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SUPPORTING THE CHOICE OF DESIGN ALTERNATIVES UNDERLYING INCREMENTAL AND RADICAL INNOVATIONS

Y. Borgianni and F. Rotini

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1. Introduction

The so-called Fuzzy Front End of engineering design cycles, i.e. the commencing activities, is acknowledged as the most crucial task to the purpose of developing innovative and successful products. As reported e.g. in [Duffy et al. 1993], 60 - 80 % of whole design costs are committed in the initial product development stages. The first step of said innovation initiatives is the product planning, which gives rise to general, sometimes vague or abstract, product ideas. Such ideas are defined in terms of the new user needs they aim at fulfilling if they consist in radical redesigns of existing products. Otherwise, if the intent of the innovation process consists in less dramatic changes, objectives are posed in terms of the deliberated improvements. Anyway, no information is available yet with respect to exploited technologies and detail aspects (e.g. subcomponents, optimization of design characteristics).
The decisions to be undertaken with respect to product ideas are thus viable to jeopardize whole innovation processes and even the destiny of enterprises. In addition, the tackling of these choices consists in considerably complex activities [Montagna 2011], because the product features and performances to be considered are hardly comparable. In other words, difficulties arise as a consequence of the lack of information and the presence of uncertainties taking place in initial product development stages [Herstatt et al. 2004], [Paasi et al. 2008]. It is therefore claimed that the ability to rapidly and proficiently evaluate and choose alternatives represents a fundamental skill of designers [Ayağ and Özdemir 2007]. However, it is widely recognized that designers and decision makers, even talented, are affected by subjectivity due to individual beliefs, background and values and that, as a consequence, their evaluations can result biased and erroneous. A recent research reported in [Kudrowitz and Wallace 2013] documents how experts tend to intuitively select product ideas characterized by remarkable novelty, but by arguable utility.
On the basis of the recalled limitations, the paper proposes a methodology to select product ideas that firms intend to develop after the preliminary consideration of projects' feasibility and overall sustainability (e.g. in economic terms or from the viewpoint of the ecological footprint). The methodology exploits information usually available after the planning phase and that attempts to minimize experts' or decision makers' personal preferences. The required data that allow the working of the tool stand in variables which are supposed to play a significant role in determining the future market success of new products. The authors are aware that other factors will contribute to enable the success of innovative artefacts, as well as organizations have to carry out with not minor care the subsequent design phases up to the market introduction. Nevertheless, in light of the mentioned complexity and lack of information, the employment of significant indexes is limited to the determinants of customer satisfaction and to the aspects majorly valued by product users. In order to

face different circumstances that can be encountered in industrial contexts, a particular objective of the proposal is the capability to individuate the most advantageous ideas in a sample of candidate alternatives including incremental product enhancements, radical innovations or a mix of them.
Section 2 highlights additional deficiencies of existing methodologies and justifies the choices that have been made to build the proposed instrument for decision making. Section 3 describes the developed decision support tool and clarifies how to select the best alternative within any set of sustainable and feasible product ideas. Section 4 illustrates a test of the proposed methodology that employs a case study from the cosmetics industry. Discussions and conclusions are entrusted to Section 5 that ends the manuscript.

