Knowledge integration of and by industrial design

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Working Paper LIU-IEI-WP--13/00003--SE
**Introduction - Integration of technological knowledge bases is important but not (always) sufficient**

Jan Carlzon, the Scandinavian airline SAS’ CEO during the successful eighties, tells a little story in his recently written comment to the 2008 Swedish re-issue of his 1985 book “Moments of Truth” [Swedish title: “Riv pyramiderna!” (2008)]. Carlzon describes how NOKIA’s CEO in the early 2000’s had told him that they worked like dogs to fill their mobile phones with values people were willing to pay for in order to keep the margins required. A short time later the telecom company Ericsson had its annual shareholder meeting and during the meeting a young girl asked: “Why does not Ericsson make phones that people want?” The chairman ignored the question – according to Carlzon the only relevant question asked – and instead he talked about lowering costs.

Was there something that Ericsson had not understood at the time? Their phones’ technical functionality was good so why did not people want them? Roughly ten years later we would like to, somewhat simplified, say that Ericsson had not quite understood the need for beauty in their sophisticated high-tech products. They managed to integrate everything apart from a sense of beauty, i.e. the aesthetic and symbolic aspect that made the young girl and others prefer other brands. Even if Ericson had been aware, had they able to integrate beauty and knowledge about “beauty aspects” in their products? No doubt had Ericsson been able to integrate a number of more or less related, complementary technological knowledge bases, but can knowledge about aesthetic and symbolic aspects, what we call “beauty”, be dealt with in the same way?

The contemporary need for depth of knowledge leads to increasing specialization and subsequently companies’ need for increasingly sophisticated means for integration of knowledge has increased. This is reflected in the field of knowledge integration (KI) which empirically has explored integration of knowledge bases from a rather technical, rationalistic perspective, and outputs of KI processes have in earlier research been framed in terms of efficiency, effectiveness and innovation (Tell, 2011). This is a limitation it shares with strategic management research (Dalpiaz et al 2010). However, we argue that the complexity in today’s products and services may extend beyond what the KI field have hitherto acknowledged.

A future development of the KI field could be to explore the user perspective on, and role in, the value creation and appropriation system, and to include the aesthetic and symbolic nature of products and services. This paper aims to contribute to the KI field, by exploring some consequences of extending the scope of knowledge integration to include integration of and by Industrial design.

Industrial design is a practice and a field of knowledge that spans the divide between rationalistic problem-solving and the seeming irrationality of the aesthetic and the socio-cultural (Verganti 2003). Industrial design is interesting in this context both for its content, i.e. as a field of knowledge to be integrated, and because of its process view that may be seen as an approach on how to integrate. This paper thus aims to discuss integration of and by design in order to broaden the dominating technological empirical scope of KI. We will relate integration of and by design to previous understandings of KI as a way to explore the hierarchy of capabilities (Grant 1996a).
The coming section gives a very brief introduction to KI and its relative neglect of the increasingly important knowledge about what makes people want and desire things apart from their technical functionality or use value. Then follows a section on Design and especially Industrial design where we use Grant’s (1996a) characteristics of KI to discuss how industrial design can contribute to competitive advantage from a KI view. The following section “Integration of and by design” somewhat artificially separates the content of industrial design as a field of knowledge from the view that industrial design may be a leading function pushing the envelope of technological knowledge, and thus a way of integration knowledge(s). Finally there is a discussion summarizing our arguments and findings and proposing how to go on.

**Knowledge integration**

As knowledge becomes more specialized, firms’ need for integration of knowledge increases. This is the seemingly simple logic behind the growing interest for knowledge integration (KI) during the last decades. Grant writes that as knowledge as critical inputs for firms is dispersed across different individuals within (and outside) the firm, “the primary role of the firm is integration of knowledge” (1996a: 377). Knowledge integration is a field that has come of age. From the formative contributions such as Kogut and Zander (1992) and Grant (1996 a, b), the list of publications has been increasing (Tell 2011), boundary conditions have been set, and communities formed (Berggren et al., 2011). Thus, knowledge integration has been defined as the combination of specialized but complementary knowledge bases in a goal-directed process aiming to achieve a significant outcome for the concerned organization(s) (Berggren et al. 2011 p.7).

In his overview of previous KI research Tell (2011) discusses factors that influence KI as well as outcomes of KI. He finds that task, knowledge, and relational characteristics have an influence on KI. The knowledge characteristics identified are of a rather general character, i.e. internal vs. external, tacit vs. explicit, etc. This, just as the general definition by Berggren et al., does not in any way discriminate between different knowledge bases relevant to the task at hand. KI is in that sense generic.

