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An exploratory review of the design literature: Gaps and avenues for future research

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An exploratory review of the design literature: gaps and avenues for future research

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Abstract
The importance of design has been recognised by scholars from different fields such as artificial sciences and engineering, innovation, arts and creativity and management. Despite a shared understanding of the role of design as a potential enabler of innovation, it still acknowledges a wide range of meanings for two main reasons: the differing motivation underpinning a design project (from purely artistic to purely engineering, problem-solving) and the types of knowledge design can rely on (e.g., rational and calculative knowledge for engineering designers; subjective and expressive knowledge for graphic designers). It appears difficult to draw boundaries within the design field and identify a criterion for a clear-cut differentiation, yet most of the available definitions seem to share three attributes: design may refer to a process, which is goal-oriented; and the set of goals consists of solving problems, improving situations, or creating something new. The paper reviews the extant design literature and contributes to it by providing a structure for a deeper understanding of design. It emphasises: (i) the passage design has undergone from as expressing certain product specifications to being an important tool that can shape firms' strategy, and (ii) the extent to which both organisational and institutional factors have contributed to this process. It concludes by identifying the gaps within the literature that deserve further attention.

Keywords
Design, literature review, design science, design activity, design industry, design management.

JEL Classification

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The opinions expressed in this paper are those of the author. The usual caveat applies.

1. Introduction

This review paper intends to build up a multi-faceted view of the literature on design, a value-creating activity that has the potential of contributing significantly to firms' competitiveness (Roy, 1990, Walsh et al., 1992, Walsh, 1996). The paper's contribution is twofold: first, the review lends transparency to the current literature by identifying the key streams of thought in the field of design, either with an engineering, strategic scope or a purely artistic one. Second, the paper seeks to identify the major themes within the literature that could be object of future investigation. With this remit Section 2 identifies the meaning of design in different contexts: as a tool for scientific and methodological development (Section 2.1), as a concern of management teams (Section 2.2); and as an emerging creative industry (Section 2.3). While there seems to be agreement on the fact that design influences positively the growth of firms and industries, where the specialised knowledge for design is generated and how this is utilised for the sake of innovation still remain largely unexplored. In response, Section 3 summarises the contemporary theoretical and empirical research and discusses some promising avenues for future investigation. Section 4 draws some conclusions.

1. A proposed line to inquire about design

The importance of design has been recognised by scholars from different fields such as artificial sciences and engineering (Simon, 1969, March and Smith, 1995, Hevner et al., 2004), innovation and aesthetics (Petroski, 1996, Walsh, 1996, Verganti, 2003), management (Dumas and Mintzberg, 1989, Walsh et al., 1992, Cooper and Press, 1995), arts and creativity (Olins, 1986, Sparke, 1986, Potts and Cunningham, 2008, Potts, 2009). Despite a shared understanding of the role of design as a potential enabler of innovation, it still acknowledges a wide range of meanings for two main reasons: the differing motivation underpinning a design project (from purely artistic to purely engineering, problem-solving) and the types of knowledge design can rely on (e.g., rational and calculative knowledge for engineering designers; subjective and expressive knowledge for graphic designers).

It is suggested that a starting point consists of looking at the semantics of the term 'design', whose etymology is the Latin 'de + signare' and refers to "making something, distinguishing

it by a sign, giving it significance, designating its relation to other things, owners, users or goods" (Verganti, 2003:157). Design can be a noun or a verb, that is, "a product which has been made by humans may be referred to as 'a design', while the activity that produced this product is the act of 'designing'" (Beltagui et al., 2008:5). It follows that design should not be an isolated function within a company, but rather it should engage with the different business functions of the firm and contribute to developing the experience of the end consumer.

It appears difficult to draw boundaries within the design field and identify criteria for a clear-cut differentiation, yet most of the available definitions seem to share three attributes: (i) the word design refers to a process, (ii) this process is goal-oriented, and (iii) the set of goals consists of solving problems, meeting specific needs, improving situations, or creating something new or useful (Friedman, 2003).

From this perspective, the aim of this paper is twofold: first, it seeks to review the extant design literature and second, the review has the ambition to contribute to the design literature by segmenting it in disciplinary areas and providing a standard frame of reference which design scholars, amongst others, can refer to. There have already been some attempts to review such literature (Beltagui et al., 2008, Ralph and Wand, 2009, Le Masson et al., 2011, Luchs and Swan, 2011), yet these studies address the interests of specific audiences and tend to overlook others. Beltagui et al. (2008) reviewed the definitions of design and proposed a model in which design is conceived as combining elements of art, science and technology, all of which are applied to the problem creatively in order to achieve a desired result, and as requiring predictions of the future, for instance with regard to customers' tastes. On another account, Ralph and Wand (2009) developed a formal definition of the 'design' concept and proposed a conceptual model that links concepts related to design projects. The definition provided by Ralph and Wand includes agent, object, environment, goals, primitives, requirements and constraints. The design project conceptual model is based on the view that projects are temporal trajectories of work systems, which include human agents who work to design systems for stakeholders and use resources and tools to accomplish this task. The ultimate scope of their model is to classify design knowledge and design approaches and facilitate future research on design phenomena. Yet, their focus is mainly on creating a set of concepts that can guide practices

and education within the specific domains of information systems and software design. Le Masson et al. (2011) analyse the relationship between creativity issues and design theory and point to the dialectical interplay that links them, structured around the notion of 'fixation effect'. By reviewing different design theories, they argue that those could open new paths for reflecting on innovation management. By considering the design literature relevant to marketing, Luchs and Swan (2011) reviewed the articles on product design published in eight leading journals and offered a definition for product design and product design process. In this latter instance, the review and the authors' recommendations are confined to marketing and, although relevant (Bonnet, 1986, Black and Baker, 1987, Bruce and Biemans, 1995, Beverland, 2005, Luchs and Swan, 2011), may not be enough to explore the problem-solving and analytical function played by design. Finally, Ravasi and Stigliani (2012) review the literature on product design within the business studies domain. They draw attention to established and emerging perspectives of approaching the literature and propose a segmentation based on three core areas, which correspond to three different stages of the design process, that is: design activities, design choices and design results. In general, the authors argue that management scholars possess conceptual and methodological tools suited to enriching, amongst many, two relevant issues: the construction and deployment of design capabilities and the organisational and institutional context of design activities (Ravasi and Stigliani, 2012).

In general, researchers have developed a wide range of theories about designing and designs across a large number of disciplinary areas (Love, 2002). This review introduces a segmentation of the literature that could capture how different groups of interest have interpreted design and assigned specific meanings to it. More specifically it concentrates on analysing design at three main levels: design at product/process level, which emphasises the engineering element of design and the efforts made to develop a science of design; design at firm level, which focuses on the managerial issues attached to the coordination and exploitation of design for the aims of improving firm performance and competitiveness; design at industry level, which intends to grasp the industry element of design and its establishment as a creative industry (Table 1).

