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THE USE OF DESIGN VISUALISATION METHODS TO SUPPORT DECISION MAKING

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1. Introduction

In this paper we examine two industrial projects currently running in an SME company specializing in pipeline maintenance equipment, in order to understand how visualisation methods originating from design can contribute to decision making processes. We first describe the range of visualisation methods and how they are used in relation to decision making in the management and design fields. We then describe the use of four design visualisation methods used in these two projects in order to evaluate how useful design visualisation methods have been in supporting decision making during the projects, and highlight the benefits of these methods in conjunction with other more established visualisations methods used in management context.

2. The application of visual techniques

2.1 What are visualisation methods?

Discussion and research of visualisation methods is fragmented across diverse disciplines such as management, human-computer interaction, design, education and psychology. Lengler and Eppler [2007, pp. 1] define a visualisation method as:

>   'a systematic, rule-based, external, permanent, and graphic representation that depicts information in a way that is conducive to acquiring insights, developing an elaborate understanding, or communicating experiences'.

In the same paper, Lengler and Eppler attempts to define and categorise existing visualisation methods in order to develop a systematic overview using the periodic table logic and visual metaphor. They identified 6 types of visualisation: data, information, concept, metaphor, strategy and compound.

2.2 Visualisation in decision making

The importance of visual representation to support decision making has been emphasized and explored by many researchers [Eppler and Platts 2009], [Lurie and Mason 2007], [Lohse et al. 1994], [Tufte 1990], [Foil and Huff 1992], [Morgan 1993], [Eden and Ackermann 1998], [Tan and Platts 2003]. In general, these researchers suggest that visualisation provides ways of examining and improving managerial judgement by transforming raw data into accessible forms of knowledge representation. Eppler and Platts [2009] compared the challenges of strategizing and their corresponding strengths in a thorough literature review. They identified the three main challenges of strategizing (cognitive, social and emotional) and the benefits that visualisation can bring in addressing each of these. The cognitive benefits include facilitating elicitation and synthesis of information, enabling new perspectives, providing better and more exhaustive comparisons and easier recall and sequencing ability. Eppler and Platts [2009] also describe the social benefits as enabling different perspectives to be integrated and

also tracking and showing interdependencies; and the emotional benefits which include the creation of better engagement with stakeholders, providing inspiration and generating convincing information.

2.3 Visualisation in design

Visual representations are a common feature of designing. Visuals used in the process of designing are represented by a number of forms, for example drawings, CAD renderings, photographs and storyboards. These methods are used to help the designer explore, inform, analyse and communicate the design concept. In particular, the role of sketching has been widely explored in design research literature. According to Cross [2006, pp. 54-58] sketching enables designers to handle levels of abstractions, identify and recall relevant knowledge, structure problems, and promote the recognition of emergent features and properties in the solution space. Goldschmidt [1991] suggests that sketching externalises the content of an image at a particular point and is used as an internal reasoning (dialectic) process during the development of design concepts. Recently there has been a renewed interest in visualisation methods from service design literature [Holmlid 2005], [Partício et al. 2008] [Mager 2008], [Akama 2009], [Clatworthy 2009] where they are identified as a way of differentiating current management and marketing methods used in the development of services. There are even resource websites dedicated to documenting and describing a range of design methods, notably the Service Design Tools website [Tassi 2009] which lists 40 communication tools supporting the design process.

In design research visuals are generally used for three purposes: (a) for reflection and exploration, (b) as a tool for analysis and knowledge generation and (c) as a communication, facilitation and discussion tool [Yee 2012-pending]. In professional design practice, Segelström [2010] pointed out that for service designers, there are 3 main reasons to use visualisation: (a) to articulate insights, (b) to keep empathy and (c) to communicate insight. His research also indicates that there appears to be a set of standard visualisation techniques used by service designers, which can be grouped into journeys, narratives and personas. Literature discussed thus far highlights the role of visualisation in a design process. Visualisations can be used internally as a way of articulating insights and maintaining empathy with the user or context, while at the same time used as a communication tool with project stakeholders.