However, even if KI in principle does not discriminate among different knowledge bases, there seem to be an empirical bias towards the integration of different kinds of technological knowledge in the literature. Turbines (Enberg et al. 2010) and electrotechnical products (Schmickl & Kieser 2008) are a couple of representative examples. As another example, Tell (2011) presents no less than 35 definitions of KI. Six of these definitions mention or refer to what kind of knowledge(s) to be integrated. Of those six, five are in some way explicitly referred to as technological (including Enberg et al. and Schmickl and Kieser), while the sixth one more generally talks about product, service and market knowledge. Berggren et al. (2011) argues that large firms in industries as aerospace, automotive, heavy electrical equipment, telecom, and tooling, can be seen as critical cases for knowledge integration as they are under the influence of three major trends: internationalization of R&D and manufacturing, market transformations, and changes in the character of developments in science and technology. While acknowledging the value of the trends so formulated, there may be room to extend the dominant view and argue that the complexity in today’s products extend beyond what the KI field has to date featured.
The intangible nature of products and processes has increased (Teece, 2011). Not only in terms of the number, depth and complexity of technological knowledge areas, but also in the value that products and services represent and the relationship of users to the product and services. The linear industrial value system conception has been challenged, instead proposing different value creation and appropriating regimes, where one part is a reconceptualization of the firm – user interaction where co-production (Ramirez, 1999), or co-creation (e.g. Pitelis 2009 ) of value is emphasized. Products have been ‘conceptualized’ (Greenspan, 2002), where the criticality lies not only (or even mainly) in the intrinsic combination of technological knowledge fields, but, increasingly, in what the product or service represents, what it symbolizes and how it is experienced.

A particularly challenging intersection is provided by firms that are “design-intensive” (Verganti 2008), coupled with products that are both ‘high tech’ and ‘high touch’. These are products that have a challenging technological content, as well as intervening in the user’s personal life. These products have a problem-solving functional value, as well as being objects of social capital (Ravasi and Rindova 2008). Examples include passenger cars, mobile phones, computer games hardware and software, and lap-top computers. In addition, several of the firms engaged in these industries and activities are acting under highly competitive and dynamic conditions (Eisenhardt and Martin 2000), placing exacting demands for cost efficiencies. Many of these products are produced for a competitive global market, requiring attention to global scale sourcing and distribution costs, built on a dynamic technology frontier, requiring technological innovation and update, while also becoming objects of enchantment and identification.

A key managerial challenge here is knowledge integration, the integration of aspects of a wide scope of knowledge areas. For the field of knowledge integration, this leads to an issue of what is being integrated, i.e. how are the fields defined that are being integrated, and what are the consequences of extending that range of fields to include processes producing social capital? A limitation observed in strategy research, and possibly shared by the KI field, is that the focus has arguably been on the material and the supply side, at the expense of the immaterial and the demand side (Dalpiaz 2010).

“(a) extant research has focused on producer activities and on the cost side of the value-creation equation (see Priem, 2007) to the neglect of the role of consumer perceptions and practices; and (b) extant research has focused on the importance of technology in value creation to the neglect of cultural and symbolic resources (Ravasi & Rindova, 2008; Rindova & Petkova, 2007)” (Dalpiaz et al. 2010).

To find more explicit discussions on those aspects in relation to development of new products and innovation, we turn to the field of design, and more specifically, Industrial design. While constituting a field of its own, design is no stranger to New Product Development (often relating to marketing, see e.g. Journal of Product Innovation Management issues 1, 2/2005, 3/2011), and according to Hobday et al. design is “a central part of industrial innovation” (2011, p. 7).

**Design**

Design is a somewhat elusive concept used in different ways in different contexts. We do not enter the debate on definitions as we chose to focus on Industrial design, a field that incorporates
an integrative aspect, stretching across the divide between the rational and problem-solving and the ‘irrational’ of the aesthetic and symbolic. The integrative element is discussed at large in design literature, not the least in the subfield of design management (see Cooper et al. 2011) and in the discussions related to business strategy (e.g. Svengren 1995). Buchanan (1992) already 20 years ago wrote that the emergence of design thinking in the twentieth century has been important in the context of an increasing need for integrative disciplines to complement the arts and sciences. Design as an activity and profession is inherently integrative across ‘arts’ and ‘sciences’, but it is the integrative element that is at the forefront.