Table 1: A structure to the extant design literature

A Design as a process/product
A.1 Developing a science (theory) of design
A.2 The 'engineering component' of design
B Design as a management concern
B.1 Design and firms' competitiveness
B.2 Design and firms' organisational structure
B.3 Design and firms' strategy
C Design as a creative industry

In focusing on three different levels (i.e., design as a process/product of engineering science, design as a management concern, and design as a creative industry) this section draws upon a series of consideration which have supported the process of splitting the literature in sub-areas. First, in moving from Group A to Group C, the meaning of design moves from one extreme, engineering, which conceives design as the product or process of engineering thinking (Section 2.1) to the other extreme, aesthetics, which conceives design as the expression of individual or collective creativity (Section 2.3). In between, the research included in Group B regards a set of managerial aspects about the coordination and exploitation of design in an organisational context (Section 2.2).

Second, it is possible to notice that the literature included in the different sub-groups is tackled by specific research communities, namely: in Group A scholars belong mainly to the research communities of Information System and Engineering Design whose interest focuses on design at either product or process level; in Group B, management scholars from different fields (e.g., growth of the firm, decision-making, organisational design and behaviour) tend to focus on the design issues at firm level. Finally, industrial and policy economists in Group C pay attention to the importance of design as a creative industry and explore how it could shape the innovativeness and competitiveness of a given economy.

In general, the proposed structure offers an overarching understanding of design to the extent that it ties together the numerous facets of the design activity and may potentially complement one's background on some aspects (e.g., input of design to firm competitiveness) with others similarly relevant (e.g., industry dynamics such as technology

advancements or professional associations that a firm can impinge on by undertaking design activities). It follows a wider awareness of how design impacts on innovation processes and growth at different levels.

Methodological note

Despite the fact that the review does not aim to be totally comprehensive, Table 1 develops a basic framework around which future research could be positioned. The literature review supporting this structure is included in Table A.1 (Appendix A), which specifies, for each of the contributions, the following details: type of source (e.g., book, journal, etc.), name of the source, and keywords provided by the authors (where lacking, these were identified based on the content of the publication). Unsurprisingly, there are some overlaps across the different dimensions and some contributions could easily be included under more than one category.

The selection of the literature partly follows a genealogical Foucauldian approach in the sense that the concern is not about writing the history of a particular subject, rather to diagnose or understand the present. As Foucault puts it, it is about writing "the history of the present" (Foucault, 1993:31). To this aim, this review discusses how design evolved from a product-level matter to a concern for firms, and then industries, and how the underpinning body of knowledge has developed throughout this process. In fact, it is possible to notice how the profile of the professionals acting within each domain changes: from engineers within the product engineering domain, to architects or industrial designers in a firm context, to artists when the focus shifts to the industry dimension of design as a creative activity.

1.1 Design as a process/product

This section reviews the stream within the design literature that focuses on design as an engineering process based on which a science can be constructed (Section 2.1.1) and design as a product of engineering knowledge, which leads to the creation of information systems, software and design methods (Section 2.1.2).

2.1.1. Developing a science (theory) of design

It appears that publications by designers date back to Roman times, notably by Vitruvius;[1] however, it was not until the 1960s that major research programmes were initiated. These programmes were initially founded by the systems view and used concepts from operations research (Jones and Thornley, 1963). A desire to 'scientise' design can be traced back to the twentieth century Modern Movement in design, when the protagonists for the movement espoused a desire to produce works of art and design based on objectivity and rationality, that is, on the values of science (Cross, 2000). In fact, a serious debate on design as worthy of in-depth, scientific investigation was triggered in the early 1960s with two conferences. The first one held in London in 1962 and a second one held in Birmingham in 1965 (Maffei, 2010). The term 'design science' was officially introduced by Gregory (1966a) who proposed that "design science is concerned with the study, investigation and accumulation of knowledge about the design process and its constituent operations. It aims to collect, organise and improve those aspects of thought and information which are available concerning design, and to specify and carry out research in those areas of design in which are likely to be of value to practical designers and design organisations" (Gregory, 1966b:123). In any case, Simon's (1969) *Sciences of the Artificial* is the landmark contribution that considers the natures of the disciplines as dealing with phenomena that are artefacts. As he warns us, "we need a science of design – intellectually tough, analytic, partly formalisable, partly empirical and teachable" (Simon, 1969:xii). Despite the fact that a few decades have passed since then, a unified body of knowledge and theory about designing and designs has not emerged yet. Love (2002) argues that this would generate adverse consequences, namely: theoretical conflicts between researchers, especially those working in different domains; difficulties in validating theories against their ontological, epistemological and theoretical contexts; a lack of clarity about the scope, bounds and foci of fields of research and theory-making about designing and designs (Love, 2002). This multi-disciplinarity is proven by the fact that the research conducted in the field of design relies upon a diverse set of disciplines. To mention an example, Ulrich (1995) assesses the role of product architecture in the manufacturing firm by looking for linkages between the architecture of the product and five areas of managerial relevance, that is: product change,

[1] Vitruvius was a Roman writer, architect and engineer, active in the first century BC. He is best known as the author of the multi-volume work *De Architectura* ("On Architecture").

product variety, component standardisation, product performance and product development management.

Provided that a science of design would rely on a cross-disciplinary approach, scholars agree that such a science is directed to create things that serve human purposes (March and Smith, 1995, Love, 2002), so that design emerges as a key activity in practice-oriented domains such as architecture, engineering and urban planning (Schön, 1993). Design courses were first introduced within engineering graduate courses in order to teach students how to solve open-ended problems, bridging the gap between solution strategies that are effective for the science and mathematics courses, and those needed to solve open-ended engineering problems (Starkey et al., 1994, Director et al., 1995).

March and Smith (1995) emphasise that design science, along with natural science, are important to ensure that research on information technologies (what these sciences focus on) is both relevant and effective. In their opinion, the products of design science are of four types: constructs, models, methods, and implementations. There is a need for a basic language of concepts (i.e., constructs) which are combined in higher order constructions, often termed models, in order to describe tasks, situations or artefacts; moreover design scientists develop methods as a way to perform goal-direct activities, and implement these in specific products or tasks. Unlike natural sciences, where this list is complemented by the development of theories, the major scope of design science is "to create models, methods and implementations that are innovative and valuable" (March and Smith, 1995:254).

Design science research has become an accepted mode of research within the Information Systems discipline, though the boundaries and contours remain fuzzy due to the (perceived or real) distinction between 'doing design' and 'studying design' (Purao et al., 2009:4). In fact, this path of research had already been explored by scholars working on the notion of Artificial Intelligence (AI), which concerns the study and design of intelligent agents. Despite a forerunner contribution to both the logicist tradition in AI and the connectionist tradition generated in the early 1940s (McCulloch and Pitts, 1943), it is only in the mid-1960s that the theme of AI attracts most of the attention and AI systems emerge as those systems that "either think or act like humans, think or act rationally" (Russell and Norvig, 1995:5). Not surprisingly, the period overlaps with the increasing attention towards a science of design, and the need to construct a common basis of understanding the generation and

development of artefacts for solving problems. Is there a science of design as of yet? The question remains unanswered and is continuing to attract scholars' attention in the design and cognitive sciences.

