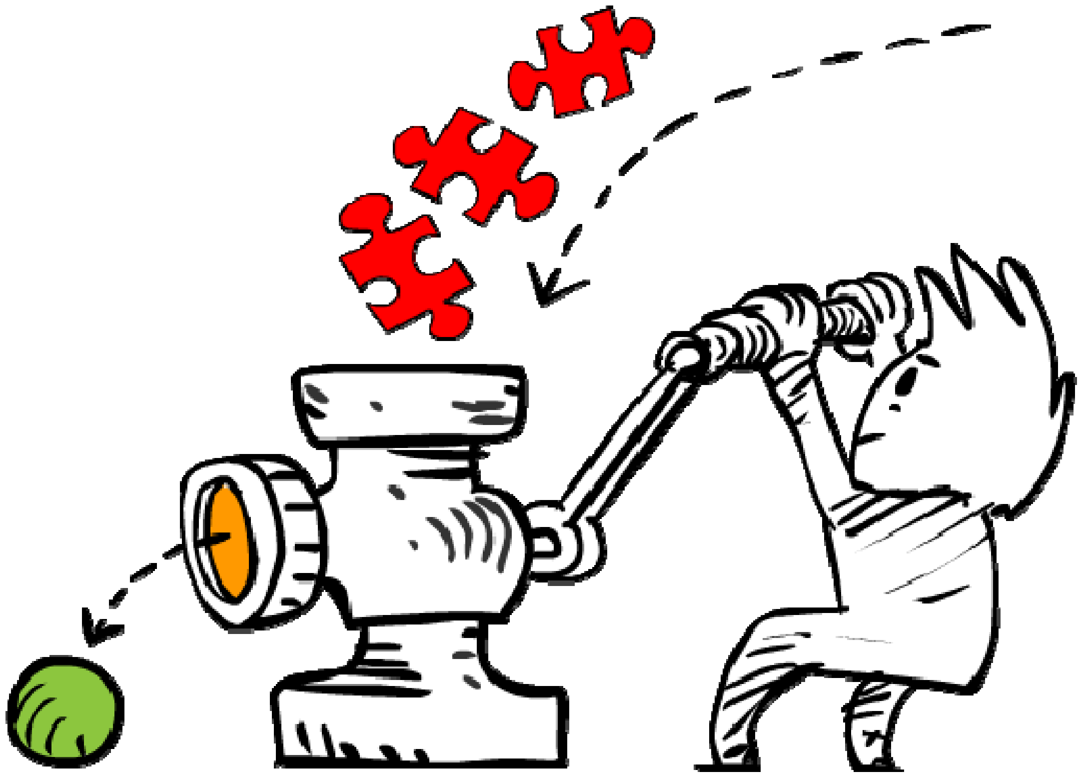
TETRIS

Teaching TRIZ at School

Guide on introducing TRIZ at school

Based on TETRIS project experience



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1 Introduction to the TETRIS project

L. Mercatelli, F. Tomasi, M. Masutti (AREA Science Park)

We live in a rapidly changing world.
The speed of changes and the appearance
of novelties are growing abruptly.
It is not easy to orientate oneself in this world.
Knowledge quickly gets out of date
and new knowledge appears.
The situation in the world and in the regions
of the countries around us is also changing,
as well as economic conditions.
Cultures are integrating.
Today, it is not enough, as it was previously,
to master one specialty, learn typical professional
solutions and use them all through one's life…

Nikolai Khomenko 2008
(TRIZ Master certified by G.S. Altshuller)

The TeTRIS Project has as its primary objective the dissemination of TRIZ principles, techniques and operating systems in the world of higher education institutions and of specialized training in companies.
TRIZ is a theory created to systematize processes and procedures related to innovation and creativity in the solution of problems.
TRIZ is a Russian acronym which can be expressed in English as 'Theory for the Solution of Inventive Problems' and consists of a theory, operating procedures and a range of tools created by Genrich Saulovich Altshuller (1926-1998) from 1946, with the objective of capturing the creative process in technical and technological contexts, codifying it and making it repeatable and applicable, in short a proper theory of invention.
The capability of inventing is usually deemed to be a natural quality and not a process which may be systematized with a scientific approach. Altshuller did not agree with the idea and started from the study of patented ideas to come up with the deduction of the general principles governing the evolution of technical systems underpinning the theory of invention he formulated.
TRIZ allows the analysis, the structuring of models and, finally, the solution of problems with a systematic approach based upon a series of subsequent stages and operating tools.
Up to this day, the TRIZ methodology has proved to be the most efficient to solve inventive problems and one which may be learnt and used without any need for an innate individual creativity. Supporting the validity of the methodology is the diffusion in companies both in small and medium enterprises, as well as in several giants at a worldwide level, among which it is worth citing 3M, BAE Systems, Boeing Corporation, Daimler Chrysler, Dow Chemical, Ford, GM, HP, Hitachi, IBM, Intel, Johnson & Johnson, LG Electronics, Motorola, Kodak, NASA, Nestlé, OTIS Elevators, Panasonic, Procter & Gamble, Samsung, Siemens, Toyota, UNISYS, Xerox, Whirlpool, Saipem and BTicino.

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1.1 The operating context

The so-called 'information society' we live in implies a very rapid obsolescence of knowledge and the subsequent necessity to develop in all sectors a high capability to manage atypical information and situations, diverging from traditional, customary schemes.

Those called to solve problems in an innovative way need, therefore, new, unusual, efficient tools and operating procedures to develop a new problem-solving methodology in a varied, wide range of sectors of application.

TRIS positions itself, in this context, as an efficient theoretical and operational platform for the development and improvement of capabilities and tools allowing to handle both typical and atypical situations, the validity of which is shown and supported by the large number of enterprises using such methodology, as described above, and investing significantly in training for their personnel.

Traditional TRIZ training requires at least 200 course-hours, following Altshuller's suggested parameters.

In the West, TRIZ training takes place mostly in 2- to 5-day seminars, in which only some of the concepts, principles and tools can be presented, yet results remain insufficient and limited, especially when it comes to supplying in-depth, trustable knowledge which may allow those working for a given company to bring their significant, efficient contribution.

Bringing forward the teaching of TRIZ in the secondary school may, therefore, be a unique opportunity for the dissemination of a systematic approach for the solution of problems at an age in which the specific individual problem-solving approach is moulded. Unlike the training carried out in a company context, the objective is not so much an immediate increase in problem-solving efficiency, as much as the understanding that the identification of innovative and creative solutions for technical problems is not an innate quality, but a skill which can be learnt and results can be achieved by applying an appropriate technique and through practice. The first step is getting past the psychological inertia which leads to accept the first available solution coming to mind, on the basis of past experience - i.e. compromise solutions - instead of trying to find new solutions closer to ideal ones.

1.2 The TeTRIS project: teaching TRIZ in an innovative way

Funded by the EU Commission's Leonardo da Vinci Lifelong Learning Programme, with a duration of 2 years and counting on the active cooperation of 12 European partners, TeTRIS focuses on the training needs of those professionally dealing with training for the improvement of individual problem-solving skills, with the objective of achieving better results through the introduction of the TRIZ methodology.

Experts and researchers part of the scientific committee have, therefore, created a whole range of materials and tools developed to be used in secondary schools and in companies, aiming at supporting and facilitating the learning of TRIZ and improving individual problem-solving capabilities.

TeTRIS counted upon the cooperation of prominent international partners from the worlds of research, universities and secondary education, treasuring the individual specific skills and experiences, integrating them and comparing them in a fruitful, satisfactory process of collaboration.

The involved organizations have participated, each on the basis of their own individual features, to the definition and development of the project, which started off with the description of the cognitive requirements, advantages and difficulties encountered in relation to TRIZ training.

Trainers and experts have then participated in a constructive comparison, sharing their own experiences in training at school, university or in companies.

On the basis of the obtained results and suggestions, the programmes were prepared for the introduction of TRIZ in schools and companies, acknowledging the specific needs and requirements so highlighted, not least the creation of appropriately structured training materials and training programmes for trainers and teachers.