“Placing industrial design within art or technique, however, is an almost impossible task. Industrial design is a combination of both, and it is this combination that is the core of the profession. An industrial designer always takes the beauty of forms into consideration. But he or she never does so regardless of function and the production process, thereby distinguishing themselves clearly from “pure art” and artists.” (Johansson et al, 2003, p 2)

Buchanan argues that design is an integrative discipline and that designers “explore concrete integrations of knowledge” (1992, p. 6). More recently Hobday et al. (2012) stated that design ought to be viewed as a “knowledge creating, generation and integration activity”, not just as problem solving. One aspect of this is the increasingly important individual and social meaning of products, not yet much discussed from a KI perspective.

“Through capturing, recombining and integrating knowledge about socio-cultural models and product semantics in several different social and industry settings, designers help in creating breakthrough product meanings.” (Verganti 2003)

**Industrial design**

Industrial design may be seen as a distinct field of knowledge, in practice exercised by ‘design’ professionals with a specific education and training, and may in the appropriate context be seen as a distinct resource and/or capability for creating and sustaining competitive advantage for the firm, for example through involvement in NPD processes. *Industrial design* is defined by the ISDA (Industrial Designers Society of America) as follows:

> “Industrial design (ID) is the professional service of creating and developing concepts and specifications that optimize the function, value and appearance of products and systems for the mutual benefit of both user and manufacturer.”

This definition specifies industrial design as an activity *mediating* between two parties, the user and the manufacturer. The definition places the two parties on an equal footing, i.e. it does not promote a singular shareholder value perspective, which is a standard assumption of the contemporary mainstream perspective on business strategy and management theory and practice. As stakeholder perspective it is, however, clearly limited in this form. Nor does the definition portray design as a supply side activity only. The definition clearly places the activity within an *organized context*, i.e. it is part of a value system of activities and not a free, independent ‘arts’ activity. It does not contain a placement of the activity as *internalized or externalized*, meaning that the definition incorporates activities of an internal design department as well as external design consultants. The definition also specifies a set of *output values*, in ISDA’s definition
named function, value and appearance. The word ‘optimize’ is interesting as it signals rationality and a search for a final and one best solution of the design process.

So what is design knowledge? As remarked by other reviewers of the field (e.g. Hobday et al. 2011) the concept of design is elusive and definitions abound, and it is necessary to specify a set of sufficiently distinct boundary conditions. We find it useful to distinguish between a core set of content, and a core set of processes. The process side of the definition of design is often emphasized by professionals and academics in the field, e.g. “Design … shapes ideas to become practical and attractive propositions for user or customers” (Cox 2005, from Hobday et al. 2011, p. 6). The uniqueness of the process of design being the linking of the user to the activities of the firm, and the ‘shaping’, but possibly more important that of design as predominantly concerned with the fuzzy front end of innovation for the planning of subsequent replication, emphasizing interaction, modelling and prototyping. Design rests on a careful consideration of its methodologies; it has even been claimed that “design is process” (Gorb and Dumas, 1987). Resting with the process perspective is however somewhat problematic and risk not to prove a sufficiently distinct boundary, as the stage - gate model of design project practice or the propositions in the sub-field of ‘design thinking’ - which aims at exporting the design processes to a broad set of managerial fields, are based on a teleological logic (Van de Ven and Poole 1995) common to management theory. Much of the design discourse returns to Herbert Simon’s seminal work of design where “design is the transformation of existing conditions into preferred ones” (1996:111).

In order for industrial design to denote a specific set of managerial issues, it is necessary for it to encompass not only a process interest but also a content matter. The distinct body of the content matter of design knowledge may be described as knowledge about how humans perceive, interact with, and understand artefacts (Heskett 2002); artefacts here being both physical objects and interactive processes, e.g. software interface design. A significant body of this knowledge concerns the two- and three-dimensional nature of artefacts. It is a set of skills related to the ability to manifest ideas in form and process, such as drawing, moulding and computer graphics, as well as a set of related methods of the design process. Perhaps the most striking quality of design thus understood is the explicit consideration of aesthetic and symbolic content of artefacts and processes, in parallel to the consideration of the rational concerns of technology and costs. The content of the field of design stretches beyond the confines of the technical/economic paradigm of the management discourse, and regards the user and consequently the firm – user interaction in humanistic terms as well as technical and economic.

