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Exploring the 'interface culture' between ergonomics and product interface design

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Product and interaction designers are important beneficiaries of ergonomics research. The availability of ergonomics data, guidelines, models, methods, techniques and case studies which could be used during the design process is immense. Despite this, a review of the literature suggests that these resources are not exploited or effectively implemented within the design process due to cultural differences in design approach. However, implicit in the literature is the notion that designers have empathy and covert understanding of ergonomics principles. Two studies are described which investigate how far ergonomics methods pervade design organisations. The first study, a telephone survey, explores how and what type of current ergonomics principles are currently used in 48 commercial consulting organisations. The second study contrasts two design organisations to gain more detailed insights into how different design cultures can affect the adoption of ergonomics principles. Broad conclusions are drawn on what type of delivery mechanisms should be provided in order that the implementation of ergonomics principles is more effective.

1   Introduction

Product and interaction designers are important beneficiaries of ergonomics research. The provision of ergonomics data, guidelines, models, methods, techniques and case studies which could be used during the design process is immense. Despite this, the literature suggests that this resource is not exploited or effectively implemented as part of the design process. A study by Klein and Brezovic (1986) suggest that designers poorly rate literature based research findings in favour of personal experience and prototype development. A much larger study by Grudin and Poltrock (1989) indicate that strong relationships usually exists between human factors specialists and industrial designers with the latter reporting a high level of human factors competence. However, the study further reports a high need for human factors information across a wide range of project specialisms (such as marketing and software engineering) although interestingly a high incidence of external rather than internal consulting was reported to obtain this information. Hammond et al (1983), in interviewing a small number of software designers, found that designers were not familiar with human factors literature and also reported concern over the relevance of the information provided by in-house human factors specialists but nevertheless had a good understanding of the type of input that should be provided by human factors practitioners.

These studies should present some concern for the ergonomics community as they suggest the prevailing design culture has poor regard for ergonomics literature along with a degree of

scepticism of 'in-house' ergonomics practitioners. However, implicit in all the studies is the notion that designers have empathy and covert understanding of ergonomics principles. One of the possible reasons for any disparity in cultures between the two disciplines could be at the communication 'interface' between the disciplines. Bishop and Guinness (1966) clearly identified many overlapping domains of interest between the two disciplines but also identified differences in approach, they state, 'The designer approaches a problem in a systematic way, but is not structured by the scientific rigor of the human factors specialist. The industrial designer is more widely eclectic. His interest in a design problem and its final solution need not be as narrowly defined as that of the human factors specialist. He relates solutions to the complete resolution of the design problem, using widely diverse criteria.'

They suggest, through examples that these differences in approach can complement each other where the human factors specialist can offer problem convergence by defining or focusing the problem in contrast to the industrial designer who offers problem divergence through a 'spectrum of possible solutions'. This view point suggests only a meeting of complementary skills is adequate rather than a full sharing and integration of approach which would seem a more inappropriate model for multi-disciplinary design teams.

Clearly, working cultures differ, industrial designers reason inductively usually adopting a 'solution-focused' strategy with an initial idea created early on which guides the development process (Lawson 1980), while ergonomists adopt a deductive reasoning approach, Wilson and Corlett (1990, p2) state 'Ergonomics is both a science and a technology and thus has a need of techniques for both data collection ... and application' . Both disciplines place a high importance on the 'end user', although this is less rigorous in industrial design where Grant and Fox (1992) suggest there is a strong reliance on a strong aesthetic criterion to design evaluation and use only themselves to evaluate their work. However, some industrial designers are departing from these 'internalistic' approaches by using simple user trials to challenge the designers' instinctive assumptions about a product (Fulton, 1993). This is supported by McClelland, (1990) who suggests that a wide range of ergonomics methods and techniques can be adopted by industrial designers to assess and justify their design solutions.

Within these studies, there are two issues which are inter-twined: the integration of different design roles and the 'presentation', both in terms of content and style, of ergonomics literature. Some studies have addressed the accessibility and relevance of ergonomics guidelines, (Burns et al, 1997) or explored the validity of different design and evaluation 'dimensions' such as heuristics, principles and standards (Bastien and Scapin 1995) or the need for a common representational framework between different design disciplines (Rouse et al , 1991). However, very few studies have addressed how ergonomics data and information should be presented to designers (Rouse and Boff 1998), in other words the 'interface' or culture between ergonomics and industrial design.

