TRIZ Ontology. Current State and Perspectives

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2 Abstract

The report contains a description of the TRIZ Ontology project. This project was initiated by a group of TRIZ specialists as part of TRIZ Summit 2019.

The report presents a description of the approach with the changes that were made during the project run, and also information on how to become a participant in the project.

3 Introduction

Today, the formalisation of the TRIZ areas of knowledge is going in several directions:

1. the existing TRIZ concepts are being clarified and new tools and concepts are appearing.
2. TRIZ integrates with other fields of knowledge (e.g. Design Thinking, Product Development, Lean Production, Product Management, Business System Engineering and others). In the course of such integration, it is necessary to harmonize TRIZ concepts and models and concepts from other areas of knowledge.
3. Systems of TRIZ education and systems of evaluation of knowledge and TRIZ skills are developed.

An ontology helps to achieve a deeper level of formalisation of the fields of knowledge of TRIZ.

4 TRIZ Knowledge Development Stages

Conditionally TRIZ knowledge development can be divided into 3 stages. In Table 1 we presented consolidated data on the 3 stages of TRIZ knowledge area development.

Table 1: Development stages of TRIZ knowledge area

Stage	Period	What is done	Number of terms
TRIZ 1.0	1956-1988	• No unified glossary of TRIZ terms. • The results of the stage are recorded in the TRIZ-88 Overview of G. Altshuller [1].	112
TRIZ 2.0	1989-2020	• V. Sushkov's TRIZ Glossary [2]. • Body of Knowledge of TRIZ 1.0 [3]. • Requirements of MATRIZ on the level of TRIZ knowledge [4].	415(+303)
TRIZ 3.0	2020 -	• TRIZ Ontology • TRIZ Glossary 3.0 • TRIZ Body of Knowledge 3.0 • Several TRIZ knowledge evaluation systems, including the TRIZ knowledge evaluation system of the International Council of TRIZ Masters, an the MATRIZ certification system.	

4.1 1st stage of TRIZ knowledge area development

Stage 1 was associated with the activities of TRIZ author G.S. Altshuller and lasted from 1956 until 1988. As result of this stage can be considered the TRIZ-88 overview by G.S. Altshuller, where he summarizes the TRIZ development and describes the prospects of its further development. As part of Stage 1, no unified glossary of TRIZ terms was created. In fact, the TRIZ-88 overview played the role of such a glossary: in it 112 TRIZ terms are mentioned. Also, there was no unified TRIZ Body of Knowledge or a similar document setting the boundaries and scope of the application of TRIZ, as well as a regulation of the scope of knowledge required to be considered a TRIZ specialist.

Fig. 1 shows the structure of the field of TRIZ knowledge based on the criteria of the TRIZ-88 reference.

See the Picture in the original paper

Figure 1. TRIZ knowledge area structure (1st stage)

As can be seen, such sections as FSA, TRTL, TRIZ in science and art in the 1st stage have not yet become part of the main body of TRIZ knowledge: at that time they were new directions for TRIZ development.

4.2 2nd stage of TRIZ knowledge area development

Phase 2 is associated with the rapid spread of TRIZ around the world, and also active development of new TRIZ tools. Conditionally the 2nd stage has lasted since 1989 until 2020. During this period, the TRIZ Glossary [2] and the TRIZ Body of Knowledge [3] were published, and also the TRIZ specialists certification system [4] under the auspices of International TRIZ Association (MATRIZ). Figure 2 shows the structure of the areas of knowledge of TRIZ in this 2nd stage.

See the Picture in the original paper

Fig. 2. TRIZ knowledge area structure (2nd stage)

It can be seen that the FSA, along with functional and system analysis, has taken over its rightful place in the main body of TRIZ knowledge. TRTL[1] was merged with RTV[2] and formed into a single unit *Personal Development.* TRIZ in science and art are at the beginning of a separate branch *TRIZ in non-technical areas.*

During the 2nd stage new promising directions for TRIZ development appeared: OTSM-TRIZ by N.N. Khomenko [5] and evolutionary systems science by M.S. Rubin [6].

The *TRIZ in non-technical areas* branch has also been seriously developed, including:

- Art and literature
- Biology
- Medicine
- Ecology
- Programming
- Business
- Pedagogy
- Patentology
- Research tasks in science
- Team development

4.3 3rd stage of TRIZ knowledge development

In the 2010th years, there were continuous discussions within the TRIZ community about the need for a serious revision of the areas of TRIZ knowledge: a new organization has appeared – the Council of TRIZ Masters – which has developed and spread a new assessment system for TRIZ knowledge and skills *Icarus and Daedalus* [7], the new MATRIZ Presidium is discussing the development of a new version of the TRIZ Glossary, a specialized association *TRIZ in Business* was founded, which brings together specialists applying TRIZ in business systems.

All these facts indicate the need for a new audit of the field of TRIZ knowledge and transition to a 3rd stage of TRIZ development.

