International Journal of Engineering Education Vol. 29, No. 2, pp. 355–364, 2013
Printed in Great Britain

0949-149X/91 $3.00+0.00

IDEATRIZ—A Methodology for New Product Ideation*

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Organizations seeking to be innovative face many dilemmas. The main one is that, though it is necessary to innovate, innovation is a highly risky activity. The focus of this paper is on the root of product innovation, which is new product ideation. The prevailing literature in this area tends to put emphasis on the external source for new product ideas—namely, the market. The fact that the external source cannot lead to truly original product ideas seems to be ignored. In this paper, the IDEATRIZ methodology is presented. This is a different approach to new product ideation, based on the use of the internal source—an organization's own resources. A background for this approach is provided, as well as a description of the methodology itself and activities conducted regarding its validation—tests performed during its development and three cases where the methodology was used for new product ideation in real projects. Results show that the methodology is effective, with a higher output of creative (both original and useful ideas) than other ideation methods and methodologies. Finally, planned activities regarding the computerization of IDEATRIZ are discussed.

Keywords: product development management; product innovation; new product ideation; Computer Aided Ideation; TRIZ (Theory of Inventive Problem Solving).

1. Introduction

Introducing new products is one of a company's most important activities. There is a significant correlation between innovative firms and leadership status [1]. On the other hand, evidence shows that most of the new products introduced fail [2].

There are many reasons for market failures of new products. This paper deals with one of the main potential sources for success or failure in new products: the quality of new product ideation. Ideation is at the start of product innovation, as recognized by eminent authors in the field such as Cooper [1], Otto & Wood [3], Crawford & Di Benedetto [4], and Pahl et al. [5].

According to the 2005 Arthur D. Little innovation study [6], idea management has a strong impact on the increase in sales associated to new products. This impact is measured as an extra 7.2 percent of sales from new products and makes the case for giving more attention to new product ideation.

Ideally, only successful new product ideas should be generated. Thus, no resources would be wasted in developing products with little or no chance of market success. The problem is, how to assess if a product will be successful or not? Is it possible to determine that beforehand? These are the questions of our research.

In this paper, we present an effective new product ideation methodology—IDEATRIZ—which was designed to consistently lead to valuable new product ideas. A background is provided, as well as a description of the methodology itself and activities regarding its validation—tests performed during its development and three cases where the methodology was used for new product ideation in real projects. Finally, conclusions are drawn.

2. New product idea sources and the external source bias

Essentially, there are two major new product idea sources: External and Internal. External sources are based on the use of some form of market-derived information. Internal sources rely on employee creativity.

External new product idea sources are highly valued in new product development literature [7–9].

According to a survey conducted by Cooper & Edgett [10], external sources include the subcategories Voice of the Customer, Open Innovation and Other. The Voice of the Customer subcategory is composed by Ethnography, Customer Visit Teams, Customer Focus Groups, Lead User Analysis, Customer as Designer, Customer Brainstorming, Customer Advisory Boards, and Communities of Enthusiasts. Open Innovation includes Partners and Vendors, External Scientific/Technical Community, Small Businesses and Start-ups, External Finished Product Designs, External Submission of Ideas and External Idea Contests. Other sources are Peripheral Vision, Disruptive Technologies, Patent Mapping, and Internal Idea Capture Systems.

In their survey, Cooper & Edgett [10] investigated how extensively each ideation method is used—the popularity of each method—as well as management's perception of the method's effectiveness in generating high-valued new product ideas. According to this survey, the most popular and effective are Customer Visit Teams, Peripheral Vision, Focus

* Accepted 19 October 2012.

Groups, Lead User Analysis, and Disruptive Technologies. It is interesting to note that Cooper & Edgett [10] do not include the wealth of Idea Generation Techniques (IGTs) as possible new product idea sources.

Marketing theory focuses on many different ways to exhaust the External source of new product ideas—the market. However, historic data reveals that many new and surprising product ideas were devised by people that had absolutely no knowledge about what later would become the market for those products.

