

Research on the Conceptual Modeling Method Base on System Six-view and Ontology

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Abstract- With the application of simulation technology in the field of equipment support, how to solve the communication problems exist in the military field personnel and Simulation technicians has become a focus problem in the current research. On the basis of the research conceptual model approach, this paper puts forward a conceptual modeling method based on the system six-view and ontology. From the system environment, system components, system architecture, system status, system operation, system function, it completes the description of the conceptual model. Finally, this paper focuses on the analysis of equipment support system, uses the method to build a conceptual model.

Keywords- six-view; ontology, equipment support, conceptual model

I. INTRODUCTION

With simulation technology widely used in the military field, and its effectiveness, economy, security features are favored by a growing number of military experts. Military simulation has become "Battle Lab" in military. With the development of science and technology, the accurate attack as the information technique core feature has become a major feature of the high-tech war, and the high-tech war is a major challenge to the military simulation technology for newer and higher requirements on simulation technology. Exploring and researching new military simulation technology commensurate with the high-tech war will certainly contribute to the improvement of the military's combat capability.

II. THE CONCEPTUAL MODELING METHOD BASE ON SIX-VIEW AND ONTOLOGY

The conceptual model is a model that expresses closer to natural language, compared with other models it has a certain advantages. But it is limited by many problems in the process of development and application of military conceptual model, such as: the communication problem between the military person and simulation person due to the different knowledge background; the lacking and repeating problems of modeling elements due to the different modeling view; the nonstandard description problem of conceptual model due to lack of unified modeling standard.

In [1], it analyzes the Conceptual Models of the Mission Space (CMMS) of the modeling and simulation master plan released by DMSO [2], and summarizes the defects of conceptual modeling method based on EATI. From the point of the system, it has put forward the six-view abstract modeling method to solve the above-mentioned problems, and construct the conceptual model.

Based on the conclusion of references [1] [3] [4], this paper argues that the conceptual model base on the six-view abstract modeling method should be recognized as a tech-framework. We can use the six-view abstract modeling method to complete the analysis of the object system, establish a complete abstract model, give a clear description that the conceptual model will be described, but as a conceptual model, it lacks a normative description of the conceptual model.

This paper puts forward a conceptual modeling method based on the system six-view and ontology. It introduces the ontology to the six-view abstract model to build a complete, normative and clear conceptual model.

Ontology is an explicit formal specification of a shared conceptual model [5], it studies the exist of the things, reflects the recognized knowledge in some fields, and recognizes a set of concepts of this field. The goal of ontology is to provide a common understanding of the knowledge, and to determine the description form of the mutual recognition vocabulary, then give the explicit description of the concept and the relationship of the inter-linked concepts. The form of the conceptual model built is shown in Fig. 1.

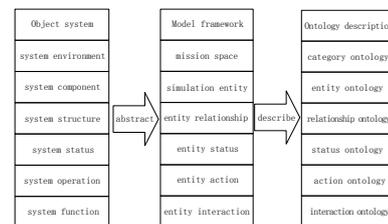


Figure 1. The conceptual model base on system six-view and ontology

III. THE CONSTRUCTION OF EQUIPMENT SUPPORT CONCEPTUAL MODEL

A. The framework of conceptual model of equipment support

Equipment support system is a typical complex system, and it has the general characteristics of a complex system, mainly as follows: huge rules, complex structure, integrated function, many factors, initiative, uncertainty, uncertainty intellectual, multidimensional, developing system, dispersed [4]. It is a technology challenges for the modelers to analyze and build the conceptual model of the equipment support system. When constructing the conceptual model, using the system six-view abstract modeling method, we can analyze the system and confirm the six elements of the conceptual: task space, simulation entity, entity relationships, entity status, and entity

behavior and entity interaction. Then, use ontology theory to construct the six ontologies, the form is shown as follow:

$$CM ::= \langle C, E, R, S, A, I \rangle$$

And C (Category) represents the task space that the system is in, E (Entity) represents all the entities that the system involves, R (Relation) represents the relationship that the system composes between the elements, S(STATUS) represents the state of the entity, A (Action) represents the behavior of the entity, I (Interaction) represents the physical and information exchange between the entities.

