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## Abstract

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## Introduction

Product language is intended as the set of a product's elements - i.e., materials, form, color, finishing texture and joining elements - that can convey a message to users about the product's meaning. Accordingly, product language innovation is the change of such elements to convey new meanings and cultural messages (Peirce et al. 1935; Rindova *et al.*, 2011; Verganti, 2003, 2008, 2009; Noble and Kumar, 2010; Krippendorff, 1989; Butter and Krippendorff, 1984).

The literature considers product language innovation as particularly relevant in design-intensive industries, in which "design addicted customers" are particularly sensitive to product language innovation, especially during the launch of new technologies (Rindova and Petkova, 2007; Rindova *et al.*, 2011; Sanderson and Uzumeri, 1995; Cautela and Simoni, 2013; Cautela *et al.*, 2018; Verganti, 2011). Indeed, when a new technology is launched, firms develop new product languages both to sustain the diffusion of new technology and to become a relevant player in the new technology-based market. Two main strategic approaches to reach this goal are recognized by the literature: i) a product language divergence strategy and ii) a product language convergence strategy (Cappetta *et al.*, 2006; Dell'Era and Verganti, 2011; Desai *et al.*, 2001; Filippetti, 2011; Laplume and Srivastava, 2014; Simoni *et al.*, 2014; Talke *et al.*, 2009; Verganti, 2011).

The product language divergence strategy consists of a firm's attempt to develop a product language that maximizes the difference between the firm and the other firms that have adopted the same new technology. The main advantage consists to achieve a unique market position based on the firm's own product language (Dell'Era and Verganti, 2007; Verganti, 2008; Simoni et al., 2014). The main disadvantage is the risk that the firm product language will not be accepted by the market because an alternative product language emerges as the reference point for the new technology (Simoni *et al.*, 2014).

In contrast, the product language convergence strategy consists of either explicitly or implicitly adhering to a common product language template that is developed with other firms adopting the same technology. Once this common template is established, each company develops its own product language variants to mark its

products and launch them in the market (Karjalainen, 2007; Karjalainen and Snelders, 2010; Simoni et al., 2014).

The main advantage of this approach is the possibility of creating a product language "critical mass" that sustains the diffusion of new technology and allows firms to share the market risk with other players (Dell'Era and Verganti, 2011). Indeed, the risk that a common product language—i.e., one that is adopted by many companies—will not be accepted by the market is considerably reduced. The main disadvantage of this approach is the limited availability of product language options that firms can leverage to differentiate themselves from their competitors (Simoni *et al.* 2014).

To implement these two different strategies, firms in design-intensive industries usually engage external designers that are responsible for developing the product language of the firm's new technology-based products (Lehrer *et al.*, 2012; Dell'Era and Verganti, 2009; 2010a; Capaldo, 2007; Abecassis-Moedas et al., 2012).

In the design-intensive industries, where the collection and sedimentation of heterogeneous design stimuli and "styling knowledge" represents a source of competitive advantage (Cillo and Verona, 2008), designers are typically organized in a designer portfolio, intended as "*array of external collaborators"* that are engaged by companies to develop new products *"and other externalities"*—such as, for example, new forms of knowledge connected to the new product development (Dell'Era and Verganti, 2010a).

The literature has pointed out that designer portfolios may be analyzed according to several characteristics: the size of the portfolio, the portfolio concentration, the cultural diversity, the popularity of the designers involved, the exclusivity of the relationship between the firm and the portfolio, the firm-designer relationship historicity and intensity that induce forms of "path dependence" (Capaldo, 2007; Dell'Era and Verganti, 2007, 2009, 2010a; Dell'Era and Verganti, 2007, 2009; Ravasi and Lojacono, 2005; Stompff, 2010). Each characteristic has been investigated in terms of advantages and disadvantages for the firm's product design activities and the related creative process.

Specifically, previous studies have analyzed how different designer portfolio characteristics (Capaldo, 2008; Dell'Era and Verganti, 2009, 2010) affect the innovation capacity and the economic performances of firms. In the same vein, other studies have investigated the formation of trust and reciprocity between designers and managers with the lens of knowledge exchange within projects of new product development (Filippetti, 2010, Filippetti and D'Ippolito, 2017). Additional contributions have also highlighted how designer engagement generates different tradeoffs and dilemmas related to specific designer traits and company processes (Cautela and Zurlo, 2011).

Although these studies have shed light on the role that the designer portfolio plays in the firm's product design process, still a clear understanding of the relationship between the characteristics of the designer portfolio and the design strategy of the firm is lacking.

Our paper tries to address this gap investigating which types of designer portfolio are associated to different product language strategies.

At this aim, we adopt the configuration approach, defining the designer portfolio in terms of set of characteristics that mutually interact and jointly contribute to the firm's design strategy's implementation (Fiss 2007; 2011; Miller 1986; 1992; Meyer, 1993; Ketchen *et al.*, 1993; Short *et al.*, 2008). Accordingly, we identify the configurations adopted respectively by firms with a product language divergence strategy and by those with a product language convergence strategy and conceptualize the configurations as archetypes able to highlight alternative organizational logics to implement these strategies.

We place the study in the decorative lighting industry, which is recognized as a typical design-intensive industry, during the early phases of the technology discontinuity created by the introduction of Lighting Emitting Diode (LED) technology. In so doing, we can observe how firms react to this new discontinuous technology in terms of both product language strategies and designer portfolio configurations. The study considers the firms that adopted the LED technology in the first 5 years following its introduction (2007-2011) in the Italian market and, through a Qualitative Comparative Analysis (QCA) methodology, identifies which designer portfolio configurations, adopted by these firms, are related to a divergence product language strategy and which to a convergence product language strategy. Accordingly, the paper describes four different designer portfolio archetypes associated to these strategies.

Our article contributes to the design and innovation management literature, providing a systematic approach to interpret and relate designer portfolio choices to product language strategies and to analyze the complex nature of the interdependencies among the various characteristics of the firm's designer portfolio. In so doing, the paper highlights that the relationship between firm designer portfolio and design strategy can be better understood when an organizational configuration perspective is assumed. In addition, the paper offers helpful guidelines to design managers and practitioners on the logics that can underpin the building of the firm's designer portfolio according to the specificities of the firm's design strategy.

## Theoretical background

### *a. The product language divergence and convergence strategies*

Various studies highlight how design-driven innovation has become a strategic option for innovation (Verganti, 2008, 2009), to be added to the two paradigmatic innovation patterns recognized as the "technology push" and the "market pull" innovation (Christensen, 1997; Dosi, 1982).

In design-driven innovation, the subject of innovation activities is the "product language", which is intended as the set of elements—i.e., form elements, texture, materials, joining relationship, color and other symbolic features of the product—that companies, in collaboration with designers, employ to convey new "product meanings" (Verganti, 2006, 2008, 2009) and novel "cultural messages" (Ravasi *et al.*, 2012; Dell'Era, 2010). Employing a semantic perspective, "product language" is thus a composite code composed of the

combination of various formal aesthetics and styling elements that can either follow the current sociocultural models or challenge dominant social and cultural frames.

In design-intensive industries, the changing pace of product language is particularly high (Cappetta *et al.*, 2006; Dell'Era and Verganti, 2007; Cillo and Verona, 2008; Rinallo and Golfetto, 2006). This is because in industries such as furniture, accessories, fashion, home interior and appliances, the market expects both continuous language evolution and products' ability to evolve with society's aesthetic preferences and cultural frames. Companies, thus, compete based on their capability to affirm new "product meanings" (Verganti, 2009) and to change the industry's "cultural repertoires" (Ravasi *et al.*, 2012). Finally, especially in these industries, designers compete each other to be engaged by companies according to their ability to challenge existing stylistic streams, thus affirming their cultural "leadership" (Stompff, 2010).

Depending on new product launching time, as even framed in other industries, in design-intensive industries both "innovators" (companies that attempt to challenge currently "fashionable" product languages and affirm new language streams) and "followers" (firms that develop product languages that are consistent with current and emerging language templates launched by competitors) are recognized to mark the evolutionary dynamics of product innovation (Dell'Era and Verganti, 2007).

Notwithstanding the sole idea that design is employed for a unique differentiation strategy seems to be too simplistic (Filitz and Henkel, 2015). A recent approach tended to deepen the design forms of competing according to an "horizontal differentiation", a "vertical differentiation" and a "relative differentiation".

In horizontal approach design leverages heterogeneous customer tastes trying to address different preferences. This happen mainly in mature market where the marginal value attributed to performance improvements offered by the new technology tend to decrease. This horizontal differentiation explicitly remarks the diverging and differentiating side of design that appears "intuitive and empirically sound" (Filitz and Henkel, 2015). A "vertical differentiation", instead, creates variants of a given product line, in order to reach differentiated customer segments and relative preferences.

Lastly the option of a "relative differentiation" captures the "effects of a visual proximity on consumer preferences and thus on firms' competitive positions" (Filitz and Henkel, 2015). That approach turns in a substantial convergent design option where different products seem to show high similarity degrees with a reference product. This strategic approach – according to the scholars - leverage "design innate preferences, quality signals through design, trends and fashion and technology-driven interactions". This is particularly true in fashion industries where a certain rhythmical alternation of convergent and divergent styles occurs (Cappetta et al. 2006) or in specific technology innovation period (Filitz and Henkel, 2015) – related to different kind of industries – where during the transition between period of "variation and selection" – dominant architectures for new product categories are searched (Anderson and Tushman, 1990).

