"Systematisation of Substance-Field Analysis and its Application Beyond the Technological Sphere"

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General characteristic of research work

For a number of years the author has attempted to teach the original 76 Standards of Substance-Field Analysis to Australian engineers. The results were disappointing. Most of the learners were unwilling to use the 76 Standards after two days of study. Engineers found Standards difficult to learn and were unable to apply the tool well. To resolve this, and to help engineers acquire Substance-Field Analysis, the author systematised its solution procedure.

This new procedure incorporates five main steps which cover the whole solution process – from modelling the original situation to choosing the solution that is most suitable in the existing conditions. Seventy-six Standards have been replaced by five simple Model solutions – five general blueprints of a possible solution. Every model solution works in a similar way to a Standard – it recommends the framework of a solution idea to the user. A model solution is "translated" into real solution ideas by employing the mnemonics of MATCEMIB. This mnemonics highlights interactions which belong to eight fields: Mechanical, Acoustic, Thermal, Chemical, Electric, Magnetic, Intermolecular and Biological (MATCEMIB) as well as to the substances and actions associated with these fields. The most practical solution is chosen out of the solution ideas after taking into account the existing conditions.

During the last eight years, this new procedure of Substance-Field Analysis has been successfully taught to diverse audiences in Australia, Singapore, Malaysia and Austria. Engineers, managers, school teachers, university and school students have learnt this procedure. It has helped many professionals in their day-to-day work. The new Su-Field procedure has also helped them to use their knowledge more effectively by assisting professionals to look for solutions outside of their profession. Furthermore, this new approach has generalised a solution procedure, enabling a practitioner to apply Substance-Field Analysis to resolve situations that are beyond being simply technical in nature. Also the new procedure found its effective usage in Failure Analysis and Failure Prevention.

Over the last few years the systematised procedure of Substance-Field Analysis has helped to significantly increase the number of people utilising the basics of Su-Field modelling and, as a result, further enhanced the standing of TRIZ among educationist and practitioners.

Relevance of the theme of the research

Although thinking and problem-solving tools of the Russian Theory of Inventive Problem Solving (TRIZ) have been used by engineers and scientists for over 30 years, Substance-Field Analysis (Su-Field) has not yet found many followers in the West.

There are two main reasons why so few professionals use Su-Field in the non-Russian speaking world. One is associated with lack of proper study materials. The other is due to the time constraints that Western professionals find themselves under in the fast-paced 21st Century.

Firstly, it is relevant to consider the absence of an appropriate textbook and educational methodology suitable for self-study. Several books have been written on Su-Field in languages other than Russian (Salamatov Y., 1999; Terninko J., Zusman A., Zlotin B., 1996; Fey V., Rivin E., 2004). Although these publications offer a reliable review of the 76 Su-Field Standards, on their own they cannot be used efficiently to study the methodology. Traditionally, publications introduce Substance-Field Analysis as 76 Standard solutions in more or less the same way that the Standards had been presented in 1986 (Altshuller G., 1986) expecting that a Western reader will be able to master these standards, as many Russian engineers did three decades ago.

These publications do not take into account the vast differences in educational habits and expectations of a busy Westerner. Learning TRIZ in Russia in the 1980s was mainly a group exercise. It normally required many hours of face-to-face interaction with a Master at TRIZ seminars and months of practice under his supervision. Printed materials were required only as concise reminders of the procedures, which were learnt and revised during the seminars. It was the Master and the fellow learners who filled the gaps in the learning methodology that were missing in the materials. Furthermore, the examples provided to illustrate the methodology in such publications were almost entirely based on Russian patents. Many of them were confusing and were difficult to comprehend unless a learner held a degree in Mechanical Engineering. Group discussions by the participants of TRIZ seminars, as observed by the author many years ago in Moscow, were vital to learning and helped a novice by offering more suitable examples, which made the problem-solving procedures of TRIZ tools clearer. Considering real problems, often proposed by the seminar participants, as exercises, was equally essential for a learner to gain the required comprehension of the tools.

Because of the prevailing group mode of learning, proper TRIZ textbooks were not a vital necessity under the Russian conditions in the 1980s and 1990s. Consequently, only very few TRIZ books published in Russia during the time were suitable for self-learning. None of these books was devoted to Su-Field. In the last 10 year, Westerners have been offered TRIZ books which were either directly translated from the Russian TRIZ publications of 1980s, or have been compiled from the information available from such sources. Thus, it is not a surprise that engineers from the Western world were unable to efficiently use the content, as it was only suitable for a Russian audience 20 years ago.

