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A product innovation method based on the synergy between TRIZ and Interaction Design

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Abstract

Modern industries operate under very selective conditions, as all the competitors develop efficient and effective products. For this reason, innovation is one of the main ways to lead the market. There are some methods and tools to analytically help designers towards the generation of new ideas. TRIZ is one of these methods. But all of this is not enough to generate a success product, because a fundamental actor is still underestimated, the final user of the product under development. To satisfy the user's requirements, designers and developers must keep into consideration also the Interaction Design methods. Unfortunately, these methods are not as structured as the TRIZ theory and very often it is very difficult to apply them in an effective way. For all of this, it appears quite reasonable to think about the development of innovative, easy-to-use products, as helped by a synergy between the Interaction Design and the TRIZ theories. After some highlights about analogies and differences of these two domains, this paper develops the basis for the generation of a new integrated analytical method able to suggest a collection of guidelines for the definition and implementation of engineering requirements. Then this method is described, and the summary of a case study performed to validate the method closes the paper.

1 Introduction

Nowadays product innovation is one of the most challenging issues in the industrial design and production domains. To be competitive, an industry must enter the market with new products; to be more competitive and to lead the market, these products must be innovative. The main difference between a new and an innovative product stands in adopting creative, sometimes unexpected, solutions [1,2].

To reach innovation, competitors must pay attention to product design mainly during the concept generation phase. They can operate in two ways: by creatively generate new ideas or new product concepts from scratch, or by performing some re-design of existing products or the re-engineering of the processes to generate them, aiming at solving problems in an original and innovative way.

Innovation becomes systematic innovation when concepts, methods, tools, etc., are placed in a usable framework presenting a clear architecture. This happens in the theory considered in this research, TRIZ. TRIZ - the Latin acronym for Theory of Inventive Problem Solving - has been developed by Genrich Altshuller, and it is a set of methods, tools, strategies, etc., for solving technical problems in an innovative way and using innovative concepts. It suggests solutions by exploiting a knowledge base generated by analyzing over a million of patents [3-5].

Today the application of TRIZ ranges from the solution of mechanical design problems as the improvements of rotary compressors, heat exchangers or other structural or mechanical optimization problems, etc. [6-8], to chemical safety problems [9,10], till biology and bio-inspired design [11,12], and service industry or business management [13,14].

Interaction Design - ID - is another important aspect where product innovation can count on. It regards the design of interactive products aimed at supporting people in their everyday and working life. The ID practices typically focus on complex systems such as multiuser software packages, mobile devices, home electronics, interactive services, etc. The ID defines the behavior of these artifacts or systems while interacting with their users. This way, interaction designers work with the emphasis on users' goals and experience, and evaluate designs in terms of cognitive compatibility, usability effectiveness, etc. [15-19].

Some meaningful examples of the application of the ID principles include Personal Computer or mobile and smart phone interfaces (e.g. iMac, iPhone, etc.), till interactive household appliances or new services [20,21].

The analysis of the literature highlights that TRIZ is for sure one of the most known systematic approaches for creative design, but it has not been developed to provide a deep understanding of users' needs. On the contrary, ID is widely diffused as a design methodology for good product design in a user-centered view, but is not characterized by a systematic and structured approach.

Then, any possible synergy between these two innovation strategies should be studied. This paper investigates in detail the correspondences and, even better, the possible synergies, between TRIZ and ID, in order to enrich the collection of Design for multi-X methods for product development [1]. The reason for this is that in the last years these two topics have been rediscovered and appreciated by product designers and engineers involved in Human-Centered Design of consumer products [22, 23], but there have been really few attempts to couple them to maximize the effectiveness of their synergic adoption.

The next two sections, 2 and 3, contain an overview of TRIZ and ID, highlighting design activities and specific methods and tools. The structure and content of these two sections have been thought in order to ease the comprehension of the activities described in the rest of the paper. The section 4 describes the search for correlations and synergies between them and the section 5 the generation of a new integrated method that includes the benefits of TRIZ and ID, while section 6 describe a case study and section 7 lists some discussions about the results. The paper ends with conclusions and perspectives on the possible integration of these two design methodologies in a wider framework for product development.

2 TRIZ

2.1 Fundamentals

TRIZ was originally proposed by Altshuller in 1946. This theory comes from the idea that every engineer or people in general, can become an inventor and solve very difficult technical problems by proposing innovative solutions in a systematic way.

The TRIZ systematic approach guides people during problem solving activities avoiding a random exploration of the space of solutions. TRIZ gives directions to explore a restricted space for finding innovative solutions; it also guides problem solvers towards solutions or strategies that have demonstrated their efficiency and effectiveness in similar situations in the past, in the same or in completely different application domains [4,5]. TRIZ does not give solutions directly applicable; it suggests only research directions to find solutions, then leaving place to the designers' creativity. With TRIZ, inventors can generate more ideas than before, faster than before, and select the best ones in an automatic way.

