharing and integration. The overall structure of IMF is shown in Figure 1.

Object model describes static and structural aspects of the system. To model these aspects, Object-Relationship diagram and object scheme are used. Object-Relationship diagram is similar to the extended ER diagram with two special relationships IsA and IsAggregateOf. The detail information of an object or a relationship is specified at object scheme. Object scheme is decomposed of three parts, object name and informal description, system-defined relationship, and properties.

In view of object model, facet is an aspect of a property of an object or a relationship. A property can have more than one facet. Mathematical model is described as a facet graph. Facet graphs represent computational dependency among facets. Computational rules are specified as declarative and subscript-free style. A facet graph may be used either as a standalone model or a leaf process of event/process model.

Event/process model specifies dynamic and procedural aspects of the system. Event and process are the basic constructs for modeling system dynamics. To capture the system dynamics, external events are identified, which stimulate actions of the system. For an external event, the actions occurred by the external event, are modeled as a top level process. Processes are decomposed until leaf processes. Leaf processes are classified by two types, object operation and model instance. Object operation means basic object manipulation operation such as insert, delete, update of objects. Model instance is an instantiation of a facet graph. To composed a model instance, the condition which object instances are involved in the model instance should be specified for all the objects included in the facet graph.

[Figure 1] Overall Structure of Integrated Modeling Framework

III. Hypertext-based Integrated Modeling Environment : HIME

1. Overview

HIME is implemented using a hypertext authoring tool, Toolbook which operates on PC Microsoft Windows 3.1. To store instances of objects, dBase file is used. The basic structure of HIME is the same as that of IMF. Major fuctionalities of HIME is to support model specification based on IMF.

2. Model Specification

(1) Object Modeling

Object modeling is an essential part of IMF, because object model has central roles for model integration and sharing. To support object modeling, OR Diagram and Object scheme are used. Figure 2 shows the implementation of object scheme. On the basis of object specification, database structures are automatically generated. Data instances are directly connected and manipulated in HIME without using other data management softwares.

[Figure 2] An example of Object Scheme

(2) Mathematical Knowledge Modeling

Mathematical Knowledge is modeled as facet graph, which is an acyclic graph of facets. A graphic editor for facet graph is implemented to provide visual modeling environment. Figure 3 is an example of Facet graph. Rounded rectangles denote facets, and arrows represent computational dependency. By double clicking a facet, the detailed information about the facet can be displayed. Figure 4 is an example of facet specification. Facet specification includes "called facet" list and computational rule. Computational rule specification is supported by a computational rule editor to prevent errors.

[Figure 3] An example of Facet Graph

[Figure 4] An example of Facet Specification

(3) Event/Process Modeling

At Event/Process Modeling, dynamic and procedural aspects of the system are modeled. Figure 5 is an example of event/process diagram. To support event/process modeling, a graphic editor is supported. The editor provides the connections to decomposed diagrams and to detailed information of events and processes. At leaf process, it can be connected with a facet graph. The detailed information of process "CalNetProReq" is specified in Figure 6. The leaf process is a model instance of facet graph "CalNetProRequirementis", which is shown in Figure 3.

