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Mastering technologies in design-driven innovations: how two Italian furniture companies make design a central part of their innovation process

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Mastering technologies in design-driven innovations: how two Italian furniture companies make design a central part of their innovation process

Overview

Design is more and more viewed as an important strategic resource. However, even though there is a lot of talk about design, there are only a handful of companies that have truly mastered the design-driven approach to innovation. There is even less research that has tried to understand how these companies are able to successfully manage this approach. This paper aims to understand what it means to make design a central part of the business process, something able to add value to products and create new markets. More specifically, it focuses on the interplay between functional and semantic dimensions of a product. In-depth case studies about two leading Italian companies that operate in the furniture industry (Kartell and Luceplan) underline different interpretations of the role of technologies in radical innovations in product meanings. The empirical results highlight two main interpretations of the role of technologies in radical design-driven innovations: technologies as enablers of new product meanings, the importance of a supply network that allows to rapidly change product technologies and supports the experimentation of new ones.

Key concepts

Innovation management, Product semantics

1. Introduction

In today's business and academic arenas, design is increasingly viewed as an important strategic resource. In fact, over the last couple of years, we have seen a real explosion in business and research literature that sees scholars and companies alike trying to continuously link design to innovation and business strategy. However, even though there is a lot of talk about design, there are only a handful of companies that have truly mastered the design-driven approach to innovation. There is even less research that has tried to understand how these companies are able to successfully manage this approach. Consequently, the aim of this paper is to try to better understand what it means to make design a central part of the business process able to add value to products and create new markets. The paper focuses on the interaction between technological breakthroughs and breakthroughs in product meaning (e.g. emotional and symbolic values of products). Usually, theories on the management of innovation assume that design becomes relevant in the mature stages of industries (if ever). However, recent evidence shows that the radical innovation of meanings is a key factor at the beginning of an industry's development, when technology is still in the fluid phase. For example, Verganti (2009) uses the Wii case study to analyse the interplay between technology-push and design-push approaches to innovation[1]. With the Wii, Nintendo completely overturned the electronic entertainment industry. The Wii effectively combines a radical innovation in meaning with a radical innovation in technology. It has redefined the meaning of playing with a game console, not as passive immersion in a virtual world targeted to young players, but as active entertainment in the real world for people of all ages and demographics. At the same time, the company has achieved this result thanks to the use of a breakthrough technology: MEMS (microelectromechanical systems) accelerometers, which allow the console to sense the speed and orientation of the controller. The paper aims to investigate the role of technologies in the development of radical innovations in product meanings. Consequently, it focuses on the analysis of technologies adopted by leading design-driven companies in the proposal of breakthrough innovations.

The paper is organised in the following way. Section 2 is dedicated to the theoretical background: first, we introduce the concept of design-driven innovation, then we describe the interplay between functional and

semantic dimension of a product. In section 3, the research objectives and methodology are described. In section 4, the empirical results of two case studies are provided; our results are discussed in section 5, and managerial implications are presented in section 6.

2. Theoretical background

Interpreting the new product development process as a process of the generation and integration of knowledge, the literature identifies two principal sources: knowledge about the availability of new technologies and knowledge about explicit customer needs. Dosi (1982) introduces two antithetical approaches to innovation: market-pull and technology-push[2]. On the one hand, the market-pull approach is primarily characterised by the dominant role that the comprehension of market needs plays over the introduction of new technologies. Consequently, with this particular approach, the main source of innovation is the market, and new product development is a direct consequence of explicit needs manifested by the consumers. However, the primary assumption of this approach is that user needs are explicit elements that can be identified, captured and translated in new products able to satisfy consumer needs[3]. On the other hand, the technology-push approach looks at the innovation process from a completely different perspective; in fact, this approach doesn't believe in a process driven by the market. Instead, it believes that the source of innovation stems from the research and development activities of the company that, through the identification and development of new technologies, allow it to achieve the creation of new products[4]. Verganti (2003 and 2006) describes the design-push approach as complementary to the previous ones proposing a third knowledge source to add knowledge about user needs and technological opportunities[5]: knowledge about product languages *"is the knowledge about the signs that can be used to deliver a message to the user and about the socio-cultural context in which the user will give meaning to those signs"* (see Figure 1).

Insert here Figure 1

In all approaches to innovation, three types of knowledge (knowledge about user needs, knowledge about technological opportunities, and knowledge about product languages) are present, but their relative importance is different: in the case of the design-push strategy, the driver of innovation is the ability to understand, anticipate and influence the emergence of new product meanings. Verganti (2003 and 2006) defines design-driven innovation as *"an innovation where novelty of message and design language is significant and prevalent compared to novelty of functionality and technology".* Design-driven innovation is based on the idea that each product has a particular meaning; style is just a possible language that can be exploited to communicate it. Expanding and elaborating the concept of form, this definition allows to capture the communicative and semantic dimension of a product. The Swatch, launched first in 1983, was a design-driven innovation. It transformed the interpretation of watches from jewels or time instruments into fashion accessories[6]. The adoption of a design language characterized by the intensive use of plastic material and colourful style, added to lower range price, helped to diffuse this new interpretation in the market. The Alessi's well-known product line "Family Follows Fiction" composed by a set of coloured-plastic kitchenware products can be considered a good example of design-driven innovation because the use of specific design languages such as daring colours and transparent plastic allow to convey peculiar product meanings such as irony and a sense of childhood[7]. At the same time they don't provide additional features and don't improve performances in comparison to products developed by competitors.

