Design Approaches to Creativity Support with Embedded Artificial Intelligence

By

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Abstract

This research investigates designers' attitudes and approaches towards using AI (Artificial Intelligence) to support their creative work. It consists of three studies with people working in creative roles in the design industry: a survey (n=45), a month-long diary study (n=30), and a 21-day digital probe study (n=5). Mixed-methods data analysis identified several factors that influenced participants' preferences for the type and level of creativity support they desired for a particular task, and their willingness to accept support from an AI system. These factors were found to divide into three groups: *Categories*, *Confines*, and *Competencies* of support.

Three *Categories* of creative support were requested by participants: *Information* support, related to receiving the necessary data, references, or feedback need to complete a creative task; *Generation* support, related to direct help with the tools and processes of generating creative outcomes; and *Situation* support, related to organising and facilitating working environments, schedules and conditions for creativity. Of these, Information support was the most frequently requested.

The *Confines* of support related to the participants' distinction between creative tasks which they considered of personal value, and which they were less likely to share with an AI system, and tasks which were not considered of personal value. This was found to relate to the perceived originality and creativity of the task experience.

The *Competencies* of support related to the participants' perception of the knowledge and abilities required to support a task, and how this related to their own knowledge and abilities. Participants were more likely to fully delegate tasks to AI that they already had experience of completing themselves, and preferred to work directly on tasks that were new to them.

These factors were tested across the different studies, and formalised into a Creativity Support Framework, which forms part of the contribution of this research, along with the design and implementation of an embedded AI digital research probe, used in the final study.

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Dedicated to the best supporters of creativity – Jenni, Martha, and Orla.

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Chapter 1 Introduction

1.1 Overview

This research investigates designers' attitudes and approaches towards using AI (Artificial Intelligence) to support their creative work. Through three separate ethnographic studies with people working in creative roles in the design industry, this research aims to better understand the types of support that designers require in their creative work, and what role they might ideally wish AI to play in providing that support.

The research has identified several factors that influence designer’s preference for creative support, and in particular their preference for AI-based creative support. These are presented as a Creativity Support Framework which can be used to model the types of creative support that AI tools may be able to provide designers, and could be valuable for use in the design of AI-enabled Creativity Support Tools (AI-CST).

The research has focused particularly on the potential uses of embedded AI systems in creativity support, which do not rely on data shared, stored and processed on the internet, and therefore afford more personal, private applications than conventional cloud-based AI systems.

In addition to investigating the use of embedded AI systems within Creativity Support Tools, this research also utilised embedded AI devices as a data collection tool within the final study, and provides some observations related to their use in research contexts.

1.2 Context

This research has taken place at a significant and transformational time for the combined topics of Creativity and AI. Over the six years of this PhD research, these two terms have become closely, and, to some extent, problematically associated with each other through the rapid rise of generative AI technology.

Generative AI tools enable people to instantly produce creative outcomes such as images, text, and video, without requiring any creative production skills, through the use of simple text prompts. These tools can potentially be used to support the work of creative professionals, or automate large parts of their work.

Generative AI tools have developed significantly over the last six years, both in terms of the standard of the output, and the availability to the public. To take image generation as an example, six years ago the state of the art in AI generation used the Generative Adversarial Model approach proposed by Goodfellow *et al.* (2014). This enabled the generation of photorealistic images at a maximum of 512x512 pixels (e.g. Brock, Donahue and Simonyan (2019)) with images frequently containing visual mistakes and distortions. Running these kinds of models required specialist hardware and coding knowledge, which made it mostly inaccessible for anyone outside of the research labs of large technology companies and universities.

In 2024, it's possible for anyone with an internet connection to generate a photorealistic 2624 x 1472 pixel, 2K resolution image, or even a 10-second long 720p resolution video clip, to their own specifications in just a few seconds, using cloud-based services such as Runway (2024).

The accessibility and availability of AI image generation has grown so much that it is now built into popular search engine tools like Bing (Microsoft, 2023), and comes as a standard feature in design industry software such as Adobe Photoshop and Illustrator (Adobe, 2024a).

At a time when technology companies have invested heavily in developing and promoting generative AI, public perceptions of the technology, and its use within creative contexts have evolved quickly. There has been much public discourse in the press about the growing ability of AI to perform creative tasks (Milmo, 2024; Fleming, 2024; Sillars, 2024; Christian, 2023), and research indicates public concern about AI impacting creative jobs (UK Department for Science, Innovation & Technology, 2024).

Ethical concerns about the use of AI tools have also emerged as part of the public discourse about AI in recent years. In particular, these relate to plagiarism in the training data and outputs of generative AI models (Metz and Ford, 2024; Hutchinson and John, 2023; Marr, 2023; Tapper, 2024), privacy concerns related to how data shared with AI systems is stored and used (O'Flaherty, 2024; White, 2023; Rahman-Jones, 2024; Rajappa, 2024), and the environmental cost of AI's high power and water usage (Olivo, 2024; Sorkin *et al.,* 2024; Calma, 2023; Criddle and Bryan, 2024; Naughton, 2023).

Amidst this rapid evolution of creative AI technology and the public opinion surrounding it, the real-world needs and attitudes of creative professionals likely to be most impacted by generative AI have received much less attention in research. AI tools are already available which can perform parts of the creative process which until recently could only be done by humans, such as image generation and manipulation (Adobe, 2024b), translating sketches and mock-ups into working designs (Figma, 2024), shooting videos (Runway, 2024), writing scripts and synopses (OpenAI, 2022), and creating 3D models (Meshy, 2024). With these kinds of advanced automation tools available, more understanding is needed about how, or even if, designers want to use these AI tools to support their creative process.

This research has, therefore, focused on the attitudes and approaches of those working in creative roles in the design industry. It has built on the existing field of research related to Creativity Support Tools (Shneiderman, 2007), to understand what kind of supportive role designers want AI to play in their current practice. It focused especially on designers' existing creative practices and approaches, investigating when they might desire support for a creative task and what role AI could play in providing that support.

In doing so, the research acknowledged that creativity is a deeply personal and subjective topic which crosses many different disciplines and approaches, as well as professional and personal contexts. It therefore situated creative practice as a personal experience and aimed to gain insights into how individuals constructed and perceived their own approaches to creative tasks.

The research used ethnographic methods of data collection and analysis to gain insights into the current experiences and attitudes of those working in creative roles. It used both qualitative and quantitative analysis methods to build a picture of the working practices of study participants, and to make recommendations about how and when creativity support from AI systems may be appropriate.

In investigating potential uses of AI, the research focused on embedded AI as a version of the technology that may be useful for supporting personal forms of creativity. Embedded AI refers to AI applications which run offline on small hardware platforms and personal devices, rather than relying on sharing data and functionality with cloud-based services (Brandalero *et al.,* 2020). It therefore has advantages relating to privacy and personalisation which many online tools do not have.

Currently, generative AI tools normally exist as online applications, as the hardware needed to quickly perform tasks like image generation is not available on most devices such as laptops, desktops or phones. The generative functionality, therefore, happens on online servers, and the results are sent back to the user via the Internet. Embedding AI functionality on personal devices may remove the need to share data with online services and the associated risks to privacy.

However, embedded AI hardware can not yet easily support generative features such as media generation. The area of this research related to embedded AI in creative tasks is, therefore, primarily future-focused. It aims to define the opportunities for the use of embedded AI within future creativity support tools by better understanding the support needs of individuals in relation to the personalised and private forms of AI functionality that embedded AI systems represent.

1.3 Studentship and Industrial Partner

This PhD is an AHRC Techne Doctoral Training Partnership NPIF CDA Studentship at University of the Arts London, with funding provided by the AHRC and Techne. The NPIF (National Productivity Investment Fund) studentships each included a collaboration with an industrial partner engaged in work relevant to the topic. For this studentship, the industrial partner was Google, and in particular the Artificial Intelligence User Experience team based in London.

