Invisible Innovation: models of design facilitation in the supply chain.

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Abstract:
It has been assumed by design professionals and educators that designers are innovators or at least contribute to innovation, indeed there have been numerous studies linking design to creativity and innovation. Often design is linked to intangible as well as tangible values in product success but do we know exactly how; what models exist; and how do designers really provide real value to the organisation and indeed to the supply chain? These are the questions that our current research study has been addressing in the UK.

Introduction:
This paper will present two models developed in our study of a number of designers and how they operated in the development of products, throughout a number of different environments (i.e. as in-house designer, outsourced, with large, medium and small companies, across a variety of industrial sectors). The models illustrate the way in which designers operate within companies and their supplier chains, the way in which designers influence decision making, what decisions and where; it considers the results of such influences on the level of innovation and change – at both a business and strategic product level.

Twelve case studies are being used as a basis for analysis, along with theoretical work on creativity and design competencies. The analysis of the case studies results in identifying models of design relationships, the personality of the designer; illustrating how the designer(s) influence decisions about the product, its manufacture; target market(s) and supply chain policy. Comparisons are made of the different operational models that occur, depending on the size and culture of the organisation and its relationship with the designer(s).

The models illustrate not only traditional paradigms of designer/client relationships, but importantly, new paradigms where designers form relationships and networks which result in innovation in both existing and new markets, through technologies and by creating virtual enterprises. The research also illustrates the often ‘invisible’ nature of the design influence and resultant innovation, suggesting why it is crucial to make these explicit thus capitalising on the contribution of design skills and competencies that can make to innovation in the changing organisational structures in our economy.

The Benefits of Design and Effective Design Management
It is widely accepted that design can lead to a variety of positive strategic benefits. However, for these to be commercially realised, a framework of organisation and planning is necessary. Design managers have traditionally assumed the role as intermediary, to organise the design process and manage relationships between designers and other managers. However, since the business environment has radically changed, design has become more involved with the goals of other business functions, playing a more significant part in company strategy. Inevitably, as the role of design has broadened, the responsibilities of the design manager have expanded. Morzota (1998) offers three levels of design management (Fig 1).
**Role**

<table>
<thead>
<tr>
<th>Operational</th>
<th>Design is involved to improve a system or operation. Marketing / Engineering / Communications etc.</th>
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<tbody>
<tr>
<td>Functional</td>
<td>Design as a tool in achieving a competitive advantage. Creation of new products / markets.</td>
</tr>
<tr>
<td>Strategic</td>
<td>Design operates at a corporate level by influencing and contributing directly to company vision.</td>
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(Fig.1) Levels of Design Management – Morzota (1998)

However, Cooper and Press (1995) argue that the term Design Management contains a fundamental contradiction. Whereas design is based around exploration and risk-taking, management is founded on control and predictability. The outcome of combining the two presents a risk that the management framework might reduce the creative scope of the designer. For those ‘managing’ design the danger of restricting the flair and imagination of designers is an important concern and only the systems that leave space for innovation should be implemented. It is important that design managers truly understand the way designers work so that the project is managed well without inhibiting creativity.

**The Designer**

Since every design task is unique, it possesses different conditions, constraints and resources. Designers must develop their own knowledge system and co-ordinate existing and new skills and knowledge together successfully in order to meet the requirements. ‘Designers use their innate skills to translate ideas and knowledge about the world around them into new products, messages and environments.’ (Cooper and Press, 1995). Although designers from different disciplines have particular strengths in their specialised field, Bruce and Cooper (1997) classify the skills of a ‘designer’ into two main categories – ‘practical’ and ‘cognitive.’ Traditional types of skills involved in undertaking design projects which distinguish the ‘designer’ from other professionals include visualising, model-making, simulating and testing, and technical drawing and diagrams.

