CAN THE SPORTS DESIGN PROCESS HELP THE INCLUSIVE DESIGN COMMUNITY?

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Abstract

As the global population ages, inclusive design is becoming more important to companies due to customer demands and increased competition. It is also acknowledged that the use of a formalized design process is of commercial benefit to a company. There is therefore a need to consider the user more fully throughout the design process. Sports products are highly user-centered due to their need to improve the overall sporting performance of an athlete, therefore it hypothesized that strengths from the sports product design process could be utilized within the inclusive design approach. This paper reports on practical study, which investigated the similarities and differences between the sport and product design processes followed by companies in practice. It was found that there was little variation between the core stages of the design process, although large companies were found to follow a more structured approach than small companies. A key difference observed between the sports and product design approaches was the level of user involvement within the process. Sports companies showed greater user involvement, with usability and user performance being the emphasis of the process.

Keywords: Design process, Design practice, Inclusive design, User centred design, Sports Design

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Please cite this paper as:
Surnames, Initials: *Title of paper*. In: Proceedings of the 20th International Conference on Engineering Design (ICED15), Vol. nn: Title of Volume, Milan, Italy, 27.-30.07.2015

1 INTRODUCTION

The design process is defined as "a rigorous, cyclical process of enquiry and creativity… consisting of a series of methods that are put together to suit the nature of each design project" (Best, 2006). The Design Council (2007) suggested that there is a direct correlation between business success and the use of a formalised design process as it allows identification of areas for improvement and ensures that those within the company understand the decision process (Cooper, 2001). It is therefore suggested that a formalised design process that focuses specifically on addressing the needs of the user would be of commercial benefit to companies.

It is hypothesised that the sports design process will be highly user-centred due to the performance requirements of athletes and that this approach could be applied to other aspects of design where user needs are key to product success, such as inclusive design. However, there is a lack of research into the sports design process. This research aims to identify the similarities and differences between the design processes followed by sport and product design companies in practice, in order to investigate the potential for identifying a user-centred design process followed by sports companies. This study will form part of a triangulation approach for a larger piece of research, which will aim to define the sports design process and apply its strengths within an inclusive design setting.

2 BACKGROUND

It is difficult to standardise the design process due to the diverse nature of design problems (Design Council, 2007). Many models have mapped out and illustrate the design process (McGinley & Macredie, 2011) and (Cross, 2000), resulting in multiple representations of the process. However, the majority of these models are similar in structure and appearance. Ulrich and Eppinger's model (1995) shows a mainly convergent process made up of planning, concept development, system-level design, detail design, testing and refinement, and production ramp-up stages. Pugh's model of total design (Pugh, 1991) shows similar key stages – market, specification, concept design, detail design, manufacture and sell. Despite differing terminology, both models contain similarities between core stages and a linear representation with iterations between stages. The Design Council's (2005) Double Diamond model provides a more simplistic approach to the design processes using only four key stages – discover, define, develop, and deliver, while illustrating the divergent and convergent nature of design.

Despite the number of theoretical design models, there is extensive literature that suggests these models are not representative of design processes followed in practice (Maffin, 1998). It was stated by Clarkson and Eckert (2005) that "there is no single model which is agreed to provide a satisfactory description of the design process". Goodman-Deane, *et al.* (2010) found that although companies structured their design processes using similar core stages to existing models, there were often key differences in how the design process was implemented and the level of detail shown between companies.

As will be discussed in this paper, there is an increasing need for more user-centred approaches to design, due to increased competition and customer demands. Many theoretical models do not appropriately show user involvement within the process. Although the user is considered in the background text that accompanies these models, Maffin (1998) suggests that many designers do not have more than a basic understanding of those models. There is therefore a need for a process that is both reflective of design practice and places the user at the heart of the development process.

Inclusive design is a design philosophy that aims to consider the needs and capabilities of the whole population during the design process (Johnson, et al., 2010), without compromising business goals and customer satisfaction (Clarkson, et al., 2003). The UK population is ageing – by 2050 a quarter of the population will be aged over 65, with 8 million over 80 (Cracknell, 2010). This will result in a diverse range of user capabilities (Johnson, et al., 2010) and an increased demand for products that are designed to cater for those needs (McGinley, 2012). Clarkson and Coleman (2010) suggest that people are disabled by the environment around them, which does not take into account the full range of human capabilities. There is therefore a need to consider not only the user more fully during the design process but also the range of capabilities of those users.