The partnership for this PhD included three placements with the company, each lasting two months and taking place over the summers of 2019, 2020, and 2021. These enabled knowledge exchange with teams at Google researching methods of creativity support with personal and embedded AI tools. The PhD's focus on embedded AI aligned with their research at the time, and their experiments with products such as AIY (Do-It-Yourself Artificial Intelligence) toolkits (Google, 2024b).

There were some limitations on completing research directly with Google as part of these placements. These included commercial confidentiality, the COVID-19 pandemic, which impacted the second two placements, and the shifting research priorities at the company over the course of the placements. The placements are discussed in more detail in Chapter 5.

The most significant outcome of the placements was the completion of a diary study with research participants recruited at Google through their internal research and testing processes. This diary study investigated the creativity support needs of participants over the period of a month, and the findings from the study informed the final study of this research.

1.4 Questions

Following a review of existing literature and practice related to Creativity, AI and Creativity, and Creativity Support Tools (Chapter 2), specific research aims emerged as priorities in investigating design approaches to creativity support with embedded AI. These aims stemmed in particular from the recognition of creativity as a personal, subjective, and interdisciplinary practice, as well as the diverse and fast-evolving, approaches to achieving creativity through AI systems.

The research aimed to meet the following objectives:

- To understand the attitudes of individuals working in creative roles towards AI, and the ability of AI systems to support their personal creative process.
- To understand the attitudes of individuals working in creative roles towards sharing creative tasks with AI systems.
- To understand the specific requirements for creativity support experienced by individuals working in creative roles and what opportunities exist for AI, and in particular embedded AI, to provide support in these situations.
- To understand how the requirements for creativity support experienced by individuals working in creative roles change across different activities and contexts for creativity.
- To ground the research and development of AI-based creativity support tools in real-world experiences of personal, embedded, and distributed creative practice (e.g. those defined by Still and d'Inverno (2016), and Glăveanu (2013)).

These objectives are addressed in the following research questions:

1. What role do individuals working in creative roles in the design industry want AI to play in supporting their personal creative practice?
2. What factors influence the type of creativity support individuals working in creative roles in the design industry are willing to accept from AI systems?
3. What opportunities exist for creativity to be supported by personalised, embedded AI systems?

These questions required an analysis of the attitudes and requirements of individuals in relation to their personal creative practice, which may be interdisciplinary and disrupted across different personal, social, and professional contexts.

1.5 Scope and Terms

The research questions focus on 'individuals working in creative roles in the design industry' as the user group for the research. This relatively broad description was used to recognise that not all people working on creative tasks or requiring creativity support may identify themselves as 'creatives', just as not all people working in interdisciplinary design professions may identify themselves primarily as 'designers'.

The selected definition could, for example, include people working primarily as illustrators, creative producers, and developers in design-related fields. Individuals in these kinds of roles may not include the term 'designer' in their job role, but they may benefit from the type of creativity support aimed at helping people produce design outcomes. The main requirements for inclusion in the research studies was that the individuals should be in roles that involve working on creative tasks, and that the work should broadly be within the context of commercial design (rather than, for example, fine art practice).

The 'design industry' is also a broad term which covers many different commercial disciplines and fields within the global creative industries. In the UK, where this research was primarily based, these industries include disciplines such as product design, interaction design, graphic design, fashion design, and architecture (Department for Digital, Culture, Media & Sport, 2001).

What links all these disciplines is the applied, commercial use of creative practice. The focus of this research is primarily on supporting personal creativity, which has led to and included an expansive definition of design and creativity within each study. This means that the results may apply to many of these different sections of the creative industries. However, for the purpose of the three studies the primary design fields the research focused on were Digital Product Design and User Experience Design. These areas were chosen as they corresponded with the work being undertaken by the industrial partner for this research, Google.

The interdisciplinary nature of the Digital Product Design and User Experience Design meant that the research covered many different skills and types of outcome. Research participants working in this area had varied roles, requiring creative work across different disciplines, media, and contexts, including digital and physical outcomes. Data was therefore collected about a wide variety of tasks, and the resultant conclusions and recommendations could be applicable to a range of design contexts.

Further analysis and definition of the terms Creativity and Design is included in the Literature Review (Chapter 2).

1.6 Overview of Thesis

This thesis is structured to present the research in the following chapters:

Chapter 1. Introduction

This overview chapter.

Chapter 2. Literature Review

An analysis of existing literature related to the research topic. The literature review specifically analysed three areas of research: Creativity Research, Artificial Intelligence and Creativity, and Creativity Support Tools. Key concepts and definitions from these areas of research were identified and informed the design and analysis of the studies.

Chapter 3. Methods

A review of the methods that were used in each of the different stages of research, with a rationale for their use and references to key literature on each of the approaches.

Chapter 4. Survey Study

This chapter details the first primary research study. This was an online survey of professional designers (n=45), asking them about their attitudes towards creativity, AI, and their preferences for sharing creative work with AI systems. Results were analysed using a mixture of quantitative and qualitative methods. This study revealed largely positive and practical attitudes amongst respondents, and identified potential areas of creativity support that influenced the design of the next study.

Chapter 5. Google Diary Study

This chapter covers the next research study, which was completed as part of a placement with the industrial partner for the research, Google. This was a diary study (n=30) that was carried out over the course of a month with employees from across the company working in creative roles. Results were analysed using thematic analysis and quantitative methods. Findings from this study informed the initial design of a proposed Creativity Support Framework which forms one of the contributions of this research.

Chapter 6. Creativity and Cognition Workshop

This chapter contains analysis and reflections on a conference workshop run at ACM Creativity and Cognition 2022 as part of this research (Main *et al.,* 2022). The workshop was run with a group of eight researchers working in the field of creativity, and involved activities and discussion around the themes of this research. Several elements of the Creativity Support Framework were tested and discussed, and reflections from the workshop informed the final study of the research.

Chapter 7. Digital Probe Study: Device Design

The final study involved the design of a research probe device which was used in a multi-week engagement with participants (n=5), corroborating and extending findings from the Google Diary Study. The probe device was kept in participant's workplaces for 21 days, and allowed participants to report on creativity support needs as they occurred. The device utilised some embedded AI features to allow voice recognition and recording as part of the data collection, whilst including several privacy-preserving features to protect participants. The devices were designed specifically for this study in order to meet the necessary research requirements, and the design process is detailed in this chapter. The design and implementation of the probe research devices forms another contribution of this research.

Chapter 8. Digital Probe Study: Study Design

This chapter describes the research design for the probe study. It details how the questions were designed to follow up on insights from the Google Diary Study, and how the required data collection was integrated with the probe functionality.

Chapter 9. Digital Probe Study: Results and Analysis

This chapter details the results of the probe study and provides insights using thematic analysis and quantitative methods. Findings from this study reinforced results from the Google Diary Study, and provided further observations which facilitated updates to the Creativity Support Framework. An updated framework, along with additional findings that may be valuable for the development of future creativity support tools, are presented in conclusion.

Chapter 10. Conclusions and Recommendations

This chapter summarises the conclusions of all three studies, relating the findings to the original research questions. It describes the findings which have informed the final version of the Creativity Support Framework and details the factors which have influenced participants' attitudes towards creativity support across the three studies. It also presents observations on the methods used in the research and in particular the design of the probe devices. It concludes with recommendations for future research based on the findings from these studies.