Market drivers become relevant in the case of the incremental innovation, where, in other words, incremental adaptations of product meanings are determined by the continuous and natural evolution of explicit cultural models adopted by customers. Market factors lose importance in the case of the radical innovation, where innovations originate from new cultural scenarios. In the technology-push approach the availability of new technical opportunities represents the key driver in the innovation process. The more the technology represents a mean of generating a change in meaning, the more the technology-push approach to innovations can be considered design-push.

Another model useful in understanding design-push approach is proposed by Zurlo et al. (2002), in which the relationship between product and customer can be analysed in relation to three different levels of interpretation[8]: tools, results and effectiveness. In this interpretive model, the tools refer to the intrinsic

characteristics of the product that are its building blocks from a functional and semantic perspective. A peculiarity of this classification is that the tools are considered to be completely independent of user interpretation; they allow product innovation and refer to an intrinsic characteristic of the product. In contrast, the results classification of this model focuses on the interaction that occurs between the product and the user. Finally, the effectiveness classification benchmarks or rates the type of interaction in terms of the performance characteristics or the meanings that the user gives the product. In other words, this last classification tries to measure the degree of effectiveness of the functional and semantic dimensions of a product. Three approaches to innovation previously introduced (market-pull, technology-push and design-push) focus on specific dimensions and levels as shown by Figure 2.

Insert here Figure 2

The model foresees two different dimensions: a product can be innovated upon acting alternatively or jointly on the functional dimension and the semantic dimension. If one splits up the functional dimension according to the three interpretative levels previously mentioned, it is possible to identify technology, function and performance. From this point of view, the innovation can be pursued by developing new technologies that, incorporated in the product, allow one to access new functionalities and improve performances as perceived by the customer; this type of innovation represents only one of the levers that can be activated. If we instead look at the semantic dimension, we see that it allows the company to innovate by creating new messages and proposing new meanings in relation to the socio-cultural models that govern the context in which the product will be proposed. Of course, as illustrated in Figure 2, there is a strong interaction between these two dimensions on all three interpretive levels. This characteristic of the model underlines the reciprocal influences that each dimension has: for example, a product language is typically not defined solely in semantic terms; it is often influenced by technological opportunities and user desires. From a managerial point of view, the framework proposed in Figure 2 suggests to combine research activities about product technologies with socio-cultural analyses and lifestyles scanning. Both the industrial design and academic worlds have understood the importance of the semantic/design dimension

in the development of successful new products[9]. In fact, some scholars go so far as to state that design is "making sense of things"[10]. The semantic dimension is able to modify the meanings embedded in products in order to allow them to evolve with society. Acting on the semantic dimension of a product, a company can create new languages and propose new meanings in relation to the socio-cultural models that govern the context in which the products will be proposed. Consequently, several practical models and tools developed by theorists of design can support the innovation of product semantics.

3. Research objectives and methodology

As mentioned before, the paper aims to investigate the role of technologies in the development of radical innovations in product meanings. It focuses on the analysis of technologies adopted by leading design-driven companies in the proposal of breakthrough innovations with the purpose of highlighting the interplay between technology and design. We feel that the case study methodology is suited to the exploratory nature of this research, as it allows us not only to explore the phenomenon in its complexity but also to discover those variables that we deem critical to better understanding the problem. Consequently, the case studies conducted focus on the furniture industry, are exploratory, retrospective and multifaceted in nature, and have literally been replicated[11]. Each case study was developed using a brief questionnaire meant to gather background information as well as two in-depth interviews. The questionnaire has allowed us to collect general data on topics such as turnover, employees, history, organisation and awards. Both interviews were planned around a protocol sufficient to track the decision-making process involved in the development of a new product and composed of two main sections: the concept-generation phase (the trigger for the innovation, the initial idea, sources of stimuli, key actors) and the development phase (eventual concept changes, implementation, technical problems, key actors). The first interview was organised with company management, while the second was organised with a critical external actor who was participating in the process of new product development (e.g., a designer, an engineering studio) identified in collaboration with the management during the first interview. Both interviews were developed by two authors. Before starting the data analysis phase, we retrieved additional

data through secondary resources, especially regarding awards for specific products. The content analysis was developed with each author coding the principal phases of the innovation process[12]. Finally, a synthetic report about each case study was shared with interviewees to obtain final approval. In order to increase the robustness of the interpretations, a few different interpretations by three authors were verified by re-contacting the interviewees by phone.

4. Empirical results

As previously mentioned, the empirical results are based on two case studies developed in collaboration with two Italian leading design companies: Kartell, which is mainly involved in the production of pieces of furniture like chairs and tables, and Luceplan, which is a lighting company.

Kartell

Kartell was founded in 1949 by Giulio Castelli, a chemical engineer and student of Giulio Natta (winner of the Nobel prize for Chemistry in 1963). Castelli's technological competences and innate creativity allowed Kartell to give furniture products a new sense of modernity through the use of plastic materials. The adoption of plastic was reinterpreted to the point where it assumed the position of a “noble” material. After few experiments in the automobile accessory field, Kartell entered the furniture industry proposing revolutionary products made using plastic. Kartell decided to bring plastic into the home through household goods and to deepen technological research. Progressively, the core of the business moved toward the ability to process plastic products and develop frontier research. The historical “heart” of the company is in its R&D department, which strongly distinguishes Kartell from its competitors. Plastics were no longer restricted to rounded forms but corners and grooves were implemented; they became opaque and acquired a particular touch, and the colour range was customised product by product. As technology advanced, technological frontiers became wider and wider and the focus shifted from “hard” to “soft”. Today, Kartell is the undisputed market leader in plastic household production, with a widespread presence worldwide. Its ability to manage its image, its distribution skills, and the way it markets and sells products

are critical factors for Kartell, but they are not as important as its traditional ability to work in plastic. New product development is managed in collaboration with mould manufacturers and chemical companies that contribute to the definition of the materials and moulds that will be used in the production phases. Generally, Kartell prefers to use outside companies that are located nearby, as intense co-operation between company managers and suppliers has always been required in the development of new products. Kartell does not formalise its relationships with its network of suppliers; the collaboration is mainly based on long-term horizons, but it is rarely formalised by specific contracts.