Gillan and Bias (1992) offer some suggestions related to the structure of this 'interface' including educational tools and an 'electronic gatekeeper'. However, this study does not go on to provide practical implementable solutions which are appropriate to designers by exploring the designers' task domain. Before practical solutions can be sought, some consideration is required to identify acceptance criteria of any interface between these two design cultures. Carroll (1991) states that

for any applied science to be contextually relevant depends on two criteria: *specificity* where the content is relevant and *applicability* where the 'use of the science must conform to the processes of application in the target domain'. These acceptance criteria are considered throughout the two surveys described in this paper. This is reinforced by Rouse (1991) who suggests that further research is required to understanding 'the human factors of design if we expect to be successful in integrating human factors engineering into the overall design process'.

This study attempts to further this understanding of the 'human factors of design' by conducting two interview surveys of designers. Firstly, a telephone survey, which addresses both the issues specifity and applicability by exploring what type of current ergonomics methods are currently used in commercial consulting organisations and how; while the second survey involved detailed interviews with two design organisations to gain more detailed insights of their design culture and their approaches to integrating ergonomics methods. The survey was designed to be exploratory and not to provide fully conclusive results but rather to explore the 'interface' between the two cultures.

2 Telephone based survey on the use of ergonomics methods in design organisations

Rationale for study

The purpose of this study was to establish what, if any, type of ergonomics methods are currently used in industrial design practices and more specifically during the design of product interfaces. The primary objective was to contact a broad base of commercial organisations and to begin understanding the range and factors affecting the uptake of design methods used during the product development process. From this, more specific questions were asked to extract indicators related to the usage of ergonomics methods and literature. Questions were not specifically asked on the impact of any ergonomics methods or literature used but rather to identify examples of ergonomics methods or data that fitted successfully into the industrial design process.

To achieve this a telephone survey was conducted in order to cover a wide variety of organisations quickly and cost effectively. One of the benefits of this approach was that large sampling was possible. The number of design consultancies in the UK is relatively small, therefore a large representative sample was possible.

Method

A list of 122 practising design consultancies in the UK was obtained from the 'Directory of Designers' (1991). A more up-to-date directory was not found for this study. The survey was designed to take no longer than 10 minutes. This was deemed a necessary constraint in order to gain more willingness on the part of the respondent to take part. This presented a number of constraints on the number of questions that could be posed and the level of detail that could be gained. Three key areas were identified as important: general area of design expertise; ergonomics design methods currently used and suggestions on how ergonomics methods and literature could be improved. On this basis, a questionnaire acting also as a checklist was drawn up.

Design organisations were then contacted and a senior designer or design manager was sought. Once contact had been made, a brief explanation of the purpose of the call was given, explaining the interview would only take 10 minutes. If the respondent agreed, the interview was conducted or, if necessary, an appointment was made when the respondent was available.

All comments were noted on the questionnaire along with quantitative data. Finally, respondent were asked if they could be contacted again if necessary for further clarification.

Results

Attempts were made to contact all 122 organisations which had identified industrial design as part of their expertise, from this original directory list 21 had closed, 9 declined to take part in the survey, 15 organisations were eliminated because it was difficult to contact the appropriate individual, and 27 replied that they undertook little industrial design work. Therefore 50

organisations took part in the survey, of these, 2 were used in the pilot study. So the final sample size was 48. Of those contacted in the survey, 64% described themselves as designers and 27% described themselves as either the proprietor or director of the organisation.

The mean number of employees in the surveyed organisations is 18.5 ranging from a minimum of 1 to a maximum of 60. Of these, the mean number of designers employed is 5.2 within a range between 1 and 22.

Figure 1 Frequency count of design specialisms

[pic]

Respondents were asked what areas of industrial design work they specialise in and also to indicate an approximate percentage weighting to each area of specialism. Most organisations tend to specialise in 2 -3 different areas. The results, Figure 1, indicate that 25 (52%) of the organisations surveyed design 'consumer products' as part of their portfolio of activity. Many organisations identified a wide range of design activity which has been classified as 'other' and includes design activity such as packaging, tablewear, furniture and sports equipment.