Secondly, the time required for a novice to learn the basics of Su-Field is often considered to be excessive by the Western specialists. The quality of traditional Russian education is universally known. It is partially based on extensive student workloads and strict performance requirements. These requirements meant that learners in Russia expected to allocate months for mastering the tools of TRIZ. It was the norm for a learner to put time and effort into study, without ever daring to ask why there was such a heavy study load. Such an approach ensures quality and depth of understanding in the material, but is often considered unacceptable by people educated under non-Russian conditions. Moreover, the rapidly changing world of the

21st Century and the mindsets of learners, which belong to generation X and Y, require different educational approaches to those that suited Russian learners in the past. The modern students expect to learn the basics of a new subject in just a few hours and to master it in a few weeks or even days.

Therefore, 76 Standard Solutions, which have formally been finalised by Genrikh Altshuller in 1985 (Petrov, 2003), needed improvement both from the perspective of teaching them to wide audiences and for making it more effective in application. Over the ten year period from 1975 to 1985 the number of standards increased from 5 to 76 (Petrov, 2003). Since 1985 various changes have been proposed to 76 Standards to make them more efficient and easier to learn and deploy. The following are some of the most significant of those improvements.

Boris Zlotin and Alla Zusman (1989) have suggested using mnemonics to remind a practitioner of the fields to be utilised. The word MATCEM (Mechanical, Acoustic, Thermal, Chemical, Electric, Magnetic) has been created. Before the MATCEM mnemonics a user was left on its own guessing what field, substance or action can be considered to resolve a specific situation using Su-Field. The MATCHEM mnemonics made life of a user much simpler and resulted in significant increase of ideas generated by the user. In late 1980s Boris Zlotin and Alla Zusman developed the system of operators and a computer program to use these operators (IWB), which transferred the ideas of classical Su-Field Analysis to professional software for problem solving.

Lev Pevzner (1990) has developed a concept of micro-standards. Micro-standards in opinion of Pevzner, would be much more helpful in application when 76 Standard solutions. The latter were considered by Pevzner as too general.

Zinovy Royzen (1999) has merged the Function Analysis and Su-Field Analysis to create the Tool-Object-Product (TOP) Function Analysis. TOP modelling improved understanding of the conflict, and significantly simplified formulation of the natural contradiction present in the situation.

To make 76 Standards more suiting the needs of a professional of the 21st Century, Vladimir Petrov (2003) has expanded the system of standards to over 500.

In order to make the standards easier to learn and apply, Sergei Iakovenko (2008) regrouped the original 76 Standards into 28.

The above-mentioned changes addressed two main goals: to make Su-Field easier to learn and use and to make it more efficient in application to real problems. Having these considerations in mind, and simultaneously fostering a desire to help Westerners gain the advantage of the methodology, the author has systematised the Su-Field procedure to better suit the educational habits of engineers and scientists of the 21st Century.

Over the last eight years, the course on Su-Field that was developed by the author (Belski, 2000) has been taught to engineers, scientists, teachers, university and high school students. Systematised Su-Field methodology has been successfully used by hundreds of practitioners from Australia, Singapore, Malaysia and Austria. It has helped them in improving their products and processes, in discovery and removal of failures, and in enhancement of accuracy of measurements.

This new methodology is based on the original 76 Standard solutions. Systematising the Su-Field procedure made it possible for a learner to gain the basics of it in just a few hours, and to become proficient in it after just a few days of practice. Furthermore, the solution procedure became more general and systematic, which meant that the use of Su-Field could be expanded beyond technical systems.

Goals and tasks of the research

The main goal of systematisation of Substance-Field Analysis was to make the logic underpinning the classical Su-Field approach known to a new generation of engineers and scientists. Although the author identified high school, polytechnic and university students as his major focus, he wanted to involve as many practicing engineers and scientist into deploying the Su-Field methodology as possible. Also, the author expects that if a professional learnt to apply systematised Su-Field well, he would be able to acquire knowledge of 76 Standard solutions without much extra effort.

The main tasks of the research were:

- to establish patterns of similarities in the existing 76 Standards in order to reduce the number of standard solutions to less than ten model solutions;
- to identify the cognitive basis for the efficiency of Su-Field Analysis and to enhance the procedure accordingly;
- to evaluate whether the Su-Field procedure can be used outside its original technology-based applications.

Research method

The recommendations of the 76 Standard solutions of the classical Su-Field have been carefully studied in order find similar recommendations and to reduce the overall number of standards.

The procedure of Substance-Field Analysis has been analysed under the light of the current knowledge of psychology and cognition in order to find ways to enhance the methodology and to fine-tune it to the needs of the learners and the users of the 21st Century.

The domain of knowledge in Human psychology has been researched in order to construct the Table of the "Human" fields.