2.4 Design visualisation methods in decision making

Lengler and Eppler's [2007] periodic table of visual methods lists over 100 diagram types, originating from various disciplines, and presents different ways of classification. It is a useful framework and resource to understand the range and application of visual methods. However on closer inspection, there is a distinct lack of diagram types that originate from design. This may be due to the fact that when selecting the methods for inclusion, Lengler and Eppler only looked at methods that were: documented, applied in organizational settings, applicable by non-experts and evaluated, while design methods are rarely documented and evaluated within an organizational setting.

We define design visualisation methods as visual methods that originated from design and are commonly used in design processes. Examples sampled from the Service Design Tools website [Tassi 2009] and the Design Council's Method Banks [Design Council 2007] include: personas [Cooper 1999], [Pruitt and Grudin 2003], scenarios, cultural probes [Gaver et al. 99] design documentaries [Raijmakers 2007], mood boards, comparative analyses, empathy maps [Xplane, date unknown] and user journeys. Although some of these design methods are used to elicit information from users, the resultant data collected are in visual forms that are used to support decision making. We are also using Lengler and Eppler's [2007, pp.1] definition of visualisation methods to help us define what we mean by design visualisation methods, which we repeat as:

'a systematic, rule-based, external, permanent, and graphic representation that depicts information in a way that is conducive to acquiring insights, developing an elaborate understanding, or communicating experiences'.

The key difference between design visualisation approaches and non-design visualisation approaches is the type of information that it visually represents. Visualisation in design is used to project a 'new' product or service and as a result, most design visualisations are attempts to present as believable and realistic a future scenario as possible. In contrast, knowledge management visualisation tools are

designed to visually represent existing quantitative data (for example pie charts and line graphs), information (for example process maps or treemaps) or concepts (for example concept maps or Gantt charts). Visualisation in decision making is generally discussed from a knowledge management or change management point of view. Used in conjunction with existing methods, design visualisations can be used to support decision making by enabling the decision makers to envision how their decisions might effect the future of the company.

3. Analysis framework and evaluation

The two projects are presented as case studies of how design visualisation methods are being used in decision making processes. Each project is lead by a project lead who is carrying out the bulk of the work supported by an internal project team and an external university-based team. At the time of the data collection, the two projects were in the 13 months of their planned 24 month implementation, and have been through some key decision making phases. The project leads were asked to select and reflect on the documentations produced during the project which use various forms of visualisation. They were asked to note down how these documentations were used and received, and the impact that visualisations had on their efficacy. At the start of the project, both project leads documented their learnings and reflections on an internal blog which they shared with each other. They were asked to refer back to it when reflecting on the documentations and visual methods applied. Two visual methods from each project (from a range of between 8 and 5 respectively) were chosen for discussion in this paper based on whether:

a. the visual method is derived from design OR have been repurposed for design
b. the visual method was used to support decision making (by the project lead or the project team)

The project leads were also asked to rate the visualisation methods based on their feasibility, usability and utility. The overall impacts of these methods were then evaluated against the other methods on the project teams' decision making. The list of the communication formats and visualisation methods used in the project are listed in Table 1. To supplement the project lead's reflection and evaluation, two semi-structured interviews were conducted with the company's marketing manager and sales director (both of whom were involved in the two projects) to provide external evaluations of the methods. The marketing manager was able to comment on all four of the chosen methods, while the sales director was unable to comment on the Business Canvas tool as he was not involved in its use.