Respondents were then asked if they had any involvement in the design of the control or display aspects within product design projects, 37 (77%) of the respondents replied as having some involvement. They were then asked what stages in the design process they would be able to influence interface design.

Figure 2 Type of involvement in interface design

[pic]

The responses are presented in Figure 2 are obviously not mutually exclusive. Although involvement centres around pure interface design activities, 48% of respondents involved in interface design conduct some form of user requirements analysis and 70% undertake some form of evaluation study. Those recorded as 'other involvement' would include design aspects such as graphic design or including corporate identity. More specifically, the respondents were asked what type of design role they would typically have in interface design. Table 1 presents the clustered responses.

Table 1 Level of involvement in interface design

```
|Response                |Frequency    |
|                        |(n = 37)     |
|Design elements not done by|9          |
|client                  |             |
|Design of interactive   |8            |
|elements, not internal  |             |
|mechanisms              |             |
|Design of all aspects of|7            |
|controls and displays   |             |
|Design interface graphics|3           |
|Client leads interface  |2            |
|design process totally  |             |
|Placement of controls   |1            |
```

Only 7 organisations (18%) reported any real level of autonomy over interface design. These data have to be treated carefully as many respondents qualified their responses by stating that there was a great deal of variation between projects and also more importantly between clients.

Respondents were then asked if they involved users in their design process, 33 organisations (69%) replied that they involve users in some form. Those that commented that users were not involved usually stated that the client would possess some knowledge of user requirements typically through market research. Again, respondents suggested that the design process varied from project to project. Many respondents said that they would introduce user testing if the client had not already done so.

Figure 3 Response frequencies to consulting
users in the design process

[pic]

Figure 3 provides the response frequencies for consulting users in the design process; 'In house trials' were defined as consultation with other designers within the organisation. The results indicate a high degree of user consultation but less testing or evaluating design proposals with users. When asked more specifically about user testing and how it is or may be conducted on existing or proposed products, 8 more organisations admitted to conducting some form of user trials than reported in Figure 3.

When asked what type of paper based ergonomics resources were used, anthropometric based information is used predominantly (Figure 4). Respondents were then specifically asked if they used ergonomics design standards or guidelines during their project work. Six organisations stated that they may use British Standards and only two organisations use Design Council literature as design guidelines.

Eight of the organisations surveyed stated that they would or have used ergonomics specialists particularly if they felt that their 'in house' expertise was not adequate. When asked if they used any specific ergonomics data or methods in the design of product interfaces, 19 organisations (79%), that felt that they often contributed significantly to product interface design, stated that they did. However, 8 of these, described computer aided design tools (CAD) as an important part of the human factors design process. Four organisations used some form of printed material and three organisations said they used design guidelines.

Figure 4 Response frequencies for the use
of paper based ergonomics resources

[pic]

The final question posed was, 'How could ergonomics based information and data be improved?'. Very few respondents answered this directly, those that did suggested that more use could be made of the computer based medium with more interactive data resources such as CD ROMs. Most of the respondents perceived that ergonomics should be an integral part of a CAD package providing support and data when appropriate, particularly physical user three-dimensional user models.

Discussion

The sample size of 48 represents a substantial proportion of the estimated industrial design consultancies in the UK. Attempts were made to use a more recent directory of consultancies but there have been no subsequent editions of the Designer Directory. However, enquires were made to establish how many current practising industrial design consultancies exist in the UK from the Design Council and the Chartered Society of Designers (CSD). Unfortunately, both organisations were unable to provide up-to-date information. This information was not available for two reasons. Firstly, defining an industrial design consultancy is difficult as many organisations provide services across a number of design disciplines. Secondly, there are a high number of fluctuating small consultancies or sole traders. However, estimates suggest that there are approximately 120 organisations. Although the sample is large, caution should still be taken with the findings. Only one individual within any organisation was spoken to and only for a short period of time and points of discussion were addressed in broad and high level terms. The survey provided little opportunity to discuss issues in any detail. In particular, the variation in design approach depending on the design project was consistently stated as a response to many questions and therefore many generalisations have taken place.

