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DESIGN OF INNOVATIVE PRODUCT PROFILES: ANTICIPATORY ESTIMATION OF SUCCESS POTENTIAL

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ABSTRACT

According to the current trend to extend the domain of application of Engineering Design to the whole Product Cycle, i.e. from the definition of the product profile to the management of the dismantling procedures, the authors are investigating the possibility to define a practical toolkit to support the earliest stages of product development both in terms of prescriptions to generate new value propositions and assessment of the expected market appraisal. The present paper deals with the second objective and proposes a twofold version of Value Assessment Metrics (VAM) which allow to estimate the success potential of a new product through a balance of its functionalities and features with respect to the alternatives existing in the market. After reporting the methodological approach adopted to build the VAM, the paper presents their preliminary validation and an exemplary application to the proposition of an innovative lipstick.

Keywords: New Product Development, TRIZ, Blue Ocean Strategy, Functional Classification

1 INTRODUCTION

Engineering Design methods and techniques are extending their domain of application beyond the limits of the classical stages of Product Development, i.e. conceptual design, embodiment design, and detailed design. In fact, more and more a systematic and structured approach is needed since the earliest stages of product definition to the follow-up management of after-sale services. The former is a crucial issue in order to avoid the waste of resources for developing poor-valued products: it is well known that market failures are more than 99% of the submitted innovation projects in industry [1]. Besides, the design and efficient management of after-sales support functions is a further important direction of investment, since they significantly contribute to the quality perceived by the final customers.

Not surprisingly, several research lines within the Engineering Design community are devoted to these topics. Among the others, major efforts have been dedicated to needs identification and to the formulation and modelling of product requirements. Nevertheless, the phase of needs identification is mostly limited to marketing inputs and the observation of customer's behaviour to elicit the Voice of the Customers (VoC). As already pointed out by several authors, the major limit of an innovation driven by the VoC is that "Customers don't know what they want in the future" [2], although to be competitive it is necessary to aim at "being the first to give it to them". A current strategy is to "be open as much as possible, to new ideas, to new approaches and, most importantly, to people with new research findings". Besides, this approach does not reduce, in principle, the waste of research resources towards poor-valued innovations. Vice-versa, targeting innovation projects according to a value-oriented product or service is currently not properly supported by systematic and reliable methods and tools.

In fact, the typical contribution of Engineering Design techniques to product innovation is essentially limited to the development of new solutions to already identified problems, while the proposition of new product profiles is just marginally supported. A further, not negligible, critical issue related to this deficiency is a lack of integration between the activities of new value proposition, i.e. the definition of new sets of product attributes which can be considered value-wise by the market, and the following design phases for the implementation of such product profile.

The authors' work aims at developing engineering tools to generate innovative profiles of products and to estimate in advance their chances of success in the market. Within this research, a direction of interest is the systematization of the logic of the Blue Ocean Strategy (BOS) [3], a well known consulting strategy for Value Innovation, just marginally relevant from the scientific point of view, but

noticeably spread in the industrial world. In a recent paper [4], the authors have proposed a classification of the product attributes according to TRIZ functional features, as a means to identify systematic guidelines to identify new market opportunities. The original contribution of this paper is the combined analysis of successful case studies from the BOS literature and market failures from other scientific sources as a means to build, through linear and logistic regressions, heuristic formulas for estimating the perceived value of a product profile. Thus, instead of anticipating the commercial opportunities of innovative items through the simulation of market shares and customers behaviour, as classically performed in the industry, the here presented approach aims at predicting success likelihood on the basis of the pursued product development strategies.

According to the overall goal of the research, the next section presents a state of the art analysis within the perspective of needs identification for new value proposition, a summary of the previous research outcomes achieved by the authors and a more specific description of the objectives of the present study. Section 3 describes the methodological approach to select and analyze case studies about market failures to be compared with the value profiles of BOS success stories. Then, an original correlation analysis is proposed to formulate mathematical models for the anticipatory estimation of success potential of an innovative product. Such models have been first tested with a third set of success case studies not belonging to the BOS literature; then, an exemplary application to design the profile of a value-wise innovative lipstick is described in section 4, where the results of these preliminary tests are widely discussed also through a survey within a number of potential customers. The final discussion (section 5) reports the authors' vision to integrate the proposed contribution within the Product Development cycle with potential interactions with inventive design methods and tools.