With the exception of very simple products and extensions, product development takes considerable effort and time. Hence, designing products based solely on voice of the customer studies and need assessments made at the initial stages of product development means that the latter will be designed for the past. Clearly, the External source can provide only indications about the past [8, 11].

According to Ries & Trout [12], most marketing surveys are reports on the past. Market research tells what customers already did and wanted, and not necessarily what they will do and want. Ottosson & Nordin [13] stated that innovation and the voice of the customer (Quality Function Deployment) are "like fire and water".

Goldenberg & Efroni [14] proposed that it is of no use to look for new product ideas in the market, because:

- it is impossible to extract new and surprising ideas from a latent market, since at this stage the market is not yet aware an cannot provide information about them;
- it is useless to extract information from a market saturated with information about a particular product, for the simple reason that the information extracted will not be innovative or surprising.

As a means to compensate for the lack of timeliness of market information in new product development, some authors [15–17] have tried a somewhat different approach to explore the External source for new product ideas: compiling and using market trends. Arguably, market trends indicate future customer's needs.

However, published market trends are very generic, rendering them of limited usefulness in new product ideation. This becomes especially true when they are compared with the heuristic IGTs, discussed in the next session.

We are critical of the excessive focus on the External ideation approach that prevails in marketing literature. The absence of reference to IGTs in Cooper & Edgett's [10] research seems to be a symptom of that. We defend that IGTs can be an effective new product ideation approach; because our experience shows that their use can result in genuinely original ideas.

3. Idea generation techniques and their effectiveness

We have been experimenting with the effectiveness of IGTs since 1997.

There are hundreds of IGTs, which makes experimenting with each one of them impractical. However, when a closer look is taken at the vast variety of techniques, it becomes apparent that there are many similarities. Thus, we considered that a focused study could be performed, encompassing the most representative techniques. After analyzing the literature on IGTs, we considered these techniques as representative of:

- intuitive IGTs: Brainstorming [18], Brainwriting [19], Synectics [20], Lateral Thinking (LT) [21], and Gallery [22];
- systematic IGTs: Value Analysis [23], and Morphological Method [24];
- heuristic IGTs: Inventive Principles [25], Separation Principles [25], Smart Little People [25], 121 Heuristics [26], Evolution Trends [27], Su-Field Analysis and Standards [25], and ARIZ [25].

The experiments applying selected IGTs where conducted between 1997 and 2007, in training environments. Participants were undergraduate students and young professionals in different technical careers. Mainly, participants came from these areas: mechanical, electrical and civil engineering, and product design.

The general procedure for each experiment was:

(1) Instruction about the specific IGT by the author;
(2) Application of the IGT by teams of 4 to 6 training participants, under author's supervision, with support of a standard form, specifically created for each IGT;
(3) Evaluation of results (ideas generated) by the teams, and discussion involving all teams;
(4) Evaluation of ideas by external experts in the subject area of each application.

The underlying concept for the last evaluation is that a creative idea is one that is both original and useful, as judged by domain experts [28]. This is based on the assumption that people, and especially experts, can identify a creative idea, even when they are unable to supply a list of properties which characterize a creative idea in their domain.

The results are summarized in Table 1. The Table includes total number of experiments, the size of the sample analyzed (about 30% of experiments), and the statistics of interest: number of generated ideas,

Table 1. Results of Experiments with IGTs [29]