The proposed new models have been extensively trialled at various seminars and workshops over the last eight years. Numerous improvements have been made to the systematised Su-Field procedure and its application on the basis of those trials. Findings have been presented at international conferences and published as peer reviewed papers.

Scientific novelty of the research

As a result of this research, the systematised procedure of Substance-Field Analysis has been created. A number of peer-reviewed papers have been published on the matter in the last eight years (see the list of publications). The results of this research have been delivered to numerous scientific conferences. This procedure has been published in the book (Belski, 2007). The following is the novelty of the current work:

- Proposed 5 Model solutions to replace 76 Standard solutions of classical Su-Field. Systematised and generalised the procedure of Su-Field. Developed a simplified heuristics of Su-Field.
- Updated the Su-Field procedure to enhance the usage of the MATCHEMIB mnemonics in idea generation and problem solving with Su-Field.
- Showed how Su-Field modelling can help a user to generate numerous solution ideas and to utilise their knowledge more efficiently.
- Developed and enhanced the Method of Len Kaplan, which has significantly simplified choosing the most suitable substance to be inserted between the two substances of the conflict triad.
- Suggested that the Su-Field modelling procedure can be used in many fields of human endeavour, far beyond its original technology focus. Developed the set of "Human Fields" and demonstrated how they can be deployed using the Su-Field procedure to resolve problems, which involve humans.
- Proposed the way of deploying the systematised Su-Field procedure for Failure Analysis and Failure Prevention.

Practical significance of the research

The systematised procedure of Substance-Field Analysis has significantly reduced the time required to learn the Su-Field modelling to just a few hours. Being simple to learn, the systematised procedure of Substance-Field Analysis has been found very efficient and suitable to the needs of learners by school teachers as well as polytechnic and university lecturers. A number of schools, polytechnics and universities have taught this procedure to their students and found it very effective in enhancing students' thinking in problem solving skills. This has practically unlocked the doors of educational institutions in the West TRIZ thinking and problem solving tools.

Many professionals have quickly and successfully learnt the classical approach after using the contemporary Su-Field for a few months. This has created better industry awareness not only of the classical Su-Field and 76 Standard solutions, but also about TRIZ as a system of resolving complex problems.

Overall the systematised procedure of Substance-Field Analysis has helped to significantly increase the number of people utilising the basics of Su-Field modelling and, as a result, further enhanced the standing of TRIZ methodology among educationist and practitioners.

Main provisions presented for defense

The following are the provisions presented for defence:

- Systematising the 76 Standard solutions into 5 Model solutions.
- Developing and enhancing the Method of Len Kaplan.
- Suggesting how the Su-Field modelling procedure can be used in many fields of human endeavour, far beyond its original technology focus. Developing the set of "Human Fields" and demonstrating how they can be deployed using the Su-Field procedure to resolve problems, which involve humans.

- Proposing the way of deploying the systematised Su-Field procedure for Failure Analysis and Failure Prevention.

Personal contribution of the applicant

Most of the work on the systematised procedure of Substance-Field Analysis has been performed solely by the author. Nonetheless, it is of importance to acknowledge the following colleagues, who helped the author at various stages of his work, personally (in an alphabetical order): Mark Barkan, Ellen Domb, Sergei Ikovenko, Len Kaplan, Lee Sing Kong, Alex Lyubomirskiy, Vladimir Petrov, Vladimir Shapiro, Teng Tat Chong, Boris Zlotin, Alla Zusman.

Validation of the research work

The systematised Su-Field procedure has been praised by the ***de Bono Institute***, the ***National Institute of Education*** of Singapore and introduced by various schools, polytechnics and universities as a formal course. This resulted in a number of educational awards, including the Carrick Citation given to the author by the Australian Government (see some opinions and Awards in the Appendix).

Since 2001 this new Su-Field procedure has been taught to:

- Over 700 engineers of Australia, Singapore, Malaysia and Austria;
- Over 400 school and polytechnic teachers of Singapore;
- Over 2000 school and polytechnic students of Singapore;
- Over 150 university students in Australia;

The systematised Su-Field procedure has been successfully utilised by engineers to resolve over 80 real company projects. Many of these solutions have been made on patentable level.

Over 10 real failures have been resolved by means of the Su-Field Failure Analysis procedure.

Over 100 products and processes developed by the participants of the TRIZ4U training have been significantly improved with the Su-Field Failure Prevention procedure.

Application of Su-Field with the "Human" fields has helped to resolve over 20 non-technical problematic situations.