Although a high number of respondents reported that they undertake interface design, there is evidence that their clients largely determine the functional specification of the interface leaving the design consultancy to have either residual or peripheral input. The number of organisations who reported involving users in the design process (Figure 3) also appear encouraging with the use of interviews, observation and focus groups rated highly. However, as the survey was so short it was not possible to investigate the type of impact users might have on design proposals. When respondents were asked to comment on the type of user trials adopted, there appeared to be some wide interpretation of this term. Originally, this question was posed to establish if any form of usability testing is conducted. However, this question has been more widely interpreted to include user consultation such as 'observation of users with existing products'.

Industrial designers still appear to use a narrow sub-set of available ergonomics data and methods (Figure 4) with anthropometric based data providing the key resource. Interestingly, Humanscale (Diffrient et al, 1985), or 'Dreyfuss' as it was usually referred to, is still an important resource despite its age. This may be due to its compactness and a strong visual presentation of information. British Standards were also reported as a resource but it was not determined if these were consulted purely as ergonomics based standards. Certainly when the question was posed openly, very few respondents alluded to any design or evaluation methods specifically related to interface design. However, when this was posed, those that stated that they did use them, tended to discuss these in terms of CAD software, with only three organisations explicitly stating that they use interface design guidelines. It would have been interesting to investigate the reasons for such a poor uptake of interface design or evaluation methods. Again there appears to some contradiction between the general and specific questions where prompting the respondent elicits a new sub-set of information. There could be several reasons for this. Firstly, respondents may just find it difficult to recall all design methods from questions which were specifically targeted, also and respondents may not define or view the design process with the same objectivity required from the questioning. Secondly, there may be a willingness by the respondent to appear to be conducting full and exhaustive studies. Thirdly, many ergonomics methods may simply be viewed as an implicit part of the design process and not regarded as a separate conscious activity and therefore not mentioned explicitly as an ergonomics method.

Very few designers presented any suggestions related to how ergonomics data or methods could be improved for designers. Nearly all the suggestions focused on providing computer based resources particularly linked to CAD packages. This may have been a fault of the questionnaire design as the penultimate question allowed them to consider the broad range of tools they use and then to focus on ergonomics based tools. The preoccupation with CAD packages may have carried over to the final question.

One of the problems with this short telephone survey has been the alignment of terminology and perspective on each of the organisation's design culture. It was clear from the survey that designers do not see the process in an abstracted linear fashion but clearly for the purposes of the survey this had to be imposed on the questions. This has led to some anomalous findings particularly between the generic and specific questioning. To overcome this, deeper more lengthy interviews were commissioned in the second part of this study to explore in finer detail how different industrial design cultures implement ergonomics methods.

3   Detailed interviews with two design groups

The second part of the survey follows on from the telephone survey and attempts to address some of the obvious deficiencies that have been identified, such as the brevity of the interviews and the lack of contextual relevance and the ability to discern differences in organisational design culture. In this survey only two organisations were interviewed which were known to offer very different design cultures.

Rationale for study

The main objectives of the survey were to:

1. investigate in more depth how ergonomics is integrated into the design process

2. compare and contrast the use of ergonomics between two organisations having markedly different design philosophies

The second objective is important because, as mentioned earlier, applicability is an important criterion in acceptance and usage of an applied science. Comparing two quite disparate organisations, in terms of design approach, should help to understand and define this criterion. Comparing the two approaches allows qualitative judgement about the critical success factors that may define improvements at the interface between the two ergonomics and design cultures.

Method

The interviews were semi-structured and were of broad and wide ranging nature and were not specifically related to any particular design approach or use of a particular ergonomics method. Interviews were informal and were conducted at times when the designers were not busy. Anonymity for each organisation has been preserved and are referred to as company A and B. Company A can be described as possessing more 'traditional' industrial design methods while Company B provide a strong user participative philosophy with design work largely conducted in design workshops.

The two interviewees at Company A were both industrial design graduates while at Company B interviews were conducted individually with one industrial designer, one computer scientist, two mechatronics engineers, a usability engineer and an 'Industrial' PhD student. Notes were taken during all the interviews and interviewees were encouraged to illustrate or provide examples to support their answers such as presenting video clips, current project work or report documentation.