B. The construction of conceptual model of equipment support

1) The construction of mission space model

Mission space is a sum of that which is associated with the system beside the equipment support system, especially the external environment of the equipment support system and other military organizations and activities that is unrelated to combat missions. Equipment support systems and task space interact each other. On the one hand, the system operation is limited by the environmental factors, and gets the necessary resources from the mission space, then changes the surrounding environment based on its willingness; on the other hand, the military organizations and operational activities beside the equipment support system have a certain impact on the system operation, and change its own status through the influence of the equipment support system.

Equipment support system is closely associated with the mission space, so when building equipment support system model, first, we must clear the boundary of the system and mission space, and determine the described granularity. The mission space is divided into the natural environment, social environment, nuclear, biological and chemical environment, electromagnetic environment, and other military organizations. The task space model framework is shown in Fig. 2.

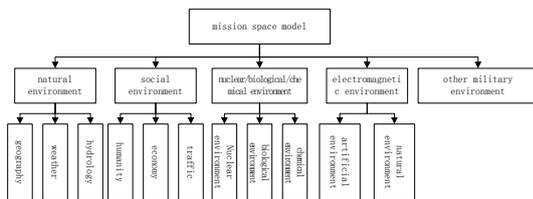


Figure 2. The framework of mission space model

2) The construction of simulation entity model

Simulation entity is abstract from operational activities that contain entity, entity attributes and operation. Description of the simulation entity is to provide a clear description of the entity that involved in the combat activities, and build the level association. Through that, it is convenient to query, use and maintenance operations in the system development process.

The selection of simulation entity must be strictly in accordance with the demand of the system development, and abstract according to the task space convention described granularity. Usually, the composition of the entity has a level characteristics, it can be divided into

main and non-main body according to the own initiative. The main body is the system that has self-awareness, and capable of carrying out independent action, such as military persons and organizations. And the non-main body can change their selves' status through the combat process, such as the equipment, this corresponds to a non-main operational activities, non-subjective means equipment, material, and so on.

According to the object-oriented method, the attributes of the entity description can be defined by the characteristics; the operation of the entity can be described by the ability to participate in activities. The Fig.3 is the model of the person and equipment.

person	gun
-age : int	-weight : double
-sex : string	-caliber : double
-stature : double	-ammunition : string
-avoirdupois : double	-number : int
+firing()	+fire()
+moving()	+remove()
+report()	+initial setting()

Figure 3. The model of the person and the equipment

3) The construction of entity relationship model

Equipment support system relationship is the structure with a certain function that the entities combine with each other; it focuses on the various relationships between the entities and the forms of the system structure [6]. The relationships can be divided into two categories: static and dynamic relationships [7], such as membership, command, guidance, coordination, support, etc.

The static relationships mainly contain the classification and combination, it reflects the hierarchical relationship and the subject relationship between the entity. The Fig.4 is the classification relationship of a certain division support forces, and the Fig.5 is the combined relationship of the mechanized division.

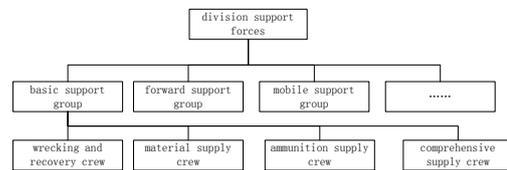


Figure 4. The classification relationship of a certain division

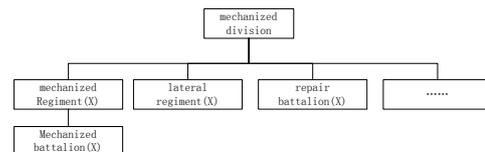


Figure 5. The combined relationship of mechanized division

Dynamic relationship is the relationship between the entities caused by the action of command, coordination, support, it is a stable representation of the entities in the action, such as the command relationships, collaborative relationship, the supportive relationships, as it is shown in Fig.6.

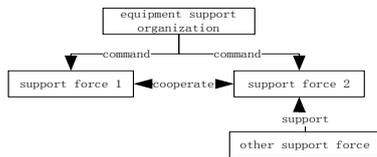


Figure 5. The dynamic relationship

The construction of the relationship model is support by the entity model, so when establishing the relationship ontology, it often combined with the constructing of the entity ontology.