The confidentiality of many of the abovementioned solutions places restrictions on sharing the outcomes of the new Su-Field process. The following is an opinion of an engineer, who used the new Su-Field procedure for failure analysis and prevention and for improvement of an existing product: [1]

...Su-Field in failure analysis ... has opened my eyes on how many effective ideas this simple tool can generate by just systematic thinking. Simply by drawing circles and arrows, and going through all the five rules, I have experienced for myself how ideas which I have never ever thought of previously, can be generated effortlessly through this thinking process. In terms of the (...) problem, Su-Field has opened up extra possible failure scenarios, which were never considered in the past…

[1] This quotation is taken from the reflections of engineers on their experience of using TRIZ for company projects. It has been adjusted for the purposes of confidentiality.

The following are two great proposals, which are likely to find their way to the market in the near future. School and university students used the systematised Su-Field procedure to develop an environmentally friendly washing machine, which cleans clothes without water by means of electrostatic charge. Its prototype has been successfully tested in 2005. School teachers came up with a way of detecting corrosion on aircrafts in which the corroded spots reveal themselves by changing the paint colour. This idea has also been successfully trialled.

Publications

Book: Belski, I., (2007) *"Improve your Thinking: Substance-Field Analysis",* TRIZ4U, Melbourne, ISBN 978-0-9803293-0-8,196p.

Papers:

1. Belski,I., (2007). *TRIZ Course Enhances Thinking and Problem Solving Skills of Engineering Students*, Proceedings of the TRIZ-future conference, Frankfurt, Germany, 6-8 November, pp 9-14.
2. Belski, I., (2007) *Improvement of Thinking and Problem Solving Skills of Engineering Students as a result of a Formal Course on TRIZ Thinking Tools*, 13th International Conference on Thinking, Norrkoping, Sweden, June, Volume 1, pp11-17.
3. Belski,I.,(2006). *Reinventing TRIZ Thinking Tools: Substance – Field Analysis*, 5th International Conference TRIZFutures 06, Kortrijk, Belgium, October.
4. Belski,I.,(2005). *The Role Of Practice In Mastering TRIZ, Proceedings of MATRIZFest*, St. Petersburg, Russia, June.
5. Belski,I.,(2005). *Improving the Skills of Engineers in Systematic Thinking*, 4th Global Colloquia on Engineering Education ASEE/AAEE, Sydney, September.
6. Belski,I., (2002). *Systems Thinking – The Innovators Challenge,* Proceedings of the 9th Asia-Pacific Conference of Engineering Management Educators, Brisbane, Australia, October.
7. Belski,I.,(2002). *Seven Steps to Systems Thinking,* Proceedings of the 13th Annual Conference and Convention Australian Association of Engineering Educators, Canberra, Australia, September, pp 33-39
8. Belski,I., Gray,D.C., (2007). *Enhancing Students' Systems Thinking: Four-Screen Representation of Electronic Systems,* Proceedings of the 13 Conference on Engineering Education AAEE, Melbourne, 9-13 December.
9. Belski,I., (2007). *Using Task Evaluation and Reflection Instrument for Student Self-Assessment (TERISSA) To Improve Educational Assessment and Feedback*, Proceedings of the 13 Conference on Engineering Education AAEE, Melbourne, 9-13 December.
10. Belski,I., Gray,D.C.,(2003). *Four-Screen Representation Of Electronic Systems,* Proceedings of the 33rd ASEE/IEEE Frontiers In Education Conference, Boulder (CO), USA, November.
11. Belski,I., Shapiro, V., (2002). *Contradictions and Evolution of Technological Systems,* Proceedings of the 9th Asia-Pacific Conference of Engineering Management Educators, Brisbane, Australia, October.

12. Shapiro, V., Belski,I., (2000). "*The Universal Method for Technology Forecast: Does the Panacea Exist?",* Transactions from the 12th Symposium on Quality Function Deployment, Novi, Michigan, USA, June, pp 242-251.
13. Belski,I., (1999). *"Solving problems with Method of the Ideal Result (MIR)"*, Transactions from the 11th Symposium on Quality Function Deployment, Novi, Michigan, USA, June, pp 192-203.
14. Belski,I.,(1998*). "I Wish The Work To Be Completed By Itself, Without My Involvement: The Method Of The Ideal Result In Engineering Problem Solving"*, Proceedings of the World Innovation and Strategy Conference, Sydney, August, 199-206.

Structure and size of the thesis

The textbook on Su-Field Analysis (Belski, 2007) of 196 pages is used instead of the formal thesis. The following is a short description of the content of the book's eight main Chapters.

Chapter 1

Chapter 1 explores the meaning of a 'substance' and a 'field' in Substance-Field Analysis. It presents the expanded mnemonics of eight fields of MATCEMIB and explains why different users sometimes have different opinions on interactions between substances. It shows how a technical system can be modelled by means of Substances and Fields. It explains, that Fields in Su-Field are used for two purposes: to help in modelling situations and, more importantly, as prompts during idea generation. The expanded Table of "Fields" is presented.

