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Education, Audiovisual & Culture Executive Agency

TETRIS – TEACHING TRIZ AT SCHOOL

Final Report

Public Part

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Executive Summary

TeTRIS: an innovative approach to the teaching of TRIZ to systematize innovation and creativity

This document has been produced primarily for EACEA to enable the Agency to monitor and assess the achievements of the project, but also to the benefit of the project partners and for peers, as a useful source of reference on the work done and on the relevant achievements. The report is, furthermore, a means for further dissemination and exploitation of the project and its results, also beyond the project's lifetime.
TETRIS was developed with two main objectives, i.e. identifying the learning needs of vocational education systems and of trainers to introduce TRIZ at school and in companies and developing a course and training materials with a practical and innovative approach to improve problem-setting and problem-solving capabilities. At the same time, the intent was to reduce the learning process in terms of time avoiding oversimplification, encourage a wide dissemination, create the necessary conditions for direct interactions between the world of education and the industrial and corporate worlds, provide directions for future developments, foster cultural and best-practice exchanges among companies and with educational institutions, spread project results through specific activities, involving decision makers, stakeholders and potential users. In the long term, TETRIS aims at becoming a reference for the teaching of creativity, problem-setting and problem solving, creating the conditions to introduce TRIZ in secondary schools and to enhance TRIZ training in European companies, thus increasing their innovation capabilities and competitiveness.
The TETRIS partners were selected to put together complementary expertise and achieve the stated project goals. Some of the partners normally use TRIZ (*Siemens, the University of Florence, EIFER*) and some teach TRIZ (*AREA Science Park, the University of Florence, the Jelgava Adult Education Centre*). The involvement of schools (*ISIS Malignani, HTL Wolfsberg and Jelgavas 1.gimnazija*), a technical university (Fachho*chschule Kaernten*), enterprises (*Siemens, Stenum and ACC*), an experienced multimedia expert (*Studio Flosser*) and of the external partners (*ETRIA and the Friuli Venezia Giulia Regional Office of the Italian Ministry of Education*) was crucial to channel a joint effort and benefit from contributions coming from a wide range of stakeholders.

After polling all project partners and involved stakeholders on their past experiences with TRIZ and in consideration of the obtained feedback, relevant factors, suggestions and specific restrictions to the introduction of TRIZ at school and in companies, a training model was developed, based on an innovative approach ('*Knowledge items*') and synthesizing all the requirements in a single set of training materials, defining at the same time a training process comprising a mixture of self-study and training sessions (in presence and/or online), using the resources made available through the TETRIS project, with a focus on multimedia animations as a means for immediate understanding and dissemination. Testing was widely carried out, both through 'train the trainers' courses and training programmes developed at secondary schools and in companies. Feedback was consistently collected and several adjustments made to tailor training materials and methods for the requirements of all relevant target groups. Dissemination and promotion had a central role throughout the project lifetime to promote project activities and communicate results and achievements. Dissemination and exploitation actions are still ongoing and further activities are envisaged for the future. Throughout the project lifetime several results were achieved, including the realization of the project website (www.tetris-project.org) and of promotional materials, the educational kit (handbook, multimedia animations, a set of exercises and examples with solutions, a guide on introducing TRIZ at school, a CD comprising all of the above), an educational requirements report, 'train the trainer' and testing courses, a whole range of events and courses dedicated to educational institutions, secondary schools and companies around Europe. Significant prospective exploitation and dissemination opportunities have arisen during the project lifetime, offering very promising developments after the end of the project lifetime, both as concerns the usage of TETRIS materials in secondary schools, companies, stakeholders' associations, universities, university networks and in courses addressed to innovation training for enterprises across Europe and with the further opportunities for the translation of training materials into other languages (Chinese, Farsi, Japanese, Korean, Romanian, Spanish). All materials are and will be freely available online on the project web-site.

Project web site: www.tetris-project.org

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1) Project Objectives

1.1 The context

"The growth and competitiveness of enterprises in industrial and service sectors depends on their ability to adjust quickly to change, to exploit their innovative potential and to develop high-quality products" (Decision No 1639/2006/EC).

While enterprises adapt themselves to change, the educational system still refers to traditional industrial systems and their outdated requirements. Creativity, problem-setting and problem-solving are becoming new essential skills, just like using a computer or speaking a foreign language.

TRIZ ('*Theory of Inventive Problem Solving'* created by G. S. Altshuller starting from 1946 and further developed until now) offers a systematic approach to the generation of solutions, producing less ideas than other methodologies but more oriented to the objective, thus reducing the cost of testing new concepts and prototypes.

Traditional TRIZ education would require no less than 200-hour courses, yet in all European countries TRIZ is mostly taught in short 2- to 5-day seminars, with just a small percentage of attendees really benefitting from the training, not to mention the high costs related to a comprehensive educational programme which requires, for a start, the dismantling of existing logics and overcoming of psychological inertia.

Creativity and problem-solving techniques, furthermore, are usually not taught at school, whereas major benefits could be achieved by bringing forward TRIZ fundamentals to school years in order to reduce psychological barriers, introduce an alternative approach to trial-and-error practices, share knowledge about the evolution of systems as useful cultural elements.

1.2 The objectives

In this context, TeTRIS was developed with two main objectives:

1) Identifying the learning needs of vocational education systems and of trainers, with the intent to improve the efficiency of initiatives aimed at developing individuals' problem-solving skills and at introducing TRIZ at school and in companies (focusing specifically on similarities and peculiarities of their educational requirements as a resource to establish new forms of cooperation in educational activities).

2) Developing a course and training materials, also suitable for distant learning and including lessons with animations, exercises complete with solutions, tests, a handbook for teachers and trainers.