Table 1. List of communication formats and visualisation methods used in both projects

Communication formats used in Project A	Visualisation methods used in Project A	Communication formats used in Project B	Visualisation methods used in Project B
• PowerPoint Presentations • Training maps • User research report • Organizational chart • Competitor analysis report • Product training report • Brand audit and review	• Organizational chart • Personas • Stakeholder map • Pie chart • Cycle diagram • Gantt chart • Box plot • Timeline	• PowerPoint Presentations • Process mapping report • Customer order report • IT Procedural guide • Vendor comparison report and presentation	• Process mapping • Business canvas tool • Gantt chart • Mood board • Pie chart

This paper uses the conceptual framework for strategy visualisation developed by Eppler and Platts [2009, pp. 47] to categorise, analyse and evaluate the range of methods used in both case studies. Eppler and Platts' framework covers the entire strategising process, from analysis, development, planning and implementation. The framework addresses three questions relating to:

- What type of strategy content needs to be represented? (content);

- What are the expected advantages of using visualisation for strategizing (benefits);
- What are the appropriate visualisation formats or methods that can be used? (methods)

We use Eppler and Platts' criteria for evaluation for assessment based on: feasibility, suitability, usability, and utility (i.e. did the visualisation provide a useful tool in helping the project team make key decisions?). Eppler and Platts' framework does not account for design visualisation methods, and instead focuses on traditional management methods like bar diagrams, line charts, decision trees, Gantt charts and strategy maps. To provide a design perspective to this evaluation, we have also used Segelström's [2010] study on the role of visualisation in service design to help us evaluate and discuss the usefulness of the methods to the project lead and team. We also refer to Diana, Pacenti and Tassi's [2010] framework to describe the format of the visualisation. Their framework is built on two notions of analysing visualisation: *iconicity* and *time*, visualised as Cartesian coordinates. The axis of *Iconicity* ranges from abstract to realistic, referring to whether realistic materials (such as photographs) or abstractions are used. The second axis of *Time*, ranging from synchronic to diachronic, refers to whether visualisations are used to depict a specific moment of a service or used to visualise a sequence of interactions that describes the service experience over a period of time. Table 2 brings together all three frameworks and models used in this research.

Table 2. Analysis framework for this research derived from Eppler and Platts [2009], Segelström [2010], Diana et al [2010]

Benefits of visualisation for strategizing [Eppler and Platts, 2009]	Purpose of visualisation in service design [Segelström, 2010]	Visual Format [Diana et al 2010]
• Elicitation and Synthesis (cognitive) • Perspectives and comparison (cognitive and social) • Sequence and Interdependence (cognitive and social) • Motivation and tracking (emotional)	• Articulating insights • Keeping empathy • Communicating insight	Synchronic<----------> Diachronic Abstract < ------------ > Realistic

4. Case studies

The case studies are derived from two connected Knowledge Transfer Partnership (KTP) projects. KTP is a UK government-funded scheme that involves the formation of a strategic partnership between an academic institution and a local company, through the appointment of a recent graduate (the 'associate'). These particular KTP projects involve collaboration between Northumbria University and a SME company based in the North of England that specializes in pipeline maintenance. This company is one of the world's leading suppliers of pipeline maintenance equipment, and provides a product range that includes foam pigs, spheres, weld testers and monitoring equipment, as well as the launching and receiving of hardware.

The two KTP projects are two-year long strategic projects designed to implement improvements to business processes and develop new income streams, through brand positioning and the improvement of training services within the company. The projects are running concurrently and are complimentary in that they form part of the company's larger strategic plan to improve their internal and external business processes and service offerings.

Project A aims to develop and embed a training and support service for sales agents and other staff, in order to establish the company as a preferred source of expertise as well as product. This is a strategic decision taken by the company to improve its market position and be recognised as the foremost expert in the pipeline industry. Project B aims to undertake a major redesign of business processes and information systems in order to provide strategic management information to support future growth

and development. The associate for Project A has a design background while the associate for Project B has a business background, but has been exposed to design methods through their completion of a multi-disciplinary postgraduate programme involving design, business and engineering. For the purpose of confidentiality, information illustrated in the visual examples has been anonymised or blanked out.

