A Method for Domain Analysis and Modeling of Cooperative Work

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domain model, cooperative work, SFC, ERD

ABSTRACT

A domain model is proposed for cooperative work domain in which several kinds of personnel have access to shared information. There are three items to express such a domain, i.e., personnel, shared data items, and work flow in which the personnel have access to the shared data items. ERD (Entity Relationships Diagram) is used to show the cooperative relationships between the personnel, the works and the shared data items used in the cooperative works. SFC (Sequential Function Chart) is used to describe the work flow of the personnel. A domain process model is proposed for analyzing the cooperative work domain. The Navigator based on the domain process model is developed.

INTRODUCTION

Domain analysis and modeling ([Prieto-Diaz and Arango 1991] [Itoh et al. 1996] etc.) is the process which obtains the domain specific model with the terminology, the problem solving / system analysis / system design strategies, the target system structures, etc. It is obtained by analyzing, identifying an organizing the properties of a family of target systems and the heuristic and reasonable knowledge for a family of past practices of system development. Its purpose is to improve the software productivity and reusability effectively.

Cooperative work domain exist in concurrent engineering (CE) fields (e.g., in [Carter and Baker 1992]). The authors obtained a domain model by the domain analysis for the cooperative work domain. The applicability of the domain model of common general works such as cooperative works range over different application areas widely. The authors’ domain model is able to reuse for the analysis and modeling on various cooperative domains such as hospital management, production management and building management cooperative domains.

In addition to the cooperative domain, the authors’ domain analysis and modeling for common general works range over the sales management, rental management, allocation activity, plant monitoring and operation, etc.

TRIADIC DOMAIN MODEL

The authors propose “Triadic Domain Model” (TDM) in [Itoh et al. 1996] as shown in Fig.1. TDM consists of domain problem / product / process models. “Domain problem model” is a model of a set of problem components with specific works and interrelationships. “Domain product model” is a model of specifications, programs, etc. that are solutions for the problems. In addition, “domain process model” is a model of the process by which the latter model is led from the former model.

COOPERATIVE WORK

This paper uses a hospital management domain as the example of cooperative works. Here are several kinds of personnel such as doctors, nurses, pharmacist, and receptionists. As an example of cooperative works, they perform the diagnosis and treatment activity for patients in cooperation sharing and using a karte.

Cooperative work is a work in which several kind of personnel mutually share information. When cooperative work is analyzed, it is necessary to clarify the cooperative components with specific works and interrelationships. In order to develop software and the system in the cooperative work domain, it is ne-
cessary to clarify what works each components perform as shown in Fig.2.

The charts should be used in order to enumerate the components with specific works and interrelationships. Domain model for cooperative work domain is described using such charts.

The domain model for cooperative work domain is described by ERD (Entity-Relationships Diagram) and SFC (Sequential Function Chart). First, personnel, works and data items are enumerated as components in terms of ERD. Second, the work flow by personnel is described in terms of SFC.

Cooperative works are represented explicitly by extracting the multiple work flows by cooperative personnel and identifying the shared data items in the work flows. The work flows can be described in terms of SFC. The multiple work flows by cooperative personnel are described by describing multiple SFCs in parallel. The shared data items are arranged between SFCs in order to represent the shared data.

The domain product model in the cooperative work domain can represent the model of specifications. It is obtained by the analysis on cooperative work domain in terms of ERD and SFC. The domain process model can represent the set of processes. It is obtained by the analysis of past practices for development of specification of cooperative works.

PROCESS MODEL FOR COOPERATIVE WORK DOMAIN

The authors propose the procedure by which the charts such as SFCs and ERDs are derived as shown in Figure 3.

First, personnel and works are enumerated in the cooperative domain as shown in Fig.3(1)(2). Second, the group of works are ordered in sequence in Fig.3(3). This sequence is called a work flow. There exist conditions for the work to begin or to complete. These conditions can be regarded as the inputs and outputs for the works. If input information on a certain work needs output information from another work, the sequence exists between these works.

The assignment of personnel to works are clarified in Fig.3(4). Data items that personnel use are enumerated in Fig.3(5). The relationships between works and data items are clarified in Fig.3(6).

Cooperative relationships between personnel/data items are described with ERD in Fig.3(7). The work flows by personnel are described with SFC in Fig.3(8).

SFC is suitable for showing the sequence of work flow if the condition in a certain work by each of personnel is filled. Therefore, SFC is appropriate to describe the regular job part of the work flow in cooperative work. ERD is appropriate to describe the cooperation relationships situation between personnel/shared data items.