Different nuances of converging dynamics in new product development – mainly related to the context of design-intensive industry have been pinpointed also by Gemser and Wijnberg (2001) where, in a study about

the effects of reputational sanctions on competitive imitation of design innovation, they state: "imitation may take different forms, from straightforward copying down to the last details, to being inspired by the examples set by others or following a fashion trend".

The convergence though a common product language template is indeed highlighted also by Verganti (2006, 2008) where he defines, with the term "design discourse", the implicit and silent dynamics – usually leveraging on a cultural proximity – that competitor companies with other players (retailers, anthropologists, sociologists, technology providers, artists) run to question and forge the future directions of product meanings and the relative product languages. These dynamics seem to be particularly evident when companies join cultural projects to challenge and envision new product meanings (Dell'Era, 2010) or during the diffusive efforts of new product meanings in design intensive settings where companies seem to be clustered around common meanings and product language determinants (Dell'Era and Verganti, 2011).

A crucial moment, where updating and questioning the product language strategic option become particularly relevant, relates to the adoption of a new technology, especially if it is a discontinuous technology innovation (Hargadon and Douglas, 2001; du Gay *et al.*, 1997; Desai *et al.*, 2001; Rindova and Petkova, 2007; Sanderson and Uzumeri, 1995; Cautela and Simoni, 2013; Simoni *et al.*, 2014; Talke *et al.*, 2009; Verganti, 2017; Dell'Era *et al*., 2017).

Approaching a new technology, companies operating in design-intensive industries are placed in front of a strategic dilemma: should they launch new, discontinuous technology by creating product languages that are far from the templates that other competitors are developing or should they launch new, discontinuous technology that adheres to emerging competitors' product language streams (Cappetta *et al.*, 2006; Dell'Era and Verganti, 2011; Simoni *et al.*, 2014; Verganti, 2011)?

These two opposite strategic choices are in this study labeled product language divergence in opposition to the product language convergence.

The choice of one of the alternative options lays on a specific tradeoff.

The product language divergence consists of increasing the difference, in terms of the language of the new technology-based products, from other firms that have adopted the same technology. The main advantage of this choice is that the firm can achieve a unique market position based on its product language. In other words, these companies mark their uniqueness in the marketplace by pursuing a product language-based differentiation (Dell'Era and Verganti, 2007; Verganti, 2009). The main disadvantage is the risk of being out of the market despite the substantial effort required to develop a unique firm product language. Betting on one or few differentiating languages coupled with a new discontinuous technology could lead the company in a niche or even in a marginal market position (Simoni *et al.*, 2014).

The product language convergence, instead, consists of either explicitly or implicitly adhering to the development of a common product language template with other competitors to launch the new technology (Verganti, 2008). Within this common product language template, companies can develop limited language

variants that identify their products (Cappetta *et al.*, 2006; Cautela and Simoni, 2013; Cillo and Verona, 2008; Dell'Era and Verganti, 2011; Filitz and Henkel, 2015).

The main advantage of this approach is that it augments the "speed" and "contagion rate" of what companies select as their "main stream" languages (Dell'Era and Verganti, 2011).

Companies create a sort of product language "critical mass" that sustains new technology diffusion, sharing the risk with other players that the new product language is rejected by the market (Dell'Era and Verganti, 2011). In other words, during the early diffusion of the new technology, some "dominant product languages" (Verganti, 2008; Dell'Era and Verganti, 2010b) tend to emerge and companies opt to adhere to that language to minimize the risk of being marginalized.

The main disadvantage of this option is that companies sharing converging language templates tend to develop similar products that the market could perceive as undifferentiated commodities. Moreover, adhering to a language template that has not been developed "in house" creates a necessary realignment of all the marketing levers (e.g., communication campaign, retailer styling, brand interfaces, and the event to launch the campaign) with the product language, resulting in additional costs.

In order to implement a precise product language strategy – divergence *versus* convergence – managers in design-intensive industries have to assemble the relatively consistent designer portfolio. In other words, once managers have chosen the firm's product language strategy they should act accordingly: building the coherent organizational vehicle to reach that direction. Leveraging the extant literature in the current paper the designer portfolio is conceived as a set of interdependent traits that jointly determine the accomplishment of a given strategic orientation. The following part stresses the main features that literature states as relevant in assembling and managing designer portfolio.

*b. The key dimensions of the designer portfolio*

As highlighted in the extant literature, the engagement of a designer in a collaborative project to develop a new product usually does not involve the mere choice of the "right designer" (Dell'Era and Verganti, 2010a). In other words, companies only rarely choose designers solely on the basis of their individual personal traits. Thus, the main literature on this topic sheds light on the fact that companies engage designers in different new product development projects assessing the potential interactions and knowledge complementarities possibly emerging among all the innovation projects (Dell'Era and Verganti, 2009; 2010a).

This is because new product development projects are not recognized for the single outcome they deliver (new product concept) but also for the derivative knowledge they produce (as for instance the application of a new material), that can be blended and accumulated through different interactions with the designers allocated in different projects. This pushed scholars to consider the collaborative relationship that companies develop with designers as an extended organizational territory, a sort of "context of knowledge" (Dell'Era

and Verganti, 2010a) in which a strategic dialogue about innovation between manager and designers continuously occurs.

This concept is specified as follows: *"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 array of external collaborators. 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."* (Dell'Era and Verganti, 2010a).

Furthermore, framing designers as "bridges" to the market, each with her own "design philosophy" (Capaldo, 2007) and "cultural register" (Rindova *et al.*, 2011), the literature argues that companies engage different designers looking at the overall market strategy and consider each designer as a specific "voice" to orient to the ears of a specific market segment (Capaldo, 2007).

Here strategic and organizational issues appear as strictly intertwined, where the organizational choices on how to manage design and designers causally orient strategic pathways. The insourcing of design process to internal departments or the outsourcing to external designers impact the relative competitive advantage and the appropriability regime (Filippetti and D'Ippolito, 2017; Gemser and Wijnberg, 2001). Moreover – even the outsourcing of design in the hand of external design professionals – per se does not determine a unique strategic direction. New products development can be achieved by different designers with the strategic aim to vary the product languages catching the preferences of different market segments (Capaldo, 2007) or alternatively controlling the collaboration with a reduced number of designers can enhance a more consistent brand identity and a more homogeneous product portfolio addressing a specific known market (Karjalainen, 2007; Karjalainen and Snelders, 2010).

Therefore, increasing the number of collaborative projects with designers on the one hand impacts the company's knowledge capital for innovation (Dell'Era and Verganti, 2010a) and, on the other hand, expands the market's potential, capturing the preferences of various market segments (Capaldo, 2007).

The designer portfolio is indeed considered by the literature as an organizational construct expressed as the "*array of external collaborations*" (Dell'Era and Verganti, 2010a) or sometimes as an external network in which the strengthening of ties over time creates a sort of "*inner circle*" (Capaldo, 2007).

Given the network-based and systemic nature of this organizational construct, each choice is made looking at the overall balancing of various characteristic and structural features.

The innovation management literature emphasized different key characteristics of the designer portfolio that impact "new product languages development".

The first dimension relates to the degree of insourcing *versus* outsourcing of new product-development projects. In other words, usually companies neither purely insource nor purely outsource the complete design process.

The full placement of the design process within a company's boundaries leads to a trust-based company-designer relationship, the immersion of designers within the company culture, and the clear advantages with respect to the time to market and the control of the creative process by internal management (Capaldo, 2007; Stompff, 2010; Filippetti, 2010). Conversely, the use of external designers is expected to introduce fresh stimuli and insights into the creative process (Abecassis-Moedas and Rodrigues Pereira, 2016; Bruce and Jevnaker, 1998; Bruce and Morris, 1994; 1997; Czarnitzki and Thorwarth, 2012; Filippetti and D'Ippolito, 2017). These stimuli can counterbalance the conservative tendencies of firms, particularly under the advent of new discontinuous technologies, the evolution of new socio-cultural models and the emergence of new market trends (Bruce and Morris, 1994). Consistent with this concept, various studies have highlighted a trend toward outsourcing design expertise and placing the design function outside firm boundaries (Abecassis-Moedas *et al.*, 2012; Bruce and Docherty, 1993; Bruce and Morris, 1994; Dell'Era and Verganti, 2010a; Westmocott, 1992; Filippetti and D'Ippolito, 2017). Dell'Era and Verganti (2010a) observed the following: *"Many industries collaborate with external designers to source fresh insights, creativity, and knowledge. This perspective is in line with a general tendency toward open innovation and the development of business ecosystems, where companies recognize that most of the valuable knowledge for innovation resides outside their boundaries"*.

This means that most companies combine insourcing with outsourcing, attempting to balance the benefit and the disadvantages connected to these two extreme options.

Another key dimension analyzed by literature is the size of the designer portfolio.

The size of the designer portfolio affects the coordination and openness of the design and creative process. Indeed, a portfolio that involves a large number of designers ensures variety in terms of stimuli and sources of creativity but implies lower levels of efficiency in managing the products developed. In contrast, companies that manage a small designer portfolio gain an advantage in terms of project management efficiency but suffer disadvantages in terms of the number and variety of stimuli brought into the development of new product design languages (Capaldo, 2007; Dell'Era and Verganti, 2010a).

The concentration degree of designer portfolios—intended as the number of collaborative projects assigned to each designer involved in the development of the firm's product portfolio—is another key dimension of the designer portfolio. Literature relates this dimension to the opportunity to foster a clear "design leadership"—i.e., a sort of straightforward design direction (Topalian, 1984)—in the event of high concentration or, in contrast, to promote individual design experimentations in the event of low concentration. Indeed, scholars have argued that concentrated design activities ensure a greater control of the creative process, less time to market, and a more coherent and homogeneous product portfolio in terms of design solutions (Bruce and Jevnaker, 1998). In design-intensive industries, it is not unusual to find companies that historically link their image, languages and destiny to one or a very few designers. The cases of Castiglioni with Flos, Magistretti with Cassina, Carlotta de Bevilacqua with Artemide and Danese, and

Philippe Stark with Kartell constitute real evidence of historical collaborations in which the heritage of designers and that of companies overlap.