2 OVERVIEW OF INNOVATION METHODS BASED ON CUSTOMER NEEDS AND PERCEIVED VALUE

The identification and the fulfilment of customers' needs represent a crucial step for designing and developing successful products [5]. Regardless of the recalled limitations of VoC tasks, the wide involvement of customers into design activities plays a significant role with the aim of obtaining new ideas and suggestions. Since the 80s of the previous century, the literature reports experiences regarding the employment of lead users into the product development phases [6]. At the current state of design research regarding the human needs and, consequently, the engineering requirements to be fulfilled for their achievement, the following themes are broadly debated:

- the tools to be employed for the individuation of seeded needs, which allows to achieve strategies offering superior customer value [7];
- the task of correlating emerging needs and design specifications, that is also affected by the ambiguous terminology of the domain [8];
- the necessity to represent human needs and their implication into acknowledged design frameworks and models [9];
- the choice regarding which customer requirements to be addressed and which new functionalities to introduce in order to obtain relevant competitive advantages [10].

2.1 The dynamics of user preferences

A further issue regards the dynamics concerning the modifications of user preferences and customer perceived satisfaction. In this context it is well established that both technological innovation [11] and market conditions [12] consistently influence the emerging of new demands and changes in consumers' preferences. The interplay between technical and business aspects hasn't reached yet an integrated and harmonized model; nevertheless both domains share the vision about evolution schemes depicted through long periods characterized by incremental innovations interrupted by product breakthroughs, causing consistent market turbulences [13, 14]. Such discontinuities act as a trigger for remarkable modifications within the bundles of customer requirements to be fulfilled and their role played within the perceived satisfaction of the products in the marketplace.

If this mechanism represents a chance to fulfil new business ideas, on the other hand it results in a further hurdle for correctly satisfying the user needs at the right time. The capability to anticipate customer preferences would thus result in a substantial competitive advantage within New Product Development initiatives.

Within this perspective, while the attempts of formulating laws regarding the development of customer needs (e.g. the proposal advanced by Petrov [15]) have resulted in poor industrial applicability, the most acknowledged frameworks that link user demands, product attributes and originated benefits are viable to describe just a static frame of the evolving picture.

From this viewpoint Kano model [16] stands for a remarkably useful instrument to point out the current market situation for a given product or service and to investigate the potential appeal of new attributes [17, 18]. Moreover, some scholars [19] have depicted an evolving logic of the Kano categories of customer requirements, motivated by the consolidation of consumers' habits and expectations. However both the original model and its integration don't hold any means to suggest new product requirements and new needs to be served, being addressed just at estimating their capability of impacting customer satisfaction, after they've been separately identified.

2.3 Overview of business approaches to meet customer needs

The branch of the literature that witnesses attempts to identify new needs to be fulfilled is currently limited by entrusting the task to single, although acknowledged, trends, without offering systematic frameworks that support diversified domains, situations and tendencies. Within this field of research Du et al. [20], on the basis of the mass customization phenomenon, propose a tool to support the need of manufacturing individualized products by integrating such task within design cycles.

The missing knowledge concerning the codification of latent needs contributes in the absence of systematic procedures for developing innovative products characterized by leaps in customer value. Such lack is particularly relevant within Engineering Design, while, from a managerial viewpoint, BOS has gained consensus in the recent years about its expected capabilities to foster industrial policies aimed at answering unexpressed customer demands by reorganizing market boundaries [21] and overcoming the trade-off between differentiation and low cost [22]. Given the appraisal of the industrial world attributed to BOS, the research within engineering field acknowledges the need to subsume its general principles into the design tasks addressed to strategically define the product platforms [23, 24].

2.3 The identification of value guidelines to support New Product Development initiatives

Even accepting with a pragmatic approach the utility of BOS as a reference source of inspiration, the limited opportunities for the implementation of it clues into the product development cycle are consistently caused by its limited formalism. As a matter of fact, the strategy developed by Kim and Mauborgne results very elegant to describe past successes, but not really prescriptive [25]. Moreover, the BOS reference tool, i.e. the strategy canvas, stands just for a visual technique to represent ideas that have been separately developed [26].

Given these premises, the authors have started a research activity with the aim of systematizing the BOS logic and structuring its application through Engineering Design tools. Among them, the Four Actions Framework (FAF) is viable to facilitate the successful transition from the value profile representing the industrial standard to an innovative set of competing factors and related performance levels. The most severe challenge is however the capability, besides poorly supported, to introduce unprecedented and valuable product attributes [27].

The first step of the ongoing research is reported in [4], whereas an in-depth analysis has been performed of the successful case studies employed as BOS examples, in order to point out common patterns of value evolution. More in detail the survey has individuated which categories of competing factors are preferentially transformed within the treated value transitions with respect to the Eliminate, Raise, Reduce, Create actions belonging to the FAF. The same attributes have been clustered according to the functional role (in TRIZ terms) they play within customer perception of product and services, i.e. positive outcomes, limitation of undesired effects, reduction of required resources (functional features) and more detailed sub-classifications (sub-functional features), as summarized in Table 1 [4].

