



## User involvement in the design of complex digital tools for employees in a large organisation

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### Abstract

Large organisations are designing complex technology-based tools for their staff to use. In busy workplace environments, it can be difficult to get user input about a design. This paper describes the designer and user interactions in one such organisation, gaining insights that could be useful in other similar settings. The findings are based on a set of interviews with designers and researchers within the organisation. The paper identifies the current practices and constraints involved in understanding and capturing users' needs and discusses potential solutions.

*Keywords: design practice, design methods, user testing, user involvement, designing internally*

## 1. Introduction

As the complexity of tasks in the workplace increases, so do the digital solutions used by large organisations. Many industries are utilising technology such as virtual reality (VR), augmented reality (AR), and increased use of artificial intelligence (AI) (Hornung & Smolnik, 2022). VR simulations can help workplace designers validate designs through simulations by using them in place of actual designs (Caputo et al., 2018). This can result in cost savings as problems can be identified before an actual design has been built. AI and machine learning (ML) technology can support and cut costs in workplace training, learning and staff development (Wilkens, 2020). Such technology can be adopted into useful tools for employees when completing work-related activities and could improve efficiency and cut costs. The current study took an in-depth view of how one large organisation designs new or improved complex digital interfaces and tools for its employees. The study used semi-structured interviews to obtain insights about how users interact with designers throughout the design process. The paper explores user involvement and consideration of users within the design process with a focus on current practices, constraints, and suggestions for improvements. User involvement refers to the communication and input that the design team has from user groups during a design process. Capturing current practices and highlighting constraints can inform design practice and help stakeholders consider ways to enhance a design process when organisations design internally for employees. Understanding how a design process involves users contributes to the overall understanding of what organisations use in practice when designing new or improved designs for employees and where there may be room for improvement. Product design commonly struggles with limits on time and budget which can result in limited opportunities to capture users' needs. Not capturing user requirements nor getting feedback at earlier stages in the design process may result in rework and adaptations that may be challenging or impossible to achieve (Dong et al., 2004). Moreover, it can result in designs being built that are not fit for purpose and do not achieve what they are intended to do.

Additional challenges present themselves when designing for employees internally. With a diverse and ageing workforce (OECD, 2017), how people use different digital interfaces may vary. Different capability levels create a diversity of potential needs among users and it is important to understand these when designing for people's use (Keates and Clarkson, 2003). Without this, some of the users may struggle to use a design or use it the wrong way, resulting in additional time or cost associated with a work task or increased frustration for users. As a result, the design may need modifications and could impact on the wider system where the design is being used.

To address this, organisations are increasingly considering the use of usability testing and design thinking. However, introducing more usability and design thinking practices can be challenging as there may be resistance to new techniques, especially in more traditional organisations. This resistance can be addressed by showing stakeholders the value and the potential return on investment of using such design practices (Shneiderman and Hochheiser, 2001). Attaching monetary value and forecasting the potential benefit, are ways to get buy-in from organisations (Mieczakowski et al., 2013). In addition, inclusive design theories suggest that highlighting the cost of not using design approaches can be a helpful way of understanding why they are needed (Dong et al., 2004). A study looking at the use of usability in organisational design practices showed that there was an increase of up to 720% in organisational productivity when usability was kept in mind at the start of a design process (Landauer, 1995).

### 1.1. Approaches and methods for user involvement

Different approaches can be used to support organisations to think about how users can be involved in the design process. These include user-centred approaches that help designers understand and put the user at the centre of the design process (Wilkinson and De Angeli, 2014). When evaluating how a user-centred approach can tackle the needs of interface design in a diverse office environment, obtaining feedback is beneficial and can underpin the importance of using a user-centred approach to tackle diversity in the workforce (Irizar-Arrieta and Casado Mansilla, 2017).

The inclusive design approach puts users at the centre of the design process and helps designers consider the diversity of users (Dong et al., 2004; Clarkson and Coleman 2015). This approach focuses on understanding users by thinking about the diversity among them. User diversity includes differences among users' needs, capabilities, attitudes, and mental models (Clarkson and Coleman 2015). The approach suggests using observations, journey mapping, and personas to help understand users' needs and advocates early feedback to improve the inclusivity of the design (Goodman-Deane et al., 2023). Methods such as user trials and using survey data to identify and quantify people who are likely to be excluded from a design can help tackle the challenge of designing for a wider range of users (Goodman-Deane et al., 2014). Survey data can also provide insights about the wider user group when user testing is limited or conducted with smaller sample sizes (Petyaeva et al., 2022).