On the other hand, a "path dependent" effect caused by historical and intense relationship has been highlighted by various studies (Capaldo, 2007; Filippetti, 2010; Filippetti and D'Ippolito, 2017). It has been argued specifically that design-driven companies – recognizing a decline in performances and creativity – revamp their strategic path building a dual-networking organization (Capaldo, 2007) – where new "peripheral" designers are asked to refresh creative stimuli and knowledge capital in order to replace the consolidated position reached through the old "inner circle".

Alternatively, in order to avoid path dependence dynamics managers can pursue dispersed design activities in which the number of products developed by each designer is very low (only one product at the limit) to explore different product design philosophies and sources of creativity.

Another key dimension that impacts the designer portfolio is the designers' popularity.

Some companies leverage anonymous designers as the main sources of creativity for the new product design process, thus avoiding the risk that a well-known designer will blur the company's identity and reputation (Abecassis-Moedas *et al.*, 2012; Abecassis-Moedas and Rodrigues Pereira, 2016; Cautela and Zurlo, 2011, 2012; Filippetti and D'Ippolito, 2017). The aim of this approach consists of building a strong company identity that is disentangled from any specific design star and solely linked to the firm's brand. Conversely, other firms prefer to exploit well-reputed designers and thus limit the firm's role in the new product design process (Cillo and Verona, 2008; Durgee, 2006). These designers are frequently contemporary artists or "Archi-Stars" who have enhanced their reputation and brand awareness largely through the media and exhibition systems that have promoted them, their work and their design philosophies. These designers are used by firms as an additional marketing and communication tool to strengthen company product offerings and enhance the potential to reach design-oriented market segments. In fact, according to this approach, designers act as a second brand that is juxtaposed with a firm's own brand (Abecassis-Moedas and Rodrigues Pereira, 2016; Cautela and Zurlo, 2012; Durgee, 2006). The risks and costs associated with this choice are related to the typically higher fees that a famous designer requests for designing products and to the risk of the designer's name cannibalizing a company's brand.

Another key dimension that not only can be considered relevant for innovation capacity but also can affect how to launch new technologies pertains to the appropriability regime that characterizes the company-designer relationship.

As in other competitive domains, particularly in technology-intensive sectors, companies could use two opposing approaches with respect to the benefits and relative effects of protecting or not protecting a certain design application and specific creative knowledge (Filippetti and D'Ippolito, 2017; Teece, 1986). Some firms prefer to engage designers through an exclusive relationship to prevent the knowledge developed within the firm to be shared with other firms (Gemser and Wijnberg, 2001; Abecassis-Moedas and Rodrigues

Pereira, 2016; Cautela and Simoni, 2013; Filippetti and D'Ippolito, 2017). By building strong and exclusive relationships with designers, companies attempt to protect the intermediate and final knowledge outcomes by reasonably defending their distinct positioning in the sector.

Other firms allow designers to work simultaneously with many firms or engage designers who are already cross-tied (Gemser and Wijnberg, 2001; Filippetti and D'Ippolito, 2017). In this case, the protection of the creative process decreases, but benefits may arise from sharing knowledge with other firms. In fact, such firms aim to exploit the network position of designers (Hargadon and Sutton, 1997; Verganti, 2003) to access certain experience and specific channels of knowledge and, most likely, to share a design framework (tacitly or explicitly) with other competitors.

Finally, the heterogeneity of cultural frames and "design philosophy" that designers can bring to their collaboration seem particularly important.

In that regard, scholars have observed that firms have adopted two possible approaches. Some firms reduce the variety of the sources of design knowledge in attempt to exploit past design expertise for new product development. In contrast, other firms systematically seek out new sources of design knowledge to explore possibilities for product design (Capaldo, 2007; Dell'Era and Verganti, 2009, 2010a).

At this juncture, internationalization is relevant. In fact, the management literature considers cultural diversity (Ancona and Caldwell, 1992; Bantel and Jackson, 1989; Cox and Blake, 1991; Iles and Hayers, 1997) largely as a team feature that enhances knowledge diversity, fosters creativity and dissolves consolidated past paradigms.

Considering designers as bridges to address emerging and international markets, to grasp new cultural frames and to enter new customer segments (Capaldo, 2007; Verganti, 2009), it is undisputedly affirmed that design companies manage highly international designer portfolios to increase their exposure to different competitive environments, new emerging cultural contexts and new language frames (Dell'Era and Verganti, 2009). A designer portfolio's degree of internationalization thus expresses a company's exposure to different cultures, design philosophies, markets and language frames. Italian design is famous worldwide not only because of Italian designers but also because of the engagement of international designers who reframe certain values, abilities and style patterns of companies according to their cultures (Verganti, 2006). Moreover, recent studies have demonstrated that the internationalization of their designer portfolios affects the innovative capabilities of companies: a more international designer portfolio increases the exposure of a company to heterogeneous cultural frameworks and new insights for innovation than a designer portfolio that is less internationalized (Dell'Era and Verganti, 2009, 2010a). The cost and difficulties associated with harmonizing different cultural stimuli and design philosophies within a single product offering mitigate the tendency towards high degrees of internalization of the designer portfolios in favor of greater efficiency and a more homogeneous product portfolio language. Here there is a risk that an extremely internationalized designer portfolio could become a babble of product languages.

*c. The designer portfolio as an organizational configuration*

The configurational approach to studying organizations takes organizational configuration, broadly defined as a set of various characteristics of an organization that commonly occur together and synergistically concur to the organization's outcomes, as the unit of analysis. One core tenet of this approach is that analyzing how several dimensions of an organization interact, instead of attempting to highlight each dimension's individual contribution, better captures both the complexity of organizations and the relationship between an organization and its strategic performance (Fiss, 2007; Meyer *et al.*, 1993).

The emergence of specific configurations among the theoretically infinite number of possible combinations of organizational characteristics is usually explained according to two different arguments (Miller, 1986).

First, environmental pressures and competitive forces select out only a few configurations that have a higher fit with the context. Organizations with poorer performance may be prompted to move towards the organizational configurations of the most successful organizations (Miller, 1992).

Second, organizational characteristics are interrelated in complex ways. That is, changing one single aspect of a configuration may produce relevant and unexpected effects due to the non-linear interaction of that aspect with the other characteristics of the organization. Therefore, configurations that appear effective in achieving certain performance tend to be stable over time (Ketchen *et al.*, 1993; Short *et al.*, 2008).

A designer portfolio can, thus, be studied through the lenses of the configurational approach to extent that: (a) rather than focusing on single designers the analysis considers the array of designers engaged, over a certain period of time, by a firm to implement its strategy; (b) the analysis considers the characteristics of the designers to qualify the key features of the whole portfolio of designers.

Accordingly, in this paper we adopt a configurational approach following three key assumptions:

- the combination of the different designer portfolio dimensions can produce several possible organizational configurations that the firm can employ to develop its new product languages;
- each of these organizational configurations is the outcome of the multiple choices related to the engagement and assignment of external professional designers to different new product development projects;
- the design strategy ensured by certain designer portfolio configurations and the nature of the interactions among the different designer portfolio characteristics jointly determine the configurations observable among firms in an industry.

The research's methodology is thus designed to capture the association between complex designer portfolio configurations and a product language divergence or convergence strategy.

## Methodology

### *a. The field of study*

The study we show is situated in the residential and architectural lighting industry, in which product language and stylistic innovations play a central role in orienting customer preferences and determining competitive dynamics (Dell'Era and Verganti, 2007; 2011).

Over time, the residential and architectural lighting industry has been the object of many subsequent technological shifts that have triggered a profound rethinking of the design and stylistic features of decorative lamps. Beginning with the incandescent bulb, the technological evolution of lighting has been subsequently marked by fluorescent lighting (1938), metal halide (1961), halogen (1959) and compact fluorescent lamps (CFLs) (1981). The common foundation of these technologies consisted of competencies that were based primarily on electro-mechanical knowledge. In 1996, LED technology was introduced, representing a discontinuous technology that dramatically improved product performance (as measured by the lumen/watt ratio) and spurred the transition from an electrical-mechanical-centered competence system to an electronic-based system in designing and managing new product development (Collis and Furey, 2011; Menanteau and Lefebvre, 2000; Steigerwald *et al.*, 2002; United States Department of Energy, 2012). The first commercial applications of LED in the residential market appeared circa 2007 and prompted the early adopters of this innovative technology to explore, develop and launch new product languages for LED-based decorative lamps. These firms thus needed to build an appropriate portfolio of designers to develop LED-based lamps and to manage this portfolio to converge with other firms toward a common LED-related product design framework or to diverge from them.

This study considered the universe of Italian LED technology early-adopter firms that resorted to an external designer portfolio to develop new LED-based lamps and that commercialized their products from 2007 to 2011 (Simoni *et al.*, 2014).

The firms therefore share a common productive know-how, are immersed in the same cultural atmosphere, and are representative of the "Made in Italy" approach to conceiving and producing new product languages (Verganti, 2006).

Nine early adopter firms, 166 LED-based products and 55 designers involved in the development of these products are studied for the 2007-2011 period. Table 1 highlights the main characteristics of the firms included in the sample.