IGT	Total number of experiments	Size of analysed sample	Number of ideas generated		Number of original ideas		Number of useful ideas		Number of creative ideas (considered both original and useful)		Percentage of creative ideas
			a	s	a	s	a	s	a	s	
Brainstorming	160	30	58.5	13.9	33.9	10.5	25.5	4.3	10.1	4.2	17.3
Brainwriting	160	30	91.3	8.1	45.3	13.9	27.2	8.5	15.5	8.2	17.0
Synectics	150	27	44.5	8.7	30.8	9.3	13.5	4.1	9.2	3.7	20.6
Lateral Thinking	130	25	27.8	6.3	18.9	6.2	12.8	5.2	4.5	2.1	16.2
Gallery	130	25	49.1	9.7	24.6	6.8	11.0	5.8	6.3	3.8	12.8
Value Analysis	109	20	22.3	7.1	12.7	5.9	15.4	4.4	5.2	1.8	23.3
Morphological Matrix	160	30	20.8	6.6	6.2	3.2	12.2	3.6	4.2	2.0	20.1
Inventive Principles	89	17	23.1	6.3	15.7	5.1	13.8	4.2	7.6	3.2	32.9
Separation Principles	14	3	18.5	4.2	12.3	3.4	8.0	3.7	6.4	2.6	34.6
Smart Little People	14	3	14.3	4.4	11.2	3.1	6.7	2.3	5.2	1.8	36.3
121 Heuristics	14	3	27.5	8.2	17.9	6.2	12.2	5.2	8.5	2.6	30.9
Evolution Trends	14	3	55.0	12.1	30.3	9.6	17.3	7.2	15.2	3.2	27.6
Su-Field Analysis and Standards	14	3	13.5	3.2	7.5	3.3	6.0	2.2	7.2	2.7	53.3
ARIZ	14	3	14.2	3.5	6.4	3.0	5.3	2.0	7.4	2.1	52.1

number of original ideas, number of useful ideas, and number and percentage of creative ideas. A discussion of the results is provided below.

Experiments with Brainstorming resulted in 17.3% creative ideas, on average. Originality was 33.9% on average, and usefulness, 25.5% on average. For instance, in a Brainstorming session focused on the problem of paint removal from a wall, not very practical ideas such as ''use cats to scratch paint'' and ''use nano-technological paint remover'' were suggested. In a typical Brainstorming session, ideas that negate or change the initial objective are often proposed, such as ''use materials that make painting unnecessary'', ''no paint'', and ''eliminate walls''. Experiments made evident that good results in Brainstorming are highly dependent on the team's profile and moderator action. Average time demanded for preliminary analysis and selection of generated ideas was 162 minutes, more than 3 times the average ideation time of 49 minutes.

Brainwriting results were similar to those obtained with Brainstorming: 17.0% of creative ideas. We found evidence contrary to Hellfritz's observations [22]: in our experiments, when compared to Brainstorming, Brainwriting frequently resulted in a bigger number of ideas generated—and thus, to more idea evaluation work.

Regarding Synectics, our experience is in general accordance with Altshuller's observation [30] that it is more effective than Brainstorming (average of 20.6% creative ideas against Brainstorming's 17.3%). We observed that Synectics fosters a better understanding of the problem. Besides that, Synectics uses analogies, which tend to result in more original ideas [31]. The smaller number of ideas generated tends to reduce the evaluation time.

Results obtained with Lateral Thinking (average of 16.2% creative ideas) were similar to Brainstorming ones (17.3%).

For the Gallery method, we expected results similar to the ones obtained with Brainwriting. After all, Gallery is very similar to Brainwriting, with the difference that ideas are not described in text, but drawn. However, the average of creative ideas was 12.8%, significantly below Brainwriting's 17.0%. We suspect that the reason might be that Gallery's procedure is more prone to foster adherence to particular thinking patterns and make it more difficult to explore ideas outside those established paths.

Value Analysis tends to result in moderately creative ideas (average of 23.3%). Ideas tend to be focused on the most important problems in a product, as identified in the ''problem analysis'' phase of the procedure. Ideas are generated in a relatively smaller number, in accordance with a checklist. This makes the evaluation process easier. On the other hand, because of the very nature of the method, resulting ideas are mostly focused on a product's subsystems and parts, and not an entire new product idea.

The Morphologic Method resulted in an average of 20.1% creative ideas. The main disadvantage of this IGT is the time it takes for careful parameter definition, research and/or idea generation for each parameter and skillful combination, so as to maximize the exploration of different ideas while still minimizing the evaluation effort.

Heuristic methods tend to require significant time. In our experience, the shortest was a 30 minutes Separation Principles session and the longest, a 350 minutes ARIZ session. The average time for all heuristic IGT sessions was 110 minutes. However, what could be considered a high time investment pays itself. These IGTs are among the

highest in creativity, varying between 27.6% creative ideas for Evolution Trends and 53.3% for Su-Field Analysis and Standards.