Bookworm, a bookcase designed by Ron Arad[13] in 1994, represents a meaningful example of the Kartell approach to innovation. Ron Arad created a real sculpture that could furnish a wall; the idea was to exploit the stable flexibility of tempered steel to form a series of shelves on a single continuous thread. Bookworm was initially made as a product to be used in the offices of professional people. Arad's "sculpture" was, however, destined to become much more than a simple work of art available for a limited number of people. The meeting between Arad and the Italian design world and, above all, its entrepreneurial approach, transformed a piece of art into a piece of furniture. In the early '90s, Giulio Castelli became Honorary President and entrusted the company to Claudio Luti, founder of Versace. Luti's capability and sensibility led Kartell to collaborate with Ron Arad in the development of Bookworm. The implementation of the original concept required an amazing effort on the part of the R&D department to find a flexible, sinuous, elastic, coloured, but also sturdy and resilient material.

> *"Making Bookworm was very complex because the blend, the mixture of polymers had never been produced by anyone before. Firstly, we went to the large chemical companies like Bayern to see how they produced the materials in order to understand their characteristics and then use them in furniture production."*
>
> [Giulio Castelli, Honorary President and founder of Kartell][14]

The R&D department's research was very complex; the selected material was the flame-retardant polyvinyl chloride. The band was extruded by a technology that uses machines called single screw and double screw

extruders and forces molten thermoplastic resin through a draw plate and then through a calibrator to achieve the required profile. The shelves, while made with the same material as the band, were made using the process of injection moulding. This production method aims to produce manufactured items in long runs because the presses and moulds are extremely expensive. The injection presses fill one or more cavities with a quantity of the pre-plastified and packed mould mass. The piece is solidified through cooling. As in many other design-driven companies, also in this case the effort developed by the R&D department aimed to provide a technological solution able to convey meanings conceptualized by the designer assuring the innovativeness of the initial idea. In some extents we can say that designer is the owner of product meanings, while R&D department provides product languages and technologies able to embed values conceptualized by the designer. The final version of Bookworm took around one year to develop and was proposed in three different lengths. Bookworm gives the customer great freedom of expression by allowing him or her a say in the final shape. The fascination that people have with it originates from the chance they are given to interpret the wall by designing a free shape (see Figure 3).

Insert here Figure 3

The market impact of the piece was incredible because Kartell had proposed something completely innovative based on continuous experimentation. The product was a great success, both commercially and in terms of image. Sales were immediately very high[15] and Bookworm was considered one of the first example of mass customization in the furniture industry. Today, Bookworm is one of the best sellers of Kartell. The critics were not indifferent to this genial and unusual product. In 1994, Bookworm was selected for the “Compasso d'Oro” award. The bookcase has also been displayed several times in museums such as the Museum of Modern Art in New York and the Die Neue Sammlung in Munich.

Luceplan

Established in 1978, Luceplan was created with a very clear mission: to create only a few products, all highly innovative with reference to shape, material, function and typology. Today, Luceplan has more than 100

employees and shows a turnover of around 20 million €; it is managed by Riccardo Sarfatti, who focuses on the promotion of new products. Sandra Severi coordinates the communication and promotional activities of the company, while Paolo Rizzato is the President and has designed the great part of the lamps currently present in the catalogue. Alberto Meda entered in the company in 1984 as designer and in the last 25 years has collaborated with Paolo Rizzato on several projects. More specifically, Meda is an expert on plastic materials and has used this specific competence in the development of many products. Titania was the first suspension lamp developed by Luceplan and was designed by Alberto Meda and Paolo Rizzato in 1989. The following sentences by Paolo Rizzato underline the innovative interpretation proposed by the Titania concept.

> *"Years ago there was the need to have a central point in the room and to divide the space in symmetric parts; consequently lamps had to diffuse uniform light. In modern architecture the room dimensions are reduced, in the same rooms you can carry out different activities … Therefore we don't need a centre. Titania is conceived as a solid ellipse in order to be able to stay in every position and therefore to be freely oriented in the space".*
>
> [Paolo Rizzato, President of Luceplan][16]

The important technical problem of finding the proper light bulb to insert into the ellipsoid diffuser emerged very quickly. The flat and high ellipsoid progressively became less thin. In order to respect the initial idea, Alberto Meda and Paolo Rizzato decided to dematerialise the shape of the lamp. They introduced a new per reflection light emission instead of a simple per diffusion one throughout an opaline surface. During the prototype phase, the designers adopted CAD systems for the first time to develop the product, and these tools helped the idea to become concrete. After the first prototype, the project was stopped for about one year because the shape was so extreme that Luceplan management didn't believe it would see market success. Only the proposal by Paolo Rizzatto of a new version with different colours convinced Riccardo Sarfatti and Alberto Meda to launch Titania on the market. The colour was the element of the lamp that demolished the impasse, and it became the element that facilitates consumers'

impressions of the piece. Titania didn't look like a mere static object; it was more like a tool one could use (see Figure 4).

