# Standard VDI 4521 “Inventive Problem Solving With TRIZ” Completed

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**Abstract.** The project of establishing an industrial standard for TRIZ has entered its final stage with the edition of VDI 4521 pt. 3 in draft version. The objectives of the standard mainly are

- standardization of TRIZ terminology to foster common language and understanding among TRIZ users and researchers
- preservation of original TRIZ conceptions
- providing reference material for TRIZ training
- providing standard contents for technical education in schools
- providing an overview on TRIZ and references to recommendable literature for students
- qualifying TRIZ as an established technical procedure for engineers

The paper explains the structure and the contents of the three parts of the standard and appeals for using it.

**Keywords:** Standard, VDI 4521, VDI Standard, Nomenclature, Terminology, Glossary.

## 1 Introduction: Standardization of TRIZ

In this year of 2018, it has been 20 years after the decease of the founder of TRIZ, Genrich Altshuller – who shall be remembered at this place [1] – and the methodology has since been spreading worldwide. This process brought about the centers of TRIZ development dispersing to differing countries, places, and persons – in contrast to G. Altshuller’s age when he could act as a central developer and coordinator of the methodology. Multiple developers in multiple cultures tend to develop regional variants of a subject, including regional dialects of terms and methods. To maintain a common language and common understanding of their subject, TRIZ users therefore feel the need to establish a guideline defining a terminology and to agree on the concepts of basic terms.

To this end, Litvin, Petrov, Rubin, and Fey compiled a catalogue of standard tools and methods together with reference to appropriate literature into the “TRIZ Body of

Knowledge" [2]. Souchkov provided a comprehensive glossary of TRIZ terms [3] on behalf of MATRIZ and Petrov created another one incorporating input from various schools [4].
After consultation with MATRIZ and the TRIZ community, a Technical Committee consisting of an international group of TRIZ experts from industry and science has been set up. Supported by the standard organization VDI, this group of volunteers started in October 2014 to draw up the content of the new VDI standard based on a first version of [3]. The first part of VDI 4521 was published in 2016-04 [5] and the second in 2016-12 in draft and in 2018-04 as a valid standard [6]. Part 3 is under progress and is expected to appear in draft edition by autumn of 2018.

## 2 Contents of the standard

### 2.1 Part 1: Fundamentals, terms and definitions

VDI 4521 Part 1 contains a list and glossary of TRIZ terms with their respective definitions, figs. 1 and 2, explains basic concepts, and provides an overview on the general process of problem solving. It lists selected methods and tools and assigns them to the following parts of the standard, which explain them in more detail; the part also lists recommended literature.



**Fig. 1** Contents of VDI 4521-1 [5]

**2 Terms and definitions**

For the purposes of this standard, the following terms and definitions apply:

***40 Inventive Principles***
last collection of Inventive Principles authorised by *G. Altshuller* published in [1]

***administrative contradiction***
problem situation in which neither a contradiction nor a solution is evident

***algorithm of inventive problem solving*** (ARIZ)

*Алгоритм Решения Изобретательских Задач*
algorithm for the solution of a problem with various TRIZ tools which intensifies the problem by reformulating it in a series of steps

**Fig. 1.** TRIZ glossary defining terms (extract) [5]

The technical committee critically reviewed the terms in the glossary by V. Souchkov, removed doublets, and determined which terms should be included in Part 1. The general approach was to compare various works of literature – favourably translations of Altshuller's works – and then to decide on the most common expression. Terms to be included in the standard were tools and methods that constitute the undoubted state of the art, in accordance with the VDI principles of describing the generally accepted status of science and technology [8]. First of all, these were Altshuller's terms; additionally, terms established and described in the literature such as function analysis, problem formulation, or root-conflict-analysis were included. Not included were new tools and tools that do not yet qualify as "general state of the art" due to limited dissemination. The committee would not judge the quality of tools and any term that will be more common in the future may be included in a later edition of the standard.

Terms that are closely connected with an individual tool – e.g. the 40 Inventive Principles – are described together with the respective tool in Part 2 or 3.

### 2.2 Part 2: Objective, problem definition, and prioritisation

VDI 4521-2 explains TRIZ tools and methods, i.e. tool systems, which the user employs in particular in the phases of describing objectives, problem definition, and solution prioritization in the problem-solving process. However, many TRIZ tools and methods can be used in different phases of the problem-solving process, so the assignments made in Table 1 only reflect the typical application. In practice, users employ and combine the methods and tools in many ways.

**Table 1.** TRIZ tools with focus on the definition phase (■ typical use, □ applicable) [5]

| TRIZ Tool | Type of tool | Description of objective | Problem definition | Search for a solution | Solution selection |
|---|---|---|---|---|---|
| Ideality | Objective Creativity | ■ | ■ | | ■ |
| TRIZ forecasting | Analysis | ■ | ■ | □ | □ |
| Function analysis, function model | Analysis | | ■ | ■ | |
| Innovation checklist | Analysis | ■ | ■ | □ | |
| Problem formulation | Analysis | | ■ | ■ | |
| Root-conflict analysis | Analysis | | ■ | ■ | □ |
| Cause-effect chains analysis, cause-effect diagram | Analysis | | ■ | | |
| Patent circumvention | Knowledge | | ■ | ■ | |

The standard explains the tools mentioned in Table 1 in a concise manner following the objective to define a tool rather than explain it to a beginner. The standard does not intend to be a textbook for studying TRIZ. A tool description therefore generally refers to suitable literature.

