ICED13
INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN, ICED13
19-22 AUGUST 2013, SUNGKYUNKWAN UNIVERSITY, SEOUL, KOREA

OVERVIEW OF METHODS SUPPORTING PRODUCT PLANNING: OPEN RESEARCH ISSUES

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ABSTRACT
The capability to innovate and thus to renew the commercial offer, is becoming the mission of several companies in order to dramatically increase the customer satisfaction. To this aim, the design activities should be effectively supported, paying specific attention to the earliest phase of design, i.e. product planning, in which the designers have to identify the user needs and translate them in product requirements. In the last decades, there have been some attempts to systematically support this critical design activity. The authors undertook an analysis of these methods, highlighting how they support the product planning phase, their strengths and weaknesses. The comparison of the collected contributions shows a plurality of viable research directions, poorly investigated up to now, in order to effectively support the task of product planning. The paper suggests new functionalities to be introduced in the methodologies proposed so far and stresses the attention on performing further tests to increase the reliability of a great amount of poorly validated, although promising, design approaches.

Keywords: new product development, innovation, product planning, systematic design methods

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1 INTRODUCTION

The capability to innovate the commercial offer is becoming a key aspect for the survival of companies due to the high competitiveness of the market. Among the activities performed within an organization, product design undoubtedly represents an important ring in the value generation chain of the outputs expected by customers. Indeed, as widely witnessed by literature (Pahl and Beitz, 2007), such a phase strongly impacts the success of products in the market. For this reason, firms should carefully analyze and continuously improve their product design activities. Obviously, a particular attention has to be plainly paid towards those tasks that result crucial in determining the successful achievement of innovation initiatives.

Conceptual Design is acknowledged as a fundamental step towards the definition of original, novel and sustainable technical solutions. Another strategic design phase is undoubtedly Product Planning, whose outcome constitutes the product idea on which the company will concentrate design efforts and available resources (Montagna, 2011). Product Planning basically consists in the identification of customer needs, the analysis of current lacks in the market and the definition of new product characteristics capable to fulfill customer expectations. In many cases, markedly in SMEs, Product Planning is entrusted to intuition and experience of few decision makers. In larger companies, the task is commonly supported by conjoint activities that often involve multidisciplinary teams constituted by marketing and technical experts. Marketing professionals usually perform a preliminary benchmark analysis and examine the needs expressed by end users, taking the Voice of the Customers (VoC) into the company. Designers analyze these indications and investigate the most promising and technically feasible product features in order to fulfill the needs of end users. One of the main output of Product Planning is the list of product requirements (e.g. Shinno et al., 2006; Pahl and Beitz, 2007), which represents the reference for the subsequent phases of engineering design. Such phases are then focused on definition, selection and development of the most valuable technical solutions.

The literature witnesses the great impact and the disruptive effects that the above activities may have on the life of firms. Ulrich and Eppinger (2008) estimate that up to 80% of the forthcoming cost of the product is committed by the decisions undertaken in the initial design phases. Furthermore, Haig (2011) and other researchers highlight how a great percentage of product failures is ascribable to not efficient/efficacy planning activities. Notwithstanding the critical role it plays, Product Planning still results insufficiently supported. As a consequence, several scholars belonging to the engineering design domain point out the need to develop specific approaches aimed at supporting actions and decisions of professionals involved in Product Planning.

In this context, the authors and their research team have concentrated several efforts in developing methods and tools to systematically support strategic activities that may lead to considerable improvements of companies' performances (e.g. Rotini et al., 2012). A key topic concerns the analysis of the needs of professionals involved in Product Planning and the subsequent development of tools to assist its constituent activities. According to this general objective, a preliminary investigation has been carried out of methods that provide a support in planning new product ideas and in selecting the most promising alternatives. The present paper describes the results of this analysis, highlighting current lacks and sketching the main research questions to be addressed in the future.

The second section of the article reviews the collected methods and tools, shedding light on their strengths and weaknesses. Subsequently, the third section defines a set of criteria used for the comparison of the collected methods, presents the results and performs a discussion aimed at highlighting new promising future research directions. Finally, the main research evidences are summarized in the fourth section, that concludes the paper.