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The 55 designers considered in this study are either individual professionals or design studios. In most cases, as usual in design intensive industries, individual professionals name the studios with their own name. In terms of characteristics, a variety of typologies of designers were analyzed: from designers that have offices in different countries and are highly popular in the international setting, to designers essentially rooted in Italy and not highly renowned. Examples of very popular and internationally rooted designers, that were involved in the development of the product languages for the first LED-based decorative lamps, are for instance - Philip Stark (Flos), Agatha Ruiz de la Prada (Nemo), Karim Rashid (Artemide), Ingo Maurer (Ingo Maurer).

*b. The Qualitative Comparative Analysis (QCA)*

A Qualitative Comparative Analysis (QCA) methodology is employed to analyze the relationship between designer portfolio configurations and firm design strategies. QCA attempts to "*integrate the best features of the case-oriented approach with the best features of the variable-oriented approach*" (Ragin, 1987: 84). As opposed to classical quantitative statistical methodologies, that measure the net effect of a single variable, QCA assesses the relationship between an outcome and a combination of multiple predictors (Longest and Vaisey, 2008). Indeed, as noted by Fiss (2011), "*the basic intuition underlying QCA is that cases are best understood as configurations of attributes resembling overall types and that a comparison of cases can allow a researcher to strip away attributes that are unrelated to the outcome in question.*" In particular, this methodology builds on a set-theoretic approach that focuses on the set-subset relationship to identify the configurations associated to certain outcome. That is, using Boolean algebra, QCA examines the set of members that obtained a certain outcome and all the subset of combinations of attributes associated to that outcome. As a result, this approach allows to identify multiple theoretical pathways to the given outcome (Ragin, 2000, 2006; Smithson and Verkuilen, 2006).

For this reason, QCA has spread among management scholars interested in addressing the complex interplay between multiple managerial decisions and firm's strategies or results (Crilly *et al.*, 2012; Fiss, 2011; Greckhamer *et al.*, 2008; Krivokapic-Skoko and O'Neill, 2011). Recently, QCA has also found relevant applications in design and innovation studies. It has proved particularly fruitful to understand how sets of different factors affect various aspects of the creative and innovation process (see for example Hemonnet-Goujot et al., 2018).

Adopting QCA provides several advantages to our study (Rihoux, 2006).

First, QCA is well suited for a multidimensional comparison among small number of cases (i.e., 5 to 50 observations), as in our research that counts 9 firms.

Second, it identifies multiple paths to a given outcome (*equifinality*), thus allowing to highlight different designer portfolio configurations for each product language strategy.

Third, this method models the joint conditions that are required for each factor to have an effect (*conjunctural causation*), thus facilitating the understanding of the logical relationship between designer portfolio characteristics and design strategies.

Fourth, it distinguishes successful from unsuccessful causal pathways, therefore allowing to focus on those configurations that are clearly associated to one of the two product language strategies analyzed in our study.

For further details on the application of QCA in this paper please see Appendix A.

In our study the analyzed outcome is the firm's product language strategy (i.e., divergence or convergence) and the attributes are the designer portfolio characteristics.

*c. The analytical model and the variables operationalization*

Two main product design strategies are analyzed in the study: product language convergence and product language divergence.

Designer portfolio configurations are identified considering all main characteristics that the previous literature has highlighted as relevant to a firm's designer portfolio: degree of outsourcing of the portfolio, size, concentration, designers' reputation, sharing of designers with other firms, and degree of internationalization.

The variables employed in the study are defined and operationalized as follows.

*Product language convergence/divergence measure*

The product language design convergence/divergence (variable's name *Convergence/Divergence*) was measured using the style profile distance method proposed by Chen and Owen (1997). According to Chen and Owen (1997), the design of a product can be described by a vector of attributes measured through polar adjectives, on a six-degree Likert scale. This vector represents the style profile of the product. Products with a similar style profile will show a smaller distance between their vectors, whereas products that are informed by different styles will show a greater distance. We assumed that the repertoire of all style profiles of the products in a firm portfolio is a proxy for the firm's product languages. Accordingly, we measured the product language convergence/divergence in terms of average style profile distance between the products in a firm portfolio and those in the product portfolios of all other firms. Firms with a product language divergence strategy will exhibit a set of product language traits that largely differ from those of other firms in the industry and therefore will show a greater average style profile distance. Firms with a product language convergence strategy will exhibit a set of product language traits that are shared with other firms in the industry and therefore will show a smaller average style profile distance.

We used a set of 14 polar adjective pairs to measure the following five core attributes of product language: form elements, joining relationships, detail treatments, textures and color treatments. These attributes and their specific polar adjectives were selected by adapting the original instrument developed by Chen and Owen to the lighting industry and by assessing the inter-coder reliability of the measurement tool via Cohen's (1960) kappa test.

The canonical measure of the style profile distance was used to evaluate the degree of similarity between the style and the aesthetic language of two given products in the dataset please see Appendix B for further details.

To determine the degree of product language convergence/divergence of the firms, an index was calculated as follows. Given two firms, x and y, we calculated the product language convergence/divergence index as the average of the minimum distance of the product languages of firm x from the product languages of firm y and of the product languages of firm y from the product languages of firm x, which were normalized by the mean distance between the product languages for all the products in the two portfolios.

$$(1)\ Conv/Div_{x,y} = \frac{((\sum_{i=1}^{n} dmin(A_{x,i}, A_y))/n + (\sum_{j=1}^{k} dmin(A_{y,j}, A_x))/k)/2}{(\sum_{i=1}^{n}\sum_{j=1}^{k} d(A_{x,i}, A_{y,j}))/nk}$$

where *Con/Div* is the product language convergence/divergence index for firm x and firm y, *dmin* is the minimum distance between the product of one firm and the products in another firm's portfolio, and *n* and *k* are the number of products for firms *x* and *y*, respectively. A lower index indicates greater similarities between firms' product portfolios. As an extreme theoretical case, a value of zero would imply that each product in the portfolio of the first firm corresponds to an identical product in the portfolio of the other firm, which would indicate that the two firms share their respective product languages and propose identical style solutions. These firms are characterized by a high level of product language convergence. By contrast, the maximum value of 1 would imply that the product portfolios of the two firms maintain an average uniform distance and that their products do not exhibit particular similarities. As a result, these products are informed by entirely different product language traits, highlighting that the firms are characterized by a high level of product language divergence.

*Designer portfolio measures*

To identify the different designer portfolio configurations, we considered the variables that the literature has associated with the key characteristics of a firm designer portfolio.

The degree of outsourcing (variable's name *Outsourcing*) of the designer portfolio was measured by assigning to each firm's designer a value of 1 if she/he is an independent professional and 0 if she/he either is

tied to the firm in an employment relationship or is the firm's internal design chief. An average was calculated for each firm, weighted by the relevance of each designer in the firm's product portfolio. The variable ranges from 0, which indicates total insourcing of the designer portfolio, to 1, which indicates total outsourcing.

The size of the designer portfolio (variable's name *Size*) was obtained by dividing the number of designers by the number of products. The resulting value is always greater than 0 because a product is by definition always associated with at least one designer. This measure is higher for firms that use relatively large designer portfolios and lower for firms with narrower portfolios, as normalized by the number of products. Size has a maximum value of 1.

The concentration degree of the designer portfolio (variable's name *Concentration*) was calculated as a Gini index that also ranges from 0 to 1 (Gini, 1921). A value of 0 indicates that the product portfolio is equally distributed among all the designers of the firm, whereas a value of 1 indicates that only one designer develops all the firm's products.

The popularity of the designers (variable's name *Popularity*) was measured using Google Internet citations as a proxy (Dou *et al.*, 2010). The number of times that a designer's name is found in an Internet search is directly associated with the strength of his/her popularity. We normalized the designers' popularity by dividing each value by the average calculated for the entire sample of designers that, at time, worked for the firms analyzed in our study. For each firm, we calculated the average value of the popularities of the designers employed to design LED-based products weighted by the number of products designed by each designer. The result is an index of the average popularity of each firm's designer portfolio.

The degree of sharing of the designer portfolio among different firms (variable's name *Sharing*), was measured as the presence in the designer portfolio of designers who develop products, based on the same technology, also for other firms. It was calculated by assigning a value of 1 to a designer who works for more than one firm and 0 to a designer who works exclusively for one firm. An average of the values for the firm's designers was calculated for each firm; designers were weighted proportionally by the number of products that they designed for each firm. A value of 0 characterizes firms that do not share any of their designers with other firms, whereas a value of 1 characterizes firms that share all their designers with other firms.

Finally, we assessed the degree of internationalization of a firm's designer portfolio (variable's name *International rooting*). Internationalization in design practice and consultancy can occurs in different modes and it's not strictly related to the designer nationality (Abecassis-Moedas et al., 2012). Here we employ the concept used by Abecassis-Moedas et al. (2012) – namely "Glocality based creative KIBS" - where authors refer to designers and design consultancies with a proximity to foreign markets. Opening foreign offices in strategic countries and markets, designers - as matter of fact – increase their "client intimacy" and their exposure to foreign views and novel socio-cultural tendencies.

Designers whose resumes indicates offices in foreign countries other than Italy were assigned a value of 1, whereas designers with a strict Italian presence were assigned a value of 0. An average of the firm designers' value was calculated for each firm by weighting designers according to the number of products designed in the product portfolio of the firm. The resulting index ranges between 0 and 1. If all the designers in a firm have a national coverage, then the firm would have a degree of internationalization of 0, whereas firms that utilized only designers with international rooting would have a degree of internationalization of 1.