Some other approaches that can support organisations when designing for employees include a co-design approach that incorporates the end user as an active participant in the design process (Trischler et al., 2018) and is seen as a collaboration between the user and designer. A systematic design process allows for changes and adaptations to be made along the way. It suggests that product design is central to any product development and that the organisation of design is dependent upon the organisation (Wallace et al., 2007).

## 2. Method

The current paper presents part of the exploration phase of a wider study which investigated how a large communications company designs complex digital tools for their employees to use. The scope of the current paper is to examine the involvement of users throughout the design process, capturing current practices, highlighting barriers, and suggesting ways of improvement.

Semi-structured interviews provided insights into the design process including interaction with users. The interviews were conducted in two parts. The first set of interviews was conducted with individual participants and examined the first part of the design process from idea to proof-of-concept, but also provided insights into the design process post-proof-of-concept to when the design is fully deployed and what happens next. The second set of interviews consisted of individual participant interviews and one

group interview. These interviews validated the information already found and explored the post-proof-of-concept part of the design process in more detail.

## **2.1. Sample**

### **2.1.1. First set of interviews**

The first set of interviews included (n=15) participants who are research designers from different levels within the research design team who were responsible for the initial proof-of-concept phase of design. The initial sample was selected due to their pivotal role in the design process and to enable the capture of this part of the process. Research designers are people who work in roles within research and design departments on new digital technology for both internal and external customers. For the current study, we are mostly interested in people who work on designing new or improved digital interfaces to be used internally by employees. These include roles such as, research design team managers and principal project leaders, complex technology research specialists, and those who have experience working on design projects of new or improved complex digital technology to be used by staff internally. Research designers provided an overview of the whole design process and indicated other relevant stakeholders to talk to.

### **2.1.2. Second set of interviews**

The second set of interviews (n=7) focused on designers who work with the design from the proof-of-concept phase, and conduct user testing, deployment, and maintenance. The interviews were conducted with individual participants (n=5). One group interview (n=3) was also included. One of the participants who took part in the group interview also took part in an individual follow up interview. The sample group was small as recruitment was focused on key stakeholders who provided information about the design post-proof-of-concept phase and validated what was already said in the first set of interviews. Designers in these teams work not only on designs that come to them through to the proof-of-concept phase but other designs where they complete the design from start to finish.

## **2.2. Semi-structured interviews**

Semi-structured interviews were used to allow for exploration of topics through open discussions. Questions covered topics such as the design process of complex interactive digital technology, key people and critical roles, examples of current design developments, user understanding, and design approaches and theory. The current paper focuses on the insights gained from questions pertaining to user interaction. The interviews were conducted online with participants and lasted approximately 1 hour. The recordings of the interviews were transcribed, anonymised, and made ready for analysis.

## **2.3. Data analysis**

The interview data was analysed using swim lane mapping and thematic analysis. Swim lane mapping differs from other techniques as it shows the people involved in the process (Pedó et al., 2022). Using a swim lane diagram helps to capture stakeholders and highlights the interaction between designers and users and helps to show where stakeholders' needs are considered. Due to restrictions of the current paper format, a modified swim-lane diagram is presented that focuses on the relationship between designers and users. Thematic analysis (Braun and Clarke, 2002) was used to help analyse the data. Results presented focus on the design process and the users' involvement and address topics that help understand the user and design teams' interaction, the people involved, the design process, and the methods used.

## **3. Results**

The swim lane diagrams (Figure 1 and 2) capture research designers' interaction with different user groups throughout the design process. It was observed through the interviews that there are two main parts of the design process. The initial part takes the design from the initial ideas through to proof-of-concept which can be seen in Figure 1. Figure 2 displays the design and user interaction throughout

the second part of the process when the design goes from proof-of-concept through to when the design is being maintained post-deployment. The interviews suggest that design projects can occur for different reasons; assignments arise from different departments, and it is necessary to either design something new, create a new version or update an existing design. There are both long- and short-term goals that are set by the organisation and the design teams explore different technologies to meet these goals. Additionally, there may be interest projects which arise from individual design team members.

