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Designer empathy in virtual reality: transforming the designer experience closer to the user

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Empathy is a key driver for designers to unlock their user's perspective. However, its multi-dimensional nature can be detrimental to the design process; therefore, a structured approach is vital. The current emergence and capabilities of Virtual Reality (VR) technology have inspired this research to explore how designers can achieve the optimal level of empathy required to produce innovative design solutions. A qualitative study involving semi-structured interviews with design engineers working with industry was performed to analyse current challenges in empathic design and identify how VR can address such challenges. The study highlighted that communication and resource factors were the main barriers to designer empathy. In response to this finding, this research bridges the gap between the designer and the user through the digital transformation of the designer's profession that provides enhanced value to human-centricity, social and ecological interactions. The outcome of this study entails the creation of a specification for a novel fully immersive virtual environment: The Digital Empathic Design Voyage that augments designers' empathic skills and empowers the designer to achieve cognitive and affective empathy towards their user from multiple perspectives. This research is a platform for a future empirical study addressing the impact of digital empathy on creating user-centred and innovative design solutions.

Keywords: empathic design; XR technology; human-centred design; design engineering

1 Introduction

Empathy is central to a human-centred design (HCD) process that facilitates the designer to obtain a deep understanding of the user's requirements (Giacomin, 2014). Philosophers and psychologists have argued on defining empathy and how the optimal level of empathy can be achieved due to its multi-dimensional nature. In fact, empathy is mainly categorised into cognitive empathy, which is determined by understanding someone's circumstance, and affective empathy, which is generated from emotional reactions (Kouprie & Visser, 2009). According to Hess and Fila (2016), a combination of both components is required to achieve the optimal level of empathy in design. Although research revealed the effectiveness of empathy in creative and competitive product ideation (Alzayed et al., 2022; Genco et al., 2011; Johnson et al., 2014), other research has argued that limitations to empathic

product development could lead to design fixation (Janes & Olson, 2010), which occurs when designers fixate on a singular perspective or user experience (Gray et al., 2015). For instance, Genco et al. (2011) and Johnson et al. (2014) argue that the nature of empathy could lead to controlled responses from the user rather than encourage radical thinking.

The power of Virtual Reality (VR) technologies in emotionally engaging users and in generating empathy has been explored. This is demonstrated by the technology's visual and interactive elements that enable users to fully immerse in a virtual space and embody a digital self (Markowitz & Bailenson, 2019). Despite this, empathy in VR within the context of design research has not been extensively explored (Hu et al., 2021). Additionally, technology can be a limiting factor towards creating empathic social interactions (Barbot & Kaufman, 2020), thus, there is a need for empirical and scientific knowledge that demonstrates VR's potential in transforming human experiences (Villalba et al., 2021). This research contributes to knowledge by presenting findings from a qualitative study aimed to address current challenges in empathic design and to empower designers in reaching the optimal level of empathy towards their users using VR technology. The outcome of this study led to the creation of a novel specification for a fully immersive virtual environment, entitled The Digital Empathic Design Voyage. The specification facilitates designer empathy from two scenarios representing two distinct perspectives. The first scenario fully immerses the designer into the user's situation from a first-person perspective and therefore gives the designer the freedom to explore the full user experience from the user's point of view. The second scenario allows the designer and other project stakeholders to observe and interact with a virtual agent representing the end user from a second-person perspective. Through the future configuration of VR tools and empathic methods to support designers, the goal of this research is to perform empirical studies on an operational VR environment to analyse the impact of this application on designers' empathic skills enhancement and on reaching a step further towards generating user-oriented solutions.

2 Empathy in the physical and virtual experience

In the engineering design field, empathy is defined as a skill that encourages designers to produce quality ideation through 'increased awareness of the user's experiences and emotions, whilst maintaining control of their own' (Walther et al., 2017). On the other hand, Battarbee et al. (2002) describe empathy as 'leaving the design office and becoming immersed in the lives, environments, attitudes, experiences, and dreams of the future users', which implies that the designer has less control over their own experiences and is completely absorbed into the user's environment. Philosophers and psychologists have argued on how empathy would be best achieved. For instance, Lipps (1903, as cited in Kouprie & Visser, 2009) claimed that empathy is achieved when there are no boundaries between the empathiser and the person being empathised. On the contrary, Stein (1917, as cited in Kouprie & Visser, 2009) argued that boundaries do exist even though the empathiser and the person being empathised are closely related. This dichotomy implies that empathy is a multi-dimensional concept. Empathy is mainly categorised into two main dimensions: cognitive empathy which depends on understanding the user's circumstance, and affective empathy which is based on emotional reactions (Duan & Hill, 1996). Hess and Fila (2016) argue that both dimensions are required to achieve a deep understanding of the user's requirements. This research aims to explore how designers can achieve the optimal balance between the two components when experiencing empathy towards their users, as described in Figure 1.