2.1.2. The 'engineering component' of design

Design science has its roots in engineering and the sciences of the artificial (Simon, 1969) and consists of two basic activities, building and evaluation. Building is the process of constructing an artefact for a specific purpose while evaluation is the process of determining how well the artefact performs (March and Smith, 1995). Put differently, design is a problem-solving activity that involves the definition of the problem, the identification and generation of alternative solutions, and the evaluation and selection of the most suitable one. In order to make these decisions, designers must rely on their skills and experience, which can remain tacit in nature or instead, be codified and implemented through procedures and manuals. Petroski (1996) for instance, in his book *Invention by design: how engineers get from thought to thing* describes a few cases of inventions and illustrates how articulate and complex knowledge is made explicit and applied for the appropriation of added value. Despite the fact that design is endemic to many professions and it constitutes an important process, it is not always possible to codify this type of knowledge, or make it less implicit (Hevner et al., 2004).

Many design activities within the Information Systems discipline have been extensively studied, formalised, and transformed into routine. Engineering design finds its reason of existence in the need to capture such knowledge, to give it a structure and to make it accessible in a form that can be readily interrogated and used to support decision-making and problem-solving (Edwards, 1994). Engineering design can be discussed at different levels of abstraction, leading to stratification around engineering design science, namely: general epistemology, engineering design epistemology, engineering design science, engineering design methodics, engineering design practice. Designers do not act at random despite the creative and intuitive nature of their activity, but they use more or less sophisticated methods to structure their design operations and make their creativity and intuition function within the framework of their methodical approach (Eekels, 2000). A practical consideration coming from these operations is the judgement, which can then be extended over all the branches of engineering. Engineering devices are by definition made

to be used, and feedback of knowledge from use to design is essential, because it generates experience that will take the form of design rules of thumb or other types of statements (Vincenti, 1990).

This line of argument has triggered further interest towards specific techniques and methods that designers use to represent design as a process, i.e., prototypes. These have emerged as the schemas that support the initiation and continuation of the act of designing (Gero, 1990). In Gero's view, "a design prototype is a conceptual schema for representing a class of generalised heterogeneous grouping of elements derived from alike design cases that provides the basis for the start and continuation of a design" (1990:35). In summary, prototypes are useful because the designer or other members of the product development team can rely on a first model to make further improvements. Beyond the mere product architecture, prototypes can also be used to carry out experiments, a form of problem-solving that is fundamental to innovation (Rosenberg, 1982). The advent of new technologies has amplified the benefits of prototypes. Thomke et al. (1998) have shown how experimentation in manufacturing organisations has been radically affected by the introduction of software-based methods and technologies such as computer simulations and rapid prototyping. More generally, virtual prototyping techniques have proven to be effective in facilitating multi-functional processes coordination and multi-disciplinary knowledge integration (D'Adderio, 2001).

In switching the focus to a manufacturing context, the term 'engineering design' has often been analysed in comparison with the term 'industrial design'. On the one hand, it is said that as practiced, engineering is too limited in its scope; if only engineering were wider in compass, there would be no need for industrial design (Moody, 1980). On the other hand, industrial design is conceived as an integral part of the wider notion of engineering that brings a set of skills, knowledge and understanding to the creation and production of useful artefacts (Torbett et al., 2001). Strictly speaking however, engineering, the art of translating engineering knowledge into practical works, *is* design, i.e., the art of assigning a mark, or meaning to a given object. Moody (1980) adds that this may be one of the reasons why most universities initially refused to accord engineering design a separate identity. This attitude experienced a change with the increasing recognition that engineering design knowledge is embedded in individuals and organisations (Petroski, 1985, 1994, Braha and

Maimon, 1997), and therefore the emergence of an organisational identity for design triggered the rising of new design disciplines such as product design, graphic design, fashion design, interaction design, etc. This latter dimension has become particularly relevant in the context of organisational studies and paved the way to a strand of research on the contribution of design in its various shapes to innovation processes. Following this perspective, Section 2.2 below reviews the literature centred on the role of design as an integral part of firms' growth and competitiveness.

1.2 Design as a management concern

It is widely accepted that there is a strong mutual relationship between a firm's choice of a strategy and its environment and, given its strategy, between the types of product and process innovations developed by a firm and the specific capabilities that are deployed for this aim (Utterback and Abernathy, 1975). In this light, design has emerged as an important component of firms' strategic approach and competitiveness because it allows the synthesis and integration of external knowledge with a firm's organisational capabilities. Major empirical studies dating back to the 1970-80s illustrated how the integration of specialised activities such as design and manufacturing constitutes an essential element of innovation success (Gardiner and Rothwell, 1985, Cooper and Kleinschmidt, 1986, Johne and Snelson, 1988). Since the early 1990s, scholars' attention began to focus on how the design activity could influence firms' decision-making and their efforts to build a competitive advantage.

Although there is a general agreement on the fact that design influences firms' competitiveness, scholarly contribution has developed in different directions, namely: the impact of design on firms' performance; the tension between internalising the design activity and outsourcing it and the subsequent shaping of the organisational structure; the role of design in the context of a firm's innovation strategy (categories B.1, B.2 and B.3 in Table 1). This criteria of grouping is partly in line with Cooper and Kleinschmidt's (1995) argument according to which a company's overall new product performance depends on the new product development (NPD) process and the specific activities within this process, the organisation of the NPD programme and the firm's NPD strategy together with the senior management commitment to it. The following subsections dig into these aspects in depth.

1.2.1 Design and firm's competitiveness

Design is an important tool in industrial competition because it facilitates product differentiation (Wasserman, 1990). Scholars have investigated the influence of design on firm competitiveness. A first major initiative aiming to promote and evaluate the use of professional design expertise in small and medium-sized firms across the UK has been the Funded Consultancy Scheme/Support for Design (FCS/SFD) programme, launched by the British Government in the 1980s, and which led to numerous reports and academic journal articles (Walsh, 1983, Walsh and Roy, 1983, Roy et al., 1986, Potter et al., 1991, Walsh et al., 1992). These concur that product design impacts both price and non-price factors such as product performance, ease of use, durability and product delivery. Moreover, design plays an important role in the realisation of both radical and incremental innovations (Walsh, 1996), and more specifically technological innovation (Trueman and Jobber, 1998, Dell'Era and Verganti, 2009). Further contributions have regarded the relationship between design effectiveness and corporate performance (Gemser and Leenders, 2001, Hertenstein et al., 2005) or the role of design as a source of innovation (Filippetti, 2011). Yet, it is suggested that the impact of industrial design on company performance may depend on the skills and talents of the designers involved (Gemser and Leenders, 2001).

Due to the knowledge-intensity of design activities, it is difficult to capture how design is integrated with firms' existing practices and strategy building. In the context of this review it is suggested that additional research is needed in this direction, with particular emphasis on the likely deployment of organisational routines and capabilities that would favour the embeddedness of design know-how.

1.2.2 Design and firm's organisational structure

The practical implementation of design within the matrix of firms' activities entails three options: (i) outsourcing, (ii) in-house development of the relevant expertise, or (iii) a combination of the previous two (von Stamm, 2008). Interestingly, on the one hand, there are barriers to use external designers because of the high costs involved, while on the other hand, there is no vade mecum as to where the design activity should be located within or outside organisational boundaries. In some firms the designer can act as the art director and address the direction of the firm's growth, in other cases professional designers are only one piece of the puzzle amongst all the others (Ulrich and Eppinger, 1995). Partly due to the creative and implicit nature of design, organisations may also fail to understand design, and

rather than considering it as a crucial underpinning or core of the product development process, they associate it mainly with aesthetics and styling.