1.3 The partners

The consortium created for the development of the TeTRIS Project involved a selected shortlist of international organizations listed to follow:

Lead partner and coordinator of the project:

AREA Science Park Consortium, Trieste (Italy)

Partners:

University of Florence (Italy)
Siemens AG (Germany)
EIFER - European Institute for Energy Research (Germany)
Jelgava Adult Education Centre (Latvia)
Harry Flosser Studio (Germany)
ISIS Malignani, Udine (Italy)
Istituto Tecnico HTL Wolfsberg (Austria)
Jelgava 1. Gymnasium (Latvia)
Fachhochschule Kärnten (Austria)
Stenum Gmbh (Austria)
ACC Austria Gmbh (Austria)

1.4 The objectives

TeTRIS has, first and foremost, the function of identifying the needs and requirements of the education system, especially of secondary schools with scientific and technical curricula, and more widely of training organizations, with the objective of improving the efficiency of training initiatives aiming at developing individual problem-solving skills, particularly through the introduction of TRIZ in schools and companies.

Specific attention is placed in highlighting similarities and peculiarities in training parameters and specific requirements, with the aim of individuating new opportunities of cooperation in training.

The development of training materials and the organization of specific courses are the following steps in the process of dissemination of TRIZ at a theoretical and practical level following the most significant suggestions, listed to follow:

- introduce appropriate techniques to avoid psychological inertia and resistance to new methodologies for the handling and solution of problems;
- eliminate the tendency to proceed empirically by trial and error attempts for the improvement of efficiency in innovation;
- supply a structured approach for the analysis of problem situations and for creativity applied in a technical context through the introduction of systematic processes to implement when facing problems and based on the fundamental principles of the ARIZ algorithm for the solution of inventive problems;
- introduce the fundamental principles of the evolution of technical systems and of the objective laws identified by TRIZ experts.

1.5 The tools: training materials and their validation

The training materials created for the TeTRIS project include a handbook, 5 animations illustrating in an immediate and efficient way the TRIZ methodology and a guide to introduce TRIZ at school, all of the above available in 5 European languages (French, English, Italian, German and Latvian) and freely downloadable on the project’s website, ‘www.tetris-

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project.org'.
Material can furthermore be made available for translation into other languages.
As concerns companies, several partner organizations (Siemens AG, ACC Austria Gmbh, Stenum Gmbh, Eifer) organized in-house training courses for the teaching of TRIZ in Austria and Germany in 2009, whereas in Italy AREA Science Park, the lead partner based in Trieste, organized in the month of May 2009 a course addressed to enterprises which was welcome with great interest and obtained significant success with participants.
As concerns the world of school institutions, instead, training materials were tested by the three schools partners of the project - ISIS Malignani in Udine, Higher Technical College Wolfsberg in Austria and the Jelgava 1.gymnasium in Latvia. Their three experiences, described in detail in the following paragraphs of this introduction, show how even in rather different contexts, TRIZ can be taught with good success to secondary school students.
A comparison of the experiences will certainly help every teacher intending to teach TRIZ fundamentals at school.
All participants in this testing phase, teachers, trainers and students have filled in standard questionnaires for the evaluation of the TeTRIS training materials they were supplied with. The analysis of such data and suggestions lead to revising the first version of the training materials and its publication on the TeTRIS website, www.tetris-project.org, where it is freely available for all users who will register (registration is free of charge).

1.6 Main features of materials and tools made available for training activities
The training approach was developed by experts from various sectors in such a way to satisfy the requirements of different contexts of use and final users in schools and in companies.
The training model was defined systematically, representing the constitutive elements and limitations to the integration of TRIZ in a training programme addressed to schools and companies. Such model, described in detail by A. Sokol in Section 2 of the present guide, considers parameters such as the type of institute, programmes in which TRIZ is to be implemented, type of expected integration, teacher's requirements, use of resources available online, cooperation with the industry, the role of the programme within the relevant regulations, financing, age of learners, etc.
Since training materials need to attract seconday school students, besides the handbook TRIZ tales were created, a series of multimedia animations making understanding TRIZ easier and more interesting.
The guide to use IUSES training materials written by G. Cascini in the third section of this guide is undoubtedly a further, precious help for the teacher or trainer for the teaching of TRIZ.

2 How to use TETRIS educational kit

Gaetano Cascini (University of Florence)

2.1 Starting point

This handbook is one of the outcomes of the TETRIS Project, an initiative within the European Lifelong Learning Programme aiming at:

- identifying the educational requirements of upper-secondary schools, universities and industries from different European countries interested in the introduction of TRIZ (Theory of Inventive Problem Solving) in their curricula/training programs;
- attracting secondary school students to the study of methods and tools enhancing their creativity and supporting their problem solving skills with systematic means;
- defining an educational model suitable for addressing the heterogeneous demands of TRIZ education;
- producing and validating educational materials adaptable to heterogeneous specific situations , that can be used in a wide variety of different contexts.

The structure of the handbook has been conceived to guarantee the maximum adaptability to the heterogeneous requirements of TRIZ learners: a selected portion of the classical TRIZ Body of Knowledge has been divided into independent items, to be assembled according to specific needs and contexts of teachers, students, newcomers, practitioners.

Therefore, different readers might opt for selecting different subsets of chapters and paragraphs as described below.

The whole volume is divided into 5 main chapters related to the following topics:

- Introduction(s)
- Laws of Engineering Systems Evolution
- Algorithm of Inventive Problem Solving
- Su-Field Analysis and System of Inventive Standards
- Tools and Principles for solving contradictions

Moreover the handbook is accompanied by an appendix with a set of exemplary inventive problems with solutions and 5 animations.

2.2 Structure of the chapters

Each chapter is related to a specific topic as detailed below; moreover, the chapters are divided into paragraphs dealing with more detailed subtopics. For example, readers interested in a general overview of the TRIZ Body of Knowledge can limit their reading to the first sections of each chapter, highlighted by means of a red bar on the side of the page. Besides, those who want to go deeper into a specific topic can study the related chapter, discarding the rest of the handbook.

Whatever is the level of detail of a topic, the related paragraph is divided into the following subsections:

- Definition: short definition of the selected Topic (hereafter referred as “T”);
- Theory: theoretical aspects related to T;
- Model: conceptual model and graphical representation of T;
- Method/Tool: operative instructions about how to use/implement T;
- Example: exemplary application of T;
- Self-Assessment: exercises to assess the reader’s level of understanding about T;
- References: further reading about T.

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2.3 Topics of the handbook chapters and related scope

Chapter 1: Introduction(s)

- The first paragraph introduces teachers and adult readers to TRIZ, explaining its rationale and expected benefits;
- The second paragraph is an introduction for students that is aimed at motivating younger readers into TRIZ study;
- The third paragraph introduces some reference concepts supporting the comprehension that can be helpful in understanding the following chapters.

Chapter 2: Laws of Engineering Systems Evolution

- The observation of the history of technical systems has demonstrated that any human artifact evolves by following repeatable patterns, despite the specific goal of such transformations. In other terms: Technical Systems evolve according to objective laws which are not dependent on the field of application or the function that the technical system is supposed to deliver. These laws govern the development of technical systems just like natural laws regulate the development of biological systems. The knowledge of genetics allows to predict the characteristics of a living organism; just like the Laws of Engineering Systems Evolution allow to anticipate future developments of technical systems.
- The second Chapter describes the 8 general Laws of Engineering Systems Evolution which can be used to analyse the level of maturity of a certain technical system and/or to guide the development of inventive solutions with an efficiently focused approach.

Chapter 3: Algorithm of Inventive Problem Solving

- System evolution implies the resolution of contradictions, i.e., conflicts between a system and its environment or between the constituting elements of the system itself. According to TRIZ research, the inventive solutions bringing a major contribution to the development of a technical system don’t compromise opposite requirements. Overcoming contradictions is thus a driving force behind technology evolution and their identification is the first step of any invention process.
- The third Chapter introduces the readers to the TRIZ approach for analysing and reformulating a problem in the form of conflicting pairs of parameters (in TRIZ terms, contradictions); the step-by-step algorithm embeds the TRIZ logic and its practice progressively increases individual’s problem-solving skills.

