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The Process Modeling Technology for Virtual Maintenance Training of Mechanical Equipment

Weijun Chu[1], Xiaohui He[1], Zicheng Zhu[2] and Xingxin Li[1]
[1]Army Engineering University of PLA, Nanjing, Jiangsu,210007, China
[2]China Heavy Truck Group Co.,Ltd, Jinan, Shandong, 250116, China

***Abstract*—Firstly, this paper presents the logic modeling problem in the development of the general platform for the virtual maintenance training system of mechanical equipment, explains its content and composition, and points out two difficulties in the logical modeling of virtual maintenance training system of mechanical equipment. The main virtual maintenance training process modeling and control technology are discussed. Then, aiming at the training process of content level, four components of the virtual maintenance training process model are divided and expatiated. Finally, the method of establishing virtual maintenance training content model is introduced based on the above. This study provides a viable method for the systematic and standardized development of the general platform for the virtual maintenance training system of mechanical equipment.**

Keywords—virtual maintenance training; process modeling; general platform; content model; mechanical equipment

I. INTRODUCTION

The equipment virtual maintenance training is widely accepted, and the virtual maintenance training sysetm based on the general platform is recognized. To develop a general virtual maintenance training platform for different majors and different equipment can solve the problems of unified process, data sharing and diversified configuration. The level of desktop virtual maintenance training is greatly improved, and the development method of maintenance training system can be made systemized and standardized.

II. VIRTUAL MAINTENANCE TRAINING LOGIC MODELING

An important content of general platform development of maintenance training system is logical modeling, which includes: virtual maintenance prototype modeling, process modeling, fault diagnosis virtual training, standard design data conversion to virtual maintenance training data and other technologies. There are two difficulties in the equipment virtual maintenance training logic modeling. First, the same logic modeling method is applicable to different types of equipment, different types of maintenance training content, and different virtual maintenance interaction modes, which is the problem of establishing a general model. Second, how to integrate and interoperate maintenance training with the existing mature standards of design data and related majors, which is the problem of standard modeling.

III. VIRTUAL MAINTENANCE TRAINING PROCESS MODEL

The process model of the virtual maintenance training logical modeling is an abstraction and description of virtual maintenance training process. Process model is a set of tools for developing virtual maintenance training in the development system, which can be used to define and describe a specific virtual maintenance training process. The training system is embodied as the operation mode and control process of virtual training, and the training process control can be realized based on the process model.

The virtual maintenance training process can be divided into different levels according to the described unit. When the virtual maintenance training process is described with the training subject as the unit, the process model is generally a simple time, process corresponding table, and simple process relationship. When it is described with the training content as the unit, the process model is the same simple time sequence relationship. The complexity and variability of the virtual maintenance training process is reflected in the training process of specific content. Different equipment, different knowledge types and different training modes have different process relations, and the process logic relationship of complex virtual operation steps. This paper focuses on the content - level training process.

IV. VIRTUAL MAINTENANCE TRAINING PROCESS MODELING TECHNOLOGY

The virtual maintenance training process model consists of four parts: a group of virtual maintenance operation activities, the relationship between activities, a group of virtual training links, the relationship between virtual training links and virtual maintenance operation activities. Figure 1 shows this relationship. Virtual maintenance operation activity and activity process can constitute the virtual maintenance process, and the virtual training link comes from the activities of trainees and the trainees activities from other training elements.

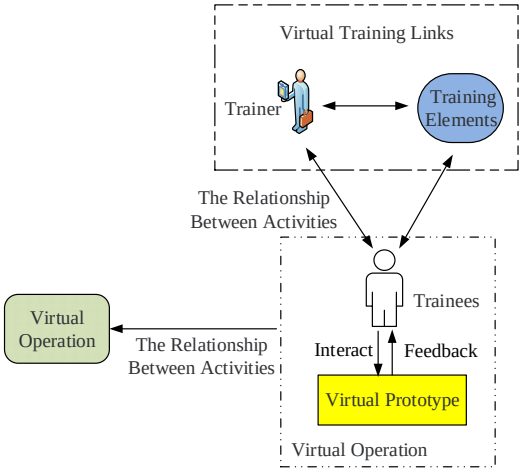

FIGURE I. VIRTUAL MAINTENANCE TRAINING PROCESS MODEL

Virtual maintenance operation activities. Virtual maintenance operations means the minimum activities for trainees to perform virtual maintenance on a virtual prototype which is normally one operation step.