4. Elements of an effective new product ideation approach

Considering the arguments presented in session 3, we concluded that a more effective new product ideation approach should not be based on the External, but on the Internal source (IGTs). Moreover, the experiments described in session 4 provided evidence that the most effective IGTs, with the highest creativity scores, are the heuristic ones. This is also supported by previous research conducted by Horowitz & Maimon [32].

However effective, by experience, we know that heuristic IGTs are not ready for use in new product ideation in their original state. With their strength comes a congenital problem: heuristics were derived mainly from patent information [30]. Hence, they are well connected with technology evolution patterns, but not necessarily with customer's potential interests. As a consequence, if the heuristics are used directly for new product ideation, a significant amount of work is left to the idea selection phase, at which point a long process of filtering out ideas not potentially interesting to customers must happen.

We considered that three main concepts would allow taking advantage of the heuristic methods' strengths and avoiding their weaknesses in our new product ideation approach:

- the concept of value [23] as the main guideline for new product ideation;
- the concept of the voice of the product [33] as a more effective means of adding knowledge about the market to the ideation process;
- the concept of disruptive innovation [34] as a way of considering that innovation can also be achieved by low-end and new-market disruptions.

Value, first formulated by Lawrence D. Miles [23], makes it clear that customers are generally interested in more and better functions and/or the lowest possible associated costs. Yezersky [35] united the concept of value and the use of heuristics in his General Theory of Innovation (GTI)—in that case, for the finality of technological forecasting.

Another contribution of Yezersky's GTI [35] was the notion that value can be stated as the reason between functions and connections. In the initial phases of product development—and even more so in ideation—information about cost is scarce. Hence, the original value equation's denominator, cost, can be advantageously replaced by connections—conduits that allow energy, matter and information flows between a system's elements, and between one system and other systems or users. For ideation purposes, it is more practical to think of connections than cost.

According to Goldenberg et al. [33], products evolve in response to environmental pressures. These are represented by customer's needs. Products that do not satisfy customer's needs disappear, while the ones that do survive, at least until there is a new environmental change. As a result, customer's needs are mapped or coded into a company's products. Generating ideas from these, by imagining transformations of current products, or "listening to the voice of the product" is thus an effective means of generating new product ideas with a minimum of formally researched market information.

The disruptive innovation concept was proposed by Christensen [34]. In short, it is an innovation that the market does not expect, because the prevalent industry paradigm of increasing functions and improving performance is not followed. Typically, disruptive innovation is lower priced (low-end disruption) or designed for a different set of consumers (new-market disruption). A low-end disruptive innovation is aimed at mainstream customers for whom price is more important than quality. A new-market disruptive innovation is often aimed at consumers who would not have used the products already on the market.

5. Proposed new product ideation approach—IDEATRIZ methodology

Based on the reasoning described previously, we devised a new product ideation methodology we chose to name IDEATRIZ, illustrated in Fig. 1.

Since it is based on the voice of the product concept, IDEATRIZ starts with the definition of the product to be heard. Then, heuristics are used with the purpose of generating ideas that increase value. Frequently, creative ideas have disadvantages. In the third phase, these are explicated in terms of contradictions and solutions are sought. Finally, results are evaluated and new product ideas to be implemented are chosen. Each phase is described in more detail below.

5.1 Define product to be heard

Any product can be the focus product for ideation, or the product to be heard. However, positioning the company's current products along a Value and Potential Profit Matrix (Fig. 2) can be useful to subsidize this decision.