[Figure 5] An Example of Event/Process Diagram

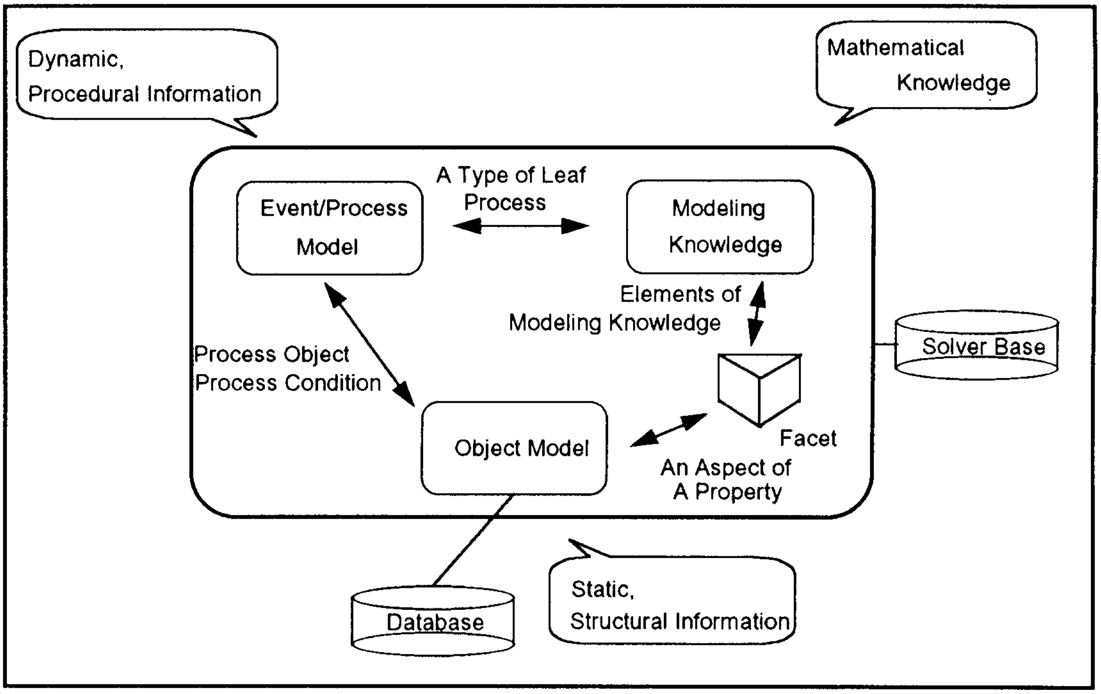
[Figure 6] An Example of Leaf Process Specification

3. Model Evaluation

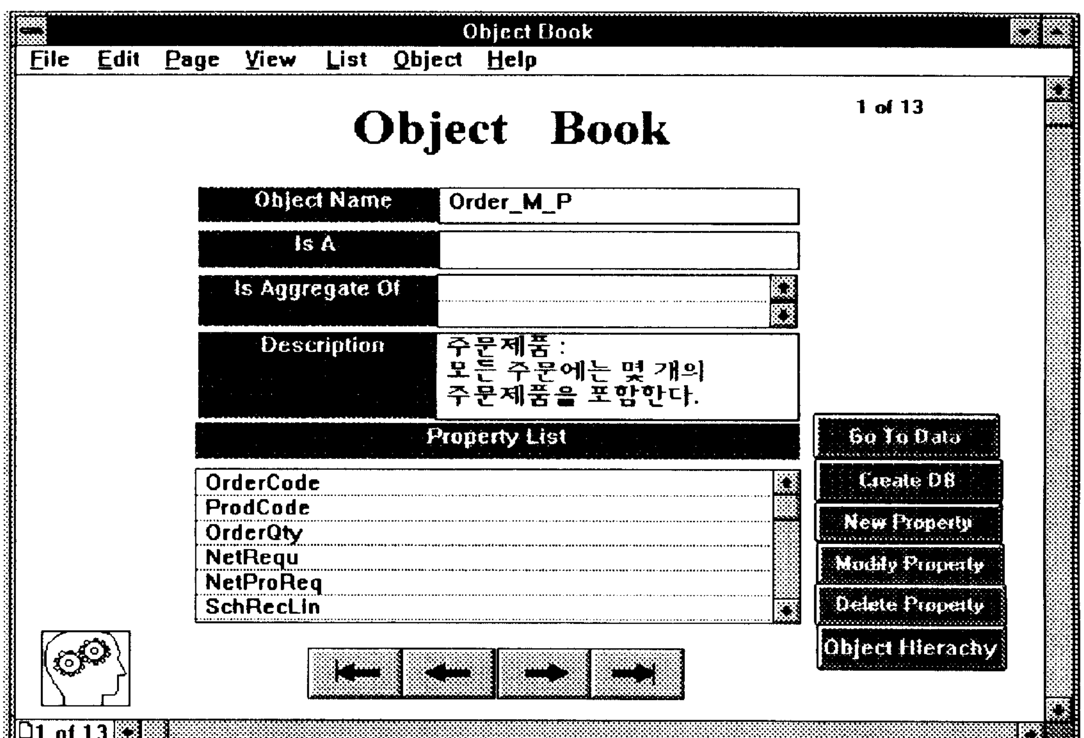
Model evaluation facility is essential for executable modeling environment. The model evaluation in HIME is the extension of that of current modeling environments, which means that system dynamics are simulated with execution of analytic models. The model evaluator provides the following benefits; (i) forecasting of specified system's behavior before implementation, (ii) "what-if" analysis of change alternatives, and (iii) checking the soundness of the specification.