2 OVERVIEW OF DESIGN METHODS FOR PRODUCT PLANNING

The authors limited the overview to contributions that can support Product Planning activities for the identification and selection of new product ideas or single innovative product features. The analysis has been further restricted to those methods that supply the list of product requirements (or the basic information to easily obtain it). Such requirements include both current product characteristics and new features, commonly introduced to satisfy emerging or unspoken needs. In the remainder of the paper, the authors will indicate with the term "latent needs" the complex of unprecedented customer requirements that are discovered, stimulated or aroused.

Two main categories of Product Planning approaches can be identified in literature: responsive and proactive methodologies (e.g. Narver et al., 2004; Atuahene-Gima, 2005). The former consider the industrial standard as a reference for identifying lacks in the offered product features and in the delivered performances. Responsive methods swivel on marketing surveys whose results are used as input information to define a new product idea. Hence, the task of pointing out desired improvements is almost entirely entrusted to the end user, who represents the real decision-maker, while the innovation strategy implemented through these approaches is mainly based on the fulfillment of expressed needs. Therefore, the team in charge of the Product Planning task has to collect, analyze, interpret the customers expressed needs and translate them into product requirements. The first three activities are typically managed by the marketing professionals, whereas the fourth one is often delegated to designers. Proactive methods attempt to capture unspoken wants of customers or even induce new needs for end users. They aim at developing product ideas radically different from the industrial standard. Therefore, these methods do not involve the end user in the investigation of the aspects that could represent potential innovation opportunities. Benchmarking analyses are used to analyze the market context while all the decisions about the definition and the selection of the most promising product ideas are totally in charge of design teams.
Besides the recalled typologies of methods, the survey performed by the authors has revealed the existence of contributions that merge, as a matter of fact, peculiarities of both responsive and proactive practices. They essentially try to discover and fulfill customers' latent needs by involving the end users of the product or service in the idea generation process. Indeed, the users are asked to provide feedback about the new product ideas that are generated by the design team and/or collaborate in proposing new ones. The authors decided to introduce a further category of contributions due to this evidence, named "hybrid", through which to classify all the methods that present both responsive and proactive characteristics.
In the following subsections the surveyed contributions are described, briefly highlighting how they support the Product Planning phase, their strengths and weaknesses.

2.1 Responsive Methods

Responsive methods focus on the analysis of the VoC, collected especially through questionnaire surveys. In this field, the main efforts of the scholars are devoted to the development of data analysis tools aimed at supporting the identification of the main customer preferences.
Liberatore and Stylianou (1995), as well as Matsatsinis and Siskos (1999), suggest a set of statistical tools to combine the inputs coming from customer surveys, expertise of internal personnel and market analysis, in order to generate a list of the most beneficial product requirements. The two instruments have been implemented in computer aided systems and tested through industrial case studies in companies manufacturing flooring and agricultural products, respectively. Even if a single test cannot constitute a proof of reliability and general applicability, the tool developed by Matsatsinis and Siskos (1999) seems to be ready-to-use in different industrial fields, because it uses a generic formulation that makes the approach adoptable for variegated products. Furthermore, it integrates a forecasting tool that supports the analysis of customer preferences dynamics. Such a characteristic results useful for responsive methods because customer surveys constitute time-consuming activities, hence customers' orientations can change in the meanwhile. The two methods need both marketing and technical competencies in order to respectively support the analysis of the VoC and the definition of product requirements. Their main strength concerns the competitors' analysis that provides the design team a clear market vision. On the other hand, the main weaknesses are related to the statistical analysis that requires significant data samples and the subjective experts' decisions, viable to jeopardize the reliability of the results.
Chan and Ip (2011) propose a method that follows a different procedure, if compared to the previous contributions. The design team has to assess, on the basis of experience, the most beneficial product attributes and features for the end user. The emerged characteristics are submitted to several samples of potential end users to analyze the purchasing behavior through questionnaires. Then, the obtained data are matched and the best set of product features is identified. This method too provides a forecasting analysis to take into account the dynamic behavior of the customer preferences. The scholars have applied the method in the power tool industry, obtaining encouraging results; however, also in this case, a single test is not sufficient to fully assess its reliability. Furthermore, the considered approach shares some weaknesses with those previously cited, because it needs to collect and analyze

