121 HEURISTICS FOR SOLVING PROBLEMS

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Lulu, Inc.

Morrisville, NC

2003

Library of Congress Cataloging-in-Publication Data

DE CARVALHO, MARCO AURÉLIO; WEI, TZ-CHIN; SAVRANSKY, SEMYON D.

121 Heuristics for Solving Problems

346 p; 24 cm

Includes bibliographical references and index

ISBN 1-4116-1689-8

1. Engineering – Methodology. 2. Problem Solving – Methodology. 3. Creative Thinking. 4. Technological Innovations. I. Title.

AKNOWLEDGEMENTS

The authors are very grateful to their families for their support. They are also grateful to these persons and institutions that contributed to the publication of this book:

- Vitalie Belousov, Ph.D. and Gheorghe Doncean, Ph.D., from Romania, who idealized the book;
- Carlos Cziulik, Ph.D., from Brazil, who revised the manuscript;
- NuPES (Concurrent Engineering R&D Laboratory) and IFM Institute, from Brazil, for supporting the research.

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PREFACE

All around the world, an increasing number of companies are developing new products, processes and technologies, as their main strategy to achieve competitiveness, increased revenues and growth. This can be viewed as an effort to cope with the two main forces that drive contemporary economy: globalization and technological change (Doyle 1998). As a consequence, the need for better and faster problem solving methods arises. How to rapidly develop new and better solutions? How to manage the ever-increasing body of knowledge and make the continuously growing amount of information useful?

It is in this context that TRIZ (Theory of Inventive Problem Solving), the knowledge-intensive problem solving methodology created and developed by Genrich Saulovich Altshuller (Altshuller 1969, 1979a, 1984) and his associates is being widely adopted worldwide.

In contrast with some people involved with TRIZ - who seem to view it as a finished work - we rather understand that it is at an initial stage of development. Although the foundations of TRIZ were established early in the 1950´s, its development was much hindered by the political context in the former USSR. As a consequence, a critical mass of practitioners and researchers was only recently achieved.

Several TRIZ researchers and practitioners have focused on attempts of hybridization between TRIZ and theories, methodologies and methods more familiar to problem solvers outside the former USSR, such as the Theory of Constraints, QFD, Taguchi Methods, Six Sigma, amongst others. Other researchers and practitioners have been placing their efforts in reorganizing TRIZ Heuristics. Although we recognize that some useful results were reached through these approaches, we have chosen a different path, which is to augment TRIZ knowledge base via the input of new Heuristics validated in the international patent database. In this book, the focus is on Heuristics developed in Russia by professor Alexander Ivanovich Polovinkin (Polovinkin 1985, 1988, 1991). We have concentrated our efforts in the validation work.

In one of the letters to his associates G. S. Altshuller wrote about research on TRIZ (Altshuller 1979b) "*... So, there is an interesting key. It is necessary to look for locks which this key can open*." Polovinkin´s Heuristics are the keys considered in this book. We have found some locks which can be opened with them (examples), mainly through patent search. These are presented in Appendix.

Although this book has a technical bias, on the tradition of so-called hard TRIZ[1], its scope is general: it is not focused on a single technical specialty. As it seems to happen with all really good ideas, Polovinkin´s Heuristics are universal and can be used for solving technical problems in different areas and also non-technical problems[2]. This makes the book instrumental to any person interested in solving problems and developing his or her creativity.

A somewhat unusual aspect of this project is that the authors are living in 3 different continents and have been collaborating by e-mail (unfortunately, they have never met each other personally). The authors, as well as G. Doncean (who proposed the idea of the book and who, by the way, lives on a fourth continent) use English as the communication language. English is not our native tongue, and the reader will probably find - hopefully few - language mistakes throughout the book. We apologize for that.

We would greatly appreciate all comments, opinions and suggestions. We are specially interested in knowing about reader´s results using the Heuristics and examples presented in this book. For this reason, the authors´ addresses are provided below:

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[1] Hard TRIZ is the term used for TRIZ applied to technical systems and processes. Soft TRIZ refers to the use of TRIZ in management, arts, pedagogy, and other areas.

[2] We have not conducted research in order to scientifically check the validity of this statement. However, the authors´ personal and professional experiences indicate that Polovinkin´s heuristics are also useful for non-technical problem solving.

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1 - INTRODUCTION

1.1 - Project goals

Very often, a person faces a problem that he or she does not know how to solve. This may be due to the absence of an appropriate approach and/or knowledge about existence of a solution and its uniqueness. The problem solving methodology named TRIZ (Theory of Inventive Problem Solving) frequently can help the engineer with a hint that allows to limit the multitude of solution attempts and solving approaches, and concentrate only on those aspects that conduct to promising solutions (Altshuller 1969, 1979a, Savransky 2000).

Human beings use hints from the beginning of civilization. These hints have been developed for centuries in different areas of human activities. Perhaps, the first understandings of the importance of hints appeared in Ancient Greece, with Plato and in Ancient China, with Lao-Tzu. These philosophers collected hints that they considered useful. The modern scientific name "Heuristic" was coined by French philosopher Rene Descartes (1596–1650), based on the Greek word "heurisko", which roughly means “a discovery aid”. Unfortunately, we do not have yet a good common definition for Heuristic. Heuristics can be rules, strategies, principles or methods for increasing the effectiveness of a problem resolution. Heuristics neither provide direct and definite answers, nor guarantee a solution for a problem. They only provide a help to aim at an easier problem solving.