[1] Theory of the development of a creative personality.

[2] Development of a creative imagination.

5 The role of ontology in the formalization of TRIZ

[8] shows the role of TRIZ ontology as the basis for restructuring all regions of TRIZ knowledge, including the TRIZ glossary, areas of knowledge and TRIZ tools, kinds of TRIZ activities. In turn, the TRIZ body of knowledge is the basis for both TRIZ training as well as for certification of the level of knowledge and skills of TRIZ specialists. At the new stage, the different parts of the area of TRIZ knowledge must be combined into a single system as shown in the figure. 3.

See the Picture in the original paper

Fig. 3. TRIZ knowledge area structure (3rd stage)

In the new system, TRIZ ontology acts as a link between the different parts of the TRIZ area of expertise.

TRIZ ontology is represented as a set of ontological diagrams. Each of them describes several concepts of connection between different TRIZ concepts. Links between the concepts of TRIZ make it possible:

1) to see the interrelationships between different TRIZ concepts.
2) to ensure that the definitions of these terms are complete and correct, and also detect formal and methodological errors made in such definitions.
3) to see the links between the concepts of TRIZ and those borrowed from concepts in other areas of knowledge.

5.1 The data sources for a TRIZ Ontology

As basis was taken the TRIZ Glossary 1.2 [2]. It were added TRIZ terms, that were previously missing in the glossary. In addition, the TRIZ terms were classified into 3 groups: TRIZ 1, TRIZ 2 and TRIZ 3. Each group contains TRIZ terms accepted for use in the field of knowledge at the relevant stage of TRIZ development. Thus, the group of terms TRIZ 1 contains the TRIZ terms, which were introduced into use before 1988 and are mentioned in TRIZ-88 and TRIZ writings of this period.

In addition, the terms of the glossary were classified by another criterion (see Figure 4).

See the Picture in the original paper

Fig. 4. Classification of TRIZ terms

The basic concepts consist as of terms borrowed from other subject areas of knowledge, e.g. system, function, harm, as well as terms that have been defined in TRIZ or acquired specific meaning in TRIZ, e.g. ideality, contradiction, field, resource etc.

A model is a concept of TRIZ, which includes other concepts. For example, *sufield* is a concept of TRIZ, since it integrates the concepts of substance, field and connections. The concept *technical contradiction* is also a model, as it includes concepts such as known solution, improvement, undesired effect. In TRIZ both simple and complex models are used. Complex models include such models, for the construction of which complex rules and procedures are applied. For example, the *functional model of a technical system*, the *model of an inventive task in ARIZ* and others. There are currently more than 200 terms in the glossary describing various models in the field of TRIZ knowledge.

The rules include the TRIZ terms, which describe the ways of working with one or another of the TRIZ models. Simple rules refer to terms such as, for example, completion of the sufield, sharpening of a contradiction, change of parameter. complex rules include techniques for eliminating technical contradictions, inventive standards, evolution lines of technical systems. The category of rules also includes individual instruments and methods applied in TRIZ, e.g. sufield analysis, cause and effect chain analysis, function-value analysis, ARIZ, the system operator.

One of the conclusions from such a classification of terms is the fact that in a number of TRIZ tools and methods there is no clear division between models and rules. This fact makes the tool less clear, it is difficult to make any improvements. Thus, the system operator or, alternatively, the multiscreen scheme was developed as early as in stage 1 of TRIZ development, and is one of the key ones in the TRIZ knowledge system. However, it has not been formalized so far, in particular, it has not been strictly determined the model that is used for the system operator, and no rules for working with this model have been formalised. TRIZ specialists so far apply this model in different ways in practice and interpret the resulting findings.

A *group of terms* is a description of sets of concepts, models and rules. Examples of such groups are the system of techniques for eliminating technical contradictions, system of inventive standards, system of evolution laws of technical systems, effect indicators, card indexes, etc.

Another category of terms are *synonyms*. At previous stages of TRIZ development for different reasons in different parts of the field of knowledge different terms were introduced to refer to the same concept. For example, conflict and contradiction, technical conflict and conflict of properties, etc. A large the number of synonyms appeared in the translation of TRIZ terms into English, e.g. engineering system and technical system, contradiction and conflict and etc. To date, the glossary contains about 3 dozen of such synonyms.

6 Ontological charts

6.1 Ontologies ***TRIZ*** and ***TRIZ Model***

Taking into account the history and dynamics of knowledge development in the field of TRIZ, an top level ontological chart[3] *Theory of Inventive Problem Solving* (TRIZ) was formed:

[3] `https://triz-summit.ru/onto_triz/`,
`https://onto.devtas.ru/new?view=c38a00d7-e97c-9648-bbc2-2af7b21d5d0e`.