data samples and requires subjective inputs. However, subjectivity issues are better managed, since the comparison among surveys can highlight the presence of incongruities.
In general, the authors agree with some researchers, e.g. Bonner, (2005) and Atuahene-Gima et al., (2005), when they claim that responsive approaches, like the illustrative ones, can reduce the level of uncertainty related to the market response towards new products ideas. Anyway, the authors disagree with the opinion of the same scholars when stating that these methods can reduce design expenses and time to market, since customer surveys involve a great amount of time and resources in order to obtain reliable results. Eventually, an additional weakness of these methods consists in their impossibility to provide useful aids to explore new valuable features and market contexts (e.g. Ulwick, 2002), by entrusting just to explicit customer requests.

2.2 Proactive Methods

The scientific community focused efforts to the development of tools supporting the analysis of the reference market and the discovery of latent needs. As a result, proactive methods support the development of breakthrough product ideas without involving the end user in the Product Planning, as it will become more apparent in the followings. Conversely, their main shortcomings actually lie in high expenditures committed to NPD tasks (Levinthal and March, 1993) and the possibility of guiding the designer towards product ideas resulting too distant from customer tastes (Ulwick, 2002).
Lee et al. (2010) propose a procedure that supports all the activities of Product Planning from the product idea generation to the selection of the most promising alternative. The method involves a design team striving to identify the potential user needs and product requirements through a scenario-based analysis. The selection of the most promising set of product features is performed according to a criterion based on a benefit-cost analysis. The proposal has been tested through an industrial case study (i.e. the development of a tangible user interface) obtaining good results. A remarkable limitation is constituted by the need of a large design team since the members have to confront each other during idea generation and selection to obtain reliable results.
In the last years, a growing consensus in the industry (Lindič et al., 2012) is attributed to the Blue Ocean Strategy (BOS) by Kim and Mauborgne (2005), i.e. a mindset aimed at supporting the NPD initiatives. It provides thinking tools that support the vision about possible radical modifications of current industrial standards. Starting from a benchmarking analysis as input, the designer identifies a new product profile, i.e. a new set of product features, by the application of guidelines empirically obtained through the careful analysis of past market successes. Unfortunately, although these tools seem to have a general validity, their reliability has still to be demonstrated. Moreover, the BOS toolkit offers only mere qualitative indications that are not sufficiently systematic to support the designer during the whole Product Planning process (Aspara et al., 2008).

2.3 Hybrid Methods

As previously claimed, hybrid methods merge characteristics of responsive and proactive approaches. These methods can involve the customer:

- in an active way, with the aim of collaborating in the generation of new product ideas;
- in a passive way, in order to obtain preliminary judgments about the new ideas.

The active involvement of the users represents a distinguishing factor of the well-known Brainstorming method, originally developed by Osborne (1953). This approach is extensively used in the industrial practice (Geschka, 1996), because it can be easily and intuitively implemented. A group constituted by end users, guided by a moderator, discusses about new product ideas. At the end of the procedure, the design team analyzes the results and compares the collected ideas and their feasibility. The original method however supports just the first phase of the Product Planning, concerning the idea generation, but it does not support the following selection activity. Osborne stresses the importance of focusing on the quantity rather than on the quality of the ideas, by claiming that the abundance of hints results in greater chances of achieving successful outcomes. Nevertheless, too many alternatives create considerable problems in the selection phase and the scarce quality of the outputs can lead to not promising results. Furthermore, whereas Brainstorming advocates claim that such method is more effective than entrusting idea generation to a plurality of individuals working separately, other studies (e.g. Diehl and Stroebe, 1991) assess that groups employing Brainstorming produce a smaller quantity of ideas (besides less feasible).