**Supply chain relationships**

Companies are becoming more dependent upon relationships with suppliers, as these provide a vehicle by which to deliver ‘high quality, value for money products’. This involves close communication and data sharing, and exclusivity of designs (Bruce and Moger, 1999). It is also argued that companies should focus on closing the satisfaction gaps faced by customers in order to improve relationships (Harland, 1996). Benefits of building collaboration include a better understanding of needs and thus the ability to have the correct marketing mix (Eversman, 1999). Partnering enables companies to develop and transfer technologies (Hergert and Morris, 1987, cited in Bidault and Cummings, 1994). However, Bidault and Cummings (1994) themselves suggest that managerial hurdles that are often found in partnerships can commonly offset predicted innovation advantages, and that there is a considerable tension between innovation and partnering. Gomez Arias (1995) argues that although strategically
guided networks can be highly successful, innovative and leading edge, it is often innovative organisations that enter into partnering, and that a direct relationship between partnering and corporate performance is unclear.

Bruce et al (1995) highlight some of the problems associated with partnering, which include cost, a low success rate, an inability to meet expectations of collaborating parties and reduced control over the product development process. Porter (1990, cited in Bruce et al, 1995) argues that ‘most alliances are unstable’, attributed to the degree of trust between partners and a fear of leaking information (Hamel et al, 1989, cited in Bruce et al, 1995). Other problems of partnerships include disagreements regarding scope, pace and timing of decision; imbalances of power; dependency; uncertainty of ownership; mutual suspicion; conflicting loyalties and insufficient identity within the partnership, undermining credibility (Wilson, 1999).

Case Study 1

The Company

Company 1 are a UK based company specialising in the supply of systems that harness ICT for group teaching and learning in Education and Training establishments. Since they were founded in 1996 they have established a global profile, quickly becoming one of Europe’s leading developer and manufacturer of interactive systems. They were awarded Millennium Product status in 1999, by the Design Council, and are now widely accepted as being at the leading edge of technology with 6000 plus installations in the UK alone.

The Designers

The designers are an experienced and creative design consultancy, specialising in industrial, medical and scientific, electronic and consumer/domestic products. Their offices are located in the northwest of England. They have vast experience of taking projects from concept generation through prototyping to production tooling, using SDRC I-DEAS and ALIAS 3D modelling software, and rapid prototyping techniques. They have designed successful products for companies such as Siemens, GenRad, Taylor Hobson, Micromass and Time Computers.

The Concept

In essence, it is new technology created into a user-friendly system that aims to replace traditional display systems within the classroom, boardroom and lecture theatre. It is a whole group teaching and learning resource. But, most importantly, it is not a tool designed to be used solely in an ICT room – it is totally cross curricula. Although the interactive board has a matt white finish for glare free protection, it is still possible for the user(s) to use at its most simple level – as a dry wipe marker board.

The primary purpose of the board is as a projection surface and is connected to a personal computer and or a video cassette player. This is when the interactive board can be used to replace the dry wipe marker board, blackboard, OHP, flipchart and television. The projector sits in front of the interactive board and shines the computer or video image onto its surface. In a mobile situation the projector may be on a table or trolley, but projectors can also be ceiling mounted.

When connected to a PC the screen image, normally displayed on a monitor is projected on to the interactive board. In essence, it becomes a 75” monitor. However, because it is electronic, the user may use a battery free pen on the screen akin to the way one would use a mouse on a PC.
Using the software provided, the user may also annotate in electronic ink over any PC application, web page or image. These annotations are digital and can therefore be printed off, exported as a web page(s) or saved onto a disc. In addition to freehand annotations the interactive board comes with over 100 pre-drawn annotations which include maps, science equipment, grids and boxes. Therefore, a teacher may control the PC whilst remaining in the front, sharing all resources available via the PC to the entire group.

For complete group interactivity an interactive slate is provided with the screen. This would allow control from anywhere within the room; thus the teacher may move around and still be able to control the PC. Alternatively, it enables student contributions, without them having to leave their seat.

The interactive board can also play host to radio transmissions. The company have developed a “classroom response system” which this case study focuses on, which in essence is similar in intent and function as “ask the audience.” However, in addition, devices may be registered to pupils and individual performances may be assessed and calculated.

