

Ontological modelling of flight preparation manual

Abstract. This paper describes ontological modelling processes for the formation of flight operation guidelines. The modelling was performed using Fluent Editor – an ontological creation tool based on Controlled Natural Language (CNL). Ontology for pre-flight inspection of the airplane's flight preparation was designed using Yak-52 airplane's flight preparation manual. The created ontology is considered as a base for creation of electronic manuals. Pros and cons of the Fluent Editor have been analysed for applicability in electronic manuals creation.

Streszczenie. W artykule opisano ontologiczne procesy modelowania wykorzystywane do tworzenia wytycznych dla operacji lotniczych. Modelowanie przeprowadzono przy użyciu Fluent Editor - narzędzia do tworzenia ontologii w oparciu o CNL – Kontrolowany Język Naturalny. Ontologia do kontroli przedstartowych przygotowań do lotu samolotu został zaprojektowany z wykorzystaniem instrukcji przygotowania lotu samolotu YAK 52. Stworzona ontologia jest traktowana jako baza do tworzenia podręczników elektronicznych. Wszelkie argumenty za i przeciw narzędziu Fluent Editor były analizowane z punktu widzenia jego przydatności w tworzeniu elektronicznych instrukcji. (**Ontologiczne modelowanie instrukcji przygotowania lotu**).

Keywords: ontology, manual, Fluent Editor, verification.

Słowa kluczowe: ontologia, instrukcja, Fluent Editor, weryfikacja.

Introduction

At the present time, experts tend to carry out the creation of manuals without the use of automated systems. Strict no formal rules are applied in the organization of work in the preparation of documents for manuals. Lack of regulations could lead to ambiguities, errors or omissions in the guidelines, which is unacceptable in the operation, installation and use of any product or parts thereof.

One solution to the problems of ambiguity and excessive simplification of the described models is the use of semantic technologies. Processing conceptualized knowledge repeatedly put forward thinkers, since the Renaissance partly used in the best years of the planned Soviet economy, but the functional embodiment grew just now. All the necessary components, methods and technologies necessary to work with the ontological models are subject to semantic processing technologies. The word "ontology" means the total knowledge. The term "semantic technologies" emphasizes the fact that they provide the work with a sense of information [1]. Semantic approach also allows us to formulate rules of the relation of essence and attributes of an object belonging to a class of objects with this attribute [2].

In this paper, we propose an algorithm for constructing manuals using ontological modelling. An example would be a manual for preliminary examination of the Soviet sports and training aircraft Yak-52 [3].

Instruments of ontological modelling

Visual design methods of ontology contribute to a more rapid and complete understanding of the structure and knowledge of any subject area, which is invaluable when checking the quality of the knowledge described. Requirements of ontological editor for creating manual:

- easy to write an ontology consists in structuring the text manual due to the use of special controlled languages, for example, Controlled Natural Languages, Attempto Controlled English, Simplified Technical English, etc.;
- comprehensive visualization mechanisms in the form of a clear and easy-to-understand graphic representation of all the subjects, objects and relations between them in the manual;
- support OWL and RDF, ontologies for integration formats and then use it in other programs.

In this paper, we propose to use to ontology for the inspection of the airplane management ontological editor Fluent Editor. Fluent Editor uses the formation of ontology from Controlled Natural Language (CNL) [4].

CNL - the mechanism of realization of building ontology editor Fluent in which there are rules for suggestions. Firstly, a proposal for a controlled language is formed in the following sequence of its members "subject predicate complement". Secondly, the class names are written with a lowercase letter, and copies of the names with the title. If the class name and the instance consist of several words, they do not need to share spaces and hyphens. Thirdly, the management provides the use of built-in memory keyword in ontology editor, for example, the word "and". Using keyword will reduce the size of the ontologies.

Standards

The main document on the creation of manuals in Russian is GOST 2.601-95 [5] "Unified system for design documentation. Operational documents." The term "Manual" means "document containing information about the structure, principle of operation, characteristics (properties) of the product, its components and instructions necessary for proper and safe use of the product (intended use, maintenance, maintenance, storage, and transportation) and evaluation of its technical conditions in determining whether to send it in for repair, as well as information on the disposal of the product and its components".