1.7 Publications

During the course of this research, three papers were written for publication in order to share methods and outcomes from the initial phases:

- Main, A., & Grierson, M. (2020). *Guru, partner, or pencil sharpener? Understanding designers' attitudes towards intelligent creativity support tools. arXiv preprint arXiv:2007.04848*.
- Main, A., Grierson, M., Yamada-Rice, D. and Murr, J. (2022) *Augmenting Personal Creativity with Artificial Intelligence: Workshop proposal for Creativity and Cognition 2022. In Proceedings of the 14th Conference on Creativity and Cognition (pp. 462-465)*
- Main, A., Cunningham, C., Marchant, R, Butler, T. (2023) *Creativity Support Roles: Understanding the Role AI Should Play in the Creative Process.*

The first paper, Main & Grierson (2020), presented findings from the Survey Study (discussed in Chapter 4), and was published as an e-print on the open-access archive arXiv. The second paper, Main et al (2022), was a workshop proposal for the ACM Creativity and Cognition Conference (discussed in Chapter 6), presenting the themes and methods used in that workshop. The third paper, Main et al (2023), presented findings from the Google Diary Study (discussed in Chapter 5), and was co-authored by colleagues at Google. This was cleared for publication by Google and submitted for the ACM Designing Interactive Systems conference 2023, although it was not selected for publication. This paper is included in Appendix 6.

1.8 Findings

This research has led to several unique findings which may inform the development of future AI-enabled Creativity Support Tools.

All three studies highlighted participants' positive and pragmatic attitude towards receiving creative support and collaboration from AI systems. The participants did not tend to have the concerns about the use of generative AI in their work which might be expected based on public discourse on this subject. The framing of AI as supporting, rather than replacing, their creative work, may have influenced this positive attitude.

Analysis of participants' descriptions of the creative problems they were facing, along with the details of the support they requested, led to a modelling of support needs, forming the basis of the Creativity Support Framework. This framework comprises three elements: *Categories*, *Confines*, and *Competencies*.

Categories describe the different types of support that participants requested. These requests all aligned with three categories: *Information* (where participants needed specific knowledge, data, or feedback in order to complete their task), *Generation* (where participants needed support for the production of design outcomes), and *Situation* (where participants needed support related to their creative environment or way of working, such as organisation, scheduling and motivation). Information was the most popular of these support categories, with the majority of responses indicating that participants needed some form of information to resolve a creative problem. This finding provides a new perspective on the design of Creativity Support Tools, many of which conventionally focus on supporting the generation of outcomes rather than supporting the communication of information.

The *Confines* element of the framework relates to the observation that participants tended to differentiate between types of creativity support they viewed as personal (for example, organising workspaces, scheduling work, or motivation) and support they viewed as task-focused (for example, helping to generate outcomes, finding references, creating visualisations). Participants were less likely to want to accept support from AI for issues that they viewed as personal, rather than task-focused. How they differentiated between personal or task-focused support was specific to each individual and not easily predicted.

The *Competencies* element of the framework helps define the knowledge and ability that a potential collaborator or tool providing creativity support would need to assist on a task. Analysis of this competency data showed that participants sometimes wanted a creative collaborator who had the same skills or knowledge as themselves, and sometimes wanted a collaborator with different skills and knowledge. How participants decided which competencies were needed by a collaborator was sometimes counterintuitive. This helped inform one of the findings of the research related to the perceived creativity of tasks. Participants often wanted to hand over to a collaborator the tasks for which they already had the knowledge or skills to complete, and instead preferred to personally work on tasks where they didn't already have the knowledge or skills to perform. This suggested that the potential to have new and creative experiences formed part of participants' decision making when choosing the level of creative support they wanted on a task.

Additional findings from this research relate to the framing of creativity in the design and implementation of AI-enabled Creativity Support Tools. Through the review of literature, and all studies carried out as part of this research, it was found that personal and process-focused definitions of creativity were most helpful for defining the type of work and support that participants required. This framing of creativity was linked in particular to Still and d'Inverno's definition of N-creativity (Still and d'Inverno, 2016), and Glăveanu's definition of distributed creativity (Glăveanu, 2013). This personal, process-focused framing of creativity puts emphasis on the creative experience of the designer, and differs from the definition traditionally used in Creativity Support

Tool research, which has historically been focused on product and outcome, rather than process and experience.

Further details of the findings from the research are presented in Chapter 10.

Chapter 2 Literature Review

2.1 Introduction

The focus of the research intersects three distinct domains of theory and practice:

- **Creativity** - The areas of human psychology and cognitive science concerned with how people behave creatively, with particular focus on creativity within design activities.
- **Artificial Intelligence (AI)** - The area of computer science engaged in developing technologies capable of performing tasks normally requiring human intelligence. In particular, the technologies associated with embedded or on-device AI.
- **Creativity Support Tools** - The branch of Human Computer Interaction focused on developing computer technologies which enhance aspects of the creative process.

Each of these domains comprises significant bodies of research, some of which is of direct relevance to the work presented in this thesis. This review will summarise the relevant literature from each in turn, concentrating on areas of overlap and resonance between them, and defining the issues which underlie the development of artificially intelligent creativity support tools for designers.

This research focuses on how embedded AI systems may support creativity in the context of design practice. Embedded AI, as opposed to cloud-based AI, affords more personal and private interactions between AI and individuals (as discussed in more detail below). In tackling the breadth of literature associated with the topics above, this review will, therefore, focus on areas related to personal creativity in contexts relevant to design practice.

2.2 Creativity

2.2.1 Understanding Creativity

Determining how to effectively support creativity first requires a workable definition of what creativity is, and how it is achieved.

For a term so commonly used within personal and professional life, creativity is still a complex concept to define. "Human creativity is something of a mystery, not to say a paradox", according to Boden (2007). The intrinsically human quality of creativity means that it might often be understood intuitively by those performing it (Hardman, 2021), rather than through well-defined, and easily articulated parameters. Cardoso, Veale and Wiggins (2009) call creativity “an elusive phenomenon to study”, noting that if you ask most people for a definition of creativity, “you are more likely to elicit an anecdote, an aphorism, or a metaphor than you are a literal definition” (Cardoso, Veale and Wiggins, 2009, p.16).

Götz (1981) notes a similar lack of specificity in how the word is defined not just in everyday usage, but within research into creative practice. Plucker and Beghetto (2004) reinforce this with a survey of creativity research articles showing that only 40% of those sampled offered an explicit definition of creativity. Still and d’Inverno (2016) call the word creativity “vague but redolent with promise and progress” and quote Cardoso, Veale and Wiggins (2009) saying “The word [“creativity”] has, historically, undergone several shifts in meaning, and it continues to mean different things to different people” (ibid, p.21). Yet, as Baer and Kaufman point out, “the use of the single word ‘creativity’ to encompass so many diverse kinds of things suggests a common element, something that links all creative endeavors” (Baer and Kaufman, 2005, p.158).

In fact, a broadly consistent definition of creativity has been present since 1950, when Guilford helped establish the scientific study of creativity (Guilford, 1950). This defines creative outcomes as those which exhibit the qualities of novelty and value. As Still and d'Inverno discuss in their *History of Creativity for Future AI Research* (2016), Guilford included the concept of novelty in the founding definition of scientific creativity research, identifying creative people by their ability to have novel ideas. While the concept of value was more clearly integrated by Stein (1953), who stated that as well as being novel, a creative outcome needed to be "accepted as tenable or useful or satisfying by a group in some point in time" (ibid, p.153).

Runco and Jaeger (2012) describe how the basic elements of novelty and value represent the 'standard definition' of creativity. They provide an extensive overview of the evolution of this definition, describing how the specific terms differ slightly within individual definitions. For example, novelty may also be referred to as originality or surprise, and value might be described as effectiveness, usefulness, fit, or appropriateness. The general principle of the standard definition remains the same, however. Creative outcomes are expected to be different to existing outcomes, but the originality shouldn't just represent randomness, it needs to be meaningful or useful in some context. It is this dependency on context which can represent a weakness in the standard definition, and introduces complications for supporting creativity.