The output of the research has been the individuation of suitable preliminary guidelines for the definition of product profiles, by observing the evidences of the correlation among BOS actions and features. These guidelines are structured as a collection of suggestions in terms of types of new valuable product attributes to create, existing properties to enhance, current features whose

performances are viable to be reduced and eventually product characteristics to be eliminated without relevant drawbacks.

The robustness of the arisen indications has been checked by the means of a χ^2 test, adopted to highlight whether the distribution of actions and features could be due to chance.

The so determined guidelines are viable to support the process of generating new business ideas, by delimitating the space for alternatives within new value proposition tasks.

Table 1. Functional and sub-functional features to classify product attributes subjected to BOS actions within value transitions

Functional features		Sub-functional features	
Useful functions (UF)	positive outcomes delivered by the system to the user	Threshold (THR)	capability to impact the user at an expected extent
		Versatility (VER)	capability to adapt the behaviour according to different operating conditions
		Controllability (CTRL)	capability to generate the desired outcome according to the user's will
		Robustness (ROB)	capability to provide the same desired outcome under varying inputs
Harmful functions (HF)	measures to attenuate drawbacks provoked by the system functioning	on the System itself (SYS)	safeguard of system integrity and functioning
		on the Super-system (SUP)	limitation of the impact on the surrounding systems and on the environment
		on the Object (OBJ)	limitation of the impact on the user and on the object modified by the system
Resources (RES)	mitigation of the impact due to resources' consumption	Space (SPA)	e.g. the reduced critical dimensions
		Time (TIME)	e.g. quickness in delivering certain operations
		Material (MAT)	e.g. the avoided employment of tools or substances
		Information (INF)	e.g. practice of use, limited skills required
		Energy (ENE)	e.g. efficiency
		Costs (COS)	e.g. cheapness

At a first glance the main indication provided by the research stands in the reduction, within value evolution cycles, of direct benefits and positive outcomes provided by products and services in favour of attenuated impacts of undesired effects and the resources demands requested to customers. More in detail, the most straightforward guidelines can be summarized as follows:

- no particular preference is remarked in the implementation of new attributes at the first level of classification; further on, benefits can arise by introducing new features centred on the reduction of employed resources in terms of required information, know how, practice of use;
- within the Raise action it is observed that the meaningful mitigations of the inconveniences due to Harmful Functions (HF) and to the consumption of Resources (RES) seem to be recommendable; a leap concerning the cheapness of the system results to be consistently advantageous;
- the main trend related to the Reduce action is the drop of the performances defined as Useful Functions (UF) and specifically of those ranked into Threshold Achievement (THR);
- the Eliminate action tends to be applied mainly to the UF attributes; the features that are eliminated or that do not represent anymore competition issues, deal significantly with the versatility and the adaptability of the system, i.e. successful new markets can be found through specialization.

The preliminary results need however to be strengthened basically from the viewpoint of both their reliability and the usability of the guidelines in the design phases that require the correct identification of product attributes to be implemented. Regarding the consistency of the emerged guidelines, the sample of examined case studies could result affected by the choice of examples performed by Kim and Mauborgne, thus potentially neglecting relevant patterns concerning other successful value

propositions that do not fit the general ideas underpinning the BOS. At the same time failing transitions of value profiles should be carefully investigated. With respect to the applicability of the directions arisen in [4], the consistent size of the set of guidelines does not allow a thorough integration of the emerging suggestions. On this basis, priorities to be assigned for their implementation would result favourable for Engineering Design activities, as well as further criteria would support the choice among alternative product profiles to be developed.

In this perspective, the contribution of the current paper stands in a more comprehensive survey of new value propositions, leading to the definition of Value Assessment Metrics (VAMs), viable to support the strategic choice among different alternatives of product platforms by taking into account the expected value for the customers and consequently the success likelihood.

3 EXPLORING METRICS TO ESTIMATE THE EXPECTED PERCEIVED VALUE OF AN INNOVATIVE PRODUCT PROFILE

As mentioned in the previous chapter, in [4] the authors have proposed a first set of guidelines identified through the analysis of 32 success case studies from the BOS literature by correlating the Four Actions of BOS with the TRIZ-based functional classification summarized in Table 1.

In order to avoid possible biases due to the extraction of these guidelines from a list of examples unilaterally proposed by Kim and Mauborgne, in this paper the study has been extended to a range of innovations never mentioned in the BOS literature, some related to market successes, others resulting in commercial flops. More in detail the study has been conducted according to the following steps:

1. Selection of a number of product/service innovations with adequate availability of information in scientific and/or technical literature;
2. Identification of the main attributes characterizing their value profile and related classification according to the FAF and the TRIZ functional features mentioned above;
3. Application of linear and logistic regression criteria to the categorized parameters identified at step 2 belonging to the BOS successful innovation and the market failures; extraction of (VAMs) for innovative product profiles;
4. Validation of the VAMs through the set of success stories not belonging to the BOS literature, analyzed at step 2 and not used at step 3;
5. Exemplary application of the VAMs to the evaluation of an innovative profile for a lipstick and related appraisal test with a range of potential customers.