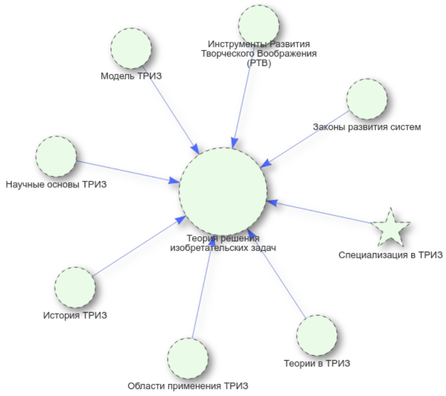


Figure 5: TRIZ top level ontological chart.

In general, the section names on the ontological chart *TRIZ* speak for themselves, we will only clarify several sections. The section *Specialisation in TRIZ* covers materials on training methods and courses, certification systems and information on professional associations and companies in TRIZ. The *TRIZ Model* section covers information on how TRIZ handles the solution of inventive tasks and system development in general.

The *TRIZ Model* (Figure 6) is a schematic designation for the step-by-step transition from tasks to the TRIZ model of a task, then to the TRIZ model of a solution and then to the solution of the task itself. Another way in the TRIZ Model: from the *system as it is* to the TRIZ model of the system, then to the TRIZ model of the new system and then to the actual system's change. The TRIZ model includes the main components of inventive thinking: analysis, synthesis, evaluation.

See the Picture in the original paper

Figure 6. Visualisation of the *TRIZ Model* and the corresponding structure of the model of inventive thinking.

The top level of the *TRIZ Model* ontological chart is shown in figure 7.

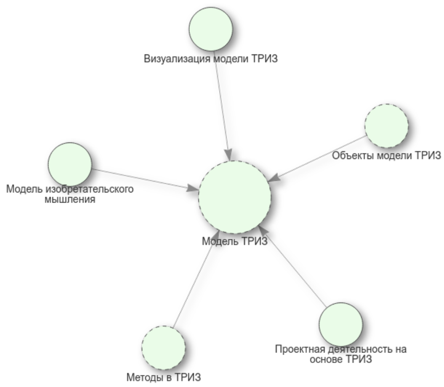


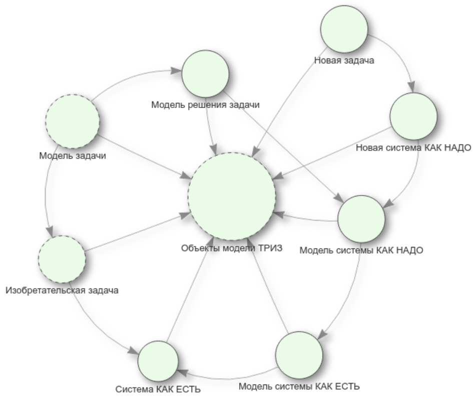
Figure 7: TRIZ Model ontological chart
`https://onto.devtas.ru/new?view=2c3fc934-2486-76ba-4262-ed91a8ca1570`

The TRIZ Model ontological chart contains:

- examples of visualisation of the TRIZ Model, e.g. as in figure 6,
- objects of the TRIZ Model (Figure 8)
- methods for transforming objects of the TRIZ Model into others.

The TRIZ model is linked to the model of inventive thinking, as it is not possible to apply TRIZ methods in practice without the appropriate components of inventive thinking.

The ontological chart *Objects of a TRIZ model* is shown in Figure 8.



. Figure 8: Ontological chart *Objects of a TRIZ model*
`https://onto.devtas.ru/new?view=29e5aabb-996c-8fba-1554-b94dacb696ae`

This chart shows that the *system as it is* can contain an *inventive task*, can be transformed into a *model of the system as it is*. The *task model* is derived from the *inventive task* and can be transformed into a *model of task solutions*. The *model of the system as it should be* can contain an *model of task solution* and can be transformed into a *system as it should be* (synonymous with *new system*), which in turn may contain a *new task*.

Each transition from one object of a TRIZ model to another is carried out by appropriate TRIZ methods, which are described in the *Methods in TRIZ* ontology. The current status of this section[4] is given below in the text of this report.

Ontology *Methods in TRIZ*

- Ontology *Methods of systems analysis brought to TRIZ*
  - Ontology *MPV Analysis*
  - Ontology *Function Value Analysis* (FVA)
  - *Benchmarking* Ontology
  - Ontology *Parametric Analysis*
  - Ontology *RCA+ Analysis*
  - *Ishikawa Diagram* Ontology
  - Ontology *Cause and effect analysis*
- Ontology *Methods of systems analysis developed within TRIZ*
  - *Functional Analysis* Ontology

[4] `https://triz-summit.ru/onto_triz/mod/metod/`

  - Ontology *Element-Field Analysis*
  - Ontology *Component Analysis*
  - Ontology *Resource Analysis*
  - Ontology *Flow Analysis*
  - Ontology *Diversion Analysis*
  - Ontology *Structural Analysis*
  - Ontology *Analysis of the principle of action*
  - Ontology *System Operator Analysis*