2.2.2 Creativity in Context

Context is addressed directly in Rhodes' influential definition of the four components of creativity (Rhodes, 1961), which became canonical elements of the developing field of creativity research (Glăveanu, 2013; Still and d'Inverno, 2016). These are the Four P's - Person, Process, Product, and Press (where Press represents the social context or environment for creativity).

Glăveanu (2013) extended these further into the 5 A's - Actor, Action, Artefact, Audience, and Affordances, developing each of Rhodes' P's, and clarifying the often unclear 'Press'. Both definitions recognise creativity as a heterogeneous process, involving not just a creative individual (Person or Actor) and a creative outcome (Product or Artefact), but systems and contexts in which the creative act takes place (Process and Press, or Actions, Audience and Affordances).

Defining the context of creativity is not always simple, given the variety of disciplines associated with the subject, and therefore the variety of ways that creativity may be defined, assessed, and supported. The specific requirements of creativity in musical practice, for example, may differ considerably from those in engineering. A subfield of creativity research has therefore focused on aiming to define the specific domains for creativity, as a way of understanding the different requirements for creativity in different contexts, and how far individuals can be supported to perform creatively across domains.

Plucker and Beghetto (2004) argue that creative abilities are both domain-general (having some qualities which can be shared across different domains and disciplines), and domain-specific (having some qualities which can only be assessed within the context of a specific domain or discipline). Baer and Kaufman's Amusement Park Theory of Creativity (APT) (Baer and Kaufman, 2005) refines this further by proposing a hierarchy of four domain levels (initial requirements, general thematic areas, domains, and micro-domains) which run from highly general (applicable to many different disciplines) through to highly specific (applicable to only a niche area of discipline). Baer and Kaufman propose that these different levels of domain specificity can be used to help plan how creativity is assessed and supported, particularly within education.

Carson *et al.* (2005) are more specific in identifying particular subject domains where creativity can be assessed. They propose the Creative Achievement Questionnaire (CAQ) as a means of measuring creativity, and within this identify ten different contexts for creativity. These are visual arts, music, dance, architectural design, creative writing, humour, inventions, scientific discovery, theatre and film, and culinary arts. The authors suggest that these can be combined into three general categories of creativity - expressive, performance, and scientific. While these different domains and contexts cover a broad range of potential creative activity, they present a challenge when it comes to the multidisciplinary, cross-domain, activities of design.

2.2.3 Creativity in a Design Context

Further analysis of the design process will be discussed later in this chapter. As a starting point however, Bonnardel and Bouchard (2017) in their review of creativity in design, draw on historical definitions of design which position it as a systemised process of problem solving. They define design as “a process in which the problem space (based initially on the design brief) is gradually transformed into the solution space” (ibid, p.404). As with other researchers working across the related fields of creativity, design, and AI, Bonnardel and Bouchard refer in their definition to Herbert Simon’s work.

Simon defines design as a process of synthesis following analysis, which involves “conceiving of objects, of processes, of ideas for accomplishing goals, and showing how these objects, processes or ideas can be realized” (Simon, 1995, p.246). This incorporates the dual concepts of analysis and synthesis, which Koberg and Bagnall (2003) had already suggested were the essential components of the kind of problem-solving approaches required for design.

Simon’s definition emphasises design as a process which can be applied across many different forms of outcome from material to conceptual. It also asserts that a designer is not just responsible for conceiving an outcome, but also for showing how it can be realised. This positions design as an activity which crosses domains, and requires both general and specific domain knowledge.

The cross-domain problem-solving represented by design makes it difficult to define the type of creativity required against the contexts offered by models such as the CAQ or Baer and Kaufman’s APT. For example, a person working within digital or interaction design might be required to demonstrate creativity across contexts such as visual art, moving image, writing, and sound design.

In certain ways, design practice provides a clear context for the standard “valuable novelty” definition of creativity. Novelty and value may not always apply consistently in some forms of artistic creative practice. For example

Ingold (2014), questions the importance of novelty in creative endeavours such as calligraphy and musical performance, and value or utility are questionable priorities within the context of fine art practice. But within commercial design practices, the standard definition of creativity is more clearly applicable, as originality is often linked directly to literal commercial value.

2.2.4 Commercial Design Practice

Whilst there are many different commercial contexts for creativity, and creativity support, this research focuses specifically on commercial design practices. The Design Council's 'Design Economy' report (Hay, Todd & Dewfield, 2022) shows that even within the field of commercial design, designers may be working across many different contexts. They define the Design Economy as designers working within specific design industries (such as architects, web-designers, and product designers), and also designers working in other sectors of the economy (such as finance, retail, and construction).

The fact that the Design Economy often involves types of creative practice which cross domains (Abraham, A., 2022; Scotney *et al.,* 2019) and disciplines (Muratovski, 2017), is part of what makes it valuable. Darbellay, Moody, and Lubart (2017) note that the interconnected concepts of Creativity, Interdisciplinarity, and Design Thinking are highly valued in various economic settings, and "reflect a current trend that is clearly oriented toward openness and cross-fertilization of knowledge across multiple domains" (Darbellay, Moody and Lubart, 2017, p.xi).

What links all roles in the Design Economy is the applied use of design skills in a commercial context. The need for design outcomes to be commercially, as well as creatively, viable means that in this context the standard definition of creativity as a balance of originality and value has particular pertinence.

The specific commercial context for design work is likely to influence the attitudes of designers towards their creative process, and how they choose to balance the priorities of originality and value. The Design Economy report provides more detail about the economic pressures that may affect designers' attitudes towards creativity, and the type of creative support they desire. For example, 25% of workers in the Design Economy are self-employed, compared to 15.3% in the rest of the economy (Hay, Todd & Dewfield, 2022, p. 133), which has an impact on individual workload and job security.

In the field of Digital Design, which is the focus for this research (as discussed in section 1.5), there are particular pressures on productivity, with workers in the Digital Design sector reported as generating 15% more economic outcome per year than the UK average (ibid, p. 18). Relatedly, the diversity in this sector is limited, with the majority of workers in Digital Design being male, and aged between 16 and 34 (ibid, p. 162). This may place additional pressures on workers from outside this demographic.

The economic pressures faced by designers are reflected in surveys and reporting within industry publications, which regularly state that design workers report feeling over-worked, and concerned about job security (for example, Dawood, 2017; Wong, 2021; Gorny, 2022; May, 2023; May, 2024).

This commercial context will be taken into account when analysing the attitudes and priorities of individual designers taking part in this research.

2.2.5 Personal Creativity

In terms of defining creativity for the purposes of support, the context of design can therefore be challenging to specify. Whilst the definition of "valuable novelty" makes sense in this commercial setting, the subjectivity of the terms 'novel' and 'valuable' means that creativity may be defined differently across the multiple disciplines and domains in which an individual designer is operating for a particular task.

To address this issue, some fields of research take an alternative approach to defining creativity. One which focuses less on the external, objective assessment of creative outcomes, and more on the personal processes and experiences of the creative individual.

Defining creativity at a personal level means accounting for subjectivities and personalisations amongst individual creative practitioners. Creativity can be a personal process, and creative practitioners have a tendency to formulate their own particular approaches and methods of creativity.

The best demonstration of the tendency of creative practitioners to personalise the creative process is perhaps the amount of work dedicated to establishing and analysing new models of the creative process itself. It seems to be a natural inclination amongst those working in creative roles, and particularly designers, to review and define their own creative process. This may be due to a tendency, encouraged by design education, towards reflective practice (Schön, 2017), or perhaps because the commercial value placed on creativity encourages the development of individual “signature styles” (Elsbach, 2009). In either case, the number of models that exist of the design process has resulted in a large body of literature in itself dedicated to surveying representations of the design process. For example, Dubberly (2005), Cross (1984), Taylor (2017), Bobbe, Krzywinski and Woelfel (2016), Design Council UK (2024), Gericke and Blessing (2012).