The following paragraphs of this section will detail the first four steps of the study, while the latter step constitutes the section 4 of the paper.

3.1 Selection of the case studies

For the scopes of the first research activity [4] the authors have analyzed 32 case studies from the BOS literature, extracting from them a total number of 273 attributes characterizing the products among useful functions, harmful functions and resources consumption.

Through an extended search within journal articles, books, web sites and forums, 27 new case studies not mentioned in any BOS publication and related to the proposition of innovative value profiles were selected and classified as follows:

- Success stories (13): Crocs, Facebook, Geox shoes, Hermann Miller Aeron Chair, IKEA furniture, ING Direct, iPod, Nintendo Wii, Outlet Villages, Pink Taxi, Redbull, Rim's Blackberry, Toyota Prius, Youtube.
- Market failures (14): BMW C1 motorbike, DuPont's Corfam, Federal Express' Zap Mail, Ford Edsel, Kellog's Cereal Mates, Maxwell House ready-to-drink coffee, Mc Donalds' Arch Deluxe, Motorola Iridium, Polaroid Polavision, Rasna Limited's Oranjolt, RJ Reynolds' smokeless cigarettes, Sony Betamax, Telecom Italia FIDO, Unilever Persil Power.

3.2 Value attributes identification and classification

The documents collected about each innovation have been carefully and independently analyzed by two researchers and then openly discussed among the four authors in order to check incongruent evaluations and to limit the subjectivity of the following classifications.

As detailed in [4] and briefly summarized in section 2, the value attributes characterizing each case study have been analyzed in terms of actions according to the FAF schema (Create-Raise-Reduce-Eliminate) and functional classification as in Table 1.

Table 2 summarizes the number of value attributes for the two classes of case studies distributed according to the first level classification of the functional features. The same analysis has been performed also for the sub-functional classes in order to have more detailed terms of comparison for the following correlation analyses; thus, a total number of 52 classes of value attributes have been identified, corresponding to the pairs Action (4) - Sub-Functional features (13).

3.3 Value Assessment Metrics

The value profiles of the 14 market failures, classified as described in the previous paragraph, can be compared with the analogous analyses applied to the 32 BOS success stories. According to the objectives of this paper, it is interesting to check the existence of correlation between the proposed classification of the value attributes and the market results of those innovations.

Table 2. First level classification of the value attributes of the 32 innovative product profiles analyzed in [4] and the 27 new case studies mentioned in section 3.1.

Success stories from BOS literature					Success stories outside BOS literature					Market Failures				
	UF	HF	RES	TOT		UF	HF	RES	TOT		UF	HF	RES	TOT
Create	45	7	23	75	Create	21	5	9	35	Create	6	2	1	9
Raise	40	15	47	102	Raise	19	5	21	45	Raise	6	5	7	18
Reduce	41	5	11	57	Reduce	12	8	10	30	Reduce	12	1	14	27
Eliminate	31	2	6	39	Eliminate	12	1	9	22	Eliminate	9	1	3	13
TOT	157	29	87	273	TOT	64	19	49	132	TOT	33	9	25	67

More in detail, each of these 46 case studies has been coded into a vector containing 53 cells:

- 4 cells with the number of “create” attributes related to the sub-classes of UF;
- 3 cells with the number of “create” attributes related to the sub-classes of HF;
- 6 cells with the number of “create” attributes related to the sub-classes of RES;
- 13 further analogous cells for each of the remaining BOS actions (raise, reduce, eliminate);
- 1 binary cell distinguishing between successful innovations (1) and market failures (0).

Table 3 depicts an excerpt of the resulting 46 x 53 matrix set up to perform a statistical analysis of successful/failed innovations.

In order to build mathematical expressions that link the highlighted aspects of product development strategies and commercial results, the task can be carried out by means of both linear and binary logistic regression. Both the statistical approaches present advantages and drawbacks. The linear regression analysis does not require a huge number of case studies to be performed with sufficient reliability. The outcome consists in a mathematical formula that returns a non-dimensional index to be compared with the characteristic value of successes (1) and flops (0). Such index could assume even odd values outside the 0-1 interval. The output expression of the logistic regression is capable to provide outcomes in the form of success percentages ranging from 0 to 100% for planned new value propositions. However, such an approach is affected by the need of a consistent set of examples for a reliable computing and by the impossibility to reach the convergence in the iterative calculation process of the regression coefficients, due to the lack of observations falling between pure successes and failures, as remarked in the last column of Table 3.