Notwithstanding these options, existing research into design management, both of theoretical (Dumas and Mintzberg, 1989, Bruce and Morris, 1994, Walsh, 1996) and empirical (Dickson et al., 1995, Roy and Riedel, 1997, Bruce et al., 1999, Ahire and Dreyfus, 2000, Perks et al., 2005) nature is still scarce. Dumas and Whitfield (1989) have investigated practices and attitudes towards the management of design in British industry and the major findings were the existence of four distinct types of company, each with their own approach to design and the pronounced effect a design manager has upon attitudes within a company. They conclude that, unlike the case of technology developments, design developments are not clear-cut and companies struggle to manage them. Other scholars have emphasised the difficulty of managing the relationship between manufacturers and professional designers (Ravasi and Lojacono, 2005, Ravasi et al., 2008). Filippetti (2010) has emphasised that very often designers are located outside the firm, a condition that raises a central management issue for the firm. In his paper, he argues that there is an 'essential tension' between the two parties, and an important determinant of a successful collaboration lies in the designer's deep understanding of the firm's features, such as production processes, innovation strategy, branding and communication approach. The author finds that external designers are an important source of competitive advantage (e.g., through new ideas), therefore managing the tension is essential for developing a long-term, sustainable advantage. Filippetti's (2010) approach however does not take into account the extent to which a firm's technical expertise adapts to or is shaped by the collaboration with the designer. For this reason, his findings can be partly complemented with the contribution by Perks et al. (2005), who explored the role of design within the NPD process of mid-size to large UK manufacturing companies. They empirically derived a taxonomy and profiled three likely roles for design:

a) Design as a functional specialism: designers in this category concentrate purely on design; they are perceived by the business as a resource. They undertake the basic tasks of receiving the brief and carrying out sufficient research to inform their own design. The set of skills developed for this purpose centre on the traditional design skills, which include aesthetics, visualisation and technical skills.

b) Design as part of a multifunctional team: a team approach is used throughout the development process. Being design identified as a crucial aspect of the product development activity, designers emerge as key players of the team; they are encouraged to provide a support role to other functions, such as participating in the field or in-house reliability testing.
c) Design as NPD process leader and a major force for innovation: designers drive and support actions throughout the entire development process and across a broad scope of functional activities (Perks et al., 2005).

In each of these categories, the designer plays a different role with regard to managerial choices ('a' the designer is mainly involved with aesthetics, 'b' the designer plays a relevant role in NPD, 'c' the designer's expertise is a major force for innovation) and as a result, (s)he is differently positioned within the firm ('a' independent professional; 'b' member of the product development team; 'c' cross-functional role). A further line of research in this direction may investigate how other business functions would benefit from establishing a relationship with the designer in the three scenarios and whether this matters for the decision of in-housing or outsourcing design competencies.

1.2.3 Design and firm's strategy

Gorb and Dumas (1987) and Borja de Mozota (1990a) have regarded design as strictly intertwined with firms' management concern. In reality, this belief dates back to the early 1980s, when Kotler and Rath (1984) drew attention to the importance of design as a strategic tool and defined it as the process seeking to optimise consumer satisfaction and company profitability through creating performance, form, durability, and value in connection with products, environments, information, and identities. They suggested that satisfactory results can be achieved by training general managers, marketers and engineers to understand design, and designers to be aware of and learn about the role of these people.

With increasing globalisation, the focus upon the importance of design as a strategic tool has been stronger. Verganti (2003) illustrates the central role of designers within those organisations that base their strategy on radical design-driven innovations. In referring to a practical example such as the 'Metamorfosi' lamp by *Artemide*, the author implies that firms should research new languages (e.g., brainstorming ideas through workshop attended by

the firm's CEO and managing director for brand strategy, five well-known designers and a design professor), new technologies (e.g., by exploiting new applications of lighting technology), and new product developments (i.e., by combining the new meanings with the new technologies). In more general terms, Verganti proposes that firms should build their competitive advantage by drawing upon three unique ingredients: a personal network of long-term relationships with brokers of languages, a range of alternative channels that enrich and guarantee access to this knowledge, and an internal process whereby these contributions can be integrated (Verganti, 2003:42).

With a broader perspective, Verganti (2008) proposes a possible direction to fill the gap in the innovation management literature. In particular, he presents a metamodel to investigate design-driven innovation in which a manufacturer's ability to understand, anticipate, and influence the emergence of a new product meanings is built by relying on external interpreters (e.g., designers, firms in other industries, suppliers, schools, artists, the media) who share the firm's problem. The interaction with these interpreters – Verganti suggests – is essential in order to be able to access, share, and internalise knowledge on product languages and to influence shifts in socio-cultural models. Partly in line with this perspective, Martin (2009) suggests that firms should follow a design-thinking paradigm, that is, approaching managerial problems in the same way designers approach design problems.

It is clear how, in moving away from the engineering component of design, the term 'design' ends up including an increasingly broader meaning: it moves from being a product-related issue (i.e., product architecture) to an organisational issue (i.e., design-driven approach to organisational management). The next subsection shifts the focus to the industry level of analysis and attempts to account for the creative nature of design.

1.3 Design as a creative industry

The previous sections illustrated how the meaning of design has grown during the last few decades and, despite the fact that it originally referred to 'making a drawing', it is now a concept that includes activities such as the development of product architecture, the formulation of innovation strategy, the blending of aesthetics together with functional requirements. In other words, design is a case in point of how creativity still remains one of the most mysterious subjects in human thinking behaviour (Liu, 2000). This argument is

further supported by Tether (2006), who discusses how the various fields of design involve different types of knowledge, ranging from the rational, calculative knowledge used by engineering designers to the expressive subjective knowledge of graphic designers.[2]

There is still a lack of agreement as to where the boundaries of this service activity lie, which is reflected in a lack of statistical data about its position as an industrial activity or sector. If one considers the NACE revisions it would be noted that the different types of design activities are classified as a sub-category of other sectors (e.g., R&D) rather than design itself,[3] although the most common approach is to categorise design under the umbrella of creative industries, that is those industries based upon activities that originate in individual creativity, skill and talent, and have the potential for wealth creation through the generation and exploitation of intellectual property (DCMS, 2007).

While previous sections have reviewed the literature on the impact of design on new product development processes and firms' growth, this section explores the industry dimension of design and regards how and the (minor) extent to which it has been explored as an emerging industry. This dimension should not be overlooked, especially given the growing evidence that creative industries play an important role in stimulating innovation in many parts of the economy as well as in diffusing and adapting innovations (Bakhshi et al., 2008).