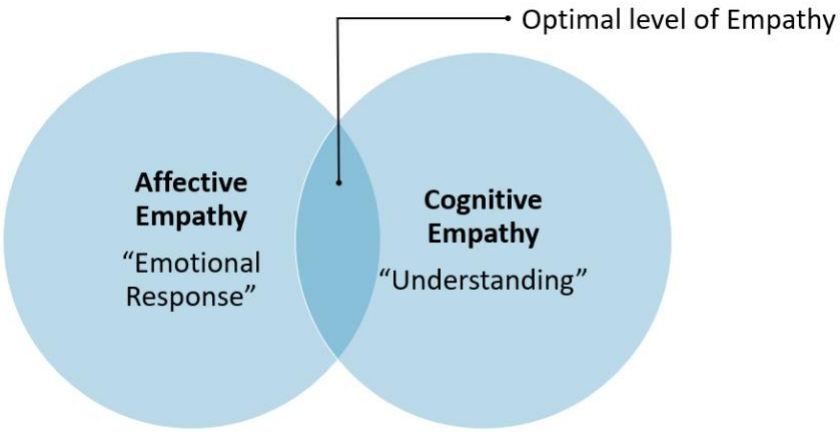

Figure 1. Main dimensions of empathy

Empathy has been a key driver towards creative and competitive product ideation (Alzayed et al., 2022; Genco et al., 2011; Johnson et al., 2014). However, Genco et al. (2011) and Johnson et al. (2014) argue that the nature of empathy could lead to controlled responses rather than encourage radical thinking. This could place designers into what is known as an "empathy trap". Empathy was observed to be enhanced when users are experiencing humiliation or ridicule (Krach et al., 2011), however, this was found to be detrimental to creativity and such scenarios were more prone to design fixation (Janes & Olson, 2010). Design fixation occurs when previous experience inhibits designers' creativity by preventing the generation of innovative ideas and increasing attachment to tested or faulty solutions (Crilly & Cardoso, 2017). This can also occur when designers fixate on a singular perspective or user experience (Gray et al., 2015). From a psychological perspective, Breithaupt (2019) defines the term "empathic vampirism" or selfish empathy which involves making the experience of users owned by the designer over time, without consideration of the long-term users' experience. The development of VR technology has led this research to explore its potential to experience empathy whilst addressing such limitations.

2.1 Empathy in the physical experience

There are various methods and techniques that currently support designer empathy. Empathy can be experienced by simply observing the user in their own environment (Patnaik, 2009). Moggridge Associates sent a designer to observe and interact with fishers in their real environment to successfully develop their marine device. This approach served as a foundation for the global design company, IDEO in adopting human-centred design practices (Battarbee et al., 2015). Empathy can also be achieved through a simulation of the user experience (Gray et al., 2015), known as empathic modelling. This is achieved by simulating the perceptual and physical abilities of users in their everyday life, through various props and scenarios (Nicolle & Maguire, 2003). This has been particularly useful in cases concerning extreme users, which applies to situations where the user experience is more foreign to the designer. Examples of extreme users would be the elderly or users having cognitive or physical differences from the designer (Raviselvam et al., 2022). For instance, Patricia Moore transformed herself into an 85-year-old woman to obtain a deep understanding of that target user group. Her approach pioneered empathic design that focuses on product useability and the core needs of the user. This eventually led to the recognition of empathy as central to the generation of inclusive and user-oriented design solutions (Moore, 2012). Ford developed a "third age suit" that also simulated the user experience of the elderly. The suit made the effects of ageing more realistic to the designers

which led to the success of their inclusive design (Hitchcock et al., 2001). However, such close user interactions can be time-consuming and cost-inefficient despite their robustness (Shah & Robinson, 2007). This research explores the potential of VR to address such challenges. The next section reviews state-of-the-art VR applications aimed at generating empathic experiences.

2.2 Empathy in the virtual experience

VR is defined as a digital simulation or replication of a 3D environment, accessed through a Head Mounted Display (HMD) (Neo et al., 2021). According to Schutte and Stilinović (2017), VR's capability of generating empathy is attributed to the immersive and interactive experience achieved when embodying another person. In fact, the term Perspective Taking VR (PTVR) describes the experience of embodiment from a first-person perspective (Herrera et al., 2018). An example of PTVR was applied by Berezina-Blackburn et al. (2018) through the development of a virtual reality simulation that immerses the participant into the world of someone living with dementia. The study led participants to successfully generate emotional empathic responses of dementia patients. In a design context, Zhang et al. (2022) simulated the perspectives of end-users involving children and adults in a wheelchair. Participants' perspectives matched the intended perspective of the end-user, demonstrating VR's potential of generating successful designer empathy. Van Loon et al. (2018) argue that a higher level of empathy from PTVR could be attributed to the "novelty effect" generated due to the innovativeness of the technology. This encourages further exploration of the long-term effects of PTVR for empathic development.

Empathy in VR has also been explored when viewers observe others from a second-person perspective. Bahng et al. (2020) investigate empathy that encourages reflexive contexts. In their study, participants successfully experienced a deep reflection on loneliness and death instilled between the viewer and a virtual character. This research implies VR's potential to generate more reflexive and reflective empathic responses when experiencing a second-person perspective. Further research is needed on what are the mechanisms that drive such responses and enable designers to experience critical reflexivity towards their users. Empirical evidence is also required to determine what dimension of empathy – whether cognitive or affective – can be generated through VR technology (Pratte et al., 2021).

3 Methodology

A qualitative study composed of semi-structured interviews was performed to identify challenges experienced by designers when empathising with their users and generating user-oriented solutions. The interviews also discussed how VR technology can be applied to address such challenges and transform current work practices. The sample size consisted of seven design engineers, six of whom work at the National Manufacturing Institute of Scotland (NMIS), and one is a founder and director of a business company. Five participants were male, and two participants were female. The interviews consisted of open-ended questions about the participant's experience related to empathic design and its potential digital transformation. The target was to identify what features designers would require in the VR specification developed in this study. Interviews were conducted in person, in the designer's work environment, and were approximately one hour long.