4.1 Visual method 1: User research through personas (Project A)

Method:	Persona
Benefits:	Cognitive: elicitation and synthesis of user research
	Social: communication and alignment of goals
	Emotional: revealing positive insights of the company's reputation
Purposes:	Keeping empathy (most important for the project lead), articulating and communicating insights (important for project stakeholders)
Visual format:	Realistic and Diachronic

Personas are a visual model used to describe users' goals, skills, abilities, technical experience and context of use. They are detailed descriptions of archetypical users constructed out of well-understood, highly specific patterns of data based on knowledge collected about real users. The use of personas as a research method was introduced by Cooper [1999] and later popularised by Pruitt and Grudin [2003] who developed them as a method to understand users of an interactive system when developing Microsoft's new browser MSN Explorer. Personas are considered to be a visualisation method because it is a graphic representation of a particular archetype user depicting information to enable the design team to acquire insights and understanding. It has been used as an example by Segelström [2010] as a visualisation technique commonly used in service design. The role of appropriate visual representations (i.e. it is recommended that the profile picture is not sourced from a stock photo library) is to ensure a level of authenticity and believability. Although profile pictures are the most common way to depict an archetype user, other visual methods are also used in a persona, such as a box plot used in the example persona sheet in Figure 1 to depict their knowledge level of the industry. For the purpose of this project, personas were created to represent the wide spectrum of stakeholders within the project, in order to identify user requirements and guide decision making during the development of the e-training service specification. Interviews were conducted with a range of potential service-users to inform the development of the personas. A total of six personas were created. Figure 1 shows an example of one of the personas created.

Using Segelström's [2010] study which identified 3 broad reasons to use visualisations in a service design practice, the application of the personas was found to be beneficial in all three areas: articulating insights, helping the project lead and team keep empathy with the end users and finally, using it to communicate this insight with other project stakeholders. For the project lead, the exercise of collecting information on potential service-users enabled him to learn about the industry, how it worked and the various contexts in which the system would eventually be used. It provided him with not only a broad overview of the industry, but also a deeper understanding of the wide spectrum of user needs and requirements within that industry. The structure of the personas enabled the associate to communicate his user research in a format that was succinct and engaging. The visual nature of this method, compared to the more traditional customer segmentation report, provided a distinct benefit that was noticed and commented upon by the company's marketing manager and sales director, with the visual summary of the user's requirements, knowledge level and issues providing a succinct yet rich picture of the company's service users.

The personas were not only used to present the findings of the user research, but also to inform the design criteria of the e-training system. Discussions using the personas lead to further conversations about the system requirements and content to be delivered. Decisions around the system requirements were facilitated and validated by the use of the persona method, as it enabled the project team to confidently agree to the design criteria based on the information communicated through the personas. Additionally, the marketing manager saw the personas as an opportunity to determine which key customer to focus on in their marketing strategy. Due to the time consuming nature of a market segmentation analysis, she felt this method could provide the marketing team with an overview of the

current range of customers, the means to decide which market to focus on, and the ability to identify any current gaps in provision.

The persona method also had unexpected benefits. The marketing manager suggested its use as a training method to induct new staff members in her sales and marketing team, as the six personas personify the company's full range of customers. Additionally, the sales director was surprised to discover that the user research and the personas it generated had revealed positive insights on the company's reputation. He thought that the method was 'brilliant' and was very effective as it he has not seen it being used in the company before. The use of personas in this context has demonstrated the method's value outside the discipline of interaction design and software development. It has been used not only as a learning and communication method, but also as a decision making tool. It led to conversations around the purpose, aims and requirements of the e-training system and shaped its design requirements. It highlighted where communication is particularly poor with agents and resellers in certain regions, and provided the sales and marketing team with a better understanding of how their customers viewed the company. We therefore propose that personas are a useful substitute to a more detailed market segmentation report, as they result in a much more succinct, meaningful and accessible piece of communication.