Design is commonly classified as a creative industry (Sunley et al., 2010), and some scholars believe that it has evolved as an industry in its own right. Cooper and Press (1995) found that the role of the designer as a consultant rather than an employee was defined by the pioneering American industrial designers of the 1930s, such as Raymond Lower and Walter Dorwin Teague, who were interpreting their function as market-driven jobbing stylists. As Heskett (1980) points out, a new generation of industrial designers emerged and these were coming from diverse backgrounds, methods and achievements. However, as a result of their

[2] Another account of the creative dimension of design could be captured through the definition of knowledge-intensive business service (Miles et al., 1995), which identifies design as a service activity that relies significantly on intellectual knowledge (hence, highly subject to individual creativity) and the output of which is an innovation itself as well as an innovative input to further innovations.

[3] For instance, one would find: the activity "Design and assembly of industrial continuous process control systems" within the Class 33.30 "Manufacture of industrial process control equipment"; the activity "Consulting architectural activities: building design and drafting, etc." within the Class 74.20 "Architectural and engineering activities and related technical consultancy"; the activity "Fashion design related to textiles, wearing apparel, shoes, jewellery, furniture and other interior decoration and other fashion goods as well as other personal or household goods" within the Class 74.84 "Other business activities n.e.c." (NACE, 2008).

work, design came to be recognised as an essential feature of commercial and industrial activity. Along with the increasing contribution of design to the American industry, employers began to establish in-house design teams, usually based within the engineering departments. Japanese firms followed the approach in the post-war period. In reality, the use of design expertise by companies grew significantly only during the 1980s, and mainly through external consultancy (Cooper and Press, 1995).

This evidence draws our attention to the key players emerging within the design industry at that time. We could observe the pioneering role of Americans, who tended to develop design expertise in-house along with the proactive approach of the British government. In Britain, although the designer profession arose from graphic design and illustration, the post-war evolution was significantly influenced by state policy, popular culture and close ties with the retail industry instead of 'mere' manufacturing requirements. The Society of Industrial Arts was created in 1930 and since then, government-led initiatives became increasingly more common (Cooper and Press, 1995, Bruce and Morris, 1996). Even other countries such as Germany and Italy began to undertake design initiatives as a means to exploit the manufacturing potential offered by new production systems. These trends drew attention to different aspects: the impact of design upon consumption; the relationship between designers and the manufacturing industry; the way in which the output of design is influenced by the structure of retailing; the evolution of the designer as a practising professional; and the efforts of design promotion and reform bodies to influence mass taste (Sparke, 1986).

The concept of the 'consultant designer for industry' first appeared in the United States in the late 1920s. Until then, designers had not realised the full potential of their role, rather they had leaned on the skills of others, whether the fine artist, the architect, the craftsman, the engineer, or the technician. Sparke (1983) argued that the designer should stand firmly in the centre of these specialisations and understand and synthesise them without specialising in any of them. This is thought to be a first step towards the acceptance of the designer as a consultant, and it is interesting to observe how industrialised countries have dealt with this issue.

Throughout the nineteenth century, the term 'designer' was surrounded by a mist of vagueness and ambiguity especially due to a state of flux, caught half-way the eighteen

century as a crucial formative period in the evolution of the modern designer for industry (Sparke, 1983:7). The differences can be grasped by reviewing the change of the activities labelled 'design' across different countries such as United States, Germany, Italy, Scandinavia and United Kingdom. It is worth recalling some key points in this context.

As stated earlier, United States were amongst the pioneers in considering the designer as a professional consultant whose contribution would be vital to the firm growth. Alongside the States, even Germany adopted a realistic attitude towards the co-operation of designer with the industry in the early twentieth century. In post-war Italy instead, manufacturing firms were motivated towards a new start, and design was seen as the means whereby national reconstruction could take place. The furniture, textile and automobile industries all experienced significant growth, due, in part, to the importance of design. The mid-30swere significant for Scandinavian design: the 1930 Stockholm Exhibition constituted the breakthrough for functionalism in Scandinavia, which showed how designs could be readily mass-produced in an efficient manner. Great Britain saw the emergence of design as a distinct profession, blending the craftsman's intuitive dexterity with the complex needs of industrial manufacture (Design Council, 2006). The British design consultancy tradition dates back to the 1880s and 1890s, when the Silver Studio growing out of the Art Manufacturing movement offered their specialisation textile design. However, except a few instances (e.g., British graphic design movement developed during the mid-twentieth century), it was only towards the end of the 1960s that Great Britain experienced its 'golden age for design and designers' (Olins, 1986:61). The Design Council was active in spreading the culture of British design abroad through passing by what was happening in other European countries with a great tradition in design, that is: Italy with its architect-product designer base, Germany with the Bauhaus-Ulm tradition, Scandinavia with its respect for simplicity and natural materials (Olins, 1986).

More recently, the Universities of Salford and Lancaster in partnership with British Design Innovation (BDI)[4] have conducted a project aiming at investigating future scenarios which reveal the threats and opportunities facing the UK commercial design industry over the next

[4] BDI is a British non-profit organisation founded in 1993. It is a trade body representing industrial designers involved in product, service and interaction design; their initiatives are fully financed by the joining members and run by voluntary national and regional boards of professional designers (http://www.bdi.rm.community.librios.com).

15 years with specific reference to brand and corporate identity, multimedia, new product development, packaging, and service design. Ten potential business models for the sector have been identified (i.e., UK design centres in BRIC economies, small independents, specialised innovation services, own brand entrepreneurs, intellectual property investors/speculators, design strategists, UK export engine, global design non-governmental organisations, special interest group niche network and mega design corps), of which only five were considered as viable by policy maker respondents. Additional findings suggest that further measures are necessary, namely: revising education, creating a single professional body for accreditation, and encouraging design companies to radically rethink their business models (Cooper et al., 2009).

2. Discussion and future research direction

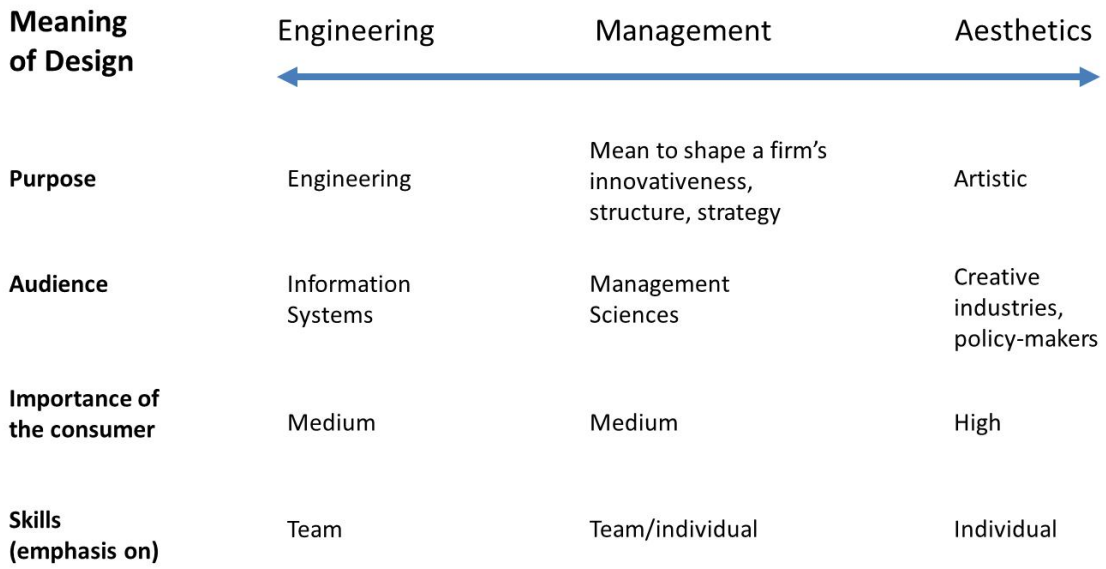
To gain a clearer understanding of the design discipline it has been necessary to review the numerous definitions. Design cannot be relegated to a secondary role, or be seen simply as 'context'. Design is central to understanding how actors develop ideas or artefacts and exploit them within built environments. Moreover, design is a social phenomenon: it shapes behaviours, it relies on social interactions (e.g., feedbacks are of crucial relevance), and it creates new ways of perceiving the social setting.