### 2.3 Part 3: Problem solution

The selection of tools treated in VDI 4521-3 concentrates on the problem solution phase. Table 2 represents the subjects described in this part. Once again, the assignment is arbitrary to some degree.

In the same way as above, the literature including available training materials was evaluated and the state of the art summarized. Some tools have experienced considerable development work during the last decades without evidence of general agreement on one version, as is the case with the Laws of Evolution or the Inventive Standards. In these cases, we limited ourselves to describing the last undisputed version, i.e. Altshuller's.

## 3 Discussion

At the beginning of the standardization work, some TRIZ experts expressed concerns that a standard might interfere with their work by requiring some sort of certification or restrain future development [9]. This is not the objective of this project and is not usual for VDI standards – these are a mere description of the state of the art [8] and anyone may describe the methods he or she used as "according to" or "differing from" VDI 4521 in a certain aspect.

**Table 2.** TRIZ tools with focus on the solution phase (■ typical use, □ applicable) [5]

| TRIZ Tool | Type of tool | Description of objective | Problem definition | Search for a solution | Solution selection |
|---|---|---|---|---|---|
| Contradiction | analysis | | ■ | ■ | |
| Inventive principles | knowledge | | | ■ | |
| Anticipatory failure identification | creativity | | ■ | ■ | |
| Catalogue of effects | resources | | | ■ | |
| Feature transfer | resources | | □ | ■ | |
| Laws of engineering systems evolution | knowledge | ■ | | ■ | ■ |
| Function-oriented search | resources | | | ■ | |
| Size-time-cost operator | creativity | | | ■ | |
| Resource analysis | resources analysis | | □ | ■ | □ |
| Principles of separating contradictory demands | knowledge | | | ■ | |
| Substance-field analysis | analysis | | ■ | | |
| Inventive standards | knowledge | | | ■ | |
| System operator | creativity resources | | □ | ■ | |
| Trimming | resources | | ■ | ■ | |
| Contradiction matrix | knowledge | | | ■ | |
| "Smart little people" model | creativity | | | ■ | |
| ARIZ | procedure | ■ | ■ | ■ | |

Some peculiar methods of TRIZ were not included in the standard such as OTSM [10], but other modern tools like Directed Evolution were listed. This selection may in fact reasonably be – and has been – debated. Nevertheless, the technical committee came to the decision that these methods are not part of common TRIZ curricula and not sufficient literature was available to the committee to qualify them as "generally accepted state of the art". So, not including a specific tool does not mean any judgement on its suitability, though, and if good documentation is available, it may be included into the next version of the standard. As a living standard, its actual state is the starting base for future extensions. The next version may then revise the decision which contents and sources exactly to consider as relevant (thanks to D. Cavallucci for this discussion): Only Altshuller's or sources published in highly indexed journals or the state of the art in practical TRIZ, which was pursued in this edition.

In the process of reviewing the state of the art, definitions and agreements showed up which have become common but which in some cases seem to lack perfect consistency. The edition of a standard constitutes an opportunity to clean up organically grown contents and to straighten the systematics. The committee however would not

dare to do so and resisted this temptation since we did not consider ourselves legitimated enough. Nevertheless, it may be worthwhile to discuss several points at this conference (some were mentioned before in [11]).

- The Engineering system is defined as "Man-made assembly of several interacting elements which meets a purpose." – The aspect of a purpose is crucial because this implies that engineering systems are always open systems and that they serve the needs of their creator or user. The limitation to man-made objects seems needless, though, since there is no reason to exclude tools and constructions used by animals.
- Field and function: These terms are not well differentiated from each other. According to Bytheway [12], L.D. Miles coined the term of "function" at the end of World War II. Could it be that Altshuller was not acquainted with this concept and therefore chose "field"? Function and Substance-Field analyses would benefit from reuniting both terms.
- In Substance-Field and Function analyses, undulated arrows are commonly used to represent harmful functions. Ordinary illustration software does not draw this kind of arrows. Could we therefore agree to use another type of symbol, e.g. a double arrow?
- Separation principles – Altshuller mentions four principles in [13]: Separation in space, time, transition states, and system structure. Later publications list varying numbers of principles. The committee arranged them into five: 1 space (*where*), 2 time (*when*), 3a relation (*for whom*), 3b change of conditions (*under what conditions*), and 4 structure (*on which system level*). The numbering 1 – 4 respects the common classification, but 3a and 3b are in fact different – so why not five?

## 4 Conclusions and outlook

The international evolution of TRIZ has reached a level at which determination of the vocabulary and the definition of tools seem essential, so this task was addressed by several TRIZ masters and a VDI technical committee. This committee consisting of some 20 TRIZ specialists has reviewed relevant material with related literature and summarized it in standard VDI 4521. The Association of German Engineers, VDI is an internationally renowned standardization institution who facilitated this process. Parts 1 and 2 of the standard have already been published, part 3 will be published by the end of 2018. The international TRIZ community will then be welcome to file suggestions for improvement for 6 months after which period the final version will appear.

All VDI standards undergo revision every 5 years. Later modifications required due to technical progress can thus be considered in the next edition.

The official version is edited in English and German, a Russian version is being prepared, and additional translations are desirable. Additionally, a textbook as an extended version is scheduled.

Since a standard draws its value from being employed, we would wish to request all authors to kindly refer to VDI 4521.

## 5 Acknowledgements and interests

The committee express their gratitude to several TRIZ masters for kind counselling and to VDI for project management. The committee members do not seek any personal advantage by this project nor are they obliged to any institution who does so.

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