The challenges in creating the personas were generally around the quality of data used to generate them. The user research revealed communication problems with specific agents and resellers in different geographic regions. Some agents were unresponsive, possibly due to a lack of time. This made it difficult to ensure that each persona had the required depth to make them meaningful. The lack of direct information from certain agents were overcome partly by interviewing staff who work with these agents directly and have a better understanding of their needs. Details about each persona must be in-depth enough to provide meaningful engagement with each character in order to be able to 'design' for them. As Pruitt and Grudin [2003, pp. 12] stress, 'well-crafted personas are generative: Once fully engaged with them, you can almost effortlessly project them into new situations'. The advantage of having well-developed and believable personas is that they can then be reused in training or marketing analysis, extending the benefit of the method.

4.2 Visual method 2: Competitor analysis (Project A)

Method:	Competitor Analysis
Benefits:	Cognitive: elicitation and synthesis of competitor's products and services as well as identifying the company's current market position Social: communication and alignment of goals Emotional: validation of the project's goal
Purpose:	Articulating and communicating insights
Visual format:	Abstract and Synchronic

A competitor analysis is an assessment of the strengths and weaknesses of current and potential competitors. The analysis is also used to map and compare the competitors' product and services with the company's own offering. Although a competitor analysis is often conducted as part of a marketing and strategic management activity, the visual way in which the results were mapped out and presented in this project differentiated it from its traditional application. This approach is also similar to a comparative analysis often conducted in design projects to compare features and functionality of existing product and services. The competitor analysis in this context also included a comparison of the competitors' products and services.

Two visual maps were created to communicate the results of the competitor analysis. Figure 2 illustrates a shortlist of the company's key competitors' products and services, and places these within a comparison chart. While the second diagram was a more detailed visualisation of the complete range of pipeline maintenance companies round the world. The services were also broken down into categories of manufacturing, distribution and training. The map provided an immediate feedback as to where the gaps were in the market, and benchmarked the company's position in relation to their competitors. It justified to the project team the importance of the project, due to the lack of quality training services offered by competitors. It also enabled the company to benchmark against key competitors, and to ensure that the e-training service they planned to develop had key differentiation from any existing training packages.

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The competitor analyses were presented to the project team and the company's management to highlight the range of products and services currently available in the industry. The associate found that it was a lot easier and quicker to communicate the value of the project based on the gaps visualised in the charts. External audiences immediately grasped the current position of the company in relation to its competitors, while clearly seeing the opportunity gap in producing a high-quality e-training system. Although the company knew there was an opportunity to exploit the gap in the training market, they did not have an accurate picture of its competitors until the results of this exercise were presented back to them.

The application of visualisation techniques to establish strategic and management tools such as the competitor analysis has enabled a range of stakeholders to engage with the results, thus improving its effectiveness. It provided the project team with an early confirmation of project benefits based on the analysis of available training offered by their competitors. The visual charts translated raw data into accessible knowledge representation, that helped to engage a wider internal audience in the company. An added benefit of the competitive analysis charts was the ease of dissemination to staff outside of the project team, demonstrating to them the value of the project and benchmarking the company in relation to competitors. This all helped build confidence in the project, and the direction the company is heading in.