The most important source of TRIZ is the knowledge base generated by the analysis of thousands of patents and pieces of technical information. This theory is also based on the analysis of scientific literature, on the psychological behavior of inventors, and, of course, on the analysis of existing methods and tools for product innovation. As explained in [5], the three primary findings of this analysis are: problems and solutions are repeated across different domains (industries and sciences); patterns of technical evolution are also repeated across different domains; innovations use scientific effects outside the field where they are developed. This huge work generates the knowledge base used in the heuristics and tools of TRIZ. Each time a new problem is solved, the knowledge base becomes richer.

During the patent analysis, Altshuller discovered that very different technical systems and processes share similar peculiarities in their evolutions. Sometimes the same generic problem had been pointed out and solved with the same generic principle of resolution but in different technical domains and the solutions were separated by many years.

For this reason, in TRIZ the specific problem is elevated to a higher level of abstraction before being solved. The specific problem must be first identified and described precisely. Then, the particular problem is converted into one of the TRIZ generic problem types, under the form of technical or physical contradiction, or substance-field model. Next, some standard solutions may be found for the particular problem by examining all the standard solutions provided by TRIZ for that type of generic problem - there are 76 solutions for solving substance-field problems and 40 principles for solving contradictions. After that, the standard solutions are evaluated against the technological evolution trends to further enhance the goodness of the standard solutions. Finally, the problem solvers exploit their experience and expertise in deriving and customizing a specific solution that is practical to the particular problem [3-5].

2.2 TRIZ concepts and tools

The set of fundamental concepts and heuristics used by TRIZ to solve complex problems have been implemented in several tools. In literature these tools are usually collected in two sets: TRIZ analytical tools - problem modeling - and TRIZ knowledge-based tools - problem solving - [24].

The research described in this paper exploits the following TRIZ knowledge-based items.

- *Laws of system evolution*. During its lifecycle, a system is always evolving and this evolution is governed by objective laws. This concept allows anticipating future ways of evolution of systems that show some sort of similarities [4,5].
- *Ideal Final Result - IFR*. This concept is strictly connected to another one, the Ideality. This is a psychological concept that allows finding the best solution for a complex problem without taking into account cost, time, space or any problem constraints. Ideality is defined by the ratio between the positive and useful functions of the system and the negative and harmful ones. It defines a sort of virtual goal. In TRIZ, Ideality is a goal. All systems evolve towards the increase of their degree of Ideality. The perfect system, called Ideal Final Result - IFR, has all the benefits the customer wants, with no harmful effects. The ideal system is often a utopia but it could guide toward seldom-explored directions [5].
- *Functional analysis and trimming*. Each system has its main, overall function, and all its components have to contribute to this function in the most effective way. Otherwise there could be some underuse and/or conflicts. The trimming concept exploits the functional description of the product, because it increases the value of the product by eliminating components and suggesting how to transfer their sub-functions to the untrimmed components. The goal is of course to keep the overall function of the system unaltered. Functional analysis and trimming are helpful in defining the problem and improving the Ideality of the system. Moreover, the notion of functionality allows the generalization of the different aspects of the system. This gets easier the transfer of knowledge and know-how among different application fields, such as the technical, the medical, the biological one, etc [3,9].
- *40 Inventive principles*. These principles come from the Altshuller's analysis of patents. They have been derived from the study of the principles used in the top few percents of the global patent literature, where a breakthrough invention had actually occurred. Principles are used to guide the TRIZ practitioners in developing useful concepts of solution for inventive situations. Each solution is a recommendation on how to make a specific change to a system for eliminating a technical contradiction [3-5].
- *Contradictions and the contradiction matrix*. In TRIZ, problems can be described in terms of contradictions. An inventive problem contains at least one contradiction, and an inventive solution overcomes totally or partially this contradiction. A contradiction is

a conflict in the system and it arises when two requirements or needs for a system are mutually exclusive but both are required by the overall function or, in other words, to reach the system goal. Contrary to classical methods for creativity stimulation, as brainstorming, trial and errors, etc., TRIZ refuses trade-offs and tries to eliminate the contradiction. TRIZ theory has specific tools to solve contradictions. The most important one, the contradiction matrix, recommends which principles should be considered in solving approximately 1250 different types of contradictions [3-5].

- *Multi screen or Nine box approach*. This is the simplest and most powerful TRIZ concept, also known as time and space interface. It works on all problem types, both technical and management, and allows investigating the system context and behavior in different situations. This concept is figured as a 9x9 square matrix where the columns describe three different times- past, present, and future - and the rows contain three different levels of system description - super-system, system and sub-system. This method is used in system analysis, to define the system environment - super-system - and all the system details - sub-systems -, taking a look to the past, considering the present, and trying to foresee the future [4,5].
- *ARIZ*: it is the algorithm used for the inventive solution of complex problems. It is not very used because it requires a big workload and for this reason the other TRIZ techniques are more frequently used. Some different versions exist and the most known one is composed of 10 stages, starting from collecting and classifying the pieces of information, proceeding with the problem analysis and reduction, until the concept generation and evaluation.