While it is acknowledged that it may not be possible to consider all users in the design process, there are improvements that can be made that will see a wider range of users accommodated. User-centred design is an approach that places the user at the heart of the design process (Clarkson, et al., 2003). In

order to be people-centred, the user must be considered throughout the design process, from the initial problem to refinement to the final solution (McGinley & Macredie, 2011). It is well documented throughout the literature that understanding the user is increasingly vital to design (Formasa, 2009) and it is becoming more apparent that usability is dictating the market success or failure of a product (Bruder, 2000). Bruseberg and McDonagh-Philp (2000) suggest that the user should therefore be involved more often and earlier in the design process.

As sports products should aim to enhance performance (Froes, 1997), it is expected that the approach to sports design will be highly user-centred. A sports product on its own will not produce sporting results, it must work with the athlete in order to improve the overall performance of the athlete. Despite the large amount of research that has been undertaken to model various design process (inclusive design, design for environment, etc.) there are a lack of studies to date that have focused on the design process behind sports products. This is surprising on two counts.

1. With the increasing demand in sport to continually improve sporting performance, it would be expected that more interest would have been taken into the process behind designing sports equipment.
2. From the increase in awareness in inclusive and people-centred design it could be expected that lessons could be learnt from what is a highly user focused discipline.

This study therefore aims to identify key differences between sport and product design processes, with a view to investigating how this may influence future work on how the inclusive design process meets the needs of the user.

3 APPROACH

This research will be a practical study to investigate the design processes followed by sport and product design companies. There are many reports of differences between theoretical models and the design processes followed in practice (Maffin, 1998), (Goodman-Deane, et al., 2010) making comparisons between the practical sports design approach and the theoretical models of product design difficult. It was therefore concluded that a practical study should include both sports and product design companies to allow valid conclusions to be drawn regarding their design processes followed in practice.

This study conducted interviews with both sports and product design companies to gain an accurate overview of the processes they followed in practice, which allows for a comparison between each. Figure 1 illustrates the overall research framework, with shaded sections highlighting the work completed during this part of the study. Existing design process models and literature were reviewed and current industry practices in both sport and product design were investigated, focusing on the design processes followed by those companies and user involvement within the process. The long-term outcome will be a new theoretical model of the sports design process. It is anticipated that this model will be used to influence user-centred and inclusive design.

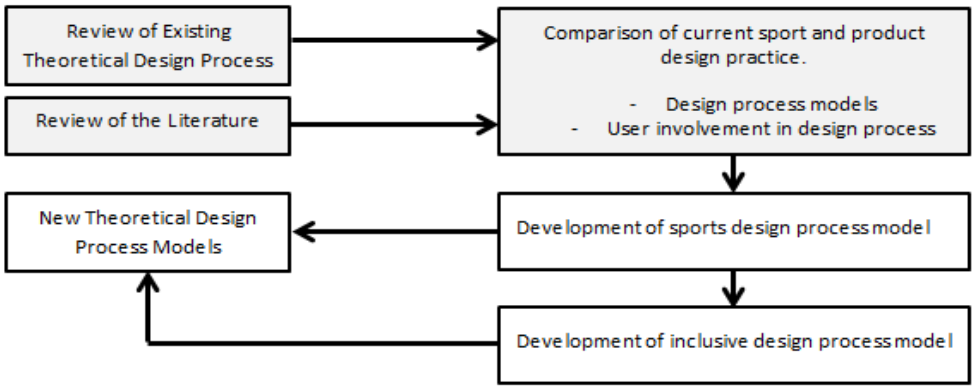

Figure 1. Research Framework

Both large and small companies were interviewed in this study as was unclear whether design processes would be influenced by company size. Company size was determined using The Companies Act (2006), which defined a small company as "meeting two of the following: annual turnover of £6.5 million or less, the balance sheet total must be £3.26 million or less, the average number of employees

must be 50 or fewer". All large companies were multi-national, while small companies were based within the UK. Sports companies developed products including football shoes, running shoes, tennis racquets and golf clubs, while product companies included the design of home appliances, domestic sound systems and printers.