Woudhuysen (2011, p. 33-34) summarizes the ‘basic design skills’ as the competence to:

“- Draw and visualize design ideas, with or without the help of IT
- Make prototypes that take account of functional, technical, and cost requirements
- Execute design ideas with a strong eye to aesthetics”

To summarize, industrial design emphasizes the professional employment of design knowledge in an organized setting for purposes more instrumental than the detached, distanced and disinterested role of the modernist arts (Pirson and Lawrence 2009), but still communicating and
bridging between supplier and the user, building on a broader set of values than strict rationality or utility.

A broader set of values

So, what constitutes the broader set of values that extend beyond utility? First, the field of design gives us some but limited clues. Design is grounded in the users’ perspective, and there is a vast literature on the role of design in human life, which partly is rather ideological in nature, and refers in general to design as concerned with ‘the betterment of the human condition’ (e.g. Heskett 2002). Some designers of the early industrial epoch developed businesses based on ideological responses to the human condition also in industrial settings (Julier, 1993). William Morris for instance

“believed that beautiful design enriched the quality of life and that the designer had a moral responsibility in his or her work towards the greater good” (McDermott, 1992).

Echoes of this ideological, humanistic position have a long reverberation over Bauhaus and Ulm, found a formal expression in the principles of Dieter Rams, found physical expression in Scandinavian furniture design of Alvar Aalto, Arne Jacobsen or Bruno Mathsson, later embodied by Steve Jobs and Jonathan Ive (Isaacson 2011), and into the contemporary with synthesizer designs by Kouthoofd of Teenage Engineering (Quirk 2012) and contemporary green architecture. These examples highlight one crucial line in the general design debate: the balancing of an industrial, technological and economical logic with an (ideological) orientation towards the needs and desires of the human being. Design here is not just an instrumental, industrial activity for the betterment of the industrial process and its performance, but also an instrument for the betterment of the human condition, processed through industry as the mass production methods democratizes quality. Low cost and industrial processes are not only seen as means to create margins and capital turnover, but means to make good designs available for a greater number of people. Industrial techniques are means, not ends. The ideological stance is not necessarily outspoken or very marked in industrial design, which is, again, a professional and embedded deployment of design knowledge, but the questioning of rational, technological knowledge as panacea remains.

“According to (Heidegger 1977/1953), modern technology essentially means an abstract, disenchanted, and decontextualized thinking of the world…” (Johansson et al. 2003, p. 4)

However, in searching for more specific and neutral definitions of value the design field is oddly wanting. We will use the ‘three worlds’ of Karl Popper as a starting point. For Popper, world 1 is the realm of physical objects, states, and systems, it is the world of natural science; this is the domain of what an object does in the material world, rather than what it represents. World 2 is the domain of individual subjective experience involving perceptions and observations, reactions, emotions, feelings "of pain and pleasure” (Popper 1978, p 143), individual thoughts, emotions, needs, wants, and perceptions judgments, perceptions. The experiential dimension is the realm of individual subjective value. World 2 contains our ability to react upon, reflect upon and subsequently alter or change the objects in world 1 and 3. World 3 is the sphere of theories, language, literature, collective narratives, symbols, and images. It is the world of "cultural objects”, using Popper’s (1978) term.
Karl Popper (1978) offers a theory of human reality. It is an all-encompassing perspective, of ‘three worlds’ that together constitute reality, and the reality of human beings is plural, not singular (Popper, 1978; 1994). Popper’s perspective on reality includes a material reality and an immaterial; the objective as well as the subjective and intersubjective. This comprehensiveness is a crucial aspect. It allows for a material and rational explanation, as well as interpretation of immaterial aspects. In Popperian terms, designed ‘things’ as well as the process that create them, may be studied from a combination of the three perspectives; as material/rational, as social/symbolic and as individual experience.

Inspired by Karl Popper’s three worlds, we will employ three overarching domains of knowledge. The material is the domain of the rational, the objective, where knowledge is codified and explicit. The symbolic is the domain of the socially constructed patterns of meaning, the objectified, where knowledge is interpretative and contextual. The aesthetic is the field of individual experience, judgment and reflection, where knowledge is grounded in corporeality while through experience creating learned emotional/cognitive patterns of increasingly higher order (Damasio 2003).