2. Overview of decision supports for product development initiatives and methodological objectives to be pursued

The present Section elucidates the basic issues that have motivated the building of an original approach to support the selection of alternative product ideas. The present overview attempts to remark the main limitations of the methodologies proposed in academia, which hinder their diffusion in industrial environments [Lopéz-Mesa and Bylund 2011]. Whereas a complete state-of-the-art analysis is out of the scope of the paper, the acknowledged shortcomings of structured models have been considered as a starting point of the research.
Although not being recent by now, a reference survey about decision-making for product development initiatives is still represented by Krishnan and Ulrich [2001]. The investigation structures the various decision methods in terms of the different design stages they support. The initial product development tasks involve basically decisions about the target values of the fulfilled customer requirements. In a certain sense, the reviewed approaches are constrained to aid choices concerning product optimizations and consequently poorly contribute to the objectives of the present work.
More recent reviews (e.g. [Nikander et al. 2013]) show how most of the systematic selection methods consist in multi-criteria decision-making systems. They stand in models that consider a wide variety of technical and economical variables in order to identify the best performing alternative. Although such systems aim at making the choices more objective, it cannot be excluded that designers adapt the relevance of evaluation criteria in order to justify their initial preferences. Not surprisingly, experiments document how designers usually employ multi-criteria selection methods in an unstructured way and sometimes contradict their initial intent with the choices they perform [Nikander et al. 2013], as well as decisions are influenced by not formally defined factors [Kihlander et al. 2008]. In addition, weaknesses are witnessed about the lack of clarity in defining evaluation criteria that further limit the applicability of structured decision methods in the business practice [Messerle 2013]. According to the above evidences, the authors opted to avoid the scheme of multi-criteria approaches.
In order to define the basic features of an original decision support tool, a first choice has to be made by evaluating pros and cons of quantitative and qualitative methods. Whereas the former provide numeric indexes characterizing the goodness of ideas and solutions, the latter basically suggest the means through which to compare the proposed alternatives. On the one hand, experiments in industry show how there is not a shared preference towards quantitative or qualitative/intuitive approaches [Kester et al. 2009]. On the other hand, many contributions turn qualitative measures into quantitative variables for the scopes of easing selection tasks [Erol and Ferrell Jr. 2003]. As straightforward, this practice does not solve subjectivity issues, which majorly stem from not measurable variables associated to qualitative information. Hence, whereas quantitative indicators identify more clearly the most beneficial product options, the objective is jeopardized if the computation of the performances employs terms characterized by high subjectivity and variability. In this context, the authors decided to examine the possibility of exploiting measurable or little subjective terms highly influencing the potential success of product innovation initiatives. The main object of investigation is therefore the individuation of the main success factors determining the end result of new product development tasks. According to literature, commercial success is primarily sustained by internal collaboration between different units of the company and the attention dedicated to manifold organizational issues [Ayers et al. 1997]. The collaborative knowledge management across product development teams is seen as a primary source of sustainable competitive advantage in [Ramesh and Tiwana 1999]. The

relevance of the relationships among different design teams is stated also in [García et al. 2008], which claims the positive effect of trust in fostering cross-functional integration. Other organizational issues and peculiarities of firms are considered as determinants for new products success in [Sohn and Moon 2003], shedding light on the role played by technological level, R&D effectiveness, managers' experience.

The above contributions pinpoint the organizational aspects and the required human resources that favour the display of fruitful and lucrative innovation projects. However, these aspects concerning innovation processes cannot be taken into account when product ideas or concepts have been designed within the same organization. Hence, decisions would be advantageously supported by taking into consideration features regarding the proposed products rather than the ways innovation processes are carried out. In this sense, the capability to generate customer satisfaction can be considered as a shared dimension that strongly influences the success probability [Pettijohn et al., 2002; Huang et al., 2004, Albers and Clement, 2007] and capable to characterize the performances of products. Nevertheless, it has to be remarked that no available source (at least in authors' knowledge) has quantitatively assessed the influence of customer satisfaction in determining the success of new products. Further on, several scholars (e.g. [Christensen and Bower 1996]) argue about the efficacy of enterprises whose mission is the achievement of customer satisfaction and that strictly adhere to the indications provided by consumers.