Product Development
The Brief
The redesign of the existing product primarily came about as a result of concerns about the way it was utilised by the user. Initial customer responses suggested that there was a distinct lack of tactile and visual feedback to the end user. The system as a whole works extremely effectively, but user interface problems demanded a significant reappraisal of the design of the hand held voting device. After initial research by the designer, a number of issues arose concerning the original product design. The designer comments that: “…the overall form was one of the big problems with the original hand device. The problem was that it is very much like a TV handset remote control, and one of the big failings is that the children when voting actually use it like a TV remote control, actually pointing it in the air. They won’t think or visually recognise what they are doing in terms of the voting process.”

User Research
After the brief, initial problem identification, and having established the needs of the client the designers then went on to actually look at the user side. The designer went into one of the schools in Sheffield who had been trialling the project. Not only with the students to find out their issues but also
to work with the teachers and the management of the school to find out what they wanted from the system. This provided the design team with an intimate knowledge of how the product was used, its current failings and how to refine and enhance its existing design. The designer adds “...I have got a video of them working on it and they are like a group of swans. Everytime they go to vote they just...there hands just come up like that...it was quite funny.”

Design concept development
In tandem with field research within the schools, the designers investigated the current market and also relative products to this particular handset and try to focus that into the idea generation process. They then produced initial ideas, which resulted in the internal idea of view where they looked at thus ensuring that they satisfied all the conditions laid out in the brief and the proposal to make sure that they were going forward in the right direction.

Fig.4 Early design concepts developed by the design team. Through close involvement of key stakeholders – many concepts were developed for internal review.

Through close involvement with key stakeholders at the initial stages; the design team developed many conceptual proposals to be taken forward at the internal idea review. Decisions were based on sound and varied inputs from a variety of experts present at the review, which also took into account the companies’ strategic future plans.

Concept refinement
At this stage, an embryonic idea for the final product is taken forward, refined and developed into a workable solution. The designer is quick to point out that: “…even though the ideas are quite rough, it is essential to get on board all of the suppliers that we have identified to work on this project and gauge their opinion. Their expert opinion is often very valuable to the end product. Again its about verifying our design decisions with the suppliers, because one of the compromises of our position in this relationship is that we have got to establish links with these suppliers, but unfortunately the part of production means that only one supplier can actually work on the product. Or alternatively, a number of suppliers working on different aspects of the product but, usually we will get 3 or 4 suppliers in to
talk about each individual component of the end product and in that way we can present the client with a number of different options in terms of cost, lead times and things like that…”

**Design Detailing**

This stage witnessed a closer attention to detail concerning the final product; in particular its aesthetic appeal and tactile qualities. Selected suppliers play a closer involvement in materials selection and production tooling, refining issues concerning its manufacturability. The designers were working in unison with all of the product suppliers constantly communicating back and forth making sure that their design decisions were faithful to the design brief. The designer then goes on to say that:

“Initially we had to heavily rely on rapid prototyping utilising CAD data to again verify our design decisions safety checks before the commitment straight down into tooling. We use that to communicate our decisions again, using the rapid prototyping to communicate right across the supply chain network; then we move further really closer to the tooling process where rapid prototyping will fall off, but then other suppliers will come in such as the ultimate packaging and graphic suppliers, logistics, technical data and things like that. They will come in closer to the actual production of the product, once you have gone through that process all of this information has been channelled into the final design which will go into tooling and production.”

**Implementation**

In all other stages of the design programme, the design function had been central to the whole project, but at the implementation stage, the designer took a step back with the client moving into a more pivotal position. This is largely due to investment factors where the client has to make strategic decisions regarding financing the product, now liasing more directly with the suppliers. However, the designer still retained an important role working with both the client and suppliers to make sure that design intent is still achieved. The designer adds, “…we have got our individual connections with the suppliers, as well as connections with the client to troubleshoot and respond with issues that are addressed. At the same time, the client, initiating the parallel supplier activity such as technical support, packaging and graphics and logistics.”

**Pre-production and Production**

At the pre-production stage, the design function is primarily concerned with ensuring that design intent is fully achieved. Although they have been ensuring it throughout all stages of the process, they are on hand to respond to any issues that are raised prior to full production. Meanwhile, the client is now liasing with the suppliers to secure the most cost-effective way to develop the product.