VI. Conclusion

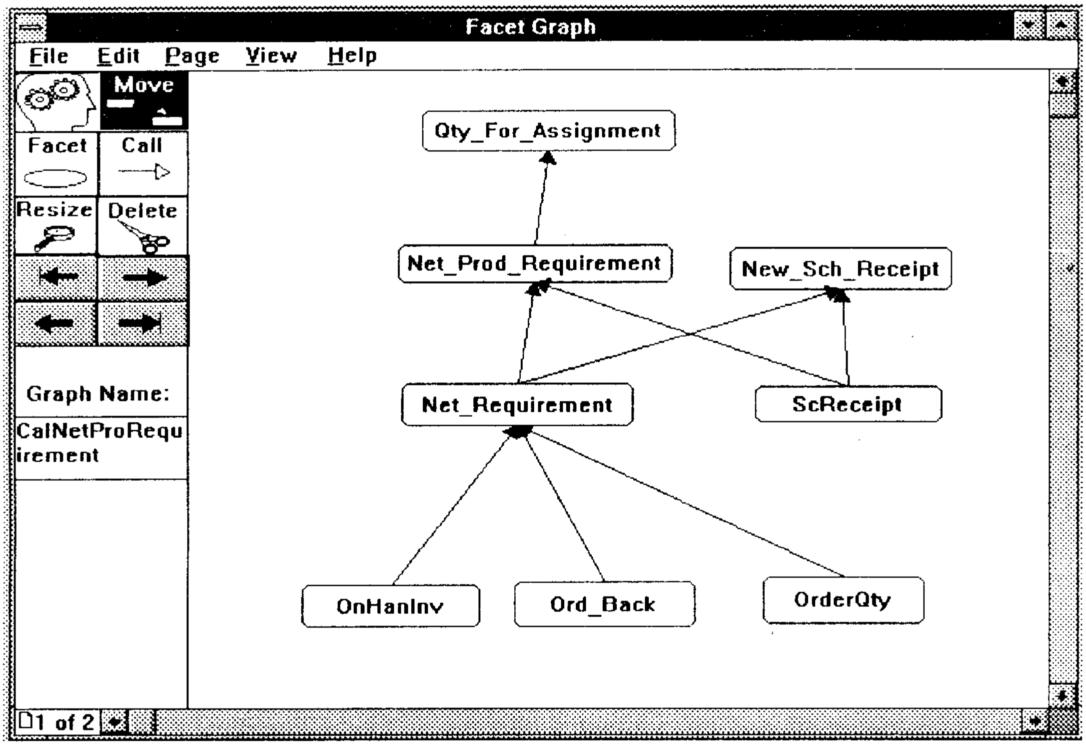
Since models are parts of organizational information resources, the model integration with other information resources, such as databases and information systems is important as well as the integration within analytic models. IMF is a formalism for support the first type of integration, and it suggests a new information system development approach which is based on modeling and computerized tool support. This approach is useful when the information systems include model components and need flexibility and integration. HIME is a prototype modeling environment which is a realization of the ideas in IMF. It has many advanced facilities to support model-related works such as graphic model specification, model evaluation, and tight integration of tools.