4) The construction of entity status model

Entity status is the internal characteristics that the simulation entity has and the expression external form, it is a static description of the response of an event. Through describing the discrete and the continuous entities' state sequence within a certain time interval, we can simulate the process of the generation, the change and the extinction. For example, the status of a repair crew with mission can be represented through the description of its own persons, the equipment types, the change of the quality and number, its location, movement attributes to characterize the state of the entity. The description contents of its status ontology is shown in Table I.

TABLE I. THE DESCRIPTION CONTENTS OF ENTITY STATUS

Contents	Value range
Entity ID	Entity name
Entity type	The classification attributes of the level, function characteristics
Entity force	The information of the persons and the quality and number of the equipment
Entity mission	The description of the mission
Space attribute	The entity's location and size
Movement attribute	The index of the entity movement characteristic

5) The construction of entity action model

The entity action is the development process of the event in the combat activities, and the real motives and the basis for entity transferring and changing, it is one of the most important content that we must describe. Indeed, the description of the entity action is a sum of the status sequences at a specific time interval in discrete or continuous time. Such as the repair action of repair organization, the ammunition supply action of the ammunition supply crew.

The modeling of the entity action is actually a sum description of entity movement, and the movement is the smallest and the basic in the composition of the entity action. Usually, we should describe the basic definition of the action, the uniquely identifies, the implement entity, starting condition, ending conditions, interrupt conditions, branch conditions and impact factor clearly, as shown in Table II.

TABLE II. THE DESCRIPTION CONTENTS OF WHOLE ACTION

Elements	Description
Basic definition	The definition of event
Implement entity	The implement entity about the action and task
Starting conditions	The initialize conditions
Ending conditions	The conditions to end the action and task
Interrupt conditions	The conditions to interrupt the action
Branch conditions	The conditions to convert to other status
Impact factor	The facts to impact the action process

6) The construction of entity interaction model

Interaction is a group of influential factors that an entity effects another entity. The nature of the entity interaction is the effect on the entity state (or other entity), and the interaction is the result of the entity actions. The trigger entities takes the initiative to produce interactive on other entities, the receive entities receive the interaction. The interaction occurs at a certain time and space. With the generation of the interaction, the flow of substance, energy and information will be happen between the trigger entity and receive entity, and eventually it leads to a physical change in state, which will affect the combat action. According to the nature characteristic on the changing of entity state, interaction can be divided into physical interaction and information interaction. Such as the bombardment is a physical interaction, it is composed by a group of damage effect parameters. And command order and report are information interaction.

The description of the interaction ontology model is usually shown in Fig.6.

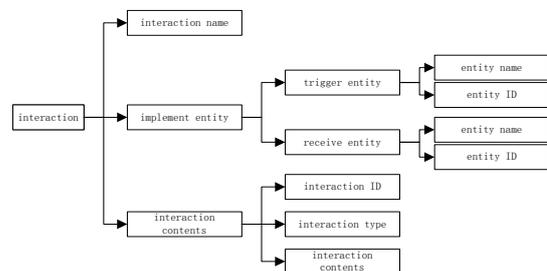


Figure 6. The description model of interaction ontology

The description contents of interaction ontology are shown in Table III.

TABLE III. THE DESCRIPTION CONTENTS OF INTERACTION

Elements	Contents
ID	XXX
Name	Ammunition support
Trigger entity	Basic support group
Receive entity	Ammunition supply crew
Type	Command order
Data	Supply ammunition X unit
Time	XXXX
Validity period	From XXXX To XXXX
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IV. CONCLUSION

Through the study of the conceptual model method, this paper puts forward the conceptual modeling method base on the system six-view and ontology. From the system scientific point, this method divides the system into

six elements: system environment, system component, system structure, system status, system operation, system function, and makes the description framework of conceptual model. On the basis of this, we use ontology modeling techniques to complete the description of the conceptual model. At the application phase, we use this method to study the equipment support system in-depth to build the conceptual model of equipment support. This paper only studies the conceptual modeling method, and changing the conceptual model into the physical model is need to further improve.

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