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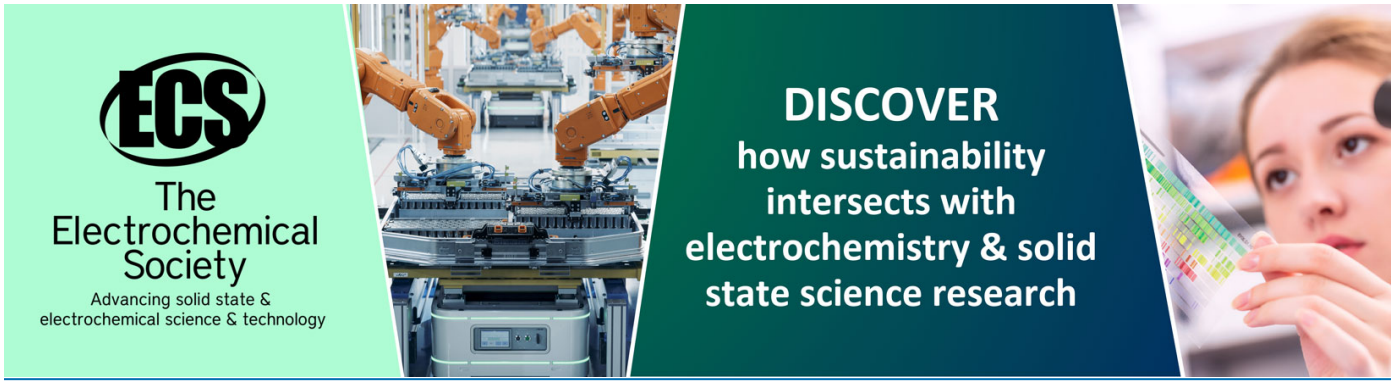

Interactive electronic technical manuals as a means to improve efficiency of operation of complex technical systems

A V Trofimov, V A Sokolova*, V A Markov, S I Zatenko, M V Taraban

St. Petersburg State Forest Technical University, 5 Institutskiy Lane, St. Petersburg 194021, Russian Federation

*Corresponding email: sokolova_vika@inbox.ru

Abstract. The article describes the use of interactive electronic technical manuals (IETM). One of the tools for implementing the requirements of the S1000D standard is the editor of interactive electronic technical manuals Seamatica. The editorial staff of Seamatica Enterprise implements the full range of IETM development activities. The pace of introduction and quality of interactive manuals in industrial engineering are clearly unsatisfactory. The article discusses the main reasons for a limited application of interactive manuals in industrial engineering, such as the lack of education in IETM-related topics for specialists in forestry machines operation.

1. Introduction

Modern technologies allow us to invent more and more materials from woodworking waste. At the same time, the priority is certainly to obtain materials from cheap woodworking waste. Processing of wood waste can be both the final stage of the wood life cycle and the initial stage of the formation of new products. The products made from waste wood and its production technologies are huge. For structuring and ease of use of production and technological information, it is recommended to use electronic systems and databases.

The effective presentation of technical systems in the market during all stages of their life cycle is one of the main tasks of a manufacturer. Operation, as a stage in the product life cycle, is no exception. At the current level of development of computer technology, there is a real opportunity to channel its power towards the solution of this problem.

The provision of personnel with electronic operational documentation is a prerequisite for the supply of sophisticated equipment to the global markets. The use of interactive electronic technical manuals (IETM) offers a solution to this problem.

The term is described in detail in GOST R 54088-2017 [1]. IETM is a set of electronic documents, technical data and software and hardware designed to provide information support for the intended use and technical operation of the product and (or) its components and to offer a direct link between the user and the management in real time, by using the interface of an electronic display system.

The tool is used to solve the following problems:

- providing reference material for users, containing information about the device, as well as technical and technological principles of its operation,
- providing reference material for maintenance and repair,
- automated collection, storage and processing of data obtained from technical condition diagnostic devices,

- search and forecasting the causes of malfunctions, and issuing recommendations for their elimination,
- planning and recording routine maintenance,
- automated ordering of materials and spare parts,
- collection of technical data obtained during operation, their analysis and issuance of recommendations for operation.
- the exchange of data between the consumer and the supplier.

Product features, if necessary, can be expanded in a number of ways:

- support for the selection of equipment usage modes,
- evaluation of operational efficiency,
- support staff for the detection of typical faults and methods of their elimination,
- technical condition monitoring,
- automated development of maintenance plans based on actual condition,
- visualization of maintenance and repair procedures using 3D modeling technologies,
- training on the use of equipment in normal and emergency situations,
- automated testing of personnel for access to the equipment.

The manual is an electronic document, supported by drawings, photo and video materials, interactive diagrams, 3D-models, and animation. IETM combines various types of operational and repair documentation, including catalogs, technical descriptions, instructions, manuals, lists, etc. [2].

The regulations for the development of national IETMs and requirements for the composition and information content are prescribed by the following standards.

- GOST 2.051-2013 "ESKD Electronic documents. General Provisions" [3].
- GOST 2.601-2013 "ESKD Operational Documents" provides a concept of an operational document in electronic form [4].
- GOST R 50.1.029-2001 "Information technology to support a product life cycle. Interactive electronic technical manuals. General requirements for the content, style and design" [5].
- GOST R 50.1.030-2001 "Information technology to support a product life cycle. Interactive electronic technical manuals. Requirements for the logical structure of the database" [6].
- GOST R 54088-2017 "Integrated Logistic Support. Operational and repair documentation in the form of interactive electronic technical manuals. General Provisions and General Requirements" [1].

2. Methods and Materials

According to GOST R 54088-2017 [1], there are five complexity classes of a document.