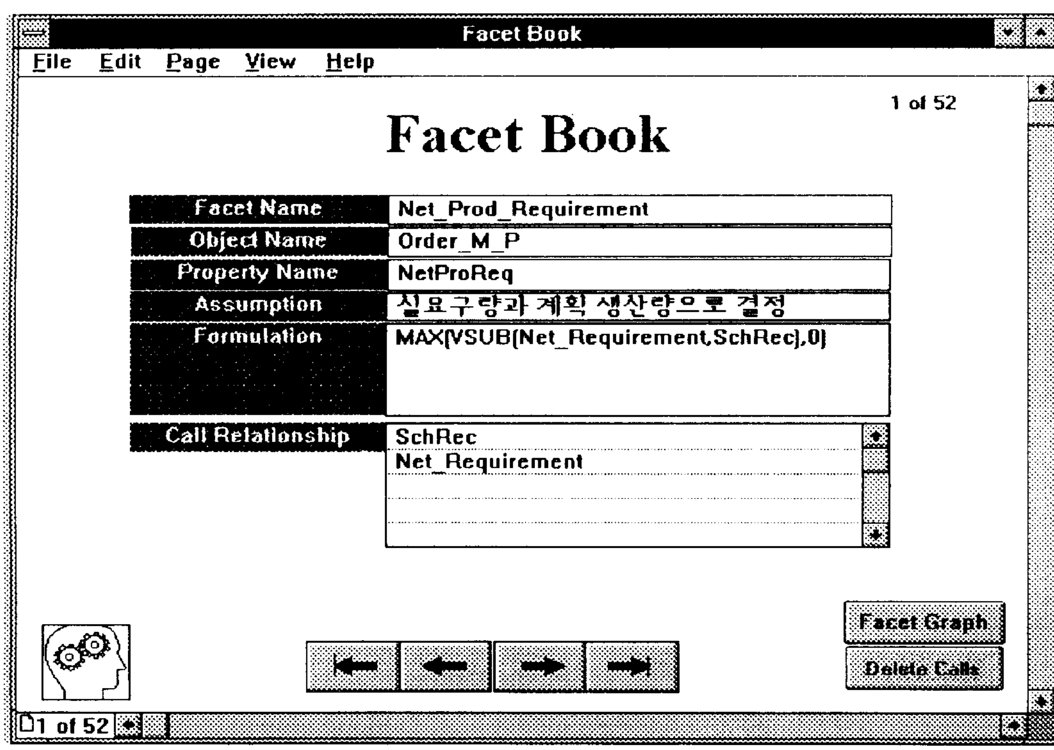
[Figure 1] Overall Structure of Integrated Modeling Framework