Chapter 2

This chapter introduces the first two steps of Su-Field:

- In Step 1 a user needs to write down the list of all the substances, present in the situation under consideration.
- In Step 2 a user is required to sketch the Su-Field model of the situation, identifying the interactions between the substances as well as expressing his/her opinion on whether these interactions are successful.

The essence of interaction between substances and the human perception of the interaction is discussed. The natural essence of the interaction between the substance-subject S_2 and the substance-object S_1 is represented by the arrows between the substances and the field F_1. This natural essence of the interaction is presented in Figure 1.

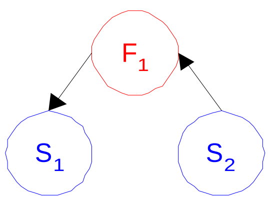

Figure 1. The natural essence of the interaction between the substances

The arrow between the substances of a triad performs the role an indicator of user happiness with the interaction. It expresses our feelings about the system: our perception. The arrow between the substances acts as a performance measurement. It indicates whether the requirements of the situation are fulfilled.

Since a human can be either satisfied or dissatisfied with something, there are two key perceptions: satisfaction and dissatisfaction. They are represented in Figures 2 and 3 respectively.

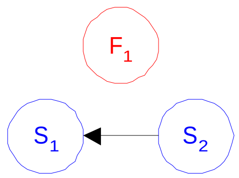

Figure 2. Human perception: satisfied

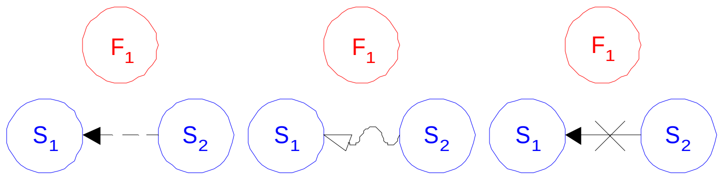

Figure 3. Human perception: dissatisfied

Chapter 3

Chapter 3 discusses the importance of conflict triads in situation improvement. It introduces the reader to Step 3 and Step 4 of the Su-Field procedure:

- In Step 3 a user deals with the conflict triads identified in Step 2. Conflict triads are considered one at a time. For every conflict triad, the user must transform the general model solutions proposed by the five rules of Su-Field into the situation-specific model solutions.
- In Step 4 a practitioner uses the "fields" of MATCEMIB to 'translate' the situation-specific model solutions into solution ideas. This process is repeated for all conflict triads identified in the system.

The model solution for Rule 1 is introduced and used for the first time to resolve a problem.

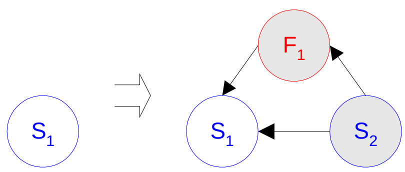

Figure 4. The Model Solution for Rule 1 (for situations with less than 3 elements)

The MATCEMIB mnemonics is deployed to generate improvement ideas for the first time.

Chapter 4

Chapter 4 consists of three sub-chapters devoted to the model solutions for Rules 1, 2 and 3, each with a separate exercise.

The first subchapter introduces the model solution for Rule 1, when the original situation contains the conflict triad. The appropriate model solution is depicted in Figure 5.

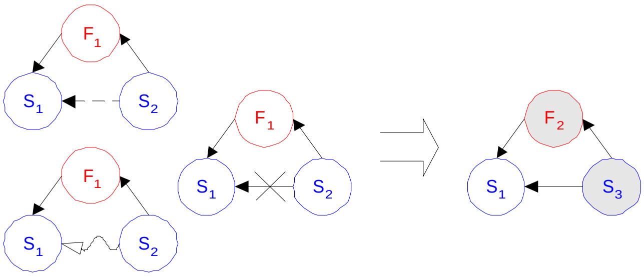

Figure 5. The Model Solution for Rule 1

The second subchapter introduces the model solution for Rule 2. The appropriate model solution is shown in Figure 6.

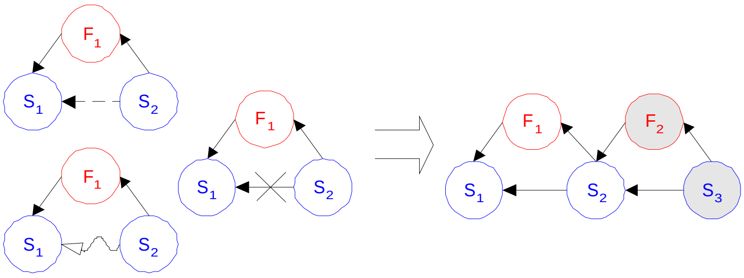

Figure 6. The Model Solution for Rule 2

The second subchapter introduces the model solution for Rule 3. The appropriate model solution is presented in Figure 7.