3 Interaction Design

3.1 Fundamentals

The ID is a discipline born recently when the user needs become the most important element for the success of a product [19]. One of the main goals of the ID is to develop usable products. Therefore, at the beginning, a large part of ID activities was related to usability evaluation and testing. After the first years of experiences in the field, the research started to study and develop methods and tools to design the interaction in the product, rather than to leave these important issues to the experience and commonsense of the classic designers. All of this moved the ID towards a really interdisciplinary domain, where different expertise coming from design, arts, technology and sciences, etc. is needed. The ID attempts to improve the usability of a product by first searching and understanding the users' needs. Designers will be able to properly tailor and maximize usability only by involving the final users of the product. Then, designers work to meet and to go beyond the collected requirements, by trying to figure out the evolution of the users thanks to the use of the product, and how these people would like to use it. All of this leads to the development of a set of ID concepts. Fortunately, even if interaction designers follow similar problem solving processes, results may differ really much each other because ID practices involve many principles and methods. These solutions are evaluated and compared, and then designers build some prototypes of the interface that implements the interaction and test them with the users to validate the concepts. Finally, the first release of the resulting system is generated and tested with final users. Based on the users' feedback, several iterations of any set of phases of the process may occur.

3.2 ID concepts and tools

As for TRIZ, the ID shows a set of fundamental concepts and some law and heuristics to solve interaction problems. The authors of this paper suggest collecting the ID items in two categories: ID description concepts - for a formal and usable description of the system under study, and ID knowledge-based concepts - characterized by items for thinking enhancement and generic problem solving.

The following ID knowledge-based items are of interest here.

- Laws of interaction design. There are some laws that interaction designers successfully use, while they can maintain their creativity unbounded. In fact, these laws guide designers' work without dictating it. Well-known examples are Fitts's Law, Hick's Law, the Miller Magical Number Seven, and the Poka Yoke principle. Fitts's law simply states that the time required to move from a starting position to a final target is determined by two factors: the distance to the target and the size of the target. Hick's Law says that the time it takes for users to make decisions is determined by the number of possible choices they have. Miller determined that the human mind is best able to remember information in max seven chunks, plus or minus two. Finally, the Poka Yoke principle states error prevention strategies [15,19].
- Norman's design principles. These are general abstractions developed to orient interaction designers towards thinking about different perspectives of their design problems. Design principles are derived from a mix of theory-based knowledge, experience, and common sense. They suggest to designers what to provide and what to avoid during the development of a system interface. Norman suggests several design principles that ideally may be used for every device and appliance. Among them, there are visibility, feedback, natural mapping, constraints, and design for error [16].
- Nielsen's heuristics. These heuristics consist in ten general principles for user interface design. Nielsen originally developed and refined his heuristics principles by analyzing 249 usability problems. The ten heuristics comprise the visibility of the system status, the match between the system and the real world, the user control and freedom, the consistency and the obeying to standards, the aesthetic and minimalist design, etc. [15,25].
- Metaphor. In the ID context, the metaphor is an important concept that provides designers the means to understand complex systems. As reported in [26,27], metaphors help to conceive and understand abstract concepts like the time, usually by making reference to more concrete objects. The way people understand new things is to conceive of them in terms of things they already know. Designers can take a familiar domain and use and exploit its characteristics to find similarities and differences between it and the unfamiliar domain. All of this makes the unfamiliar domain more usable for the final users. Metaphor can be a powerful tool for designers,

in both the process of designing and within the products themselves. Moreover, metaphors can help to redefine design problems and to solve them. They can be used as a research tool, to understand new subject areas, or as a way to generate new ideas starting familiar subjects [26,27].

- Interaction paradigms. This concept refers to a particular philosophy or way of thinking about the ID. It is intended to orient designers to the types of questions they should ask themselves during their activities. For many years, the main paradigm in ID was to develop applications to be used by single users sitting in front of a monitor, with a CPU, a keyboard, and a mouse. Now, a number of alternative interaction paradigms have been proposed by researchers, to guide future interaction design and system development. These alternative paradigms include for example ubiquitous computing - technology embedded in the environment, pervasive computing - seamless integration of technologies, wearable computing, augmented reality, physical/virtual integration, etc. [17].
- Usability evaluation methods. Usability evaluation is an essential activity for generating highly usable products. Various usability evaluation methods have been developed; they can be classified into three types: usability testing, usability inquiry, and usability inspection [25,28-31]. Usability testing employs representative users using a system or a prototype to perform typical tasks and then evaluates the cognitive compatibility of the user interfaces. Typical methods include co-discovery learning, question-asking protocol and shadowing method. Usability inquiry talks to users, observes how they use a system in real work settings, and let them answer questions in order to understand the users' feeling about the system and their information needs. Field observation, focus groups, and surveys, are typical usability inquiry methods. Finally, in usability inspection, usability experts examine usability-related aspects of the interfaces in an analytic way. Here the typical methods are cognitive walkthrough and heuristic evaluation.