Within the support of decisions, customer satisfaction can represent however a basic criterion for selecting the most beneficial alternative without becoming a guiding principle for the firm. Its determination through quantitative terms represents however a not trivial task, especially in the treated case whereas products to be assessed have not been launched yet and subjective evaluations have to be limited. The estimation of potential satisfaction has then to take into account the fulfilled customer requirements, their performance and their influence in impacting users' value. Such an assessment approach is common in decision support methods exploiting Quality Function Deployment (e.g. [Li et al. 2012], [Chen et al. 2013]), but in downstream product development stages and with a different aim, i.e. defining the measures of design variables in order to maximize customer satisfaction. An additional problem regards the possibility to assess or predict the role played by unprecedented product attributes. In other words, customer surveys can provide reliable information about the urgency and the expected impact of currently fulfilled product attributes, but may fail to assess the influence of new features generally characterizing radical innovations. Indeed, the literature clarifies how radical innovations, conversely to incremental improvements and optimizations, reconfigures the customer benefit landscape [Roy and Sivakumar 2012] and undermine some of the basic assumptions validated by experience [Summerer 2012]. In this sense, a further objective of the present work is the individuation of criteria capable to assess the expected value for customers descending from radical innovations. In other words, suitable variables have to be determined for both incremental and radical innovations, standing for the opportunity to develop the conceived ideas. The decision support tool has then to generate a unique coefficient characterizing any kind of innovation, which allows therefore selecting alternatives when the firm proposes a mix of product enhancements and brand new designs.

3. Methodological framework

As clarified in previous Sections, the objective of the paper is proposing a methodology to select any innovative product idea that has been advanced by an industrial subject. By considering the different dimensions impacting customers' perception of value when evaluating incremental or radical innovations, the authors propose tailored quantitative criteria to estimate the supposed competitive advantage provided by new products and a common term to compare the two clusters.

3.1 Estimating the enhanced perception of value generated by incremental innovations

Incremental innovations consist in moderate improvements of existing products and services regarding customer requirements the reference industry commonly competes on. Product users appreciate the generated performance enhancements, resulting in greater satisfaction.

The problem, from a methodological point of view, consists in relating the extent of improvements to the amount of additional customer satisfaction. It results straightforward that each product characteristic plays a different role in impacting customers' value. In addition, it has been demonstrated by Kano's theory of attractive quality [Kano et al. 1984], that the degrees of fulfilment of customer requirements can have non-linear relationships with the extents of consequently pursued satisfaction. This condition is particularly faced by product characteristics that customers explicitly suppose to find (must-be) and by unexpected properties and functionalities providing major satisfaction (attractive). The classical diagram underpinning Kano's model and the meaning of must-be, one-dimensional and attractive quality attributes, reported in numerous literature sources, are taken for granted for the purpose of the present work.

In each case, the curves drawn to explain Kano's model represent qualitative schemes and cannot be intended as quantitative representations relating product performances and customer satisfaction. The literature witnesses however several proposals attempting to establish quantitative links between the quality of product features and the resulting level of appreciation aroused by the consumers. Such literature contributions have been surveyed in [Borgianni and Rotini 2013]. The cited work has indicated the model described by Wang and Ji [2010] as a reference for quantitatively associating the fulfilment of competing factors and the perceived satisfaction, because of its reliability and ease of obtaining the required data to build the representative curves. Such curves adopt the share of unsatisfied customers if a product characteristic is absent (*worse*) and exceedingly contented consumers if the same feature is fulfilled to the maximum extent (*better*) as the boundary points on the diagram ordinate, which stands for the liking level. *Better* and *worse* coefficients can be conveniently calculated, as proposed in [Berger et al. 1993]. Abscissas report the performances in charge of the diverse product attributes, for which an interval ranging from 0 to 1 is arranged. Curves are then drawn connecting the points representing the minimum and the maximum degrees of quality through lines with tailored trajectories. Whereas one-dimensional competing factors are schematized by means of segments (1), the curves underlying must-be (2) and attractive (3) features are described through exponential functions, as follows:

$$S = (Better - Worse) \times p + Worse \tag{1}$$

$$S = \frac{e \times (Better - Worse)}{e-1} \times e^{-p} + \frac{e \times Better - Worse}{e-1} \tag{2}$$

$$S = \frac{Better - Worse}{e-1} \times e^{p} - \frac{Better - e \times Worse}{e-1} \tag{3}$$

In the formulas above, *S* represents the score of customer satisfaction generated by the product characteristic, according to its matching performance *p*.