The intent was improving individuals' problem-solving capabilities and speeding up the learning of TRIZ, following a few main directions:

- introducing techniques to avoid psychological inertia;
- offer an alternative to the trial-and-error approach to improve efficiency in innovation;
- providing a structured approach to problem analysis and technical creativity through systematic reasoning processes based on ARIZ (*Algorithm of Inventive Problem Solving*) fundamentals;
- introducing fundamentals on systems evolution and on objective laws, as identified by TRIZ researchers.

Secondary objectives were:

1) reducing in terms of time the learning process through up-to-date educational means based on the adoption of animations, detailed examples and exercises with solutions, at the same time avoiding oversimplifications of the theory and being attractive;

2) encouraging a wide dissemination through educational materials distributed for free, also via the Internet;

3) creating, through a 'train the trainers' course, the necessary conditions for direct interactions in the classroom on a larger scale, involving both the world of education and the industrial and corporate worlds.

4) providing directions for future developments through the implementation of several test-courses, both at school and in the industry, in several countries and the organization of events aimed at sharing experiences and at collecting feedback to improve the materials;

5) fostering cultural and best-practice exchanges among smaller and larger companies and between industrial partners with a deeper experience in the field and educational institutions, thanks to the harmonized composition of the consortium;

6) spreading project results through specific activities, such as a final conference and the project's web site, meetings and seminars with decision makers, stakeholders and potential users. Some of these were directly involved in the project (3 schools, 3 companies, ETRIA and the Friuli Venezia Giulia Regional Office of the Italian Ministry of Education).

Long term objectives:
1) becoming a reference, at least at a European level, for the teaching of creativity, problem-setting and problem solving for secondary students, young researchers, R&D centres;
2) creating the conditions to introduce TRIZ at school: the declaration of interest by the Friuli Venezia Giulia Regional office of the Italian Ministry of Education is very promising from this point of view.
3) creating attractive means for improving TRIZ training efficiency to have a dramatic impact on its dissemination in the European companies, thus positively augmenting their innovation capabilities and competitiveness;

2) Project Approach

2.1 Initial phase: polling stakeholders

In order to identify the most relevant key factors for a step-by-step, effective TRIZ training course, all project partners and external stakeholders, as for instance the Friuli Venezia Giulia Regional Office of the Italian Ministry of Education, were asked to fill in a questionnaire and share their past experiences with TRIZ training.
Since the TETRIS project partners were both educational institutions (universities, schools, educational authorities) and companies, special attention was dedicated to the identification of the differences among implemented procedures in schools and companies, as well as to the discrepancies among expectations and constraints required by schools from different countries.

For instance, schools required a different thinking approach and creativity method, whereas companies were more interested in problem-solving competence. To increase motivation in participants, schools suggested easy examples to show that the theory works and the usage of multimedia tools and game-like exercises, while companies focused on showing results. General agreement was found as concerns the contents of TRIZ introduction (fundamentals of the theory, easy-to-use tools, overview of the thinking process, prompt application of TRIZ tools for idea generation in a multidisciplinary context), though with a different duration and organization of the respective schedule (30 to 40 hours in schools against 2- to 3-day seminars in companies). As for the educational aspects, schools highlighted the importance of hands-on examples, exercises and homework, as well as the inclusion of a 'fun' element, whereas companies seemed more interested in templates for easy implementation and in benefitting from exchanges with other companies. The critical restrictions brought about by schools and companies comprised the absence of a commonly accepted standard handbook, the focus was more on the fact that 'creativity' in itself is not considered an official school subject for educational institutions, whereas for companies on direct applicability in real-life procedures.

2.2 The TETRIS educational model: from a traditional approach to a new system to meet the requirements of a 'Knowledge- based society'

In order to address the complex task of introducing totally new subjects into secondary-school students' curricula, taking into account the heterogeneous and strict requirements described in the previous section, it was necessary to perform a careful study on the educational model.
The existing system of education often proves incapable of preparing students to live in the so-called 'Knowledge-based society' we live in and, therefore, to meet society's necessities and requirements.
Norman Longworth ('*Learning Cities, Learning Regions, Learning Communities: Lifelong learning and local government*', 2006) clearly outlined the basic skills necessary in a knowledge-based society, which can be summarized as follows: the ability to manage oneself, to work with information and interpret it, to apply new knowledge into practice, to discourse sensibly and critically, to adapt, to work in a team, to resort to life long learning, developing and implementing management and communication skills, thinking abilities and creativity.
Tatiana Koke (*Latvian Minister for Education and Science*) recently described a 'Knowledge-based society' as the system of social relationships ensuring a high level of innovation, in which every individual is able to achieve a high degree of participation getting, using and developing new knowledge independently.

2.3 Introducing TRIZ

The above skills can certainly be enhanced and developed by introducing the TRIZ way of thinking. The matter is assessing how this can be achieved.
The introduction of TRIZ in secondary-school curricula can be achieved in two different ways: introducing TRIZ as a separate subject or as a methodology integrated in other subjects.

The schools belonging to the TETRIS consortium, as well as any other similar educational institution with the aim of teaching TRIZ to their students, did not have any knowledge of TRIZ at the beginning, nor any teaching materials. The educational materials, therefore, had to be customized for the specific situation. The main difference in comparison with the introduction of more classical subjects was that there are neither programs nor standards for TRIZ and the program actually needs to be defined in agreement with the system of requirements to be satisfied in the organization of the teaching & learning process.

2.4 The relevant factors

Several factors must be taken into consideration while developing the educational program:

Student-related factors: human and national values, educational needs, motivation, personal qualities, age peculiarities, cognitive factors: cognitive skills, creative skills, emotional factors (sympathy and emotions), character and strength, Individual style of learning, quantity and quality of general knowledge, work and problem-solving experience, ability to learn, ability to cooperate.

Teacher-related factors: human and pedagogical values, aptitude for professional activities, personal qualities, general knowledge, education, experience, pedagogical beliefs and preferences, professional knowledge, people skills involving students and socializing style, creativity.

School-related factors: aim of activities and development strategy, education programmes, atmosphere and microclimate, corporate culture, pedagogical traditions, teaching environment, resources (material, human, time).