To assign a fuzzy score, all the variables were calibrated. The rationale adopted for each variable to establish the three main qualitative breakpoints used to create the fuzzy sets is described in Appendix C.

Fuzzy set scores after calibration are reported in Table 2.

[PLEASE INSERT TABLE 2 ABOUT HERE]

**Results**

Through QCA, we first identify the designer portfolio configurations that are consistent with a divergence product language strategy. After evaluating all possible configurations, those that passed the consistency test were reduced to their most parsimonious solutions.

The results are reported in Table 3

[PLEASE INSERT TABLE 3 ABOUT HERE]

Two organizational configurations can be identified that share three common traits: a relatively large size of the designer portfolio respect to the number of developed products, an extensive use of outsourcing, a relationship with designers based on exclusivity. They differ in terms of the other characteristics.

The first configuration concentrates most design activities in the hands of few designers, some of them internationally rooted and highly popular. Such international "design-stars" are responsible for developing distinctive product language solutions that should differentiate the firm from other competitors in the industry. This configuration therefore appears as aimed at leveraging the talent of designers with a proven record of international past successes and at using the designers' personal popularity to promote the diffusion

of the firm's unique product languages. Accordingly, we call this configuration "*International design-star archetype*".

Nemo, specifically, among the analyzed companies, leverages this designer portfolio archetype. Indeed, all of Nemo's LED-based products were designed by external designers and 75% was developed by only one designer. Very popular designers –i.e., those with a popularity above the mean plus 1 time the standard deviation of all designers employed by the analyzed firms– developed 25% of the firm's products (i.e., one out of four LED-products initially developed by Nemo), compared to an average, in the overall sample, of 10%. Similarly, 25% of Nemo's products was developed by internationally rooted designers compared to an average of 14%. In particular, the firm employed the world-famous designer Agatha Ruiz de la Prada (with a popularity index, at that time, 13 times higher than the average of the designers in the sample) to mark its LED lamp product language with an iconic product (the product was presented in 2011 in the most important design trade fairs with the name Corazones). Any of the products in the firm portfolio was designed by designers shared with other firms.

The second configuration assigns the design activities equally to all designers in the firm's designer portfolio and employs not so much popular designers, who work exclusively for the firm and who can be either national or international. This configuration therefore appears as aimed at maximizing the access to a "crowd" of creative external sources, as talented designers who can provide unique product languages that differentiate the firm from its competitors. Accordingly, we call this configuration "*Crowd design-innovator archetype*".

Kundalini is representative of this designer portfolio archetype. Indeed, all of Kundalini's products were developed by external designers who designed, on average, only one product each. Any of these products was designed by world-renowned designers (on average Kundalini designers had, at that time, a popularity index 15 times lower than the average popularity). Similarly, any of Kundalini's products was developed by designers that worked, in the same period, for other firms. The most employed designer, with two design projects, was the Italian Patrizio Orlandi.

The total coverage value of these two designer portfolio configurations is 0.641, showing that these configurations account for almost two third of the product language divergence cases. Moreover, the total consistency of 0.956 shows that the set relationship between these two designer portfolio configurations and a divergence product language strategy is very strong (Ragin, 2006).

Through QCA, we also identify designer portfolio configurations that are consistent with a convergence product language strategy.

The results are reported in Table 4.

[PLEASE INSERT TABLE 4 ABOUT HERE]

Even these two designer portfolio configurations share three common traits: a small designer portfolio size compared to the number of developed products, a high concentration of the design activities in the hand of few key designers, and the use of designers that are not too much popular. They differ in terms of the other characteristics.

The first configuration is made by internal designers who do not have an international rooting. This configuration therefore appears aimed at rooting the design development in a more local culture and at employing designers, who are closely tied to the firm, as "ambassadors" of the firm in the interaction with other players. Accordingly, we call this configuration "*Local ambassador archetype*".

Martinelli is an example of this designer portfolio archetype. Indeed, 78% of Martinelli's products was designed by internal designers, with one single designer responsible for the development of 71% of the products in the firm's portfolio. Indeed, 10 out of 14 products were designed by the firm entrepreneur and designer Emiliana Martinelli. The remaining products were developed by not very popular Italy-rooted designers (on average Martinelli designers had, at that time, a popularity 20 times lower than the popularity observed among all designers employed by the analyzed firms).

The second configuration is made mostly by external designers, and involves international designers that collaborate with different firms in the industry and concentrate in their hands most of the designing activities. This configuration therefore appears as aimed at bringing design elements, based on other international cultures, into the product language development process and at spreading such elements among the players, via shared bridging designers. Accordingly, we call this configuration "*International bridge archetype*".

The firm that most closely reflects this configuration is Artemide. Indeed, 62% of Artemide's product portfolio was developed by external designers, with only 4 designers, out of 13 involved, responsible for more than 75% of all firm's LED-based products. In addition, 52% of products was designed by designers that also worked for other firms (in particular for Danese) and 22% of the products was designed by internationally rooted designers, compared to an average of 14%. In particular the internationally rooted designer Michele De Lucchi contributed with 9 products. The firm entrepreneur and designer Carlotta de Bevilacqua developed 14 Artemide's products. Only 3% of products were developed by very popular designers, compared to an average of 10%, as designer Karim Rashid (with a popularity index, at that time, 8 times higher than the average).

The total coverage value of these two designer portfolio configurations is 0.514, showing that these configurations account for almost half of the product language convergence cases. Moreover, the total consistency of 1.000 shows a perfect set relationship between these two designer portfolio configurations and a convergence product language strategy (Ragin, 2006).

**Discussion**

Our paper identifies four designer portfolio archetypes that relate to two different design strategies: product language divergence and product language convergence.

Previous studies have emphasized that product language divergence is a strategy by which firms aim to develop highly distinctive product languages that strongly depart from those adopted by other firms and provide a unique identity to the firm's product portfolio (Ravasi and Lojacono, 2005; Karjalainen, 2007; Karjalainen and Snelders, 2010). Scholars have highlighted that a divergence strategy requires both the exploitation of creative talented people, that freely interpret the design opportunities provided by cultural and technological change, and the ability to obtain visibility for the novel design solutions developed by the firm (Bruce and Morris, 1994; Ravasi et al. 2012; Lehrer et al. 2012; Filippetti, 2010; Stompff, 2010). In order to fully benefit from this strategy firms must be able to appropriate the results of the designers' activities on an exclusivity base (Filippetti, 2010; Filippetti and D'Ippolito, 2017; Gemser and Wijnberg, 2001).

Our findings contribute to the existing literature showing that, in design intensive industries, at least two different designer portfolio archetypes allow firms to pursue a product language divergence strategy. Both of them move into the direction of open innovation and leverage external designers to strengthen the product language development process of the firm.

The first archetype –i.e., a design-stars archetype– uses the popularity of renowned internationally rooted designers to both develop the firm's new product languages and to amplify their recognizability. In this archetype, some selected famous designers are in charge of developing iconic products used to mark the firm's new product languages. The engagement of "design-stars", on an exclusive basis, allows the firm to fully exploit the benefit of this organizational configuration in pursuing a product language divergence strategy.

The second archetype –i.e., a crowd design-innovator archetype– leverages the crowd of talented but not yet very popular designers that can be engaged both at a national and at an international level. Our results highlight that, in this archetype, firms tend to maximize the number of different designers involved in the development of new product languages, in order to increase the number of creative design solutions that the firm can exploit. Some of these solutions may emerge as particularly distinctive and become the "signature" of the firm's product language. The availability of an expanded set of different interpretations of the design opportunities, related to cultural and technological trends, allows the firm to fully benefit from this configuration in pursuing a product language divergence strategy.

On the other vein, scholars have conceived product language convergence as a strategy by which firms adopt, implicitly or explicitly, a common product language framework that is employed to mark a new technology and to guide firms in developing their own specific design solutions (Dell'Era and Verganti, 2011). Previous studies have shown that this convergence is obtained through a collective and social process in which different actors choose the "product language templates" (Cautela and Simoni, 2013) and the main essence of the "product meaning" (Verganti, 2009). This cultural "discourse", among different industry players, is usually led by firms' managers or entrepreneurs (Verganti, 2006, 2008, 2009), with designers

acting as "brokers" in the process of design-related knowledge sharing (Hargadon and Sutton, 1997; Verganti, 2003, 2009; Filippetti and D'Ippolito, 2017).

Our results contribute to current research by showing that, in design intensive industries, participation to the design discourse occurs at least through two different archetypes of designer portfolio.

The first archetype –i.e., a local ambassador archetype– leverages a small number of internal designers, mainly locally rooted, to facilitate the participation of the firm to the design discourse. These designers act in strict relationship with firm's managers and/or entrepreneur and represent an effective vehicle to convey the firm's choices to the other players involved in the development of new product language templates. The coincidence, that can be observed in some entrepreneurial firms, of the role of designer with that of entrepreneur can even strengthen this organizational configuration in pursuing a product language convergence strategy.

The second archetype –i.e., an international bridge archetype– employs internationally rooted external designers to bring, in the design discourse, product language innovative elements that stem from other markets and cultural contexts. Our findings show that, in this archetype, the managers and/or the entrepreneur are supported by bridging designers that, by working for more than one organization, help the firm in finding design templates that are shared with other industry players. The coupled effort of internal designers (especially when entrepreneur and designer coincide) and external international designers, in defining a shared product meaning, can make this organizational configuration even more effective in pursuing a product language convergence strategy.

Table 5 summarizes the key characteristics of the four configurations and the logic linking each configuration to a specific product language strategy.