Chapter 4: Su-Field Analysis and System of Inventive Standards

- The Inventive Standard Solutions (sometimes briefly named Standards) are a system of 76 models of synthesis and transformations of technical systems in agreement with the Laws of Evolution of Engineering Systems. Together with the database of Scientific Effects and the Inventive Principles, they constitute the Classical TRIZ Knowledge Base.
- The fourth Chapter details the Substance-Field modelling approach, which is the standard TRIZ tool for modelling problematic situations; then, a selection of Inventive Standard Solutions is presented with the aim of constituting a reference list of solving techniques.

Chapter 5: Tools and Principles for solving contradictions

- Any inventive problem should be analysed according to the ARIZ logic and once that the underlying physical contradictions have been identified, and the ideal solution has been depicted, a new concept can be generated by means of the separation principles.
- The fifth Chapter describes the TRIZ principles providing the directions to overcome the contradictions of a problem modeled according to the ARIZ logic.

Appendix: Collection of examples

- The appendix contains a set of exemplary “inventive” problems with a detailed step-by-step description of the solving process until the generation of a possible solution.

2.4 Content of the animations

The TETRIS educational material also includes a set of five animations which can be used both for attracting to the study of TRIZ and to support the explanation of the main models of TRIZ (teachers can stop the animations on the appropriate frame to describe with further details the concepts behind the short stories). The content of the animations is briefly summarized below:

Animation 1: History of TRIZ

- The short story shows the origin of TRIZ as a theory developed through an extensive experimental activity (fig. 1), just like other well established sciences.
- The animation also introduces the existence of Laws describing the evolution of Engineering Systems.

Fig. 1: Animation 1 – History of TRIZ

Animations 2-4: Nina at school/university/work

- The stories represent Nina at different ages; the main goal of the stories is to show how a systematic approach to problem solving can support the generation of effective solutions in any situation, in private life as well as at school/work. All the three problems proposed in these animations are approached by means of the same inventive principles in order to show that the same model of solution can be efficiently applied to a variety of problematic situations.
- These animations also constitute a practical support to help teachers in the introduction of some TRIZ fundamentals, as detailed below.
- Animation 2 presents the concept of contradiction (fig. 2) and the importance of rejecting any compromise solution by formulating the Most Desirable Result.
- Animation 2 also introduces the Tongs model (fig. 3): to identify the underlying contradictions it is necessary to compare the most desirable result with the currently available resources. TRIZ teaches that the identification of contradictions is a crucial step to generate inventive solutions.

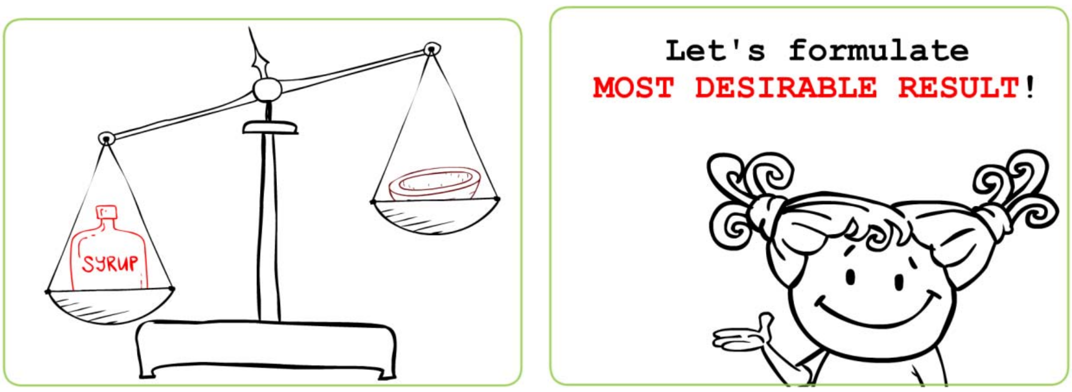

Fig. 2: Animation 2 – The concept of contradiction and the formulation of the Most Desirable Result

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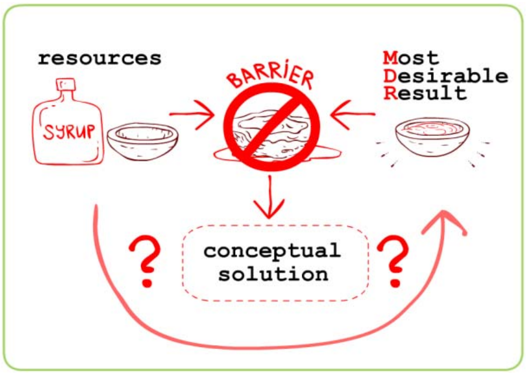

*Fig. 3: Animation 2 – The Tongs model: a comparison between the current situation and the Most Desirable Result allows to identify the obstacle in the form of contradictions***.**

- Animation 3 adds further details to the concepts introduced in the first episode about Nina: in order to avoid the psychological inertia it is suggested to intensify the contradictions. As a consequence, radical modifications can be made as a result of adopting different perspectives (fig. 4).

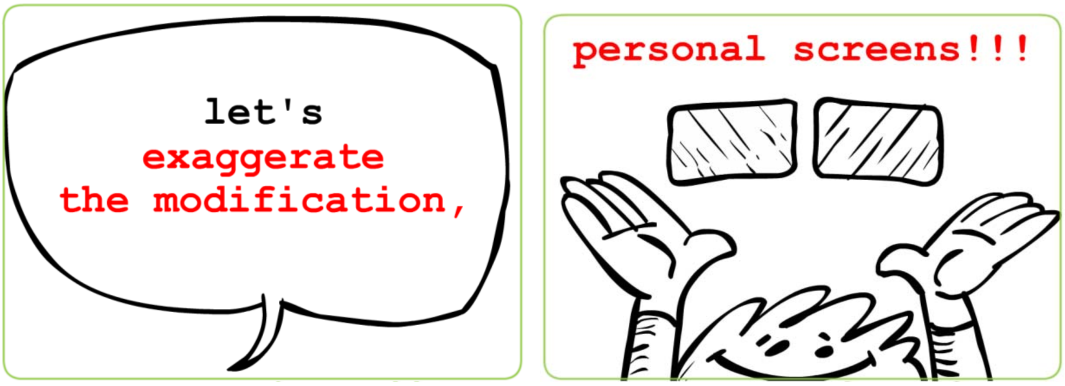

Fig. 4: Animation 3 – Exaggeration of contradictions helps overcoming psychological inertia.

- Animation 4 highlights another extremely important feature of the formulation of the Most Desirable Result: ideality suggests formulating the concept of an object of a function self-delivering the function itself, as a means to reduce the consumption of resources and to avoid harmful effects (fig. 5).
- Animation 4 provides also an extended list of products that can be associated with the Inventive Principle adopted by Nina to solve the problems described in these short stories.

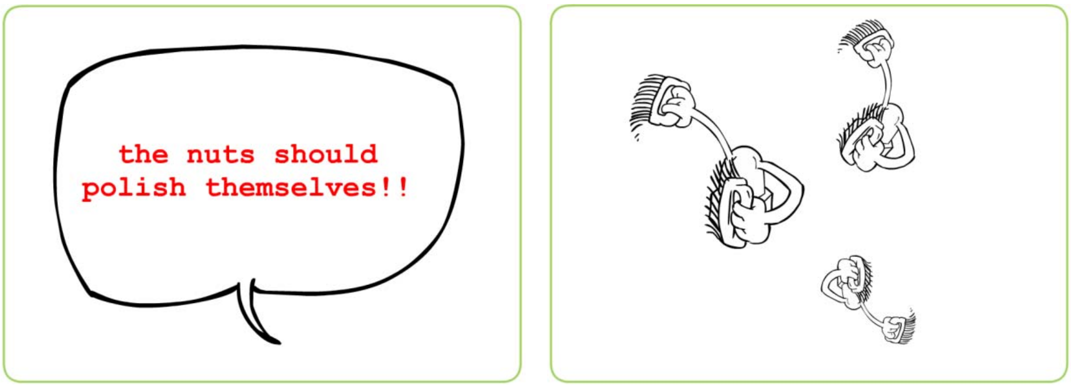

Fig. 5: Animation 4 – Ideality helps overcoming the psychological inertia and draws the attention to the cheapest and most efective solution.