- 1st class: electronic technical publications.
- 2nd class: a collection of texts in the SGML format with a table of contents. The material may include cross-references, tables, illustrations, and links to audio and video data. It is possible to search for information. The material can be viewed on screen and printed without pre-processing.
- 3rd class: data are presented as a set of interconnected information objects stored in databases and having a hierarchical structure (in accordance with the requirements of international standards and specifications derived from them). Information is presented in separate files.
- 4th class: in addition to the functions of the 3rd class, the possibility of a dialogue interaction with electronic modules for diagnosing products is provided. It is also possible to carry out troubleshooting and perform the selection of spare parts.
- 5th class: the manual includes the means of accumulating technical data obtained during operation, their analysis and generating recommendations to users on the preferred procedure for maintenance and diagnostics.

The concept of "interactive electronic technical manuals" is comparable with the concept of "interactive electronic technical publication" provided in the international standard.

The content of the term is based on a group of departmental standards of the US Department of Defense.

• MIL - M - 87268 "Manuals, Interactive Electronic Technical: General Content, Style, Format and User-interaction Requirements" (Requirements for the content, style, design and organization of dialogue with the user in the IETP) [7].

• MIL - D - 87269 "Database, Revisable: Interactive Electronic Technical Manuals, for the Support of" (Requirements for the organization of the IETR Database) [8].

• MIL - PRF - 28001 “Markup Requirements and Generic Style Specification for Electronic Printed Output and Exchange of Text” [9].

The most effective application of technologies is the international standard ASD S1000D (short name - S1000D) [10]. The standard was developed in the aviation industry and has been successfully applied in shipbuilding, nuclear energy, heavy industry and space.

The essence of the document is represented by the following positions:

- a single database for storing information;
- a modular system (information is stored in the form of modules – the minimum independent units in a technical publication; small documents are compiled into large ones such as publications and sets);
- identification of objects by unique codes with a special structure;
- information is not duplicated;
- documentation for a specific product structure is “assembled from cubes”.

The standard introduces the concept of a data module (MD-Data Modules), i.e. a block of information that uniquely describes a product and cannot be further divided into blocks. Modules are stored in a common database (CSDB-Common Source Data Base). Each module is assigned a special code. The main parts of the code indicate that the information contained in the MD refers to the specific product (SNS) and the action (maintenance, troubleshooting, etc.) performed on the product (IC).

The modular organization of the database provides several advantages in the development and maintenance of documentation:

- allows one to use a ready-made block of information when compiling documentation;
- excludes duplication of information;
- gives one the opportunity to work on the coordination and approval of information not at the level of the whole document, but at the level of a single block of information;
- allows one to simplify the exchange of information between different organizations, when necessary [11].

In new versions of the document, a different approach is implemented (there is no division into classes):

- The set of IETM functions is defined. Function groups (in version 4.1) are presented in a table called the “Functionality matrix”.
- The matrix columns show different types of schemes (each scheme describes the data structure of a certain type, for example: descriptive information, information about the planning of maintenance, information about the execution of a sequence of actions (processes), information from the training data module, etc.). The rows of the matrix describe the functions that viewers can have, which process and present information to a user of a particular scheme.
- The matrix is filled in by a customer at the stage of formation of a technical order for the creation of the IETM. The customer determines what functions and for what types of information they need.
- When preparing an IETM for a specific product from a general data base the necessary MDs are selected and a ready-made guide in the SGML format (ISO 8879) is compiled from them.

3. Results and Discussion

One of the tools for implementing the requirements of the S1000D standard [10] is the editor of interactive electronic technical manuals Seamatica [12, 13]. The editorial staff of Seamatica Enterprise implements the full range of IETM development activities.

As a result of the publication of the document, the IETM is generated in a web view, ready for viewing.

When developing the guidelines, both domestic and foreign programs are used. The following products are best known.

From foreign firms:

- SolidWorks - a product that includes the necessary basic capabilities and a number of specialized modules designed to obtain a range of graphical information for the IETP (photo and three-dimensional animation obtained using PhotoWorks and SolidWorks Animator are embedded in the IETP as embedded objects; specialized e-Drawings and 3D Instant Website designed to create interactive drawings and 3D models);
- SolidWorks Composer - a modern software product from the market leader in speakers - Dassault Systèmes SOLIDWORKS Corp;
- Mincom Link One;
- Arbortext CSDB for S1000D;
- 3DVIA Composer;
- Adobe FrameMaker 6 + SGML from Adobe;
- PIDOC Suite by PI Associes SA;
- Change 6, 7 & 8 Authoring Pack for FrameMaker + SGML by Mekon Ltd;
- AcquirED, LBSTrain of Logistics Business Systems, etc.

From Russian developers:

- Technical Guide Builder (TG Builder) - development of the national SIC CALS-technology "Applied Logistics" for the formation of IETD 3 and 4 classes [14];
- Seamatica [15].

Additionally, in each medium and high level CAD systems there are modules designed to visualize data in the required form.

When creating an electronic manual, it is necessary to take into account the economic component of the procedure. According to practice data, the cost of translating a technical manual page into an IETP of class 1 is approximately $ 2; class 2 - 10 $ -20 $; class 3 - $ 30 -40 $; Class 4 - about $ 100; Class 5 - more than $ 200. The range does not include equipment and storage costs.

4. Conclusion

1. IETM are increasingly being used in national industry as a means of increasing the efficiency of operation of complex technical systems.
2. The pace of introduction and quality of interactive manuals in industrial engineering are clearly unsatisfactory, which requires a detailed analysis of the reasons.
3. To a first approximation, we came to the conclusion that one of the main reasons is the lack of education on the IETR topic for specialists in forest machines operation.

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