[PLEASE INSERT TABLE 5 ABOUT HERE]

Previous studies have highlighted the key role played by designers for firms' competitive advantage, especially in design intensive industries, and thus have argued about the importance for firms to select the "right" designers (Durgee, 2006; Dell'Era and Verganti, 2009; 2010a; Capaldo, 2007; Cautela and Zurlo, 2011; Czarnitzki and Thorwarth, 2012; Filippetti, 2010; Gemser and Wijnberg, 2001; Hemonnet-Goujot et al., 2018). Accordingly, these studies have focused their attention on the characteristics that designers must possess to fit with the different strategic needs of the firm and on the path dependent process that guides managers in engaging internal and external designers for product language development projects (Capaldo, 2007; Cautela and Zurlo, 2011; Filippetti and D'Ippolito, 2017).

Our study contributes to this literature suggesting that a better understanding of the relationship between firm's design strategy and designers comes from the adoption of a configurational perspective. Rather than considering the single choice of picking a designer, in our paper we highlight the importance of considering the array of collaborations (i.e., the designer portfolio) that each firm assembles, in a certain period of time, to face its specific design challenges (Capaldo, 2007; Dell'Era and Verganti, 2009; 2010a; Filippetti and

D'Ippolito, 2017). We also point out that the characteristics of the designer portfolio, when properly combined, give rise to different archetypes –i.e., organizational patterns able to sustain certain firm design strategies. This implies that each characteristic of designers becomes relevant only when it is jointly considered with all other characteristics. Opposing features of the designer portfolio could be associated to the same product language strategy or the same features could be associated to different strategies.

In our study we, thus, suggest that the decisions about the involvement of designers in product development activities are driven not only by the strategy of the firm and by its contingent organizational factors (i.e., the firm's internal expertise and capabilities, the network of external partner, and the socio-economic and technological context within which they operate) but also by the search of an organizational configuration that over time is able to sustain the strategy implementation and exploit the firm's key assets (Capaldo, 2007; Cautela and Zurlo, 2011; Dell'Era and Verganti, 2009; 2010a; Filippetti and D'Ippolito, 2017; Gemser and Wijnberg, 2001).

Our study also shows that designer portfolio archetypes contribute to the firm's strategy implementation through different specific logics. These logics represent alternative approaches to obtain similar results (so called equifinality). Rather than the existence of "optimal recipes", our paper highlights the possibility for firms to explore different paths that exploit the designer characteristics and peculiarities in different ways. Archetypes, with this respect, can either represent templates to pursue certain logics or starting points for searching new original and strategically effective configurations. As noted by past strategy literature (Capaldo, 2007), the departure from a given archetype may lead to poor strategic performance only to the extend firm's managers are not able to give rise to a more effective solution. Thus, on the one hand, our study, complements previous studies by providing a finer and more extended understanding of the logics that underpin the complex relationship between firm's design strategy and designers' engagement; on the other hand, it suggests that the employment of designers responds to a far richer set of options than those identified by simply referring to single designer characteristics (Dell'Era and Verganti, 2009; 2010a).

From a managerial perspective, this paper offers also relevant insights that can help managers to effectively deal with the designers that firms employ to be competitive.

First, our study points out that, far from being simply the selection of different "right" designers, the creation of a firm's designer portfolio is a process that involves the creation of a complex and difficult-to-tune blend. An apparently reasonable decision may produce negative results if it is not evaluated within the broader set of all other choices pertaining to the firm's designer portfolio. Managers are thus alerted of the difficult challenge represented by the creation of an appropriate organizational configuration of creative professionals who contribute to design the firm's products.

Second, our article provides a systemic view to explore and understand the logics that can underpin different designer portfolio configurations. In this way, the paper directs managers' attention towards ensuring consistency between the rationale of the selected product language strategy and the logic of the selected designer portfolio. At this aim the availability of the designer portfolio archetypes, identified by this paper,

can help managers in developing specific organizational configuration related to the firm's product language strategy.

## Conclusions

This paper contributes to a better understanding of an area in design and innovation management studies that has been only partially explored: the relationship between the designer portfolio of a firm and its product language strategies.

Based on an analysis of the universe of the LED early adopters, in the Italian decorative lighting industry, and by leveraging a QCA protocol, this study highlights the complexity of the relationship between product language strategies and designer portfolio choices and shows how the alternative strategies of product language divergence and convergence can be achieved through different designer portfolio configurations. In particular, four possible archetypes of designer portfolio are identified: international design-star archetype, crowd design-innovator archetype, local ambassador archetype, international bridge archetype.

These findings point out the importance of using a multidimensional configurational approach to study the role of designers in new product development and highlights the equifinality, in terms of strategy implementation, of leveraging different designers' characteristics. Our results thus open the path to a broader understanding of the complex interaction between distinctive and firm-dependent internal and external factors, the strategy for the development of new products and the commitment of designers able to exploit the idiosyncratic factors of the organization and support effectively implementing the strategy.

The case-based nature of this research is exposed to the limitations associated with the mono-industry setting and the unique geographical context in which the study has been conducted. Thus, the findings although theoretically generalizable, cannot be extended to other industrial and/or geographical contexts without further studies.

To overcome this limitation, we suggest three possible future research strands.

First, a confirmative study based on a broader sample could statistically test some hypotheses derived from our paper. Here, the extension of the timeline and the inclusion of other firms and products (in addition to LED early adopters) could make even more robust and generalizable the research results.

In contrast, a cross-industry study could be effective to extend the findings and propositions to other industrial sectors, that should be chosen according to the varying importance of design for firms' competitive advantage. Design-intensive sectors could be compared to other sectors, in which product language plays a minor role with respect to technology (e.g., automotive, consumer electronics, services), in order to identify general trends or industry-specific approaches for managing the relationship between designer portfolios and design strategies.

Finally, instead of focusing on the characteristics of the firm's designer portfolio, future studies could complement our research by analyzing the inner dynamics of teams that, through different configurations, engage with external and/or internal designers. In this way, the understanding of the strategic logic underpinning different designer portfolio archetypes could be extended by considering the fine mechanisms that guide the interaction of the designers with other players.

A second limitation is related to the temporal setting of the case study. Indeed, the paper investigate the designer portfolio archetypes adopted by firms in the early phases of a new technology. Future studies could extend the analysis over a longer period of time, investigating over time the eventual evolution of these archetypes or even how the relationship between design strategies and designer portfolio configurations modifies along a shift from a previous technology to a new one.



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**Table 1:**
Main characteristics of firms in the sample in the period 2011-2015

| | N. of designers | N. of LED products | Foundation year | Size | N. of design awards |
|---|---|---|---|---|---|
| Artemide | 13 | 44 | 1959 | Large | 3 |
| Danese | 11 | 51 | 1984 | Small | 1 |
| Flos | 7 | 19 | 1962 | Large | 4 |
| Foscarini | 4 | 5 | 1988 | Medium | 1 |
| Ingo Maurer | 4 | 12 | 1965 | Small* | 1 |
| Kundalini | 4 | 5 | 1996 | Small | 0 |
| Luceplan | 5 | 12 | 1978 | Medium | 3 |
| Martinelli | 5 | 14 | 1973 | Medium | 1 |
| Nemo | 2 | 4 | 1993 | Large** | 0 |

The data have been gathered from different sources: firm balance sheets, economics magazines (Il Sole 24 Ore), Archivio Compasso D'Oro of the ADI (Italian Design Association) and the companies' product catalogues. Firm size is based on the European Union classification according to turnover and number of employees.
* Estimated value.
** Nemo is a brand within a group. The size is referred to the entire group.

**Table 2:**
Summary of variable values and corresponding fuzzy set scores

| | Convergence Divergence | | | Outsourcing | | Size | | Concentration | | Popularity | | Sharing | | International rooting | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Value | Fuzzy score* C | D | Value | Fuzzy score | Value | Fuzzy score | Value | Fuzzy score | Value | Fuzzy score | Value | Fuzzy score | Value | Fuzzy score |
| Artemide | 0.606 | 1.0 | 0.0 | 0.614 | 0.7 | 0.295 | 0.1 | 0.572 | 0.6 | 0.920 | 0.4 | 0.523 | 0.5 | 0.227 | 0.6 |
| Danese | 0.610 | 0.9 | 0.1 | 0.373 | 0.3 | 0.216 | 0.0 | 0.671 | 0.7 | 0.250 | 0.1 | 0.686 | 0.8 | 0.098 | 0.4 |
| Flos | 0.629 | 0.8 | 0.2 | 1.000 | 1.0 | 0.368 | 0.5 | 0.368 | 0.3 | 3.035 | 0.9 | 0 | 0.0 | 0 | 0.0 |
| Foscarini | 0.717 | 0.1 | 0.9 | 1.000 | 1.0 | 0.800 | 1.0 | 0.200 | 0.1 | 0.421 | 0.1 | 0 | 0.0 | 0.200 | 0.6 |
| Ingo Maurer | 0.676 | 0.4 | 0.6 | 0.417 | 0.4 | 0.333 | 0.3 | 0.556 | 0.6 | 2.057 | 0.8 | 0 | 0.0 | 0.583 | 0.8 |
| Kundalini | 0.731 | 0.0 | 1.0 | 1.000 | 1.0 | 0.800 | 1.0 | 0.200 | 0.1 | 0.042 | 0.1 | 0 | 0.0 | 0 | 0.0 |
| Luceplan | 0.649 | 0.5 | 0.5 | 0.250 | 0.2 | 0.417 | 0.7 | 0.417 | 0.4 | 0.185 | 0.1 | 0 | 0.0 | 0 | 0.0 |
| Martinelli | 0.648 | 0.6 | 0.4 | 0.214 | 0.2 | 0.357 | 0.4 | 0.643 | 0.7 | 0.028 | 0.1 | 0 | 0.0 | 0 | 0.0 |
| Nemo | 0.716 | 0.3 | 0.7 | 1.000 | 1.0 | 0.500 | 0.8 | 0.500 | 0.5 | 2.494 | 0.9 | 0 | 0.0 | 0.250 | 0.6 |

* Values on the left side of the column (letter C) are the fuzzy scores for product design convergence; values on the right side of the column (letter D) are the fuzzy scores for product design divergence.