4 Correlations, differences, and possible synergies between TRIZ and ID

As stated in the introduction, the goal of this paper is to investigate about possible correlations and, even better, real synergies between the systematic innovation theory TRIZ and the ID. First of all, it is important to point out that this search for correlations is possible because the items of the two domains are used for design purposes. In particular, these methods are involved in product innovation processes. Both the domains adhere to similar development frameworks, in which research and analysis phases are followed by the solution generation, and by the evaluation/validation of the solutions found. As described in section 2, TRIZ theory is based on a more systematic approach and TRIZ tools widely support the problem definition phase. On the other hand, ID methods emphasize the problem finding without a rigorous problem definition; ID follows a less structured approach and, in particular, it provides weak structures for generating solutions, but it takes into account the users' needs.

4.1 Correlations and differences

Before trying to set some synergies between these two groups of items, it is better to individuate correlations and differences between them. Given that ID has not specific and consolidated analytical methods for problem modeling - ID uses a heterogeneous collection of methods and tools for system description, only ID knowledge-based items are considered at the moment.

As summarized in Tab. 1, it is possible to find meaningful correlations between TRIZ and ID. In particular, the 40 inventive principles can be put in relationship with the Laws of interaction design, the Nielsen's heuristics, and the Norman's design principles, in terms of design guidelines that can be used in general for finding the better solutions of a design problem. Besides, these guidelines can be applied in different contexts and for different kinds of problems.

TRIZ	ID
40 Inventive Principles	Laws of interaction design Nielsen's Heuristics Norman's design principles
Laws of system evolution	Interaction paradigms Metaphors
Ideal Final Result	Usability Evaluation &Testing methods
Functionality and trimming	Metaphors
Multi Screen or Nine box Approach	Metaphors Interaction paradigms

Tab. 1 Correlations between TRIZ and ID.

There are also some correspondences between TRIZ laws of system evolution and the ID interaction paradigms and metaphors. In fact, when the ID designers imagine the future developments of a system interaction, they set a sketch of technology forecasting enforced by the use of metaphors. Another correspondence can be identified between the TRIZ Ideal Final Result and the ID Usability evaluation and testing methods. This correspondence is intended as the will of the ID designers to produce products more usable as possible or, in other words, ideally usable. Moreover, the TRIZ functionality and trimming may be related to the ID metaphors. In fact, ID designers set some sort of functional representation of the system interface during the definition of the metaphors. This representation is not as structured as a TRIZ system functional model; anyway it is an interesting contact point between these two domains. Finally, a correlation can be identified between TRIZ multi screen approach and the ID metaphors and interaction paradigms. In fact, these two ID items allow designers to analyze the system status in relation to time location (present, past and future) and in relation to its dimensions and future developments.

Together with the correlations shown in Tab. 1, it could be useful to highlight the main differences between the two domains considered here. All of this happens because the search of synergies may effectively start from them, in trying to compensate the lacks of TRIZ with the peculiarities of ID and vice versa. For example, a correlation between TRIZ contradictions and any ID item was not found. The authors of this paper have only found a soft correlation between TRIZ contradictions and the Nielsen's heuristics. Every time a usability heuristic is violated by the interface of a system under development, a sort of contradiction in the system behavior may be highlighted.

As summarized in Tab. 2, the main differences between these two set of items can be identified in the following aspects. First of all, there is the presence of a highly structured approach to problem solving in TRIZ, against a loosely structured problem solving strategy in ID. The absence of a systematic design approach is highlighted by the different focusing of the two methods. TRIZ focuses on functionality and technical aspects of the problems, while ID is oriented to interaction aspects and user's needs. Moreover, TRIZ theory and concepts emphasizes abstraction, while ID methods emphasize the real context. Finally, in ID practices the innovation is intended as a consequence of the experience and the skill of the design team members. For this reason, the results of the ID reasoning refers to the description of the 'why' aspects of the product design process, but often it does not suggest solutions. On the other hand, TRIZ, thanks to its structured approach and leveraging of other success results, may suggest the 'what' and 'how' aspects of the considered design problems [28] and, in this way, it can prescribe real solutions.

TRIZ	ID
Highly structured approach	Loosely structured approach
Focus on functionality and technical issues	Focus on interaction aspects and users' needs
Emphasizes abstraction	Emphasizes the real context
Prescribes 'what' and 'how'	Describes 'why'

Tab. 2 Main differences between TRIZ and ID.