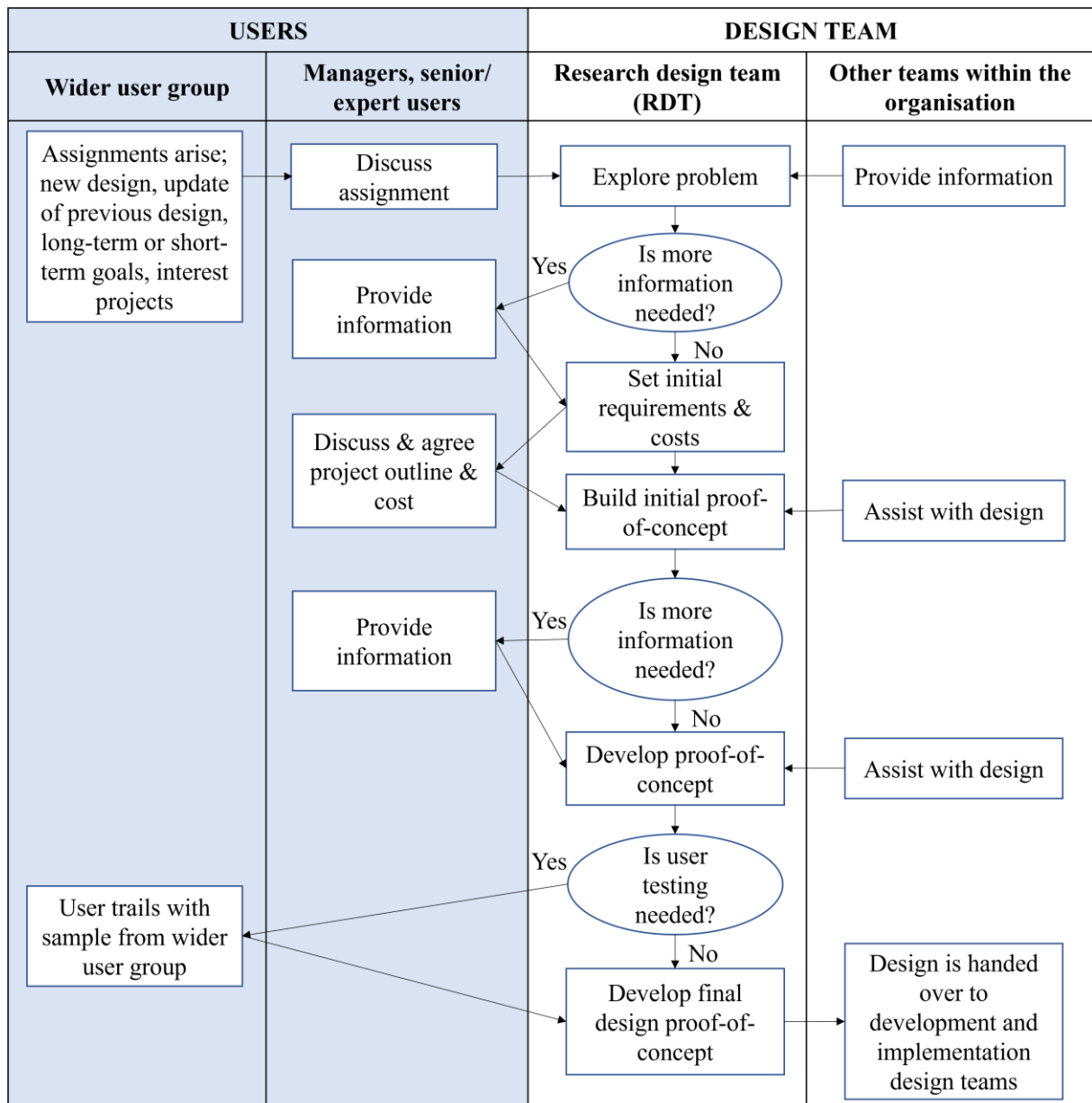
### 3.1. Who are the people involved?

The interviews showed that there are different stakeholders in the design process. These are represented in different columns in the swim lane diagrams in Figures 1 and 2 and are described below:

- Managers and senior users are employees who are in manager roles or senior positions within a specific department. They are users who have oversight over wider groups of users and may or may not use the final design, depending on the project.
- Expert users are consulted throughout the design process. These are employees who are nominated by managers or those who self-nominate and are motivated users who are known to provide feedback. Expert users may have a particular set of skills such as an expert in a particular role who is consulted about a specific workplace activity, or employees who are experienced in a specific role. The end users are commonly represented by individual expert users who are involved in the design process. In Figures 1 and 2 this group of users has been grouped with managers and senior users. Using individual expert users can be beneficial to obtain detailed insights into design parameters. When designers include expert users in consultation, they can then be good candidates to help with adoption later in the design process as they understand the design and can share their knowledge with other employees. Occasionally, only expert users or individual users are used in consultation, which may lead to requirements being identified later in the design phase as other users' needs may not have been identified, which can cause difficulties. There was an example provided of a case where an individual expert user helped capture a workplace task to be used as part of a VR training headset; however, when the design was shown to other users, they had different methods of completing the same task and this resulted in rework and delays in the project.
- The wider user group includes all the end-users of the design. The user trial sample is made up of users from the wider user group. User trials use employees who are recruited using opportunistic sampling as well as other occasions when the same groups of users are used repeatedly as they are known to provide feedback. User trials try to include a variety of users (to represent the wider user group), but this is not always possible.
- In Figure 1, research designers are a team of designers within a large organisation who focus on developing new or improved designs up to the building of the proof-of-concept. In comparison, the development and implementation design team in Figure 2 focuses on developing the design from the proof-of-concept stage up to deployment.