Figure 2 illustrates the research approach to this study. Semi-structured interviews were conducted and provided a level of detail that would not have been possible to acquire through a questionnaire-style approach. A similar approach has been followed in several previous studies as part of research into design processes/methods (Goodman-Deane, et al., 2010), (Bruseberg & McDonagh-Philp, 2000). Interviews lasted around 40 minutes and allowed clarification of relevant information to ensure key points were covered, while allowing the interviewee freedom to develop their thoughts. Interviews were conducted with designers from each company who had an understanding of their design process and supporting methods. 9 questions were asked, covering topics including design processes followed, methods used and designer and user involvement.

12 companies were interviewed as part of this research – 6 sport and 6 product design companies, with 3 large and 3 small companies of each. The names of the companies involved will remain confidential – the naming convention used for the companies is shown in Figure 2.

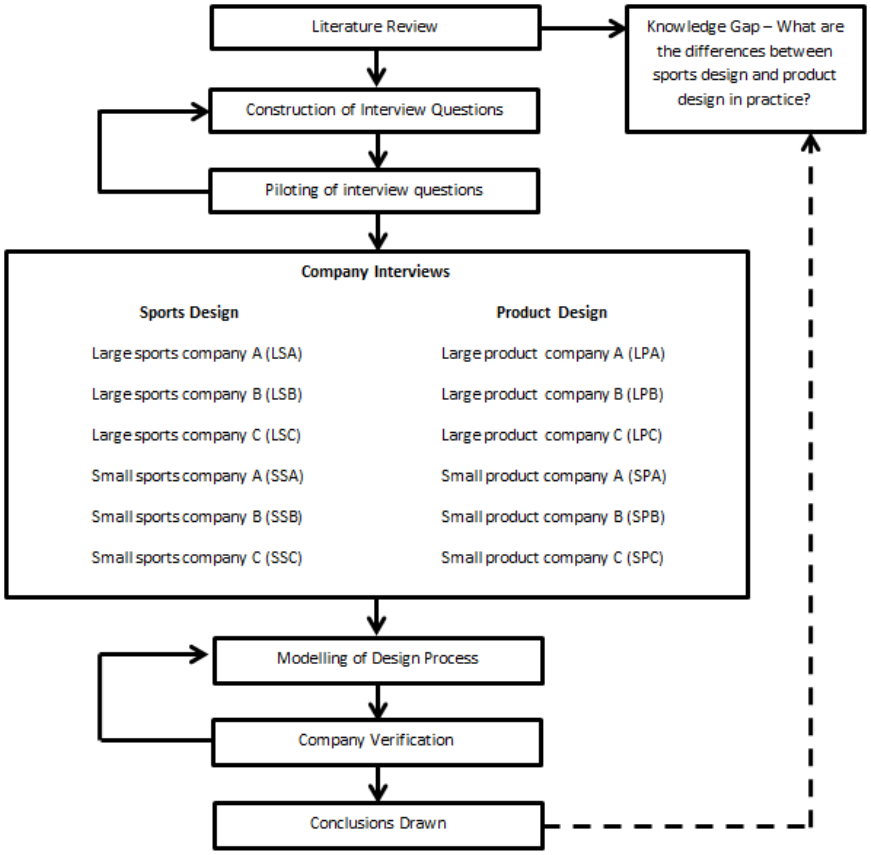

Figure 2. Research Approach

Where possible, interviews with the designers were conducted face-to-face. However, due to location, some interviews were conducted by phone or Skype. During face-to-face interviews, designers sketched out the design process. For phone and Skype interviews, the researcher sketched the process following instructions from the designer. All interviews were completely transcribed and additional information from the transcript (iterations, involvement of the user) was added to the diagram of the design process generated during the interview. Process diagrams were returned to the company via email for validation and in some cases additional information was asked for. Company transcripts were analysed using a general inductive approach (Thomas, 2006), where a framework was used to interpret and compare significant themes emerging from the interview data with findings from the literature review.

4 RESULTS

4.1 Design Process

Although no guidance for illustrating the process was given, all designers provided a linear representation. The core stages for each of the companies interviewed are shown in Figure 3, along with iterations between and within stages. Shaded areas highlighted stages implemented by the company. Names of process stages were standardised between companies.