This widespread documentation and sharing of the creative process can be seen as part of achieving a social consensus about what represents creativity. Analysing individual creative outcomes within a broader social context is an important part of traditional definitions of creativity.

Csikszentmihalyi (2013) notes the difficulty in assessing creativity on a personal level without reference to external standards or social evaluation. “Creativity does not happen inside people’s heads, but in the interaction between a person’s thoughts and a sociocultural context. It is a systemic rather than an individual phenomenon.”.

However, if an idea or concept needs to be externally evaluated before it is recognised as creative, it excludes individuals from acting creatively within the context of their own practice, or imagination. Boden (2007) accounts for this by proposing two forms of creativity; Personal Creative (p-creative) in which an outcome is novel and valuable in the context of an individual's own experience, and Historic Creative (h-creative), in which an outcome is novel and valuable in the context of the previous work of others.

When considering the implications of assessing the creativity of individual ideas against the history of similar work, certain practical limitations become apparent. Ingold (2014) critiques this distinction between personal and historic, calling "the notion of checking through the record of the past to see whether anyone has had [the idea] before. . . not just impracticable but ludicrous" (Ingold, 2014, p.127). Ingold instead positions creativity as an ongoing personal experience, likening it to Wieman's definition of how an individual "progressively creates personality in community" ((Wieman, 1961), quoted in (Ingold, 2014, p.126)). In this definition, creativity is a process of "undergoing", a constant dialogue between the understood and the unknown, where individuals "reach out from places already held, or prehended, towards the horizons of their present awareness" (Ingold, 2014, p.135).

Ingold's distinction also reflects what is often framed as traditional differences between Western and Eastern perceptions of creativity. Lubart (1998) characterises these differences in the following way; Western traditions of creativity focus primarily on the production of "observable products" which are externally assessed to be both "novel and appropriate" (ibid, p.339), in contrast, Eastern traditions of creativity are focused more on the individual and their "personal fulfilment", and "finding a new point of view" (ibid, p.340) on existing ideas, rather than inventing new ones.

Still and d'Inverno (2016) discuss a related distinction between what they define as G-Creativity and N-Creativity. These two approaches to creativity, they argue, have both been present in historical definitions of the word, but represent different philosophies of creation. G-Creative (where 'G' could mean

God, Genius, or Guilford), positions creative outcomes as products of human inspiration, and links to Western, Christian, theories of God and creation. “According to G-creative theory, the mind, like that of God, generates novel ideas which result in valuable products”. These products “exist, like God’s creation, independently of the creator” (ibid, p.152). G-Creativity, therefore places emphasis on assessing and valuing the product of creativity, rather than the process of creation, which tends to be less well defined, sometimes attributed to vague concepts such as ‘creative genius’.

Still and d’Inverno argue that N-Creativity (where the ‘N’ stands for Nature), is by contrast, associated with earlier pagan and materialistic ideas of creativity. It doesn’t attribute creative outcomes solely to the human mind, but rather to the interactions between people, environments, materials, and systems. In this way it is analogous with natural systems of creation and reproduction, linking back to earlier, pre-Christian, and Eastern ideas of creation as “bringing about or having an impact through natural forces” (ibid, p149).

Summarising the two approaches, Still and d’Inverno say “N-creative is a way of living and acting in the world and it is inherent in all activity... It goes with a concept of intelligence based on attentive inquiry, rather than a mental power. G-creative is based on the power to generate valuable novelty, and it is distinct from intelligence, which in the IQ testing tradition is a relatively mechanical process of knowledge and problem solving”.

2.2.6 Assessing Personal Creativity

Both Still and d’Inverno and Ingold’s theories of creativity give emphasis to the personal process, or experience, of creativity, rather than the outcomes, or products. In relation to Rhodes’ Four P’s of creativity, they focus more on Person, Process, and Press, rather than Product, and more closely follow Glăveanu’s Five A’s and the associated concept of ‘distributed creativity’, where creative Artefacts are produced only as part of an ongoing dialogue between the individual, and the sociocultural contexts they are working within (Glăveanu, 2013).

This turn away from products as the measure of creativity contrasts with the methods usually used to assess creativity, both in academic and commercial contexts. Scientific studies of creativity more commonly analyse the demonstrable outputs of creativity, rather than the experiences that created them. In the early years of creativity research, Rogers stated: “for me as a scientist, there must be something observable, some product of creation. Though my fantasies may be extremely novel, they cannot be usefully defined as creative unless they eventuate in some observable product” (Rogers, 1954, p.250).

This is reflected in the established methods of psychometric creativity testing, which analyse the outcomes of creative thinking, for example, Guilford’s Unusual Uses Tests, or Torrance’s Product Improvement test (reviewed in Sternberg (1999)).

This outcome-focused criteria aligns helpfully with the requirements of commercial creative work, where emphasis is naturally given to tangible outcomes which can occupy a unique and viable position within a relevant market. These commercial requirements have reinforced a focus on creative products. In their review of creativity research, Mumford (2003) notes that “over the course of the last decade. . . we seem to have reached a general agreement that creativity involves the production of novel, useful products” (ibid, p.110).

However, for the purposes of supporting creativity in commercial design, both the product and the process need to be considered. Creative products do not materialise spontaneously, but are the result of complex interplay between people and their processes and environments (Batey and Furnham, 2006).

Systems which support the production of creative outcomes therefore need to address these requisite factors. For example, improving the creative environment, supporting individual processes, or facilitating personal development. To support creative outcomes, it is necessary to focus on the creative individual, and how and when they experience creativity.

One of the most established cognitive characteristics to be associated with creativity is divergent thinking. The concept of divergence was established by Guilford (1950) and developed further by Torrance (1972) and others. What Guilford termed Divergent Production (Guilford, 1950) (in keeping with the product-oriented interpretation of creativity), describes the ability to generate multiple, diverse ideas around a specific topic, which demonstrate differences from each other, and from existing ideas on the topic. Divergence indicates a prolificacy in thinking which increases the potential for creativity through the ability to produce original ideas (Runco and Acar, 2012), although not necessarily valuable ones.

While divergent thinking focuses on producing “multiple or alternative answers from available information”, convergent thinking aims at “deriving the single best (or correct) answer to a clearly defined question” (Cropley, 2006, p.391). Although some may position convergent thinking as less creative, or even antithetical to creativity (Runco and Acar, 2012), it can also be seen as providing crucial balance to divergent activities, allowing generated ideas to be analysed, selected, and refined to ensure value as well as originality.

Convergent thinking provides a means of “converting existing knowledge into ideas”, by allowing concepts not just to be generated but “explored” (Cropley, 2006, p.397). This emphasis on convergent thinking on exploration, understanding, and analysis, rather than generation and production, aligns it more with Still and d’Inverno’s concept of N-Creative than the outcome-focused G-Creative.

Divergence and convergence are analogous to the concepts of analysis and synthesis introduced as elements of design by Koberg and Bagnall (2003). Although Simon’s definition of design positions it specifically as a process of synthesis (Simon, 1995), Koberg and Bagnall suggest both analysis and synthesis are required throughout the process of creative design. This principle has persisted in many models of the design process since and provides the basic structure of the Design Council UK's Double Diamond model, which aims to consolidate many existing design approaches (Design Council, 2024).

