INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN, ICED'07
28 - 31 AUGUST 2007, CITE DES SCIENCES ET DE L'INDUSTRIE, PARIS, FRANCE

EVALUATION METHOD FOR SELECTING INNOVATIVE PRODUCT CONCEPTS WITH GREATER POTENTIAL MARKETING SUCCESS

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ABSTRACT

Product innovation helps companies to obtain competitive advantage and operate successfully in an increasingly global market. Product development (PD) is a lengthy, expensive process. Thus, companies have a crucial need to assess whether or not they are on the right track from the early stages of product development. That is, to know whether their product is going to be creative and a marketing success. A proper assessment will allow the right decisions to be made, leading to the development of innovative products.

The conceptual design stage is critical when assessing the innovation potential of a product. In this stage, there is a shortage of methods to help companies identify the most innovative product concepts. In this article, a method for assessing the innovation potential of product concepts and selecting those with greater probability of success is described. To that avail, aspects regarding the degree of novelty of product concepts and their potential for success in the market are taken into account. These aspects were integrated into a modified QFD matrix. The proposed method was successfully applied in two companies.

Keywords: Innovation measurement, degree of novelty, marketing success potential, product concept selection/assessment.

1 INTRODUCTION

The new economic environment, characterized by the globalization of markets, pressures companies to stay competitive by providing their customers with as much added value as possible. At the same time, the expectations of 21st century customers are constantly changing and growing. Therefore, a company's speed of response to these expectations plays a vital role in its success. Innovation is then regarded as a continuous process which enables companies to respond optimally to existing market dynamism.

In order for a product to be innovative, it must be both creative and successful in the market [1]. When assessing innovation, several criteria or factors can help us predict whether a product will be innovative. A number of factors that condition product success have been selected from several bibliographic references [2-12]. These factors are listed in table 1.

The more of these factors are present, the more likely to succeed a product will be. These factors can be implemented into a task check-list, or taken as aspects to be considered during product development. However, it is not until product development is finished that we can know whether a product is really innovative or not. On the other hand, some authors [13-16] mention that a way to determine whether or not an idea is innovative is to measure its degree of novelty for the scientific community, industry, market, company, customer or the world itself.

Table 1. Factors that may lead to product success

Product-level success factors	
1	Extracting information from all relevant sources (customers, previous projects, competitors, providers, studies)
2	Defining what makes own product different from competing products
3	Emphasizing early stages of product development
4	Leadership of product development responsible
5	Setting up a multifunctional (multidisciplinary) development team
6	Using a systematic method for generating ideas
7	Assessing marketability of products in every development stage
8	Presenting customers with unexpected attributes
9	Possessing intangible attributes
10	Low development costs
11	Application of Total Quality Management
12	High marketing investment
13	Following standard development procedures
14	Planning product launch prior to finishing development
15	Applying industrial design in product development

Companies have limited resources that cannot be wasted in the development of unpromising product concepts. Intermediate indicators are needed to gauge good progress, hence reducing uncertainty over product success. Usually, intermediate tests are performed with preferred customers to reduce the risk of failure. But it is not until the new product is marketed that companies can learn about a product's success.

Thus, it would be interesting to have a tool or methodology to help select those concepts with greater innovation potential. These concepts would finally be developed into successfully marketed products. The most adequate development stage to apply such methodology would be during conceptual design, when there is the most room for creativity. Moreover, decisions made during this stage can set 60 to 80 percent of the product's final cost [17, 18]. A literature review yielded six different methods, which were adapted to be used in product concept assessment and selection [19-35]:

1. Pahl & Beitz method
2. Pugh method
3. Analytic Hierarachy Process (AHP)
4. QFD matrix method
5. Fuzzy method
6. Hypothetical Equivalents and Inequivalents Method (HEIM)

During our literature review, no method for selecting product concepts with greater innovation potential was found. Most authors have developed methods to optimize design robustness, cost, etc. [19-35], but none of them has worked on the assessment of the innovation potential of conceptual designs. Binz & Reichle [29] have developed a method to assess the degree of innovation of design specifications. Therefore, we consider there is a lack of tools or methodologies to help determine which design concepts have greater innovation potential.