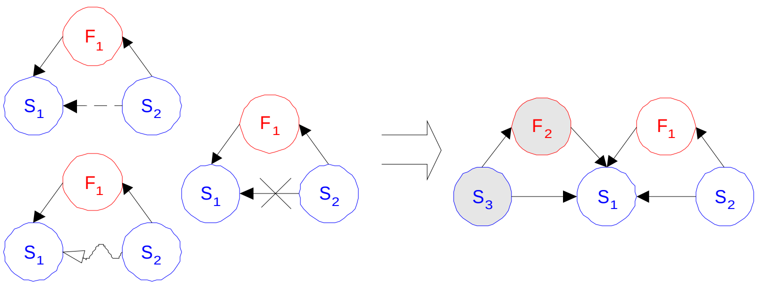

Figure 7. The Model Solution for Rule 3

Chapter 5

Similarly to Chapter 4, Chapter 5 consists of two separate parts – devoted to the model solutions for Rules 4 and 5.

Firstly it introduces the model solution for Rule 4, which is depicted in Figure 8.

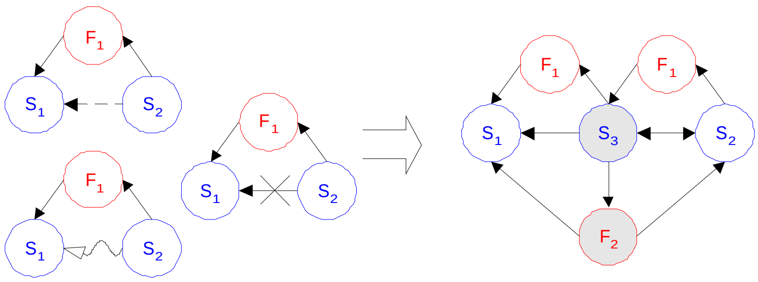

Figure 8. The Model Solution for Rule 4

Later it presents the model solution for Rule 5, which is pictured in Figure 9.

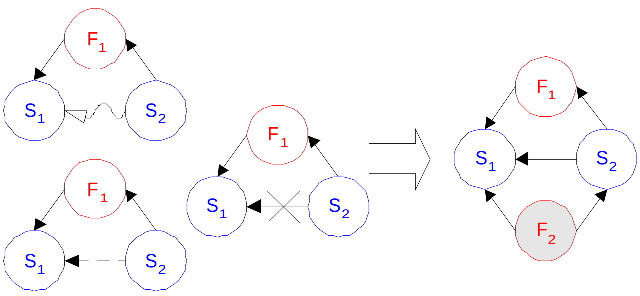

Figure 9. The Model Solution for Rule 5

Chapter 6

Chapter 6 introduces Step 5 of the Su-Field procedure, which is devoted to determining the most suitable practical solution. The five Steps and 5 Rules (Mpde; solutions) of Substance-Field Analysis are deployed together in this Chapter for the first time. The heuristics of the systematised Su-Field Analysis, shown in Figure 10 is described.

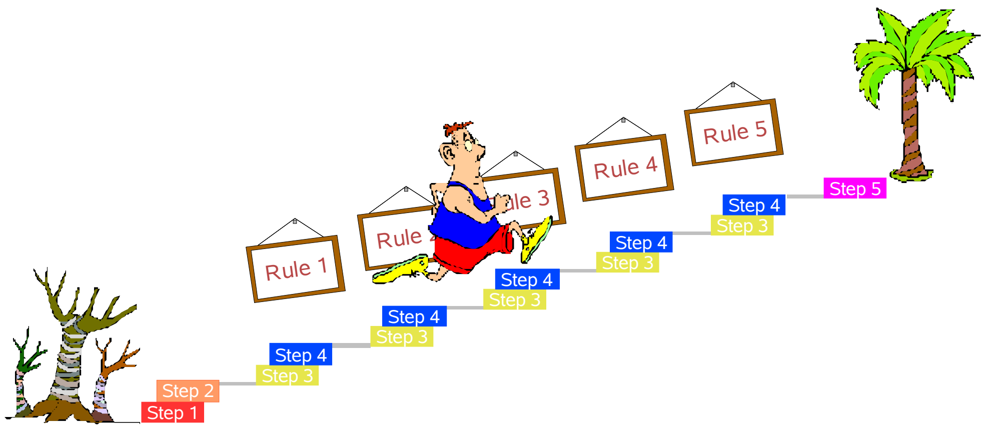

Figure 10. The Heuristics of Substance-Field Analysis

Chapter 7.