Basic requirements for manual in accordance with GOST 2.601-95:

1. The text in presenting instructions on carrying out works using verbs in the imperative mood, for example, "Open the door ...", "Press ..." etc.
2. Describes how to perform any work, which is given in a logical sequence of their execution.
3. In the development of documents, special attention should be paid to the account of the requirements for compliance with safety measures for maintenance and repair of products. The text of the warnings and requirements precautions should always stand out and clearly show the user that this is a caution or warning. It is recommended to use an appropriate graphic symbol or other clearly visible sign. A warning of the word "WARNING, CAUTION", should precede the text of these requirements.
4. To provide clarity and ease of reading, the contents of the text expounded and its explanations applies to different tables, shapes and graphic illustrations.

Ontological description of the domain's objects

Domain - the set of all objects, properties and relations between them are discussed in scientific theory. In the logic of - the domain of possible values of the variables subject

logical language [6]. In recent years, more and more widespread use of gets ontological model to describe the domain [7].

Provide a description of the structural elements of the airplane in the form of ontology to CNL (see Figure 1). When writing ontology on a Controlled Natural Language one must adhere to the above rules CNL [8].

```
Yak-52 is a airplane.
Yak-52 have Propeller and have Cowl and have Louver and have Engine
and have Landing-Gear and have Propeller-Blades and have Right-
Wing-Console and have Left-Wing-Console and have Vhf-Antenna and
have Empennage and have Right-Aileron and have Left-Aileron and
have Skin-Starboard-Side-Fuselage and have Skin-Left-Side-
Fuselage and have Arc-15-M-Antenna and have Left-Wing-Console.
```

Fig.1. Description of structural elements of the Yak-52 airplane's

Ontological model of manual

There is a need in the formation of associative relationships between objects created ontology. Since the description of the manual is generally used in the imperative form of proposals, the ontology developer to implement accurate sequence of the sentence on the CNL is necessary to introduce extra copies of "Check-1", "Check-2", etc. That, equally, will be given to temporal properties of objects of the ontology, responsible for the formation of a sequence of performing the pre-flight inspection checks in the ontology operating manual for example, "Check-5 pressure-in Landing-Gear" (see Fig. 2, 3).

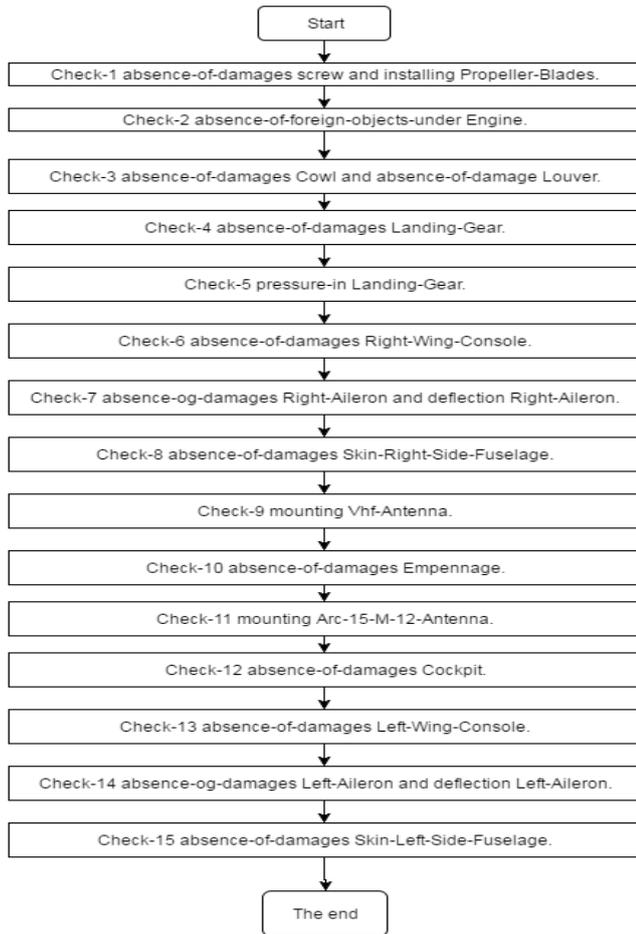


Fig.2. Formalizing model of manual Yak-52 airplane's in block diagram form and its record to CNL, using already specified domain objects

Created associative relationships are displayed in one of the Fluent Editor visualization mechanisms - Tree Taxonomy (see Fig. 4). Taxonomy - theory systematization areas of reality and knowledge, with a hierarchical structure