Insert here Figure 4

As usual, the moulds were developed in collaboration with a local company that was looking for new applications because of the crisis of the automotive industry wherein the greater part of its customers operated. The partner was particularly flexible and helped to solve a financial problem: Luceplan was not able to obtain huge investments, and the partner (much bigger than Luceplan) facilitated the relationships with some banks and the possibility of obtaining the very expensive moulds through leasing.

5. Discussion

The discussion of the results obtained through the two case studies previously described is organised around two main interpretations of the role of technologies in radical design-driven innovations: technologies as enablers of new product meanings, the importance of a supply network that allows to rapidly change product technologies and supports the experimentation of new ones.

Enabling technology for innovation of product meanings

Rodrigo Rodriquez, past president of UEA (European Association of Furniture Manufacturers), describes in the following words the success of some Italian design-driven companies:

> *"Some Italian companies that operate in the furniture industry avoid the typical loss of 'entropy' across the new product development process. Differently from many other industries, they manage the transitions from concept to development, from development to engineering, from engineering to production, and from production to commercialization 'safeguarding' the innovativeness of the initial idea and, eventually, enriching it."*

[Rodrigo Rodriquez][17]

As introduced in section 2, design-driven innovation drives the development of new meanings that change the socio-cultural context. It is not sufficient to be just sensitive to socio-cultural messages—it is also necessary to transfer different inputs and stimuli into real projects in order to exploit accumulated knowledge about socio-cultural phenomena and transform it into new product signs and languages. Even if designers can support company exposure to emerging trends in society, this "listening" activity has to be integrated with research on technologies that allow products to embed appropriate languages and consequently to convey coherent meanings. The constant research into new materials and innovative engineering methods has allowed Kartell to express its ideas on design and radically innovate product meanings; the research developed by Kartell aims to enrich the meanings of artificial materials with new and more expressive surfaces and functions.

> *"The band of Bookworm shows a surface that is not smooth but is [instead] characterized by little bubbles. This is no defect but a technological solution to give an impression of softness both to the eye and to the touch. It was not easy to achieve this aspect because it was necessary to convince the extruder to introduce a sort of imperfection."*
>
> [Simona Romano, Curator of the Kartell Museum][18]

In order to differentiate themselves from other firms as well as to develop a recognisable brand, design-driven companies have to define a clear "editorial line". The relationship between manufacturers and designers can be likened to the relationship between editors and authors in the publishing industry. The respective roles of the "manufacturer/editor" and the "designer/author" and their modality of dialogue are different from what is commonly understood in design management literature. Design-driven companies behave like the editors of books. They choose the author(s) and maintain durable relationships with them. Each project is a natural consequence of this relationship. The role of the "manufacturer/editor" is to frame and orient the relationship with the "designer/author". It manages the coherence of the "editorial line",

taking care of the portfolio of “designers/authors”, meeting them on a regular basis and stimulating specific interventions, as well as considering their spontaneous propositions. The “manufacturer/editor” provides several concrete solutions in order to free the creativity of the “designer/author” from as many constraints as possible. Concept freedom is a critical factor in attracting the most talented designers; as an author does not worry about the typing and distribution technologies behind his thoughts and words, the designer must also not worry about the production and distribution technologies for his/her ideas. Since the firm recognises the strategic value of the initial concept (often proposed by the designer), it makes all possible efforts to remove any technological constraints that might limit the designer. Giulio Castelli describes the technological innovation introduced by Kartell during the Bookworm project as an enabler of meanings conceptualized by Ron Arad.

> *“The research carried out by our R&D department to develop Bookworm was enormous and very difficult. To find the material with the right technical characteristics and the right mould able to embed concept proposed by Arad was an incredible challenge. Not even Bayer guaranteed the result.”*
>
> [Giulio Castelli, Honorary President and founder of Kartell][19]

As an editor, the manufacturer is not simply someone who provides “paper and bookshops” (manufacturing and distribution capability) to any “author” (designer); he has to be coherent in the context of its own editorial line (vision and brand). Every concept that complies with the editorial line builds upon previous concepts, and together, they sustain the editorial line; they are the incrementally building blocks of a brand. Kartell studied the applications of plastic materials in several industries parallel to the furniture one so as to collect new ideas to propose on the market. Bookworm can be considered a milestone in Kartell history able to enrich an image of leader in the development of furniture products made by artificial materials and characterized by new and more expressive colours and surfaces.

Supply network for technology rotation and experimentation

Both case studies show very informal relationships; they emphasise the continuous dialogue established by companies and designers. Dell'Era and Verganti (2009b) demonstrate as, rather than an individual spark of creativity, the value of the contribution of each designer is hardly identifiable if not seen within the context of the knowledge sourced from the entire array of external collaborators[20]. And vice-versa, knowledge developed through the collaboration with a specific designer can be exploited in several projects (eventually developed with other designers). In other words, the value of a single collaboration benefits from externalities generated by other collaborations. During the development process, this dialogue involves other actors such as technical offices and engineering studios that allow to develop innovative product languages and consequently to embed new product meanings. Alberto Meda describes the local supply network in the following words.

> *"I believe that it is fundamental, for a person who decides to do this type of job, to work in Milan. Here there is a dense network of artisans, competencies, situations … a kind of 'dispersed creativity' that is not possible to find in any other place."*
>
> [Alberto Meda, Designer of Luceplan][21]

The collaboration with a supply network with varied technical capabilities is one of the key factors in the success of design-driven companies. As previously mentioned, they provides several technological solutions to free the creativity of designers from as many constraints as possible; consequently they need to access the appropriate technology in relation to the concept proposed by each designer. In order to attract the most valuable designers and new talents they can't focus only on few technologies, but they have to enlarge their portfolio rotating several technologies.