By taking into account the summarized deficiencies, both the regression tasks have been carried out in order to assess alternative options for estimating the success likelihood.

Table 3. Excerpt of the matrix reporting the classification of attributes related to the 46 case studies analyzed to build the value assessment metric.

Case study	create/ UF thr	create/ UF ver	create/ UF rob	create/ UF ctrl	...	raise/ HF obj	...	success/ failure
Philips Alto Bulbe	1	0	0	0	...	0	...	1
Virgin Atlantic	3	0	0	0	...	1	...	1
...
BMW C1	0	0	0	0	...	2	...	0

3.4 Value Assessment Metrics through linear regression

Through the application of a stepwise linear regression to the row vectors of the matrix (Table 3), emerged that it is possible to characterize the behaviour of the input sample with a linear model which can be represented by a linear equation having one dependent variable, i.e. the success/failure index and 52 independent variables, i.e. the pairs action/sub-functional class:

$$\begin{aligned} \text{VAM (lin)} = & -0,056 + 0,167*\text{thr/create} + 0,220*\text{thr/raise} + 0,216*\text{rob/raise} + 0,528*\text{ver/create} - \\ & 0,267*\text{ver/eliminate} + 0,278*\text{obj/raise} + 0,472*\text{obj/reduce} - 0,265*\text{sup/create} + \\ & 0,825*\text{sup/eliminate} + 0,339*\text{time/create} + 0,230*\text{time/raise} - 0,792*\text{mat/create} + 0,823*\text{ene/raise} \\ & + 0,535*\text{inf/create} + 0,227*\text{inf/raise} - 0,175*\text{inf/reduce} + 0,343*\text{cos/raise} \end{aligned} \quad (1)$$

The VAM (lin) index can be considered as a measure of the expected potential of market success of a given attribute profile. It is worth to notice that in the formula (1) just 17 out of 52 possible pairs action/sub-functional class appear: they should not necessarily be interpreted as the only responsible for a product success/failure; besides, it can be claimed that according to the set of case studies analyzed so far, the other classes of attributes actions are not univocally associated to an identified market outcome.

The coefficient of determination R^2 , which is calculated for linear regressions as the square of the sample correlation coefficient between the samples and their predicted values, constitutes a preliminary estimation of the reliability of the regression parameters [28]. The R^2 value calculated for the parameters of formula (1) is 86,6% and reduces to 78,4% by applying the modification related to the number of explanatory terms (R^2_{adj}). These values allow to assume that the proposed VAM (lin) has the potential to support the proposal of an innovative product based on a different distribution of value attributes, by estimating the expected chance of market success.

Besides, in order to check its consistency the VAM has been applied to the 13 success stories not belonging to BOS literature mentioned in section 3.1, i.e. not used for the linear regression. As a result, 11 out of 13 case studies present a VAM (lin) higher than 0,5 (0 = failure; 1 = success), in a range comprised between 0,61 (Toyota Prius) and 2,26 (Facebook). The two product profiles with a VAM (lin) lower than 0,5 (Geox shoes and Pink Taxi) might result incoherent with the others due to the reduced number of attributes identified to characterize their potential value.

3.5 Value Assessment Metrics through binary logistic regression

In order to overcome the recalled problem of dealing with a limited test sample, if compared with the high number of variables potentially involved (52) in the success likelihood calculation, the authors have taken into account for the logistic regression, the functional features of the product attributes at the first detail level. Further on, with the aim of increasing the reliability of the statistical outcomes, just the pairs actions-functional feature that come out at least 10 times in the sample (constituted by BOS successes and market failures) were used as input variables. The computing was stopped at the third iteration, since the results at this stage were already showing a 99,1% measure of association between the response variable (success or failure) and the predicted probabilities. Further refinements of the expression would result in intangible benefits by the viewpoint of the formula suitability to describe the input data. Moreover, they would lead to estimations assuming just values close to 0 or 100%, due to the steadily increment of the regression coefficients in the ongoing iteration procedure (as a result of replying more and more accurately the starting set including just “extreme” indexes in the last column of Table 3).

The final result of the binary logistic regression was the following formulation of the parameter

$$\begin{aligned} z = & -2,37 + 1,68*\text{UF/create} + 3,24*\text{RES/create} + 1,64*\text{UF/raise} + 1,32*\text{HF/raise} + 1,75*\text{RES/raise} \\ & - 0,94*\text{UF/reduce} - 1,97*\text{RES/reduce} + 0,00*\text{UF/eliminate} \end{aligned} \quad (2),$$

that allows to calculate the Value Assessment Metric throughout the logistic regression as the extent of success likelihood:

$$\text{VAM (log)} = 1/(1+e^{-z}) \quad (3).$$

The test of the VAM (log) expression has been performed for the same set of success stories employed for evaluating the consistency of the VAM (lin). Within the 13 examples just 2 of them have showed an expected success likelihood lower than 50% (Pink Taxi, 33,4%, and Red Bull, 43,0%), while the other case studies have provided VAM (log) indexes ranging from 52,0% to roughly 100,0% (Rim's Blackberry, Nintendo Wii, Hubspot, YouTube, IKEA).