(objects of various fields of knowledge, disciplines, and so on). The basic concept of taxonomy is the classification - general methodological concept, meaning a form of systematization of knowledge, when the whole area studied objects are presented in a system of classes or groups, in which these objects are allocated based on their similarity in certain properties [9]. The Tree of ontological editor taxonomy at CNL displayed classification or hierarchy of classes and instances of the ontology, as well as their relationships and attributes.

```
Yak-52 is a airplane.
Yak-52 have Screw and have Cowl and have Louver and have Engine and have Landing-Gear and have
Propeller-Blades and have Right-Wing-Console and have Left-Wing-Console and have Vhf-Antenna and
have Empennage and have Right-Aileron and have Left-Aileron and have Skin-Starboard-Side-Fuselage
and have Skin-Left-Side-Fuselage and have Arc-15-M-Antenna and have Left-Wing-Console.
```

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Check-1 absence-of-damages Propeller and installing Propeller-Blades.
Check-2 absence-of-foreign-objects-under Engine.
Check-3 absence-of-damages Cowl and absence-of-damages Louver.
Check-4 absence-of-damages Landing-Gear.
Check-5 pressure-in Landing-Gear.
Check-6 absence-of-damages Right-wing-Console.
Check-7 absence-of-damages Right-Aileron and deflection Right-Aileron.
Check-8 absence-of-damages Skin-Starboard-Side-Fuselage.
Check-9 mounting Vhf-Antenna.
Check-10 absence-of-damages Empennage.
Check-11 mounting Arc-15-M-12-Antenna.
Check-12 absence-of-damages Cockpit.
Check-13 absence-of-damages Left-wing-Console.
Check-14 absence-of-damages Left-Aileron and deflection Left-Aileron.
Check-15 absence-of-damages Skin-Left-Side-Fuselage.
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Fig.3. Description of structural elements of the Yak-52 airplane's in Fluent Editor

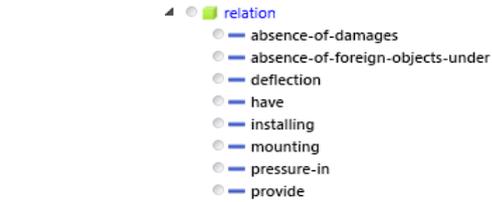


Fig.4. Associative relationship ontology visualized by Taxonomy Tree

The main purpose of the establishment of associative relationships between objects of ontology is that the establishment of such a link may specify additional concepts that are useful for indexing or searching.

Ontological modelling of manual's subject

The main airplane subject manual is the aeromechanics, that it fulfils the above-described external inspection of the airplane. On this basis, a copy of "Aeromechanic" was introduced. Aeromechanics assigned to each of the copies of the checks, "Check-1", "Check-2", etc. via an associative relationship "provides" (see Fig. 5).

However, a variety of management's actions can serve people of different professions, as well as automated tools and mechanisms that need to be obligatory as mention in the ontological manual.

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Aeromechanic is a human.
Aeromechanic provides Check-1 and provides Check-2 and provides Check-3 and
provides Check-4 and provides Check-5 and provides Check-6 and provides Check-7
and provides Check-8 and provides Check-9 and provides Check-10 and provides
Check-11 and provides Check-12 and provides Check-13 and provides Check-14 and
provides Check-15.
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Fig.5. Subjects ontological modelling of manual

Graphical representation of ontologies in Fluent Editor

For a more comfortable visual observation and analysis of the constructed ontology, it is represented with a CNL-diagram. CNL-diagram is a mechanism of the built-in Fluent Editor (see Fig. 6). CNL-diagram shows classes, in-stances and the relationship of association between them using the arrow to display a text on the type of relationship. It should be noted that there are some shortcomings when using ontology editor visualization mechanisms. Initially, the editor renders ontological objects that will take a little inconvenience if the ontology will consist of dozens of concepts and relationships. To counter this problem not

covered at any given time, objects of ontological model visualized by rectangles can be subjected to removal from the imaging field. Also, these objects can freely move around the CNL-diagram. This feature helps further helps ontology's graphical control display for the benefit of comfort built-in test of ontological management. The rest of the CNL-diagram can be rightly considered as a rational mechanism for visualization of ontologies [10].