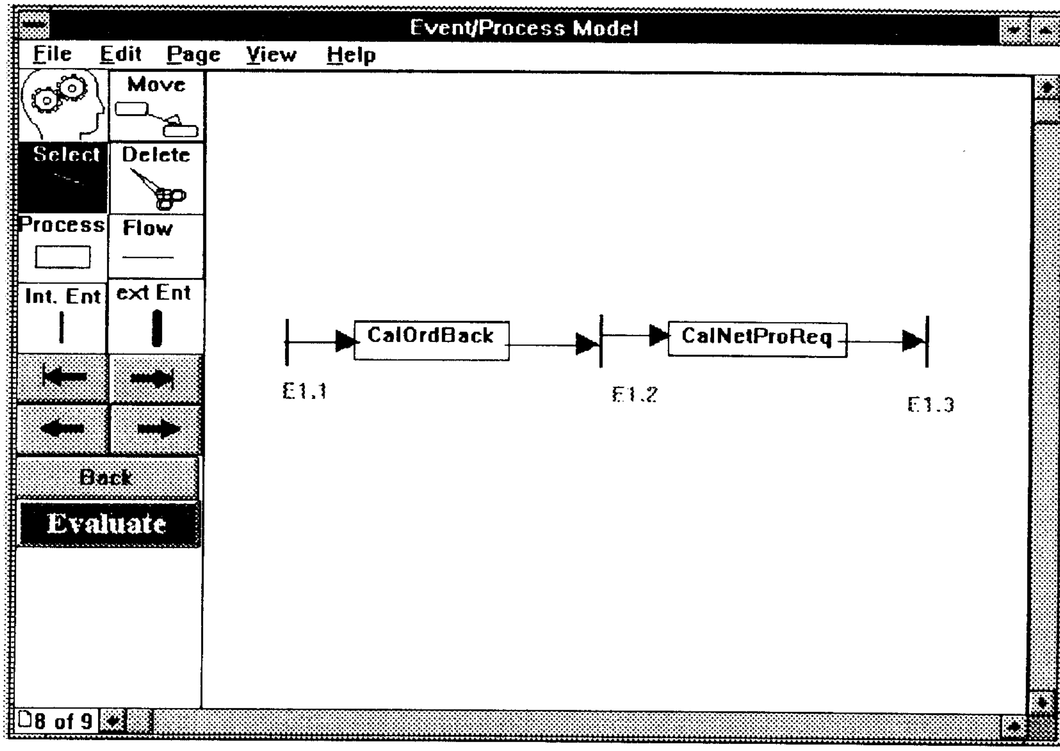
[Figure 2] An example of Object Scheme



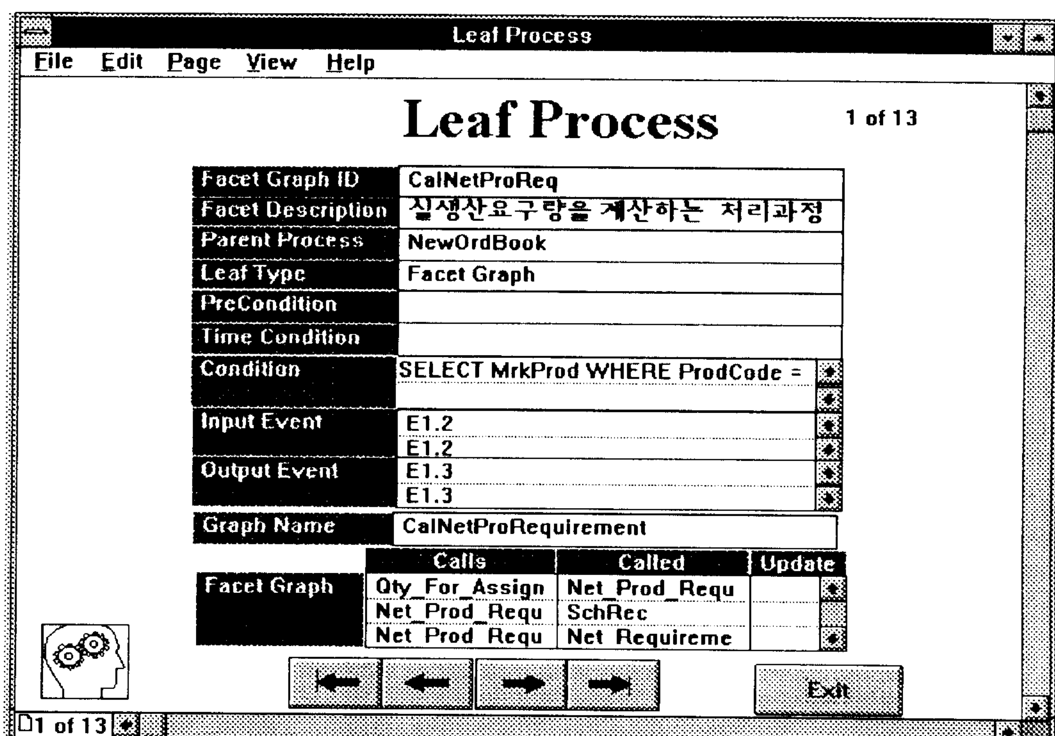
[Figure 3] An example of Facet Graph



[Figure 4] An example of Facet Specification



[Figure 5] An example of Event/Process Diagram



[Figure 6] An example of Leaf Process Specification