In any case, the overall results can be considered sufficiently reliable and coherent to each others to propose the application of both the versions of the VAM to new product innovations, as exemplarily described in the next section.

4 EXEMPLARY APPLICATION TO THE DESIGN OF AN INNOVATIVE LISPTICK

In order to check the usability of the proposed VAMs and to preliminarily check their consistency, the authors have organized an application test by assigning a MS degree student the following task: to design three new profiles of lipstick, two of them expected to gain success according to the proposed formulas, the last one expected to fail, despite it also complies with the classical BOS recommendations.

As previously recalled, the analyzed product is a make-up lipstick, thus a cosmetic item whose function consists in applying colour and texture to the lips. A lipstick is typically composed of a cylindrical stick used for the lips colouring inserted into a primary packaging useful for the stick conservation. Starting from an industrial investigation about the value generating attributes for the considered product [29], the authors have identified the attributes that companies have long competed on. The features that currently determine the value for the system under investigation have been clustered according to the functional and sub-functional features.

The new value propositions built by the MS student are summarized in Table 4, which includes, beyond the BOS actions and the subjected competing factors, the characterization of the attributes through the functional and sub-functional features. The Table additionally shows the VAM indexes, which distinguish the expectedly successful products from the failure ones.

The effective evaluation of the real probability of success or failure is a complex problem and however out of the scope of this paper; nevertheless, the authors have defined a questionnaire in order to have a degree of appraisal of innovative profiles for a lipstick; two separate samples were constituted by:

- 43 female students of the second year of degree course in Fashion Design at Politecnico di Milano;
- 36 women aged between 20 and 35 years old, from different geographical origin and field of activity.

In the questionnaire the respondents were asked to indicate the preferred lipstick profile, choosing just one product among the three profiles depicted in Table 3 and a fourth profile inspired by a currently existing product from a famous brand (L'Oreal "Color Riche", whose brand name was hidden in the test).

As visible in Table 5, that shows the results of the questionnaire, the degree of appraisal of the expectedly successful innovative profiles is widely greater than that of predicted flops.

Table 4. Application of the New Product Definition guidelines to a lipstick and related estimation of the market potential through the VAM.

<i>Lipstick 1 - VAM (lin) = 1,27; VAM (log) = 99,5% (Success)</i>	
Create UF/THR (brand image)	Raise UF/THR (niceness of fragrance)
Raise UF/THR (packaging design)	Raise HF/OBJ (absence of dryness)
Raise UF/THR (range of colours)	Reduce RES/COS (cheapness)
Raise UF/THR (pleasantness of flavour)	Eliminate UF/THR (innovative active principles)
Description: The primary packaging of the lipstick resembles Pop Art design objects (e.g. Campbel Tomato Soup) and can be collected when the product is finished. Range of colours and fragrance are increased, while the cost is higher than standard products and there are no special active principles to give it better properties (e.g. in terms of moistening the lips)	

<i>Lipstick 2- VAM (lin) = 1,19; VAM (log) = 73,1% (Success)</i>	
Create UF/VER (colours of customizable lipstick)	Reduce UF/ROB (lipstick maintaining)
Raise UF/ THR (range of colours)	Reduce RES/COS (cheapness)
Raise HF/OBJ (absence of dryness)	Eliminate UF/THR (pleasantness of flavour)
Raise UF/THR (applicability)	Raise UF/THR (niceness of fragrance)
Description: The product is constituted by a dispenser with mixes three components to produce a variable colour lipstick. The product is rechargeable by acquiring the basic colours to be mixed. Besides, the product has no special fragrance or flavour. The cost of the dispenser is about the double of a standard lipstick and each refill costs as a standard product.	

<i>Lipstick 3 - VAM (lin) = -0,16; VAM (log) = 40,1% (Failure)</i>	
Create RES/MAT (lipstick quantity)	Reduce HF/OBJ (absence of dryness)
Create HF/ SYS (absence of deterioration)	Reduce RES/COS (cheapness)
Raise UF/ROB (lipstick maintaining)	Eliminate RES/SPA (compactness of packaging)
Description: While a standard lipstick is supposed to last for 300 applications, it is proposed a product, bigger than a usual one (25 g instead of 16 g), capable to deliver 500 applications. The lipstick is characterized by average moistening properties and high duration of each application. The overall cost is slightly higher than usual, but the unitary cost per application is lower.	