In the Matrix, two dimensions are considered: the profit potential of the market and the relative value

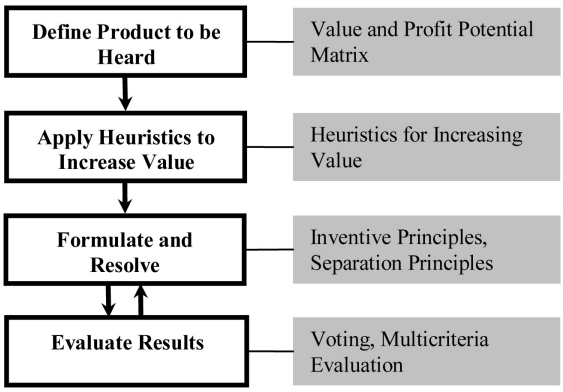

Fig. 1. IDEATRIZ New Product Ideation Methodology Phases and Tools.

provided by the product in relation to competitive offers. The target quadrant is the high profit potential and high value. The priority candidates for ideation can vary according to the company's strategy, but in general are products:

(1) In the high profit potential and low value to customers quadrant. In this case, the objective is to increase value provided by the product in relation to competitors;
(2) In the low profit potential and high value to customers quadrant. Here, the goal is to ideate means to penetrate in new, higher potential markets.
(3) In the low profit potential and low value to customers quadrant. In this case, both means to increase value and penetrate higher potential markets are needed.

Other possible focus product for ideation candidates are those not previously introduced in the market for viability reasons, but whose moment might have arrived [36].

5.2 Apply heuristics to increase value

Increase of value can be achieved, in general, through increase of functions and decrease of connections. More specifically, the following alternatives might be considered as the ideation goal:

(1) Maintain current functions and reduce connections;
(2) Increase the quantity and/or quality of functions and maintain connections;
(3) Increase the quantity and/or quality of functions and increase connections, in a proportion acceptable by customers;
(4) Increase the quantity and/or quality of functions and reduce connections;
(5) Decrease the quantity and/or quality of functions and decrease connections, in a proportion acceptable by customers.

Once the general ideation alternative is defined, heuristics should be used for ideation. IDEATRIZ heuristics are summarized in Fig. 3.

These are some examples of IDEATRIZ heuristics:

- Smartphones, result of the convergence of cellular phones and computers, are examples of Integrate with other systems (Increase Functions—Add functions—Directly correlated to the main function—Integrate with other systems);
- An ergonomic keyboard illustrates the heuristic Synchronize features (Increase Functions—Increase the effect of functions—Through objects—Ease function's acceptance—Synchronize features), because the keys are positioned more conveniently, "synchronized" to the fingers;
- The robotic mower exemplifies the heuristic Convert discreet in continuous process (Decrease Connections—In time—Eliminate time losses—Convert discreet in continuous process), because grass is mowed all the time, in very small amounts. There is no need to collect the grass, because it simply slips through the leaves and decomposes.

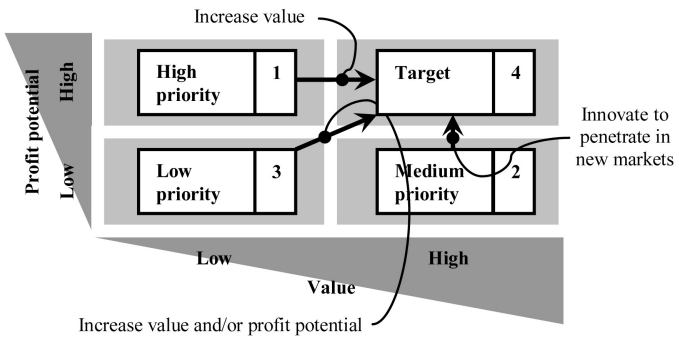

Fig. 2. Value and Profit Potential Matrix.