EXAMPLE OF HOSPITALIZATION

Domain analysis of the hospitalization was performed. In this case, three scenes exist, i.e., a scene of entering hospital, a scene of various test/treatment/medication in hospital, and a scene of departing hospital. These scenes are described one by one using SFCs.

Let us consider the scene of entering hospital. The allocation of works to the personnel is shown in Table 1. Cooperative relationships between the personnel/shared data items are shown in Fig.4. The workflow of the receptionist is shown in Fig.5. The rows and columns of Table 1 shows the personnel and works, respectively. Fig.4 is a ERD where the personnel and the shared data items are shown as “entities” and the works between entities are shown as “relationships”. Fig.5 shows that SFC can have various information such as work sequence, various data items, the conditions to advance the work flow.

REUSABILITY OF DOMAIN MODEL

The domain problem model for requirements analysis of cooperative work domain consists of the personnel, the works and the shared data items. The domain product model, i.e., a model for requirements specifications for the cooperative work domain, is described in SFCs and ERDs. The domain process model is a model of development process from the former to latter.

<Reuse in generation of system instance>
The domain model can be reused when a system instance is developed. To improve reuse, the domain analysis classifies the objective systems into groups as the domain. The domain model extracts the characteristics common to systems. When using the domain model, a system instance is generated by the replacement by the actual name, the addition of concrete constraints, and the setting of actual parameter values. The domain product model, i.e., the charts by SFC and ERD can reused as a system instance.

<Reuse in domain with small distance>

The diagnosis and treatment of outpatients can be compared with that of inpatients. The distance is very small between the both domains as shown in Fig.6

<Reuse in common work domain such as cooperative domain>

The domain process model for hospital cooperative work can be reused as a domain process model for the analysis for other cooperative work domains.

The authors examined the reusability of the domain models for cooperative work domain through five or more application areas such as hospital management, production management and building management cooperative domains.

NAVIGATOR BASED ON PROCESS MODEL

The purpose of domain analysis is to clarify a peculiar characteristic to the domain, to acquire the know-how of the method of identifying the problem of the domain, the term, and the development technique, and to improve the reusability and productivity of development. The purpose of the navigator is to reuse the model acquired by domain analysis. In developing the navigator, the process model in Triadic Domain Model described in the foregoing paragraph was used as faithfully as possible.

The authors have developed the navigator on the basis of the domain process model in the following two purposes. First, the navigator can navigate the analyst to perform the domain analysis of other cooperative work domain and to produce a model of specifications of the cooperative work domain. This navigator is the achievement of the process model which derives the chart for describing the behavior of the system in the cooperative work domain. Second, The navigator can navigate to generate cooperative work system instance with concrete specifications by giving a concrete name

Navigator is developed using Microsoft Visual Basic 4.0.

Fig.7 shows the position and function of the navigator in domain analysis. The first and second rows of Fig.7 correspond the navigator to the process model in Triadic Domain Model. Based on the domain process model, the navigator has the functions from the extraction of the component to the production of SFC and ERD as specifications for cooperative work domain. The second and third rows of Fig.7 show that the navigator has the function to generate cooperative work system which makes concrete specifications by giving a concrete name.

The advantage of the navigator is as follows:

a) The analysis technique of the cooperative work domain can be standardized by using the navigator in the organization.

b) The chart will be made common in the organization, and the granularity and quality of the analysis can be made uniform in the organization.

c) The interpretation of the charts can be made common in the organization, and the mistakes in communication and understanding can be avoided.

d) Training of the personnel with scarce development experience becomes possible by the navigator.

Fig.8, 9, and 10 show a main screen, a screen of enumeration of personnel, and a screen of making of relationships of navigator, respectively.

CONCLUDING REMARKS

In this paper, the domain analysis and modeling is performed for the cooperative work domain, and the reusability of acquired domain model is shown with the navigator based on domain process model.

Charts for work flow have been discussed by some communities such as in [WFMC 1996]. Although the
charts adopted by the authors look different with such work flow charts, the description level of the authors’ approach is compatible. In addition, the authors’ approach devises the method and the navigator for analyzing the cooperative work domains including work flows.

REFERENCES


[BIOGRAPHY]

Kiyoshi Itoh: He was graduated Kyoto University in 1974. He received the Doctorate degree of computer science from Kyoto University in 1979. He has been working in Sophia University since 1979. Currently, he is a Professor in Laboratory of Information and Systems Engineering of the Department of Mechanical Engineering. His research interests include domain analysis and modeling, software engineering, concurrent engineering, qualitative reasoning application, and performance engineering. He is a member of IEEE, ACM, IPSJ, etc.