**Table 3:** Designer portfolio configurations associated with product language divergence strategies

| **Designer portfolio characteristics** | **Product language divergence** | |
|---|---|---|
| | *International design-star archetype* | *Crowd design-innovator archetype* |
| Outsourcing | **High** | **High** |
| Size | **High** | **High** |
| Concentration | **High** | Low |
| Popularity | **High** | Low |
| Sharing | Low | Low |
| International rooting | **High** | |
| *Example of best fit case* | *Nemo* | *Kundalini* |
| Total coverage | 0.641 | |
| Total consistency | 0.956 | |

Blank space = irrelevant

**Table 4:** Designer portfolio configurations associated with product language convergence strategies

| Designer portfolio characteristics | Product language convergence | |
|---|---|---|
| | *Local ambassador archetype* | *International bridge archetype* |
| Outsourcing | Low | **High** |
| Size | Low | Low |
| Concentration | **High** | **High** |
| Popularity | Low | Low |
| Sharing | | **High** |
| International rooting | Low | **High** |
| *Example of best fit case* | *Martinelli* | *Artemide* |
| Total coverage | 0.514 | |
| Total consistency | 1.000 | |

Blank space = irrelevant

**Table 5:** Designer portfolio configurations associated with product language divergence strategies

| Product language strategy | Designer portfolio archetype | Characteristics | Logics |
|---|---|---|---|
| **Divergence** | *International design-star archetype* | *Outsourcing*<br>*Large size**<br>**High concentration**<br>**Popular designers**<br>*Not shared designers*<br>**Internationally rooted designers** | *Designer portfolio aimed at searching unique product language solutions*<br>*High degree of freedom for designers*<br>*High possibility for the firm to fully appropriate the design activity results*<br>**Exploitation of the popularity of highly recognized international designers** |
| | *Crowd design-innovator archetype* | *Outsourcing*<br>*Large size**<br>**Low concentration**<br>**Not popular designers**<br>*Not shared designers* | *Designer portfolio aimed at searching unique product language solutions*<br>*High degree of freedom for designers*<br>*High possibility for the firm to fully appropriate the design activity results*<br>**Exploitation of the variety of product language solutions** |
| **Convergence** | *Local ambassador archetype* | **Insourcing**<br>*Small size**<br>*High concentration*<br>*Not popular designers*<br>**Nationally rooted designers** | *Designer portfolio aimed at the participation to product language discourse*<br>*High possibility of control for firm's managers*<br>**Conveyance of firm's internal design choices**<br>**Exploitation of the localness** |
| | *International bridge archetype* | **Outsourcing**<br>*Small size**<br>*High concentration*<br>*Not popular designers*<br>**Shared designers**<br>**Internationally rooted designers** | *Designer portfolio aimed at the participation to product language discourse*<br>*High possibility of control for firm's managers*<br>**Diffusion of design elements through shared designers**<br>**Exploitation of the international exposure** |

* Compared to the number of products

The traits and logics shared by the designer portfolio configurations for a divergence and a convergence product language strategy are highlighted in italics, the differentiating traits and logics in bold.

**Table C1:** Summary of calibration criteria and breakpoint values

| | | Breakpoint values | | |
|---|---|---|---|---|
| | **Criteria** | **Minimum** | **Maximum** | **Cross-over** |
| Outsourcing | Cross-over = intermediate value of the variable | 0.0 | 1.0 | 0.5 |
| Concentration | Minimum=minimum value of the variable | 0.0 | 1.0 | 0.5 |
| Sharing | Maximum=maximum value of the variable | 0.0 | 1.0 | 0.5 |
| International rooting | Cross-over = proportion of international designers in the sample<br>Minimum=minimum value of the variable<br>Maximum=maximum value of the variable | 0.0 | 1.0 | 0.11 |
| Popularity | Cross-over= average designer popularity<br>Minimum=minimum value of the variable<br>Maximum=values above the cross-over + 1 std. deviation | 0.0 | 3.27 | 1.0 |
| Size | Rank ordered procedure | 0.216 | 0.800 | |
| Convergence/Divergence | | 0.606 | 0.731 | |

**Appendix A**

To apply QCA, each observed case must be described according to multiple variables that are coded either as dichotomous (i.e., 0 or 1) or as fuzzy (i.e., included in a range from 0 to 1). In the case of dichotomous variables, each variable measures the presence (i.e., value of 1) or the exclusion (i.e., value of 0) of each observed subject in the set of subjects presenting a certain trait. In the case of fuzzy variables, each variable measures the degree of belonging of each case to the set of subjects sharing a certain trait. Values above the threshold of 0.5 denote that a certain case is more inside than outside of the set, whereas values below the threshold denote that a certain case is more outside than inside of the set.

In this paper, variables are fuzzy; therefore, measures of both causal variables (i.e., measures related to designer portfolio characteristics) and the outcome variable (i.e., the degree of product language convergence/divergence) were converted into fuzzy scores that range between 0 and 1.

Fuzzy variables pinpoint the qualitative state of an observed case by assessing the degree of inclusion/exclusion from a given set. Thus, each variable must be calibrated to reflect the degree of membership.

As noted in the literature, calibration requires substantive knowledge and is possible only through specific theoretical and empirical speculations regarding the possible values that a variable can assume. More specifically, it is essential that three qualitative breakpoints be clearly specified: full membership in a given set (a fuzzy value of 1), full non-membership in a given set (a fuzzy value of 0) and the crossover point at which there is maximum ambiguity regarding the inclusion or exclusion of a case from that set (a fuzzy value of 0.5) (Rihoux and Ragin, 2009).

Accordingly, the variables used to analyze the convergence/divergence of product languages and the designer portfolio characteristics were carefully calibrated.

After variables have been coded as fuzzy set variables, the next step in QCA is to build all possible configurations of predictors and measure the level of membership of the observed cases in each configuration. It is customary to label predictors with a capital letter (e.g., A) to signify the level of a case's membership in a set and a lowercase letter (e.g., a) to denote its exclusion (i.e., 1-A). Belonging to a given configuration is calculated using a minimum operator. For example, given two predictors A and B, membership in the configuration that combines A and B will be A · B = min (A, B), whereas the configuration is a · B = min (1- A, B).

The next step is to evaluate whether each configuration can be considered a subset of a given outcome by calculating its fuzzy set theoretic consistency as follows (Ragin, 2006):

$$(2)\ CON_{X,Y} = \sum \min\left(x_i, y_i\right) / \sum x_i$$

where X is the predictor configuration, Y is the outcome set, $x_i$ measures the membership of case *i* in configuration X and $y_i$ represents its membership in set Y.

Values closer to 1 indicate that the observed cases have membership scores in Y that are higher than the membership scores in X (e.g., $x_i = 0.8$ and $y_i = 0.9$ for the *ith* case). In turn, this result implies stronger consistency in the assertion that X is a subset of Y, that is, "if X then Y."

Different methods can be used to determine whether a configuration X should be considered a sufficient condition for Y.

In this paper, a comparison between the consistency of X in Y and a threshold value that is set at 0.9, following Ragin (2006), is applied. Consistency is calculated according to (2). In this manner, we can distinguish configurations that are highly consistent with a certain product language strategy (convergence or divergence) from those that are not consistent with that strategy.

The last step in QCA involves transforming the analytical solution into a parsimonious solution by adopting a reduction algorithm that eliminates redundant conditions. More specifically, it is possible to remove solutions that present similar configurations and differ only for the state of one specific set using the Quine and McCluskey algorithm (Longest and Vaisey, 2008). For example, if two configurations ABC and ABc are both sufficient conditions, then the algorithm will display only AB because both C and not-C (i.e., c) can be eliminated.

**Appendix B**

According to Chen and Owen (1997), stylistic features are psychological qualities of products that are perceived by an individual and can be captured using a semantic differential analysis based on an appropriate set of polar adjective pairs. The vector of the values assigned to each polar adjective pair represents the product's style profile. Given two products, the distance between their vectors is a proxy for the differences between their styles.

To analyze the style profile of the LED products offered by the 9 firms in the sample, we adapted the original assessment tool developed by Chen and Owen (1997) to the peculiarities of the lighting sector. More specifically, we first asked four experts to suggest the changes necessary to better analyze lighting products. The experts suggested minor changes that involved better specifying some attributes that were ambiguous in the context of lighting.

Second, we tested the tool's reliability. For this purpose, we recruited two raters who are expert in the design field. The raters were trained on the use of the assessment tool by reading the original work of Chen and Owen (1997) and discussing the meaning to be assigned to each item in the tool. Both raters separately evaluated a common set of 50 randomly chosen products, and their assessments were compared using Cohen's Kappa inter-rater reliability test. Following previous studies, items with Kappa values that were not statistically significant and below the threshold of 0.2 were removed from the tool (Banerjee *et al.*, 1999; Durand, 2003; Jakobsson and Westergren, 2005; Landis and Koch, 1977). The two raters were then asked to

evaluate another set of randomly selected products and to discuss each evaluation to remove any discrepancy in the use of the tool (Bernardin and Buckley, 1981). The process was reiterated until all misalignments were resolved. After the reliability assessment phase, the tool consisted of five categories, each of them as articulated by the following polar adjective pairs:

(i) Form Elements: harmonious-contrasting, homogeneous-heterogeneous, geometric-biomorphic, simple-complex, and balanced-unstable;
(ii) Joining Relationships: monolithic-fragmentary, self-evident–hidden, and static-dynamic;
(iii) Detail Treatments: uniform-multiform and angular-rounded;
(iv) Textures: harmonious-contrasting; and
(v) Color Treatments: harmonious-contrasting, single-multiple, and cool-warm.