Results

Each organisation was asked the same type of questions and summaries of the responses are provided.

Company A

The two industrial designers out of a team of four were interviewed and had been with the organisation for about 5 years while the other for 18 months; they often worked on projects

together. The design group work as an internal consultancy and negotiate design projects with different parts of the organisation. Most of the work was considered to be 're-packaging' where facia panels would be provided with different colourways and new graphics. There was some degree of major styling work which involve the design of new controls and displays. The design group were anxious to be involved in 'conceptual' design work where the fundamental concepts of what a product could be in terms of functionality, form and identity were under scrutiny.

The design skills required were traditional, using 2D and 3D illustration and modelling software tools with marker pen illustrations and foam modelling. Contact with users was recognised, within the organisation's culture, as important but was a role designated to marketing groups rather than designers.

What type of involvement do you have in the design process?
Both stated that it varied depending on the type of product and the type of brief given to them. Company A own many brands which in the past were independent manufacturers which still retain many indigenous working practices and culture. Management structures and decision making processes therefore vary and indeed attitudes towards using industrial design affect the level of involvement. Typically, however, most design projects are 'facelifts' where an existing design is modified mainly in visual appearance. Degrees of freedom tend to be narrow with a high emphasis on low cost or re-investment using the same technology or technology from a higher specification model. Areas where alterations can be made tend to be in graphics, although some relocation of controls and consideration of size and shape of controls is required.

How are design proposals derived?
A design approach may be derived from external marketing consultancy reports, from competitors or through 'trend mapping' where a particular design style or lifestyle has been identified. Proposals are developed and then printed and pinned on the wall; discussions will take place between the designers about the merits and shortfalls of each solution. End users are not involved in this process. If ergonomics criteria are considered then generally they will be assessed on the flow and sequence of operation. User needs may be derived from a list entitled 'factors of influence' which is used as a checklist of psycho-social factors that may affect the user's perception of the product. Final design solutions are usually derived by bringing together different features of a range of design proposals. Final decisions on design proposals are made by external groups. This is usually the marketing department. For other products this could be through product planning groups or steering committees.

Are users involved in the design of user interfaces?
During the design process, no. Users are only consulted during 'clinic research' which is undertaken by marketing divisions with existing or 'near-to-market' products. The products are assessed against other competitor products but the trials are based purely on visual impressions. It is not possible for the users to use the products and none of the products are switched on. The designers said that the findings from these studies are often meaningless and any conclusive findings that can be drawn from the research can often by overruled by other groups within the organisation. The designers have requested that they be involved in this process, but it is not considered necessary.

What type of design tools are currently used?
Traditional design tools are used such as sketching, 3D modelling either in card or foam, 2D and 3D computer based modelling, also some style guidelines are used for different brand identities. The design group has recently had to comply to a product development process. However, this has only recently been implemented and in frustration from not having a coherent design strategy, one of the designers had produced an internal method which considers more speculative design proposals.

This approach has been funded for one type of product and was implemented in an incremental fashion rather than working on all phases concurrently. The reason for this was that design solutions had to be 'sold' to the group providing the funding.

Company B

Company B adopt a radical and extremely innovative approach to product development. They define their design process as 'empathy driven' suggesting their approach moves beyond participative design methods. Design activity usually begins with some field study work and then around three workshops. In these workshops a whole series of design tools are used to allow representative groups of users to define their own tasks, the design problem and to allow them to become empowered to design products for themselves. Within the workshop framework the process is regarded as 'event driven'. Important events that are identified either by the users or the designers that help define the product usually form important milestones in the design process.

Workshops are conducted closely together and much of the team's work centres around planning and analysing findings from field work and the workshops. Significant or important design activity is conducted within the workshops with users taking the more proactive role in design decisions while substantiating the design proposals and design detailing is conducted between workshops. Only one of the interviewees had any formal education in industrial design.

What type of involvement do you have in the design process?
Most of the group regard their role as facilitators rather than designers. They place a high emphasis on developing and understanding how they can communicate design problems and possibilities to users, for example trying to find new ways of presenting a product specification. Planning for a workshop is also an important and time consuming task. Many of the team described how workshop procedures had changed and altered over time and undergo their own iterative development process. Many of the tools they use have evolved and changed to improve the effectiveness for empowering users.