- Ontology *Methods of system transformation*

  - Ontology *Techniques of conflict resolution*
  - Ontology *Method of trial and error*
  - Ontology *Application of laws and trends of system evolution*
  - Ontology *Method of analogies*
  - Ontology *Unification of alternative systems*

- Ontology *Methods of solving inventive tasks*

  - Ontology *Principles of resolving contradictions*
  - Ontology *Connection of principles and methods of conflict resolution*
  - Ontology *Table of application of conflict resolution techniques*
  - Ontology *Element-Field transformations*
  - Ontology *Functionally-oriented search* (FOS)
  - Ontology *Ideal final result* (IFR)

- Ontology *Methods of evaluation and development of concepts of system transformation*

  - Ontology of *Supereffects*
  - Ontology of *Secondary Tasks*
  - Ontology *Methods of generalization of the solution found*

- Ontology *Integral Methods of System Development*

  - *ARIZ* Ontology
  - Ontology *Standards for solving inventive problems*
  - *TRIZ Analysis* ontology
  - Ontology *Linking laws and trends with TRIZ tools*

In the future, the structure of the ontology *Methods in TRIZ* will be further clarified.

TRIZ projects life cycle includes 4 main stages:

- identification of undesired effects and pre-project phase,
- conceptual stage,
- verification and
- implementation.

In such a way *TRIZ Project Activities* and *TRIZ Project Life Cycle* correlate with the *TRIZ models* cycle of system development and solution of inventive tasks. We reproduce an extract from the TRIZ Ontology table of contents, related to the *TRIZ Model* ontology:

Ontology *TRIZ application areas*

- Ontology *Subjects of TRIZ application areas*
  - Ontology *TRIZ in innovative entrepreneurship*
    - Ontology *Analysis of the market from the perspective of contradictions and their resolution*
    - Ontology *MPV Analysis*
    - Ontology *Analysis of needs and their development directions*
  - Ontology *TRIZ in the development of industrial enterprises*
  - Ontology *TRIZ in programming and information systems*
  - Ontology *TRIZ in art, literature and design*
  - Ontology *TRIZ in business*
  - Ontology *TRIZ in solving scientific problems*
  - Ontology *TRIZ in team development and social systems*
- Ontology *Project activities based on TRIZ*
  - Ontology *TRIZ in solving inventive problems*
  - Ontology *TRIZ in consulting activities*
  - Ontology *TRIZ in forecasting*
  - Ontology *Road Maps of TRIZ Projects*
  - Ontology *Life Cycle of a TRIZ Project*

Thus, the theoretical basis and methods of TRIZ are directly related to practical project activities using TRIZ in system development and solving inventive tasks.

6.2 Ontology *Scientific Base of TRIZ*

In the first fundamental publication on the subject of TRIZ by G.S. Altshuller and R.B. Shapiro *On the psychology of inventive creativity*[5], the authors refer to the laws of dialectics and to scientific research in the area of psychology of creativity.

As TRIZ developed as a scientific theory, the scientific basis for TRIZ expanded: system approach, functional approach, evolutionary approach and fundamental scientific approaches are at the heart of TRIZ.

With this, scientific approaches specific to TRIZ have also been developed research conducted.

The ontology *Scientific Base of TRIZ* is the basis for all of the *TRIZ Ontology* as a whole.

At present, in the Ontology *Scientific Base of TRIZ* have been formed the following sections:

- Ontology *Dialectics*
- Ontology *System Approach*
- Ontology *Functional Approach*
- Ontology *Evolutionary Approach*
- Ontology *Parametric Approach*
- Ontology *Model Approach*
- Ontology *Psychology of creative thinking*
- Ontology *TRIZ Approaches*

[5] Г.С. Альтшуллер, Р.Б. Шапиро «О психологии изобретательского творчества» в журнале Вопросы психологии, No 6 в 1956 году.

- Ontology *Information Funds on System Development*

See the Picture in the original paper

Figure 9. Reference to the ontological chart *Scientific base of TRIZ*[6]

One of the sections of the ontology *Scientific Base of TRIZ* is the ontology *Model approach*. A model (fr. modéle from Latin modulus – measure, analogue, sample) is a system whose research serves as a means to obtain information about another system; to present some real process, devices or concepts. A model is an abstract representation of reality in a given form (e.g. in mathematical, physical, symbolic, graphic or descriptive form), designed to represent certain aspects of this reality and allowing you to get answers to the questions you are studying. [Wikipedia]

The sections of the ontology *Scientific base of TRIZ* are published in more detail on the website `https://triz-summit.ru/onto_triz/science/`.

6.3 Function and Functional Analysis

At its core, TRIZ relies on a functional approach. The concept of *Function* for TRIZ is one of the central concepts. The function is used in many tools: functional value analysis, functional analysis, functionally perfect modeling, functionally oriented search and others.

Ontologically, the concept of *Function* [9] is linked to the Functional Approach, options of function presentation, kinds and types (Figure 7).