Chapter 7 is the first chapter to consider advanced topics. It introduces the Method of Len Kaplan (MLK) and presents the reader with two idealised model solutions for

Rule 4. The MLK often simplifies the application of the model solution for Rule 4 by suggesting the most likely characteristics of the substance S_3.

The Method of Len Kaplan consists of two steps. They come into play when Step 3 of Rule 4 has been completed, just before Step 4 and the fields of MATCEMIB are used.

Step A requires the user to identify pairs of opposite characteristics for the substance-object S_1 and the substance-subject S_2 and to write these pairs down into the Characteristics Table shown in Figure 11.

Substance	S_1	S_2
Opposite Characteristics	*A*	*B*
	C	*D*

Figure 11. The Characteristics Table

Then, Step B of the Method of Len Kaplan would suggest to choose the additional substance S_3 as any of the following:

- substance similar to S_1 having either characteristic B instead of A or characteristic D instead of C or both characteristics B and D
- substance similar to S_2 having either characteristic A instead of B or characteristic C instead D of or both characteristics A and C.

Two idealised model solutions for Rule 4 are introduced later in Chapter 7. These idealised solutions suggest a way in which to further enhance solution ideas by creating the required substance S_3 from either of the existing substances S_1 and S_2 by modifying these substances (see Figure 12).

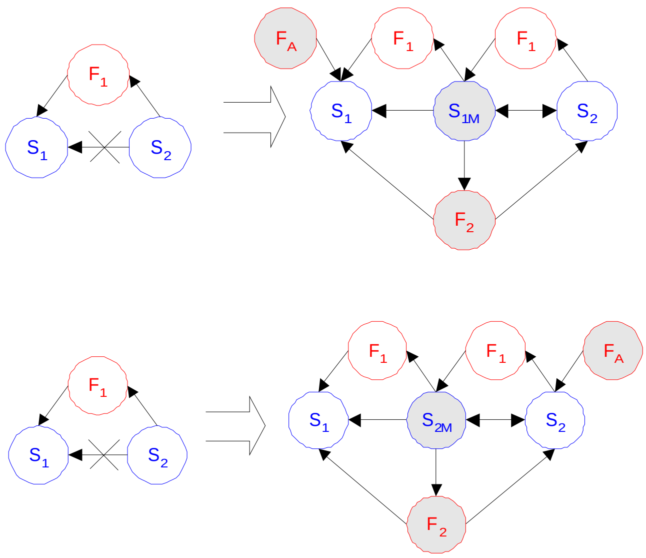

Figure 12. Two Model Solutions for the idealised Rule 4

The corresponding heuristics for the advanced Su-Field procedure, presented in Figure 13 is described.

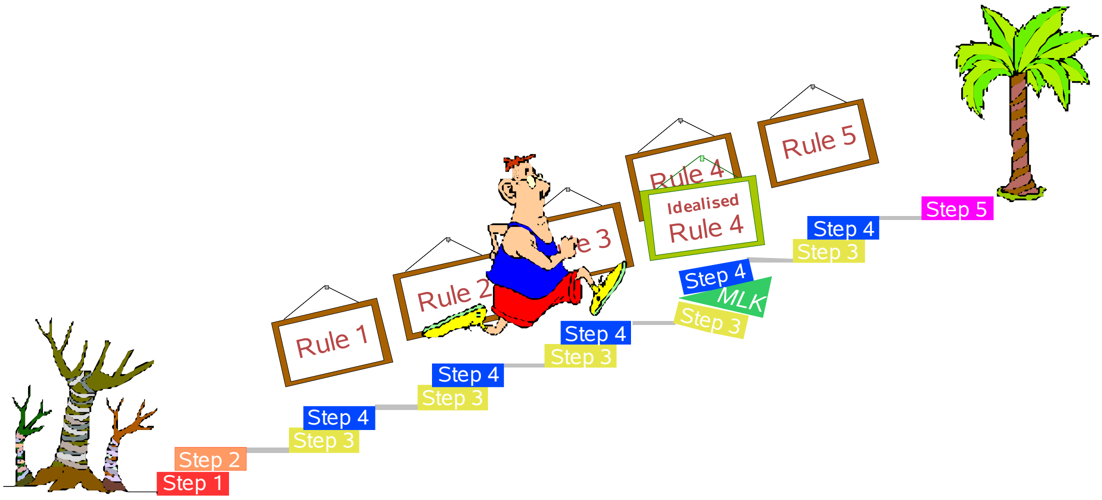

Figure 13. The Heuristics of Substance-Field Analysis incorporating the MLK and Idealised Model Solutions for Rule 4

Chapter 8

Chapter 8 is the second chapter devoted to advanced issues. This chapter concerns the application of Substance-Field Analysis to modelling and resolving problems which belong to different fields of knowledge.