Jiro Shinkai: He graduated Department of Mechanical Engineering of Sophia University in 1996. Currently, he is in the master course of the graduate school of Sophia University. His research interests include system design method, domain analysis and modeling, etc.
(1) enumerate personnel

(2) enumerate works

(3) serialize works

(4) assign works to personnel

(5) enumerate date items

(6) relate works to data items

(7) relate between personnel, data items by ERD

(8) describe work flow by SFC

--- personnel
--- shared data item
--- work

Fig. 3 Domain Process Model

Fig. 4 ERD of Hospitalization
Fig. 5 SFC of Receptionist

Fig. 6 Comparison of Medical Examination for Outpatient and Inpatient

Fig. 7 Position of Navigator

### Fig. 5 SFC of Receptionist

- **Start**: Patient arrives
- **Receipt**: Receive medical policy
- **Make Karte**: Name, sex, date, etc.
- **Finish entering data**: Data of medical examination by interview, etc.
- **Interview**: Finish entering data
- **Prepare for entering hospital**: Bed number, bed type, bed state, etc.
- **Arrange bed**: Finish briefing
- **End**: Finish entering data

- **Data of medical examination by interview, etc.**
- **Bed number, bed type, bed state, etc.**

### Triadic Domain Model

- **Problem model**
- **Process model**
- **Product model**

<table>
<thead>
<tr>
<th>Process model</th>
<th>Problem model</th>
<th>Product model</th>
</tr>
</thead>
</table>

### Analysis of Cooperative Work

**Enumerate elements and relate them**

- **Navigator**: Make a system instance of cooperative work

**Give instance names**

- **Navigator**: Instance specifications (SFC, ERD)

### Medical Examination

- **Medical examination for outpatient**
  - Doctor, inspector, nurse, accountant, receptionist, pharmacist
  - Helper, cook

- **Medical examination for inpatient**
Fig. 8 Main Screen of Navigator

Please enumerate personnel.

- personnel
- work

list
- doctor
- nurse
- pharmacist

register delete complete

Fig. 9 Enumeration Screen

Please assign works to personnel.

Relationship Table

<table>
<thead>
<tr>
<th>doctor</th>
<th>receipt</th>
<th>make Karte</th>
</tr>
</thead>
<tbody>
<tr>
<td>nurse</td>
<td></td>
<td></td>
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<tr>
<td>pharmacist</td>
<td></td>
<td></td>
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<tr>
<td>inspector</td>
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<tr>
<td>receptionist</td>
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</tr>
</tbody>
</table>

complete

Fig. 10 Relationships Screen
### Table 1 Assignment of Personnel to Works

<table>
<thead>
<tr>
<th>Personnel</th>
<th>receipt</th>
<th>make Karte</th>
<th>interview</th>
<th>call</th>
<th>prepare for medical examination</th>
<th>examine patient</th>
<th>decide remedy</th>
<th>test</th>
<th>put things in order</th>
<th>make Karte</th>
<th>prepare for test</th>
<th>decide medication</th>
<th>advise prescription</th>
<th>request to enter hospital</th>
<th>prepare for entering hospital</th>
<th>arrange bed</th>
<th>show to the bed</th>
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<tbody>
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<td>doctor</td>
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<td>receptionist</td>
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</table>

### Table 2 Comparison of Outpatient and Inpatient

<table>
<thead>
<tr>
<th></th>
<th>outpatient</th>
<th>inpatient</th>
</tr>
</thead>
<tbody>
<tr>
<td>personnel</td>
<td>doctor, nurse, pharmacist, accountant, receptionist, inspector</td>
<td>doctor, nurse, pharmacist, accountant, receptionist, inspector, helper, cook</td>
</tr>
<tr>
<td>work</td>
<td>receipt, test, examine patient, make Karte, prepare medicine, pay bill, examine by interview, etc.</td>
<td>receipt, test, examine patient, make Karte, prepare medicine, pay bill, examine by interview, cook, prepare for entering hospital, etc.</td>
</tr>
<tr>
<td>shared information</td>
<td>name, sex, date of birth, blood type, name of disease, etc.</td>
<td>name, sex, date of birth, blood type, name of disease, bed number, bed type, etc.</td>
</tr>
</tbody>
</table>