See the Picture in the original paper

Figure 10. Ontological diagram *Function*

A function can be represented in the form of a functional model (subject, performer of the action, – action aimed at changing the parameter, – object whose parameter is changed), as an element-field or, as a particular case, as a sufield representation (Figure 7).

See the Picture in the original paper

Figure 11. Ontological diagram *Type of a function*

Functions are subdivided by type (Figure 8) into useful and harmful functions, as well as a separate group of useful functions with a disadvantage is singled out in the ontology. Shortcomings of useful functions include redundancy, insufficiency, bad functions manageability or lack of the required function.

Functions are subdivided by kind of function depending on the system level: system functions, subsystem and supersystem functions. Also as kind are singled out element functions, as a representative of a subsystem, and functions of objects in the environment, as a representative of the supersystem.

See the Picture in the original paper

Figure 12. Ontological diagram *System function*

[6] `https://onto.devtas.ru/new?view=c38a00d7-e97c-9648-bbc2-2af7b21d5d0e`

The functions of the system determine the impact capabilities of the system under consideration to other systems in the supersystem (Figure 9). The *main function* of the system is a function, for which the system was created. The main function implements the purpose of the system in relation to the supersystem [2]. An *additional function* is a function that is not necessary to support the core process, but which accompanies the main function or helps to achieve it [2]. A *latent function* is a function, which was not envisaged by the system designer, but which may be performed by the system based on the needs of the system user.

See the Picture in the original paper

Figure 13. Ontological diagram *Function of an element*

The functions of an element determine the capabilities of the element in question to impact on other elements of the subsystem or supersystem (Figure 10). The element's functions are divided into main and auxiliary ones. *Main functions* are aimed at the impact on the target object of the system under consideration. An *auxiliary function* is directed at a subsystem element or at an element of the supersystem that is not the intended target of the system under consideration. Functions of object of the environment, the supersystem and subsystems are currently not classified in the described ontology.

As mentioned earlier, the term "Function" is used in various TRIZ instruments. At the time of writing this report, in the OSA system ontological charts of *Functional Analysis* are worked out [10].

Functional Analysis is part of the *Methods of System Analysis* diagram [11], see Figure 11.

See the Picture in the original paper

Figure 14: Ontological diagram *Methods of systems analysis*

See the Picture in the original paper

Figure 15. Ontological diagram *Functional analysis*

The ontological diagram *Functional Analysis* (Figure 12) illustrates the connection with the objectives of the analysis, the models of functional analysis, the construction of rules and transformations by models, and also shows two individual cases of functional analysis: functional analysis of a system and functional analysis of a process.

See the Picture in the original paper

Figure 16. Ontological diagram *Objectives of functional analysis*

The objectives (Figure 16) of the functional analysis include:

- Identification and setting of tasks;
- Search for resources within the system or in its surroundings;
- Finding new system links;
- Assessment of the functional model of the system for compliance with the requirements.

See the Picture in the original paper

Figure 17. Ontological diagram *Models of Functional Analysis*

Functional analysis models (Figure 17) are selected based on the kind of analysis. For the *functional analysis of the system*, a functional model of the system is selected that is built on the basis of a component-structural model, indicating its interactions and their characteristics. For a *functional process model*, a model is being built, a particular case of which is the *flow model*.

Having reached the function in the ontological diagram of the Functional Analysis of a system, the observer automatically enters the function diagram. Thus, there is no need to redefine the characteristics of functions.

6.4 Flow and Flow Analysis

Based on the definition from Sushkov's glossary [2], *Flow analysis* is an analytical method and a tool that identifies deficiencies in the flow of energy, substances and information in a technical system. Oleg Gerasimov [14] describes Flow Analysis as an analysis of a technical systems based on the identification of deficiencies in flows of energy, substances and information within the technical system, its grey areas, bottlenecks, bifurcations, various losses, etc.

Most of the subsequent work was carried out by Yuri Lebedev, who introduces a definition of flow (previously lacking) as a dynamic component of a system, specifying that *Flows* in the technical system are specific components. The main feature of the flow as a component is the distribution (in space and time) of its parameters. The other (stationary) components of the sytem are localised in space. Because of this difference, the flows extremely uncomfortable fit within the functional approach. For this reason, a special tool was developed – *flow analysis* (FA). Accordingly, it is proposed to consider flow analysis as a specific, particular case of functional analysis.

The construction of an ontological chart makes it possible to define flow analysis more precisely, as well as the flow model in flow analysis. In addition, to show the relationship of flow analysis to functional analysis and other TRIZ concepts. With this goal two basic ontological charts were constructed: first the ontological chart of *flow analysis* and second the ontological chart of *flow models*, as detailed below.

See the Picture in the original paper

Figure 18. Ontological diagram *Flow analysis* top level[7]

You see, that the ontology map changes the understanding of the objectives of flow analysis by passing on from the search for shortcomings to a more complex goal where the search for shortcomings is just a special case.