All large companies were able to provide a detailed explanation of their design process, which included multi-disciplinary working with good communication between teams. LPB was the only large company not to have a formalised process. However, the steps followed were clearly identified and did not vary between projects. Of the smaller companies, only SSA followed a structured process while the remainder described their process as ad-hoc. Small sports companies appeared to show more consistency and structure than small product companies – a designer from SSB reported, "it's much more ad-hoc with us, but there is some structure to it." Timescales for large sports companies were consistent, lasting 1 ½ - 2 years, while large product companies and all small companies showed more variation between project timings, ranging from weeks in product update projects to 2 years for new products – LPC stated, "there's a fair degree of variation… things that affect the length of time are complexity of the product, type of product".

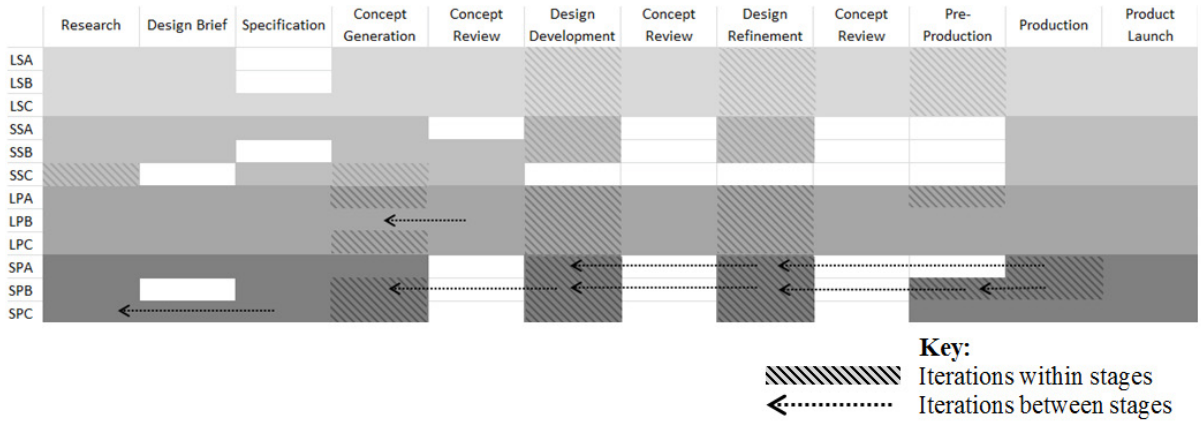

Figure 3. Common stages of the design process

All companies produced their own design briefs and/or specification with the exception of SPC which was a design consultancy although some communication was reported between the designer and the client depending on the project. The designer was only involved in the formation of the brief within the small sports companies, where data was collected by the designers themselves. All large companies produced a written design brief, with product companies providing an additional specification, although LPB appeared to lack the detail seen by other large companies. None of the small companies reported producing a detailed brief and communication was predominantly verbal. All small product companies added that their briefs lacked detail – "we get a power point with maybe 6 bullet points on it" (SPA). Data included in the brief varied between companies but market need, competitors, technology and performance targets were often included.

Prototyping early played a key role in all sports companies to allow user testing to occur early, which was a highly iterative process. LPC produced prototypes early at the concept generation and detail design stages, although this was to assess functional performance rather than usability. Other product companies prototyped individual mechanisms rather than the whole product.

All large companies included a fixed number of design review stages within their process, where company management and directors were involved in major design decisions, allowing a linear process to be mapped out. Although in some projects problems would result in significant back-tracking through the process, this was reported to be extremely rare. In contrast, review stages were rarely present in small company design processes. SPA and SPC reported occasional review meetings although these were not a formalised part of the design process and occurred infrequently and irregularly. As a result, last minute design changes were common and often problematic – SPB reported: "you'll be quite far down the road when management say, what if we add this? Well we