> *"I believe that Italy, or more specifically Northern Italy, is still the centre of the design world, and I must say that it is not just because of the design that comes from Italy, but, above all, it is because of the manufacturing culture; there is no other place in the world where you can*

find such a vast array of craftsmen and manufacturers for all intents and purposes who know the value of design ..."

[Ron Arad][22]

The introduction of radical innovations in product meanings requires a lot of experiments and, as previously mentioned, these experiments can have to do with external technologies. Consequently, design-driven companies need a supply network that is particularly flexible and willing to experiment.

"... Titania was born also thanks to experimentation with chemical photo-carving. This process is known by several companies, However, if we were in Germany, where there are large companies that use this principle, there wouldn't have been anyone who would had stopped the production process to conduct an investigation for us. In Milano there is a large local industry with very great technological capabilities and great opportunity to do experiments ..."

[Paolo Rizzatto, President of Luceplan][23]

6. Conclusions

Design is more and more viewed as an important strategic resource able to generate competitive advantage. The paper explores how some companies make design a central part of the business process, an element able to add value to products and create new markets. More specifically, it analyses the interplay between functional and semantic dimension of products. Usually, theories on the management of innovation assume that design becomes relevant in the mature stages of industries (if ever). However, recent evidence shows that the radical innovation of product meanings is a key factor in the beginning stages of an industry's development, when technology is still in the fluid phase. In-depth case studies of Kartell and Luceplan underline different interpretations of the role of technologies in radical innovations of product meanings. Acting only on the semantic dimension, it is possible to introduce incremental design-driven innovations (see Figure 5), while companies that interpret technologies as enablers of new product

meanings mix research activities related to new technologies and studies about emerging lifestyles and values in society in order to propose radical design-driven innovations.

Insert here Figure 5

More specifically, they combine the identification of innovative meanings to embed in their products with the research of new materials, surface treatments, engineering processes, etc. As argued by Verganti (2008), similarly to technological research design research consists on the real exploration of new languages embedded into artifacts and consequently it implies playing with new technologies and new materials (see Figure 6)[24].

Insert here Figure 6

The interplay between functional and semantic dimensions increases the appropriability of benefits and extends the duration of competitive advantage. Design-driven companies interpret technologies as tools for expressing a clear and defined editorial line, differentiating themselves from other firms and developing recognisable brands. To put forth several concepts that are not aligned with an editorial line can send entropic and confused messages to the market, which eventually weakens the recognition of the company. If any designer can work with any company, then what makes a difference to competitors is not simply the designer (who could bring the company's ideas, designs and knowledge to its competitors), but the manufacturer-designer combination, where the firm brings its own contribution in term of vision, which in turn protects and differentiates it from its competitors. Firms that provide the most intriguing knowledge and technological opportunities attract the most talented designers. To do that, a firm must carry out its own research on meanings and languages. Rather than investing in a few core technologies, design-driven companies need to rotate several technologies in order to propose new interpretations of product languages. Consequently, they need to establish several collaborations and partnerships with external suppliers that manage different technologies. Design-driven companies move and transfer applications

across industries rather than proposing new-to-the-world technologies. Research and Development departments aim to discover existing technologies adopted in other industries rather than to invent new ones. Considering that the introduction of radical innovations of product meanings requires a lot of outsourced experiments, a supply network that supports experimentation with new technologies is particularly relevant. The project resources involved in the innovation process have to be organised so as to favour creativity and the possibility of exploration and recombination. It isn't possible to think that a design firm possesses or wants to internally develop all of the competences necessary to innovate; rather, the project resources have to be selected from outside. The analysis of companies that operate in the furniture industry, an industry where practices of collaboration with external partners (especially designers) are usually considered as a benchmark, can provide interesting insights also for those companies that are moving their innovation strategy from a closed approach to an open one in line with a general tendency towards the development of business ecosystems and the adoption of a connect-and-develop paradigm[25].

The case studies show that there is something interesting enough to justify further research aimed at enriching the empirical results. Considering the explorative nature of this research, future studies can verify if the obtained results can be generalized in other industries and geographical contexts. Moreover, in the next step of the research, we will verify the results identified in the present paper, estimating more precisely all the variables that influence the role of technologies in radical innovations in product meanings.