Animations 5: Theory of Inventive Problem Solving

- The last animation summarises the concepts introduced in the previous ones and introduces some further elements of the TRIZ Body of Knowledge.
- The first part continues the analogy between TRIZ and other sciences proposed in the first animation; just like genetics allows to predict the evolution of a living organism, TRIZ helps anticipate the evolution of technical systems (fig. 6).
- The animation can also support teachers when introducing the System Operator (fig. 7) as well as Su-Field Modeling and Inventive Standards (fig. 8).

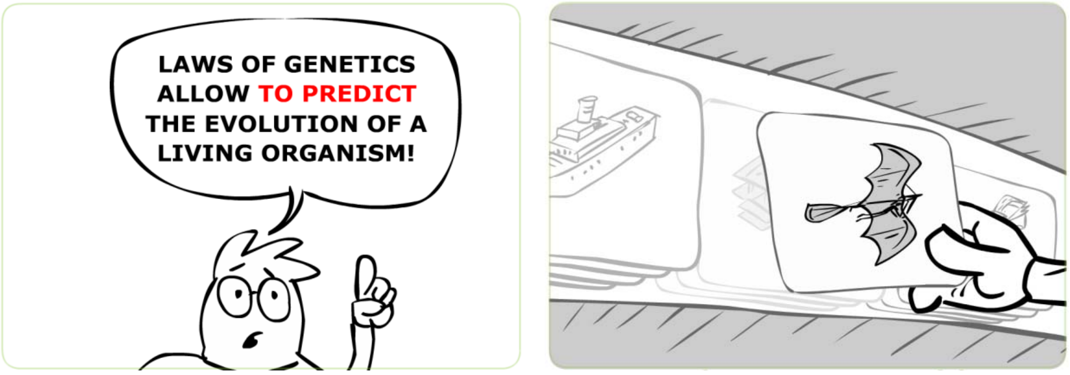

Fig. 6: Animation 5 – Ideality helps overcoming the psychological inertia and draws the attention to the cheapest and most efective solution.

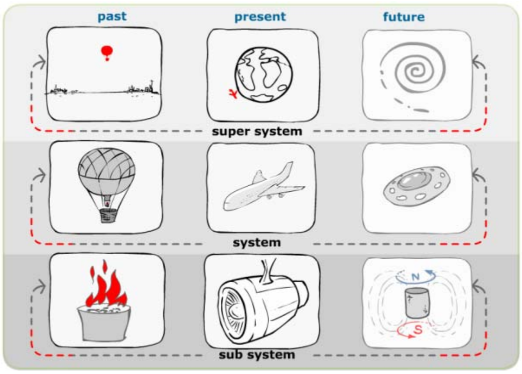

Fig. 7: Animation 5 – System operator: the TRIZ approach to system thinking.

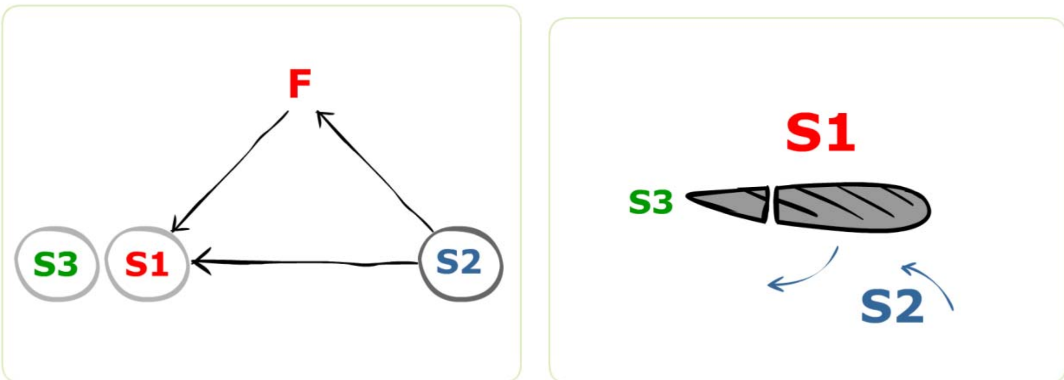

Fig. 8: Animation 5 – Su-Field modeling and Inventive Standard Solutions.

2.5 Future of TETRIS Project

The TETRIS project is the first attempt to create a unified multi-language training material to be used by teachers, students, trainers, professionals and interested readers as an alternative to multiple fragmented TRIZ education materials today available.

It is worth noting that all these materials can be freely copied and distributed provided the copyright notice remains intact. This also applies to the partial use of the handbook.

The TETRIS project team has not aimed at the development of a comprehensive set of materials to cover the whole Classical TRIZ Body of Knowledge, thus the TETRIS materials can be supplemented and improved. Those who would like to contribute to the translations into other languages, as well as to the improvement or integration of the present materials are invited to contact the project coordinator.

3 TETRIS Project. Description of the Educational Model

I. Murashkovska, A.Sokol (Jelgava Adult Education centre)

3.1 Introduction

One of the postulates of TRIZ says that "the peculiarities of a given situation should be taken into account in the course of the problem solving process" (Khomenko & Ashtiani 2007). In the context of introducing TRIZ in school, it means that there cannot be one approach that will be appropriate for all possible situations. In this Guide, we will present general problems underlying introduction of such a subject as TRIZ, describe the educational model adopted in the TETRIS project, and highlight some important decisions to be made by anyone interested in introducing TRIZ in the school context.

3.2 Rationale for Bringing TRIZ to Schools

In the 1960s the concept 'knowledge society' appeared in Europe as a response to the inability of traditional educational systems to meet the demands of the contemporary society.

The modern understanding of 'knowledge society' was presented by T. Koke as a system of people's social relationships ensuring high level of innovations in which every personality is able to achieve a high degree of participation getting, using and developing new knowledge independently.

Longworth [1] defines the basic skills necessary in the knowledge society: the ability to manage oneself, the ability to work with information and interpret it, the application of new knowledge to practice, studying skills, the ability to communicate sensibly and critically, management and communication skills, thinking abilities and creativity, the ability to adapt, the ability to work in team and life long learning.

Since the existing system of education, with the actual programmes and curricula, does not fully fulfil the task of preparing the students to the life in the knowledge society (Lipman 2003; Wiske 1998), it is necessary to modify these programmes of education according to the skills mentioned above.

TRIZ experts will recognize many skills highlighted by Longworth as those enhanced by the TRIZ way of thinking and supported by the TRIZ instruments. A more detailed definition of the skills developed by people practicing TRIZ on a regular basis is published in [2].

Therefore the introduction of TRIZ to the curriculum can be this possible change of the educational system aimed at fulfilling the new requirements of the knowledge society. The introduction can be achieved in two ways – TRIZ as a separate subject or as content integrated in other subjects.

3.3 TRIZ in school

The traditional way of planning educational content can be described as follows (figure 1):

- A school develops an experimental educational programme and defines the list of necessary list of subject
- The state accepts the subject standards
- Teachers develop subject programmes which include the list of necessary teaching materials. This means that the teacher chooses from the existing sources: course books, literature sources, Internet resources, etc., those which are most suitable to achieve the aim stated in the programme while working with the target audience.

Certainly there are cases when there are no course books and the teacher has to develop the teaching materials for the students independently. He/she does it according to the subject programme on the one hand, and on the basis of subject scientific literature on the other hand.

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The schools belonging to the TETRIS consortium, as well as any other similar educational institution planning to teach TRIZ to their students, it the beginning have neither TRIZ skills, nor teaching materials. Therefore the educational materials must be customized to the specific situation. The main difference in comparison with the introduction of more classical subjects is that there are neither programmes nor standards available for TRIZ as a subject.