The Lead Users method, by Von Hippel (1986; 2005), does not consider all the potential customers, but only pioneer users (lead users) of a product. Pioneers have spent more time in using the product with respect to the rest of the customers, hence they probably have experienced needs still latent for many potential clients. Thus, the company has to identify the lead users, e.g. through Internet searches, and involve them in the Product Planning phase. Such users are asked about new potential product features or original product ideas. Von Hippel's method supports only the idea generation phase, is quite intuitive, but the results based on users' ideas might result unfeasible for the company.
A more systematic contribution is proposed by Büyüközkan and Feyzioğlu (2004). It exploits an Internet database to collect new product ideas within a specific industrial context, which are generated not only by company designers or product managers, but also by employees and customers as well. The selection of the most promising idea is supported by a computer-aided tool, that uses a historical database collecting successful and unsuccessful product cases and a set of company's constraints. The application of this approach to an industrial case study in a toy manufacturing firm has demonstrated its capability to speed-up the Product Planning process. Moreover, the researchers claim that each type of firm can adopt this tool. Nevertheless, it is worth to notice that the proposed method can be employed only if a great number of new product ideas are stimulated, being it based on neural networks. Moreover, a great limitation of the approach lies in the inconsistent results generated without an updated historical database, as claimed by the same scholars.
Kansei Engineering (Nagamachi, 1995) extracts customers' inclinations about product alternative ideas, which are previously collected by designers who analyze existing artifacts and/or conceive new ones. The method allows studying the emotional reactions of the customers up against descriptions, images, prototypes of new or existing products, their components and features. The customers are generally asked to assess the proposed product ideas through questionnaires, that permit therefore to reveal the most promising alternatives. Hence, the method foresees a passive, although custom, involvement of the end users. One of the advantages of Kansei consists in its general applicability, since it can be used for any product, service or component. On the contrary, one of the main weakness is related to the development of the questionnaire, since it is very difficult to find the right expressions by which to render the customer emotional reactions. Furthermore, the authors believe that, even if Kansei Engineering achieved a great consensus in the Japanese industrial context, it may encounter some obstacles for the adoption in other countries because of cultural reasons.
Chen and Yan (2008) illustrate a method that supports the designer in the process of product ideas generation and selection, benefitting of customer surveys. As in Kansei, the end users are passively involved in the planning phase and provide feedback about ideas developed by the designers, who attempt to hybridize existing products features. In addition, the method can forecast customer preferences by performing a trend analysis of historical data that have been collected during time by means of user surveys. The proposed approach can totally support the Product Planning phase. Anyway, Chen and Yan show only a theoretical case study about cellular phone design to illustrate its applicability; therefore the usability of the method in the industry has to be still demonstrated.
Ultimately, the presented analysis highlights that hybrid methods merge together not only the positive aspects of both proactive and responsive strategies but, sometimes, also their disadvantages.

3 COMPARISON OF THE COLLECTED METHODS

The authors compared the collected methods and tools in order to highlight where the main research efforts have been focused up to now. The comparison allows identifying some current lacks, showing new promising research directions. The comparison model is described in the following subsections and the obtained results are subsequently presented and discussed.

3.1 Comparison model

In order to analyze and compare the collected methods and tools, the authors identified a set of properties that emerged from the performed review. The set includes peculiarities of the surveyed proposals, as well as desirable characteristics which often come out as strengths or weaknesses of the contributions. The latter comprise evaluation criteria with regards to the reliability, the systematic level and the accuracy of the investigated instruments within the support of Product Planning. Table 1 illustrates the whole sample of properties, their descriptions and their meaning within the Product Planning phase.

Table 1. Description of the properties through which to compare methods and tools