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8. Figures

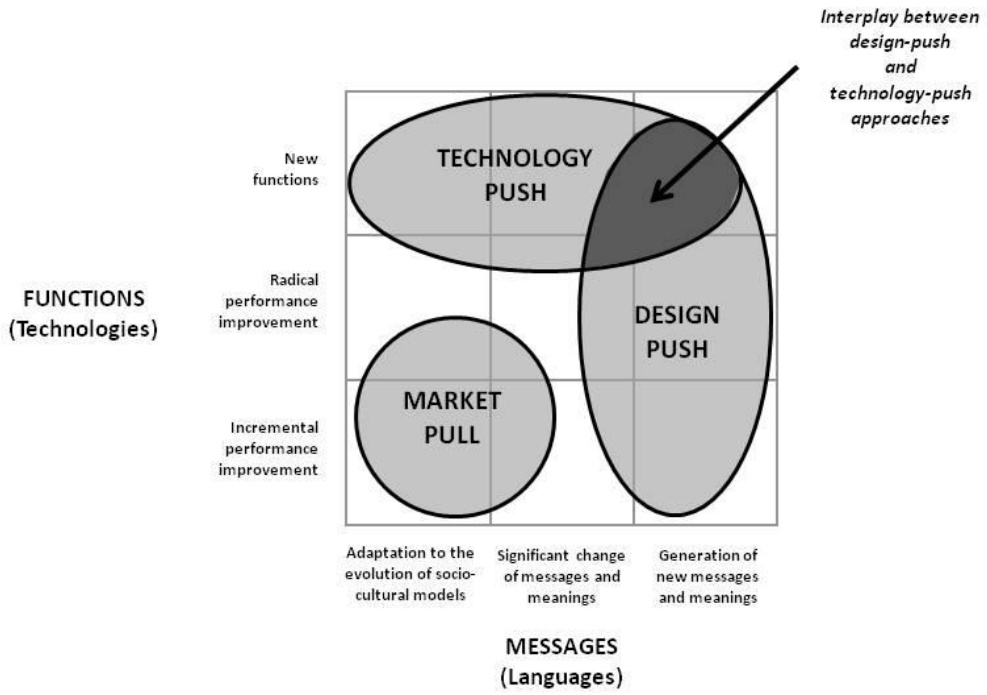

Figure 1: Market-pull, Technology-push and Design-push represent three approaches to innovation that allow to introduce different degree of radicalness[26]

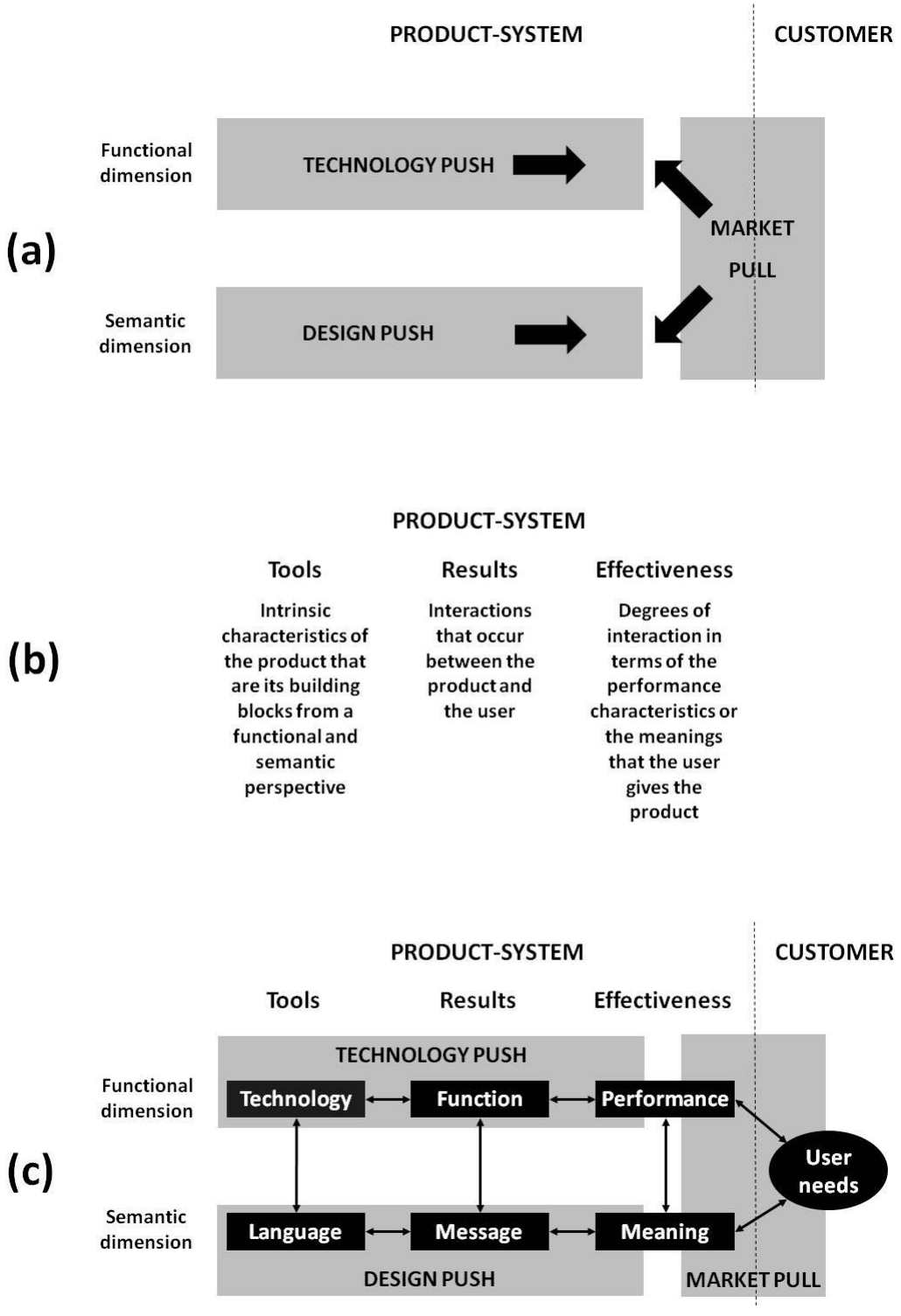

Figure 2: a - Market-pull, Technology-push and Design-push represent three main approaches to innovation; b – Tools, Results and Effectiveness represent three interpretative levels able to analyze both functional and semantic dimensions[27]; c – Market-pull, Technology-push and Design-push differently work on the functional and semantic dimensions of the product

Figure 3: Bookworm, designed by Ron Arad for Kartell in 1994, is a bookcase that gives the customer great freedom of expression by allowing him or her a say in the final shape of the product