In addition to divergence tests, competency models have been used as an alternative method to identify the conditions for personal creativity. The Epstein Creativity Competencies Inventory for Individuals (ECCI-i) (Epstein, R., Schmidt and Warfel, 2008; Epstein, R. and Phan, 2012) proposes that the competencies required for creativity can be measured in four separate categories; *capturing* (the ability to record new ideas as they occur, e.g. through sketching), *challenging* (the ability to work on open-ended, or unorthodox goals), *broadening* (the ability to learn diverse skills and knowledge), and *surrounding* (the ability to adapt to changing environments and stimuli). These competencies are identified in individuals through their responses to a series of statements (e.g. "I often read books from outside my specialty.").

The categories are based on Epstein's behavioural analysis, and therefore reflect the actions that individuals perform in order to support their personal creativity across different real world physical and sociocultural contexts. Competencies don't just focus on the mental processes of creativity, but on the behaviours and actions that are performed in order to support this. They recognise that creativity isn't just something that happens in the mind, but is embodied in action. In this regard they broadly correspond with the type of distributed creativity described by Glăveanu through the Five A's, which draw on the concept that creative cognition should be observed within the context of embodied, embedded, enacted, and extended activities (Rowlands, 2010; Glăveanu, 2013)

Competency models offer some potential in the context of creativity support. Epstein, Schmidt, and Warfel observe that the benefit of framing the conditions of creativity in terms of competencies is that a competency, like creativity itself, has the potential to be "improved through experience" (Epstein, R, Schmidt and Warfel, 2008, p.8).

The competency model identifies the individual's desire for improvement as a key motivator within creative practice, and therefore reflects some of the sense of 'personal fulfilment', and 'reaching out' described by Lubart and Ingold. Some of the positive qualities of creativity come from the personal fulfilment of both creating and experiencing new things. This is recognised in Still and d'Inverno's N-Creativity, which draws on Dewey's theories of creative experience, including the idea that "[creativity] brings refreshment, growth, and satisfying joy to one who participates" (John Dewey, 1948). An important aspect of this is that, from the perspective of personal creativity, the 'valuable originality' of the standard definition may be gained more from having original and valuable experiences as part of the creative process, than from the creative outcomes themselves.

By focusing on competencies and training, Epstein's model provides a suitable framework for assessing and supporting personal creativity. The possibility of competency training in the context of AI creativity support suggests that there may be practical methods of supporting creative processes by focusing on competencies. There may also be some opportunity to explore whether techniques for training creative competencies could be used to train creative AI systems.

2.2.7 Supporting Personal Creativity

The personal and subjective nature of creativity, combined with the cross-disciplinary aspects of design practice, makes it challenging to identify specific definitions of creativity which would facilitate support across multiple contexts. Definitions of creativity need to be flexible enough to adapt to different personal approaches in different domains. Models such as Still and d'Inverno's 'N-Creativity', Ingold's 'Undergoing', and Glăveanu's 'Five A's' are helpful, as they ground creativity in personal experience, constructed within different contexts.

The same flexibility in defining creativity also needs to be applied to supporting it. Creativity support tools ideally need to be able to adapt to the different contexts in which different creativity tasks occur, and be able to respond to the different aims and behaviours of personal creative experiences.

Furthermore, the same qualities will need to be considered when it comes to researching the creative needs of designers. To understand the creative experience from a personal perspective, and to capture insights into the different attitudes and situations related to those experiences, will require adaptive and individualised methods.

In conducting this research, it therefore seems appropriate to give particular consideration to the closing suggestions provided by Still and d'Inverno in their *History of Creativity for Future AI Research*:

"Adopt an N-creative approach to designing systems supporting being in the world; enhancing and supporting human creative activity in all of its forms" (Still and d'Inverno, 2016, p.153)

and

"Use human experience as the starting point for future system design." (ibid)

2.2.8 Creativity Literature Summary

To summarise, the literature reviewed in this section establishes the following position on Creativity, which I will be applying in this research.

The 'standard definition' of Creativity comprising of Novelty and Value (Runco & Jaeger, 2012), is well established within creativity research, and will serve as the basis for assessing Creativity within my research studies.

However, both Novelty and Value are subjective terms which are likely to be defined differently by different designers in different contexts, even within the specific discipline of digital design covered by this research. It will therefore be important to focus on personal definitions of creativity as represented by the concepts of N-Creativity (Still & d'Inverno, 2016) and Distributed Creativity (Glăveanu, 2013), to assess creativity support needs on an individual basis.

Additionally, the approach of focusing on Creative Competencies (Epstein, R., Schmidt and Warfel, 2008) as a means of defining creative characteristics, provides a practical, skills-based method of assessing the behaviours and actions performed by people working in creative roles. This may be valuable for understanding the creative needs of individuals, and the creative characteristics of the tools needed to support them.

2.3 AI and Creativity

2.3.1 Historical Context of Creativity in AI

This section of the literature review will place the current advances in AI technology in context with the history of creativity and AI, and will review the developments which have a direct impact on how AI might support creative design practice.

The current interest in combining creativity and AI is not new. AI has been defined in relation to creativity for over seventy years. In fact the academic fields of AI and Creativity share a common history. Thirty days after Guilford published his influential paper on creativity (Guilford, 1950), Alan Turing published *Computing Machinery and Intelligence* (Turing, 1950), the paper that would heavily influence the nascent field of Artificial Intelligence, providing a conceptual framework for how intelligence might be understood and measured in computers.

In Turing's paper he poses the question "Can machines think?", and begins to plan methods for testing such a concept through his proposed 'imitation game' (later Turing Test). Turing speculated about future scenarios where the intellectual abilities of machines were comparable with humans, and suggested that a machine could be defined as displaying meaningful intelligence if it was indistinguishable from a human in a blind conversation.

Turing suggested a viva voce style test, as it was “suitable for introducing almost any one of the fields of human endeavour that we wish to include”, and the questions he proposed regularly focused on creative potential. His example questions include queries about chess moves and several related to sonnet writing. The first question Turing suggests asking to a possible machine in an imitation game is “Please write me a sonnet on the subject of the Forth Bridge.” (Turing, 1950, p.434).

While Turing does not refer to ‘creativity’ directly (Guilford’s formal framing of this term was after all only a month old), he focuses, as Guilford did, on the concept of ‘originality’ as an indicative quality of human intelligence, and discusses the prospect of machines replicating this quality. In doing so he addresses Ada Lovelace’s quote about Babbage’s Analytical Engine, that it “has no pretensions to *originate* anything. It can do whatever we *know how to order it* to perform” (Lovelace, 1843, p.722).

Turing argues against this by equating originality with surprise, and explaining that “Machines take me by surprise with great frequency” due to his own miscalculations or hurried assumptions. He also questions the concept of originality itself, dismissing the idea that machines can never create anything new, with the adage “There is nothing new under the sun”. To make originality a more achievable prospect for machines, he diminishes its occurrence in humans, stating “Who can be certain that ‘original work’ that he has done was not simply the growth of the seed planted in him by teaching, or the effect of following well-known general principles” (Turing, 1950, p.450).

This conception of originality suggests that ‘original works’ are often reconfigurations or versions of existing knowledge (something that a computer could conceivably achieve). There seems to be some suggestion that a creative or developmental process is involved in the ‘growth of the seed’ which turns it from something recognisable as a ‘well-known general principle’ into something recognisable as an ‘original work’, but this is not examined further by Turing.

Turing's uncertainty about assessing individual originality could be explained in relation to Boden's later concept of p-Creativity and h-Creativity, and the difficulty in defining originality across contexts. However, the idea that individuals can transform existing knowledge into original outcomes, through processes that remain somehow unknown and separate from the individual themselves, aligns more clearly with Still and d'Inverno's concept of G-Creativity. This contrasts further with Lovelace's original notes on the Analytical Engine, from which Turing drew the quote.