don't really have space any more". These changes were reported to result in projects running over-time and additional project costs added.
All large companies carried out a pre-production stage to assess quality before mass production – a batch was produced to ensure quality was consistent when producing in high quantities. Although SPB and SPC showed a pre-production stage within their process, this was for the purpose of building one complete working prototype rather than batch producing parts to test for quality.
Large companies and small sports companies showed few iterations between stages (only LPB showed iteration between the first concept review stage and concept generation). Large companies followed a more detailed process compared to smaller companies, with more key stages illustrated in their design process (Figure 3) and only small process variations reported due to specific project requirements. LPC stated: "in terms of an overall process, we do have quite a structured approach we follow". Small product companies showed much iteration between stages, which was reported as being inconsistent between projects. It was apparent that much iteration occurred within the detail design and design refinement stages for all companies (shown in darker shading in Figure 3), with the exception of SSC. For sports companies, it was emphasised that this iteration was due to repetitive user testing and evaluation.
Designers within all sports companies had a deep understanding of the sports they were designing for, with all reporting that this aided their understanding of performance requirements. Designers within the small sports companies were involved in all stages of the process and all aspects of the company due to company size. Design decisions within all companies were mainly subjective, with designers often relying on their own experience and intuition.

4.2 User Involvement

User needs were a key focus for all sports companies with designers directly involved with users throughout the design process. Figure 4 illustrates user involvement within each company process, with shaded areas highlighting areas of user involvement reported by the designer and the level of shading distinguishing company categories. It should be noted that shaded areas represent areas of actual user involvement only –user needs still played a key role during the formation of the brief and at review stages, which was heavily emphasised for sports companies. Feedback, focus groups and observation were commonly adopted in the research and early development stages with more formal product/user testing utilised during the later development stages. Consideration of competitor products played a key role in the early stages of the design process for sports companies to assess performance characteristics and customer preferences.

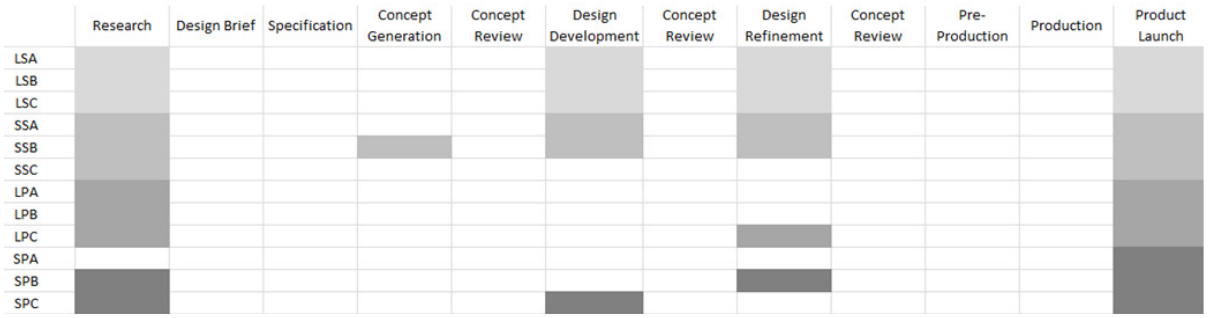

Figure 4. User involvement in the design process

In contrast, user needs were not a key consideration within product companies. User data received by designers was often secondary – in relation to user data, SPA reported, "nothing goes directly to me at all". Data was often mechanical or functional, stating performance requirements, with little data regarding the user or product usability. LPB was an exception, where designers were involved in some informal discussions with customers during the research stage, although not on every project. User feedback was often collected in the early research stage with LPA and LPC also involving the user late in the design refinement stage. Users were not involved during the development stage for other product companies, although LPC reported simulating product use with their own technicians. Small product companies did not report user testing at all throughout the design process, with the exception of SPC, although this was said to be dependent on the nature of the project.

The main emphasis of the design process for all companies (with the exception of SSC where the focus was on early user testing) was on the design refinement stage, although companies referred to this stage with different terminology. Key activities at this stage for large product companies included final product testing to ensure quality and performance were acceptable. In the case of sports companies, final product testing was key at this stage and focused on performance characteristics, with a high level of user involvement.

5 DISCUSSION

5.1 Design Process

Figure 3 illustrated the core stages of the design process for each company, which showed little variation between companies. This is in agreement with findings Gericke and Blessing (2012). Notable differences include the use of formalised design review stages within large companies and a shortened design process for SSC. Although most companies included a concept generation stage, the time allocated was dependent on new product development or existing product modification. A pre-production phase was present in all large companies to determine moulds and refine the factory process. This was not observed within smaller companies (with the exception of SPC), although SPB reported one test manufacture run at the end of design refinement. However, it was reported that there was communication between designers within small companies and manufacturers prior to production, likely during the design refinement stage, to select tooling, etc.