Country-related factors: national values, social, economic and political development, educational policy, education system, educational standard.

2.5 From a wide range of requirements to a single set of training materials

The synthesis of all the above-mentioned factors allows to discern which information is understandable and interesting for students, if they can learn independently, what tasks are more suitable for their interests and capabilities, which pedagogical approaches are going to make the learning more successful, etc. This way, it is possible to develop the most suitable materials for effective implementation to teach TRIZ in a specific school or company. However, even just within the TETRIS partnership, this would have led to 5-6 different sets of teaching materials. The necessity to develop a set of training materials to be used by the widest possible range of schools and companies led us to the development of a single set of training materials.
To develop materials fitting different target-audiences and in different conditions, a single set of training materials was developed, consisting of clearly defined structural elements that can be combined in several sets of modules, tailored to the needs of different users.

2.6 The 'Knowledge-items' model

In order to build educational materials into bricks to be combined and adapted according to each specific situation, the handbook authors defined a common structure for each item of the 'Body of Knowledge' (Fig. 1).

ID	Title	Definition (Glossary)	Theory (Details)	Tool (How to use)	Multimedia Animation	Example (Problem/Solution)	Self Assessment (Questions, Tasks)	References
0	TRIZ							
…								
2	Fundamentals of TRIZ							
2.1	Laws of Engineering System Evolution							
2.1.1	Law of completeness of system parts							
2.1.2	Law of "energy conductivity" of a system							
2.1.3	…							

Figure 1 – Structure of the TETRIS Body of Knowledge and classification of Knowledge items .

More precisely, Knowledge items were organized in "cells", belonging to a sort of three-dimensional space, classified according to three main reference axes:

- different levels of detail (vertical axis): topics, sub-topics, sub-sub-topics…;
- different types of contents (horizontal axis): title, definitions (glossary), theory, instruments (practical directions about how to use the related tools), multimedia, examples, self-assessment resources, references to literature;
- variants of the training contents (3rd dimension of the grey part of the table): mainly examples and self-assessment materials, but sometimes also tools explanations can be presented in different forms in order to leave a wider choice to the teachers.

2.7 The training process: steps and criteria adopted

The development of individual problem-solving skills and the acquaintance with the TRIZ theory was based on a training process structured according to the following steps:

1. introduction to the TETRIS training material made by a facilitator (live or through video/pod-casting);
2. self study of E-books on WEB, articles and TeTRIS animations
4. lessons in classroom with a trainer;
5. individual work

The implementation of such a process was made possible by the dedicated training materials, developed according to the following criteria and features:

- *training materials* (a comprehensive toolkit of lessons, exercises, tests and animations, a guide to teaching TRIZ at school) suited for distant learning and freely accessible on the web in different languages (English, French, German, Italian, Latvian). The materials are freely available for further translations in other languages, thus expanding exploitation and dissemination beyond the project's lifetime.
- *educational approach* developed by multidisciplinary experts, thanks to the complementary composition of the consortium, so to fit with the requirements of both company employees and high-school students.
- *attractiveness*, i.e. the capability to catch the attention of a wide audience (young students as well as older individuals), so that high-school students and company employees do not perceive the course as something imposed from above and realize from the very beginning, the benefits they will gain;
- *'train-the-trainer' courses*: pilot courses for high school teachers were implemented in Italy, Austria, Latvia to introduce the TETRIS training material and provide means to hold dedicated seminars to their students; pilot courses were organized also for companies in Germany, Italy, Austria, involving preferentially (not mandatorily) employees with an established background on TRIZ and/or responsible for in-house training.

2.8 The multiple role of animations

It is worth mentioning that, in order to attract young students to learn TRIZ fundamentals, several animations were developed to illustrate what the TRIZ is in a charming and attractive way (the title of these animation is '*TRIZ tales*'). Moreover, a visual representation of TRIZ concepts also improves their assimilation. Five animations were developed by the end of 2008 and their contents are described in the following section (*3 . Project outcomes and results*). TETRIS animations are a pioneering work, since very few attempts have been done up to now to describe TRIZ concepts visually. Moreover, TETRIS is the first integration of a comprehensive handbook on the topics with multimedia tools.

Apart from their didactical value, they are also a powerful tool to raise interest in the topic. Many of the project partners that in the past organized TRIZ courses highlighted the difficulty of promoting the TRIZ, since the methodology and the benefits it can provide to its users are hard to understand at a first glance. The animations are able to summarize in a few minutes concepts that would otherwise require much more time.

2.9 The importance of testing and collecting feedback from trainers, teachers, students and companies.

As stated above, in order to facilitate the role of teachers at school, their training was organized so to let them develop examples of each TRIZ concept within their own field of expertise. The development of those examples will show the level of their comprehension and, at the same time, it will be a means to disseminate TRIZ concepts

at school with different perspectives. These teachers were required to fill in a questionnaire and their feedback was considered when finalizing the handbooks.
In 2009, the TETRIS educational tool kit was used and tested by the schools involved in the project in three different countries (Austria, Italy and Latvia) and by several companies in Austria, Germany and Italy. Feedback from teachers, trainers, students and companies was collected by means of questionnaires and the training materials were then revised and improved according to the suggestions received. Teachers and trainers were asked, in particular, if the TETRIS training materials facilitated their teaching of TRIZ and what was their perception of the students' attitudes and achievements. Students and companies were asked about the clearness of the training materials and how they were able to support them in learning and understand TRIZ. Companies were enquired about the usefulness of the TRIZ tools explained by TETRIS in relation to company objectives. The feedback proved very satisfactory, was fruitfully exploited and 5 new exercises complete with solutions were added to the training materials, a complete linguistic revision carried out and contents were further rationalized and clarified through a detailed index.