The review seeks to demonstrate the transformation design has undergone, from design as expressing certain product specifications to design as an important tool that can shape firm strategy. Theoretically this movement derive from a synergic interplay of a series of institutional and organisational factors. In reality, with specific regard to design, it seems that only some factors come into play and generate a new body of knowledge (e.g., engineering design, design management). Others, such as those that contribute to formalise the design activity and recognise it as a standalone industry, are still very implicit. The concept of design has expanded and evolved, from the science of design to its professionalisation, then to its evaluation. At a more intangible level, per each and every single step that has been accomplished, new sets of routines and knowledge have facilitated the adaptation of (the meaning of) design to new contexts.

Figure 1 below attempts to summarise the survey of the literature in a continuum between engineering and aesthetics at the two extremes. It also identifies different dimensions

(purpose, audience, importance of the market, and emphasis on which skills) along which design can be profiled: this would help to pinpoint the major gaps within the design literature and the potentials for future research.

Figure 1: An attempt to map the meaning(s) of design



Based on Figure 1, this review paper is suggesting that there are no clear-cut boundaries between the engineering, the management and the aesthetic components; a multi-dimensional perspective is needed to understand about design instead. There follow three subsections that identify and discuss key research themes and questions emerging from the literature review and are worthy of further investigation by design scholars, but not only.

3.1 How and where is design knowledge sourced?

The review has highlighted the difficulty of recognising artificial sciences, which includes design, as a universal 'science' (Gregor, 2009). Efforts have been made in different directions to develop a science of design (Simon, 1969, Walls et al., 1992, March and Smith, 1995), but there are three main issues that need further examination.

First and foremost, the boundaries of this science are fuzzy, a consequence that Purao et al. (2009) attribute to the plurality of research orientations seeking home under the banner of design sciences. However, some contributions within the literature illustrate how disciplines of design have been established such as product design, interior design and graphic design (Beltagui et al., 2008). In this context, it is proposed that one major difficulty of recognising

design as a standalone science stems from the lack of understanding as to where design knowledge is sourced from. Although the design activity fulfils an innovative, problem-solving purpose, little is known about the extent to which general analytical, technical or creative skills are more or less important than the specialised know-how of a designer. The literature indicates how most effort has been placed on understanding how a product or process innovation should be structured and conducted by 'agents', regardless of whether it is a team or an individual effort. Here it is suggested that, in developing a science of design, greater attention should be addressed towards the contribution of individual designers to product or process innovations. By doing so, it would be easier to identify their tasks and the (emerging) body of knowledge, which could facilitate the establishment of design as a formally recognised domain.

A second theme worthy of scrutiny regards the level of analysis of existing literature and the extent to which it connects with specific research communities. In other words, here it is suggested that there could be a stronger link between the interesting themes tackled within the Information Systems discipline (Ulrich, 1995) and other more practice-oriented domains such as management or organisation studies. A step forward could be made by identifying a common language of reference to express theories and methods, which could then be applied across the various disciplines.

Thirdly, the literature on design, and more specifically engineering design, identifies the prototype as the major schema through which a group of elements could be represented and a design project undertaken. However, prototyping and the related methodologies have been substantially transformed by the advent of new technologies (e.g., computer-aided design software) and a significant proportion of physical prototyping has been replaced by virtual prototyping. Design relies significantly on learning-by-doing; designers need for their work an array of less sharply defined considerations which often do not lend themselves to theorising, tabulation or programming into a computer, they are mostly learned on the job rather than in school or from books, and tend to be carried around in designers' minds (Vincenti, 1990). Because of this, future research may need to assess the contribution of physical versus virtual prototyping to the final design, and to what extent the recent graduates (i.e., who have received a substantial training on virtual prototyping software)

acknowledge such difference; this would shed light on any likely change in design knowledge.

To conclude, the advance of design science within the information systems discipline may be reviewed as bridge-building with other disciplines that must necessarily contribute to the definition of its scope and methods and participate in discussions about claims of jurisdiction on the body of knowledge (Purao et al., 2009).

3.2 The designer as a creative professional

The literature review that focused on design as a concern for management (Section 2.2) has drawn attention to a number of issues emerged over the last three to four decades. With the progressive establishment of design as a distinct phase within new product developments, firms had to tackle three main issues: how to manage the value generated by design activities; where to source the specialised expertise and manage it in an organisational context (i.e., outsourcing versus in-house); and how to exploit design for strategic purposes. These three indicators were used to segment and review the literature (Table 1). Different questions spring to mind.

With regard to the coordination of the design activity, design can play different roles and, despite the fact that it does not have a 'business identity' of its own (yet?), it influences significantly the firm competitiveness in terms of strategic positioning, innovativeness and financial performance. Because of this pervasiveness, it would be worth looking beyond the benefits of deploying design capabilities in-house or in outsourcing (von Stamm, 2008, Ravasi and Stigliani, 2012) and investigating how the formalisation of design activities can shape the configuration of other business units. Extant literature discusses the delicate 'relationship' between design and marketing (Cooper and Kleinschmidt, 1986, Moenaert and Souder, 1990) or manufacturing (Gardiner and Rothwell, 1985, Johne and Snelson, 1988), but very little is known about whether, and if so how, design as a service and creative activity pervades the organisational structure and shapes the business model (Cooper et al., 2009). Due to the multi-disciplinarity of design and its (proven) relevance for firm competitiveness, it is sensible to explore how the internalisation of a service activity that relies on a diverse set of knowledge bases shapes firm specialisation. Moreover, this perspective would shed light on the likely emergence and affirmation of the designer as a creative professional as an insider, by learning about firms' innovation strategy and

approach to technology development, and as an outsider, by exploring new opportunities that could influence their performance.

Partly connected with the assessment of a firm's performance has been that strand of the literature that tried to develop specific performance indicators. Torbett et al. (2001) explored whether, and if so how, consulting engineering firms have developed Design Performance Measurement (DPM) practices and which difficulties firms had been confronted with. The authors found that financial indicators were the most widely used but could not, on their own, provide sufficient information about design quality. The findings indicated that there is not a single optimal scenario, but rather DPMs needed to be part of a firm's wider business strategy (Torbett et al., 2001).