Table 5. Degree of appraisal of innovative profiles for a lipstick.

Sample	Lipstick 1 (success)	Lipstick 2 (success)	Lipstick 3 (failure)	Existing lipstick
Sample 1 (#46)	11	15	6	11
Sample 2 (#36)	8	18	3	7
% Sample 1	25,6%	34,9%	14,0%	25,6%
% Sample 2	22,2%	50,0%	8,3%	19,4%

5 DISCUSSION AND CONCLUSIONS

Building a metric to anticipate the market value of a product as a function of its properties might sound as an impossible dream. Indeed, the overall goal of the authors is to propose a systematic approach to define the value profile of a New Product as presented in [4], with a statistical support about the chance of success. The paper shows that through a generalization process of the product attributes which contribute to the customer satisfaction by enhancing the provided benefits (Useful Functions) and reducing the related undesired consequences (Harmful Functions and consumption of Resources), it is possible to make a preliminary assessment of the perceived value through an abstract comparison with respect to past market success stories and failures. The original contribution of the paper stands thus in the proposal of a first exemplary tool to estimate success likelihood for new products and services in terms of value shifts with respect to industrial standards, rather than through market projections. The outcome of this research can be a valuable support for strategic marketing activities, in larger companies where the analysis can be conducted to a deeper detail, as well as in smaller companies where strategic decisions (both market-related and technical) are often taken by the entrepreneur and/or by his closer collaborators.

The authors are aware that the proposed metrics need to be further validated and probably enhanced through a more extensive analysis of other case studies, so to take into account the whole set of pairs actions/features, including also those which were neglected in the regression analyses. Nevertheless, the methodological approach described in this paper is suitable to be applied to a greater extent of products and services in order to strengthen its reliability. An alternative approach with respect to the statistical analysis would be the employment of artificial neural networks. They could be capable to anticipate the success expectations on the basis of the built sample of new value proposition cases, without the need of a huge number of cases.

A further direction of investigation to be taken into consideration is the nature of the products, for example by distinguishing between products related to primary needs and those related to less urgent expectations; Maslow's hierarchy of needs might be a relevant classification to check this hypothesis. According to the authors' vision, the introduction of engineering methods and tools for the definition of a new product can bring positive results to reduce the waste of resources for the development of poor-valued products, but can also increase the efficiency of the overall product cycle through a better integration of the development phases. In fact, after conducting the needs identification phase, also with the support of other techniques as those described in [2], the proposed tool allows to combine them into a product profile expected to get a positive response in the market. Moreover, the availability of metrics for estimating the perceived relative value of a product constitutes a useful support to the prioritization of the Customer Requirements related to the identified needs. It is clear that it may happen that the innovative product profile is not straightforwardly implementable due to some technical, possibly inventive, problems to be solved. Besides, also in this case, an explicit formalization of the product objectives is an essential step towards a proper problem formulation. Moreover, the identification of conflicts between the product attributes can be directly approached as a TRIZ contradiction also thanks to the preliminary classification in terms of useful functions, harmful effects and employed resources. Eventually, the authors are glad to share the details of the present research activity with other colleagues in order to extend the analysis to a larger number of case studies.

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LIST OF ACRONYMS

BOS: Blue Ocean Strategy
ERRC: Eliminate Reduce Raise Create
HF: Harmful Functions
NPD: New Product Development
RES: Resources
TRIZ: Theory for Inventive Problem Solving
UF: Useful Functions
VOC: Voice of Customer

REFERENCES

- [1] Stevens, G., Burley, J. 3000 Raw Ideas = 1 Commercial Success!, *Research Technology Management*, Vol. 40, Issue 3, 1997, pp. 16-27
- [2] Eisingerich, A.B., Bell, S.J., Tracey, P. How can clusters sustain performance? The role of network strength, network openness, and environmental uncertainty, *Research Policy*, Vol. 39, Issue 2, 2010, pp. 239-253
- [3] Kim, W.C., Mauborgne, R., *Blue ocean strategy: how to create uncontested market space and make competition irrelevant*, 2005, (Harvard Business School Press, Boston)
- [4] Borgianni, Y., Cardillo, A., Cascini, G., Rotini, F. Systematizing new value proposition through a TRIZ-based classification of functional features, in *Proceedings of the ETRIA TRIZ Future Conference 2010*, Bergamo, November 2010, pp. 87-97
- [5] Ulrich, K.T., Eppinger, S.D. *Product Design and Development*, 4th edition, 2008 (McGraw Hill, New York)
- [6] Von Hippel, E. Lead Users: A Source of Novel Product Concepts, *Management Science*, Vol. 32, Issue 7, 1986, pp. 791-805
- [7] Ward, D. Needs seeded strategies, *Journal of Applied Economic Sciences*, Vol. 4, Issue 3, 2009, pp. 441-456
- [8] Ericson, Å., Müller, P., Larsson, T., Stark, R. Product-Service Systems – From Customer Needs to Requirements in Early Development Phases, in *Proceedings of the 1st CIRP Industrial Product Service Systems Conference*, Cranfield, April 2009, pp. 62-67