The participants had an average of nine years of work experience working in the field. The most skilled participant had twenty years of experience working in the industry whilst the least skilled participant

had two years of work experience. Participants also had diverse roles ranging from upper management, product development team leads, senior and junior design engineers. A broad range of participants having varied roles and skills were selected to evaluate results across a broad range of expertise that the VR application proposed in this research aims to support. The concept of "information power" by Malterud et al. (2016) was applied to determine the appropriate sample size for this qualitative study that depended on the aim of this research, the sample specificity, and the quality of dialogue. Considering the participants' wide range of experience, varied roles, and the strong quality dialogue involved in the interviews, seven participants were sufficient for this study. After conducting the interviews, the results were examined using a thematic analysis by Braun and Clarke (2006) to analyse the interview outcomes and determine the requirements for The Digital Empathic Design Voyage specification. The thematic analysis process entailed familiarisation with the interview transcripts, assigning codes to the different elements discussed during the interviews, and grouping the codes into themes. The themes were analysed and collated into two final themes presented through thematic maps, which will be discussed further in the following section.

4 Results

The initial codes generated from the semi-structured for the thematic analysis included empathy barriers or challenges the designer encounters, factors that enhance empathy, empathic design methods, VR solutions and limitations, and designer attributes and aspirations. A total of ten codes were generated that reflect the central topics discussed during the interviews, as described in the radar plot in Figure 2. The number in brackets next to the code captures the frequency of mentioned codes during the interviews. Barriers and challenges to empathy were the most frequently discussed topic that aligned with the main aim of the interviews, and this was followed by how the designer currently addresses those challenges through Enhancers and Methods. Potential VR solutions were also discussed to reflect on how VR can be applied to support the designer in the virtual empathic design process.

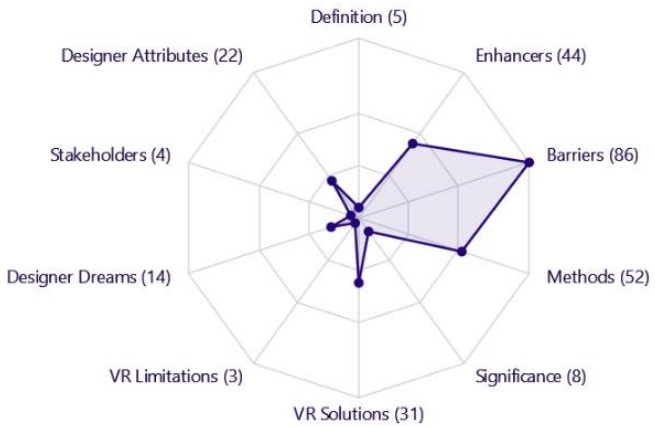

Figure 2. Radar plot of code frequency for thematic analysis.

The thematic analysis of the semi-structured interviews produced two final themes: Empathy Enhancers and Barriers to empathy. The theme of Empathy Enhancers (Figure 3) incorporates features and methods including VR solutions that leverage the advantages of the technology needed to augment the designer's empathic experience. This theme consists of three sub-themes: Resources,

Communication, and Designer Attributes. On the other hand, the Barriers theme (Figure 4) contains elements that are detrimental to the designer's empathic experience. Resources and Communication factors were also the assigned sub-themes for this theme. Each of the sub-themes in both themes contains specific features that describe the respective sub-theme.