See the Picture in the original paper

Figure 19: Ontological diagram *Flow analysis*, part *Rules to perform flow analysis*

As a result of the ontocards construction, the following definitions for flow model and flow analysis are clarified.

Flow analysis is a special case of functional analysis of processes and serves two main purposes. First, the descriptive purpose is to establish relationships and search for resources. Secondly,

[7] `https://onto.devtas.ru/new?view=e48bd4bd-3eba-c548-64da-73da1886f744`

checking the flow for compliance requirements and, as a result, the identification of useful, harmful and parasitic flows, as well as their change. The rules for performing flow analysis include rules of assessment of a flow model, rules of construction of model of flows *as they are*, rules of application of patterns of the evolution of flows in technical systems, as well as rules for building a model of flows based on the compliance with the requirements placed on it. The results of applying these rules are models of the flows *as they are* and *as required*, as well as a list of tasks and contradictions for the subsequent solution. Using techniques for changing flows, such as searching for grey zones or bottlenecks, one can move from a model of flows *as they are* to a model of flows *as required*.

See the Picture in the original paper

Figure 20. Ontological diagram *model of flows*[8]

To describe the model of flows a method of description is chosen (most often graphical). Then static flow components are defined, including the control system, channel, receiver and source. The control system may be of two types: pump or valve, and the source: source of potential or source of current. An important characteristic of flows in flow analysis is the flow content, i.e. the determination what flows through the channel, substance, energy and information. Another key characteristic is utility of the flow, distinguishing useful, harmful or parasitic flows. Most others characteristics are selected during the analysis process depending on the objectives and the content of the flow. Concerning the type of characteristic, the original notion of *flow functionality* has been changed to the *utility of the flow*, as the functionality of the flow is related to its functions, the utility with its value to the consumer.

The construction of ontological diagrams makes it possible to find grey areas and not formalised parts of knowledge. Links with other knowledge related to TRIZ are shown more clearly. The next steps may be: description of grey areas, various rules for building models, algorithms, and also a matrix of techniques for transition from the model (or system) *as it is* to the model (or system) *as required*. Renaming of terms to better represent the essence of the described concept is also one of the advantages of this approach.

6.5 RTV – Creative Imagination Development

The Creative Imagination Development (hereinafter referred to as RTV) – is an auxiliary course, the purpose of which is to develop a managed imagination and the ability to overcome psychological inertia in the process of solution of inventive tasks[9].

See the Picture in the original paper

Figure 21. Ontological diagram *Tools for the Development of Creative Imagination*

Primary differences in the RTV course:

1. The development of the imagination is based on the conscious use of the laws of system development. Thus, the method of modeling with little men is based on one of the main trends in the development of systems – increase the degree of dispersion of working bodies. In Gordon's Synectic empathy is used, that ignores this law and is therefore much weaker.

[8] `https://onto.devtas.ru/new?view=aacb6c47-827e-b850-7872-978858d06d22`
[9] `https://triz-summit.ru/onto_triz/rtv/`

2. Fantasy is seen as a vector (*jumping thought*): not only the length of the jump is important, but also its direction. The RTV course focuses primarily on developing a *controlled fantasy.*
3. The sources of strong methods and techniques are TRIZ and the *Register of SF ideas.*
4. The RTV course is related to TRIZ training: emphasis is on such exercises, that develop the qualities required for TRIZ application. At the same time the RTV course is related to the supersystem – the development of strong thinking: the course also includes exercises that go beyond technology.
5. Training – just like at TRIZ – is conducted according to the principle: demand only what has been taught (i.e. not to expect the listener to do it on their own, to be able to generate strong ideas, F-ideas, without mastering laws, rules, methods).

The RTV course includes various methods to stimulate inventive thinking, preceding the creation of TRIZ. The purpose of their study: develop components of inventive thinking, such as flexibility, variability, use of analogies, originality; the study of these methods allows to go deeper in understanding the distinctive features of TRIZ.

See the Picture in the original paper

Figure 22: Ontological diagram *Methods of psychological activation of inventive thinking.*

It seems essential to me that in the first half of the 1970th, in the classes were found effective methods – phantograms, modelling with small men, the search for an X-factor on a planet, closed by *conditional clouds*, the *golden fish*, the MTV operator[10], etc. In my opinion, the creation of a *multiscreen scheme of strng thinking* is particularly important[11].

See the Picture in the original paper

Figure 23. Ontological diagram *Methods of Development of Creative Imagination based on TRIZ.*

In the RTV course individual TRIZ instruments are included (system operator, contradictions, IFR, MTV operator, method of small men) with a description of the specifics of the application of these tools for developing a creative imagination.

See the Picture in the original paper

Figure 24. Ontological diagram *Connection with other sections of TRIZ.*

The RTV course is the TRIZ section which is most closely related to the psychology of inventive creativity. In formulating the definitions for some terms materials on the psychology of creativity are used, among other on the psychology of inventive creativity.