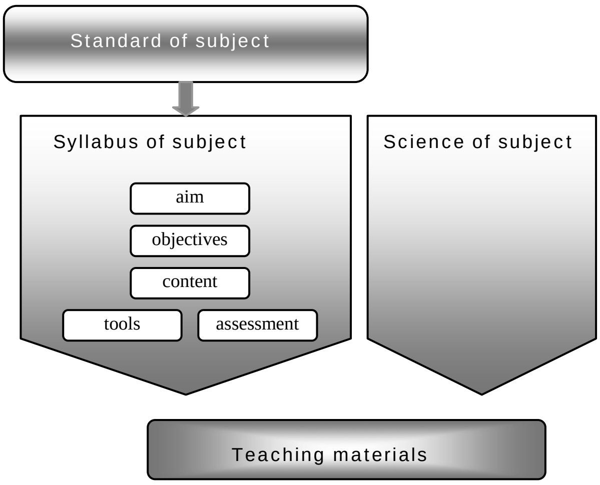

Figure 1: Traditional way of education content planning.

In fact, the programme must be defined in agreement with the system of requirements to be satisfied during the teaching/learning process. Several factors must be taken into consideration while developing the educational programme:

Student factors:

- Human and national values
- Educational needs
- Motivation
- Personal qualities
- Age peculiarities
- Cognitive factors: cognitive skills, creative skills
- Affective factors: sympathy and emotions, their character and strength
- learning style
- Quantity and quality of the knowledge possessed
- Work and problem solving experience
- Ability to learn
- Ability to cooperate

Teacher factors:

- Human and pedagogical values
- Attitude towards professional activities
- Personal qualities
- Personal culture
- Education
- Experience
- Pedagogical believes and preferences
- Professional knowledge
- Attitude towards students and the style of socializing
- Creativity

School factors:
The aim of activities and the development strategy
Educational programmes
Atmosphere and microclimate
Corporate culture
Pedagogical traditions
Teaching environment
Resources: material, human, time

Country factors:
National values
Social, economic and political development
Education policy
Education system
Education standards

The synthesis of all the above-mentioned factors allows to discern which information is understandable/not-understandable, interesting/ uninteresting for the students, if they can learn independently, what tasks are more suitable to their interests and abilities, on the grounds of what pedagogical approaches the learning is going to be more successful, etc. Thus, it becomes possible to develop the materials which will be more suitable for effective application to teaching TRIZ in a specific school or company. It also means that teaching materials for every project participant have to be different and about at least 5-6 sets of teaching materials should be developed just in the framework of the TETRIS project. However, time and budget resources do not allow for such an extensive approach. Only one set of materials can be developed.
The task clearly shows the conflicting requirements: to develop materials that are suitable for different target audiences and in different situations using only the limited resources available in the project. The contradiction – there must be many sets, there must be one set of teaching materials – was solved by separation between macro and micro level: there is one set of teaching material, but it consists of clearly stated structural elements, which can be tailored to different needs.
This solution also coincides with modern tendencies in education where the importance of context for syllabus design and the active role assigned to both the teacher and the learner are widely emphasized.
There is one more requirement the project participants have come across. The newly developed materials were to be used by teachers who have never taught TRIZ before. Thus available resources, i.e. the teacher's knowledge and expertise, had to be used to the maximum extent: the train-the-trainers courses delivered to the school teachers before the introduction of TRIZ into the classrooms, were organised in order to allow the teachers to recognise he examples of TRIZ fundamentals like contradictions, standard solutions, etc. within their own subjects. As a result, the teachers felt more comfortable with "new" subjects and a bigger set of examples was available for the students to understand TRIZ concepts. Eventually, the applicability of TRIZ instruments in different contexts and disciplines appeared more evident.

3.4 Questions to be answered

In this section we would like to propose a list of initial questions to be answered by
the colleagues who would like to introduce TRIZ in their context. On the basis of our experience of teaching TRIZ in three European countries, we would like to draw the attention to those issues we have come across. To show the spectrum of answers, we will also suggest two possible directions for thinking according to each question (marked a and b below). These di-

rections should not be taken literally; they are just possible vectors one should be aware of.

What is the aim of the TRIZ course to be introduced?

- inform students about an approach to problem solving
- change students' approach to problem solving

How will TRIZ be introduced?

- as a separate subject
- as content to be integrated in other subjects

How will the classes be organised?

- lectures followed by tasks where learners are assessed
- problem solving sessions with ongoing assessment

What will be the source of problems used during the course?

- specially developed classroom examples
- real life problems

How will the teacher be trained?

- a short train-the-trainers course to be followed by actual teaching
- an ongoing learning by regular communication with TRIZ experts

What is a long-term aim for the institution when introducing a TRIZ course?

- to meet the new demand for subjects dealing with innovation
- re-organise the school's curriculum according to the changing requirements of the modern world

Although the choice of a particular school will always depend on the peculiarities of a particular situation, we would like to stress that it is ultimately the choice b that leads to more profound changes in the education system that might eventually meet the requirements of the modern world.

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4 Piloting TETRIS Materials in the 1st Gymnasium of Jelgava, Latvia

V. Maido (Jelgava 1.Gymnasium), I. Murashkovska, A.Sokol (Jelgava Adult Education centre)

4.1 About the school

Jegava 1st Gymnasium is a general education school that provides students with secondary education required at the tertiary level. The curriculum does not include any professional programmes. When joining the project, the main motivation for the gymnasium was twofold. First of all, it was interested in finding the ways of developing powerful thinking skills of students that are necessary in any field of activity. In addition to this, the aim was to connect the process of education with real life by enlarging the students' idea about industrial processes and events.

4.2 Organisation of classes

For piloting TETRIS materials, two groups of learners were organised. Each group consisted of 15 students and comprised the learners from forms 10 and 11 (17-18 year olds). Each group had classes once a fortnight during the period of four months (from February to May 2009). As it was impossible to include the classes into the official curriculum, they were optional for learners as a part of the so-called interest education.

The TRIZ teacher attended a TETRIS course for teachers delivered before the beginning of the course in school. The actual course syllabus was developed given the total number of hours available, general knowledge of students and the level of TRIZ competence of the teacher. Introduction into TRIZ and methods of problem solving, contradictions and general methods of their resolution and laws of technical systems evolution were the main topics included in the programme. The learning processes consisted of the teachers' lectures followed by practical sessions dedicated to problems solving, during which the students worked either in pair or in groups.

4.3 Results of the lessons

In order to provide a more comprehensive picture, the results are described from the vantage point of the three groups: the students, the teacher and the administration.

The students' point of view

Practically all the students pointed out that the TRIZ animations were very convincing and they thoroughly enjoyed them. As a result of the classes, it became clear how thinking works and, most importantly, how it can be improved for reaching important personal aims. At the same time, it was pointed out that general knowledge was at times insufficient for understanding TRIZ materials and solving problems.

The teacher's point of view

Unfortunately, students are not used to dealing with general tools for thinking. Instead they tend to divide the tools and connect them with specific subjects, i.e. tools useful in physics, tools useful in biology, tools useful in chemistry, etc. This means that there is a need for applying TRIZ for solving the problem of integrating the content of education and developing a systemic picture of the world. The multi-screen model of powerful thinking and laws of system evolution appear to be the most suitable tools for this purposes.
Another difficulty faced by many students was connected with the necessity to specify the problem situation by thinking step-by-step in a certain way. Students' immediate response is an attempt at solving a problem at once. The Yes-No Technology can be successfully used for copying with this difficulty.
Students' motivation is rising when they are dealing specific problems. General approaches of OTSM-TRIZ, as well as methods of resolving contradictions, were used for this purpose.

The administration's point of view

The age group of students is well-chosen as their knowledge is enough for independent problem solving. The problem exists as students often cannot use this knowledge for modelling and transformation of problem situations. Unfortunately, powerful thinking skills often lack as well. This leads to the conclusion that is necessary to work on these skills at an earlier age – during the middle school.
Interest education has certain advantages – this kind of classes can be organised without introducing any changes to the curriculum in general or the syllabus of specific subjects. However, students see these lessons as an additional load. Moreover, their pragmatic motivation for obtaining an official assessment for a course in a record book is not satisfied. At present, alternative forms for organising classes are being considered.