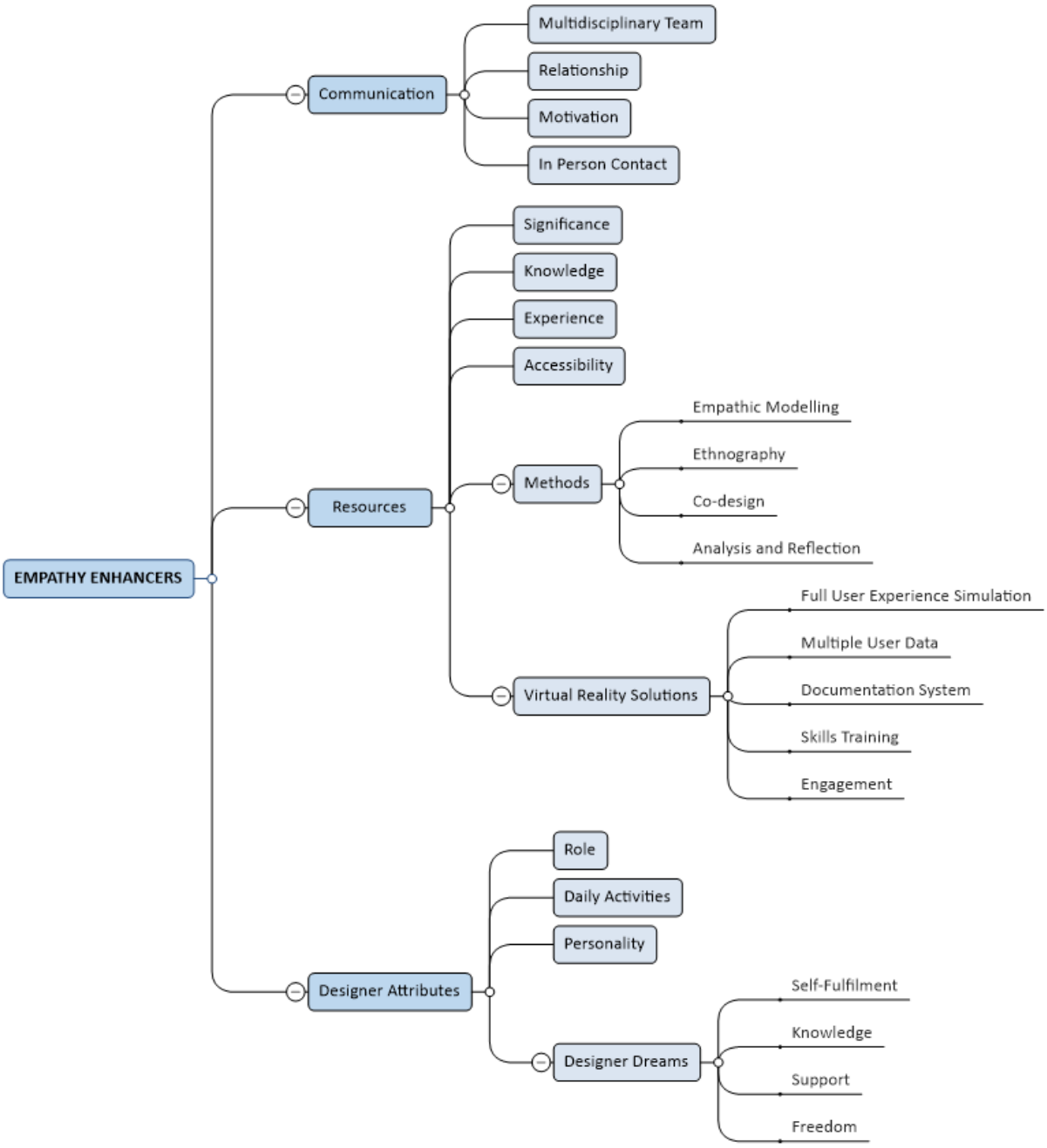

Figure 3. Empathy enhancers themes

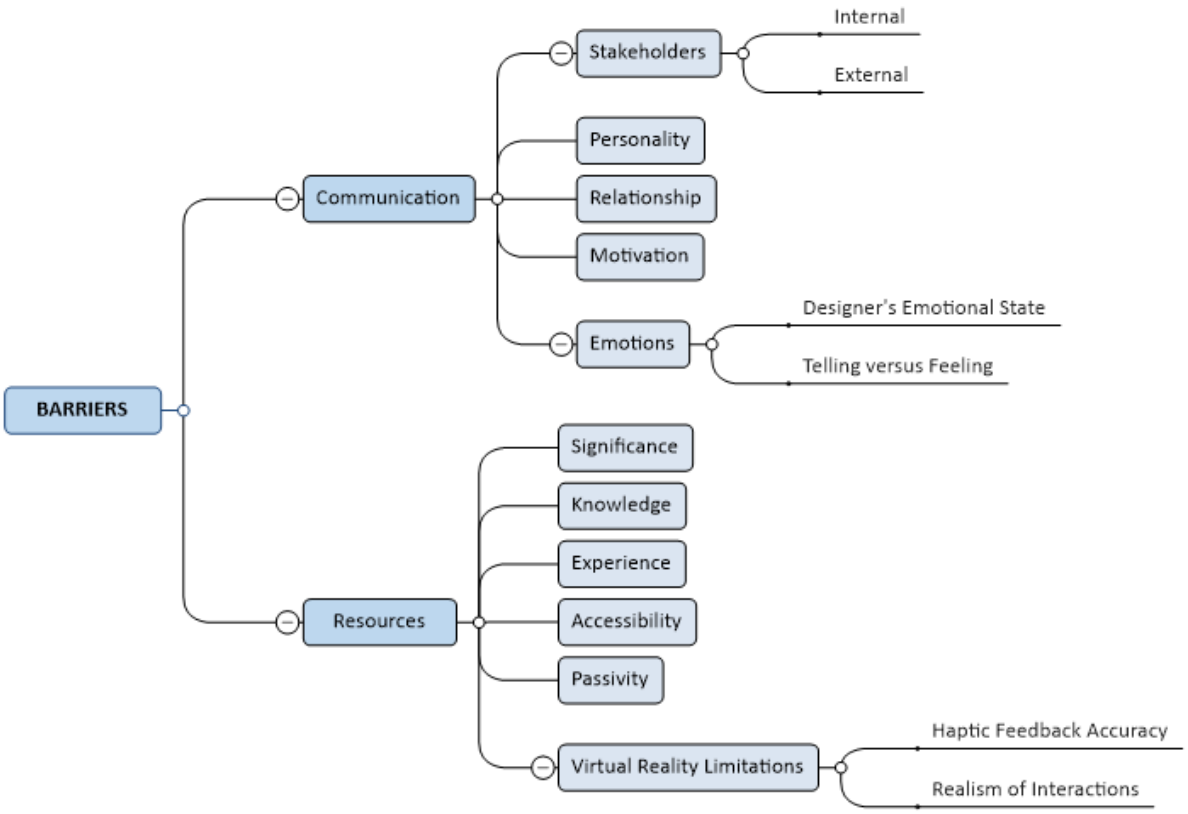

Figure 4. Barriers to empathy themes

From the interview findings, designers recognised the significance of empathy towards understanding the needs of the user and designing a product that offers innovative user-oriented solutions. Applications that require a rigorous approach to empathy were discussed. These include hazardous user environments such as an oil and gas rig, where safety concerns are paramount and when users have physical or mental characteristics that differ from the designer therefore extra effort is needed to empathise with the user.