In particular, the terms *Imagination*, *Fantasy* and *Psychological Inertia* have definitions in which the concepts of psychology and philosophy are used, and also definitions in which TRIZ approaches are used.

[10]MTV (measure, time, value).

[11]See G.S. Altshuller. About the history of the RTV course (in Russian). `https://www.altshuller.ru/rtv/rtv6.asp`

See the Picture in the original paper

Figure 25. Ontological diagram *Connection with the psychology of inventive Creativity.*

As source of methods and techniques of the RTV Course are TRIZ and the *Register of Scientific Fantastic Ideas* (hereinafter referred to as the *Register of SF-Ideas*). Therefore, some terms of the Ontology of the RTV course are linked to other sections of TRIZ Ontology in general. For example, the term *System Operator*, *MTV Operator*, *Morphological analysis* are related to similar sections of TRIZ Ontology.

Preparing the programme for the RTV Course two lines in different directions should be taken into account:

- It must be considered which components of inventive thinking are demanded for the inventive activities of a specific specialist (TRIZ training line);
- at the same time the RTV course develops strong (inventive) thinking in in general, and is based on the laws of development of thinking (the line of thinking).

Currently in the ontology *Course of Development of Creativity Imagination* methods of a "classical" course are included. Authors whose work was considered creating the ontology: G.S. Altshuller, P.R. Amnuel, M.S. Rubin, S.S. Litvin, B.L. Zlotin, A.V. Zusman, Yu.G. Tamberg, M.N. Shusterman, G.I. Ivanov, I.N. Murashkovska, A.A. Nesterenko, T.V. Klemihinina, S.V. Kreinina.

Further work on the ontology *Instruments of RTV.*

- It is necessary to establish links between the RTV Course Ontology and other TRIZ ontologies.
- It is important to elaborate the transitions to a practical RTV course and diagnostic materials on developing inventive thinking.

6.6 System operator and System operator analysis

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The System Operator is part of the *Systemic Approach* ontology.

See the Picture in the original paper

Figure 26. Ontological diagram *Systemic approach.*

See the Picture in the original paper

Figure 27. A generalised chart *Systemic Operator* from the Cmaps website.

See the Picture in the original paper

Figure 28. Ontological chart from the OSA website.

See the Picture in the original paper

Figure 29. Reference to the ontological chart *Systemic Oerator*[12]

[12] https://onto.devtas.ru/new?view=938811e9-76cb-6ef3-a2dc-aec74ff3d721

The Ontology *Systemic Operator Analysis* is part of the Ontology *Methods of system analysis.*

See the Picture in the original paper

Figure 30

Reference to the *TRIZ* and *Method of System Analysis* ontology charts. `https://onto.devtas.ru/new?view=c38a00d7-e97c-9648-bbc2-2af7b21d5d0e`.

The following figure shows the relationship between the ontological chart *Methods of system analysis* and *System Operator Analysis.*

See the Picture in the original paper

Figure 31

Reference to the ontology chart *System Operator Analysis*: `https://onto.devtas.ru/new?view=a83457ab-77bb-5466-0263-6f4bd5eb3b95`

See the Picture in the original paper

Figure 32.

Working with the *System Operator* ontology allowed better to elaborate the specifics of this TRIZ tool, its relation to the systemic approach, to the laws of system evolution, the RTV course *Development of creative imagination.* Areas of growth of methodology of building and using the system operator have been identified, we started development work on analysis of the variability of transitions on the screens of the system operator, on the methodology of iterated changes to screens, on spatial system operator and others directions of development of the system operator and system operator analysis.

Next steps:

- Complete the compilation of the Ontological charts *Systemic Operator* and *System Operator Analysis.*
- Develop methods to apply the systemic operator to the solution of inventive tasks and to forecasting system development.
- Highlight common aspects in the construction of ontological charts of various analysis methods from the *System Analysis Methods* ontology.

7 The TRIZ ontology project

7.1 Goals and objectives of the project

The TRIZ ontology project was initiated in 2019 by a group of TRIZ specialists: Andrey Kuryan, Valery Souchkov, Dmitry Kucheryavy, Mikhail Rubin, Nikolai Shchedrin as part of the TRIZ Summit 2019 based on report [8].

The objectives of the project are:

Regarding the existing TRIZ Glossary:

– check the correctness of each term in the existing TRIZ Glossary;
– clarify the terms and definitions in the existing TRIZ Glossary;
– detect and eliminate gaps in the existing TRIZ Glossary.

Regarding TRIZ in general:

– improve the quality of TRIZ training and understanding;
– help avoid incorrect use and incorrect interpretation of TRIZ terms;
– avoid unnecessary introducing of new terms;
– identify discrepancies in the use of TRIZ terms;
– contribute to the development of a theory that can provide quantitative predictive power;
– help in integrating TRIZ with or within other domains.