When the product enters the production stage, the designer’s role now becomes less pivotal, offering advice about warranty issues and refinements to later models.

**Summary**

The end product is the embodiment of all design decisions taken throughout all stages of the NPD programme. Reflecting on the project, the designer concludes by saying:
“...the end product is the embodiment of all the decisions that we have made during the design process and it’s ultimately what all of your work is judged on. Frustratingly sometimes it can be quite superficial, because a lot of the things that you see on the outside of a product, on all of the work, a lot of the true innovation goes on in the internal structure of the product and the thought process that you have gone through in order to achieve that. On this particular product, the key design decisions can be identified quite easily, and all of those design decisions have come through the collaboration that we have gone through, through the whole design process with the user, the client, the marketing department and the suppliers.”

Case Study 2
The Company

Company 2 is a new start up company primarily funded by venture capital. The directors were both ex engineering graduates from Brunel University in the UK, who are both passionate about keeping fit, which they then decided to combine their leisure interests with a radical business concept. As a result, the company was launched in October 2001, with the launch of the interactive workout cycle.

The Designers

The design consultancy is one of the leading consultancies based in the UK. They have more than 20 years experience in striking the balance between future opportunity and practical reality in world markets. Their experience spans consumer products, hi-technology equipment, medical, datacommunications and packaging sectors. They employ over 65 specialists who have skills in research, product design, engineering and multi-media/interaction design.

The Fitness Experience

Company 2 developed a ‘fitness experience’ concept to radically break away from the monotony often associated with the user interaction with exercise equipment. Reading newspapers or watching TV monitors only provided a transitory distraction. They wanted to develop a machine that creates a total mind and body experience by linking advanced, interactive software directly with the physical effort applied on the exercise bike (Fig’s. 1&2).

They suggest that their concept: “…is unique; the system motivates, it challenges, it stimulates.” The
design has the same footprint as a standard exercise bike. Its ergonomic, modular design incorporates a self-diagnostic testing approach making the system easy and affordable to maintain. The system supports a number of advanced features:

- One touch gas assisted frame adjustment
- Advanced gearbox and Electro-mechanical braking system
- Interactive software and games: ‘Gems’; ‘Solitaire’; ‘Orbit’; and ‘Space Trippers.’

The Brief
Both directors of the company had done extensive market research into fitness products, and also by visiting “…virtually every fitness and leisure company in the Southeast of England.” The initial brief was in essence – ‘how can we develop a game or interaction that was physically linked to the exercise that you were doing?’ They approached the designers with this initial design problem, requiring expertise in both the development and implementation of the cycle machine and the games software.

Design Development
Firstly, the designers turned the idea into a ‘proof of principle’ that could actually work. Once both parties agreed that the idea could be taken further into the commercial sphere, Company 2 then began the task to raise money for the venture. Through the process of iteration and mutual sharing of ideas and understanding the full potential of the idea, the designers and the company developed a close working partnership. Very quickly the designers managed to create an innovative mechanism fundamental to the concept. The director at the design consultancy is quick to point out that “…we managed to patent the special connection between the way that the software ‘kicks back’ and the gearing mechanism in the cycle.” At any one time, the project team was diverse in its composition concerning the range of expertise working on the concept. The engineers had a strong input on the cycle, design and testing a minimum of four ideas.

Based on the initial design concepts, and the new patent on the gearing mechanism, Company 2 were able to secure more funding through venture capital to take the design further towards commercialisation. Through the development of the cycle, the company forged close links with the software consultants working on the project. Their input provided crucial when working with the other experts, linking the differing disciplines together.

Prototype Testing
The design consultancy built the initial prototype of the cycle in-house and then tested them at local gyms. The designer was quick to add that “…February (2002) we are going to be working with the first gym that is officially to house a bank of 15 of these machines; just about every major gym in the country has got one of these being tested.”

User Feedback
The designer also adds, “…through testing these bikes in the gyms, what we found is not getting people on these cycles – but actually getting them off them!” He further adds – “…what you have got to remember, it’s a complete experience, because of that inter-connection, which has never happened before.”