The methods and techniques to achieve empathy towards their users such as observations and empathic modelling are vital towards obtaining an understanding of the user's requirements and are therefore listed as enhancers. Observations of the user in their own environment were highlighted as beneficial to the designers since they can directly visualise users' gestures, body language, and emotions. One participant highlighted that empathy is more strongly experienced when the designer is present when the user is in an emotional state due to a problem as opposed to when the user is describing the problem outside of the event during an interview. Therefore, the current and contextual emotional state of the user can also influence the level of empathy experienced by the designer.

4.1 Gaining access to the user and their environment

Successful application of empathic design methods entails knowledge and awareness of the topic of empathy. Knowledge of the design problem is also essential for the designer to fully understand the needs of the user. However, such empathy enhancers may prove to be futile if the designer has limited access to the end-user and user environments. One reason for this barrier might be related to the

inability of designers and users to fully communicate due to differences in physical or mental attributes between the two parties. Barriers to user accessibility might also be attributed to a geographical dispersion of users, ethical considerations, a lacking representation of a wide range of users, and limited resources, for instance in reimbursing users. User environments might also be highly inaccessible due to safety hazards, physical constraints, and environments involving a high cost-per-time ratio.

In such scenarios, designers may choose to communicate with users remotely. However, remote ways of communication such as videoconferencing can be disadvantageous compared to communication done in person. The limitations mentioned revolved around the inability to fully focus on the discussion, the inability to communicate through full body language, and consequently to build deeper empathic connections. Therefore, this research aims to bridge the gap between the designer and the user through enhanced access to users and their environment.

4.2 Getting closer to the user

When user accessibility is not an issue, designers face other challenges to empathy which stem from communication. Such instances occur when the user is not fully aware of what their need is, they are unable to understand that their need is not technically feasible, or there is a lack of interpersonal compatibility between the designer and the user. This can negatively impact designers' and users' emotional states due to potential conflicts or misunderstandings. Designers may also feel anxious when faced with a new project involving users they have not previously worked with.

Designer empathy can also be challenging when there is a lack of common ground between the designer and the user, which could be vital for building their relationship. The designer may be unable to fully relate to the user because the user's environment is foreign to the designer, or the user is from a different age group, as described by Participant 5 below. This issue stems from the limited resources available in allowing designers to pursue projects they are passionate about or can closely relate to.

> *"I was involved in this project involving the design of skiing equipment. I have only been skiing twice in my life, and it was quite hard to put myself in that position because I don't ski regularly, and the area was something that I had never researched before." (Participant 5)*

Additionally, Participants 6 and 7 noted that when the user describes the problem, the understanding of the user experience is limited to what the user shares, even if the user is expressing emotion. The wider experience, involving personal contexts and long-term implications might not be communicated.

> *"When I am doing empathic modelling of someone living with arthritis, I do not understand the whole implication of living with that over a long period…When I had a personal level connection with a user, I could see the wider implications of how his physical condition impacted him…there are certain jobs at work he cannot even do anymore, and that impacts financial incomings and then that impacts home life as well. So, you can only really get that greater level of detail from that personal connection." (Participant 6)*

> *"If a user cries, I can feel empathy. I can feel their emotion, which is sadness. If I'm going through that myself, I can experience all the emotions…a wider understanding of all the other emotions that go beyond the sadness being expressed. When I am having a one-on-one*

conversation, I can feel emotion, but it is limited to what the user is projecting to me…if I feel it myself, I obtain a full panoramic view of what's happening." (Participant 7)

Such examples demonstrate the limitation of empathic modelling in its inability to simulate the long-term user experience. Additionally, the limitation related to user observations and interviews is also revealed because these are limited to what the user is expressing or projecting and what the designer is inferring or reacting to that expression. Establishing a relationship between the designer and the user is therefore a highly important attribute for generating empathy. The designer and the end-user would often not know each other before the project and Participant 6 highlighted that this relationship must be established gradually to create and cultivate a connection that is built on honesty, trust, and genuine intentions. The user would also need to empathise with the designer to understand their perspective and their goal in satisfying their needs. Such factors, although time-consuming and therefore costly, are critical in motivating the user to openly communicate their perspective.

4.3 The post-empathic process

After designers apply empathic design methods, designers recognise the significance of analysis and reflection. Therefore, they realise the importance of acting upon empathy, which is at its core, a passive task and thus not inherently reflective (Stephan, 2023). The aim is to generate a design solution that would satisfy the needs of the user. Designers are required to produce a product design specification from the user research performed which needs to be agreed upon with the client proposing the project, who might not be the end-user, the internal project stakeholders such as upper management, and at times, the end-user themselves. The generation of the product design specification may be combined with conceptualisation and ideation of potential design solutions to obtain a decision towards one final design output.

