Research on the Application Mode of Interactive Electronic Technical Manual in Remote Operation and Maintenance

Xiong Chen[(✉)], Lin Yuan, Zhicheng Han, Zhishang Feng, Xiangcheng Li, and Jin Yang

Information Engineering University, Zhengzhou, China
`xiong_0710@163.com`

Abstract. The Interactive Electronic Technical Manual (IETM) technology plays an important role in device maintenance, especially in the remote operation and maintenance (ROM), where IETM has excellent applicability. In order to explore the feasibility of IETM application in ROM, this paper systematically analyzes the function and structure of the application mode, sorted out the responsibilities and tasks of different roles in ROM, formulated the operation mechanism specification, design IETM application mode process in ROM, and guides each role to carry out the work smoothly and efficiently. It has certain popularization value in practical application.

Keywords: IETM · remote operation and maintenance · application mode · maintenance

1 Introduction

IETM is a kind of electronic technical manual compiled in standard digital format, with interactive functions and interoperability, which can be displayed on the screen. It is an integrated information technology appearing in the process of digitization of technical data in recent years, and an important technical means of information technology for equipment maintenance support [1]. In the mid-1970s, the United States began to use electronic technical manuals instead of traditional paper technical documents and manuals. In the 1980s, after a series of program demonstration and research, the U.S. Department of Defense introduced a program for electronic realization of equipment technology data, namely IETM, which became a key element of the later developing Computer Assisted Acquisition and Logistics Support (CALS) strategy [2]. After the U.S., France, the United Kingdom, Sweden and other European countries also carried out IETM research, and after continuous improvement, the S1000D 5.0 version was released in 2019. In recent years, more and more domestic researchers have joined in the research of IETM, and carried out key technology and application research based on GJB 6600 and S1000D standards, and achieved certain research results [3].

With the rapid development and continuous progress of information science and technology, the performance of equipment is constantly improving, the function is constantly increasing, the structure is more complex, the integration, the degree of automation is higher, the use and maintenance of equipment needs more technical documents, which brings the problems of large volume, heavy weight, difficult storage, short time, high maintenance cost and low efficiency. Some devices require operation and maintainers to be stationed on site regularly or for a long period of time for maintenance and inspection, and some devices are distributed, resulting in long maintenance cycles. Even though a lot of manpower and material resources are consumed, it is difficult to improve the efficiency of operation and maintenance services [4].

In the ROM, the device can be detected, diagnosed and maintained by relying on the ROM platform and using IETM's diversified display style, good interactive features, maintainability and convenient access ability, which can break the space limitation of traditional operation and maintenance. It is of great significance to improve the maintenance ability and efficiency of device, reduce the maintenance cost and keep the device in good running condition.

2   Analysis of Application Mode Elements

2.1   Functional Analysis

In ROM, the actively using IETM technology can achieve the following four aspects of function:

Realize the technical personnel to quickly carry out maintenance support at the remote end, remote guide the site personnel to quickly carry out fault positioning and troubleshooting, quickly and efficiently flow fault information, improve the efficiency of maintenance support;

Realize the digitization of technical data, solve many problems brought by the paper technical manual, such as long preparation cycle, inconvenient inquiry and storage, repeated work, large manpower and material resources, delayed update and so on;

Realize the technical personnel can carry out online auxiliary training through video, audio, text, image, animation and other forms, solve the problems of centralized training is not strong, reduce the organizational pressure of the training organizers, improve the quality and efficiency of the training;

Realize fault data collection, solve the problems of maintainers to manually record faults, unclear recording, inconsistent format, do not support data analysis, and at the same time can provide data support for the development of maintenance device purchase plan and analysis of device failure rate [5].

2.2   Structural Analysis

Functional structure.