Large companies followed similar, structured processes where those within the company were aware of the process and their role within it. SSA also reported a formalised process, although lacked the detail of the larger companies. The remaining smaller companies did not adopt a formalised process, potentially due to the perceived time and resources required to do so. However, it can also be argued that the detailed processes of the larger companies may not be suitable in a smaller company environment. Maffin (1998) highlighted that design processes do not consider variables such as quality and availability of resources, designers and managers

Two of the small product companies reported projects running significantly overtime, with last minute design changes often coming from management. There appeared to be a lack of understanding from the management of the design process and the impact of late design decisions. It was also reportedly common practice for designers within the same company to follow different design approaches. This resulted in an increased number of unplanned iterations, duplication of work and poor communication, particularly in the small product companies. It is recommended that to improve efficiency within small companies a more structured approach to the design process is needed. However, it can be argued that the processes followed by large companies are not appropriate for use within small companies, due to limited resources, smaller teams and as observed in this study, a lack of structure. This paper therefore suggests that there is a need for more research into the design processes of small companies to develop a greater understanding of their design process and reasons for not following a more structured approach.

Differences between sport and product company approaches were evident. The design process for sports companies included a fixed number of review stages and few iterations between stages giving the process a more linear structure. Unplanned iterations were rare. Physical prototyping played a major role within sports companies, with the emphasis on producing prototypes early to allow user testing to be carried out, resulting in the high level of iteration within the design development and refinement stages. In contrast, most product companies focused mainly on early CAD work with some prototyping carried out during the design refinement stage. LPC emphasised producing prototypes early, but assessed mechanical functionality rather than usability. All companies emphasised that performance was a key requirement – for product companies, performance related to the functionality (sound, power, etc.) of the product. In contrast, sports companies viewed the user and the product as a system – both had to work together in order to be successful. This was a key factor that was emphasised by all sports companies as a product producing good results in testing on its own would not necessarily be a good product when being used by the customer.

5.2 Review Stages

Review stages were reported throughout the process by large companies, found after concept generation, detail design and design refinement stages where design decisions were taken, often involving company management and directors. It was noted that user involvement played a key role in the design review stages of the large sport companies, with focus group feedback and testing results influencing the design decision process. It is expected that the review stages were found in the larger companies due to the greater number of people involved in the design process.

A review stage was only observed after concept generation within small companies, potentially as all members of the team worked in close proximity, therefore communication was often informal and verbal. Infrequent review meetings were mentioned in some small companies when design decisions involved management and production who were based out-with the design department, although these meetings were rare. It is suggested that more frequent, structured review meetings would likely reduce the number of issues raised later in the project (as stated by SPB in section 4.1, suggestions raised by management late in the process were difficult to accommodate), reducing costs and preventing projects running over-time as was observed in many of the small companies.

5.3 User Involvement

Figure 4 illustrated areas of user involvement within the process. It should be noted that these results illustrate user involvement as indicated by the designer, rather than formalised company practice, providing a realistic representation of user involvement. With the exception of SPA, all companies considered the user within the initial research stage, although with considerably less emphasis on user needs and abilities within product companies compared to sport. All companies interviewed received feedback from the user after product launch which was used to inform the early research stages of the next project (with the exception of SSA who were developing their first product). In the case of the sport companies, the designer was often heavily involved in engaging with the user. Although no company reported involving the user at the design reviews themselves, sports companies stated that user requirements were a key focus of these reviews. Although it can be argued that product companies would also consider usability at these reviews, there was considerably less emphasis placed on this by the interviewee.

User involvement methods varied within the early stages for sport companies but included observation, feedback, surveys and focus groups. Only SSB included the customer in the conceptual design stage to aid the selection of existing products. These were then developed further by the company, with changes made to style, materials and aesthetics. User methods used by product companies included focus groups and feedback on previous and competitor products, provided to the designer as secondary data. However, user feedback was not necessarily carried out at the start of every project.