The designer faces new challenges in this post-empathic design process. The passivity of empathising with the user might be a barrier to empathy because the designer might feel pressured to deliver a product design specification within specific time constraints. This might therefore encourage designers to minimise their time in empathising with users and focus more on generating a design solution. In addition, conceptualisation and ideation are not always performed in the presence of the end user, and therefore the perspective of the end user is not always considered in this step. Multiple participants expressed the desire to have the end-user present to ensure a co-design approach.

Designers also recognise that satisfying the needs of the end user might not be feasible due to the conflicting needs of multiple stakeholders involved in the project. For instance, the designer must also comply with the requirements of the manufacturing department or installers of the designed product. Other stakeholders involved in the conceptualisation phases may be the client, upper management, and marketing representatives. These stakeholders might have perspectives that conflict with the needs of the end-user which might be driven by wider business-oriented implications. The involvement of multiple stakeholders in this process might also result in conflict and communication barriers. Personality traits and the willingness to communicate are factors that determine the quality and compatibility of the relationship between the designer, the end-user, and the rest of the members of the team. Therefore, the designer faces the challenge of finding the right balance in satisfying the needs of multiple stakeholders involved in the design project and in communicating the criticality of the essential requirements of the end-users to the team, especially when the users are not present in such discussions. The importance of empathy towards the user needs to be understood by all involved

stakeholders of the project team since this would facilitate empathy that is generated from multiple perspectives. Therefore, through increased awareness of the user's perspective, empathy is considered a key driver to innovative and user-oriented conceptualisation.

4.4 The human designer

Another major enhancer that determines the level of empathy achieved towards the user, is the personal and professional attributes of the designer, listed under designer attributes (Figure 3). This comprises their current role, daily activities, personal traits, and dreams. In their work, designers aspire to achieve self-fulfilment. Factors mentioned by participants include their desire to design for sustainability, and inclusivity, and obtain a greater focus on activities that add such value. This indicates a deep innate nature in designers to find purpose in their work by positively impacting the lives of others through the application of their inherent skills. Increased awareness of empathy would also increase the designer's willingness to empathise with users. Working on projects involving cutting-edge technologies, novelty, and practical tasks are also exciting aspirations for designers. Assistance including emotional support in the work environment is another factor that is valued by designers.

Potential VR solutions in supporting designer empathy were also discussed. Suggested VR solutions included simulating the user experience, observation methods with a virtual user that represents multiple user data, realistic interactions with the virtual world, and having a voice recording system that supports the documentation and analysis required to generate the product design specification. This recording process would generate more focus on creative ideation and reflection and less on documentation tasks, hence facilitating empathy and conceptualisation.

5 The digital empathic design voyage: transforming the designer experience

This research explores how VR can be used to allow the designer to experience the optimal level of empathy towards their user for product innovation, whilst also addressing current challenges in empathic design and augmenting designers' empathic skills. This is achieved through a novel empathic design specification: The Digital Empathic Design Voyage, which is presented in this section.

The outcomes of the semi-structured interviews revealed that the main challenges to empathy stem from communication and resource factors. The same factors in combination with designer attributes also act as empathy enhancers. From the results of the qualitative study, three solutions were generated that encompass The Digital Empathic Design Voyage specification, described further in Table 1. Such solutions are facilitated through the mechanisms enabled by VR technology, listed in Table 1. The benefits of each solution are also listed and directly incorporate the barriers, empathy enhancers, and designer aspirations that resulted from the qualitative study of this research.

Table 1. Three proposed solutions A, B and C for The Digital Empathic Design Voyage specification

Solution	VR Mechanism	Benefits of VR Solution
A. Augmented Designer and User Relatability	• The designer embodies the user from a first-person perspective. • Haptic feedback is incorporated into the virtual environment to represent realistic	• Increased knowledge and awareness of the user experience in situations where the user has different physical or mental characteristics from the designer and when the user's environment is foreign to the designer.

		interactions with the user's environment. • A documentation system enables the recording of actions, thoughts, and emotions.	• Understanding of the full user experience through cognitive and affective empathy responses • Facilitation of documentation of experience to support analysis and reflection. • Increased designer motivation and self-fulfilment for the project due to the involvement of cutting-edge technology and increased focus on practical experiences.
B.	**Enhanced Accessibility to User and User Environment**	• A virtual avatar represents the user and is generated from multiple user data. • A virtual representation of the user's environment is generated.	• Representation of user archetype generated from multiple user data. • Enhanced communication in applications involving limited user accessibility. • Increased accessibility to user environments involving safety-critical applications or scenarios having a high cost-per-time ratio. • Increased focus on developing empathy towards users which provides opportunities for empathy training. • Lower conflict between the designer and user related to a lack of user motivation and personality differences. • Increased designer motivation for the project due to the involvement of cutting-edge technology and increased practical experience.
C.	**Increased Engagement of Multidisciplinary Stakeholders**	• Project stakeholders have access to a common virtual space representing the user's environment. • Dynamic interactivity with the virtual user and the user's environment is introduced. • Haptic feedback is incorporated into the virtual environment to represent realistic interactions with the user's environment. • A documentation system enables the recording of actions, thoughts, and emotions.	• Virtual representation of the user in team meetings particularly when this is not feasible in physical contexts. • An opportunity is created for stakeholders from multiple disciplines to interact with the user and experience empathy in a group. • Enhanced conflict resolution due to a common understanding of the design problem and increased significance given to the user's perspective. • Augmented assistance in documentation activities such as meeting discussions and product design specification.