### 3.2. Design process

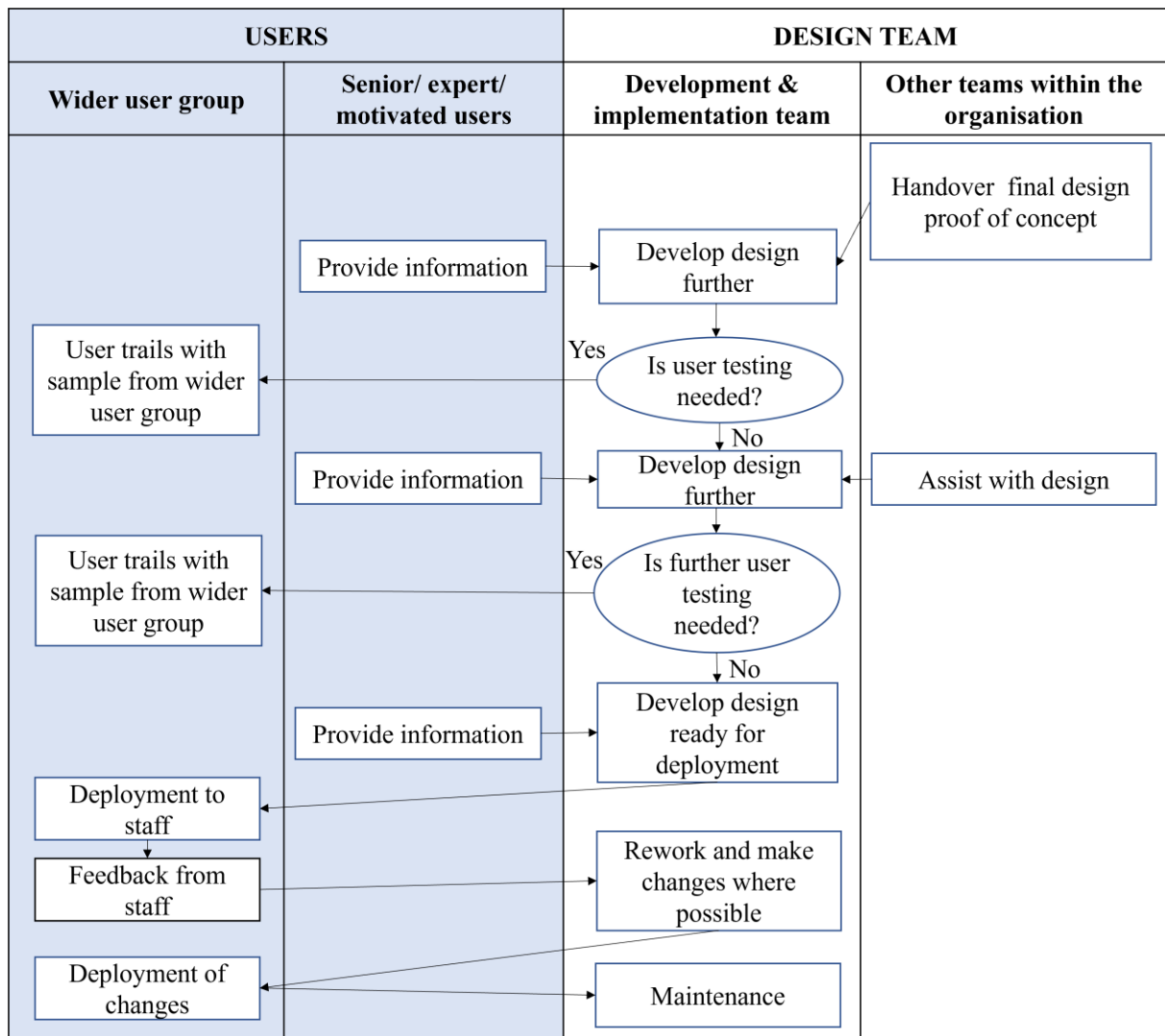
Figure 1 describes the design process from the start of the design life cycle through to the initial proof-of-concept. The research design team works with the manager and senior users to agree on requirements, project budgets, and parameters. The research design team will consult with expert users to help with the design. In Figure 1 the example of the design process is one where managers or senior users have brought the project assignment to the research design team. Data shows that managers and senior users have insights from the wider user group as they work with them and have some idea about how a design might be a fit for end-users. Figure 2 is a summary of the design process from the proof-of-concept phase to the development and implementation stages of the assignment. The development and implementation team work on projects that originate from different sources, but for the purpose of this paper, Figure 2 describes the process where a design has come from the research design team to be developed, deployed, and maintained.