4.2 Possible synergies

From the correlations and the differences between TRIZ and ID identified in the previous paragraph, it emerges that the synergic application of the two collections of items described before could represent a meaningful added-value in product innovation activities. Fig. 1 shows an overview of a proposed method coming from this integration, namely the innovation-oriented ID approach to product development. This method allows using both a new analytical method that includes only the ID items and a synergy between the systematic approach of TRIZ and the unstructured ID, mainly in the idea & concept generation phase. An important part of the method is the introduction of the ID-oriented Ideal Final Result concept. It consists in the definition of the precise goal to tend to throughout the ID activities. Thanks to the users' involvement, it should be possible to determine where and when interaction problems of the system or discrepancies from its expected behavior may occur. In comparison with a classic-style ID process, where the phases are 1) Design Research, 2) Analysis and concept generation, 3) Alternative evaluation, 4) Prototyping, 5) Implementation, 6) Testing,, the new innovation-oriented ID process is based on a more structured idea & concept generation phase, where there are some new phases: Specific problem description (2a), and Innovation-oriented ID generic problem description (2b), which represent the typical phases of the TRIZ process for the functional description of the system. Moreover, the proposed method splits the old Alternative design and evaluation phase into two new phases: Innovation-oriented ID generic solution generation (3a) and Specific solution generation (3b), for a more systematic exploration of the solution space during the ID problem solving activities. Inside this method, the ID-oriented Ideal Final Result allows measuring the performances of two phases; in fact, it is used to quantify the distance between the specific solution selected in the phase 3b and the IFR, and to measure the performances of the final release of the system (6).

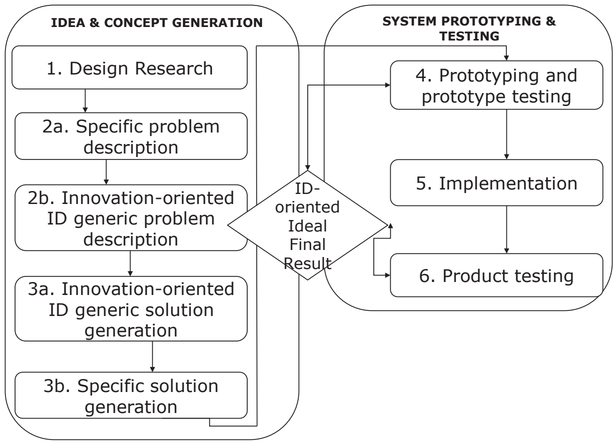

Fig. 1 Overview of the innovation-oriented ID approach to product development.

5 The innovation-oriented ID approach

This paragraph describes the six phases of the new ID approach in detail. Fig. 2 can be used as a reference for this description. A case study has been performed to test the validity of the proposed method. An innovative product should derive from the synergy between a refrigerator and a TV set and the goal of this case study was to generate a set of guidelines to get their integration as usable as possible.

Regarding the guidelines generation process, there are three possible paths, depending from the problem complexity, the available resources, and the designers' skill and knowledge. The first path (I) is based on the adoption of the basic tools of TRIZ; the second one (II) exploits the ARIZ, while the third (III) refers to the adoption of different analytical methods and tools (not considered here for space reason). Of course, all of them contain the eight phases depicted in Fig. 1. The boxes in Fig. 2 are labeled accordingly. For example, I-2a means that the box represents the phase 2a of the first path.

The phase 1, Design research, is common to all paths. It allows defining problem boundaries, complexity, type of design process (new design or redesign), etc. After that, the paths towards the generation of the design guidelines split in three.

1) Use of the basic TRIZ tools: this part is characterized by the use of the classic TRIZ tools. The first phase defined the users' needs and the specific goals of the product and the IFR is evaluated from them. Then, the functional model is generated and it allows defining a generic description of the users' needs. These are the basic elements needed for the adoption of the basic TRIZ tools. Seven tools could be applied; if they don't generate a good solution, another iteration starts, where the users' needs and the functional scheme can be revised and after that, new tools can be chosen. Some generic guidelines are found, from which the particular ones are derived and applied to the product model.