After stating that the Analytical Engine could not originate anything, Lovelace went on to describe a valuable and more human-focused form of originality that the machine could inspire:

"It's province is to assist us in making *available* what we are already acquainted with…For, in so distributing and combining the truths and the formulae of analysis, that they may become most easily and rapidly amenable to the mechanical combinations of the engine, the relations and the nature of many subjects…are necessarily thrown into new light, and more profoundly investigated" (Lovelace, 1843, p.722).

Lovelace's vision was that people would gain original insights through the experience of using the machine, rather than expecting the machine to furnish them with original outcomes itself. This version of originality is therefore focused more on process than product, and imagines a situation where humans are acting and inquiring alongside the machine, learning from and responding to the experience. It therefore represents a form of distributed creativity, and has clear connections to Still and d'Inverno's concept of N-Creativity.

Lovelace's vision also has obvious implications for the potential of using machines to support creativity in individuals. This is central to her idea of a machine which assists an individual with making their own knowledge available to them, and facilitating them to make their own original discoveries and insights. This contrasts with Turing's approach to achieving creativity through AI. Lovelace's concept focuses on computers enabling humans to achieve originality, whilst Turing's concept focuses on humans enabling computers to achieve originality. These two contrasting approaches represent competing ethoses to creativity which co-exist throughout the development of AI. They are fundamental to the current question of what role designers want AI to play in their creative process. How much of their creative output are they willing to hand over to an AI system to complete, and how much do they want to retain themselves, supported by the AI?

Turing's focus on computers producing creative outcomes themselves through the generation of surprising outcomes became the dominant theme within AI creativity. When the term 'Artificial Intelligence' was coined as part of the proposal for the influential 1956 Summer Research Project at Dartmouth College (McCarthy *et al.,* 1955), the authors included "Randomness and Creativity" as one of the seven defining aspects of the 'artificial intelligence problem'. As with Turing's idea of surprise, randomness is an attractive solution in this context, as it reduces creative originality down to a function which could be achieved with a computer, either accidentally through the kind of glitches and mistakes described by Turing, or later on through the deliberate use of computational randomisation.

Turing requested that a random number function be built into the pioneering University of Manchester Mark I computer, completed in 1951 (Campbell-Kelly, 1980). This allowed the concept of surprise discussed by Turing to be more precisely included in programs, meaning the computer could create outputs that were not fully, or explicitly prompted by the programmer.

The machine's capability for randomness was soon put to creative use by one of the Mark I team, Christopher Strachey, who wrote a programme which generated poetic love letters. The programme used a couple of simple templates and chose from lists of words at random in order to construct a love letter (Strachey, 1954). Despite the simplicity, Strachey noted the diversity and convincingness of the generated outcomes.

Although the poems appear to be an attempt to demonstrate the computer creating its own original outcomes in line with Turing's approach, Strachey's paper on the subject reveals a more critical attitude. He is clear from the beginning that "Electronic computers by themselves are not capable of doing anything at all" (Strachey, 1954, p.25). He notes that the letters demonstrate how simple it is to give the impression of creative 'thinking' on the part of the computer, despite the fact that the letters are "produced by a rather simple trick and that the computer is not really 'thinking' at all." (ibid, p.27). This is not presented as a critique of the machine, but of the expectations surrounding it.

Strachey also describes a separate draughts playing program which appears to demonstrate the capacity for originality, noting that although it demonstrated unexpected behaviour, "it did not make the next and vital step of recognising that the behaviour was either unexpected or interesting". This highlights a significant flaw in the concept of computers producing, rather than facilitating, creative outcomes. Although a computer may have an advanced capacity to generate surprising results, if it is unable to recognise when it has produced something which is both original and valuable, then it can not be relied on to produce creative outcomes by itself.

Strachey summarises this issue by stating that "computers can at the most only provide us with the raw material for new ideas. The final step of recognising the idea itself and realising that it is worth considering at all, has still to be carried out by a human being" (ibid, p.29). This expectation for humans to still be central to the creative process, with the computer facilitating them by producing 'raw materials' for their creative process, aligns with Lovelace's vision, and describes a model for creativity support which is still relevant today.

These historical observations about computing, intelligence, and creativity are seven decades old, and were made at a time when paradigms of computing and AI were significantly different to those which we are familiar with today.

However, human approaches towards creativity remain largely consistent, and the contrasting attitudes towards computers either supporting humans to produce creative outcomes, or producing creative outcomes on their behalf, remain very relevant in the contemporary landscape of AI and Generative Art.

2.3.3 Generative Art

Strachey's concept of using computational randomness as a raw material for human creativity has been adopted by many artists as means of supporting their creative practice.

Using similar techniques to aleatoric practices from music and poetry, for example the Cut-Up techniques of Dadaists such as Tristan Tzara (Wilson, 2020) , and later William Burroughs and Brion Gysin (Cran, 2013), as well as the aleatoric music of John Cage (Cage, 1961), artists used computers to help introduce randomness and chance into their creative practice, and create what became known as Generative Art (Boden and Edmonds, 2009). As Boden and Edmonds discuss, although identified under the label of 'art', this movement has impacted a broad range of creative practices, including design.

This use of machines to support creativity was actually evident before the advent of digital computers, for example Jean Tinguely's Metamatics painting machines (Herrmann *et al.,* 2016) and Desmond Paul Henry's drawings with mechanical computers (O'Hanrahan, 2016). In these examples the complexity of the machines generated intricate and surprising outcomes which expand and transform the actions of the artist.

Similar approaches underpinned the work of early digital artists, such as Charles Csuri (Csuri and Glowski, 2006), Vera Molnar (Nierhoff, 2018) , and A. Michael Noll (Noll, 1967). These artists used computers to help create the art, not only through digital production methods such as computer-controlled plotters, but also by using the random generation functions of the devices to make decisions related to form and composition, such as the positioning of visual elements, or the direction of a line.

This direct involvement of the computer in the creative process led to contrasting attitudes about the agency of the computer in the work, which broadly reflect the 'supporting creativity' and 'producing creativity' views of Lovelace and Turing .

For example, Molnar positions the computer as a machine which enables her to realise her own creativity, reflecting that "the machine, which is thought to be cold and inhuman, can help to realise what is most subjective, unattainable, and profound in a human being" (Rigamonti di Cutò, 2018). However, Noll summarised the potential role computers could take in creative activities in a different way: "In the computer, man has created not just an inanimate tool but an intellectual and active creative partner that, when fully exploited, could be used to produce wholly new art forms and possibly new aesthetic experiences" (Noll, 1967, p.89)

While it is impossible to be certain of their motivations for taking these two positions, it's notable that Molnar's background was in fine art, while Noll's was in engineering. If these different backgrounds affected the way they perceived creative agency in computational art, then it's possible that the cross-disciplinary field of design, which incorporates practices from art and engineering, may contain contrasting opinions about the role of the computer as a creative partner.

This question of how to treat the role of the computer in computational creativity has been present throughout the history of creatives working with computation. When the main role of the computer was to provide computational functions such as randomness, iteration, or reproduction, there was a fairly clear argument that it represented a tool for supporting creativity rather than a creative producer in its own right. However, this has been further brought into question by recent developments in AI, and in particular Machine Learning (ML), which have rapidly transformed the abilities of computers to learn from existing examples of human creativity, and produce sophisticated outcomes which seem to match those produced by humans.

Coined in by Arthur Samuel in 1959, the term ML refers to the principle of eliminating the need for “detailed programming” of machines by humans, by enabling “computers to learn from experience” (Samuel, 1959, p.211).