**Figure 1. Swim lane diagram highlighting the interaction between users and research designers throughout the design process to proof-of-concept. This diagram illustrates the situation where the design assignment arises from the needs of the wider user group and is funnelled through the senior users**

Design teams predominantly try to follow agile and waterfall approaches. The agile approach supports a collaborative approach to design with regular communication. A waterfall methodology is a sequential development process, where one part is completed before moving onto the next phase. Both positive and negative attitudes have been reported about using these approaches, and it has been found that when they are used, it is not always possible to use them fully as they were intended. The approaches are also modified depending on the project or business need. For example, there is a disconnect between 2-week sprints used in assignments utilising an agile approach and the ability to test with the wider user group, as major revisions to any designs can only be released on a 2 monthly basis, which can prove constraining when requiring feedback.

The interviews show interaction between the design teams and managers, senior or expert users throughout the design process. These interactions usually occur more formally at the start when agreeing on outlines and costings. Then, throughout the design and when further information is required, this is obtained by speaking to stakeholders through phone calls, emails, and meetings.



**Figure 2. Swim lane diagram to highlighting the interaction between users and research designers throughout the design process post-proof-of-concept. This diagram illustrates the situation where the design assignment arises from the needs of the wider user group and is funnelled through the senior users**

Analysis shows that there are also interactions between designers and the wider group of users. When proof-of-concept is being designed, (Figure 1) user trials are conducted mainly to the end of the process when the prototype is tested for functionality. Testing occurs with people from the wider user group. Post proof-of-concept (Figure 2) user trials are conducted to help with the development and to get projects to be deployment ready. User trail testing aims to try and test the design with a particular number of people and user trials will be re-run to try and get the number that is required. However, the results show that at times, even with multiple user trials, it is not always possible to reach the number of users sought and the design must move on to the next phase due to time and budget constraints. Recruitment for user trials is opportunistic, as the design teams try to source a variety of users and attempt to get employees from different age groups or different experiences. However, in the interviews reported in this paper there was no mention of a standard way or approach used for recruitment to ensure there is a true representation of the wider user group.

### 3.3. User requirements

Requirements are set at the start of the project and then adapted throughout. Interviews show that requirements change during the design and can become apparent through user and design team interactions throughout the design process (Figure 1 and 2). Users may not have clear ideas about what

they want as they may not know what is possible: *"When we're talking about AI and automated design, they don't necessarily know what that entails"* (P02). There are times when requirements become apparent later in the design process or after a design has been deployed: *"We've had projects where we've, handed over the final delivery and the following day we've had the requirements come through"* (P02). These are integrated into the design where possible: *"After six months or something, you suddenly get an e-mail out of the blue from someone saying if it did this, it would really help me in my job. Over time, the requests for change just disappear because the tool is doing what people want"* (P20).

Without knowing the end user group's needs, it can be challenging to ensure the design can be used by the wider user group. The interviews reported here indicated that the design team make the design as generic as possible to try and cater to the wider user group: *"We want to cater for our sort of specific user community, but we also want to keep that generic and sometimes that means that it is made more complex than it could if we could narrow it to scope, then it could be simple, we just find that limiting as designers"* (P07). Knowing the scope of intended users could improve the design process and the final design.

The interview results show that during the design process and up to the proof-of-concept user interaction is mainly concerned with functionality testing. Post-proof-of-concept user trials, there is more of a focus on usability. Both are considered important: *"Functionality is definitely important and obviously, it has to be practical. It has to do this thing that we want it to do and then obviously usability is probably equally as important"* (P18). The interviews indicate that on one hand user trials post-proof-of-concept also look at functionality testing, and on the other hand, usability is considered later down the design process or after deployment when the opportunity for change might be limited. At times it is not possible to glean all the usability insights required or be able to include them in the final design due to project constraints. There are examples where it could have been useful to obtain wider user insights earlier in the design process.

### 3.4. Methods for user involvement

Both sets of interviews reveal that there is no strict methodology or standard operating procedure for conducting user trials or other user interactions. Much depends on the project. Design teams are aware of different theoretical approaches and have heard of terms such as 'user-centred' and 'inclusive design' and try to incorporate some of these practices. Methods from these approaches such as user trials, show and tells with prototypes, and focus groups occur both in person and online.