The challenge in trying to translate established business analysis methods into a visual output was in part determined by the presence of visual communication skills within the company. The associate was comfortable producing visualisations of his research due to his design background. When asked, the marketing manager was certain that she would be unable to produce these visual charts as she does not think in a visual-spatial way and lacks the confidence to visualise the information effectively. This highlights the importance of encouraging a visualisation approach within the company to ensure that the benefit observed from the use of visual methods will not be lost after the project ends.
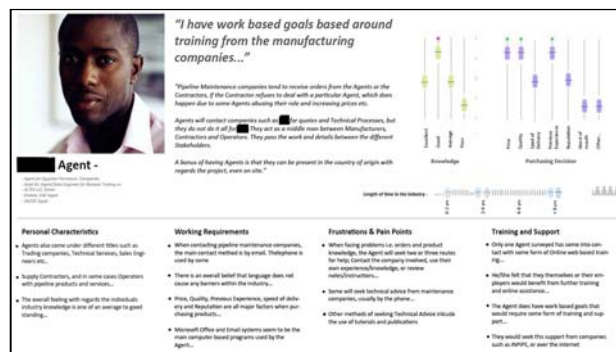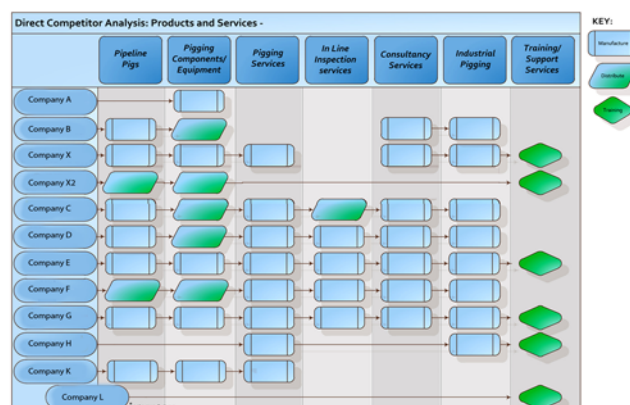

Figure 1. Example of an agent's persona

Figure 2. Competitor analysis comparison chart

4.3 Visual method 3: System options mood board (Project B)

Method:	Mood Board
Benefits:	Cognitive: synthesis of data relating to the two different systems Social: ensuring buy-in from project stakeholders Emotional: presenting a persuasive argument to the board of directors
Purpose:	Articulating and communicating insights
Visual format:	Abstract and Synchronic

A mood board is defined by Tassi [2009] as a 'visual composition of pictures and materials that propose an atmosphere by giving the generic perception of it'. It is commonly used by designers to portray the intrinsic value of a product, brand or service that is often difficult to describe verbally. Mood boards can consist of photographs, words or illustrations which can be used conceptually, realistically or metaphorically.

Two mood boards (see Figure 3 for one example) were prepared for a board meeting where the project lead was asked to present the results of his analysis of suitable information systems. Aware that he was allocated a limited time to present his case in the meeting, he decided to supplement his report and presentation with mood boards that acted as visual shorthand to highlight key points and to ensure that board members took notice. The mood boards were particularly effective as they emphasised the key points in each of the proposed systems and enabled the project lead to talk the directors through the pros and cons of each system succinctly. The boards also emphasised a 'take-home' message and helped the board members to remember the key points of each system proposed. The project lead reflected that the mood boards were probably the most significant visualisation method that he used due to the importance of communicating accurate information to the board members at such a crucial decision stage. From a director's point of view, the mood boards 'captured my interest and made me think.'

The project lead also used the mood boards strategically to make the case for the selection of a particular system. They were not only used as an information tool but also as a persuasive tool. Each mood board depicted the key points of an information-integrated system. The design of the mood boards was carefully thought out to ensure that the positive points are clearly highlighted on the preferred system. Knowing that some of the directors would be more partial to the other system due to past experiences of using the product, the project lead sought to neutralise this bias by ensuring that his countering arguments are presented clearly in the other preferred system mood board.

The challenge experienced in the creation of mood boards was to try to carefully 'design' the boards not just as an informational tool but also as a persuasive one. The project lead required the help of a colleague with a design background to help him compose a persuasive visual argument. There was also a danger of over simplifying the key points and information required to make an informed decision if based entirely on the mood boards. This was countered by accompanying the mood boards with a more detailed report given to the directors to take away at the end of the meeting for further interrogation if required.