The relationship between virtual maintenance operation activities. The relation between virtual maintenance operation activities is usually serial process relation. There will be selection relation in fault diagnosis, and there will be parallel, synchronization and other relations when multiple people cooperate. For the training effect, there will be some changes in the operation process relationship compared with the actual maintenance operation process. The main change is to simplify repeated operations and emphasize important operations.

Virtual training link activities. Virtual training link is an activity designed by the trainer, which is automatically provided by the trainer or system to the trainee or triggered by the trainee in order to express a certain training purpose and intention.The typical virtual training links include teaching, helping, guiding, prompting, etc. Virtual training link is the main behavior of training elements in the process of virtual maintenance training, which is triggered by trainees or trainers and provided by training elements according to the conditions.

The relationship between the virtual training link and the main process of the virtual operation activity. The training process model is an abstraction of the training process. In the actual modeling and control process, the activities in the training process model must be instantiated to form basic activities. The basic activity is the minimum unit that constitutes the virtual maintenance training process, contains certain maintenance knowledge and has certain training intention. The virtual maintenance training process modeling with basic activities is a training design process, and its basic idea is shown in figure 2.

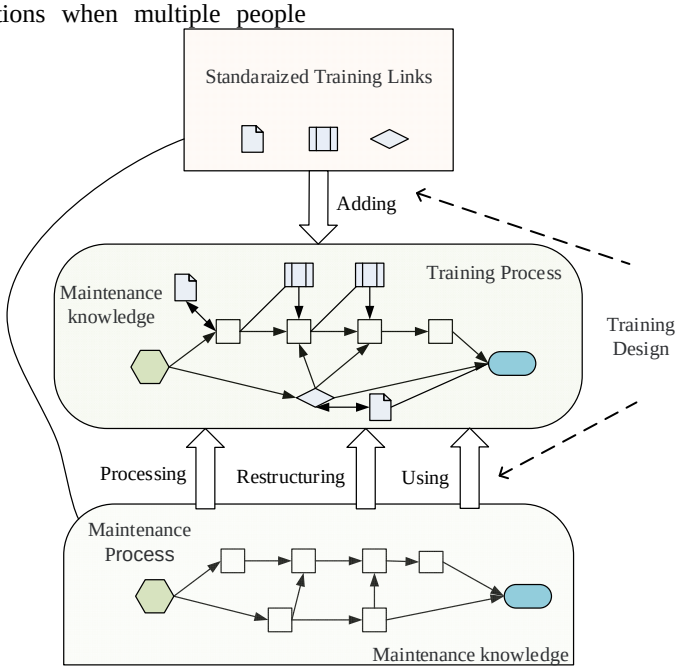

FIGURE II. BASIC IDEA OF TRAINING PROCESS DESIGN

V. VIRTUAL MAINTENANCE TRAINING CONTENT MODEL

The maintenance knowledge data constitutes the training content data after transferring to the virtual maintenance training environment. Training content data includes maintenance training data, virtual environment data, virtual prototype data, tool and equipment data and virtual maintenance training process data. The data of trainees and

training process information is generated around the specific trainees. The data generated in the virtual maintenance training process does not belong to the training content data.The training content model is the organization model and data standard of the training content data.

When the Content model of Virtual Maintenance Training is organized and managed according to SCORM standard, the data related to the virtual maintenance training content is organized into a shared virtual maintenance training content object (VMTSCO, Sharable Content Object for Virtual Maintenance Training). VMTSCO includes five types of specific data, including virtual environment, virtual prototype, tool equipment, maintenance data, and training process information. VMTSCO is defined as intellectual SCO(CMT), operational SCO(MMT) and diagnostic SCO(DMT) according to the organization methods of three types of virtual maintenance training process: knowledge, maintenance operation and fault diagnosis.