Our work is aimed at the development of a method to assess the innovation potential of design concepts suitable for any design context. Thus, said method must be easy to apply.

This article describes the method developed and shows an example of its application to the development of a pipe cutter by Spanish manufacturer Super Ego-Rothenberger S.A., located in Abadiano (Vizcaya, Basque Country).

2 RESEARCH BASIS

The main goal of our research is to develop a method to assess product concepts with high innovation potential. To that avail, we assume that our design team has taken into account the success factors previously listed in table 1. We must bear in mind that a product -according to Schumpeter [1]- has to be both creative and successful in the market in order to be innovative. Figure 1 shows the procedure used to assess the innovation potential of design concepts. Innovative concepts will exhibit *newness* and be appealing to the company and its customers (aspects related to market success). Therefore, we must assess three dimensions: degree of novelty of the product concept, customer appeal of design specifications and business feasibility.

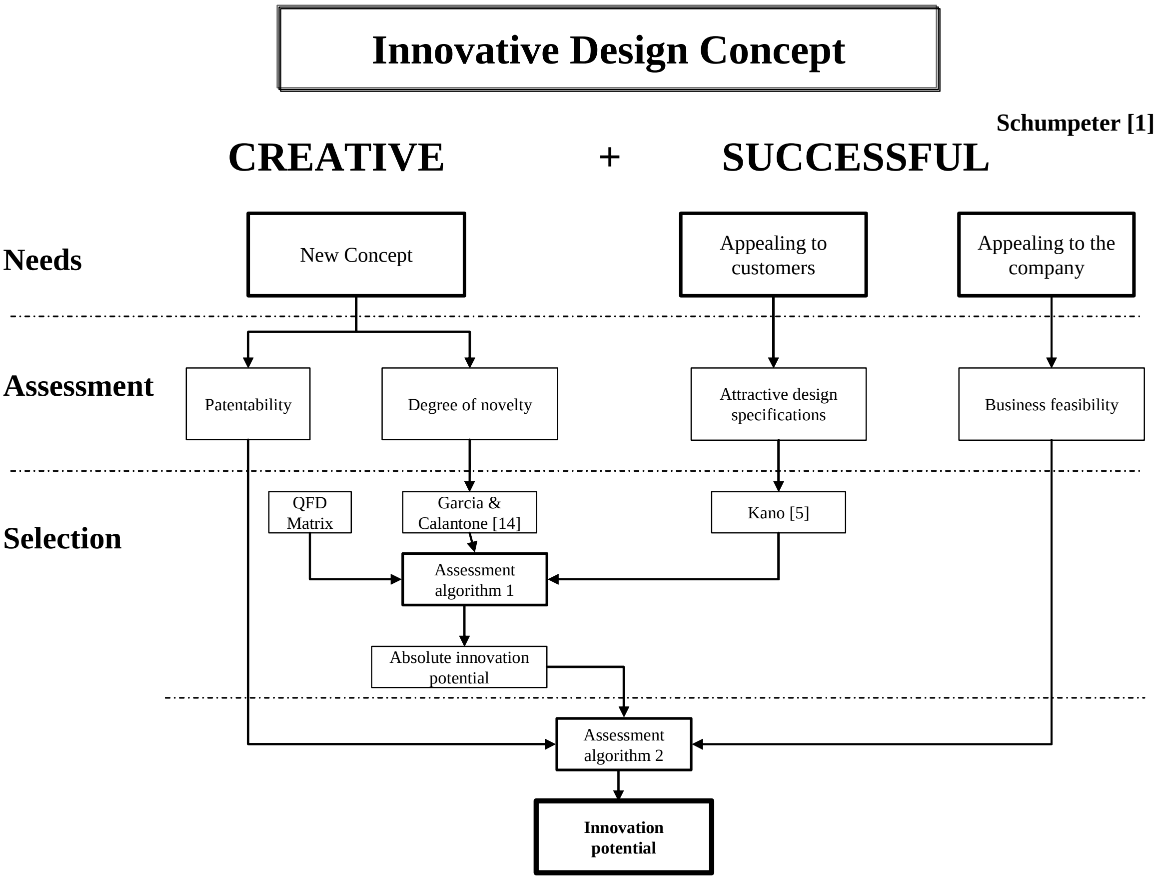


Figure 1. Procedure for assessing the innovation potential of design concepts

2.1 Newness of product concepts

The *newness* of a product concept can be assessed by looking at its degree of novelty and its patentability.