The meaning of 'substances' and 'fields' is re-defined in this chapter, in order to cover situations which involve human relationships. A new table of "Human Fields" is created (see Figure 14).

Field Essence	Field Name	Interaction	Content
Information (Intangible)	**Senses**	Vision	colour, shape, movement
		Taste	pleasant, bland, unpleasant
		Smell	charming, appetising, neutral, bad
		Hearing	pleasing, dramatic, dull, unpleasant
		Touch	pleasant, electrifying, neutral, painful
		Heat	hot, pleasant, cold
		Pain	high, medium, none
		Balance	normal, abnormal
		Body Awareness	normal, abnormal
	Verbal communication	Route	peripheral, central
		Feature	affective, informational
		Organisation	time, venue, primacy/recency effect, one-or two-sided argument
		Style	humorous, motivating, educational, threatening, commanding
	Non-verbal communication	Visible	facial expression, gesture, posture, appearance
		Paralinguistic	pitch, loudness, rhythm, inflection, voice quality
		Written	information (true or rumour), request, command, complaint, threat
		Pictorial	picture, sign, puzzle, movie
Material Possession (Tangible)	**Real Material Possession**	Money	given or taken
		Valuables	given or taken
		Authority	given or taken
	Perceived Material Possession	Money	given or taken
		Valuables	given or taken
		Authority	given or taken

Figure 14. The Table of "Human Fields"

References (in alphabetical order)

Altshuller G., (1986), *Standards for Resolving Inventive Problems*, Novosibirsk, 89p., (in Russian).

Belski I, (2000 – 2006), *A Course on TRIZ*, TRIZ4U, Melbourne, Australia, the Su-Field Chapter.

Belski, I, (2007), *Improve Your Thinking: Substance-Field Analysis*, TRIZ4U, Melbourne, Australia, 196p.

Iakovenko S. (2008)

Fey V., Rivin E., (2005), *Innovation on Demand*, Cambridge University Press, UK.

Певзнер Л.Х., (1990), *Концепция создания микростандартов для алгоритма решения задач на ЭВМ*, Журнал ТРИЗ, Т. 1, № 2, с.44 49.

Петров Владимир (2003) *История развития системы стандартов*, http://triz-summit.ru/ru/section.php?docId=3811

Royzen Z. (1999) *Tool, Object, Product (TOP) Function Analysis*, TRIZCON99, March 7-9, Novi, Michigan

Salamatov Y., (1999), *TRIZ: The Right Solution at the Right Time*, Insytec B.V., The Netherlands, pp 31 – 67.

Terninko J., Zusman A., Zlotin B., (1996), *Step-by-step TRIZ,* Responsible Management, Nottingham, NH, USA, pp 117 – 127.

Zlotin B. and Zusman A., (1989) *To come to a battlefield. TRIZ practice*. In the book The rules of the game with no rules, Karelia, USSR, ISBN: 5-7545-0108-0 (in Russian).

Appendix.

The following are opinions on the systematised Su-Field Procedure of top management from various fields of work:

"Dr. Belski was able to develop the tool (Substance-Field Analysis) to encourage a practitioner to look outside of his area of specialty, and to utilise the knowledge learnt over the years of study more efficiently. I have read a preprint of his book "Improve your thinking: Substance-Field Analysis" and am looking forward to seeing it adopted as a standard textbook on systematic thinking."
Professor Lee Sing Kong, Director of the National Institute of Education, Singapore

"The ideas Dr Iouri brought to the classical Substance-Field Analysis and the vast changes he made to it resulted in a user-friendly idea generation methodology, which is easy to grasp. Earlier this year, I read the pre-print version of his textbook on Substance-Field Analysis. It is an excellent resource, which teaches serious engineering by simple, efficient and often humorous examples and involves the reader in well-structured activities."
Dr. Richard Kwok, Chief Technology Officer, Singapore Technologies Kinetics, Singapore

"Indeed I found his ideas on systematic thinking very useful. Substance-field analysis and situation analysis are quite suitable for infusion into the first year modules. I have initiated a review of those two modules and presently working with our Centre for Educational Development for strengthening the elements related to skills of systematic thinking."
Dr. W. A. M. Alwis, Director of Academic Affairs, Singapore Polytechnic

"This work provides an introduction to creative thinking, problem solving and invention on a new scale and will benefit anyone charged with the task of breaking new grounds in systems thinking that requires concrete and tangible advances."
Max Dumais, founding CEO of the De Bono Institute
(on the book "Improve your thinking: Substance-Field Analysis")

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