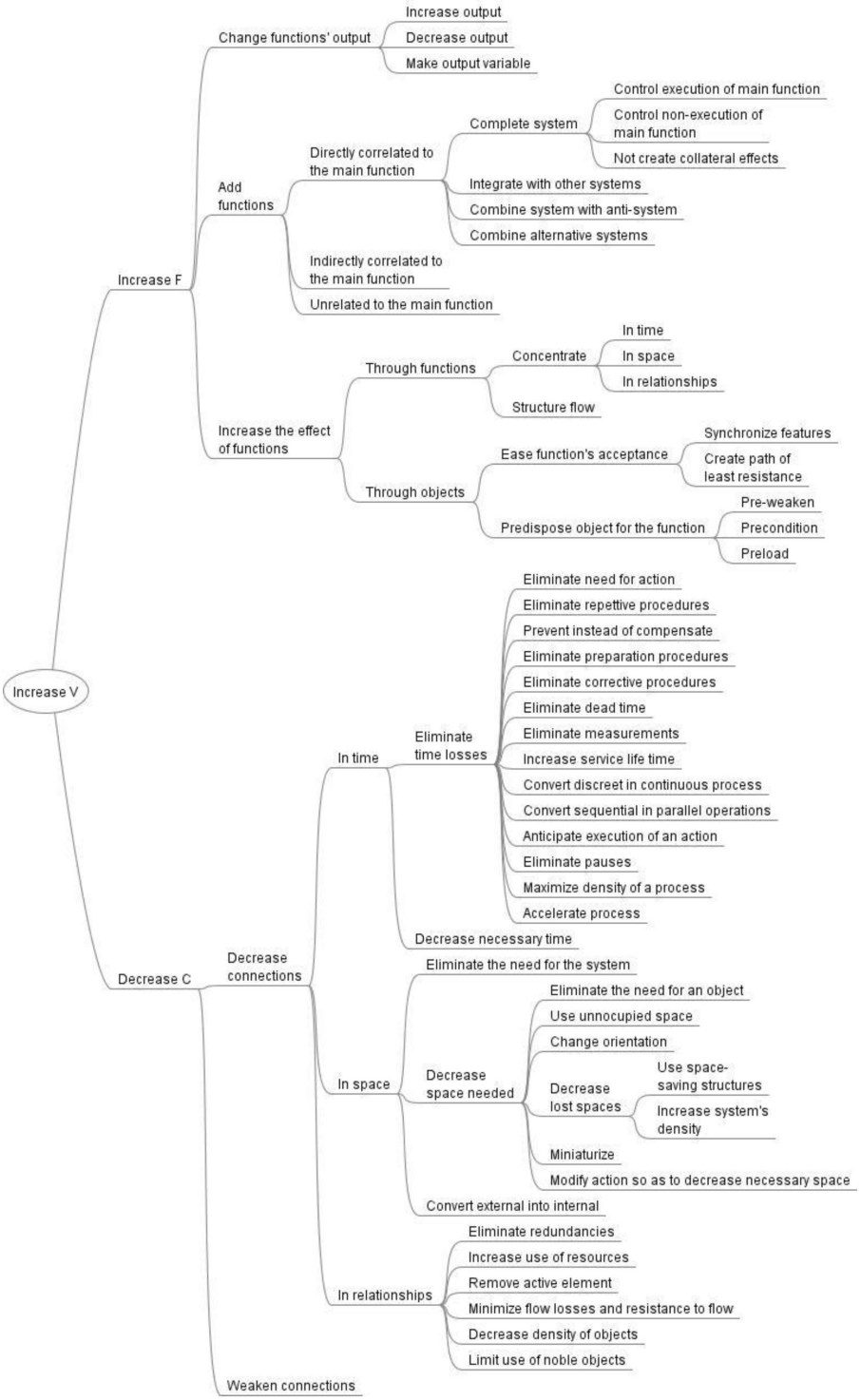

Fig. 3. Heuristics to Increase Value.

IDEATRIZ heuristics were derived from TRIZ-related heuristics such as the Inventive Principles [25], Separation Principles [25], 121 Heuristics [26], Evolution Trends [27], and Standards [25]. However, only those TRIZ-related heuristics clearly pointing to the main value maximization goal were included. Also, as mentioned before, the concept of disruptive innovation is translated in some of IDEATRIZ heuristics.