The degree of novelty is determined using tables 2 and 3. In the first place, the types of discontinuities occurring in the product concept are determined. Table 2 has some examples of different types of discontinuities. Then, in accordance with the identified discontinuity types, the type of product innovation is established using table 3. For example: if a conceptual design creates discontinuities in both micro- and macromarketing, then we can state that such a concept would provide moderate innovation.

The concept's patentability is determined by the design team on the basis of their past experience and knowledge of the product. Concepts deemed patentable are innovative in themselves, as market success should confirm later [11, 14, 29].

Table 2. Examples of discontinuities. Adapted from [14]

Micromarketing discontinuities
• Customers new to the firm
• New market approach
• Product use new to the firm
• Class of service/product totally new to the firm
• Satisfies clearly identified customer/client need
• Firm's prior experience of selling product in this line of business
• Product/service more complex than previous releases to same market
• Product responds to major changes in customer needs
• Product technology new to customers
Microtechnology discontinuities
• Change in technology used in product development
• Scientific/technological bases new to the company
• Production process new to the firm
• Product technology new to the firm
• Degree of technological differentiation over competing products
Macromarketing discontinuities
• New-to-the-world product
• Totally new competitive environment
• Product consistent with existing customer values
• Existence of potential demand
• Newness to the market
Macrotechnology discontinuities
• Science & technology state of art within general scientific community
• Level of science & technology knowledge base within the general scientific community
• Modification of technology used in other industries
• Improvement/modification of technology in use elsewhere in the industry

Table 3. Determination of innovation type. Adapted from [14]

Macromarketing discontinuity	**Macrotechnology discontinuity**	**Micromarketing discontinuity**	**Microtechnology discontinuity**	**INNOVATION TYPE**
				Radical Innovation
				Moderate Innovation
				Moderate Innovation
				Moderate Innovation
				Moderate Innovation
				Incremental Innovation
				Incremental Innovation
				Incremental Innovation

2.2 Customer appeal of design specifications

An efficient way of increasing sales of a product is to add new features to make it more appealing to customers. A proper identification of design requirements that are most appealing to customers will allow for their subsequent use as product concept assessment criteria. In this sense, Binz & Reichle's Method [29] might be applied, but the method we are proposing is much simpler. QFD Methodology employs Kano's survey [5] to select customer specifications. In this case, we will apply the survey to design specifications, hence extracting must-be one-dimensional and attractive specifications (indifferent and reverse specifications are disregarded):

- Must-be or basic specifications are those features expected by customers in every case and whose absence would lead to customer dissatisfaction.

- One-dimensional specifications are not especially significant, although the more frequently they appear, the greater customer satisfaction becomes and conversely.
- Attractive specifications are those not expected by customers and whose presence provides great satisfaction to them.

Must-be specifications cannot be missing in product concepts. Otherwise, the products developed from them will not sell well. Under this premise, design specifications are selected among the last two types –one-dimensional and attractive- because innovation in these specifications will earn greater success in the market (success factor number 9 in the table 1). If customers find these specifications in the final product, their satisfaction will increase, and sales will grow accordingly.

2.3 Absolute innovation potential algorithm

The first algorithm yields the absolute innovation potential of product concepts in a simple manner. Any of the six concept selection methods mentioned in section 1 could be used. However, if we rank these methods form the ease-of-use point of view, we can state that methods 1 and 2 are easiest to apply -closely followed by methods 3 and 4- whereas the application and implementation of methods 5 and 6 is the hardest due to the amount of previous mathematical development they require. In our case, the matrices from QFD methodology are selected as a starting point because of the following reasons:

- The philosophy of QFD methodology is oriented towards customer satisfaction, and so is our method.
- Other authors (Binz & Reichle [29]) have previously used them to measure the innovation potential of design requirements.
- This method is relatively easy to understand and to implement [20].