Finally, the two raters were asked to use the revised tool to evaluate the entire sample of products considered in the study.

After the style profile assessment, the style profile distance was calculated.

According to Chen and Owen (1997), the style distance between product *x* and product *y*, each of which is characterized by a vector of n attributes, can be calculated as follows:

$$d_{x,y} = \sqrt{\sum_{i=1}^{n} (Ax_i - Ay_i)^2}$$

where $d_{x,y}$ represents the distance between the style profiles of product *x* and product *y*, $Ax_i$ and $Ay_i$ represent the value of the i*th* attribute for product *x* and product *y*, respectively, and *n* represents the total number of attributes. Using a six-point Likert scale, the two researchers in the field of design assessed the products. The values were normalized to a range from 0 to 1, and consequently, $d_{x,y}$ varies from 0 for two identical products to √14 = 3,7416 for two products that show the maximum difference in all the attributes.

**Appendix C**

According to Rihoux and Ragin (2009) "(…) fuzzy set membership scores do not simply rank cases relative to each other. Rather, fuzzy sets pinpoint qualitative states while at the same time assessing varying degrees of membership between full inclusion and full exclusion. In this sense, a fuzzy set can be seen as a continuous variable that has been purposefully calibrated to indicate degree of membership in a well-defined set." Such calibration requires the use of theoretical and substantive knowledge to identify the qualitative breakpoints at which a case can be considered a full member of a given set (e.g., the set of design-outsourcing firms), a full non-member or a member at the crossover point where there is maximum ambiguity about whether a case must be considered more inside or outside the given set.

Therefore, for each causal variable and for the outcome variable, different breakpoints were identified and used to transform the original values of variables in fuzzy set scores.

The variables *Outsourcing*, *Concentration* and *Sharing* all range from 0 to 1. A value of 0 of Outsourcing implies that external designers designed none of a firm's products, whereas a value of 1 means that external designers designed all of a firm's products. Accordingly, a value of 0.5 of the variable implies that external designers designed only half of a firm's products. These values can be easily used as breakpoints to mark a firm's belonging to or excluded from the set of outsourcing firms. Indeed, a firm with a value of Outsourcing of 1 can also be considered fully included in the set of outsourcing firms and so can obtain a fuzzy score of 1. Conversely, a firm with a value of 0 can be considered fully excluded from the set of outsourcing firms and so can obtain the corresponding fuzzy score of 0. Finally, maximum ambiguity is observed for firms that having a value of the variable of 0.5, neither are in the set of outsourcing firms nor are excluded from that set. These firms can therefore obtain the corresponding fuzzy set score of 0.5.

Similar reasoning is possible for the variables Concentration and Sharing. For Concentration, a value of 0 implies that the activity of designing a firm's product language was equally distributed among the firm's designers, whereas a value of 1 implies that the effort to design all products was concentrated in one designer. Finally, a variable's value of 0.5 means that the effort to design the firm's products portfolio was neither concentrated nor distributed. As for Outsourcing, the values of 0, 1 and 0.5 can be assumed to be anchors to convert Concentration values to their corresponding fuzzy scores. Firms with a Concentration of 1 are those that fully belong to the set of firms that concentrate to the maximum extent the design of the product portfolio. Thus, these firms can obtain a fuzzy score of 1. Conversely, firms with a Concentration of 0 can be assumed to be fully excluded from the set of design-concentrating firms; therefore, these firms can obtain a fuzzy score of 0. Maximum ambiguity is registered for firms with an intermediate concentration of 0.5—that being at the crossover point—can also obtain the 0.5 fuzzy score.

For Sharing, a value of 0 means that designers not shared with other firms designed all of a firm's products. Conversely, a value of 1 implies that designers shared with other firms designed all of a firm's products. The intermediate value of Sharing, i.e., a value of 0.5, implies that designers who also work for other firms in the

industry, designed half of a firm's products. Thus, as for Openness, the values of 0, 1 and 0.5 can also be considered as anchors to calibrate the corresponding fuzzy set variable. Firms with Sharing equal to 1 can be considered as fully included in the set of firms that tend to create cross-ties with other firms in the industry. Therefore, these firms can obtain the maximum fuzzy score of 1. Conversely, firms with Sharing of 0 can be considered as fully excluded from the set of firms that have cross-ties with other firms and therefore can obtain a fuzzy score of 0. At a value of 0.5, there is the maximum ambiguity whether the firm is oriented toward creating cross-ties with other firms in the industry. Thus, the corresponding crossover fuzzy score of 0.5 can be assigned to this firm.

The variable International rooting also ranges from 0 to 1. A value of 1 means that a firm's products are all designed by designers with an international professional background, whereas a value of 0 implies that products are all designed by designers with a national background. A value of 0.5 would mean that international designers designed half of a firm's products. However, this value cannot be reliably used as the threshold to identify firms that with maximum ambiguity are oriented toward neither national nor international designers. Indeed, given the structure of the Italian job market, the proportion between international and national designers that are available for a firm, which without any particular preference would randomly select designers, is very biased in favor of the latter. Therefore, a more meaningful anchor to assign firms the intermediate fuzzy score of 0.5 would be the average proportion of designers with an international background who were used in the Italian decorative lighting industry to design LED-based products. Considering that the firms included in our study are all the universe of the early adopters of the LED technology in the period 2007-2011, we estimated this value by considering the ratio of international designers to the total of 55 designers employed by these firms, obtaining a value of 0.11. Therefore, a firm with a value of International rooting of 0.11 is a firm whose products are designed by a designer portfolio that exactly replicates the average observed proportion between international and national designers employed at that time by all LED adopters for the development of LED-based lamps. Therefore, this firm can be assumed to have no preference when engaging designers. This value can therefore be used as a cross-over point to identify those firms that, being neither in the set nor outside the set of firms oriented toward international designers, can be assigned a fuzzy score of 0.5. The robustness of the threshold was tested slightly by increasing and decreasing its value and verifying that results did not change.

A similar logic was adopted to calibrate the variable Popularity.

Popularity is a variable with a theoretical minimum of 0 and a maximum that is not given. Indeed, the number of positive Google citations that a designer receives can be very large and theoretically infinite. Therefore, the minimum of 0, for firms that employ entirely unknown designers, can be used as an anchor to set the minimum fuzzy score of 0. The cross-over point and the maximum value threshold must both be estimated.

To estimate these thresholds, as for International rooting, we used the set of all designers employed by the firms included in this study. We calculated the average value of Popularity and its standard deviation. We

obtained a mean value of 1 (because Popularity is normalized with the overall mean) and a standard deviation of 2.27. The average of Popularity was then used as cross-over point assuming that a firm engaging designers randomly—i.e. without any preference for famous or unknown designers—would have a designer portfolio with that level of popularity. Therefore, firms with a value of Popularity equal to 1 were assigned a fuzzy score of 0.5, which indicates that these firms are neither inside nor outside the set of firms that prefer highly renowned designers. The average Popularity plus one time the standard deviation was used as the upper threshold to identify all firms that are in the right tail of the distribution and therefore are biased toward famous designers. Thus, firms with a value of Popularity equal to or higher than the threshold were assigned a fuzzy score of 1 that means full inclusion in the set of firms that prefer famous designers. The robustness of both breakpoints was tested by slightly changing their values and determining that the results did not change.

The variables Size and Convergence/Divergence were both calibrated by using a rank ordered procedure that, starting from the extreme values, assigns the fuzzy scores based on the ranking of variable values (Longest and Vaisey, 2008). As extreme values, the minimum and maximum of the variable observed in the universe of early-adopter firms of the LED technology were used.

The minimum of Size is 0.216 and the maximum is 0.800. Thus, we assumed these values as the extreme of the range and as anchors to calibrate the corresponding fuzzy set scores. The firms with the maximum value were assigned a fuzzy score of 1 to signify their full inclusion in the set of firms that choose a large designer portfolio; the firms with the minimum value were assigned a fuzzy score of 0 to signify their exclusion from that set. Using Longest and Vaisey's (2008) procedure, firms with intermediate values were assigned the corresponding fuzzy scores based on their ranking.

A similar procedure adopted adopter for the variable Convergence/Divergence. The minimum value of the variable is 0.606 for the firm that shows the lowest level of product language divergence with other firms (highest of product language convergence) and a maximum value of 0.731 for the firm that shows the highest level of product language divergence (lowest of product language convergence). These values can thus be assumed as the endpoints to calibrate the corresponding fuzzy set scores. Firms with the minimum value of the variable Convergence/Divergence were assigned a fuzzy score of 1 to signify their full inclusion in the set of converging firms. Conversely, firms with the maximum value of the variable Convergence/Divergence were assigned a fuzzy score of 0 to signify their full exclusion in the set of design converging firms. Firms with intermediate values were assigned corresponding to fuzzy set scores based on their ranking.

Subtracting by 1 the convergence fuzzy scores, the corresponding divergence fuzzy scores were obtained.

Table C1 summarizes the criteria and breakpoint values used to calibrate the variables analyzed in the study.

[PLEASE INSERT TABLE C1 ABOUT HERE]