The three solutions presented in Table 1 revolve around bringing the designer closer to the user through augmented designer-user relatability, enhanced designer accessibility to the user and the user's environment, and increased engagement of multidisciplinary stakeholders that are involved in the design project. The first solution (Solution A) is achieved through the designer fully embodying the user and having the freedom to explore the full user experience. Solutions B and C represent enhanced interaction between the designer, other project stakeholders, and the user, who is represented by a virtual agent and designates the integration of multiple user data. Figure 5 describes how the three

solutions integrate into the two VR scenarios proposed which represent The Digital Empathic Design Voyage. An example of a domestic user environment is presented.

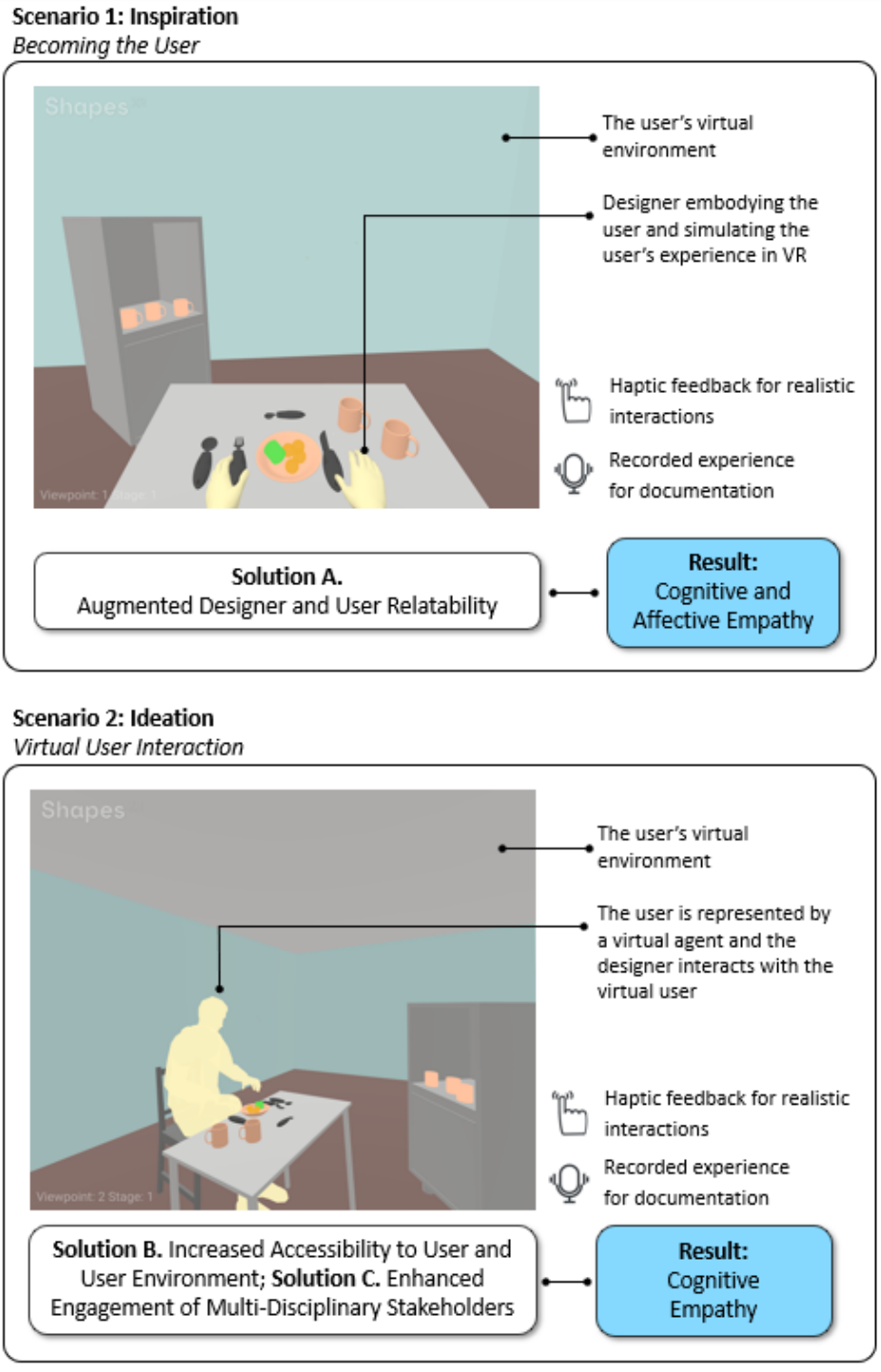

Figure 5: The digital empathic design voyage specification. Created using ShapesXR®

In Scenario 1, the designer is fully immersed in the user's situation from a first-person perspective and therefore gives the designer the freedom to explore the full user experience from the user's point of view. The achieved through full user embodiment and dynamic interactions with the user's environment. Voice recording allows documentation of thoughts and emotions experienced during

the simulation. In this scenario, the designer achieves affective empathy responses through the immersive effects of PTVR (Berezina-Blackburn et al., 2018) and obtains a holistic understanding of the user's perspective. Therefore, this scenario combines elements of cognitive and affective empathy components and supports the designer to achieve the optimal level of empathy. Scenario 1 is advantageous in applications where the designer is exposed to an environment that is foreign to them or when the designer and the user have different physical or mental attributes. It is also applicable in cases where the designer would like to gain knowledge of the user's perspective before engaging with actual users and therefore this scenario would serve as a steppingstone towards pre-establishing the relationship between the designer and the user.