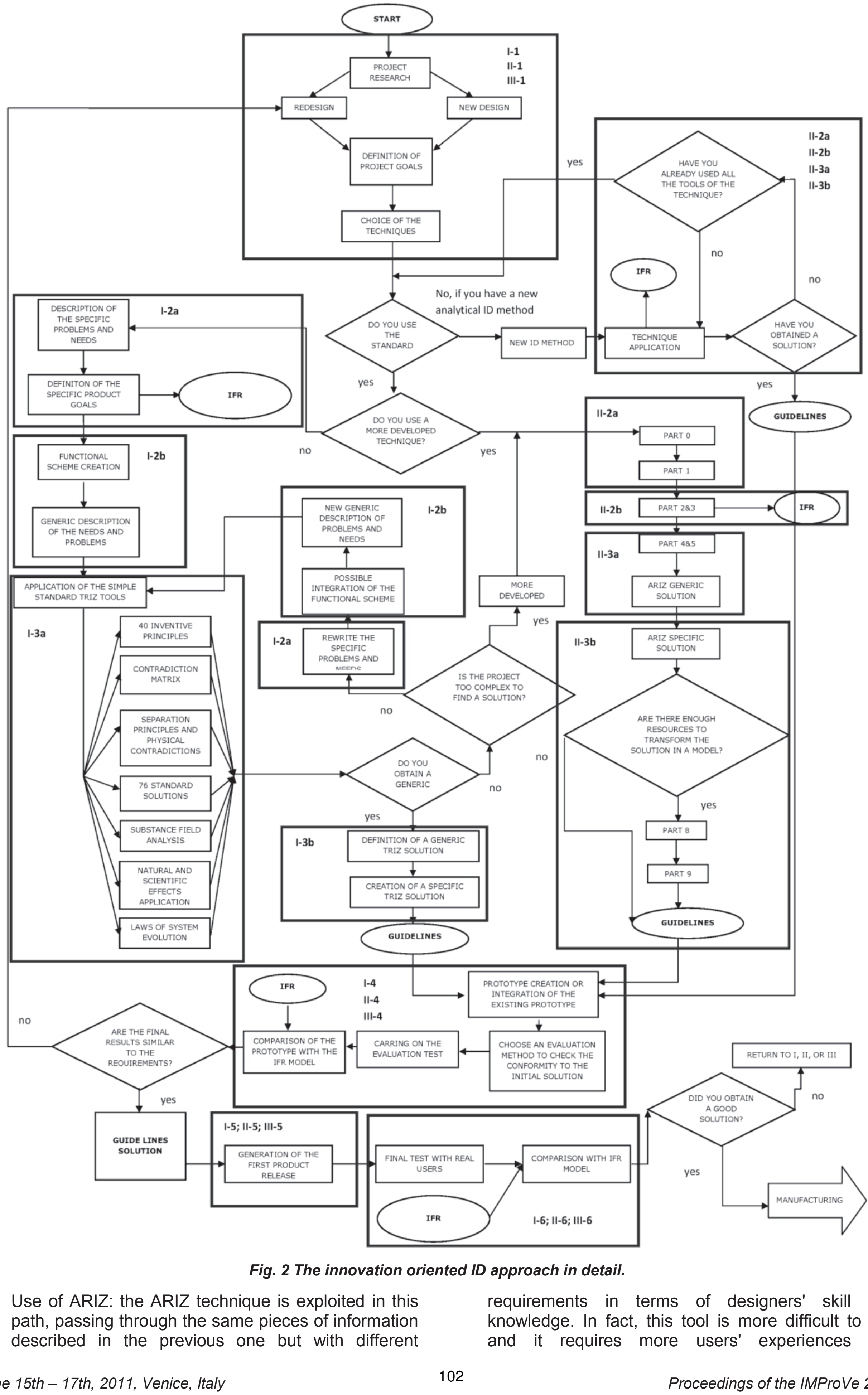

Fig. 2 The innovation oriented ID approach in detail.

2) Use of ARIZ: the ARIZ technique is exploited in this path, passing through the same pieces of information described in the previous one but with different requirements in terms of designers' skill and knowledge. In fact, this tool is more difficult to use and it requires more users' experiences and

capabilities in problem solving. On the other hand, it allows generating a generic good solution already at the first iteration. Also this technique starts with the collection and the classification of the user needs, but it is based on the principle of the reduction of the problem in simpler sub problems, so it is easy to find partial generic solutions on them. The customized guidelines are generated starting from the union of them.

3) If a different analytical methods based on ID theories is available, it can be exploited here. When a set of guidelines is found, it is necessary to evaluate if it is a good one. For this reason, the process go ahead to the fourth phase; if the test is positive, the solution is kept into consideration, otherwise another tool of the same technique could be exploited, or a different path can be chosen.

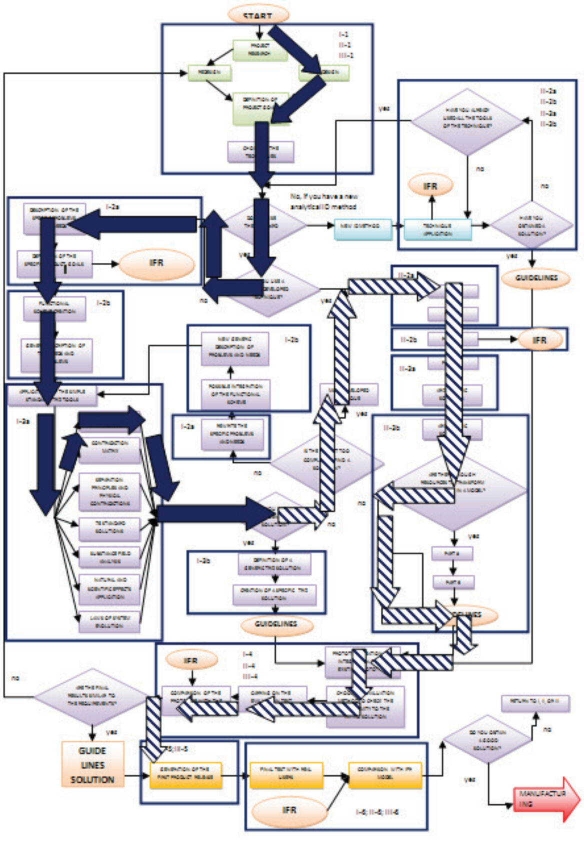

Fig. 3 Procedure of the case study.