Property	Description	Relevance of the property
Initial focus on products attributes	Predominant attention on the identification of the attributes and features of the product to be developed. Subsequently these attributes can be articulated in order to create an innovative product profile.	The analysis of the single features of a new product allows to perform insightful evaluations of customer preferences. It favors the process of developing the requirement list.
Initial focus on general product ideas	Approach aimed at identifying from the beginning new general product ideas, without analyzing single attributes.	The capability of framing a general product idea from the very beginning of the design process avoids the need to conciliate single and potentially conflicting customer requirements.
Quickness and easiness of the method/tool	It features methods resulting easy, quick and intuitive for the user, who has to learn, implement and use them.	It is important to support quickly and easily the Product Planning phase, in order to reduce the companies' committed resources.
Effective support in the individuation of latent needs	It considers the capability of effectively aiding the search of customer latent needs.	The discovery and fulfillment of latent needs supports the development of breakthrough products and allows to avoid head-to-head competition.
Integrated competitors' analysis	Characteristic possessed by the methods which include an analysis of the competition.	The analysis of the reference industry can help to individuate the competition factors and to seek a differentiation strategy.
Independence from inputs subjectivity	It refers to the limited employment of personal judgments or uncertain inputs, which can alter the final results of the Product Planning.	Such feature influences to a considerable extent the robustness and repeatability of the method or tool.
Consideration of customer preferences dynamics	It features those methods that consider the variations in the time of the customers' preferences and tastes.	Customer preferences vary in time and it is important to consider their dynamics in a right market at a right time.
Reliability of the approach	Level at which the presented contributions have been verified or validated through practical applications in differentiated industrial fields.	It is desirable to employ reliable and tested methods which can be beneficially exploited in a large range of industrial contexts.
Support in selecting the most beneficial product idea	It considers the capability of selecting the most beneficial product idea that should be developed by the company.	It is fundamental to support the last decision-making phase of the Product Planning, because it evaluates which product idea has the greatest chances to be turned into a potential market success.

With the aim of classifying the collected methods according to these properties, the authors used the information provided by the scholars and/or further indications achievable from the literature. Table 2 shows the comparison among the reference methods and tools, listed according to the order they appear in Section 2. In addition, the Table recalls, for the sake of clarity, the name or the general topic of the methodologies (second column). A trivial dichotomous system (i.e. yes/no) is insufficient to describe all the methods according to each property, because, in some circumstances, the surveyed contributions fulfill certain requirement just partially.

3.2 Discussion of the results

Table 3 summarizes the comparison of the investigated methods, highlighting the current distinguishing features of responsive, proactive and hybrid approaches.

Table 2. Comparison of the collected methods

Sources	Name of the methodology or general topic	Initial focus on products attributes	Initial focus on general product ideas	Quickness and easiness of the model/tool	Effective support in the individuation of latent needs	Integrated competitors' analysis	Independence from inputs subjectivity	Consideration of customer preferences dynamics	Reliability of the approach	Support in selecting the most beneficial product idea
Liberatore and Stylianou (1995)	*DSS for Customer Satisfaction Assessment*	Yes	No	No	No	Yes	Partially (statistics)	No	Partially	Yes
Matsatsinis and Siskos (1999)	*SW for Marketing Surveys Analysis*	Yes	No	Yes (excluding survey)	No	Yes	Partially (statistics)	Yes	Partially	Yes
Chan and Ip (2011)	*DSS based on Experts and Customer Surveys*	Yes	No	No	No	No	Partially (statistics)	Yes	Partially	Yes
Lee et al. (2010)	*Scenario model*	Yes	No	Partially	Yes	No	No	No	Partially	Yes
Kim and Mauborgne (2005)	*Blue Ocean Strategy*	Yes	No	Partially	Yes	Yes	No	Not pertinent	Partially	No
Osborne (1953)	*Brainstorming*	Yes	Yes	Yes	Yes	No	No	No	No	No
Von Hippel (1986; 2005)	*Lead Users method*	Yes	Yes	Yes	Yes (lead)	No	No	No	No	No
Büyüközkan and Feyzioğlu (2004)	*Selection from New Product Ideas Database*	No	Yes	No (survey/ elaboration)	Yes	Yes	No	No	No	Yes
Nagamachi (1995)	*Kansei Engineering*	Yes	Yes	No	Yes	No	Partially (statistics)	No	Partially	Yes
Chen and Yan (2008)	*System for product conceptualization and customer surveys*	Yes	No	No	No	No	Partially (statistics)	Yes	Partially	Yes

Table 3. Summary of the comparison results. The labels Y, N, P and NP stand for Yes, No, Partially and Not Pertinent, respectively. The numbers in the cells represent the quantity of methods complying with each property.