2.10 A focus on dissemination and promotion

From the very beginning of the project, particular attention was paid in communicating project activities and promote the adoption of the TETRIS tool kit by other users. Every partner actively contributed in promoting project activities.
One target was the TRIZ community. The project was presented twice (in 2008 and in 2009) on the occasion of the 'TRIZ Future Conference', an event organized every year by ETRIA, the European TRIZ association, and was also presented to other national associations. Since these association are extremely motivated in spreading the use of TRIZ, they will actively use the TETRIS kit. The animations presented at the European Future Conference' were warmly welcome and TETRIS is the first TRIZ educational kit addressing secondary schools.
The promotion strategy also focused on addressing final users i.e. schools and companies. Several presentations were organized for schools, educational authorities, companies and industrial associations. These activities were specifically intensified in the second year when the project products became available as well as the outputs of the first usage of the kit in the real world.
A final conference was held at AREA Science Park to present project achievements.

3) Project Outcomes & Results

3.1 The project web site: www.tetris-project.org

The web site is available in English, French, German, Italian and Latvian.
The heading of the web site includes a quotation from Genrich Altshuller (the father of TRIZ): "Creativity is not a born gift. Every engineer can learn to be inventive." which summarizes the philosophy of the project.
The web site includes the following sections:

- Home page (welcome page and web-site menus)
- About this project (description of project objectives and activities)
- How TRIZ can help you (a brief introduction to TRIZ organized by target group)
- Lifelong Learning Programme (a very brief introduction to the LLP linked with the EACEA web site)
- Partners (a comprehensive list linked to each partner's web-site)
- Web-links (a list of suggested links to related web sites)
- News (updates on project activities)
- Animations (the project animations, available on line to registered users)
- Downloads (a container for documents, reports, etc.)
- Forum (for registered users)

Three categories of users are envisaged for the download area:

- 'unregistered users': they can download dissemination materials;
- 'registered users': they can freely download the final versions of all project outcomes (at present there are 985 registered users);
- 'members': these are the project partners and EACEA officers; they can view and download all documents (including draft versions of project outputs, project management documents, minutes of meetings etc.).

From the creation of the project web site to the end of 2009, 18.975 people visited the project web site.

A dramatic raise in the number of visitors has been recorded since October/November 2008. The reason for such an increase is the publication on the web site firstly of the animations and later of the handbook.
Visitors came mostly from these countries (in decreasing order): Italy, Germany, Austria, USA, Russian Federation, France, Japan, Latvia, United Kingdom, Switzerland, Canada, India, Australia, Belgium, Turkey, Netherlands, Argentina, Romania, Greece, Brazil, Mexico, Czech Republic.
The large number of visitors from non-European countries is evidence of the innovative character of the project and of the significance of its outputs.

3.2 The "Educational Requirements Report".

The Educational Requirements Report summarizes the analysis of the partners' previous experiences in teaching TRIZ and the educational requirements outlined by the final users of the TETRIS educational tool kit (companies and schools).
On one hand, the analysis compared different ways of teaching TRIZ in different contexts and to different targets. Each partner clearly described what had worked as well as the weak points in their experience. The outcomes helped the authors of the training materials avoid mistakes already made in the past and collect proven good ideas. On the other hand, the analysis of the final users' expectations and needs helped the authors define in detail the educational objectives and tailor them to the final users' needs.
The report can be downloaded by any registered user. (A brief summary of the main outcomes in Table 1).
While no relevant differences were highlighted from the schools due to national regulations, the hardest requirement to fulfil is the limited amount of time schools (as well as small companies) can dedicate to TRIZ introduction. Besides, a realistic approach to combine consensus and feasibility is a TRIZ introduction course, where the tools are explained and practised with prepared exercises, followed by the application of TRIZ tools within other real project works (typically implemented at least in any technical or experimental school).
Moreover it was recommended to produce a comprehensive map of the TRIZ Body of Knowledge in order to give a clear overview of what TRIZ can offer and what could be studied at the end of the introductory course.

Topics / Questions	Schools	Companies
What is the goal of the "customer" (school / company) to run TRIZ lessons?	Different thinking approach & creativity method	Problem solving competence
How to increase the interest & motivation of participants? (in a starting session)	Showing with easy examples that the theory works Using multimedia & playing elements	Showing results and outcomes
What should be the content of a TRIZ introduction?	The main sayings of TRIZ Some easy to use tools TRIZ-tools that can also be applied in other lectures Overview about the TRIZ thinking process (ARIZ)	The main sayings of TRIZ Some easy to use tools TRIZ-tools that can be quickly applied for idea generation Overview about the potential applications of TRIZ Overview about the TRIZ thinking process (ARIZ)
What is a good / feasible duration for a TRIZ introduction?	App. 30 to 60 hours	Approx. 2 to 3 days
Important educational elements	Hands-on examples Exercises & Homework Fun (teamwork)	Hands-on examples Templates for easy implementation Benefit of cross-company teams

Overall critical restrictions / circumstances for TRIZ trainings	No (international) standard handbook for TRIZ trainings is available at the moment! Creativity is no "declared" school topic	No (international) standard handbook for TRIZ trainings is available at the moment! Lack of a unified, standard certification system18