At the time of the interview, two of the team had responsibility for the field work of a new project. To gain an understanding of the project visits were made to a maintenance engineer, who had been used before for such design activities. Similar to the workshops, the designers would engage in planning the interview and devising scenarios in which the engineers could express his thoughts.

The team leader differentiated between the internal design process, within the group, along with 'close friends' in other parts of the organisation and the external design process, the product development activity within Company B. The difference in philosophical approach was

sometimes treated with scepticism but he felt that this was reducing over time. Having the support of a senior manager was important to the survival of the team. Projects tended to be conceptual in nature with some mainstream work. The team leader saw that their future depended upon having more mainstream design work while using their design approach.

How are design proposals derived?
The team leader negotiated with other parts of Company B to gain design projects but only if they allowed a fully user centred approach to be adopted, however funding was not dependent upon them. At the time of the interview the MMI group were beginning to discuss design work with external organisations.

Are users involved in the design of user interfaces?
The whole design ethos places a strong and important role for the user. Users provide the impetus and direction of the design work. A great deal of emphasis is placed on making users feel at ease in undertaking this design role. There was evidence of users making posters, drawing and acting in order to articulate their thoughts.

Most of the team described in one form or another the iterative, reciprocating swing between the designers and the users. The design process was constantly checked and evaluated by users. If pressed, the designers would describe some of the 'rules of engagement' which had been built up over time. For example, if users were asked to act out a particular scenario the designers had learnt that the users should only be asked to act a role they already had experience of.

What type of design tools are currently used?
The design team use a wide range of evolving design tools both in field studies and within the workshops and include: user characters by profiling specific users against design proposals; mapping which allows users to describe tasks through 'post-it' notes; the use of drama in design; the development of scenarios with the use of cartoons, fairy tales and crystal globes; and also extensive use of mock-ups and prototypes.

The documentation of the design process is usually video based and some of the design team were wary of formalising design proposals in anyway, stating that the design solutions resided in the workshops and not on paper. One interviewee stated that one of the problems with this approach was control over the granularity of the design detail and also a sense of not knowing how viable a design solution could be. The emergence of unexpected solutions was regarded as both a positive and negative outcome of the process.

Discussion

Within the detailed interviews with both design groups, the first and most obvious observation is how both design teams, in terms of a descriptive continuum of user centred design, occupy opposite extremes. The impact that users offer on the design process at Company B is profound, whereas at Company A it is incidental. Interestingly, both organisations are fighting for legitimacy within their respective organisation but for opposing reasons. Company A regard conceptual work as an important goal or direction for the design team and are keen for this type of work to gain importance with the manufacturing organisation whereas Company B determine their success not on the wide range of conceptual solutions produced but on their inevitable

commercial viability.

The same could be said for the use of ergonomics principles. Company A have a passing interest in the full scope of design methods that could be adopted while Company B have probably superseded most conventional knowledge on the use of ergonomics principles. However, this posses some interesting discussion on how ergonomics based design tools or methods could be implemented and fulfil the criterion of applicability in both organisations. A prescriptive tool set, if implemented, would certainly suit Company A but would very likely be rejected by Company B. Further, Company A gain their work through a top-down route usually through marketing and it would be possible, although not necessarily advisable, to impose ergonomics principles on the design process. Conversely, at Company B, any new ergonomics design approach would have to be fully acceptable to the whole design team.

One of the strengths of the Company B team is the willingness to frequently change and adapt to improve the effectiveness of the tools they use. However, most of the experience and knowledge gained from these design methods is retained as personal experience within the group and therefore depends on a consistent overarching group culture. As the style and approach of the design culture is constantly changing, it makes it difficult to identify a coherent framework. Further, many of the responses to questions resulted in statements such as 'you get a feel for how to do it' or they found it difficult to define the inputs and outputs of each design tool. It would be difficult to take this culture and transplant it elsewhere. Company A, on the other hand, could have quite radical changes in personnel and still offer the same design service, in this sense Company B are more vulnerable. The clear procedural design culture used by Company A allows some form of framework on which a ergonomics design tool set could be offered. At Company B, the more informal and less procedural approach with a proactive internal agenda for design methods makes any external insertion of ergonomics design tools extremely difficult.