4.4 Impact

As a result of the project, students' vision of the problem solving process has changed. They have become aware of the importance of the theory and the necessity of using it. Many students have developed an interest in approaching problems with the help of TRIZ and believe that it will help them during further studies at the tertiary level.
The project led to another important outcome – development of a new professional study programme in the gymnasium. This programme is for advanced engineering studies and it is supported by the municipality of Jelgava, Latvian metal processing association and the Agricultural University of Latvia.
The programme has been licensed by the Ministry of Education and Science of Latvia. In September 2009, 25 students were accepted and began their study.
The programme includes TRIZ lessons which are delivered with support from the Jelgava Adult Education Centre. Familiarisation with the industrial process and the use of new tech-

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nologies at the local factories is also envisaged.

4.5 Conclusion

The gymnasium is thankful to the project for the new and useful experience, collaboration possibilities with interesting partners and a large variety of study materials that have been developed. The project has proved that it is possible and necessary to teach TRIZ in school and it is the intention of the school to continue doing it. Further possibilities for exchanging experience with partners from other countries involved in teaching TRIZ would be an advantage.

5 Introducing TRIZ at HTL Wolfsberg

DI Robert Tiefenbacher, Dir. DI Dr. Johann Persoglia

5.1 HTL-Wolfsberg "School Type "

The „HTL-Wolfsberg" is a higher technical college offering technical and vocational education and training (TVE).

Our advanced-level secondary vocational school (berufsbildende höhere Schule or BHS) starts after the eighth year of schooling;

After five years of education and a successful school-leaving exam, the pupils get a Certificate of Secondary Education and TVE-Diploma (called Reifeprüfung-Certificate or Matura.

After leaving HTL approximately 60 % start working and 40 % go to university

Typical jobs after leaving school are draughtsman, constructing engineer, programmer, software engineer, etc.

Currently there are 54 teachers and 480 students at school

5.2 Educational Focus

There are two major departments at our school and offers 5 year courses as well as an evening course.

- Higher technical college for mechanical engineering
- Higher technical college for business engineering

Higher Technical College of Mechanical Engineering

Head of Department: Dipl.-Ing. Dr. Helmut HEBENSTREIT

Automation technology

- Development of special devices

Mechatronics & Artificial technology

- Development of plastic components with Electronic components

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Higher Technical College of Business Engineering

Head of Department: Mag. Dr. Johann MILLONIG

Industrial Engineering

- Lower cost manufacturing and business Analyses and calculations

Information Technology

- Information procurement, introduction, software and IT systems support


Now have a look into the HTL Curriculum. You can see at this table that TRIZ teaching has been integrated into 2 subjects:

- CAD construction practice and in our
- final project work.

I. Table of subjects / year of education	I.	II.	III.	IV.	V.	
1. Religious education	2	2	2	2	2	10
2. German...	2	2	2	2	2	10
3. English..	2	2	2	2	2	10
4. History.........	2	2				4
5. Sports	2	2	2	1	1	8
6. Geography.......	2	2	-	-	-	4
7. Economy				2	3	5
8. Mathematics.....................	4	3	4	3		14
9. Geometry	2	1	-	-	-	3
10. Physics	3	2	-	-	-	5
11. Chemistry...	2	2	-	-	-	4
12. Informatics		2	2	-	-	4
13. Mechanics	2	2	2	2	2	10
14. Manufacturing technique..................	2	2	-	-	-	4
15. Elements of Machines........................	2	2	-	-		4
16. Electronics...............		2	2	1	-	5
17. Design / Construction practice	3	2	3	3	4	15
18.Laboratoy..	-	-	-	3	3	6
19.Workshop practice................................	8	8	-	-	-	16
School-autonomous focus	-	-	15	15	14	44
Units per week	36	38	38	38	35	**185**

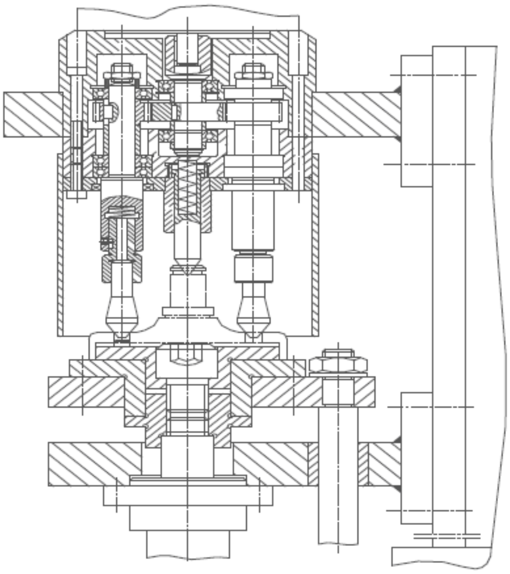
Final years project............. .... ~ 200 – 400h (partly done out of school)

5.3 Integration of TRIZ in the "CAD construction practice

Within this 3-4 hours weekly per school year students have to perform two technical projects in this exercise subject.

In detail students have to do:

- Design/construction work
- Practical technical problems, which appeared during the "CAD construction practise" were tried to be solved by **TRIZ**
- Technical calculations
- Documentation

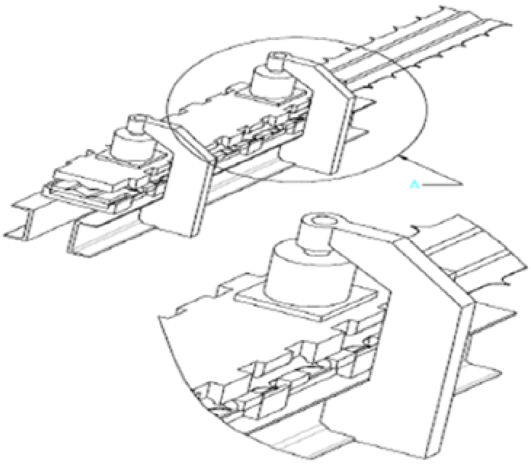


5.4 Integration of TRIZ in the "Final Year Project"

Within this final years project, which is normally done in cooperation with the local industry, students have to perform an extensive technical project.

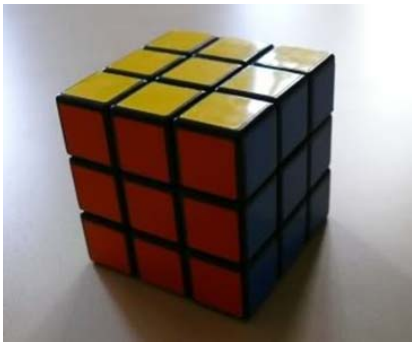
In detail students have to do:

- Design/construction work
- New innovate applications of technical problems were tried to be solved by **TRIZ**
- Technical calculations
- Documentation



5.5 Possible motivation for students in studying TRIZ

- Find good solutions for technical problems for their final projects
- Hope that TRIZ – knowledge will help to get a job….
- Be impressed by TRIZ – examples
- Be impressed by companies' names who use TRIZ (BMW, SIEMENS…)
- Being interested in technical fields, respectively have technical hobbies
- (..invent a better skateboard …)



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5.7 Performed TRIZ beginners' courses for students

We started teaching TRIZ for students at March 2009 in the

- 4th class of business engineering and
- 4th grade students of automation engineering

5.7.1 For 4th grade students of business engineering

Period of course: March – June 2009
Location: HTL Wolfsberg
Lecturers: DI Hans Peter Cervenka and Dr. Johann Persoglia
Teaching subjects: Project Management, Industrial Engineering, Cost Accounting, Marketing
Duration: 13 hours in total
Participants: 13 students

Course-topics in detail:

- General presentation of TRIZ – techniques and methods

5.7.2 For 4th grade students of automation engineering

Period of course: March – June 2009
Lecturer: DI. Robert Tiefenbacher
Teaching subjects: Construction Practice, Mechanics, Industrial Manufacturing
Duration: 18-24 hours
Participants : 21 students of regular course,14 evening school students with a former vocational background

Course-topics in detail:

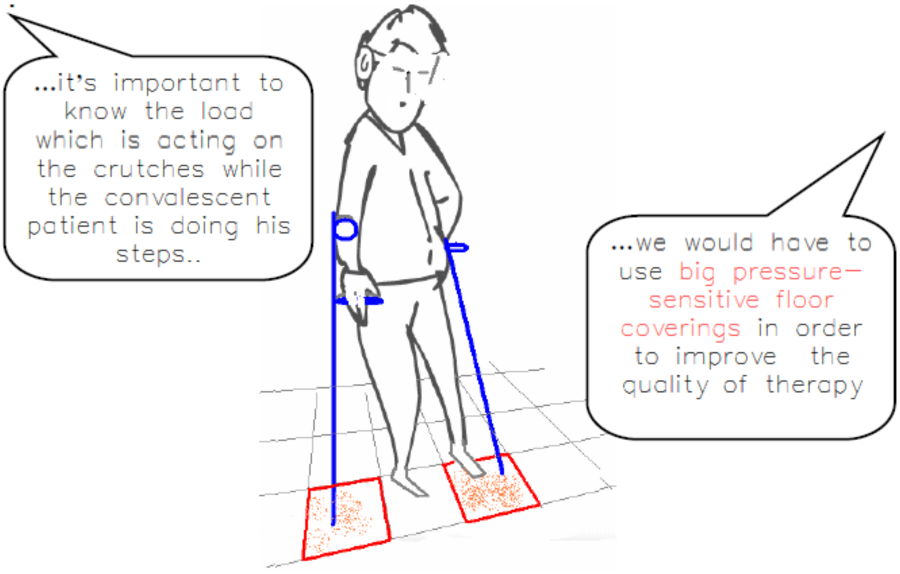
- General presentation of TRIZ – techniques and methods
- Discussion about purpose and contents of TRIZ
- Altshullers biography and the development from TRIZ to ARIZ ….
- function analysis
- contradiction matrix
- Ideality
-

5.8 Example: Implementing TRIZ in a final year's project

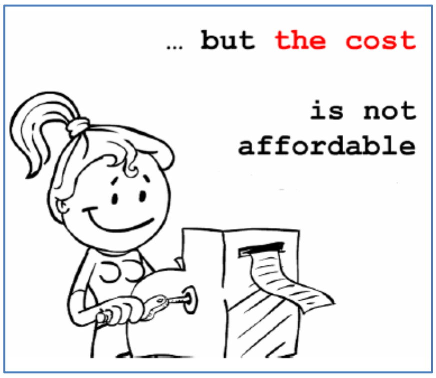
Now let's introduce a TRIZ Application from one of our final exam engineering project.
One student of the automation department will improve a common procedure in the field of medical rehabilitation.
In that case a pressure sensitive floor covering, is helping physical therapists to leg injured people to be able to walk again.
This floor covering provides the therapist with data about the loads acting on the crutches.

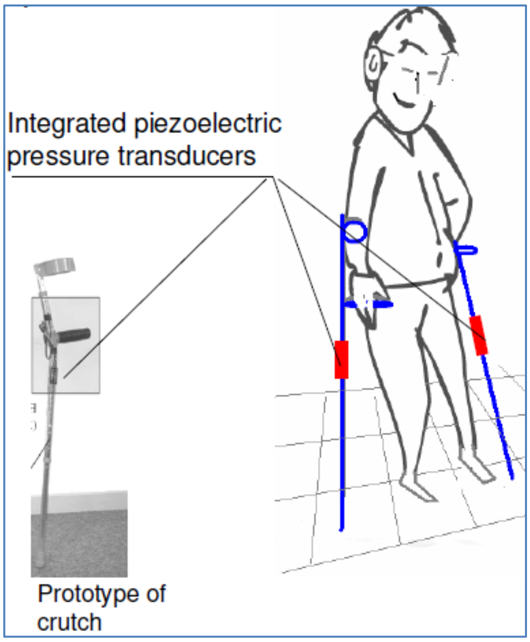
let's transfer the problem into TRIZ world……

You have to know that the patient needs a pressure- sensitive floor covering in order to improve the quality of the therapy.



But the costs for a pressure- sensitive floor are unacceptable high.





So invert the action used to solve the problem.

Final remarks

We feel confident that with the inventive power of TRIZ our students will be able to execute various innovative future projects.

The Tetris materials, like: manual, animations, cd, homepage, etc. created from the project leading team, is on the one hand a strong support for our teachers and students and on the other hand these materials will remind us of the good working atmosphere and good cooperation in the TETRIS project.

6 ITI “A:Malignani”- TETRIS* experience

Written by Rodolfo Malacrea on behalf of the Headmaster Arturo Campanella and ITI “A.Malignani” teachers involved in implementing TETRIS.

6.1 The school

Istituto Tecnico Industriale “Arturo Malignani” – Udine - represents one of the biggest Italian technical high schools as regard to the number of students.
The school has had and still has an important role in the development of industrialisation in Friuli, which is a north eastern region of Italy near the Austrian and Slovenian borders. Since the late 30's this school has qualified more than 25,000 students and a relevant number of them has given a big contribution to the transformation of Friuli from a mainly agricultural region to an industrialised one. The school has always had good relationships to the industries of the Region Friuli Venezia Giulia and a lot of the local industry managers have been trained in the school.
The school is constantly in contact with the industrial territory and the biggest firms like Zanussi, Danieli, Pittini, Wartsila, FinCantieri etc…but the industrialisation in the area is by far due to a great number of little and medium size industries which are all involved in the improvement of TQM and in the challenge of innovation.
In recent years the Institute created joint activities for applied research too that have been developed by all the specialized branches**:** Aeronautical Engineering, Building Engineering, Mechanical Engineering, Electrical Engineering and Automation, Electronics and Telecommunications
The Technical High School: the studies last five years. During the first two years students attend to a common study plan, then in the last three years each student follows one of the specialized curricula.
At the end of the five years of the national curricula Malignani the Institute offers Post Diploma courses and Higher Technical Education courses (IFTS) in the frame of a wide partnership with international industries located in Friuli Venezia Giulia region where students are engaged in training stages to apply their knowledge and to grow professionally. Because of his strategic role in the present and the past “Malignani” Institute has always been interested in finding new ways for promoting the development of powerful thinking skills and encouraging to be creative in a context of concreteness.

6.2 The teachers

The teacher have been trained by train-the-trainers courses followed by actual teaching in parallel with an ongoing learning by communication with TRIZ experts
The project has been initially presented by Fabio Tomasi (AREA Science Park) at the kick-off

** TEaching TRIz at School*
1 TRIZ (pronounced /□tri□z/) is a romanized acronym for Russian: Теория решения изобретательских задач (Teoriya Resheniya Izobretatelskikh Zadatch) meaning "The theory of solving inventor's problems" or "The theory of inventor's problem solving". It was developed by a Soviet engineer and researcher Genrich Saulovich Altshuller (1926-1998) and his colleagues starting in 1946. It has been evolving ever since.
Today, TRIZ is a methodology, a tool set and a model-based technology for generating innovative ideas and solutions for problem solving. TRIZ provides tools and methods for use in problem formulation, system analysis, failure analysis, and patterns of system evolution (both 'as-is' and 'could be'). TRIZ, in contrast to techniques such as brainstorming (which is based on random idea generation), aims to create an algorithmic (euristic) approach to the invention of new systems, and the refinement of old systems.
Some TRIZ is in the public domain. Some TRIZ resides in knowledge bases held by commercial consulting organizations. A complete and open TRIZ development process is not yet evident. Various camps work for control of TRIZ and interpretation of its findings and applications.

meeting and then a selected group of teachers has attended to the courses organized inside our school. After the opening session and the lesson held by Francesco Saverio Frillici and Gaetano Cascini (University of Florence) has runned the core training course divided in two consecutive periods.