- [9] Cascini, G., Fantoni, G., Montagna, F., Reflections on the FBS model: proposal for an extension to needs and requirements modelling, in *International Design Conference - Design 2010*, Dubrovnik, May 2010
- [10] Boztepe, S. Toward a framework of product development for global markets: a user-value-based approach, *Design Studies*, Vol. 28, Issue 5, 2007, pp. 513-533
- [11] Tripsas, M. Customer Preference Discontinuities: A Trigger for Radical Technological Change, *Managerial and Decision Economics*, Vol. 29, Issue 2-3, 2008, pp. 79-97
- [12] Valente, M. Modelling Demand for Innovative Products, in *The Eighth International Joseph A. Schumpeter Society Conference - The Millennium Conference*, Manchester, June-July 2000
- [13] Anderon, P., Tushman, M.L. Technological Discontinuities and Dominant Designs: A Cyclical Model of Technological Change, *Administrative Science Quarterly*, Vol. 35, Issue 4, 1990, pp. 604-633
- [14] Sood, A., Tellis, G.J. Technological Evolution and Radical Innovation, *Journal of Marketing*, Vol. 69, Issue 3, 2005, pp. 152-168
- [15] Petrov, V. Laws of Development of Needs, in *Proceedings of the ETRIA TRIZ Future Conference 2005*, Graz, November 2005
- [16] Kano K.H., Hinterhuber H.H., Bailon F., Sauerwein E. How to delight your customers, *Journal of Product and Brand Management*, Vol. 5, Issue 2, 1984, pp. 6-17
- [17] Matzler, K., Hinterhuber, H.H. How to make product development projects more successful by integrating Kano's model of customer satisfaction into quality function deployment, *Technovation*, Vol. 18, Issue 1, 1998, pp. 25-38
- [18] Shen, X.X., Tan, K.C., Xie, M. An integrated approach to innovative product development using Kano's model and QFD, *European Journal of Innovation Management*, Vol. 3 Issue 2, 2000, pp. 91-99
- [19] Revelle, J.B., Moran, J.W., Cox, C.A. *The QFD Handbook*, 1998 (John Wiley & Sons, Inc., New York)
- [20] Du, X., Jiao, J., Tseng, M.M. Identifying customer need patterns for customization and personalization, *Integrated Manufacturing Systems*, Vol. 14, Issue 5, 2003, pp. 387-396
- [21] Kim, S., In, H.P., Baik, J., Kazman R., Han, K. VIRE: Sailing a Blue Ocean with Value-Innovative Requirements, *Software*, Vol. 25, Issue 1, 2008, pp. 80-87
- [22] Nellis, J. Winning the Future - a Business Overview, *Finance & Management*, Issue 146, pp. 5-7
- [23] Tomiyama, T., Gu, P., Jin, Y., Lutters, D., Kind, C., Kimura, F. Design methodologies: Industrial and educational applications, *CIRP Annals - Manufacturing Technology*, Vol. 58, Issue 2, 2009, pp. 543-565
- [24] Cavallucci, D. A research agenda for computing developments associated with innovation pipelines, *Computers in Industry*, 2011, in press
- [25] Aspara, J., Hietanen, J., Parvinen, P., Tikkanen, H. An Exploratory Empirical Verification of Blue Ocean Strategies: Findings from Sales Strategy, in *The Eighth International Business Research (IBR) Conference*, Dubai, March 2008
- [26] Raith, M.G., Staak, T., Wilker, H.M. A Decision-Analytic Approach to Blue-Ocean Strategy Development, in *Operation Research Proceedings 2007*, Saarbrücken, September 2007, pp. 225-229
- [27] Sheehan N.T., Vaidyanathan G. Using a value creation compass to discover Blue Oceans, *Strategy & Leadership*, Vol. 37, Issue 2, 2009, pp. 13-20
- [28] National Institute of Standards and Technology (NIST), *e-Handbook of Statistical Methods*, 2003, obtained from the web: <http://www.itl.nist.gov/div898/handbook>
- [29] Borgianni, Y., Cascini, G., Rotini, F. Evaluating the effects of poorly performed product development phases on customer satisfaction, in *Proceedings of the 21st CIRP Design Conference*, Daejeon, March 2011, pp. 108-115

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