Figure 3. System options mood boards
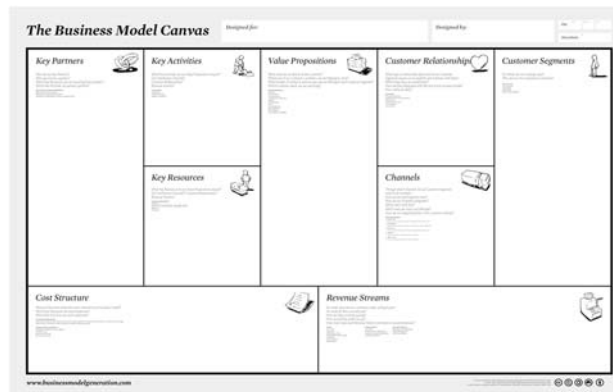
Figure 4. Business model canvas

4.4 Visual method 4: Business model canvas exercise (Project B)

Method:	Business Model Canvas
Benefits:	Cognitive: elicitation of the company's business model Social: communication and alignment of goals
Purpose:	Articulating insights
Visual format:	Abstract and Synchronic

The Business Model Canvas (see Figure 4) is a strategic management and entrepreneurial method that allows companies to describe, design, challenge and reinvent their business model. It has been developed by Alex Osterwalder and Yves Pigneur in their book, The Business Model Generation [2010]. Although not strictly a design visualisation method, this method has generated interest amongst the design innovation and social innovation community, being used alongside other more recognised design visualisation tools. It was also selected as it bridges the gap between a design approach (visual, opportunity-exploring and holistic) and a management approach (decision-making and problem-solving).

The Business Model Canvas (template available online at http://www.businessmodelgeneration.com/canvas) is made up of nine basic building blocks of a business model. They consist of customer segments, value propositions, channels to reach customers, customer relationships, revenue streams, key resources, key activities, key partnerships and the cost structure. The two project leads conducted an exercise to map out the company's business model using this visual method with the managing director, finance director and marketing manager at the start of their two projects. The original aim of the exercise was to map out the current business model and to help the project leads understand the company's business structure. The outcomes of the exercise resulted in not only a better understanding of the company's business model, but also led to discussions around the purpose and aims of the two projects. The unintended benefit was that it solidified the thinking between the three participants and helped to develop a shared vision, as described by the marketing manager:

> 'It was an opportunity to talk about how we individually thought the projects would work and how important they were strategically. And then to consolidate our thoughts we had on the project so that everybody were on the same page.'

This was important as the projects were initially developed by the managing director and the marketing manager, and the finance director had minimal knowledge of the origins and purpose of the projects. The visual and interactive nature of the exercise was unfamiliar to the three senior managers, particularly the finance director. However, with some coaxing, each participant embraced the process and enabled the project leads to converse in a more informal manner with the senior team. The visual nature of the exercise enabled the leads to challenge the individual assumptions of the company (put down on paper) and were helpful in developing a shared vision for discussion. The results of the exercise were shared in a report which was distributed to the other senior management within the company. The marketing manager felt the exercise was so useful that she suggested a repeat of a year later, in order to chart the changes that had occurred within the company during that period.

A possible disadvantage of this exercise is the unusually visual and interactive nature of the activity. It can be seen as a huge departure from a traditional conversation-based business meeting. Senior management might respond negatively and dismiss the activity. While this was not the case in this company, future facilitators of this exercise in other organisations must consider the possibility of non-participants and ensure that their presence does not derail the entire process. Although this method was not used to support a decision making process, it enabled the negotiation and development of a shared vision of the company, especially in the strategic role of the two projects. This shared understanding created a much clearer sense of purpose and generated support for the project from senior management. This has enabled decision making around the projects to be more focused and directed.

5. Discussions

The objective of the paper is to understand how visualisation methods originating from design can contribute to decision making processes. We started by defining visualisation methods and how design visualisation methods are different from existing methods used in a management context. We then put forward literature to support the use of visualisation methods in decision making and presented examples of design visualisation methods to support this argument. The four methods discussed in this paper illustrate many of the benefits and challenges of using design visualisation approaches in supporting decision-making processes over non-design approaches. We will now discuss the benefits and challenges in using design visualisations in a management context.