The result of applying this algorithm is the absolute innovation potential of each design concept. The designation *absolute* innovation potential is due to the fact that business feasibility factors have not yet been considered at this point.

2.4 Business feasibility

In order for a product concept to be feasible from a business perspective, it must meet certain requisites that depend on the firm’s characteristics and its interests. After analyzing the success factors listed in table 1, along with other factors usually employed by our collaborating firms, the following main business success factors were selected:

- Comparison with the market: the differential between the new concept and existing products in the market is quantified (success factor 2 from table 1).
- Economic efficiency: a score is given based upon costs outlook, level of complexity of manufacturing and assembly, investment required, etc. (success factor 10 from table 1).
- Marketing assessment: the firm’s sales representative, following his/her own experience and knowledge of the market, will assess the designs (success factors 7 and 9 from table 1).
- Strategic fit: a high value indicates the design concept is well suited to the firm’s strategic views.

It must be noted that a different set of influential factors could be selected. This situation would be given by the considerations made by the firm about the factors leading to product success.

2.5 Innovation potential algorithm

This algorithm is aimed at reflecting business reality when selecting product concepts. The design team may come up with a new idea that is very attractive to customers, but it will be discarded in favour of other less innovative ideas unless it properly meets business success factors.

Weighting is used as a correction of the absolute innovation potential value obtained previously (Binz & Reichle [29] employ a similar method). In this algorithm, the absolute innovation potential, along with the business success factors (economic feasibility) are the inputs, and the innovation potential of product concepts is the output.

3 METHOD FOR THE ASSESSMENT OF THE INNOVATION POTENTIAL OF A DESIGN CONCEPT

Figure 2 illustrates the assessment method used to determine the innovation potential of a product in its conceptual design stage. It comprises five steps:

1. Selection of innovative design specifications
2. Evaluation of the degree of novelty of conceptual designs
3. Assessment of the absolute innovation potential of conceptual designs
4. Selection and assessment of business success factors (business feasibility)
5. Calculation of the innovation potential of conceptual designs

These steps are further detailed next:

❶ Selection of innovative design specifications

The starting premise is that the design team has a list of design specifications. Kano's survey [5] is conducted on the specifications listed, and only those specifications belonging to the uni-dimensional and attractive categories are selected.

❷ Evaluation of the degree of novelty of conceptual designs

The design team determines the newness of each conceptual design using tables 2 and 3.