In this first scenario, the daily activities of designers are transformed. Less focus is given to obtaining access to user data and documentation activities and less time is spent in the office environment. This paradigm shift, facilitated through full engagement with the virtual user environment, provides the designer with the freedom to explore the full user experience. Therefore, this transformation towards practical empathic experiences increases designers' self-fulfilment in their roles. In addition, this scenario allows the designer to access a broader perspective of the design problem and hence bridges the gap between the designer and the user through enhanced relatability.

In Scenario 2, presented in Figure 5, the designer has the opportunity to observe and dynamically interact with the user and their environment, from a second-person perspective. The purpose of this scenario is to allow the designer to observe and critically reflect on the user experience (Bahng et al., 2020), hence cognitive empathy responses are predominant. The end-user, represented by a virtual agent, is generated from multiple user data that is characterised by a user archetype. This scenario addresses the limitation involving highly inaccessible users and user environments, therefore facilitating communication between the designer and the user. Additionally, the designer has access to a source that represents a group of users which increases the quality of the designer's empathic experiences. Designers also have flexible and repeated access to the user and their environment, hence presenting increased opportunities for skills development and training.

Scenario 2 can also be applied in the simultaneous presence of other project stakeholders to allow a common understanding of the design problem and facilitate group empathy and reflection. Project stakeholders may include upper management, the client, and even other end-users that may be physically involved in the project. Increased engagement of multiple project stakeholders facilitates recognition of the significance of the user's experience in the project, particularly when the actual user is not represented in this design phase and allows empathy to be experienced through multidisciplinary collaboration. This offers a unique opportunity for team members to collectively observe and analyse the problem from different perspectives which support group inspiration and ideation. A documentation system enabled through the recording of the reflection and conceptualisation process, assists in the generation of the product design specification.

The Digital Empathic Design Voyage offers other business-related benefits. It proposes a more sustainable and cost-effective solution in situations where resources are significant, energy inefficient, or costly. This also provides an excellent opportunity for start-ups and small and medium enterprises having insufficient resources to obtain full empathic understanding whilst wanting to gain a competitive advantage through finding innovative design solutions.

5.1 Limitations

Limitations of this qualitative study are related to the relatively low sample size leading to potential biases by participants. Future work should consider a larger and more diverse sample size, that includes designers from further institutions and varied cultural backgrounds (Li & Hölttä-Otto, 2020). The practical challenges of the proposed specification are related to the gathering of sufficient user data required to create a user archetype represented by the virtual agent in Scenario 2. Lack of user accessibility may become a challenge for who would be responsible for developing the virtual environment, which may render a rigorous process in the initial stages of the VR application development.

6 Conclusions and future work

Humans have the natural ability to feel empathy through social interactions to create a better world. The current emergence of VR technology has inspired this research to explore how VR can be applied to support designers in achieving the optimal level of empathy required for product innovation. Literature related to empathy in virtual environments demonstrates the potential for VR to facilitate empathy from a first-person perspective that encourages affective responses (Berezina-Blackburn et al., 2018; Zhang et al., 2022) and from a second-person perspective that promotes critical reflection (Bahng et al., 2020).

In this research, VR is explored as a tool that transforms the application of current empathic design methods using findings from a qualitative study. Semi-structured interviews were performed with design engineers working with industry to analyse current barriers to empathy and identify how VR can address current challenges in empathic design, whilst augmenting designers' empathic skills. The study highlighted that communication and resource factors were the core barriers to designer empathy. These same factors in combination with designer attributes were also determined to support empathy, designated as empathy enhancers. In response to this finding, this research brings the designer closer to the user through the digital transformation of the designer's profession that provides enhanced value to human-centricity, social and ecological interactions. This is performed through the creation of a novel specification for a fully immersive virtual environment: The Digital Empathic Design Voyage. For the first time, the designer is empowered to achieve the optimal level of empathy towards their user through the generation of both cognitive and affective responses whilst augmenting their empathic skill. This is achieved through a combination of augmented designer-user relatability, increased designer accessibility to the user and the user's environment, and enhanced engagement of designers and multidisciplinary stakeholders that are involved in the design project. This led to the creation of the specification consisting of two scenarios. The first scenario immerses the designer into the full user experience through user embodiment from a first-person perspective and dynamic interactivity with the user's environment. The second scenario provides enhanced interaction between the designer, other project stakeholders, and a virtual user - which represents multiple user data – within the user's virtual environment.

The proposed specification, The Digital Empathic Design Voyage enhances the quality of the empathic experience through increased dedicated focus towards communicating and interacting with a single user archetype. Additionally, this specification provides a platform for empathic skills development for all project stakeholders due to repeated accessibility, whilst also presenting enhanced significance

to co-design and co-creation of value. Therefore, this specification would be highly beneficial for designers and companies seeking to reach a step closer towards obtaining user-oriented design solutions that are not feasible in current scenarios. Through the future configuration of VR tools and empathic methods to support designers, the goal of this research is to perform empirical studies on an operational VR environment that is based on this specification. The aim of this future study would be to augment the quality of the designer's empathic experience that is ultimately focused on enhancing designer self-fulfilment and on bringing the designer closer to the user that creates a new generation of innovative user-oriented design solutions focused on human-centricity, inclusivity, and social value.

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