In the context of this review, it is believed that further efforts should be made to investigate the circumstances under which firms select certain design solutions and what are the consequences of their choices. There is not a formal discipline of design yet, and the power struggle between professional designers and producers still generates some friction in the innovation processes. Figure 1 suggests that the customer plays an important role, not to be neglected when deciding how to manage the design activity, firstly because of the impact it has on consumption patterns and secondly because of the meaning design carries with it, a meaning that is of relevance for the end consumer. Therefore indicators of the kind described above, although mainly of a financial nature, may be integrated, for instance, with a measure of customer satisfaction or the extent to which the design element in a product affects whether the customer will purchase that same product again.

These arguments are strictly connected with the advancement of design as a standalone industry, and therefore the emergence of standards that could facilitate the development of more specific indicators. Section **Fehler! Verweisquelle konnte nicht gefunden werden.** below refers to the literature reviewed as part of Group C (Table 1) and identifies gaps that need further investigation.

3.3 The industry dimension of design

A designer is most often asked to identify problems, select appropriate goals, and deliver a solution. In those cases where design is accomplished through a team effort, the designer is also required to coordinate and motivate a group of people with diverse competencies

towards the development and implementation of solutions. In other words, designers work (and act) on several levels, and in order to move from thought to action, they use of personal capacities to solve problems for clients in an appropriate and empathic way (Friedman, 2003). The idea of design as a creative and industrial activity relies upon the importance of individual talent and skills.

Fisher (1997) for instance surveys designers' experience and attitudes of working in a cross functional team in relation to their creativity. He proposes two models of creativity – one based on the romantic stereotype of the creative genius, and the other taking creativity to be an attribute possessed by all human beings in some measure, which can be enhanced by personal effort or by training. His survey suggests that in many cases designers have a pragmatic attitude to their creativity, despite the prevalence of the romantic stereotype for creativity in the literature of both management and education. More recently, Li et al. (2007) have presented a qualitative model of creativity for product innovation by integrating principles from cognitive psychology, information technologies and design theories. Their model identifies those attributes of creativity that are relevant in a creative design, which include thinking styles, knowledge, information, design methods and supporting tools. Exceptions aside, the set and nature of desirable competencies for a designer still represents an unexplored area in the innovation literature. It would be of value to investigate further what skills a designer should possess besides creativity. For instance, Bruce et al. (1995) show how management skills are essential for exploiting design expertise such as proper briefing of designers, regular communication between marketing, design and production, and effective project management.

This literature emphasises that the lack of agreement upon the definition of design still causes the absence of its formal recognition as an industrial activity. Such a disagreement leads to an unclear definition of the skills set a designer should master. In the context of this review it is suggested that more emphasis should be placed on investigating whether, and if so to what extent, the designer is emerging as a specialised, professional expert. According to the literature on professionalisation (Abbott, 1988, Hodgson, 2002, Morris et al., 2006), the existence of a formal body of knowledge would provide practitioners with a domain within which to exert their authority as experts and be recognised as 'accountable'. The attempt to apply these principles to design is mainly bound by the fact that it relies on a

non-codified body of knowledge, which hinders (almost) any chance to define what makes a designer 'talented' or the output of his (her) efforts 'good enough' and ready for the market.

By adopting a wider focus and linking to the service innovation literature (Miles, 1993, Miles et al., 1995), this aspect reflects a major gap in the literature: how do knowledge-intensive activities, like design, professionalise? How is their knowledge base made explicit and standardised for the sake of innovation? By taking Finnish design example, Valtonen and Ainamo (2008) attempted to answer the general question of 'What kinds of processes have characterised the professionalisation of product design?' by considering the theories of professions as a variant of the diffusion of world society in general, and professional models of organisation and management in particular. By combining the discussion held in Section 3.2 and in this section, it is suggested that the contribution by Valtonen and Ainamo (2008) could be complemented with an account of the dynamics that have regarded the industry of reference, an angle of analysis that might provide insights on the process of design professionalisation.

Research in this direction would also benefit scholars outside the professionalisation discipline. Firstly, a theory of professionalisation of design would benefit the understanding about other types of knowledge-intensive service activities that are increasingly populating modern economies, but of which very little is formally known and the factors that would contribute to their establishment as a standalone field. Secondly, this research theme would shed light on the role played by key actors in the context of innovation processes and the wider consequences at industry level. In the mid-1980s Clark developed a conceptual framework for analysing the sequence of technological changes underlying the development of industries by examining the interaction between design decisions and the choices of customers (Clark, 1985).[5] It can be seen that there is an important connection between the way design activities emerge and evolve and the way industries or sectors emerge and evolve, and this review is suggesting that further research is needed in this respect.

3. Conclusion

[5] Furthermore, the exploration of these themes has generated a whole stream of work on the concept of 'modularity' and how modular design systems would shape the evolution of industries and surrounding economies (Baldwin and Clark, 1997, 2006).

This paper has reviewed the extant literature on design with the aim of providing a structure that could shed further light on scholars' understanding of this topic. By emphasising the transition from design as representing a set of product specification to design as an important tool that can shape firms' strategy, it draws attention to different purposes design is used for, and the meanings that have developed accordingly.

Three main levels of analysis have been identified: the use of design as a tool for scientific and methodological development; design as a management concern for those firms that are willing to improve their competitiveness and performance (through design); and the emergence of design as an industry. This perspective of analysis has revealed different gaps within the literature that deserve scholars' future attention. This paper suggests that further efforts should be made to comprehend: (i) how and where design knowledge is sourced; (ii) how the process of embedding design knowledge in an organisational context can shape the configuration of other business units; (iii) whether, and if so in which terms, design as a body of knowledge will undergo a process of professionalisation intended as the formalisation of specific activities and/or tasks.

To conclude, there are no clear-cut boundaries between the engineering, the management and the aesthetic components, and a multi-level approach is essential to analysing design as argued in this paper.

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Appendix A

Table A.1: Segmenting the scholarly contribution to the discipline of design

	Author(s)	Source	Keywords
A.1	**Design as a process/product: developing a science (theory) of design**		
	Gregory (1966a)	Book	Design method
	Simon (1969)	Book	Sciences of the artificial
	Cross et al. (1981)	Journal (Design Studies)	Design as a scientific method
	March and Smith (1995)	Journal (Decision Support Systems)	Information system research, design science, natural science, information technology
	Russell and Norvig (1995)	Book	Artificial intelligence
	Ulrich (1995)	Journal (Research Policy)	Product architecture, software engineering, design theory
	Hubka and Eder (1996)	Book	Design science, engineering knowledge
	Cross (2000)	Web – Conference proceedings	Design as a discipline
	Love (2002)	Journal (Design Studies)	Philosophy of design, design theory, epistemology, interdisciplinary, science of design
	Hevner et al. (2004)	Journal (MIS Quarterly)	Information Systems research methodologies, design science, design artefact, business environment, technology infrastructure, search strategies, experimental methods, creativity
	Hatchuel and Weil (2009)	Journal (Research Engineering Design)	Design theory, innovation, creativity
	Gregor (2009)	Book	Sciences of the artificial, theory building
	Purao et al. (2009)	WP (Harvard Business School)	Design research, sciences of design, design as a science, discipline, body of knowledge, system of professions
A.2	**Design as a process/product: the engineering component of design**		
	Churchman (1971)	Book	Inquiring systems
	Rothwell and Gardiner (1983)	Book	Operation research, systems engineering
	Pugh (1989)	Journal (Design Studies)	Knowledge-based systems, engineering design
	Gero (1990)	Journal (AI Magazine)	Design as a process, knowledge representation, design prototypes
	Vincenti (1990)	Book	Engineering design, design knowledge