	Initial focus on products attributes			Initial focus on general product ideas			Quickness and easiness of the model/tool			Effective support in the individuation of latent needs			Integrated competitors' analysis			Independence from inputs subjectivity			Consideration of customer preferences dynamics				Reliability of the approach			Support in selecting the most beneficial product idea		
	Y	N	P	Y	N	P	Y	N	P	Y	N	P	Y	N	P	Y	N	P	Y	N	P	NP	Y	N	P	Y	N	P
Responsive	3	0	0	0	3	0	1	2	0	0	3	0	2	1	0	0	0	3	2	1	0	0	0	0	3	3	0	0
Proactive	2	0	0	0	2	0	0	0	2	2	0	0	1	1	0	0	2	0	0	1	0	1	0	0	2	1	1	0
Hybrid	4	1	0	4	1	0	2	3	0	4	1	0	1	4	0	0	3	2	1	4	0	0	0	3	2	3	2	0
	9	1	0	4	6	0	3	5	2	6	4	0	4	6	0	0	5	5	3	6	0	1	0	3	7	7	3	0

At first, Table 3 shows that a large majority of the collected methods starts focusing on product attributes. In each case, most of the hybrid methods have the capability to take into account both the validity/feasibility of general product ideas and the role played by product attributes. It might be inferred that such kind of methods, which involve the customer in variegated stages of the Product Planning, own a higher level of versatility for the designer.
As a whole, hybrid methods best support also the individuation of latent needs, but do not diffusedly integrate the analysis of the competitors. It has to be underlined that, whereas this kind of investigation is made, it is commonly not aimed at providing a clearer picture of the competitiveness in the industry, but it basically provides inputs and factors needed for exploiting the methods themselves.
A recurring lack of the benchmark methodologies for the Product Planning is the absence of a quick and easy way to be implemented and used. Such matter undoubtedly hinders the diffusion in industrial contexts of reliable approaches developed in academics. The disregard of intuitiveness affects especially the hybrid methods, likely due to the required individuation of both new needs to be fulfilled and customer surveys. It seems that existing tools do not overcome the inherent complexity derived from the consideration of sets of customer requirements, the general picture of the product and latent needs.
The most diffused weakness of all the collected methods concerns the subjectivity of the inputs, the scarce reliability and the absence of a dedicated analysis aimed at considering the rapid changes in users' preferences. The first problem is connected with the widespread use of experts' judgments, as a main driver to define and assess new product ideas. The methods that exploit statistical analyses are less affected by this problem, because they analyze a wide sample of data and provide therefore a more general view of the opinions expressed by experts and decision makers. However, they imply the commitment of a great amount of time and resources in order to obtain a reliable sample of data. The scarce reliability of the collected methods is mainly due to the focus on specific application fields and to the limited quantity of industrial case studies shown so far. Nevertheless, the early development stage of a great part of the collected methods allows ample space for enhancement. Hence, in order to achieve more consistent feedback, the most recent methods are worth of being further tested. Finally, the selection of the most beneficial product idea is included in the majority of the collected methods.

3.3 Recommendations for practitioners

According to the performed review, the authors extrapolated some recommendations or suggestions for practitioners about the usability of the surveyed methods and tools.
At first, it is worth noticing that some instruments do not support the whole Product Planning. Some methods (Kim and Mauborgne, 2005; Osborne, 1953; Von Hippel, 1986; 2005) are addressed to design new ideas, while Kansei Engineering (Nagamachi, 1995) can only be employed for selecting the most valuable alternatives. Said tools thus require additional human efforts or standard practices for accomplishing the Product Planning in an effective way. On the other hand, the same methods have never been combined and their compatibility should be tested. As a consequence, a matched version of the above tools is currently not recommendable in the industrial practice.
Any integration between hints for idea generation and strategies for concept selection has to consider the focus of the methods on general ideas and/or product attributes. For instance, the decision support system developed by Büyüközkan and Feyzioğlu (2004) is viable to be integrated with those methods initially focusing on product ideas (e.g. Brainstorming), as reported in Table 2. Otherwise, in order to use the mentioned tool for decision undertaking, the list of attributes has to be turned into more concrete product ideas.
Ultimately, when the main objective of practitioners concerns the customers satisfaction, responsive and hybrid methods dedicate more efforts to understand the potential market response. The methods developed by Lee et al. (2010) and Von Hippel (1986; 2005) result the most suitable in technology intensive industries. Indeed, design teams or lead users are asked to identify new potential technologies that can be integrated in the proposed products. The Lead Users method (Von Hippel, 1986; 2005) is more hazardous than the other approach, but it better supports the development of breakthrough products. Whereas time to market represents a key competitive factor, proactive methods are suggested. Indeed, besides covering the whole Product Planning phase, one of their main strengths lies in avoiding time-consuming customer surveys. Eventually, SMEs with limited human resources (marketing professionals, designers, teams employed in Customer Relationship Management) can benefit of methods which do not require plenty of experts' opinions. In particular, the BOS (Kim and