User input played a key role during the design development and refinement stages for sports companies with methods including field testing, play testing, observation and biomechanical analysis. Both LPC and SPB included the user at the design refinement stage to test developed prototypes – however there was little scope for design changes at this late stage in the design process without impacting project costs and timescales. In contrast, sports companies placed the emphasis on the user earlier in the process and received continuous feedback, resulting in few issues raised in the later stages. LPC stated that the user was at the heart of their design process although this was not reflected in the level of user involvement within their process – designers and technicians often simulated product use themselves rather than involving the user. It is suggested that the design process models followed by large product companies do not emphasis user involvement. There is therefore a need to not only increase awareness of the user but also to aid companies and designers in the implementation of a user centred process. The benefits of implementing a user-centred design process are well documented with increased customer satisfaction (Topalian, 2005) and competitive advantage (McGinley & Dong, 2011) widely acknowledged.

Sports companies received additional input from professional players throughout the design process during early research and design development stages. This professional input was considered to be separate from that of the standard user as the professional athlete had a deeper understanding of the sport, the equipment and the performance requirements needed to improve their game. However, it should also be noted that the professional athlete is not a paying customer, therefore while their input is highly performance focused, the standard user should also be included to inform design decisions.

In contrast, there was no "professional" involved in the product development process to influence design decisions relating to user/product interaction. Although it can be argued that everyday products do not have the same elite performance requirements of sports products, there is the need to produce a product that is compatible with the user that will improve the overall product experience. It is suggested that all products will have an equivalent of a "professional" user, using the product more often and with more experience than the standard user.
From the findings, this paper suggests that the user and performance based approach followed by sports companies could aid the product development process, in particular the inclusive design approach. Involving the user earlier is likely to result in a product that better meets user needs and improve overall user experience. Given the competitive nature of many product markets, it is expected that following a process where the interaction between the user and the product is key will give these products a competitive advantage.

5.4 Designer Involvement

With the exception of the small sports companies, designers were not involved in the formation of the design brief. Within the small sports companies, designers were involved in all aspects of the business from formation of the brief to designing, marketing and sales. Designer involvement within large sport and all product companies was predominantly focused on designing. Within sports companies, designers were more involved with users throughout the process, compared with product design companies. It is argued that this involvement with the user gave the designer a more informed view of the project, performance requirements of the product and what the user wanted. It also reduced design alterations later in the design process or the launch of poor products.
All sport designers played the sport they were involved in and had an in-depth knowledge of their sport. This experience was reported by all designers to play a major role in influencing design and decision making. However, one sports designer reported, "we are not consumers, we are not normal anymore," emphasising the need for the designer had to take into account the paying customer who needed a reason to spend money on a new product.

6 CONCLUSIONS

This paper has highlighted that the core stages of the design process show little variation between both company size and between sport and product companies. However, it is noted that larger companies have a more structured approach to design, with fewer unplanned iterations and regular design reviews. The main difference observed between sport and product design was the approach to user involvement within the design process – sports companies prototyped early with the aim of assessing user performance, while product companies focused mainly on functional performance. It was also noted that the user was often involved throughout the design process for sports companies, compared to the beginning and occasionally the end of the product design approach.
The sports design approach viewed the user and the product as a system, which must work together as the product alone will not produce sporting results. For example a running shoe will not win a race – it must operate as an integrated system with the athlete to enhance the athlete's ability so that together they perform better. This paper recommends that this approach could be adopted within inclusive design to improve user experience. Although it is acknowledged that there are many factors that must be taken into consideration during the product development process, there is no doubt that meeting and exceeding user requirements is key in product success. While it can be argued that there will be product companies that follow a user-focused approach, this paper argues that there is a general trend of sports companies being more user and performance focused compared to functionality-focused product companies.
It is noted that the sample size of 12 companies is split in to 4 categories of 3 companies, therefore this small sample size may affect results. Despite the number of product design process models that are outlined in the literature, there are none that recommend the user-system approach adopted by sports companies. This paper concludes that there is a need to review the product design process to adopt a more user focused approach.
Future work highlighted as a result of the research carried out in this study includes the modelling of the sports design approach. It is intended that the user-centred approach to sports design could be adapted to aid product and inclusive design by bringing the user into the heart of the design process.

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