A BMW car performs transportation work when taking the children to school (material value), but is highly regarded for being fun to drive and a visually attractive object (aesthetic value), and it looks great on the driveway sending a message to your neighbours of affluence and personal success (symbolic value). A Scania truck performs transportation work, but adding a HardOx steel lining makes the truck abrasion resistant (material value), and the imprinted brand name makes you as trucker proud (aesthetic value) to the envy of fellow truckers (symbolic value). An Apple computer performs computing tasks as well technically as any personal computer (material value), but has a physical design that is modernistic and appealing/aesthetic as well as a software user interface that is geared for seamless ease of use and taking the technical barrier out of the computer (aesthetic values), while the white cords and easily recognizable design signals membership of a community (symbolic value).

If these may be seen a set of ‘output values’ (c.f IDSA) of products and services that are the results of the industrial design process, this formal formulation of values may contribute to the understanding of design-intensive industries encompassing the technically and economically rationale as well as the aesthetic and symbolic. Furthermore, the organization producing these design-intensive products and services needs to contain or muster the capabilities to act in all three domains. Finally, the organization needs the capability to integrate the three domains into a meaningful and coherent whole. If the three domains are to be understood as knowledge domains, that capability is one of a higher order capability of knowledge integration (Grant 1996a; Tell 2011).

**Integrating industrial design**

Industrial design has inherently an integrative quality, and our interest is whether that integration may be further developed employing the conceptual structure developed in the KI field, and what challenges for the theory and practice of KI this might entail. With an ultimate interest in how industrial design may contribute to the creation and sustaining of competitive advantage, we will
first use Grant’s (1996a) conceptual structure regarding characteristics of knowledge integration processes – efficiency, scope and flexibility – linked to competitive advantage.

The efficiency of knowledge integration
The efficiency of knowledge integration depends in part on the ability to communicate across functional borderlines, regardless of whether the knowledge is explicit or tacit and thus if the integration mechanisms may be based on direction (explicit) or routine (tacit) (Grant 1996a). A prerequisite for communication across knowledge areas has been the level and quality of common knowledge, which rest on common language, commonality of vocabulary and conceptual knowledge. Shared behavioural norms are fundamental and “the wider the scope of knowledge being integrated...the lower is the level of common knowledge” (Grant 1996a, p. 380). Similarly concerned with managerial processes, but in another field, it has been proposed that the creation of a ‘common space’ was critical for the successful transfer of knowledge to international market entry in the form of green-field investment, in order to bridge between nationalities (Hurt and Hurt 2005). These propositions in turn have parallels to the common space of ba, conducive to knowledge conversion processes, proposed by Nonaka et al. (2000).

Industrial design, in its introduction of aesthetics and symbolic value, risks being problematic on most of these accounts. It widens the scope of knowledge to be integrated, the intra-field languages, concepts and structures are likely to be different, behavioural norms risk being different and intra-field cultural values are likely to be different.

Further, the frequency and variability of task performance influences the efficiency of knowledge integration. This would point to industrial design being successfully integrated in situations where design is part of the routines of a firm, rather than an exception.

Lastly, organizational structuring may facilitate the efficiency of KI. Interestingly, Grant (1996) uses the automobile industry, from Clark and Fujimoto (1991), to illustrate the possible benefits from sequencing, functional differentiation and product segmentation to overcome knowledge integration barriers, although without paying any special attention to design.

The scope of knowledge integration
Grant (1996a) actually argues that increasing the span of knowledge to be integrated actually has the potential to be beneficial for the firm, on two accounts. First, up to a point of ‘diminishing relevance’, different types of knowledge may be seen as complements rather than as substitutes. Second, a greater scope of knowledge increases the possibilities of a greater causal ambiguity and thus increases the sustainability through sheltering the firm from imitation.

Industrial design increases the scope of knowledge to be integrated and thus carries a promise or potential for increasing sustainability – given that the two conditions can be met. If the aesthetic and symbolic considerations of design is seen as a poor complement it may stretch beyond the point of diminishing relevance in the eyes of other organizational actors. Given the tacit nature of much of design, it may certainly contribute to causal ambiguity and thus shelter competitive advantage from imitation, but the extreme of causal ambiguity is simply fuzziness and lack of causality.
The flexibility of knowledge integration

In a dynamic market setting, sources of competitive advantage have a best-before date, and the capability for continual renewal may maintain performance.

First, a firm’s ability to encompass additional fields’ knowledge depends greatly on the ability to communicate (Grant 1996a). The more tacit, historically and culturally embedded, the more difficult to transfer and to integrate. Socio-cultural patterns of meaning creation (Verganti 2008) are certainly both path dependent and culturally embedded.

Second, an ability to reconfigure existing knowledge through new patterns of integration is a potential capability for renewal.