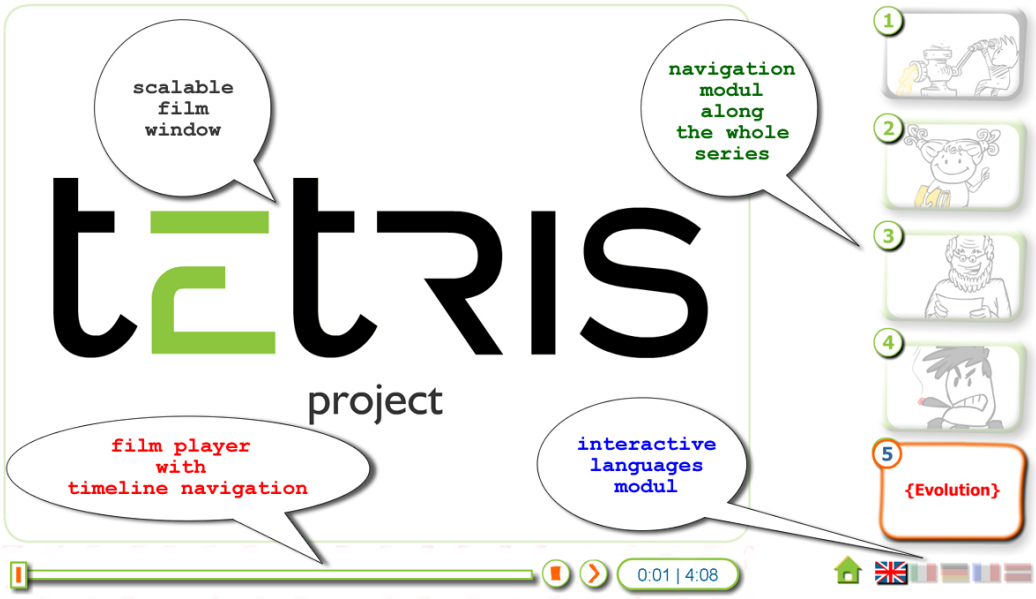
Table 1: Main outcomes of the questionnaires and experience reports from schools and companies.

3.2 The ' TRIZ tales'..... TRIZ at a glance....

The TETRIS animations were published on the project web site at the end of 2008 and were a real hit with the site visitors (the number of accesses increased noticeably) and with all the participants in the TRIZ training courses, companies, secondary-school teachers and students. All the participants stressed that the 'TRIZ tales' allow immediate, at-a-glance understanding of what TRIZ is and of how it works.

The animations were initially hand drawn, than digitized using Wacom Graphics Tablet, assembled with noises and music, animated in Macromedia (Adobe) Flash and the interactions programmed using Flash Action Script. Original soundtracks performed by composer Patrick Ehrich, Wasted Music.de, have been composed ad-hoc for the TETRIS animations.The final version presents the following features:

- they are available in several different languages (English, French, German, Italian, Latvian, Spanish, Romanian, Japanese, Russian) and it is possible to switch from one language to the other also during the screening. The Farsi, Korean and Chinese versions will soon be available;
- a scroll bar has been added to allow the viewer to stop the screening, go back and forth, etc. (this is crucial for the educational use of the animations);



The first one is about the story of TRIZ and what TRIZ is. Animations 2, 3 and 4 - depicting the adventure of the protagonist, Nina, at school, at university and at work - explain how the TRIZ principles can be used to solve real-life problems, from the preparation of candies to the design of a virtual room. It has been decided to use the same principles in all stories, in order to demonstrate how flexible TRIZ tools are and how they can be applied in very different situations. The fifth animation compares the Laws of Engineering System Evolution with the laws of evolution from biology and illustrates how the 9-window scheme works.

Some shots from the animations

3.3 The TETRIS handbook.

The TETRIS handbook is freely available on the TETRIS website to all registered users. The handbook was developed first in English and then translated into the other 4 official languages of the project and adapted to the different national peculiarities. The index of the handbook is the following:

1. Fundamentals of Classical TRIZ
2. Laws of Engineering System Evolution
3. Short Review of Altshuller's Algorithm of Inventive Problem Solving (ARIZ) illustrated by analysis of a real problem
4. Su-field analysis and standard solutions
5. Techniques to Resolve Contradictions / Resources / Effects

The use of the education materials will be totally free just by quoting the authors, the TETRIS project and the Lifelong Learning Programme. Under the same conditions, the materials can be translated in any other language (translators are requested to publish their translations on the TETRIS web site). In this respect, it should be noticed that contacts are ongoing to translate the handbooks in other EU and non-EU languages.

3.4 The guide on how to use the TETRIS handbook.

A Guide on how to use the TETRIS educational material is also available on the project web site and on the TETRIS CD.

3.5 Set of exercises.

A set of 5 exercises (solved problems with reference to related sections of the handbook) complete the educational kit (the exercises are available on the project website and on the TETRIS CD)

3.6 Examples from Siemens Innovation Tool Academy.

On the website, a set of slides is also available, presenting examples of TRIZ applications from Siemens Innovation Tool Academy.

3.7 Guide on introducing Triz at school.

A guide on how to introduce TRIZ at school is also available on the TETRIS website. The guide, based on the TETRIS Project experience, presents TRIZ, the educational model and partner schools' experiences. The index of the guide is the following:

1 Introduction to the TETRIS project
2 How to use TETRIS educational kit
3 The TETRIS Project: Description of the Educational Model
4 Piloting TETRIS Materials in the 1st Gymnasium of Jelgava, Latvia
5 Introducing TRIZ at HTL Wolfsberg
6 ITI "A:Malignani"- The TETRIS experience

3.8 The ' TETRIS CD'.

The TETRIS training materials (handbook and animations) are also available on 5000 CDs.

3.9 The TETRIS Final Conference.

The final conference, entitled 'TRIZ: SYSTEMATIZING INNOVATION AND CREATIVITY' was held in Trieste at AREA Science Park, on 10th November 2009. The conference presented the project and TETRIS training materials, stressed the importance of creativity and the way to teach it in companies and schools. TRIZ and other methodologies to boost innovation were presented. The partners involved in the testing phase (companies and schools) presented their experience. The conference was subdivided into two session: the morning session, addressing companies and research centres, and the afternoon session, dedicated to schools.