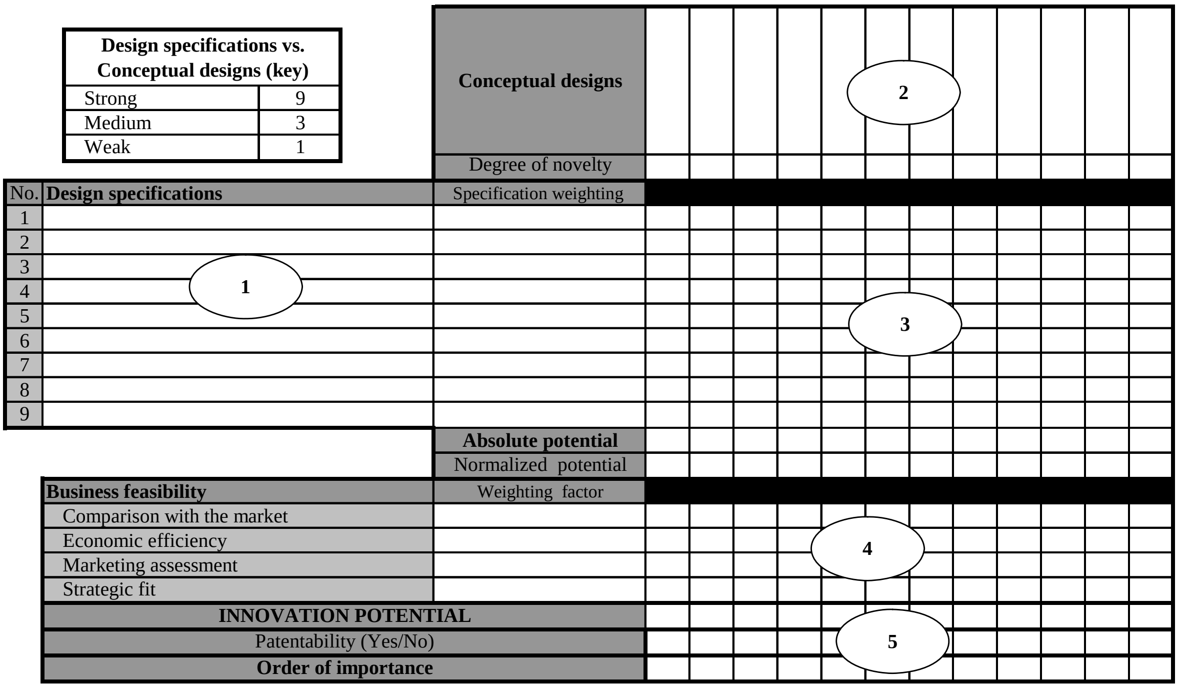


Figure 2. Matrix for selecting product concepts with the highest innovation potential

❸ Assessment of the absolute innovation potential of conceptual designs

In this step, the development team assesses conceptual designs to determine their absolute innovation potential. The procedure is as follows:

- Design specifications obtained in step 1 are placed in the leftmost column (see figure 2, number 1), and values are assigned according to their relative significance. Attractive specifications get a score of 9, and one-dimensional specifications get a score of 3.
- Conceptual designs from step 2 are placed in the top row (see figure 2, number 2), and a value is assigned considering the innovation type. Conceptual designs delivering incremental innovation get a score of 1. Moderate and radical innovations get a score of 3 and 9, respectively.
- The correlation between design specifications and conceptual designs is determined in the middle of the matrix (see figure 2, number 3). The aim is to assess how well each conceptual design meets a given design specification. If it does so very well, it gets a score of 9. Average and poor performances get a score of 3 and 1, respectively.

- The absolute innovation potential of conceptual designs is obtained using equation 1 (see figure 2, number 3). This potential is then normalized attributing a value of 100 to the highest-scoring conceptual design and proportional scores to the rest to yield the normalized innovation potential of each design concept.

$$Absolute\ innovation\ potential = \left[\sum_{i}^{n}(specification - concept\ correlation_i * specification\ weighting_i)\right] * Degree\ of\ novelty \qquad (1)$$

❹ Selection and assessment of business success factors (business feasibility).
In this step, the business success factors to be used are selected. A weighting factor is assigned to each success factor. These values are assigned at will on the basis of the interests of the firm, the design team, etc. The sum of all weighting factors must equal 10.
❺ Calculation of innovation potential of conceptual designs.
In this last step, equation 2 is used to obtain the innovation potential of each conceptual design as a correction of the normalized innovation potential we had obtained previously.

$$Innovation\ potential = \sum_{i}^{n}\{(weighting\ factor * correction\ factor_i)/10\} + normalized\ potential_i \qquad (2)$$

The most innovative concept will be the one with the highest score, although a different concept could be selected for its patentability if the design team consider this appropriate (see figure 2).

4 APPLICATION EXAMPLE

For validation purposes, our methodology was applied to the design project of an aluminium pipe cutter for plastic pipes by tool manufacturer Super Ego-Rothenberger S.A. (Basque Country, Spain). The design specifications were:

- Small size. The cutter should fit a plumber's toolbox. Maximum pipe diameter is 40 mm.
- Low weight. It should be easy to carry.
- Intuitive operation involving few steps.
- Ease of use. Few cut preparation steps (unlocking, etc.).
- Suited for all users. Anthropometric data should be used.
- Low maintenance. The blade should be replaceable in a few steps.
- Aesthetics/finishing. Good aesthetic appearance of the product will be sought while bearing ergonomics and the rest of the specifications in mind.
- Good ergonomics. This is a key specification given the tool's professional use.
- Simplicity. Few parts, easy assembly.
- Low cost, suitable for the market.