6.3 The students

After the presentation of this specific approach to problem solving and with the awareness that dealing with specific problems is the best way to get an higher level of motivation and attention we decided to consider TRIZ as a content to be integrated in other subjects and to be implemented during the school activity called “Project area”. Project area consists in few days of the school year when the regular lessons are interrupted to give the opportunity for developing a real project.

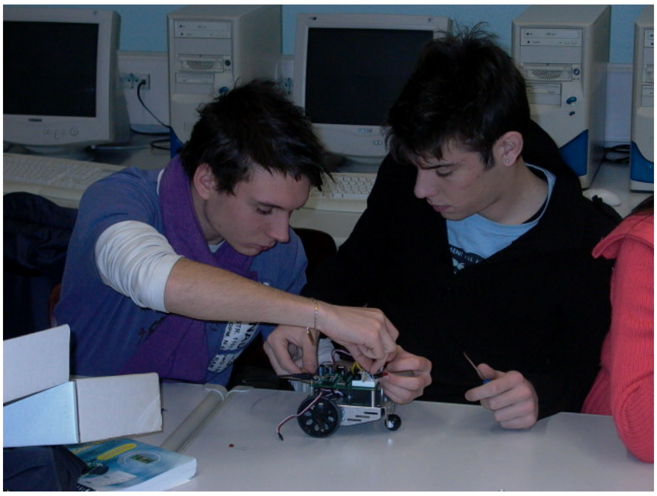
The classes were structured in order to organize problem solving sessions with ongoing assessment followed by tasks to be developed in groups. We have identified the robotics lab as the proper place to experiment problem solving and systematic innovation methodology

The problems to deal with were strictly connected to real problems regarding the sector of robotics. The small robot and microcontroller used for experimenting is supplied by the same industry that is engaged in the production of the space robots.

We have selected two classes in the Electrical area:

- 3 ELT A composed of 21 students (some of them are in the pictures)
- 5 ELI B composed of 22 students

Both classes were engaged in experimenting TRIZ mainly during the “project area” time.



6.4 Target group

3 ELT A

21 students participants to the training course

They were students about 16 years old, without any experience in project design.

The participation was compulsory, but the aims were explained in advance in order to get an agreement

The students were engaged, at an **initial level**, in the robotics activity that implies a good level of creativity.

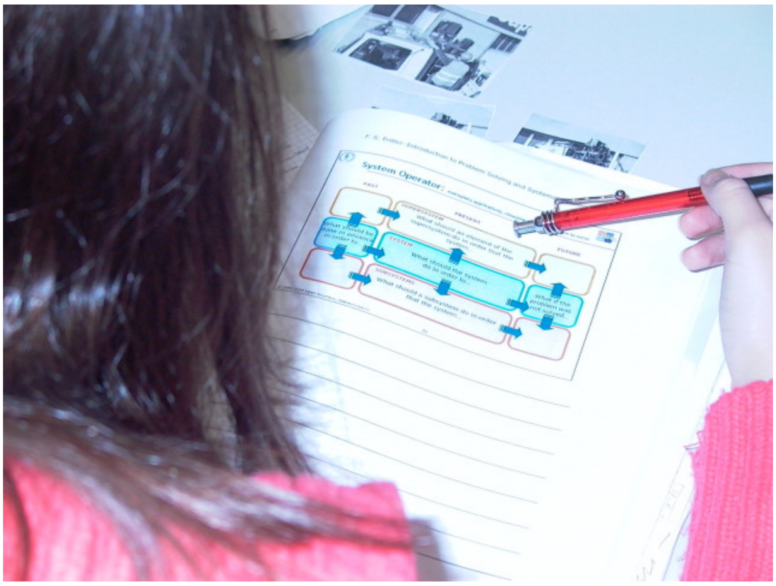
5 ELI B

22 students participants to the training course

They were students about 18 years old, with some experience in project design but no knowledge about TRIZ.

The participation was compulsory, but the project aims were explained in advance in order to get an agreement

The students were engaged, at an **advanced level**, in the robotics activity that requires a good level of creativity.



6.5 The experimental activities

3 ELT A

One school week (6 mornings plus 2 afternoons for a total amount of 36 hours) for teaching and practising TRIZ

Lessons were scheduled in full days during which the first part has been dedicated to the theory and the second one to practical applications of TRIZ linked to basic robotics.

5 ELI B

10 days divided in two periods for a total amount of 60 hours for teaching and practising TRIZ.

Lessons were scheduled in full days during which the first part was dedicated to the theory at an higher level and the second one to practical applications of TRIZ linked to advanced robotics

6.6 The methodology and the contents

3 ELT A

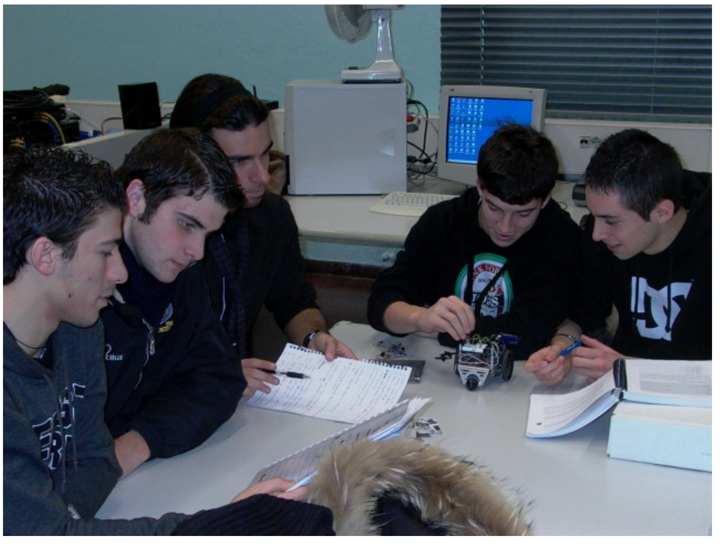
Frontal lessons and cooperative learning during lab activities with exercises and practice on real problems

Basic concept were used like contradictions A particular attention has been dedicated to System Operator.

5 ELI B

Frontal lessons and cooperative learning during lab activities with exercises and practice on real problems

Every tool presented by prof. Cascini during teachers training course except the Su-Field.



6.7 The feedback

3 ELT A

Feedback from teachers:

The methodology ha got a good level of attention especially when was presented in a simple way with a lot of examples.

The young age of the students may constitute a limit (only some teacher agrees about this).

The simple presentation of the models and the animations were of great utility.

About 60% of the students has usefully applied the method to improve effectively the robot design.

Students feedback:

The greatest part of the students actively participated to TRIZ activities. In general they were interested in System operator. They were satisfied, sometimes amused and interested in the animations. Some of them have used properly the TETRIS tool kit

5 ELI B

Feedback from teachers:

The methodology got a good level of attention.

The age of the students, in their last school year, and their good level of knowledge regarding robotics and automation has been very appropriate. The good presentation of the tools were of great utility.

The greatest part of the students has usefully applied the method to improve the advanced robot design.

Students feedback:

The greatest part of the students actively participated to TRIZ activities. They were interested in general methodology. They were critically satisfied. Some of them have used properly the TETRIS tool kit.

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6.8 ITI Malignani's long-term aim and conclusions:

- To meet the new demand for subjects like automation and robotics.
- To deal with innovation and re-organising a school's curriculum based on certification of competences in agreement with the School Reform new programs.

Robotics can be considered a macro-competence that integrates a lot of different branches of science and technologies while is constituting a good opportunity for developing motivation and TRIZ creativity.

During the student's Triz activities some brilliant ideas have been analyzed and implemented while others remained at a general level. Some of the small projects analyzed were very creative but not immediately implementable (i.e. the project for the construction of a smelling robot that follows a path traced by a particular odour or a perfume).

Istituto Tecnico Industriale "Malignani", considering the implementation of Triz as a valid opportunity and a challenge to remain one of the centres for developing innovative ideas in a context of international cooperation, confirms the intention to continue teaching TRIZ in its courses.