This mode contains 4 functions, which are implemented by each sub-module. The sub-modules include remote technical support maintenance, real-time update of technical data, online auxiliary training, fault data collection, etc., as shown in Fig. 1.
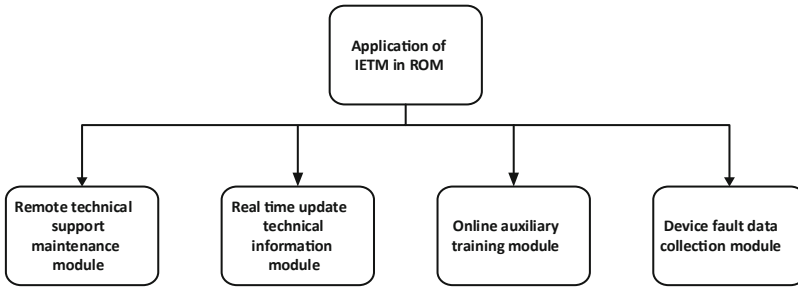
Fig. 1. IETM application mode function structure in ROM

Role structure.

Since business rules may have different impacts on different roles and thus affect the efficiency of completing tasks, when formulating business rules, the roles involved in tasks should be analyzed as much as possible, and tasks should be reasonably divided to seek the "optimal solution" [6]. The application mode of IETM in remote operation and maintenance includes five roles: operators, maintainers, ROM personnel, administrators, and developers. They take on different tasks respectively.

Operators.

Be familiar with the running state of the device.
Summarize operation skills.
Feedback the IETM operation manual suggestions.
Responsible for the operation and use of device.
Proficient in carrying out device operation training through IETM.

Maintainers.

Summarize the fault situation and the solution.
Responsible for feedback on updating IETM fault manual.
Familiar with IETM troubleshooting.
Provide suggestions on upgrading and maintaining IETM fault manuals.
Be familiar with device faults and troubleshooting methods.
Familiar with the troubleshooting process assisted by ROM personnel.
Familiar with the process of submitting remote technical support to ROM personnel through IETM.
Analyze the failure data, and provide data support for making the order plan of maintenance device and device failure rate.

ROM personnel.

Be familiar with the process of providing technical support to maintainers through IETM.
Be familiar with the troubleshooting process for maintainers.

Responsible for providing fault solutions.
Responsible for feedback on updating IETM fault database.
Responsible for feedback on upgrading and maintaining IETM.

Administrators.

Monitor and manage IETM.
Periodically back up and store IETM data.
Manage the use and maintenance of IETM.
Responsible for updating IETM database.

Developers.

Responsible for IETM development.
Responsible for IETM upgrade and maintenance.

Association between Roles.
Relationship between maintainers and ROM personnel. Maintainers can report device fault information to ROM personnel through IETM and request remote technical support. ROM personnel can provide efficient and accurate fault solutions based on the device running status information and fault information through IETM.

The relationship between operators and maintainers. Operators discover abnormal operating conditions of the device and provide feedback to maintainers to assist in locating and troubleshooting device faults. Maintainers promptly provide feedback on maintenance status to operators.

The relationship between the device maintainer and the IETM administrator. IETM administrators need to monitor and manage IETM to ensure the safe and stable operation of IETM, and to ensure that maintainers can access and diagnose device failure through IETM in time.

Relationship between operators and administrators. Operators use IETM to learn device operations, then feedback on usage. Administrators need to monitor and manage IETM to ensure normal running and security of IETM.

The relationship between developers and administrators: Developers need to upgrade and maintain IETM, while administrators need to monitor and manage IETM. Developers and administrators jointly maintain the normal operation of the IETM [4].The relationship between the roles is shown in Fig. 2.

3   Application Mode Operation Mechanism

3.1   Security Access Mechanism

In ROM, ensuring data security is the first consideration.

One is identity authentication and authorization, which can use technologies such as biometric recognition and dynamic password authentication to confirm the identity of access personnel. Different roles should have corresponding access permissions set, and users with different permissions can be allowed to access specific parts of IETM
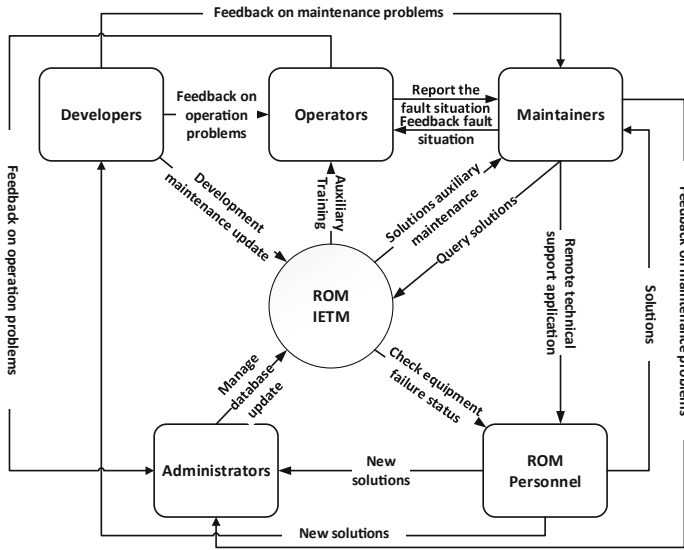
Fig. 2. The interrelationships between various roles of IETM in ROM