The search for new solutions began after analyzing the existing products in the market. Of all the concepts generated, only ten were considered in the final selection. The application of the method to the assessment of the innovation potential of these pipe cutter design concepts is explained next.
❶ Selection of innovative design specifications
Table 4 lists the design specifications used to assess the innovation potential of design concepts after applying Kano's survey to all of the design specifications given.

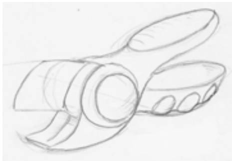
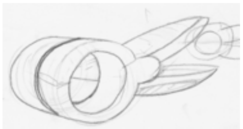
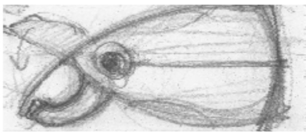
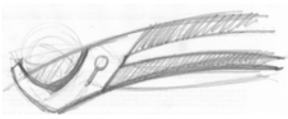
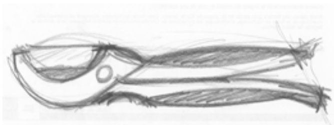
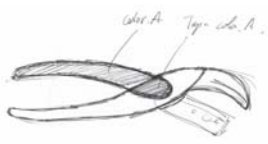
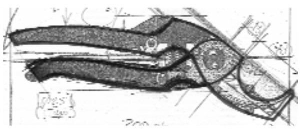
Table 4. Design requirements to be used for selecting product concepts with highest innovation potential

Design specifications	Specification category	Weighting specification
Low weight	Attractive	9
Intuitive operation	Attractive	9
Good ergonomics	One-dimensional	3
Low maintenance	One-dimensional	3
Aesthetics/finishing	Attractive	9

❷ Evaluation of the degree of novelty of conceptual designs

Table 5 shows all the ideas generated by the design team and the results of the assessment of their degree of novelty.

Table 5. Proposed conceptual designs

Concept no.	Conceptual Designs	Description	Degree of novelty
1	 	Possibility of manufacturing a frontal add-on for improved support.	1
2		Design differentiation .Rubber inserts for improved grip. Rubber cap covering fulcrum.	1
3		Closed scissor along the contour of the pipe.	1
4		Closed scissor wherein one of the two parts that pivot around the fulcrum is retracted within the other.	3
5		Sleek, simple scissor with special attention to aesthetics and robust appearance.	1
6		Bionics-inspired design, mimicking natural forms perfected through adaptation to the environment.	3
7		Design featuring two notches, one on the top side to accommodate the hand while cutting, one at the bottom to begin applying force when the scissor is fully open.	1
8		The joint is concealed and somewhat peculiar. Different-coloured handles.	1
9		Design inspired by pruning scissors. It features the notches of idea no. 7.	1
10		Exchangeable blade featuring saw-like top for improved robust looks.	1

❸, ❹ and ❺ Calculation of the innovation potential of conceptual designs.
Finally, figure 3 shows the result of the application of the proposed method. As seen in the figure, the concept with the greatest innovation potential according to its expected marketing success considering its degree of novelty and its customer appeal was concept no. 4, followed by concepts no. 6 and no. 9 (see table 5). After the application of correcting factors (assessment of business feasibility), the concept with the highest score was still concept no. 4, now followed by concept no. 9 (see figure 3).