Some of the data information of VMTSCO is included in the standard data, which can be used to design the interface with the standard data in the training data development system and transform the standard data into the underlying data of VMTSCO for processing.

When learning content aggregation, the content list and metadata in SCORM standard must be adaptively modified owing to the habitual organization pattern of maintenance training and the different training patterns of virtual maintenance trainin. Based on the above analysis, the content model of virtual maintenance training is shown in figure 3, including four layers: training material layer, basic information layer, VMTSCO layer and training content aggregation layer. Where VMTSCO is the aggregation of basic information model, and training content aggregation is the aggregation of VMTSCO.

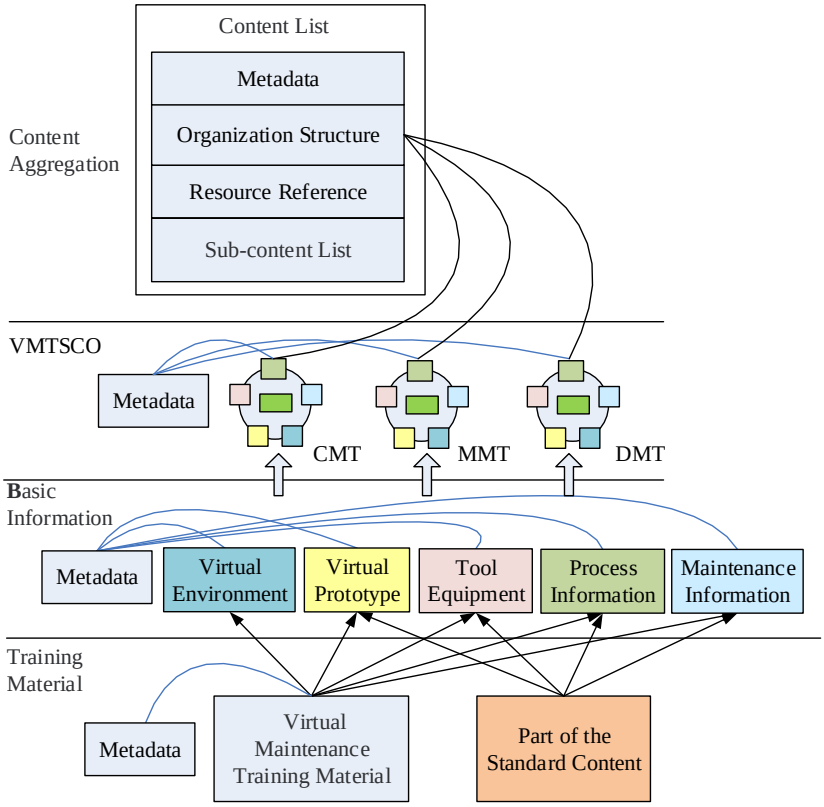

FIGURE III. VIRTUAL MAINTENANCE TRAINING CONTENT MODEL

Training platform for virtual interactive business logic function with actual equipment operation, including the number of steps, step sequence, each step involved components, parts and tools, the displacement and rotation Angle necessary parts assembly, such as virtual interaction style close to the real nature, interactive logic accuracy to millimeter level, reach the level of close combat training operation.

VI. CONCLUSIONS

The universal technology of the model for different types of equipment, different types of maintenance training content and mode is studied by the model and the system being separated from the specific training content data. A set of general interfaces is designed to control the virtual engine. The user's control behavior and the feedback of the system are separated

from the specific equipment, classified and encapsulated at the level of interaction task, provided different interaction interfaces for different interaction devices and feedback devices, and studied the universal technology for different virtual display hardware. Finally, the virtual maintenance training comprehensive model integrating function, state, interaction and process is established to realize fault state simulation, maintenance knowledge presentation, multi-mode training interaction and cross-platform engine integration based on the general model.

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