In order to obtain the total amount of satisfaction stimulated by a product, it is hereby assumed that this index can be achieved by summing the partial degrees of contentment provided by each customer requirement. This approach is common in product innovation management literature, which witnesses several contributions (e.g. [Chen and Weng 2006]) aiming at maximizing global customer satisfaction as a resultant of the level of attainment of multiple user needs. The sum of *S* variables stands thus for the whole capacity of a product platform to give rise to customer satisfaction. It then results that the chances of a new product to gain competitive advantage over the present commercial offer depends on the capability to generate greater customer satisfaction with respect to a supposed industrial standard.

In order to determine the opportunities of an incremental innovation to thrive in the marketplace, the authors propose to estimate its competitive advantage through an index named *appreciation level*, calculated on the basis of previous evidences and consolidated practices. The computation can be made in a step-by-step fashion, as follows:

- individuate and list the valuable competing factors for a specific product in a given industrial context;
- establish the degrees of fulfilment for all the listed customer requirements with respect to the proposed innovation(s) and a reference product supposed to be a standard for the market;
- characterize each product attribute in terms of Kano categories (must-be, one-dimensional, attractive) by means of tailored surveys (e.g. [Berger et al. 1993]);

- determine the *worse* coefficient, i.e. the share of drastically unsatisfied customers (with the sign -) for each competing factor, by hypothesizing that such product characteristic is unfulfilled;
- determine the *better* coefficient, i.e. the share of excited customers for each competing factor, by hypothesizing that the performance of such product characteristic is ideally high;
- obtain the partial shares of satisfaction *S* reflecting the performances of the incremental innovation(s) and the industrial standard by means of the formulas (1-3), which differ according to the deliberated Kano quality attributes;
- sum the previously calculated items in order to obtain the total amount of satisfaction referred to the incremental innovation(s) and the industrial standard;
- compute the *appreciation level* of the incremental innovation(s) as the ratio between its (their) global index of customer satisfaction and the one characterizing the chosen standard.

The last step determines therefore that innovations with *appreciation level* equal to 1 have no real competitive advantage, since they arouse the same amount of customer satisfaction generated by the industrial standard. At the same time, whereas such an index is lower than 1, the proposed incremental innovation represents a disadvantage in terms of competitiveness. The application of the calculation procedure will become more evident trough the experiment described in Section 4.

3.2 Estimating the benefits and the competitive advantage characterizing radical innovations

With respect to radical innovations, as clarified above, new product platforms drastically redefine the set of fulfilled needs that participate to the satisfaction of customers. A branch of literature is expanding devoted to support designers and entrepreneurs in carrying out innovation tasks leading to products and services capable to redefine market boundaries and hence to avoid severe competition (e.g. [Kim and Mauborgne 2005]). Competing factors and their level of achievement, employed as fundaments to determine liking degrees within incremental innovations, cannot be considered anymore as means to compare different product profiles. This is due to the emergence of unprecedented product features that are supposed to consistently modify the impact of previously relevant properties [Tripsas 2008].

Different explanatory variables have to be thus introduced in order to evaluate whether candidate breakthrough innovations are capable to obtain success in the marketplace, but little research has been conducted to clearly highlight such impacting factors. A contribution in this sense is represented by the work described in [Borgianni et al. 2013], whose objective is estimating the success likelihood of drastic product/service innovations in terms of the deviations from the commercial offer with regards to the benefits delivered to customers, users and service recipients. More specifically, the cited research computes the probability of radical innovations to thrive on the marketplace (named Value Assessment Metrics or briefly *VAM*) according to the diffusion of 12 different modalities in which the occurred transformations take place with respect to reference industrial standards. The 12 variables consist in the combination of the Four Actions introduced within the Blue Ocean Strategy [Kim and Mauborgne 2005], i.e. the introduction of new attributes (Create), the exclusion of current competing factors (Eliminate), the significant growth/decay of performances (Raise/Reduce), and three kinds of benefits subjected to the above transformations. The latter are articulated in the so called functional features, standing in:

- direct advantages for customers or users (UF);
- the attenuation of undesired effects commonly associated with the functioning of the treated system (HF);
- the lessening of allocated resources or capabilities required to employ the product under investigation (RES).