When conducting user testing, the design teams try to source users from various levels of experience and ages. However, it can be difficult to get the required user sample or feedback because employees have limited availability: *"Users are just fully booked"* (P07). Trying out new technology may not be high on users' list of priorities (especially when they lack investment with proposed technological change): *"I guess they don't like new apps coming or changes to the apps because from their perspective they just want to probably nothing to change"* (P19). This could result in limited user testing and testing occurring with different user groups compared to the end users intended for the design: *"The trials we did were with a different group of people than the users we are creating for"* (P01).

The interviews show that time constraints impact user trials and interaction, as pressure to release designs could result in limited user testing or the opportunity to hold further user trials when required: *"Pressured into getting things out quickly"* (P18).

The interviews also demonstrate that there may be time pressures which could result in limited opportunities to conduct user testing. At times, especially if the project goes on for some time, particular stakeholders may change as may the budget: *"People have moved on and you're not in that same resource pool there now it's very difficult to try and change something"* (P18). These situations impact the design and there may be changes in what was originally planned at later stages in the design process, when redesign may be challenging.

It can be seen in both Figures 1 and 2 that iterations of the design occur during the design process with the involvement of user groups: *"Been through a few iterations now"* (P20). There are examples of good practice, but also times when constraints make it difficult to conduct usability testing that could be helpful to the design process: *"I think there are huge opportunities for us to test more"* (P21).

The interviews highlight that it is not always possible to include usability users' needs, as insights come later in the design process when change is difficult or at times business needs are prioritised: *"It's done"*

*right at the end of the cycle, just before we're ready to release, and not everything that comes up in that usability testing can actually be fixed"*(P21).

Interviewees felt that having user observations, testing and more detailed requirement capture at an earlier phase in the design could be beneficial: *"If we had it as like a bit of an ideal project, we could have done much more user testing, much more prototyping, we could get these things sorted much sooner than we could have right now before they became these huge problems"* (P18). By doing so, users' attitudes to designs among other details could be understood prior to deployment, as the interviews depicted examples of projects where designs were not received by users as intended: *"When we put that out there, it was like Marmite"* (P19).

The interviews indicated other methods that were used on occasion to support the design teams with user understanding and reported examples of where observations were used to capture user requirements and proved to be beneficial. Personas were available to help understand the different types of users within the organisation, but the interviews suggested that persona use can be challenging. For example, *"You don't want the persona to be too generic and you don't want it to be too specific"* (P18).

## 4. Discussion

Investigating the design process and user interactions through the interviews reported in this paper provided insights into the practices that are used and enabled exploration of the constraints that are faced. The results revealed a flexible approach to user involvement with no specific methodology or approach, which can be beneficial as it can be adapted to a variety of projects. Conversely, using different approaches make user testing or interaction difficult to replicate, causing the process to be difficult to review and to potentially improve. Additionally, having a consistent approach could help build knowledge in a tangible way. For example, creating user insight logs that can be utilised by other design team members and provide insights about different types of users.

Among the varied interactions, the interview results highlight the limited number of users who take part in some of the design processes' user trials and expert user groups compared to the number of potential end users of a design. Using expert users can be helpful to get detailed insights and requirements about a design but can result in problems when scaling up the design to multiple users (Heier, 2021). The recruitment of participants for user testing can be difficult, which results in smaller user samples when testing designs. Constraints surround the availability of employees and attitudes towards emerging technology and change may be an influencing factor. By helping users understand how complex designs can help them with their work, rather than take over their role, could help alleviate negative attitudes (Raisch and Krakowski, 2021) towards new or improved designs and potentially improve recruitment.

It can be difficult to obtain user samples that represent the diversity of the wider user group. The interview results show that the design teams tried to source a range of users to take part in user trials. Including a wide range of users and, more importantly, a true representation of the end-user group is something that can benefit insights gained from user trials. Carefully selecting a range of users and comparing them to the whole range of end-users would help the design teams understand who is included, how representative they are of the wider group and who is not included (Dong et al., 2004). This can help design teams think about the wider range of users they are designing for and what needs and requirements they may have and may reduce potential rework in the future. Using something like a survey can help capture and understand the wider user group within an organisation. This information can then be used to compare the wider user group to the user trial sample and help bridge the gap when users are not present for user input or testing (Petyaeva et al., 2022). A survey can include relevant questions that provide insights into users' needs that can be used to provide support for designers, such as personas that can help the design teams to think about different types of end users and their requirements.