Design specifications vs. Conceptual designs (key)	
Strong	9
Medium	3
Weak	1

Nº	Design specifications	Conceptual designs	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5	Concept 6	Concept 7	Concept 8	Concept 9	Concept 10
		Degree of novelty	1	1	1	3	1	3	1	1	1	1
		Specification weighting										
1	Low weight	9	1	1	1	1	3	3	9	3	3	3
2	Intuitive operation	9	1	9	1	3	9	3	9	9	9	9
3	Good ergonomics	3	3	9	1	3	3	1	3	3	9	3
4	Low maintenance	3	3	1	3	1	3	3	3	3	3	9
5	Aesthetics/finishing	9	1	9	3	9	3	3	3	1	9	1
		Absolute potential	45	201	57	387	153	279	207	135	225	153
		Normalized potential	12	52	15	100	40	72	53	35	58	40
	Business feasibility	Weighting factor										
	Comparison with the market	2	75	60	60	70	60	60	60	55	75	60
	Economic efficiency	4	40	40	50	45	50	50	50	40	50	60
	Marketing assessment	2	40	55	30	90	60	10	50	50	80	60
	Strategic fit	2	40	40	50	90	60	20	60	40	70	60
	INNOVATION POTENTIAL		59	99	63	168	96	110	107	80	123	100
	Patentability (Yes/No)											
	Order of Importance					1		3	4		2	

Figure 3. Matrix for the assessment of the innovation potential of pipe cutter concepts

In the example case, the firm decided not to take into account whether or not their solution was patentable. Concept no. 4 was developed in the first place by reason of its higher score. This scissor concept featured a four-position fulcrum mechanism to achieve a small opening, as specified. After several analyses and failed attempts, this new product concept was deemed unfeasible. Thus, the design team chose to develop concept no. 9 instead. This type of situation is not unusual. We must bear in mind that certain technical aspects and manufacturing considerations are left aside in conceptual-level assessments. The final design approved by the firm after several prototypes is shown in figure 4. This product is available in the market today, and it has fulfilled the firm's expectations on its success. The firm's design team found the proposed method for selecting innovative product concepts to be useful and easy to use.
Additionally, we note that further method validation is in progress. It is currently being applied by plastic and metal tube container manufacturer Tuboplast Hispania S.A. (Vitoria, Basque Country, Spain). Due to confidentiality issues, results cannot be discussed in detail as of today. However, we can state that a few promising concepts are being assessed with reasonable chances of becoming patentable products.
Experimental work has shown satisfactory results, although improvement is needed in steps 1 and 2:

- Selection of innovative design specifications (step 1): Occasionally, the design team encountered problems in the application of Kano's survey to filter design specifications and extract those most valued by customers. Sometimes, they would struggle to properly categorize specifications.
- Evaluation of the degree of novelty of conceptual designs (step 2): Difficulties arose when assessing how well each design concept met design specifications (see number 3, figure 2).
- From the start of our research, we were aware that this sort of problem could occur, as they are typical of the first four concept selection methods mentioned in the introduction. In light of the results, consideration is being given to modifying the method through the implementation of Fuzzy theory to perform the assessment.

Figure 4. Final product developed from selected concept

5 CONCLUSIONS

Innovation is essential in business strategies today. In order to be innovative, a product must be both creative and successful in the market [1]. Conceptual design is the key to achieve innovation, for it is in this stage when product concepts are assessed and selected before they are developed into final products sold in the market. The current lack of methods for selecting product concepts from the innovation perspective has lead us to develop a method to assess a product concept's creativity and its chances of succeeding in the market. To that avail, the *newness* of design concepts is taken into account, along with their customer appeal and business feasibility:

- Concept newness is assessed as proposed by Garcia & Calantone [14]. Concept patentability is also assessed.
- Customer appeal is achieved through the application of Kano's survey [5] to select those design requirements that are most attractive to customers. These design requirements are subsequently used as product concept assessment criteria.
- Business feasibility is taken into account by considering economic, marketing and strategic factors.

The proposed methodology helps select potentially innovative products, but it is not after a product has been marketed that innovation can be assessed. Furthermore, the functionality and manufacturability of a product concept cannot be fully determined before its development.

ACKNOWLEDGMENTS

The authors are grateful for the funding provided by the Spanish Ministry of Education and Science (project DPI2006-15570-C02-01, with FEDER funds), by Mondragon Corporación Cooperativa (MCC), and by the Higher Polytechnic School of Mondragon.

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