5.1 Benefits

Discussions and evaluation surrounding the use of the visualisation methods by both project teams have clearly indicated the value of their use in supporting decision making at different stages of the project. The Persona method was particularly effective as an elicitation and synthesis device (refer to Eppler and Platts' conceptual framework), as it provided a ready-to-use structure for the organization and synthesis of information on existing service users. Particularly effective was the presentation format of the Personas, depicting fictitious archetypes as if they were 'real'. This helped the project team to engage immediately with the user's different requirements based on their motivations and values. The Personas validated existing knowledge of the different user groups and also provided more specific information about the requirements of different users to enable the project team to make decisions as to which user segment to focus on.

The Competitor Analysis method enabled the project team to benchmark their products and services with their competitors and, importantly, to provide a justification of the strategic importance of their project to senior management. It helped to build a common understanding of the company's standing amongst its competitors, and identified gaps in the market relating to training services.

The Mood Board method enabled the project lead to support his justification of his system preferences by using a visual shorthand to highlight the positive points of the preferred system in a succinct and memorable manner to the board of directors. It was the most direct application of visual methods in supporting decision making in these two case studies. The Business Model Canvas exercise provided the benefits of elicitation and synthesis, as well as clarifying the different perspectives of the project team and senior management. The Canvas method also has a structure that enabled participants to elaborate on information, and to build a common understanding of the company and the aims of the two projects.

5.2 Challenges

Although a number of visualisation methods have been used in these projects (8 in Project A and 5 in Project B), it was clear that not all methods had the desired impact on decision making. Some methods were focused on internal reflection, helping the project leads to capture and make sense of information, while others were more beneficial in the analysis of collected data. The four methods presented in this paper were selected based on an evaluation of their ability to inform decision making within the project team and also with senior management. A key challenge for managers wanting to implement design visualisation methods is the necessity of adopting a visual-spatial thinking approach. The marketing manager admitted that her natural tendency is to use existing marketing

methods as she does not 'think in a visual way'. An additional barrier is the ability to translate complex information into succinct and simple visual representations. We identified the importance of having visual communication skills within the project team in order to organize information into a readable and usable format, as well as having the ability to use drawing or mapping methods to present the information. However, we did observe that not all visual methods require a specific level of visual literacy and skills. The Business Model Canvas, for example, can be replicated without the need for visualisation skills or knowledge of specialist software.

It is important to ensure that any visual representation of data is accurate, and does not mislead the project team into making uninformed decisions. Visualisations should only be used if carefully constructed, and only if the data is presented clearly and accurately. The benefit of visualisation is the ability to communicate complex data in a succinct manner. However too much simplification can render the data meaningless, while too little can reduces its effectiveness. This highlights the importance of ensuring that the most appropriate visualisation medium is chosen for the specific purpose. Some visualisation methods may also have negative connotations. For example the Personas highlighted criticism of the company's service levels that was found during user research. It is then important for senior management to ensure company staff understand that the purpose of the exercise is to improve processes rather than highlight the deficiencies of any particular department or individual.

5.3 Conclusions

The benefit in using design visualisation methods in tandem with the more traditional visualisation methods have been shown to support decision making processes in the case studies presented. More research needs to be undertaken in order to compare and contrast design visualisation methods with traditional visualisation methods and how they can be used together. The use of design visualisation methods in support of traditional management methods may enable them to be better received as the combination will be less alien to managers. A suggestion would be to try to include design visualisations in Lengler and Eppler's Periodic Table of Visualisation Methods for Management [2007] to understand the role that design visualisation can play. There is also a need to develop training that embeds the visual communication skills required to create effective visualisations within companies. Finally, we echo Eppler and Platts' [2009, p.70] recommendation that companies wanting to exploit the benefit of visualisation should first encourage visualisation as an approach, rather than simply as a procedural activity of summarizing information visually.

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