Conclusions

The brevity of the telephone interview certainly constrains and limits the level of analysis that can be undertaken. It could be argued that attempts should have been made to lengthen the interview and allow for some more detailed investigation if necessary. On balance, it was probably correct to contain the interview to ten minutes as many respondents were initially reluctant to take part and could only be convinced on the basis that the interview was of short duration. Despite these shortfalls the survey has provided an overview of the extent and usage of ergonomics data and methods. The key findings from the telephone survey are therefore:

3. industrial designers have strong awareness of the importance of user involvement but not necessarily a strong commitment to user centred design

4. few designers have full autonomy over interface design issues

5. designers still use a very narrow range of ergonomics data and methods and many only use anthropometric data

6. there is little evidence that interface design guidelines are used

7. the integration of ergonomics data into CAD software was suggested

In terms of the findings of the second study, if we assume that designers will have to take ownership of any proposed ergonomics design tools then many of the design methods currently used by Company B may present problems in terms of uptake in more traditional industrial design cultures. As has already been identified, the design team function using a strong cohesive approach with heavy dependence on user participation. A design culture rarely found in any other design consultancies. A good starting point, therefore, for recommending an improved interface culture between ergonomics and design would be to suggest that proposed design tools should be placed between the two extremes by offering a framework that could be integrated into the more typical design consultancy model but at the same time allow users to be involved in a more direct and positive way. But serious consideration would have to be given to the evidence found in the telephone survey which suggests a limited uptake of explicit ergonomics methods and data.

As stated at the outset, this study forms the basis of investigative survey and the findings are not intended to be entirely representative, but it nevertheless provides pointers for further research. In drawing the two parts of the study together and addressing the issues of specifity and applicability, general conclusions that can be drawn are:

8. many designers appear to have a some tacit knowledge of ergonomics but also perhaps still unaware of how ergonomics principles could improve interface design even though the level of design autonomy at the interface design level might be quite small suggesting that specificity of ergonomics data is still an important issue

9. user centred design is still a minority practice and there is evidence to suggest that other ways will have to be found if the applicability of this type of design culture is to be integrated into the working methods of designers

In re-examining any acceptance criteria for applicability discussed above, Rouse et al (1991) state that designers obtain their information in three different ways: by human judgement (through personal experiences) which is the primary source of information, archives (the use of printed material) and models which are described as experiential, experimental and analytical. This suggests that ergonomics design tools must provide a framework that draws heavily on designers gaining knowledge through personal experience to fulfil the success criteria of applicability and not through passive means such as guidelines. Any framework must also build upon this tacit knowledge which allows ergonomics issues to be considered implicitly rather than explicitly. This study has also indicated that dramatic shifts in design culture to incorporate a wider range of ergonomics methods are unlikely to occur.

Therefore, in beginning to define an 'interface culture' between these two disciplines, this study suggests this area deserves more attention and that ergonomics methods must fit designers' requirements. Candy and Edmonds (1997) state, 'There have been a number of studies in engineering, industrial and software design that argue for computer support tools that take proper account of the real way that designers design. Requirements for support systems have been proposed and implemented as demonstrators systems. However, the extent to which fully fledged, commercially available systems have been based upon the results of empirical studies of designers

is poor.' This survey has shed further light on the need for this research direction.

Acknowledgements

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Resume

John V H Bonner is a senior lecturer at Teesside University and lectures in human factors, industrial design and interaction design. John is manager of a small research group investigating and developing novel interfaces for advanced and novel interfaces for consumer and industrial products. Much of the research is funded by an EPSRC (£100,000) grant. The research to-date has focused on the development of design and evaluation tools for highly conceptual design proposals and the development of novel interfaces using rapid prototyping techniques. A compendium of design tools have been developed and are currently being evaluated in industry.

Before becoming a lecturer, John was a freelance design and ergonomics consultant for four years and before that was a research associate at HUSAT at Loughborough University for three years working on the usability of IT products after graduating in Ergonomics. Prior to this, John spent five years as an industrial design model maker working on wide range of industrial and consumer products.

I would present the paper and require OHP and slide projector.