All of the three characteristics of knowledge integration indicate some difficulties when we introduce the broader set of values and the fields of knowledge of industrial design. We posed question marks around the efficiency of integration, partially because of communication issues; the scope of what to integrate may move beyond the point of diminishing relevance; and flexibility of integration may be slow partially because of the tacit nature of design knowledge and practice. However, following the argumentation regarding scope by Grant (1996a), the broader scope of industrial design also carries the potential for creating and sustaining competitive advantage. Great potential coupled with great difficulties.

Integration of and by design

What role may industrial design play in the knowledge integration processes? How may organizations reap the potential benefits, while overcoming the difficulties also identified above. This may addressed through exploring the placement of design in a hierarchy of capabilities (Grant 1996a).

A specific issue of knowledge integration that is highlighted from a design perspective is whether design is integrated as a function, or itself an agent of integration; whether knowledge integration takes place of or by design. Part of design management is the idea of design as integrated into the activities of the organization; integration of design. From a mainstream conception of the firm as a technical/economic optimization problem, design then needs to be added to the existing set of activities. Design is one activity along other activities, one department along other departments. How to structure, organize, place and integrate design with such a perspective is a recurring theme in design research, for example in Lisbeth Svengren’s discussion of functional integration (Svengren 1995).

A further step is to see design as integrating activity, where design is the agent of change; integration by design. Design is the activity that links, or creates links between the activities of the firm. This perspective moves design more clearly into the realm of business strategy, as the overarching process logic that binds value creating and appropriating activities together. This seems to be a growing field of interest in design research, such as Svengren’s (1995) conceptual integration.
Integration of design

With integration of design, at its most fundamental we are adding a field of knowledge to be integrated. The problem possibly being that we hereby attempt to achieve flexibility through encompassing new knowledge (Grant 1996a), something Grant sees as unlikely to be successful unless the new knowledge is explicit and communication can be found through direction. The integrating mechanism of flexibility would most likely occur through reconfiguration (Grant 1996a). Hence we have a paradoxical situation that may be difficult to resolve, and possibly a line of explaining the many reported difficulties in finding success through incorporating industrial design.

The design function is placed along other functions and activities and becomes one knowledge area among other knowledge areas. It would represent an ‘independent subsystem’ (Simon 1973; Grant 1996a), and design would have a ‘horizontal’ role. The focus would most likely be to employ and apply known knowledge.

If so we may arrive at an asymmetrical communication pattern (Johansson et al. 2003) where design need to legitimize itself vis-à-vis the mainstream technical and economic interests. This perspective leads to issues of relative importance of design compared to other functions such as technical development of supply chain management. An investment in design needs to be evaluated in the same manner as any investment.

Ericsson mobile phones

In the early 1990s Ericsson achieved a first mover advantage in mobile phones, largely due to technological innovations. As these technical developments led to new possibilities, for example due to smaller battery size coupled with an awareness of the potential of rapidly growing and internationalizing consumer markets, design issues came to the forefront of managerial attention. Ericsson increased its ambition in the area and recruited a new, international design partner, as well as attempted a more formal integration of design in the decision-making structures, through e.g. a design council. However, the design function was supported rather more verbally than in action, was hampered by lack of resources – the internal department consisting of a handful of employees – which limited the depth of dialogue with the external design bureau. There were also conflicts of interest between construction and design for example regarding cost efficiency oriented redesign. Ericsson identified a need for design content of products, and a need of design integration, but failed in the balancing of functions. Similarly, there was limited integration by design. Visions of the future of mobile telephony were carried by the R&D manager rather than by the formal design office an Atlantic ocean apart. The mobile phone was a relatively finished design when the designers were brought into the picture, and quite different views of the competitive value of the design function were held within the firm. Summarily, Ericsson recognized and formulated a need for functional integration of design, but failed in its execution, and exhibited a limited ambition to integrate by design. (based on Svengren, 1995)

Integration by design

Not mentioned in the story in the introduction of the paper was Ericsson’s competitor Nokia whose mobile phones the girl asking the question presumably was referring to as the ones people wanted.
Nokia mobile phones

A few years into the 1990:ies Nokia’s mobile phone 2110 was released in five different colours, it had a rounded keypad and an elliptical shape. It exceeded sales expectations 50 times. Nokia had discovered the importance of expression and personalisation. It was a chief designer to be who had wished to give the phone a friendly and emotional appeal.