Heuristics such as Mann's ''Increase Use of Colour'' Evolution Trend [27] were not included. Although such heuristics might result in new product ideas, they do not necessarily indicate the direction of increased functions and/or decreased

Table 2. Evaluation Phase Criteria

Criteria	Aspects to Consider While Evaluating
Atractivity and benefits	Is the potential market for the idea attractive, in size and potential growth? What is the probability of pay-off? What is the expected return on investment? Are there additional benefits, such as compliance with legal requirements and know-how that can be used in other projects?
Alignment	Is the idea aligned to the company's strategy? Are there synergies with the current product and service portfolio? Does the company have the necessary technology, considering the whole life cycle?
Originality	Is the idea original? Are there advantages that can be easily and clearly perceived by the customer, when competitive offers are considered?
Precocity	What is the estimated time to implement the idea, to implement it and to establish it in the market? Is there the possibility of being a pioneer?
Durability of advantage	How big are the barriers to new entrants? How difficult is it to copy the idea? Is it possible to protect the idea, either through patent or other strategy?
Life cycle duration Investiment	What is the market's phase in its life cycle? What is the estimate life of the product that will result from the idea? What is the estimated investment to embody the idea, considering the whole life cycle?
Sustainability	Is the idea sustainable in social, environmental and economic aspects?
Risk	Is it possible to embody the idea? What is the risk of adverse regulations? Are there oter risks that need to be considered?

connections. Evidence in this regard has been found by Bogéa et al. [37] and Da Rocha & De Carvalho [38].

5.3 Formulate and resolve contradictions

The previous phase results in ideas with potential to increase value. Some of those will have disadvantages. Our proposition is not to discard them immediately only because of the drawbacks, but seek to formulate and resolve the associated contradictions, using the Inventive Principles and/or Separation Principles.

5.4 Evaluate results

IDEATRIZ final phase involves evaluation and selection of the best ideas for implementation. If 15 ideas or more were generated, we suggest a two-step evaluation process, beginning with the use of an affinity diagram, discussion and voting. The voting should be done in such a way as to allow only 15 or less ideas to proceed to the second step.

The second step involves multicriteria evaluation, using the criteria shown in Table 2. The suggested scale ranges from 1 to 5: very bad (1), bad (2), medium (3), good (4), and very good (5).

6. Validation of IDEATRIZ methodology

In this section, we report a test conducted during the development of IDEATRIZ and results of its application in three real new product ideation situations.

6.1 Test

The test was focused only on the core of IDEATRIZ—the heuristics. To establish terms of comparison, besides IDEATRIZ, also Brainstorming and the Evolution Trends proposed by Mann (2002) were used for new product idea generation. The evaluation sessions took place in a training event. A total of fourteen individuals participated in the sessions. Five of them were mechanical or electrical engineering students and nine were professionals. From the latter, two were production engineers, three mechanical engineers and four product designers. The training session had a total duration of twenty hours, out of which eight were theoretical and twelve were dedicated to ideation.

The first step, Define Product to be Heard, was not performed in the test. We simply chose the toothbrush as product to be heard, because of the convenience of having easy access to experts that could evaluate the ideas generated. The third and fourth steps (Formulate and Resolve Contradictions and Evaluate Results) were also not conducted.

For the second step, Apply Heuristics to Increase Value, participants were divided into two teams. Each team used Brainstorming first, then the Evolution Trends and finally IDEATRIZ heuristics. Ideation results are summarized in Table 3.

Table 3. Ideation Test Results

Method	Number of ideas generated		Number of original ideas		Number of useful ideas		Number of creative ideas		Session time		Ideas per minute		% of creative ideas	
Team Number	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Brainstorming	57	91	37	55	32	50	12	17	63	72	0,9	1,3	21	19
Evolution Trends	54	65	25	35	47	50	18	17	130	140	0,4	0,5	33	26
IDEATRIZ	99	87	59	50	94	80	55	47	170	155	0,6	0,6	56	54

The originality and usefulness of ideas was evaluated by two dentists. These professionals have experience both in their clinics and as consultants to a toothbrush manufacturer.

In the case of Brainstorming and Evolution Trends, consistency with previous results (Table 1) was noted. For Brainstorming, the previous rate of creative ideas was 17.3%, and 21% and 19% for each team in the test. For Evolution Trends, the previous rate was 27.6%, and 33% and 26% in the test.

The result obtained with IDEATRIZ heuristics was 56% and 54% of creative ideas generated. This result is similar to the values obtained in the previous evaluation with Su-field Analysis and Standard Solutions (Table 1—53.3% of creative ideas generated). This allows us to infer that the efficacy of heuristic techniques in creative idea generation was preserved in IDEATRIZ. Test results indicate that the strategy of taking advantage of TRIZ heuristics, within a framework consistent with the objective of maximizing the value, was successful in generating creative (both original and useful) ideas.