to prevent illegal access and incorrect operation (For example, equipment maintenance personnel can scope maintenance information, but cannot modify the database structure) [7].

The second is the firewall. By monitoring and controlling network traffic, only specific traffic is allowed to pass through, ensuring that only authorized users can access network resources and preventing illegal network attacks. Develop security policies based on actual business needs and security risk assessment, and regularly test and verify firewall policies. If vulnerabilities are found, update firewall rules in a timely manner.

The third is to strengthen the security awareness of personnel. Through the establishment of perfect remote operation and maintenance rules and regulations, refine the rules and processes, and strengthen the responsibility subject. Enhance the authority management awareness of personnel in different roles, divide the scope of authority and usage scenarios, and combine security technology with security awareness, so as to avoid security incidents caused by users' lack of security awareness and non-standard operations [8].

3.2   Security Check Mechanism

Periodically remind maintainers to check device components, network status, database storage status, device run logs, and data backup and storage status in IETM (allowing the system to perform automatic checks or tests to ensure that the system or device is in a safe and functional state).

IETM generates the check list of device during shift change, reminds shift change-over personnel and shift-over personnel to confirm the status of device item by item, and

records the status of device during shift change-over. Periodically generate inspection and repair lists and guide device maintenance personnel to check related components of the device to ensure that the device is in good running condition. After the processing is complete, the running time of related components is reset and counted into the next inspection and repair cycle.

Before performing specific safety checks or procedures, maintainers and operators can use IETM to formulate detailed check lists to ensure correct operation sequence, reduce incorrect operations, and reduce the probability of device damage [9].

3.3 Maintenance Task Scheduling Control Mechanism

Maintenance task scheduling control mechanism is an effective means to give full play to the advantages and specialties of maintainers and ROM personnel, and solve the shortage of maintenance ability to the maximum extent under the condition of limited maintenance resources. To formulate the task scheduling control mechanism, we should fully consider the complexity of the fault, fault location, maintenance cost, maintenance hours, equipment reliability and other factors, and distinguish between fixed scheduling and temporary scheduling.

Fixed scheduling means that maintainers, ROM personnel, and administrators perform maintenance tasks according to the established task division and process. Temporary scheduling refers to the adjustment of task division and process scheduling when the task cannot be completed according to the established maintenance task scheduling control mechanism in case of sudden emergency [10].

3.4 Maintenance Capability Analysis and Evaluation Mechanism

Maintenance capability evaluation is mainly to evaluate the maintenance support capability of maintainers, ROM personnel and maintenance organizations, among which the storage of maintenance equipment, the status of maintenance equipment, ROM platform usage and IETM usage are important factors for maintenance capability evaluation.

Regularly organize maintainers, ROM personnel, and IETM management personnel to conduct device failure analysis and evaluation based on device failure situations and maintenance records, calculate device failure rates and possible development trends, and determine whether preventive maintenance is necessary for the device; Maintainers verify whether the inventory of spare parts is sufficient based on recent maintenance and repair situations; IETM management personnel will add or revise fault solutions as appropriate based on the evaluation results, update the IETM fault database, and synchronously publish updated information.

4   Application Mode Process Design

In the ROM mode, IETM adopts a C/S structure and is deployed on the server side of the ROM platform. IETM developers upload information such as device operation and usage manuals, fault maintenance manuals, fault handling steps, and maintenance precautions to the ITEM database during device development. Below is an analysis of three modes: IETM assisted training, IETM assisted maintenance, and remote technical support maintenance. The different roles work according to the business process.