Programme:

Morning session

TETRIS - Improving problem solving skills in companies

- Presentation of the TETRIS project – F. Tomasi (AREA Science Park)
- Invention on Demand and Innovation Tool Academy, an example of TRIZ introduction in a company – R. Adunka (Siemens)
- Blue Ocean: a tool to support market innovation – J. Jantschgi (Fachhochshule Kärnten)
- ESIL – European Sustainable Innovation Licence – J. Fresner (Stenum)
- TRIZ: Experiences in Italy – C. Rizzi (Apeiron)

Afternoon session

TETRIS - Improving students' problem solving skills

- What's TRIZ? – G. Cascini (University of Florence/ Milan Polytechnic)
- Creativity and Thinking Skills in Language Education – A. Sokol (Jelgava Adult Education Centre)
- Teaching TRIZ at school: A. Campanella (ITI Malignani), J. Persoglia (HTL Wolfsberg), A. Sokol (Jelgava 1gymnasium)
- TRIZ Tales –H. Flosser (Harry Flosser Studios)
- "Using "Yes-No" games for teaching OTSM-TRIZ – N. Khomenko, TRIZ - Master Certified by G. Altshuller

The conference was a hit with the public: around 100 people from companies and schools attended the 2 sessions. On the project website at the address: http://www.tetris-project.org/index.php?option=com_content&view=article&id=89&Itemid=64&lang=en it is possible to watch the video and the presentations of all the conference speakers.

3.10 TETRIS leaflet

For the final conference, a leaflet presenting TRIZ and the project was produced in English and Italian. The leaflet was designed to be an effective 'card' to explain what TRIZ is and how the methodology can help companies promote systematic innovation, efficiency in research, development and creativity, overcoming technical problems and enhance problem-solving skills at school.

3.11 TETRIS course for ISS tutors:

In December 2009, the course for ISS tutors was delivered. The Friuli Venezia Giulia Regional Office of the Italian Ministry of Education decided to support the TETRIS project and test it within the ISS National Project (Teaching Experimental Studies). Originally the course was addressed to ISS tutors only, yet the final conference and

project presentations in fairs and workshops were so effective that a lot of teachers asked to participate in the training course, envisaged for the ISS tutors, in charge of the training of other teachers.

Also the Agency for Vocational Education of Croatia - Department for curricula development and professional teacher-training in Zagreb was interested in the project and took part in the course organized in Trieste. The aim was to learn more about this methodology, about the experience of the schools involved in TETRIS project and to evaluate the introduction of TRIZ in Croatian secondary-school curricula. 27 teachers participated in the courses.

3. 12 'Train the trainer' courses

TETRIS organized 3 'Train the trainer' courses for the teachers working for the schools participating in the project: Malignani (Italy), HTL Wolfsberg (Austria), Jelgava 1. Gymnasium (Latvia).

3.13 Testing courses:

Tetris project carried out the following testing courses:
In schools: the three schools participating in the project tested the TETRIS material with their students.
In companies: EIFER, ACC, SIEMENS, STENUM tested the TETRIS training material with in-house courses and AREA organized a course for 18 Italian companies. Feedback from participants was requested at the end of the course and about six months after the end of the TETRIS training sessions.
At University: Siemens also tested the TETRIS training materials during a course at the University of Erlangen-Nurnberg.

3.14 Seminar to present the Siemens model

A seminar presenting the Siemens model was organized on the occasion of the project meeting in Nurberg. During this event the Innovation Tool Academy implemented by Siemens was illustrated. Siemens explained how the company applies the TRIZ methodology, the results and benefits it gained as well as the difficulties it met during its application.

4) Partnerships

The Consortium was set up in an attempt to gather the complementary expertise necessary to develop the project. Some of the partners normally use TRIZ (Siemens, the University of Florence, EIFER a joint venture of EDF France and the University of Karlsruhe, Germany) and some teach TRIZ (AREA Science Park, the University of Florence, the Jelgava Adult Education Centre). The consortium also involves schools (ISIS Malignani, HTL Wolfsberg and Jelgavas 1.gimnazija), a technical University (Fachhochschule Kaernten) and enterprises (Siemens, Stenum and ACC). In order to develop a charming and effective multimedia product, a well-experienced multimedia expert was also involved in the project (Studio Flosser).

The definition of *training requirements for companies* was carried out by those stakeholders involved in the project which regularly provide training courses on TRIZ topics (AREA and the University of Leoben).
The development of *the TETRIS course* was within he responsibility of those partners with a deeper knowledge and experience in using and teaching TRIZ (the University of Florence, Siemens, the University of Leoben, the Jelgava Adult Education Centre and EIFER).
The *development of the training materials* was led by the multimedia expert (Studio Flosser) with the contribution of AREA (expert in training and education): they designed the framework and lay out for the content produced by the partners developing the training course.
Testing and validation of the TETRIS products was done by the stakeholders (schools and business partners) and by those who organized the test courses and are expert in training.
Every partner contributed to the *dissemination and valorisation of project results*. A really significant effort was made by all the involved stakeholders, the project coordinator and the external partners ETRIA and the Friuli Venezia Giulia Regional Office of the Italian Ministry of Education.The joint participation in the project of schools and companies was of fundamental importance in the interest of the final stakeholders and helped define their needs and expectations from the very beginning of the project.

AREA - Consorzio per l'AREA di ricerca scientifica e tecnologica di Trieste (Italy) (Project Coordinator)

AREA Science Park is the main Italian multi-sector science and technology park and among the most important at a European level, where, next to prestigious research laboratories, several world-level scientific institutions and enterprises can be found.It is in the mission of the Consortium to develop innovation and

internationalization, contributing to competitiveness through actions of technology transfer and dissemination of innovation, enhancing knowledge through relevant training programmes. AREA defined the layout of the handbook , planned the procedures for the testing of the training materials and organized a course dedicated to Italian companies. It was furthermore responsible for dissemination activities in Italy.

University of Florence (Italy) Dept. Of Mechanics and Industrial Technologies

The university has coordinated the definition of the educational model and the development of the handbooks and the definition of the animations storyboard. Its experts are in charge for all the TETRIS training activities in Italy.

