Solution to Model Consistency in Equipment Support Simulation

Bin Liu, Shaoshuai Wang, Lu Gao, Weiyi Wu and Peng Yan
School of Shijiazhuang Campus, AEU, Shijiazhuang, China

*Corresponding author: 178508362@qq.com

Abstract. In order to solve the problem of multi view inconsistency in equipment support simulation, a semantic oriented MCM method based on ontology model is proposed. Firstly, the rules of extracting the basic elements of the model are given. Secondly, the algorithm description of ontology mapping is given. Finally, each meta concept in the domain is described by some model description method to form the corresponding description model.

1. Introduction
The multi view of equipment support simulation conceptual model architecture has the relationship of correlation, constraint and cooperation, which can describe the equipment support system clearly and comprehensively, but at the same time, it also brings another problem the consistency of multi views.

The consistency problem of multiple views refers to the "inconsistency" between or within views. The word "inconsistency" comes from the field of logic. It describes a situation: in a certain logic system \( \Pi \), there is any proposition \( a \), both \( a \) and \( a \) hold. We know that such a logical system has no meaning to us, because any theorem is tenable in this logical system.

To solve the problem of multi view consistency is the basis of correct expression model and correct execution model. Therefore, the analysis of multi view consistency is an important work in multi view based conceptual model architecture modeling [1].

2. Causes of Consistency Problems
The consistency of multi views is an important factor to be considered in the development of conceptual model architecture of equipment support simulation. It is of great significance to maintain the rationality of architecture and the effectiveness of conceptual model modeling. Because the conceptual model architecture is an important work in the early stage of conceptual model development, any minor errors or inconsistencies in it may have a disastrous impact on the subsequent conceptual model development work. So, what are the reasons for the consistency problems caused by the multi view approach? The main reasons are as follows:

One is the influence of complexity of equipment support system. Equipment support system is a typical complex system, which has many elements and complicated relationship. The existence of this complex relationship not only affects the efficiency of system operation, but also deepens the complexity of the system. At the same time, the system also contains many subsystems with different properties and functions. Therefore, the equipment support system itself contains the problem of consistency, which will affect the modeling personnel's understanding of the system.
The second is the influence of modeling language. In the conceptual model architecture based on multi view, graphical symbolic language is often used to model. Conceptual models in different views may use different symbols when representing the same thing, resulting in "inconsistency". It is an effective method to describe the view and the conceptual model under the view by using the formal method.

The third is the influence of multi view method itself. The original purpose of introducing multi view method is to describe the system from different perspectives and establish a unified and complete understanding of the system from multiple perspectives. Each view in the multi view model system represents the model content recognized by certain stakeholders, thus simplifying the complexity of the model. However, the views from different perspectives overlap. When the elements in one view change, the elements in the other associated views must be changed accordingly. For example, the behavior in the operation view is implemented with the support of certain organizations. The organizational units and roles involved in the behavior model should be reflected in the organization model. In this way, the organization information in the behavior model can be derived from the organization model, and the requirements for organizational structure adjustment in behavior modeling can be reflected in the organization model.

3. Consistency Analysis

From the perspective of language, consistency can be divided into grammatical consistency and semantic consistency. Grammatical consistency means that the model established in the process of modeling is consistent with modeling language and modeling method; semantic consistency means that the content expressed by the model is consistent with various elements in the real world.

From the view point of view, consistency can be divided into internal consistency, inter view consistency and internal consistency. Among them, the internal consistency of a view is the attribute of a single view, which means that the model under a single view must meet the same grammatical and semantic requirements. For example, the mobile model and emergency repair model under the running view inherit the structure and properties of the behavior model, and the consistency between the two must be ensured [2]; the consistency between views is the relationship between multiple views, which refers to each view. The first mock exam model is also designed to satisfy the same grammatical and semantic requirements. For example, information and operation views may contain information descriptions. When describing a certain information, there is no inconsistency. Consistency within a model refers to the consistency of the internal description elements in the model, and the elements in the same model should be maintained in terms of expression, meaning and so on. There should be no inconsistency.