The experience made Nokia’s marketing and developing people regard phones as personal accessories, not just phoning devices, and lay the foundation for Nokia’s subsequent emphasis on factors as simplicity and style. By developing an awareness of fashion and other cultural phenomena NOKIAs ambition was to pace important social trends as a way to secure continued success.

(based on Ravasi & Lojaconi 2005)

As described in the Nokia illustration, design may on the other hand, compared to ‘integration of’, be a higher order capability with a ‘vertical’ responsibility. A facilitator of knowledge integration processes, with responsibility for creating meaning and order throughout the process. Compare with the issue whether an architect should be a consultant among other functional fields, reporting to the builder (the Swedish system), or should the architect by responsible for the whole project (the Danish system)?

The technical envelope

While integration of design would most likely work within a set boundary of technology and apply that level of knowledge, it is easier to see integration by design as pushing that boundary, in order to meet the visions of the design. Integration by design would be pushing the envelope of technological knowledge, not accepting the given. Design would be the leading function, and a specific field of technological knowledge a resource or a subordinate capability in the hierarchy (Grant 1996a). Design would have a ‘vertical’ field of authority.

Through out the history of Apple products there are numerous stories of when Steve Jobs refused to accept boundaries of existing technological fields of knowledge (Isaacson 2011). For example, when the iPhone was being developed, the front with one single glass surface was an integral part of the vision. The problem being that there was no glass material hard enough for the intended use, which risks stalling or stopping the entire project. True to his style, Steve Jobs phoned the CEO of Corning, flew over and convinced Corning to spend research time inventing the impossible. Within a month Corning had found an unused technology and the glass surface issue was solved.

Design as agent

Integration by design implies that the design activities are leading, that design is the agent of change. The designer’s issue:

"Is he willing and able to provide the link – the calculable link – between absolute value, marginal value, price, premium and cost without losing control of those intangible, cultural values of which he must remain the guardian?" (Archer, 1969)

Steve Jobs as agent?

Steve Jobs was not a technician by training, but grew up with an interest in things technical in Silicon valley at a time when the new binary code technologies were developing in both software and hardware. He combined a
fascination for things technical with a personal journey into Zen Buddhism, meditation, walking barefoot, a passage to India and rather extreme food regimes. His personal formative years seem to have developed a capability to straddle the technology – human sciences divide, and he brought this ability into the company he founded. Steve Jobs’ interest in details of visual hardware design as well as the intuitiveness of software design and his unwillingness to compromise is legendary, if not notorious, and may have constituted an ability to unite ‘poetry and processors’ (Isaacson, 2011). As a consequence, technical development was pushed beyond the limits commonly perceived. The later products, following his return, reflect the same ambition, now incorporated into a very big organization. The strict design principles of design manager Jonathan IVE, partially imported from German designer legend Dieter Rams, the intuitive interfaces, the hardware and software integration, and an aura of a calling are all aspects of the Apple products that create reactions of irritation or wow, leave few customers unaffected, and for some becomes part of personal life.

(based on Isaacson 2011)

The example of Steve Jobs describes how he as top manager could act as ‘guardian of intangible, cultural values’, and thus be an agent of design pushing the limits (most likely with the help of others regarding costs considering Apple’s margins). Apple may though be an extreme example and an outlier among firms.

Another approach is illustrated in the example from Orrefors below. Orrefors recruited its first designer (or artist as they were called back then) 1916 and has ever since been a company which have relied heavily on its designers for the development of new products with commercial potential combining an artistic content with cost-efficiency consideration (whether manufacturing is completely manual or mechanical or combinations thereof).

**Orrefors**

It is late August in south-eastern Sweden and there are worries at the so called Product Council at Orrefors, a Swedish manufacturer of high-end glass products (stemware, bowls etc.). The council has gathered to review and discuss the different product propositions for next season’s collection of products. The company’s eight designers have half an hour each at their disposal to present their product propositions, at this stage still mostly as prototypes, in an “audition-like fashion” to the council: the CEO, the marketing manager, the production manager, and, when needed, representatives from the different departments. The council’s task is to decide which of the suggested new products, shall be launched the coming spring. What has been presented so far is reckoned to be too little, in many cases not good enough, and the process is severely delayed.