The three paths join again at the phase 4, where the generated guidelines are used to update the product model and to generate a prototype of the result. Then this prototype is evaluated using techniques compatible with the available resources and the result of the evaluation is compared with the IFR. If the test gives a positive answer, in other words if the product satisfies the usability requirements, the process goes ahead with the generation of the final product - phase 5 - that will be tested again, for the last time for this iteration of the procedure, regarding the IFR.

In the case study, the process is followed until phase 4, because of the lack of the possibility to generate a real prototype.

Fig. 3 shows the roadmap of the case study: first, the path I has been followed, by applying the basic TRIZ tools to the design - full arrows in Fig. 3. Then, given that the results weren't so satisfactory, the process proceeded using the path II, based on ARIZ - dashed arrows in Fig. 3.

Some of the resulting guidelines suggested by the proposed method run as follow.

- The structure of the door of the refrigerator must be able to house an integrated touch screen;
- The two parts of the new product - refrigerator and TV set - must be easily taken apart each other;
- The new product must be able to play TV programs as well as radio ones;
- There should be some functions using both the devices at the same time, in synergy. For example, on-line shopping;
- The door of the refrigerator could be built using a special material, the electro chromic glass, in order to make easier the evaluation of the refrigerator content during the shopping on-line.

6 Discussion

The lack of synergies between two of the most promising techniques for product innovation, TRIZ and ID, suggested the research described in this papers. The highlights of their correlations and differences allowed the definition of the proposed method. It demonstrates that this integration of TRIZ and ID is possible and it is quite clear that the functional approach of TRIZ may be used for describing interaction and/or usability problems in a more structured way. In fact, the ID theories consider the users' needs and expectations and TRIZ supplies a list of analytical instruments that allow generating innovative solutions from them, joining together the technique benefits. In this way designers can generate easy-to-use and innovative products. These two aspects are decisive for the success in the market. For these reasons, as will be suggested in the conclusion and perspective paragraph, an ID-oriented customization of TRIZ solutions, engineering parameters or effects, will be investigated as it has been done for other research domains, such as the chemical and the biological ones [9-12,32]. Moreover, the TRIZ approach to technical problem solving can give an important contribute to the creative phases of the ID process, particularly if interaction issues concern physical aspect as in ergonomics, where, for example, the laws of system evolution represent effective tools for pointing designers towards improved and effective solutions. In general, the synergy with TRIZ can make up for the ID lacks about technical issues or, in other term, can help in generating the 'what' and 'how' answers to the ID 'why' questions.

7 Conclusions and perspectives

An initial taxonomy about some aspects of the systematic innovation theory named TRIZ and of the ID suggested an investigation about the presence of possible correspondences between them. All of this drove to the discovery of some significant contact points between these two methods; for example, the presence of design guidelines - TRIZ 40 principles and ID interaction design principles -, or the analysis of evolution trends. Then, the research exploited these findings in searching possible synergies, starting from the main differences between these two domains.

As a result, a new method for ID has been developed and it seems to prove that TRIZ and ID complement each other very well. The systematic TRIZ approach remedies the non analytical and unstructured ID approach, while the user focus of ID should be integrated in the problem definition of TRIZ. Within this method, interaction problems may be analyzed and solved using a more systematic approach.

The research is at the beginning. This paper describes the potentialities of the synergy between TRIZ and ID and depicts the items where the development of this synergy can count on. In future papers, the authors will investigate the possibility of setting and implementing this synergy into an existent framework for product design, and they will test it using some case studies. Moreover, there will be some research to find out if and how the TRIZ methods, for example the inventive principles or the engineering parameters, could be tailored and/or extended to some particular ID contexts.

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References

[1] D., Ullman. *The Mechanical Design Process*. McGraw-Hill, New York, NY, USA, 2002.

[2] J. E., Ettlie. *Managing Innovation.* Second Edition: New Technology, New Products, and New Services in a Global Economy. Elsevier Butterworth-Heinemann, Burlington, MA, USA, 2006.

[3] G., Altshuller. *And suddenly the inventor appears. Appeared-TRIZ, the Theory of Inventive Problem Solving*. Technical Innovation Center, INC. Worcester, MA, 1996.

[4] M. A., Orloff. *Inventive Thinking Through TRIZ: A Practical Introduction.* Springer, Berlin Heidelberg, Germany, 2006.

[5] K., Rantanen, E., Domb. *Simplified TRIZ: New Problem Solving Applications for Engineers and Manufacturing Professionals*. St Lucie Press, Boca Raton, FL, USA, 2002.

[6] V., Krasnoslobodtsev, J-Y., Lee, J-B., Lee. *TRIZ Improvement of Rotary Compressor Design*. Journal of TRIZ in Engineering Design, 1(1) (2005), pp. 2-13.

[7] B., Busov, D., Mann, P., Jirman. *Heat exchangers Case Studies In TRIZ: A Novel Heat Exchanger (Use of Function Analysis Modelling to Find and Eliminate Contradictions)*. TRIZ Journal, 12, (1999); http://www.triz-journal.com/archives/1999/12/b/index.htm.

[8] S., Campo dall'Orto. *Innovazione sistematica e Triz. Casi di applicazione nelle Pmi*. Edizioni Franco Angeli, Milano, 2008.