4. Solutions to Consistency Problems

To ensure the consistency of multi view conceptual model architecture is an important problem in the development of equipment support simulation conceptual model. In the traditional multi view model system, one view is often used as a core view to realize the association of multiple views. For example, ARIS (architecture of integrated information system) reference system associates its four views by control view. However, the association between multiple views is often difficult to express through a core view, which will lead to the rapid increase of the complexity of the core view, and the expansion of the user’s view will also be limited.

In the conceptual model architecture of equipment support simulation, the differences between different conceptual models mainly come from the differences of modeling methods, and are essentially reflected in the differences between meta conceptual models (meta models of conceptual models). Therefore, to solve the problem of consistency between conceptual models, we should start from the mapping between meta conceptual models (MCM). The foundation of the conceptual model architecture of equipment support simulation is meta conceptual model layer, which maintains the common semantic framework and ensures the consistency among different views. Based on this, various conceptual models under multi view can be established.
At the same time, as an explicit description of domain concepts, ontology is a recognized concept set about the domain. The concepts in it contain recognized semantics, which are embodied by various associations between concepts [3]. Therefore, using ontology model to build Semantic Oriented MCM can describe the relationship between domain concepts and concepts, which is an effective way to solve the consistency and reusability of conceptual model. Based on the above analysis, this paper introduces the idea of ontology in the construction of equipment support simulation MCM, forms the ontology based MCM, and realizes the conceptual modeling of equipment support simulation based on MCM. The framework of conceptual model architecture of equipment support simulation based on multi view is shown in Figure 1.

![Hierarchical framework based on multi view conceptual model architecture](image)

**Figure 1.** Hierarchical framework based on multi view conceptual model architecture

According to Figure 1, the architecture of equipment support simulation conceptual model mainly includes six views, namely component view, function view, structure view, operation view, information view and environment view. Although the categories of views are different, they are the same at the technical level. In this paper, the ontology based MCM is used as the foundation of the whole multi view conceptual model architecture, which is the key to maintain the consistency between views.

### 5. Ontology Based Conceptual Model

MCM identified by ontology semantics is also called identification method, which is a lightweight ontology meta modeling method, as shown in Figure 2. In the process of building MCM, a descriptive ontology is introduced to define the attribute set of the MCM metaclass. The MCM defined by this method is loosely coupled with the ontology model, so it is a lightweight method. Since the original intention of introducing ontology is to build a semantic oriented MCM by using the concept of ontology, the structure we use in building ontology based MCM is the MCM structure of ontology semantic identification.
The construction process of ontology based conceptual model includes three steps: extraction of basic elements, ontology mapping and model description, as shown in Figure 3[4].

5.1. Extraction of basic elements
This paper uses multi view method to extract the corresponding meta concepts. View is the horizontal spatial dimension of domain model, which describes different aspects of domain attributes or behaviors. Different views are integrated to form a consistent whole, and they are interrelated. According to the theory of system science, domain system is divided into six Views: function, composition, structure, operation, information and environment. We extract the concept of function element from function view, entity element concept from composition view, organization element concept from structure view, task and behavior element concept from operation view, information element concept from information view and environment element concept from environment view.

5.2. Ontology mapping
After defining the meta concept of domain, it is necessary to describe and explain it. Based on the meta concept of domain ontology, ontology MCM mapping is established to realize the combination of ontology and meta concept. The way of ontology MCM mapping is to define the corresponding ontology meta language (concept, attribute, relationship, etc.) for each meta concept, and clearly describe the relationship between these meta languages. For example, the concept of behavior element is related to ontology meta language such as role, behavior and information. The relationship between role and behavior is participation in, and the relationship between behavior and information is work out.
5.3. Model description
On the premise of ontology mapping, a model description method is used to describe each meta concept in the domain, and a corresponding description model is formed. Domain system can be abstracted into seven basic elements, which correspond to corresponding MCM, namely functional MCM, entity MCM, organization MCM, task MCM, behavior MCM, information MCM and environment MCM. We will use UML to describe these MCMs respectively.

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