Fachhochschule Kaernten (Austria) CUAS - Carinthia University of Applied Sciences

Since its foundation, CUAS has developed into a unique educational institution in Carinthia. Through constant further development of the degree programs at CUAS and intensive cooperation with the worlds of business and science, those studying at the university can be certain of a forward-looking education with its finger on the pulse of time. CUAS lives the vision of direct practical experience. Full- and part-time lecturers, as well as guest speakers from industry and business ensure an interdisciplinary, internationally oriented education. Currently, around 30 degree programs are offered in the fields of civil engineering and architecture, engineering, as well as management, healthcare and social issues. The School of Management offers study programs in the fields of Business Management, Public Management, Organisation & IT, Hotel Management & Development as well as International Business Management and Regional Management. Besides these educational activities, research and development is another focus of CUAS, which is reflected in numerous national and international R&D projects. The University coordinated the analysis of the educational requirements and its experts wrote a chapter of the handbook. The University also coordinated training and promotional activities in Austria.

Jelgava regional Adult Education Centre (Latvia)

The centre contributed to the definition of the educational model and to the definition of the handbook index, organized a teachers training course in Jelgava, Latvia and coordinated the testing and promotional activities in Latvia.

Jelgava 1. Gymnasium (Latvia)

The school Taught TRIZ to a group of its students using the TETRIS educational kit and provided suggestions and feedback to improve training materials.

Istituto Tecnico Industriale A. Malignani (Italy)

It is one of the largest Italian technical high schools for the number of its students, about 2,000, subdivided into six specialisation groups: Electrical engineering, Electronics, Aeronautics, Mechanics, Constructions and Scientific-Technological High School. Students have a 36 hour-per-week timetable, half of the sessions deal with general knowledge, while the rest deals with technical subjects. The school taught TRIZ in some of its classes using the TETRIS educational kit and provided suggestions and feedback to improve the training materials.

EIFER - European Institute for Energy Research (Germany)

EIFER is a joint research institute involving EDF (Électricité de France) and the Universität Karlsruhe (TH), located in Karlsruhe (Germany). Its activity is focused on energy and the environment. A team of 75 persons from 9 different countries is working in the following research fields (Energy Environment Economics, Sustainable Energy in Territories, Energy in Urban Context, Renewable Energies, Distributed Generation, Fuel Cells & Hydrogen). EIFER wrote a chapter of the handbook and tested the TETRIS training materials.

HTL Higher Technical College Wolfsberg (Austria)

The higher technical college offers technical and vocational education and training. The advanced-level secondary vocational school starts after the eighth year of schooling; after five years of education and a successful school-leaving exam, students get a Certificate of Secondary Education and a TVE-Diploma. After three years of vocational practice, they can apply for the title of engineer. For our 500 students we are offering 2 Departments: Mechanical Engineering focusing on Automation and Mechatronics & artificial material technology and Business Engineering specializing in Information Technology & Business Management. The school taught TRIZ in some of its classes using the TETRIS educational kit and provided suggestions and feedback to improve the training materials.

STENUM (Austria)

STENUM GmbH is a consultancy specialized in resource efficiency (waste minimization, water efficiency, energy efficiency). Since 1992 some 2000 companies in 30 countries have been consulting in preventive environmental management. STENUM tested the TETRIS training materials and provided suggestions and feedback to improve them.

ACC Austria Gmbh

Appliances Components Companies is a young, independent Group, leading the world in designing, manufacturing and marketing components for household and commercial appliances. ACC tested the TETRIS training materials and provided suggestions and feedback to improve them.

Siemens AG

Sector Industry, Industrial Automation and Drive Technology (Germany)

Siemens offers automation, drive, and low-voltage switching technology as well as industrial software from standard products up to entire industry solutions. The industry software enables our industry customers to optimize the entire value chain – from product design and development through manufacture and sales up to after-sales service. Our electrical and mechanical components offer integrated technologies for the entire drive train – from couplings to gear units, from motors to control and drive solutions for all engineering industries. Our technology platform TIP offers robust solutions for power distribution. Siemens provided the project team with its expertise in training TRIZ within the so called Invention on demand and Innovation Tool Academy. Siemens applied and tested the TETRIS training materials.

Harry Flosser Studios (Germany)

This young company specializes in visual technologies: from simple illustrations to high-level interactive animations and web-design for entertainment, science, industries and educational supplies. The studio designed the project web site and the multimedia animations.

External partners involved in the definition and development of the project:

ETRIA, the European TRIZ Association contributed to the dissemination of the project, giving the opportunity to present TETRIS at the 'TRIZ Future Conference' (2008 and 2009).

The Friuli Venezia Giulia Regional Office of the Italian Ministry of Education participated, cooperating with AREA, in testing the TETRIS training course including also the tutors of the ISS National Project (Teaching Experimental Studies).

5) Plans for the Future

The prospective exploitation and further dissemination of the TETRIS educational model and materials, when considering the data available at the end of the project lifetime, appear vey promising, both inside and outside the consortium. Companies and research institutions directly involved in the project (ACC Austria, EIFER, Siemens and Stenum), as well as those which participated in the training courses are and will increasingly be applying TRIZ in their activities, as can be deduced from their feedback.
As concerns the schools involved in the project (Malignani Udine, HTL Wolfsberg, Jelgava 1 Gymnasium) they have been and will be using the TETRIS educational materials in their courses. In Italy and Austria, TRIZ will be included in the special projects which each school realizes autonomously in the frame of the respective national curricula. In Austria TRIZ will be integrated in 'CAD construction practice' in the students' final project developed in cooperation with the local industry and in the course for 4th grade business engineering and automation engineering students. In the 2010 courses will be organized for secondary school teachers with the collaboration of Alexander Sokol (JAEC) and visits to the production plan of ACC in order to show to students how TRIZ is applied concretely in the industry.
In Italy, the involvement of the tutors of the ISS National Project (Teaching Experimental Studies) in the course organized in AREA Science Park will lead to further dissemination, since they are in charge of the training of other teachers, who will in turn use the TETRIS materials in their daily activities.