**Crossing Boundaries**

A key part of the success of this project was the design project leader networking across different organisational boundaries and disciplines. The project leader was not an engineer, although the project was an engineering led programme. But, he had great networking skills that allowed him to call in experts when the project needed critical knowledge input and integrating the functions into one focused team. The Director of Strategy at the design consultancy, comments that “…what I find very interesting with these types of projects is that where you have a lot of technical input, some designers don’t really identify with that, and equally with people on the other side don’t necessarily identify with industrial design. But, there are some people who feel really comfortable going across all that because they see it more holistically.”

The designers transferred the knowledge and expertise of their links with industry into the project, ‘relying on their network of external suppliers of components, materials and sometimes processes’ The designer adds “…we have a guy in here whose job it is to manage the knowledge if you like of all those supply bases; he’s got a database of saddles, gears etc”

**Design Contribution**

The success of this project could be mainly attributed primarily to the cohesive nature of the designer’s involvement throughout all stages of the programme. His role and skill was to ‘glue’ together all the differing functions associated with the cycle machine, bonding them into a focused cross discipline team. By communicating to the different groups, both explicitly and implicitly, he managed to enable them to share knowledge and technical skills, greatly contributing its overall successful completion. The consultancy appointed someone to manage the project within the company; the Director of Design Strategy comments that:

“…We go through the commercial side before a project manager is appointed. When a job is appointed then so is a manager, which could be one of a number of people. That is partly because who is available but also who would be ‘right’ for the job. It’s a combination of many things, but ultimately it’s to do with skills and what type of skills would the job require. You cannot have a CAD specialist if the job is 70% design engineering or vice versa. Nick incidentally is not an engineer, he’s an experienced industrial designer, but with good networking skills that he can go to whoever he wants to and has personality to call in experts when he’s out of his depth.”

It could be argued that these types of (design) enablers are very comfortable crossing boundaries, talking to anybody at any level and bringing people in and persevering until they get the right answers from the relevant experts. The Director of Design Strategy further adds:

“…That’s partly helped here, because that’s a part of the company culture, how were structured etc. Its all about integrating different skill bases to encourage that; but at the end of the day its about ‘individuals’ and some are better at it than others…[the project leader] is a great guy because he takes the complicated supply chain inputs in his stride, even though he’s not an expert in a lot of the issues involved. More importantly, the people on the other side feel very comfortable working with him – it’s a great strength.”
Conclusions:
There are 2 domains within design in organisations – the designer and the client/organisation itself. When these are both brought together it is important to manage the ways in which the ‘client’ and the designer build their relationship in order to access and share knowledge, and also to innovate and make decisions. Also, the number of suppliers is a variable that will change from client to client, and this will affect the ways in which knowledge is transferred, and also the degrees of power held by the designer and the supply chain. The designer will have a more direct influence over a client with no supply chain. Three models can be identified:

Within all of the above models it is important that there is a key individual/design champion to facilitate the designer client relationship, in order to maximise innovation. The role that this person would play would vary to some degree depending upon the model used. However some common characteristics would apply in all models, namely: authority, access to people within the organisation, a gatekeeper, open to change and new ideas, empathetic, a designer or with designer characteristics, empowering, a good networker, persuasive, a good communicator, particularly of brand values of the organisation, and the ability to facilitate and manage relationships with users and suppliers. Within the intermediate model the key individual may be the managing director, and issues regarding finance will be of greater importance, due to limited resources. This requires openness and sharing of information with the designer, in order to get feasible design solutions. Tighter project management is also key in order to ensure that the project runs to schedule and hidden costs do not arise. If the design function is out-sourced it is important that the key individual has the skills to build relationships with the network of suppliers sourced by the designer, in order to be able to take over these once the designer has exited the company. In the ‘direct’ model the above characteristics are important, but trust is a key issue.
Communication must be open and transparent and the key individual and the designer must work together to understand suppliers and users, and to learn from them. However, clearly defined roles and boundaries of the project are important, and the organisation needs to understand the value of the designer and what they can expect.

(Word count: 4738)

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