	Dym (1994)	Book	Engineering design
	Edwards (1994)	Journal (Materials & Design)	Engineering design, materials, guidelines, databases
	Pahl (1996)	Book	Engineering design
	Petroski (1996)	Book	Knowledge, invention
	Eekels (2000)	Journal (Journal of Engineering Design)	Engineering design science, engineering design epistemology
	D'Adderio (2001)	Journal (Research Policy)	Knowledge and capabilities integration, integrated software systems, product design development, virtual prototypes
	Tovey et al. (2003)	Journal (Design Studies)	Conceptual design, drawing, visual thinking, automotive design, CAD
	Salter and Gann (2003)	Journal (Research Policy)	Engineering design, innovation, tacit knowledge, project-based firms
	Ralph and Wand (2009)	Web (Design Requirement Workshop)	Design, information systems design, software design project, requirements, goals, science of design
B.1	**Management – Design and the competitiveness of the firm**		
	Moody (1980)	Journal (Design Studies)	Industrial design, technological innovation
	Black and Baker (1987)	Journal (Design Studies)	Product design, competitiveness, small companies
	Cooper and Kleinschmidt (1987)	Journal (Industrial Marketing Management)	Product innovation, success factors
	Wasserman (1990)	Web – Conference proceedings	Design strategy
	Walsh et al. (1992)	Book	Design, technology, product design, international competitiveness
	Cooper and Kleinschmidt (1995)	Journal (J. of Product Innovation Management)	NPD, success factors
	Trueman and Jobber (1998)	Journal (Long Range Planning)	Competitive advantage through design, Values, Image, Process and Production (VIPP's)
	Nixon (1999)	Journal (Intern. J. of Technology Management)	Evaluating design performance
	Gemser and Leenders (2001)	Journal (J. of Product Innovation Management)	Industrial design, company performance, product development process
	Creusen and Schoormans (2005)	Journal (J. of Product Innovation Management)	Product design, firm success, product appearance
	Hertenstein et al. (2005)	Journal (J. of Product Innovation Management)	Industrial design, corporate financial performance
	Candi (2006)	Journal (Int. J. of Innovation Management)	Technological innovations, industrial design, organisational effectiveness, performance standards, industrial management
	Chiva and Alegre (2009)	Journal (J. of Product Innovation Management)	Design investment, firm performance, design management

	Filippetti (2011)	Journal (European J. of Innovation Management)	Innovation, design, companies
B.2	**Management – Design and the organisational structure of the firm**		
	Dumas and Whitfield (1989)	Journal (European Management Journal)	Design management, manufacturing and service firms
	Moenaert and Souder (1990)	Journal (J. of Product Innovation Management)	Product development, marketing and R&D personnel
	Bruce and Morris (1994)	Journal (Technovation)	External design professionals, product development process
	Bruce et al. (1995)	Journal (Journal of Marketing Management)	Design investment, management skills at the firm level, design expertise
	Walsh (1996)	Journal (Research Policy)	Design function,
	von Stamm (1997)	Journal (Design Journal)	External designers, design outsourcing
	Twigg (1998)	Journal (Int. J. of Operats & Prod Management)	Design and development, suppliers, competitive advantage
	Bruce et al. (1999)	Journal (Design Studies)	Design management, small businesses
	Twigg (2002)	Journal (Integrated Manufacturing Systems)	Co-ordination, design, integration, product development, manufacturing, suppliers
	Perks et al. (2005)	Journal (J. of Product Innovation Management)	Role of design in NPD
	Valtonen (2005)	Journal (Joining Forces)	Role of design function, in-house design
	Verganti (2006)	Book	Innovating through design
	von Stamm (2008)	Book	Managing design, managing creativity, in-house vs outsourcing of design
	Dell'Era and Verganti (2009)	Journal (R&D Management)	Radical design-driven innovation, design-driven laboratories
	Dell'Era and Verganti (2010)	Journal (Long Range Planning)	Collaborative strategies, portfolio of external designers
	Filippetti (2010)	Web	Industrial design, innovation, product development, case study, essential tension of design
B.3	**Management – Design and the strategy of the firm**		
	Kotler and Rath (1984)	Journal (Journal of Business Strategy)	Design, strategic tool
	Gorb and Dumas (1987)	Journal (Design Studies)	Design activity, methodology, interaction with non-designers, silent design
	Borja De Mozota (1990a)	Book	Design as a strategic management tool
	Borja De Mozota (1990b)	Book	Design, management concern
	Cooper and Press (1995)	Book	Design management
	Utterback (1996)	Book	Innovation management
	Bruce and Bessant (2002)	Book	Strategic innovation, design business
	Verganti (2003)	Journal (Design Management Journal)	Radical design-driven innovation, Italian design, design consultant

	Lojacono and Zaccai (2004)	Journal (MIT Sloan Management Review)	Design-inspired enterprise
	Perks (2007)	Journal (Creativity and Innovation Management)	Inter-functional integration, new product portfolio decision-making
	Verganti (2008)	Journal (J. of Product Innovation Management)	Design-driven innovation, meanings, interpreters, manufacturing firms
	Martin (2009)	Book	Design thinking, competitive advantage
	Le Masson et al. (2010)	Book	Strategic management, design, innovation
C	**Design and the industry dimension**		
	Heskett (1980)	Book	Industrial design
	Sparke (1983)	Book	Design consultant, designer in industry
	Olins (1986)	Book	Industrial designer
	Sparke (1986)	Book	Design in Britain
	Bruce and Morris (1996)	Journal (Technology Analysis & Strategic Manag.)	Design consultancy industry, business performance
	Caves (2002)	Book	Creative industries
	Maffei and Simonelli (2002)	Book	Design in Italy, made in Italy, local production systems
	Beverland (2005)	Journal (J. of Product Innovation Management)	Fine line between design and marketing
	Cappetta et al. (2006)	Journal (Research Policy)	Evolutionary change, innovation, stylistic innovation, symbolic industries
	Vinodrai (2006)	Journal (Economic Geography)	Local labour markets, career paths, intermediaries, design, Toronto
	Bruce & Daly (2007)	Journal (Journal of Marketing Management)	Design management, marketing, integrated design, process of design management
	Utterback et al. (2007)	Book	Design-inspired innovation
	Aage and Belussi (2008)	Journal (Industry and Innovation)	Fashion industry, creative industry, industrial district
	Moultrie et al. (2008)	Conference report	Design system, design scoreboard
	Sunley et al. (2008)	Journal (Journal of Econ Geography)	Innovation, design, firm, sites
	Verganti (2009)	Book	Design-driven innovation, rules of competition
	Dell'Era et al. (2010)	Journal (Research Technology Management)	Role of design within Italian manufacturing firms