During the test, a relatively small amount and variety of ideas was generated with the heuristics to Reduce C, compared to those obtained with the heuristics to Increase F. The reason for this was the very subject of ideation. The toothbrush used as product to be heard is a trimmed product in TRIZ language, i.e., a simple or streamlined product. If a more complex product had been the focus of ideation, the heuristics to Reduce C could have been more useful.

Looking beyond the statistical results, a noteworthy aspect were the comments of the participants involved in the study. Many already knew about Brainstorming, which therefore was not a novelty. Evolution Trends were unknown to the participants and considered a useful approach. Most participants appreciated working with IDEATRIZ. A comment that summarizes the opinions of participants is that it is "very logical", i.e., as soon as a heuristic is well understood, the ideas associated with it are generated almost directly. One suggestion was to increase the quantity and variety of examples for each heuristic, in order to facilitate understanding and make it independent from an instructor or facilitator.

6.2 Real applications

The first real application of IDEATRIZ was conducted with company A, a small company which manufactures plywood and a small variety of plywood products. Using the Value and Profit Potential Matrix, it became clear that the product to be heard should be the plywood trowel, because it had both low profit potential and low perceived value by A's customers.

Because the plywood trowel is a very simple product, we decided to use only the heuristics to Increase Functions. With the use of IDEATRIZ heuristics and subsequent formulation and resolution of technical and physical contradictions, a total of 416 ideas were generated, with 320 original ideas, 313 useful ideas and 229 (55%) creative. The resulting ideas were evaluated with the use of an affinity diagram, voting and the criteria shown on Table 2. A plan for the development of new products was created and the company is currently implementing it.

The second case involved company B, which manufactures plastic caps and closure systems. The company decided that the product to be heard should be a retractable cover, because this is their main non-standard product and there is a design freedom with this product which is not possible in other products. Thus, there was no portfolio analysis and the Value and Profit Potential Matrix was not used for decision in this case.

In the process of ideation, both sets of heuristics, Increase Functions and Decrease Connections, were used, as well as the formulation and resolution of technical and physical contradictions. A total of 338 ideas were generated via Increase Functions. Out of these, 237 were classified as original ideas, 290 as useful ideas, and 204 (60.4%) as creative. With the Decreasing Connections set, 410 ideas were generated, out of which 279 original, 346 useful and 221 (53.9%) creative. The grand total of creative ideas was 425 (56.8%). In this case, the process of idea evaluation is undergoing.

The third case study was conducted at company C. This company manufactures electronic equipment for security and access control. The Value and Profit Potential Matrix was applied and the product selected for ideation focus was the access controller that had the lowest profit potential and perceived value by the main customers.

In this case, both sets of heuristics were used, as well as the formulation and resolution of technical and physical contradictions. With the Increase Functions set, 320 ideas were generated. From these, 231 are original ideas, 253 are useful ideas and 190 (59.4%) are creative ideas. The process of idea generation with the Decreasing Functions set is undergoing.

There are still no products on the market which were originally ideated with IDEATRIZ, but we expect to see them in the near future.

7. Conclusions and future research

The main research objective of proposing an effective new product ideation process was achieved. IDEATRIZ was not statistically validated, but the

test and especially the real applications indicate that it is an effective approach to new product ideation, leading to more creative (both original and useful) ideas than other approaches.

Our ongoing research extends in three directions. One is conducting more real applications, with a variety of industries and products, for experimentation and improvement of the methodology. The second is keeping track of the final results (the actual introduction of new products ideated with IDEATRIZ). The third direction is related to the computerization of IDEATRIZ. In this case, the objective is to add new product ideation to the set of tools available to product developers.

Acknowledgements—The author expresses his gratitude to all who helped in this research, especially the sponsors Instituto Fábrica do Milênio (IFM), Financiadora de Estudos e Projetos (FINEP), Federal University of Technology—Paraná (UTFPR) and Fundação Araucária.

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