Professionals need to carefully verify the visualization of ontology with the use of CNL-diagram. The following are the sequences of action:

1. Selecting one of the copies of the "Check-1", "Check-2", etc.
2. Continuation of checking relations between instances for each of the branches of the selected item 1 instance. Moving along the branches towards the object and the associated relationship, you can get a complete description of the action performed.

3. Repeat steps 1 and 2 points for each instance of "Check-1", "Check-2", etc. consistently verify relations between objects and subjects of ontology related to each of the steps.

4. The conclusion of correctness of the instruction manual.

5. Supplement the necessary leadership and relationship instances.

6. Verification amended guidance.

Thus, achieve the most correct text of the manual.

For example, after the initial test "Check-1 is performed, aeromechanics and man serves to identify the lack of damages to the propeller and to try fitting the propeller blades of Yak-52".

The integration of the ontology built is performed with the use of mechanisms to export the file from Fluent Editor in OWL / RDF format and HTML. It is also possible to specify an additional machine-interpreted semantic resource.

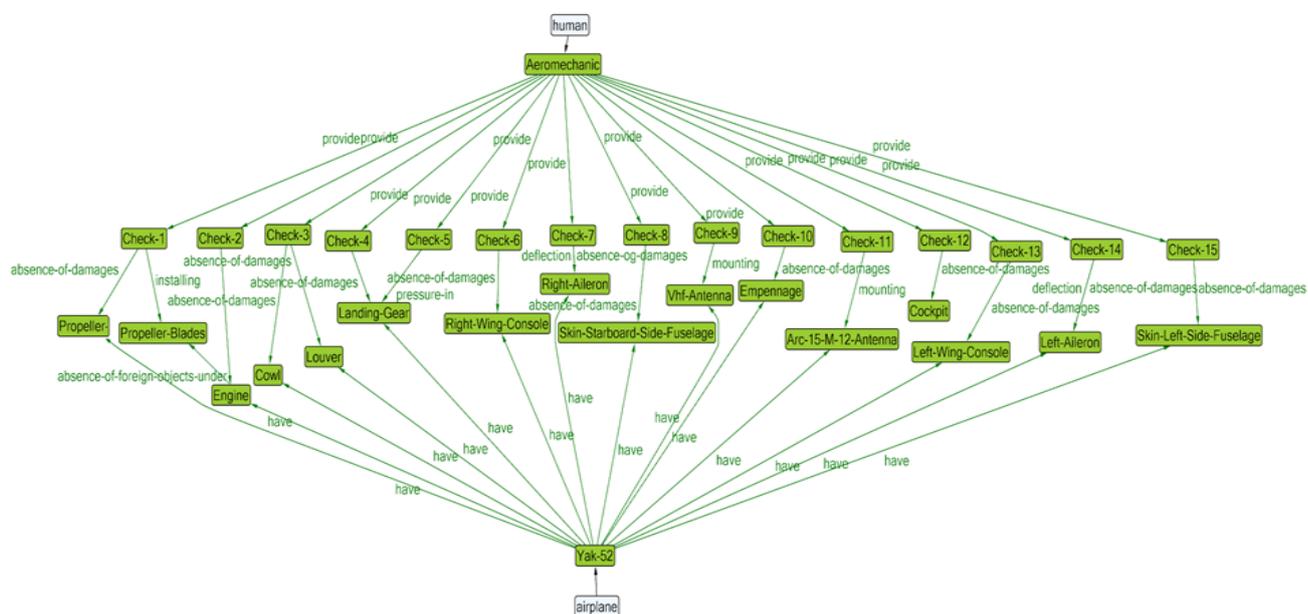


Fig.6. Visualization of ontology to the CNL-diagram manual

Conclusion

Used ontological editor "Fluent Editor" has the necessary mechanisms for the implementation, conceptualization and formalization of ontology. It is sufficient to verify the written technical manuals. These mechanisms include the use of Controlled Natural Languages in the formation of an ontology, visualization of relations and associations between objects and subjects of ontology and also integration of ontology in formats for further use in other programs. It contributes to the convenience of the ontological modelling of such class of technical documentation as user manuals.

The ontology of the "Flight manual of the airplane Yak-52" can be used as a base for the creation of electronic manuals on airplane flight preparation.

The ontology is later implicated into formats compatible with other software. The ontology described in this paper can be used as a base for creation of ontology.

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