The next designer enters the room. She presents her suggestions in a very structured manner and for each product/product line there is ample information on not just why she thinks it is a good product that can add something to the present product range, but also detailed information on manufacturing costs and how manufacturing technology can be improved to press costs down further provided some investments are made. One of her suggestions is a series of vases in different sizes for different purposes. From the little one for carnations via a medium-sized one for “roses from the husband” to a really large one. She is asked why the large vase is in the series and she answers that it is intended for the southern European countries where flowers are cheap and bouquets larger. At the answer it is suggested by one of the council members that it could be even bigger. The size is though determined by a maximum measure in one of the machines in the glassworks. Even if the vases are intended to look handmade, they are partly manufactured with the help of machinery. The designer presents her other ideas and afterwards the CEO thanks for her good work. When the designer leaves the room the comments are very appreciative.- “It is hard to take anything out of this.”- “It is so thought-out.” - “No one is as prepared as she is.”

(based on Andersson 2002)
An often referred to expression in the glass works when designers presented their sketches, sometimes drawing with chalk on the floor of the glassworks, was “it can’t be done” (“de’ gaur inte” in the local Swedish dialect), which was another way of saying “we have never done that”. More or less everything in the company centred around the company’s eight designers, recruited in order to be different from each other, expressing their individuality in their products, while working under the umbrella of the brand and its tradition. Creating commercial potential by pushing (technological) limits, and stretching but not breaking the tradition of the brand, was thus the essence of integrative design(ers) at Orrefors.

The organizational level of where to find ‘integration agents’ may, as the Apple and the Orrefors examples show, vary. Grant (1996a) writes however that the hierarch of integration is not to be confused with the administrative one of authority and control, and that the two hierarchies, in most organizations, do not correspond closely with each other.

Discussion

In the design literature, the issues surrounding integration of design with other functional areas, and by design as part of the firm’s strategy abound, and present an open wound of bitterness and feelings of misunderstanding.

“The modern split between engineers and industrial designers or between art and business, therefore, appears not to be a small ditch simply to jump over. Rather, it seems to be of such a magnitude that it is doubtful whether it is even worth trying to overcome it.” (Johansson et al. 2003, p 10)

By introducing industrial design into the knowledge integration process we have extended the scope of what to be integrated. We have identified a managerial issue that formally encompasses both the material and the immaterial (Hodder 1991), the rational and the ‘irrational’, use value and user value (Boztepe 2007), functional and symbolic value (Ravasi and Rindova 2008); encompassing the poetry and plumbing of management (March and Weil 2005). Some of the world’s most highly valued companies, such as Apple or BMW, are undoubtedly ‘design-intensive’ firms (Verganti 2008), building their success on a combination of rational problem-solving and meaning creation. Whether this combinative capability (Kogut and Zander 1992) is called industrial design or not is in a way secondary. We have here sought to explore some consequences of introducing industrial design into the KI framework, specifically what the consequences may be of knowledge integration of or by design.

The industrial design knowledge represents at its most basic a distinct set of resources. The employment of these resources requires distinct operational capabilities, and the integration of which may require higher order capabilities.

The ‘designer’ uses the input of the resources of knowledge content through the capability of process knowledge to ‘design’ things and processes as output.

With this perspective, industrial design is inherently integrative, bridging the needs, desires and self-perceptions of the user, and the resources and capabilities of the firm. Industrial design, in content and process, represents an identifiable and distinct resource and/or capability for the
firm. The placement of industrial design in a hierarchy of capabilities (Grant 1996a) is in fact a critical managerial issue, indicative of whether the integration is seen as integration of or by industrial design.

Integration of design means that design (with its distinct capabilities) is placed besides other functions, and thus could be described as extending the horizontal dimension in Grants (1996a, p. 378) figure of organizational capabilities. Adding design widens the scope of knowledge to be integrated by the company. This calls for efficient integrative capabilities at a higher level that are able to handle the “wider set of values” discussed above. If those higher level capabilities are not sufficient, there may be problems like those illustrated in the Ericsson example above. In this case, design does not really, or is not given any chance to, contribute to its integration.

Integration by design, on the other hand, refers to the vertical dimension in Grants (1996a) hierarchy of capabilities. The short examples from Nokia, Apple, and Orrefors illustrate that integration by design may come in very different shapes. Common to all three examples is that design – spanning the functional/technological, the aesthetic, and the symbolic – to a sufficient extent permeates the organization and thus becomes, or even constitutes, an integrative capability in itself, wherever its agent(s) reside.

Even if we have separated of and by for analytical purposes, integration by design most likely in some way comprise ‘integration of design’ and thus require some design expertise in the organization. This does however not mean that a formal design position is where the integrating agent, if there is one (which is a question on its own), is to be found. That is just one of many possible roads ahead.
References