The reference proposes to calculate the success probability through two alternative ways, i.e. a formula obtained through a regression model and a computer estimation performed by Artificial Neural Networks. The first option is preferable in order to allow any organization determining the *VAM* score, which is then calculated as follows, by computing beforehand the index *z*, which depends on the quantity of encountered transformations expressed in terms of pairs constituted by each functional feature and Action (4, 5):

$$z = -3{,}19 + 3{,}44 \times UF/create + 1{,}32 \times HF/create + 2{,}87 \times RES/create$$
$$+ 0{,}97 \times UF/raise + 1{,}75 \times HF/raise + 0{,}41 \times RES/raise - 0{,}84 \times UF/reduce$$
$$- 0{,}27 \times HF/reduce - 1{,}78 \times RES/reduce - 0{,}46 \times UF/eliminate \quad (4)$$
$$- 9{,}49 \times HF/eliminate - 1{,}65 \times RES/eliminate$$

$$VAM = 1/(1 + e^{-z}) \quad (5)$$

For instance, the consistent improvement of two useful effects (UF/raise) requires to add 0,97 twice for the computation of the *z* coefficient. Success probability scores have then to be transformed in terms of *appreciation level*, in order to make the comparison of radical and incremental innovations feasible. The rule to be followed is to assign the value 1 for such a coefficient to those product ideas providing no real competitive advantage with respect to the industrial standard. In the case of radical innovations, such "neutral" situation can be considered for product ideas showing 50 % success probability (*VAM* = 0,5). By doubling *VAM* index it is then possible to achieve *appreciation level* coefficients that represent positive (negative) effects on competitiveness when holding values greater (minor) than 1. In order to compute the *appreciation level* for each radical innovation, it is thus required:

- to list the planned changes in terms of benefits for customers or users with respect to the market standard of the reference industry;
- to describe such transformations through the Actions introduced within the Blue Ocean Strategy (Create, Raise, Reduce, Eliminate);
- to identify the proper functional features (UF, HF, RES) that characterize the product attributes subjected to the above Actions;
- to count the mutual relationships between Actions and functional features included in the list of modifications of the benefits, so to apply the formula (4);
- to calculate the *VAM* value as in (5) and to determine the *appreciation level* by doubling it.

4. Application of the decision support tool

The test of the proposed system for aiding the undertaking of decisions has been carried out by benefitting from a literature case study, whereas a mix of incremental and radical innovations has been already ideated and proposed. In particular, the exploited case study regards the development of four new alternatives pertaining to lipsticks for women's make-up, whereas three product ideas represent radical innovations and have been already subjected to the computation of the *VAM* coefficient [Borgianni et al. 2013]. The distinguishing features of said radical innovations concern a vintage primary packaging, multiple colours that can be blended and a bigger stick, respectively.

No assessment had been performed conversely with respect to the incremental innovation, consisting in an elegant new lipstick owing the characteristics of L'Oreal Color Riche, candidate to become a successful product in the high-end market of cosmetics industry. In order to achieve the required data for computing the *appreciation level* for such a product, the authors obtained some information through the collaboration with an Italian enterprise manufacturing make-up lipsticks for famous brands. At first, the firm provided a list of the current competing factors in the lipsticks' industry, resulting in a set of 21 customer requirements. All of them were evaluated in terms of their quality, performance or level of attainment with respect to their products (considered as a standard) and the innovation mimicking the proposal of L'Oreal. A Kano survey was then conducted to assess the relevance of each product characteristic and to determine the most suitable quality attribute of the same features. 25 managers and salespeople participated to the survey, providing all the needed data to calculate the expected competitive advantage for the incremental innovation, as shown Table 1. For the sake of clarity, Kano categories represent the most diffused quality attributes as emerged by the proposed questionnaire, which revealed also the *worse* and *better* indexes, calculated as in [Berger et al. 1993]. The performances *p* of both the lipsticks have been assessed by the firm and are reported as *quality* in the Table. The customer satisfaction *S* generated by each product feature is computed according to the formulas proposed in [Wang and Ji 2010] and expressed through (1-3).