In Latvia, furthermore, TETRIS led to another, very promising outcome, the development of a new professional study programme for advanced engineering studies at the Jelgava 1 Gymnasium. The programme, supported by the municipality of Jelgava, the Latvian Metal Processing Association and the Agricultural University of Latvia, was licensed by the Ministry of Education and Science of Latvia and in September 2009, the first 25 students were accepted and began their studies. Lobbying activities addressed to educational authorities are still ongoing in Italy, Austria and Latvia to enforce a wider use of TETRIS educational kit.

The participation in the TRIZ training course for teachers of representatives of the Croatian Ministry of Education will lead to the dissemination of the TETRIS educational materials also in that country. Moreover, several teachers and trainers who learned about TETRIS from the website contacted us to use the TETRIS materials (from France, Argentina, Israel and many others who simply downloaded the materials without notifying their use). Indeed, since the TETRIS materials are freely available to anyone who is registered on the TETRIS web site, the potential for exploitation is rather substantial (there are at present 985 registered users), yet it is hard to monitor the exact number of actual users. It should be underlined that a peak in the number of new visitors and registered users to the web-site was registered in November 2009, when TETRIS was presented at the ETRIA Conference and the project Final Conference was held in Trieste.

The universities involved in the project (University of Florence, Italy and University of Applied Science of Kaernten, Austria) are going to use TETRIS materials on a regular basis in the frame of their institutional educational activities as well as in commercial courses offered to companies or teachers. Further usage is envisaged also in several other universities: Milan Polytechnic (I), University of Bergamo (I), University of Applied Science of Graz (A), University of Erlangen-Nurenberg (D), Katholieke Universiteit Leuven, (B), "Politehnica" University of Timisoara (RO), University of Arad (RO), Holon Institute of Technology (IL).
AREA Science Park is going to use the TETRIS educational materials on a regular basis in its post graduate training and in courses dedicated to companies. At present AREA is holding a training course (*Support - Sustainable Innovation Tools*) in which the TETRIS educational materials are widely used. It should also be underlined that the TETRIS materials are disseminated also through the European Project ESIL - European Sustainable Innovation Licence. Moreover, the TETRIS educational materials will be used in Friuli Venezia Giulia in two of the regional training clusters: Mechanics and Aeronautics and Marine Activities (AREA Science Park and the Malignani High school are directly involved in both of them).

Harry Flosser Studios is planning to develop further visual materials based on the same model and layout of the TRIZ tales and presentations of the 'TRIZ Tales' at international film festivals are undergoing.

Several presentations of the TETRIS materials are envisaged at: ESK – European School in Karlsruhe, Germany; TechDynova Ltd. In Karlsruhe, Germany; IPI (Institute for Industrial Promotion, a technical agency of the Italian Ministry of Economical Development); AICQ (Italian Association for Quality Control); University Torvergata Science Park in Rome, Italy; Chamber of Commerce of Treviso.

Further dissemination activities are planned in the form of papers to be presented at the ETRIA 'TRIZ Future Conference 2010' and of further articles on in-house organs
On behalf of the City of Graz, STENUM is managing a network of 160 enterprises which work on process optimisation, water consumption reduction and energy conservation. STENUM is involved in similar networks in Vienna and Vorarlberg and will disseminate information on TRIZ, the TETRIS materials, and the courses in these networks, to start involving these companies stepwise in activities to promote and teach the TRIZ.

TETRIS materials are going increasingly international: in 2010, thanks to the voluntary work of several TRIZ fans, the TETRIS educational materials will be translated into Korean, Chinese and Farsi.

Moreover the project web site is still visited by a large number of new visitors, with an increasing rate of visitors from countries not directly involved in the project.

Partners are planning several national and European projects to further disseminate and implement TETRIS materials.

6) Contribution to EU policies

According to the '*Lisbon Goal'*, Europe is meant to become 'the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion'. To be a dynamic, knowledge-based economy, which implies creating more and better jobs, Europe needs more people with enhanced creativity and better problem-setting and problem-solving skills.
Today the teaching of these skills is limited to training activities organized by the most innovative companies, whereas this does not apply to schools, which fosters three consequences:

1) creativity, problem-setting and problem-solving are rare to find;
2) these skills are learned at an adult age, when they are more difficult to assimilate;
3) the learning of creativity, problem-setting and problem-solving are available only to a small minority of people, whereas reading, writing, learning a foreign language, using a computer can be learned at school.

Introducing the basic principles and techniques of creativity, problem-setting and problem-solving at school will help Europeans create a more innovative and more fair society.
As mathematics is a fundamental basis to learn engineering and other experimental sciences, the principles and techniques learned with the help of the TETRIS project will ease an in-depth learning of creativity, problem-setting and problem-solving methodologies.

The project, furthermore, addresses the following *key competences of the Lifelong Learning Programme*, a combination of knowledge, skills and attitudes appropriate to the context:

1) Learning to learn: the Tetris project will spread the basic knowledge of techniques and methodologies to enhance creativity, problem-setting and problem-solving capability and will help overcome psychological inertia.
Further learning of more advanced methodologies will be much easier and effective.
An improved problem-setting and problem-solving capability will furthermore ease comprehension and learning of technical and scientific subjects.
2) *Mathematical competence and basic competences in science and technology*: creativity, problem-setting and problem-solving, the basic principles of TETRIS are also the basic principles of scientific and technological research.
TRIZ is furthermore a methodology originally developed to solve, through a serious and strict scientific approach, technical problems mostly related to engineering issues. TRIZ is therefore particularly relevant for engineering studies and related disciplines since helps transfer the theory learned at school or University into real life and solve practical problems in an innovative and efficient way.

The relevance of the TETRIS project towards the strategic issues of the 7th Research Framework Programme:
1) *Research and development*: enlarging the number of people with enhanced creativity, problem-setting and problem-solving skills will contribute to the training of researchers.
2) Industry – Academia of the People Programme: TETRIS will contribute to networking educational institutions and the business world, creating a course which can be implemented both at school and for the initial training of young researchers and product designers in the academic and industrial world.