4.1   Pre-Job Training Process

After the newly hired operator takes up their job, they can access IETM, query operation instructions, load operation tutorials, quickly learn device operation and use, and conduct training and assessment. At the same time, IETM can provide operators with various forms of operation instructions such as video, audio, and text, and can repeat learning. Through IETM auxiliary training, to promote equipment operators quickly familiar with the equipment, master the operation skills. By visiting IETM and inquiring the maintenance manual, the new equipment maintenance personnel can quickly get familiar with the maintenance skills, improve the maintenance support ability, and reduce the on-site training of the manufacturer, greatly reducing the training time and cost.

4.2   Maintenance Process

After discovering a device fault, the maintainers can access IETM over the network, query the solution, select the most appropriate solution, and load the solution. Then, the maintainers can quickly and accurately locate the fault location and cause, isolate the fault, and rectify the device fault according to the solution provided by IETM. If the fault cannot be solved, the maintainers can choose a new solution. If IETM fails to provide an effective solution, maintainers can submit an application for remote technical support to ROM personnel. At the same time, IETM provides device running status and fault information. The ROM personnel can analyze the fault cause and upload the solution to IETM. After troubleshooting, maintainers will report the troubleshooting result to ROM personnel.

4.3   IETM Data Update Process

The remote operation and maintenance staff revises, refines and solidifies the new solution, and feeds back to IETM managers and developers. IETM managers are responsible for updating the IETM fault database and publishing it across the network to realize real-time data update. Meanwhile, IETM records equipment maintenance and equipment replacement, providing data support for making maintenance equipment purchase plans.

4.4   Evaluation Test Process

In the use and maintenance stage, it is necessary to evaluate and test the use of IETM, focusing on whether it meets user requirements and design specifications. The evaluation tests include functional testing, performance testing, usability testing, etc. In case of design defects, the relevant information can be reported to IETM R&D personnel for IETM upgrade and maintenance (see Fig. 3).
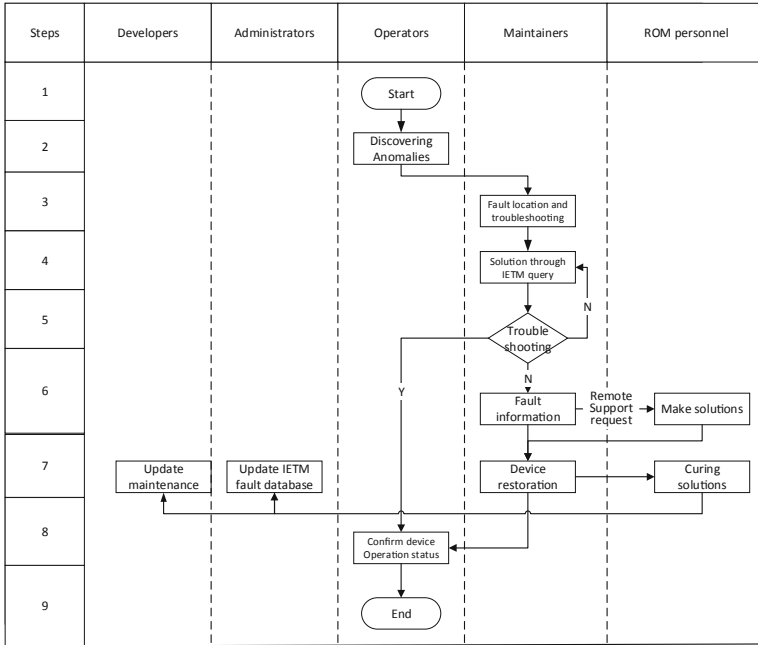
Fig. 3. Flowchart of IETM application in ROM

5 Conclusion

With the progress of technology and the development of device, IETM will be more and more people's attention, many devices in the demonstration of the construction plan, IETM has been included in the important indicators. IETM is an important technical data support tools in the whole life cycle of equipment, its design, development, use and maintenance of different stages need IETM research and development personnel, management personnel and equipment maintenance personnel such as different roles, formulate reasonable business rules, to maximize the benefit of IETM, better support the remote operational equipment security. This paper mainly analyzes the function and structure of IETM application mode in remote operation and maintenance, formulates a more reasonable operation mechanism and designs a standardized business process, which has certain practical value for optimizing maintenance process, reducing maintenance costs and reducing on-site support pressure of support personnel.

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