Analysis shows that user involvement does occur at different times in the design process, but the design teams would find it beneficial to have user insights at earlier stages in the design. In the first part of an assignment, during the design of the proof-of-concept, testing with groups of users is considered more towards the end of the design process. User involvement occurs post-proof-of-concept of the design, but again it was observed that obtaining some user insights would have been more beneficial earlier in the design process. Using inclusive design or co-design methods could support designers, as the approach suggests getting user feedback at earlier stages in the design process, and this could help control the



emergence of requirements by having user involvement methods that could provide user insights when they would be most useful. This is in line with the results, which show that having a more comprehensive observation phase of the design assignment proves valuable.

In the interviews, there were times when the expectations of the end-users were not met and there was a misalignment between the designer's aims and how the design was received. Understanding the needs of users and stakeholders using user-centred methods could support the alignment of expectations of the design. Using design methods that support the understanding of users' needs, attitudes, and mental models (Clarkson and Coleman 2015), could help designers understand how designs could be designed to better match users' expectations.

#### **4.1. Limitations**

There were some limitations when conducting this study. The data was difficult to summarise as there is no one way to tackle user and design interaction. Capturing user interaction across two groups of design teams and following design examples through from one part to the other proved challenging. There were problems with recruitment, and it could have been beneficial to talk to more development and implementation designers who worked on designs received from the research design team. This study looked at a single organisation and it is unclear how widely generalisable it is, although the results do agree with other findings from the literature (Shneiderman and Hochheiser, 2001; Keates and Clarkson, 2003; Dong et al., 2004; Raisch and Krakowski, 2021).

#### **4.2. Further work**

Further work could expand current research to compare findings to other organisations to identify ways in which inclusive design approaches can be easily adopted by designers. Further work could look at ways of providing insights and guidance for researchers and practitioners looking to improve user interaction when designing complex tools for employees within an organisation.

### **5. Conclusion**

Insights from the interviews discussed in this paper show that there are different user involvement methods that are used in the design process, but there are varied constraints that occur during a design project. The current study agrees with previous research about the difficulties of conducting user trials and interactions during a design process and highlights common challenges in business where time and money are influencing factors. Having input from individual users and a general understanding of how a new tool may fit into the workplace is useful. However, a lack of input from the full range of users can result in needing to make changes to a design later in the process when this may be costly or no longer possible. Furthermore, the lack of a specific process for user interaction allows for flexibility but can result in low levels of user involvement in some projects. It also makes it difficult to compare and improve methods.

Using the design approaches suggested in this paper could improve how new complex digital technology is designed within an organisation, by helping the design team to obtain wider user group understanding through different methods of user involvement. When capturing an understanding of the wider end-user group perspective, inclusive design methods among others can enhance existing practices to support user involvement in a design process. Moreover, they can provide insights about users who have not taken part in the user interaction. Highlighting the value of user involvement can be a helpful way to encourage organisations to promote user involvement in new or improved complex digital technology designs.

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#### **References**

Braun, V. and Clarke, V. (2022). *Thematic analysis: a practical guide*. London: SAGE Publications, London.