Table 1. Assessment of performances and customer satisfaction for the proposed incremental innovation

				Standard lipstick		L'Oreal Color Riche	
Customer requirement	**Kano category**	***Worse***	***Better***	**Quality (*p*)**	**Provided satisfaction (*S*)**	**Quality (*p*)**	**Provided satisfaction (*S*)**
Stick colour	Must-be	-0,8	0,2	0,9	0,14	1	0,20
Stick colour precision	Must-be	-0,64	0,16	1	0,16	1	0,16
Stick taste	Must-be	-0,48	0,12	0,7	0,00	0,9	0,08
Stick scent	Must-be	-0,64	0,16	0,7	0,00	0,7	0,00
Absence of foreign bodies in the stick	Must-be	-0,8	0,2	0,8	0,07	0,9	0,14
Stick surface porosity	Must-be	-0,48	0,12	0,8	0,04	0,8	0,04
Lipstick applicability	Must-be	-0,64	0,16	0,8	0,06	0,8	0,06
Presence of active principles in the lipstick	Must-be	-0,48	0,12	0,7	0,00	0,7	0,00
Lipstick resistance on the lips	One-dimensional	-0,28	0,28	0,5	0,00	0,6	0,06
Avoiding irritation phenomena	Must-be	-0,8	0,2	0,6	-0,09	0,9	0,14
Quantity of product in the lipstick	Must-be	-0,48	0,12	0,6	-0,05	0,6	-0,05
Duration of lipstick properties	Must-be	-0,48	0,12	0,7	0,00	0,7	0,00
Customizable stick shape	Attractive	-0,16	0,64	0,2	-0,06	0,6	0,22
Special effects	Attractive	-0,16	0,64	0	-0,16	0,7	0,31
Compatibility of the primary packaging with the stick	Must-be	-0,64	0,16	1	0,16	1	0,16
Colour of the primary packaging	Must-be	-0,64	0,16	0,8	0,06	0,9	0,11
Resistance of primary packaging	Must-be	-0,16	0,04	1	0,04	1	0,04
Functionalities of primary packaging	Must-be	-0,64	0,16	1	0,16	1	0,16
Technical dossier	Must-be	-0,64	0,16	1	0,16	1	0,16
Product labeling	Must-be	-0,64	0,16	1	0,16	1	0,16
Cheapness	One-dimensional	-0,48	0,48	0,9	0,38	0,4	-0,10
TOTAL CUSTOMER SATISFACTION					1,23		2,05

Eventually, the total amounts of customer satisfaction pertaining to both the industrial standard and the new product allow determining the *appreciation level* of the incremental innovation by simply dividing the global scores. The outcome is then roughly 1,67.
The values of the same index for the radical innovations can be trivially calculated by doubling the already available *VAM* scores, as indicated in Section 3.2. The verification of the reliability of the emerging outcomes can be made by using the results of a questionnaire, still included in [Borgianni et

al. 2013], whereas 101 potential users of lipsticks expressed their preference with respect to any of the four proposed alternatives in light of the main product features highlighted in the questionnaire. The summary of the results is illustrated in Table 2, which shows both the final determination of *appreciation level* indexes and the number of preferences attained by each proposed innovation.