G. S. Altshuller explored patent databases with the purpose of developing Heuristics for problem solving (Altshuller 1969). In his work, the levels of patents and the rating of the Heuristics usage (and thus the probability of their use in the future) were taken into consideration. His famous group of 40

Heuristics (known as Inventive Principles) is helpful in finding solutions for many problems (Altshuller 1969, 1979a; Savransky 2000).

Less known is the set of Heuristics selected by Professor A. I. Polovinkin. They are derived from the best practices of problem solving by engineers and machine designers from the former USSR (Polovinkin 1985, 1988, 1991). These Heuristics can be organized in groups that reflect the changes of main attributes of a technique[3], such as shape or material. They were also selected based on the effectiveness of their use according to the frequency of their occurrence in the technical literature, although without a proper statistical analysis.

There are two major reasons why Polovinkin's Heuristics are not currently widely used:

- until the turn of this millennium they were published only in Russian, in "hard-to-find" books;
- there is a lack of examples that would make their understanding easier and proof their value for international problem solving practice.

The main goal of this book is to reduce these problems by publishing Polovinkin´s Heuristics in English and providing a set of examples from the international patent database.

We have decided to reduce the initial set of Polovinkin's Heuristics. The reason is that, firstly, some of the original Heuristics reflect legal and safety aspects of engineering design particular to the former USSR - hence, they can not be used worldwide. The second reason is that some of the original Heuristics are only important for the detailed design stage. We have chosen not to consider these Heuristics, because they do not contribute to the core competence of TRIZ - conceptual problem solving. Finally, several of the original Polovinkin's Heuristics describe the evolution of technique[4] and, thus,

[3] We use the term "technique" to refer both to technical systems (technical artifacts) and technical processes. A definition of technical systems and technical processes can be found in (Hubka & Eder, 1988).

[4] See, e.g., the works of Salamatov (Salamatov 1999), Savransky (Savransky 2000), Doncean et al. (Doncean et al. 2000), and Zlotin & Zusman (2001).

examples for these are usually beyond the scope of a single patent, making the search much more difficult.

Other major goals of our research are:

- to verify our assumption that the selected Heuristics are valid worldwide;
- to test our hypothesis that selected Heuristics are culture-independent, and;
- to verify our assumption that Polovinkin´s Heuristics can enlarge the knowledge base of TRIZ by comparing them with the Inventive Principles.

Seeking simplicity, in this book we call the reduced set of Polovinkin's Heuristics as 121H.

1.2 - The Role of Heuristics and their Examples

Empirical investigations of several psychologists have confirmed that analogical reasoning is central to human thinking (Mayer 1992). Analogical problem solving can be defined as a strategy that transfers knowledge from past problem solutions to a new problem, which presents significant similar aspects with the past problem. Thus, it is possible to relate the corresponding past experience and employ the transferred knowledge to construct novel solutions for the specific problems. Using this reasoning strategy, we try to solve a new (target) problem by analogy to a previously solved similar (source) problem. Indeed, analogy applied to human reasoning is particularly valuable in ill-defined, difficult and complex problems, or situations unfamiliar to the problem solver. It is often easier and faster to find the proper source problem that fits the conditions of the target problem than to try a solution for this problem directly, from first principles, using knowledge or intuition.

The main purpose of a Heuristic is to provide help with solving problems, making it more efficient by reusing past experience to guide the generation of solutions for new problems.

Unfortunately, it is not enough to know the right Heuristic itself. Several investigations have been concerned with differences in the use of analogy, depending on the expertise of the problem solver and on the actual situation. According to Mayer (1992), people tend to perform better in analogical problem solving when they are given:

- explicit instruction;
- description of sources;
- feedback.

Heuristics play the role of explicit instructions. Examples that represent solutions for past problems act as descriptions of sources[5]. The result of our research allows easier application of Polovinkin's Heuristics to target problems. Thus, our intention is that the Heuristics and examples together will help find solutions for problems that are relevant to the reader. Therefore, successful resolution of the reader's target problems will provide the feedback, as suggested by Mayer (1992).

1.3 - Why Another Set of Heuristics in TRIZ?

A reader familiar with TRIZ literature might ask "Why would a problem solver need another set of Heuristics? Is it not enough to have such tools as the 40 Inventive Principles, the 76 Standard Solutions to Su-Fields, the Separation Principles, the tables of effects, and ARIZ?"

We can answer with following reasons which support the 121H project:

- We do not see TRIZ as a completed work, but rather as a methodology in progress. TRIZ is very rich, but there is plenty of opportunity for its improvement.
- There are evidences that the 121H effectively complement TRIZ original knowledge base. This is demonstrated in Chapter 5.

[5] Appendix 1 contains a collection of patent examples for Polovinkin's Heuristics.

- As the famous Psychologist Abraham Maslow put: "It is tempting, if the only tool you have is a hammer, to treat everything as if it were a nail" (Maslow 1966). We would like to add some special tools (the Heuristics and their examples) to the problem solver´s toolbox.
- Although 121 can be a relatively high number of Heuristics, a problem solver will start working with them from only 8 classes, as described in the next Chapter.