- Caputo, F. A, Greco., D'Amato, I., Notaro, S. S. (2018). On the use of virtual reality for a human-centred workplace design. *Procedia Structural Integrity*, Vol 8, pp 297 – 308. <https://doi.org/10.1016/j.prostr.2017.12.031>.
- Clarkson, J., Coleman, R. (2015). History of Inclusive Design in the UK, *Applied Ergonomics*, Vol. 46, pp. 235-247. ISSN 0003-6870, <https://doi.org/10.1016/j.apergo.2013.03.002>.
- Dong, H., Keates, S., Clarkson, P.J. (2004). Inclusive Design in Industry: Barriers, Drivers, and the Business Case. In: Stary, C., Stephanidis, C. (eds) *User-Centered Interaction Paradigms for Universal Access in the Information Society*. UI4ALL 2004. Lecture Notes in Computer Science, vol 3196. Springer, Berlin, Heidelberg. [https://doi.org/10.1007/978-3-540-30111-0\\_26](https://doi.org/10.1007/978-3-540-30111-0_26).
- Irizar-Arrieta, A., Casado Mansilla, D., 2017. "Coping with user diversity: UX informs the Design of a digital interface that encourages sustainable behaviour". *Conference: 11th Multi Conference on Computer Science and Information Systems*. Jul 21 - 23, Lisbon, Portugal, pp 1 - 20.
- Goodman-Deane, J., Bradley, M., Lazzarini, B., Roca Bosch, E., Waller, S., Clarkson P.J. (2023) Effectiveness of the Inclusive Design Wheel in practice: Lessons from five pilot projects. In: Goodman-Deane, Lazar, Heylighen, Dong, Clarkson (eds). *Design for Sustainable Inclusion*, pp. 191-200. Springer.
- Goodman-Deane, J. Ward, J. Hosking, I. and P.J. Clarkson (2014). A comparison of methods currently used in inclusive design. *Applied Ergonomics*. Vol.45, No. 4, pp. 886-894. <https://doi.org/10.1016/j.apergo.2013.11.005>.
- Heier, J. (2021). "Design Intelligence - Taking Further Steps Towards New Methods and Tools for Designing in the Age of AI". In: Degen, H., Ntoa, S. (Ed.), *Artificial Intelligence in HCI*. Springer, vol 12797. [https://doi.org/10.1007/978-3-030-77772-2\\_13](https://doi.org/10.1007/978-3-030-77772-2_13).
- Hornung, O., Smolnik, S. (2022). AI invading the workplace: negative emotions to-wards the organizational use of personal virtual assistants. *Electronic Markets*, Vol. 32, pp123–138. <https://dx.doi.org/10.1007/s12525-021-00493-0>
- Keates, S., Clarkson, P.J., 2003. Countering design exclusion: bridging the gap between usability and accessibility. *Universal Access Information Society*. Vol 2, pp 215–225. <https://doi.org/10.1007/s10209-003-0059-5>.
- Landauer, T.K. and American Council of Learned Societies (1995) *The trouble with computers usefulness, usability, and productivity*. Cambridge, Mass. MIT Press.
- Mieczakowski, A., Hessey, S., Clarkson, P., 2013. "Inclusive Design and the Bottom Line: How Can Its Value Be Proven to Decision Makers?", [online] *Universal Access in Human-Computer Interaction. Design Methods, Tools, and Interaction Techniques for Inclusion*. Available at: [https://doi.org/10.1007/978-3-642-39188-0\\_8](https://doi.org/10.1007/978-3-642-39188-0_8)
- OECD (2017), *Pensions at a Glance 2017: OECD and G20 Indicators*, OECD Publishing, Paris, [https://doi.org/10.1787/pension\\_glance-2017-en](https://doi.org/10.1787/pension_glance-2017-en).
- Pedó, B., Nguyen, Q.A., Koskela, L., Tezel, A., Vrabie, E., Whitelock-Wainwright, A., Potter, D., Robinson, S. and Tzortzopoulos, P. (2022). Devising and Implementing Process Models Within Infrastructure Engineering Design. *Proceedings of the 30th Annual Conference of the International Group for Lean Construction (IGLC30)*, Edmonton, Canada, 2022, International Group for Lean Construction, pp 504–515. [doi.org/10.24928/2022/0155](https://doi.org/10.24928/2022/0155).
- Petyaeva, A., Goodman-Deane, J., Bradley, M., Waller, S., and Clarkson, J. (2022) "Improving our understanding of user trial samples using survey data", *Proceedings of DRS2022*, Bilbao, Spain, 25 June - 3 July, Design Research Society, <https://doi.org/10.21606/drs.2022.676>.
- Raisch, S., Krakowski, S. (2021). *Artificial Intelligence and Management: The Automation–Augmentation Paradox*, [online] *Academy of Management Review*. Available at: <https://doi.org/10.5465/amr.2018.0072> (accessed 10.11.2023).
- Shneiderman, B., Hochheiser, H. (2001). "Universal usability as a stimulus to advanced interface design", *Behaviour & Information Technology*, Vol 20 No. 5, pp 367-376. <https://doi.org/10.1080/01449290110083602>.
- Trischler, J., Pervan, S.J., Kelly, S.J., Scott, D.R. (2018). The Value of Codesign: The Effect of Customer Involvement in Service Design Teams. *Journal of Service Research*, Vol. 21, pp 75–100. <https://doi.org/10.1177/1094670517714060>.
- Wallace, K., Pahl, G. (Gerhard), Blessing, L., 2007. *Engineering design: a systematic approach*. Springer, London.
- Wilkens, U. (2020). "Artificial intelligence in the workplace – A double-edged sword". *International Journal of Information and Learning Technology*, Vol, 37. No. 5, pp. 253 - 265. <https://doi.org/10.1108/IJILT-02-2020-0022>.
- Wilkinson, C. R., De Angeli, A. (2014). "Applying user-centred and participatory design approaches to commercial product development", *Design Studies*, Vol 35, No. 6, pp. 614-631. <https://doi.org/10.1016/j.destud.2014.06.001>.