Mauborgne, 2005) supports the definition of new product ideas without entrusting to knowledge seeded in a given industrial domain.

3.4 Research issues

The vision offered by the review suggests that the objective of developing a fully systematic methodology for Product Planning in engineering design is far from being accomplished. In this sense, a further issue to be investigated would consist in establishing which strategy results more beneficial between focusing on product attributes vs. overall innovative ideas. The latter requires to elicit the main traits of the selected idea in such a way to produce the requirements list. The analysis of single product attributes is more versatile, because the customer requirements can be combined in several ways creating different product profiles. Anyway, such a strategy complicates the matters in the subsequent design phases, whereas an advantageous mix of product features and performances cannot be translated in a feasible artifact.

The survey has highlighted the need to focus more markedly on certain aspects that are currently neglected to a considerable extent. These features include basically the ease of use of the methodology, the introduction of functions to implement the search for latent needs and the analysis of the competitors to favor differentiation strategies.

A not negligible concern regards also the problem connected with the subjectivity of the inputs, which hinders the development of systematic methodologies providing rigorous results. Furthermore, the diffused absence of analyses pointing out the dynamic variations of users preferences diminishes the reliability of methodologies requiring time consuming operations. The scientific community is also urged to provide a better understanding of these phenomena, their common patterns, the repeatability of the trends across different industrial sectors.

Furthermore, it could be interesting to consider the possibility to match the analyzed proactive and responsive methods in order to obtain new hybrid methods that merge the strengths of the two categories. In the same way, major research efforts could be paid to combine methods basically addressed to only ideas generation or selection, which are highlighted in 3.3. Eventually, a not negligible issue is represented by the absence of reliable approaches to validate the methods dedicated to Product Planning. Several contributions have been applied to real industrial case studies with the aim of verifying their usability. However, these experiences cannot be considered a real validation. In the perspective of developing design methods for Product Planning capable to provide reliable results, the development of validation procedures represents a pressing need.

4 CONCLUSIONS

Because of the lack of systematic tools to support Product Planning in engineering design, besides crucial for the success of future commercial offers, the paper reviews a sample of acknowledged methods, focusing on the ones mostly addressed to facilitate the task of providing the requirements list.

These methods were subdivided in three categories, according to two acknowledged clusters, i.e. proactive and responsive, and using a further hybrid category, as identified by the authors, that blends some features of both the previous ones. In order to compare the collected methods, the authors identified a set of basic properties that emerged from the review. A qualitative analysis of the results has highlighted where the main efforts of the scholars have been focused up to now, strengths and weaknesses of the surveyed proposals. On the basis of such examination, the paper offers practical recommendations and outlines future research directions. Research priorities can be summarized in:

- extensively testing the existing methodologies through additional industrial case studies;
- adding new functionalities by fulfilling requirements not currently satisfied;
- implementing the most reliable and systematic approaches in a simpler environment and/or developing new computer-aided tools.

The presented survey is certainly affected by the limited sample of methods and tools that has been preliminary examined. Nevertheless, the investigation highlights that a lot of contributions suffer from very diffused weaknesses, which should be taken more into account by both academia and industry. The authors invite other researchers to strengthen the outcomes of the work by proposing additional methods and tools to be analyzed through the lenses of the properties listed in Table 1.

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