Table 2. Appreciation levels for the proposed mix of radical and incremental innovations

Innovation	*VAM*	Total Customer Satisfaction	Total Customer Satisfaction of the matching Industrial Standard	*Appreciation level*	Customer preferences
Radical 1– Vintage	0,97	-	-	1,95	23
Radical 2 – Multi-colour	0,86	-	-	1,72	42
Radical 3 – Bigger stick	0,15	-	-	0,30	10
Incremental – L'Oreal	-	2,05	1,23	1,67	26

Although the interview of a limited number of customers, constituting a sample of convenience, cannot be considered as a validation activity, some evidences arise from the analysis of the results shown in Table 2. A first remark can be made with respect to the most beneficial product innovation, showing a conflict between *appreciation level* scores and the quantity of preferences provided by the respondents. In this sense, the decision support tool would be deemed to select the wrong product idea, if customers' opinions are considered as a reference for the effective innovation success. However, it has to be highlighted that the values of the supposed competitive advantage concerning three alternatives (the first two radical innovations and the incremental one) are quite similar and reliable rankings cannot be performed in this case. Just one out of four *appreciation level* values substantially differs from the others and it refers to a product idea to be surely discarded according to consumers' preferences. Generally speaking, if the proposed system was not capable to clearly identify the most advantageous product alternative, it can be considered useful in discerning "good" from "bad" innovation proposals. This can be confirmed by matching the sets of values concerning *appreciation level* scores and customers' preferences, leading to a Pearson's correlation coefficient equal to roughly 0,72. In other words, the proposed decision system is deemed, for the given case study, to explain the future appreciation and success of innovative products to an extent greater than 70 %.

5. Conclusions and future activities

The paper has illustrated a novel quantitative method for supporting decisions in industry, which combines in an original manner contributions aimed at quantifying the expected customer satisfaction and success chances. A distinguishing feature of the proposal is the employment of different metrics for estimating the goodness of radical and incremental innovations, since their appreciation is supposed to arise through dissimilar mechanisms. A particular objective of the work consisted in the limitation of decision makers' subjectivity that affects the choices performed during product development initiatives, even when using structured approaches. Within the proposed methodology a certain degree of subjectivity can regard the evaluation of product performances (when not directly measurable), which is a required step for assessing the competitive advantage of incremental innovations. However, the authors believe that this task, although not being error-free and unbiased, is not directly influenced by the individual preferences already conceived by designers when urged to tackle decisions about innovation projects to invest in.

The shown instrument for supporting decisions can be employed whenever a firm or a design team advances a set of new product ideas, whose main distinguishing features and benefits delivered to perspective users are well defined. The sample of proposals can include product profiles with extremely varying degrees of novelty. Decision makers have to identify an industrial standard in the industry they operate in order to evaluate the changes brought by each alternative. Therefore, limitations of the methodology regard its usability within brand new markets or whenever it is not possible to clearly identify the target performances of the new artefacts.

From the viewpoint of the benefits displayed by the illustrated design method, the system has demonstrated to basically select innovations viable to achieve success from probable flops. The first

experiment has however led to partially satisfactory outcomes on the basis of the difficulties in identifying the most promising alternative. It has also to be noticed that the data employed for verification purposes cannot be considered sufficient for a full validation of the proposal, which would require to launch the new products in the marketplace and observe their real commercial results. Such a task cannot be currently performed due to long execution times and because it is preferable to fine tune the methodology prior to test it in such a hazardous situation.
Enhancements of the decision support tool are indeed expected. At first, the authors will try to further reduce the subjectivity of the required inputs, by establishing more systematic criteria to define performances and any other index whose designation would result poorly robust. Subsequently, a required test has to concern a sensitivity analysis with respect to the variability of the introduced coefficients and indexes. Whereas any variation would result exceedingly impacting with respect to the computation of *appreciation level* scores, measures should be taken in order to account for the uncertainty of terms employed to support decisions. Eventually, modifications of the methodology can regard the consideration of additional parameters related to the product showing a remarkable impact in determining future market success. In this sense, given the great influence of changing boundary conditions in product design contexts, authors are evaluating the opportunity to take into consideration the dynamic impact of product characteristics [Nilsson-Witell and Fundin 2005], [Tripsas 2008], [Chong and Chen 2010].

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Yuri Borgianni, Eng., Research Assistant
University of Florence, Department of Industrial Engineering (DIEF)
Via Santa Marta, 3, 50139 Firenze, Italy
Telephone: +39(0)55-4796514
Email: yuri.borgianni@unifi.it