The project envisages:

1) Identification of key TRIZ concepts that are related to other concepts of TRIZ through various relationships.
2) Development of ontological diagrams showing the links between by the concepts of TRIZ.
3) Discussion of ontological diagrams in the circle of TRIZ specialists.
4) Development of new definitions of TRIZ concepts based on TRIZ ontologies.

The project is open, i.e., every TRIZ specialist can take part in the project, including the development of ontological diagrams, discuss already existing ones or definitions of TRIZ concepts.

7.2 The OSA Website

This part of the Russian original is skipped since the site `https://onto.devtas.ru/ts2o1` is in Russian and requires a registration specific to Russian naming rules.

Note also that the links to `https://onto.devtas.ru` subpages cited below do not produce the pictures displayed in the paper.

7.3 The triz-summit.ru Website

TRIZ Ontology is being developed using three tools. A preliminary, general picture of the specific ontological section is being prepared on a specialised website `https://onto.devtas.ru/ts2o1`.

See the Picture in the original paper

Figure 40: An ontological chart of the top level ontology

These connections are then transferred to ontology charts in the OSA system, which has already been mentioned above and can be found at this link `https://onto.devtas.ru/new?view=c38a00d7-e97c-9648-bbc2-2af7b21d5d0e`

To improve the availability of developments under the TRIZ Ontology project and the organization of discussions all information on the project is published on the Summit website of TRIZ developers `https://triz-summit.ru/onto_triz/`.

In this section we will briefly describe the content and role of this website in the project ...

This part is also skipped since it can be explored at the given website link,

All main pages with description of ontologies of different concepts are constructed in approximately the same form. On the page is described:

- the hierarchy of the given concept in the TRIZ Ontology,
- the definition in terms of the glossary by V. Souchkov (translated into Russian)
- Changes, additions or refinements. Proposal for a new definition.

Synonyms.

- A list and references to dependent terms and concepts is given.
- Ontological charts are provided with a link to the OSA website.

Here are some examples (only the links are given here).

- Description of the Ontology *Administrative contradiction (problematic situation)* `https://triz-summit.ru/onto_triz/science/triz_ap/invent/contradict/adm/`
- Description of the *System Operator* Ontology: `https://triz-summit.ru/onto_triz/science/sys/sys_op/`

If new concepts are introduced, a rationale for introducing a new term or concept are prepared and published for discussion. For example, on the website `https://triz-summit.ru/onto_triz/science/sys/sys_op/svayz/var/` the rationale for introducing the concept of *Variability of System Transitions* has been published. On this page

- a hierarchical path to this concept is given: Home → TRIZ Ontology → Ontology *TRIZ Science Basics* → Ontology *System Approach* → Ontology *System Operator* → Ontology *Links between screens.*
- a brief description and examples of usage is provided.
- the rationale for introducing this concept (tool, analysis elements, etc.) is given.
- an illustrative material is published.

Several figures are skipped.

Next steps and plans for the future:

- Complete the structure of the TRIZ Ontology section on the website.
- Update definitions of terms and links to ontological maps.
- Organise feedback to discuss sections and terms of the *TRIZ Ontology* and the project development in general.
- Enter a classification index of TRIZ materials in accordance with the TRIZ ontology.
- Correct the *Icarus and Daedalus* system according to the TRIZ Ontology.
- Develop a guidebook for the TRIZ Summit website in accordance with the index of TRIZ materials.

7.4 How the project is organised

Note that all material on the sites described below are in Russian only.

An open platform has been created for the implementation of the TRIZ Ontology project. It includes:

1. a separate OSA platform for the development and storage of ontological diagrams;
2. A *TRIZ Ontology* section on the `https://triz-summit.ru` website (hereinafter referred to as the TRIZ Ontology website), where the descriptions of TRIZ Ontologies are located.

The following figure shows the structural diagram of the platform for Ontology TRIZ.

See the Picture in the original paper

Figure 46. Platform structure of the TRIZ Ontology project

The following table describes the stakeholder structure and responsibilities within the TRIZ Ontology project.

Moderator	A TRIZ Ontology team member. He is responsible for creating tasks to develop parts of the ontology by experts, as well as to monitor performing these tasks.
Expert	A TRIZ Ontology team member. He is responsible for creating ontological diagrams and their descriptions.
Visitor	This is any person who is interested in the area of TRIZ knowledge in general and the TRIZ Ontology in particular. A visitor can study ontological diagrams and their descriptions on `triz-summit.ru`, accept to participate in discussions and express his opinions and ratings.

The TRIZ Ontology project website also contains a description of the project and sections *Instructions for project participants* and *TRIZ Ontology proposals* `https://triz-summit.ru/onto_triz/proj/predl/`.

Several pictures are skipped.

8 Conclusion

Compiling a TRIZ ontology is a necessary step for the development of TRIZ today. It is the foundation on which a new version of TRIZ knowledge should be built.

It is impossible to create a TRIZ Ontology without the participation of a wide range of TRIZ specialists. The authors of the report encourage all interested parties to engage in TRIZ Ontology project.

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