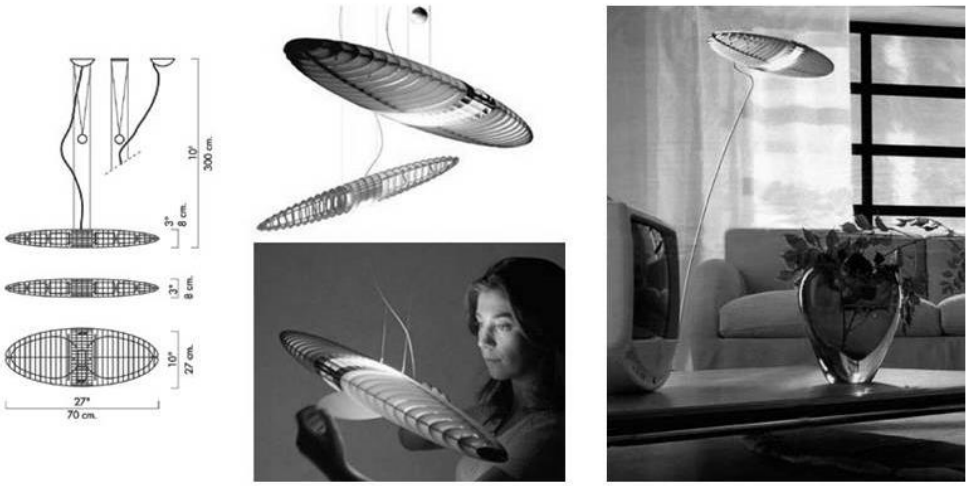

Figure 4: Titania, designed by Alberto Meda and Paolo Rizzato for Luceplan, is a lamp characterized by an innovative ellipsoid diffuser

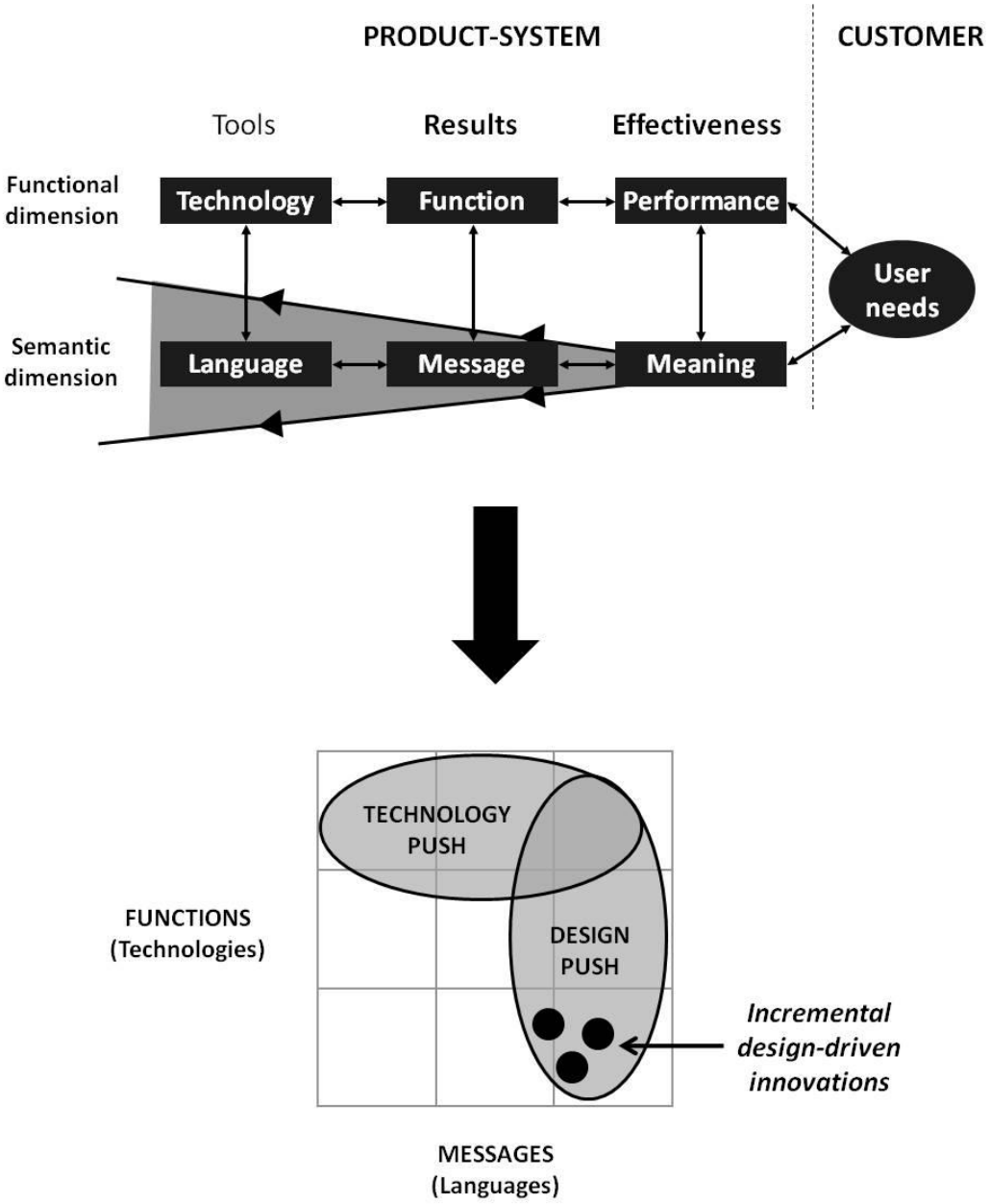

Figure 5: Innovating only the semantic dimension of a product, it is possible to introduce incremental design-driven innovations