[9] G., Cortes Robles, S., Negny, J-M., Le Lann. *Case-based reasoning and TRIZ: A coupling for innovative conception in Chemical Engineering*. Chemical Engineering and Processing, 48 (1) (2009), pp. 239 –249.

[10] J., Kim, J., Kim, W., Lim, Y., Lee, I., Moon. *Application of triz creativity intensification approach to chemical process safety*. Journal of Loss Prevention in the Process Industries, vol 22(6) (2009), pp. 1039-1043.

[11] J. F. V., Vincent, O., Bogatyreva, A. K., Pahl, N., Bogatyrev, A., Bowyer. *Putting Biology into TRIZ: A Database of Biological Effects*. Creativity and Innovation Management, 14 (1) (2005), pp. 66-72.

[12] J. F. V., Vincent, O, Bogatyreva, A. K., Pahl, N., Bogatyrev, A., Bowyer, A. K., Pahl. *Biomimetics: its practice and theory*. J. R. Soc. Interface 3 (2006), pp. 471-482.

[13] J., Zhang,K. C., Tan, K. H., Chai. *Systematic innovation in service design through TRIZ*. The TRIZ Journal, September Issue (2003), pp. 1-12.

[14] K. H., Chai, J., Zhang, K. C., Tan. *A TRIZ-Based Method for New Service Design*. Journal of Service Research, vol 8(1) (2005), pp.48-66.

[15] B., Moggridge. *Designing Interactions*. The MIT Press, Cambridge, MA, USA, 2007.

[16] D., Norman. *The design of everyday things*. Basic Books, New York, NY, USA, 2002.

[17] J., Preece, Y., Rogers, H., Sharp. *Interaction Design. Beyond human-computer interaction*. John Wiley and sons, New York, NY, USA, 2002.

[18] N., Streitz, A., Kameas, I., Mavrommati. *The Disappearing Computer: Interaction Design, System Infrastructures and Applications for Smart Environments* - Lecture Notes in Computer Science, Springer-Verlag Berlin-Heidelberg, Germany, 2007.

[19] D., Suffer. *Designing for Interaction: Creating Smart Applications and Clever Devices*. Peachpit Press, Berkeley CA, USA, 2006.

[20] Apple: www.apple.com; accessed: 24th January 2011.

[21] D., Braun. *Home smart Home*. Siemens -Pictures of the Future, Spring 2007, http://w1.siemens.com/innovation/en/publikationen/publications_pof/pof_spring_2007/livable_megacities/household_appliances.htm; accessed 24th January 2011.

[22] A., Van Pelt, J., Hey. *Using TRIZ and Human-centered Design for consumer product development.* proceedings of TRIZ Future World Conference, October 9-11, 2006 Kortrijk, Belgium.

[23] B. L. W., Wong. *Inventivity In HCI Education, in Inventivity: Teaching Theory, Design and Innovation in HCI*. In proceedings of HCIEd2006-1, First Joint BCS/IFIP WG13.1/ICS/ EU CONVIVIO HCI Educators, Hvannberg, E.T., et al. (Ed.), Limerick, Ireland (2006), pp 67-72.

[24] K., Yang, H., Zhang. A Comparison of TRIZ and Axiomatic Design. In proceedings of ICAD2000 First International Conference on Axiomatic Design, Cambridge, MA, USA, 2000, pp 235-242.

[25] J., Nielsen. *Usability Engineering*. Morgan Kaufmann, San Francisco, CA, USA, 2004.

[26] J., Hey, A. M., Agogino. *Metaphors in conceptual design*. In proceedings of the ASME 2007 International Design Engineering Technical Conferences & Computers and Information in Engineering - IDETC/CIE, Vol 3, pp 125-134.

[27] D., Suffer. *The role of Metaphor in Interaction Design*. Master Thesis in Interaction Design, School of Design, Carnegie Mellon University, Pittsburgh, PA, USA, 2005.

[28] USEIT: http://www.useit.com/papers/heuristic/ accessed: 24th January 2011)

[29] J., Karat. *User-centred software evaluation methodologies*. In Handbook of Human–Computer Interaction, Helander, M.G., Landauer, T.K., Prabhu, P.V. (Eds.), Elsevier Science, Amsterdam, The Netherlands, 1997, pp. 689-704.

[30] J., Nielsen, R. L., Mack. *Usability Inspection Methods*. John Wiley & Sons, New York, NY, USA, 1994.

[31] D., Zhang, B., Adipat. *Challenges, methodologies, and issues in the usability testing of mobile applications*. International Journal of Human–Computer Interaction, vol 18, (3) (2005), pp 293–308.

[32] J., Fresner, J., Jantschgi, M. S., Birkel, J., Bärnthaler, C., Krenn. *The Theory Of Inventive Problem Solving (Triz) As Option Generation Tool Within Cleaner Production Projects*. Journal of Cleaner Production, vol 18(2) (2009), pp 128-136 0.1016/j.jclepro.2009.08.012.