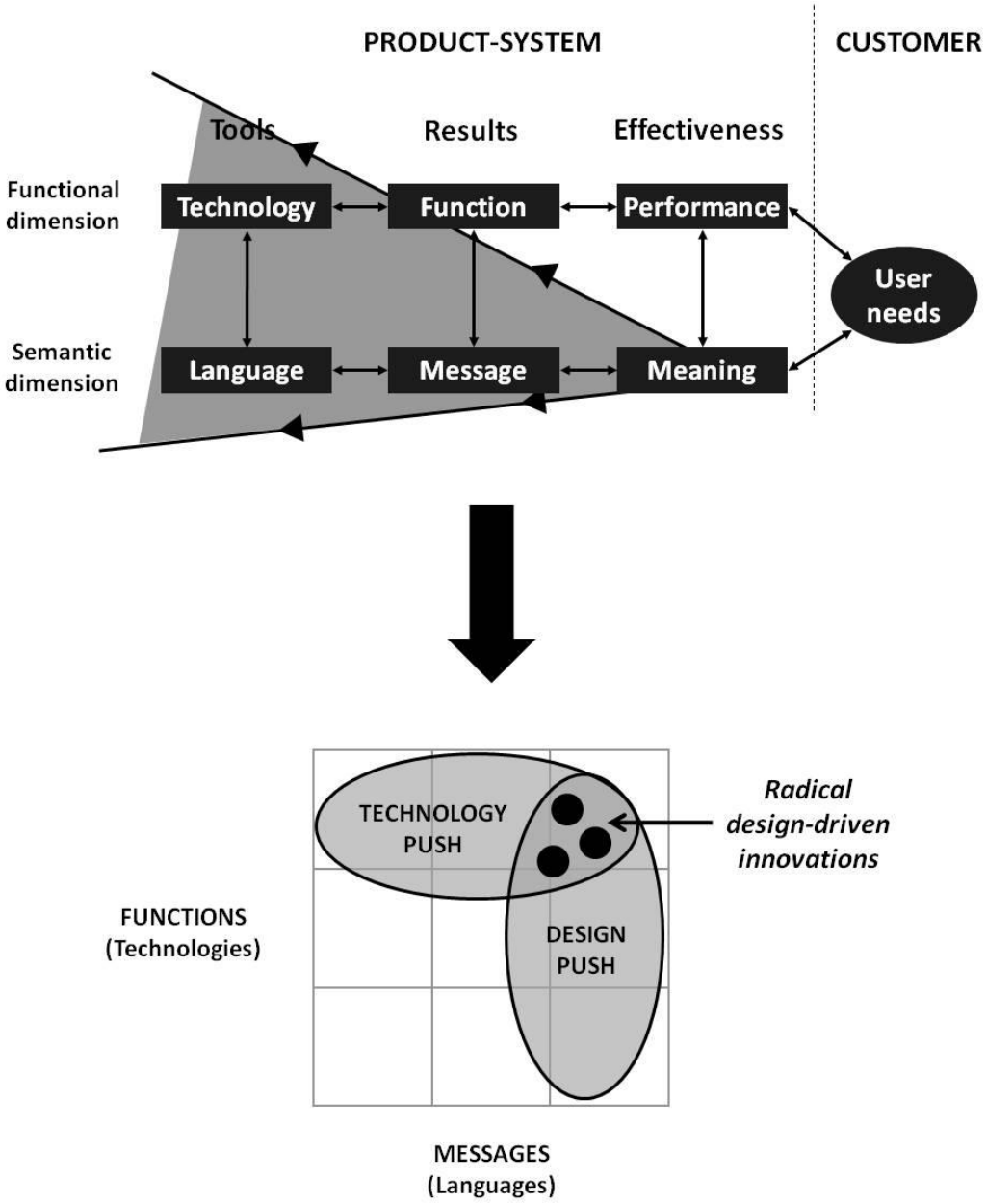

Figure 6: Combining the identification of innovative meanings to embed in new products with the research of new materials, surface treatments, engineering processes, it is possible to introduce radical design-driven innovations

9. References and notes

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[13] Ron Arad (born 1951 in Tel Aviv, Israel) is an industrial designer, artist and architect. Ron Arad attended the Bezalel Academy of Art and Design in Jerusalem between 1971 and 73 and the Architectural Association in London from 1974 to 1979. He is Head of the Design Products Department at the Royal College of Art.

[14] Interview developed by Claudio Dell'Era and Roberto Pellizzoni in November 2003.

[15] Sales: 31.850 pieces (1996); 28.570 pieces (1997); 27.980 pieces (1998); 21.850 pieces (1999); 21.310 pieces (2000); 19.330 pieces (2001); 17.600 pieces (2002); 15.500 pieces (2003).

[16] Interview developed by Alessio Marchesi and Rosanna Rubino in December 2003.

[17] Interview developed by Claudio Dell'Era and Roberto Verganti in April 2004.

[18] Interview developed by Claudio Dell'Era in February 2004.

[19] Interview developed by Claudio Dell'Era and Roberto Pellizzoni in November 2003.

[20] Dell'Era C.; and Verganti R. 2009b. Collaborative strategies in design-intensive industries: knowledge diversity and innovation. *Long Range Planning*, forthcoming.

[21] Interview developed by Alessio Marchesi and Rosanna Rubino in December 2003.

[22] Interview by Giulia Crivelli published on *Il Sole 24 Ore* (05th April 2005).

[23] Interview developed by Alessio Marchesi and Rosanna Rubino in December 2003.

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