In practical terms, allowing a computer to ‘learn from experience’ entails providing the system with a large amount of data containing the features you want to identify, and allowing it to construct its own rules or models of identification based on statistical analysis of the contents. This approach is only possible with the application of significant computational processing power and the availability of large quantities of training data. While this has historically limited the complexity of the models which can be learned by a system to simple problem-solving tasks such as solving mazes or playing checkers, rather than more complex creative and generative tasks, such as writing sonnets, in the last decade, technological advances have led to significantly more capable models which can successfully learn complex patterns from increasingly large collections of data.

Alpaydın (2021) describes how the digitisation of many aspects or daily life, coupled with the connectivity of the internet, has led to a “Dataquake”, where enough detailed data is collected about specific topics to enable detailed analysis to spot patterns, and computationally ‘learn’ enough about the topic to accurately predict and replicate features. This data, coupled with ever-developing processing power of computers, has enabled recent improvements in ML.

Just as analysis affords synthesis in theories of design, so the ability of ML systems to transform data into models has in turn afforded the ability to transform models into new data. Although earlier implementations of Machine Learning were used for analysis and detection (for example computer vision, face recognition, speech recognition, and translation (Alpaydın, 2021), once the system had learned the data features associated with a certain concept, it could then be used to reproduce those features.

The combined functionality of data analysis and synthesis has made ML the dominant form of AI over the last decade or so, enabling new forms of computation across various sciences and industries. In the context of the creative industries, two particular developments in Machine Learning have had a significant impact on how creatives produce their work. These are Generative Adversarial Networks (GANs) (Goodfellow *et al.,* 2014), and transformer-based Large Language Models (LLMs) (Vaswani *et al.,* 2017).

GAN technology has led to the development of increasingly sophisticated media generation applications, which have become popular tools over the last few years. For example, Midjourney (2024) which offers subscribers methods of generating high quality images by simply entering a text prompt (a short description of the content they want the AI to generate); Dall-E from OpenAI (OpenAI, 2024a) which made text-to-image generation available to general users; Runway, which offers subscribers a wide range of AI-enabled creative design and production tools (Runway, 2024); and Adobe Firefly image generation tools, which are built into the company's industry standard design software (Adobe, 2024a).

LLM's have enabled a new generation of text synthesis and chat tools, allowing users to access text generation tools using typed or spoken prompts, and receiving natural language responses in return. This format has been utilised for the most popular LLM applications, including OpenAI's ChatGPT (OpenAI, 2022), and Google's Gemini (Pichai and Hassabis, 2023). Both these systems offer chat interfaces, allowing users to perform a wide range of tasks, such as requesting information on a particular topic, drafting documents and emails, editing and summarising existing text, and writing poetry. These tools are freely available on the internet, and have gained many users, with OpenAI claiming to have 100 million weekly users (Porter, 2023).

The development and popularisation of these generative AI tools have obvious implications on the working practices of creative professionals, enabling the automation of significant portions of their work. This automation could have positive and negative consequences on creative jobs, on one hand posing the threat that skilled jobs may be lost to generative AI systems, and on the other offering tools to creative professionals which could help them speed up their work, or focus it in more rewarding areas.

Wider use of generative AI tools by the public has been accompanied by a higher level of attention and scrutiny of the potential negative consequences. Common concerns expressed in press coverage include the environmental, privacy, and plagiarism concerns of using generative AI discussed in Chapter 1.

The potential value of generative AI tools, balanced against the concerns being raised about their use, place renewed importance on the question of what role AI should play in the creative process. The improved outcomes of generative AI may make it easier to position the tools as producers of creative outcomes in their own right, creating original and valuable outcomes on behalf of people. However, it's possible that the kind of professional and ethical concerns noted above make creatives more disposed to use generative AI in a less direct way, preferring it to support their own creative activities, rather than supplanting them, as a way of controlling and mitigating any potential risks to their creative process.

2.3.6 Embedded AI Systems

To address the kind of public concerns raised above, technology companies have taken different approaches to trying to mitigate some of the risks associated with their AI tools. For example, Google have attempted to address environmental concerns about the use of energy in their data centres with a plan for carbon-free energy use by 2030 (Google, 2024a), OpenAI now offer some limited controls for opting out of your data being used for future training (OpenAI, 2024b), and Adobe have attempted to make their own generative AI models which are not trained on copyrighted data, and therefore "safe for commercial use" (Adobe, 2024a).

Several of the concerns listed above stem, at least partially, from the fact that most contemporary AI tools are cloud-based. When users generate text or images using services such as ChatGPT, Dall-E, Midjourney, Runway, or Adobe Firefly, the computer processing required to complete the generation does not happen on the user's device, but ‘in the cloud’. In other words, on servers in data centres far away from the user. All these tools require an internet connection, and the user’s prompt is sent over the internet to the server-side software, and a generated response is sent back to them.

Cloud-based AI solutions remain the norm for generative systems, because the computer hardware required to quickly perform machine learning tasks (typically multiple GPU processors) isn’t normally found on consumer devices at present. Transferring this work to servers therefore makes the process more accessible to users.

However, this approach can introduce various risks. For example, there may be a greater risk to privacy when prompts and conversations with the AI system are not kept exclusively on the user’s device, but transferred over the internet, and stored and processed on a remote server. This may raise concerns around personal privacy, but also the privacy of commercially sensitive information.

Cloud-based AI may also be associated with some environmental concerns. The power and water requirements of running large data centres 24 hours a day, and keeping the computing equipment constantly cool enough to operate, have a significant environmental and human cost (Monserrate, 2022). These issues are exaggerated by the scale of the infrastructure required for centralised AI processing.

Embedded AI represents an alternative to cloud-based AI systems. With embedded AI systems processing happens entirely on small digital hardware platforms such as Raspberry Pi, or personal devices such as phones and laptops, rather than on remote servers. This means the AI functionality can be accessed without relying on an internet connection. The use of embedded AI systems is also referred to as Edge AI, as it represents an approach where AI computation is figuratively pushed out from the central location of cloud-based data centres, to individual devices at the edge of the network.

The aim of embedded AI is for “intelligent data processing [to be] brought closer to the embedded systems to sustain latency and security requirements” (Brandalero *et al.,* 2020). By reducing the network ‘distance’ between the source of data (e.g. a user or an environment) and the hardware performing the processing, AI computation can be performed more efficiently without the lag times and bandwidth requirements of transmitting data, and without the same security risks (Garcia-Perez *et al.,* 2023; Su *et al.,* 2022).

This has several benefits in relation to the issues discussed above. Privacy is better protected because data never leaves the device, and is not stored on third party servers, and the extensive power and water requirements of data centres are not required.

The limitations of embedded AI are that the extensive processing power of the hardware in data centres is unlikely to be replicated on an individual device, meaning that the outputs from embedded AI are likely to be simpler. In addition, the models which make up an AI system can take up a lot of storage, making them harder to store and run on smaller devices.

However, the limitations of embedded AI systems are likely to improve over time as hardware performance increases, and models become more efficient. In the meantime, several existing applications of embedded AI have demonstrated the potential of this approach in more creative contexts.

Both Apple and Google now include dedicated Machine Learning hardware on their phone and tablet devices which allow AI-enabled functionality to be built into apps without requiring an internet connection (Apple, 2024a; Gupta, 2023). These embedded AI chips enable increasingly commonplace tasks such as voice recognition for virtual assistants, autocomplete for composing text, image recognition for photos, and the ability to recognise and copy text from images.

As the embedded AI chips installed in devices become more advanced, their ability to support creative tasks expands. For example, the M4 chip in the latest Apple iPad Pro supports a range of AI-enabled video editing functions such as object detection and automatic background removal (Apple, 2024b).

The ability to perform Machine Learning tasks on devices also means that systems can become more personalised to individual users, learning from their actions and preferences, and retraining existing models to respond to user preferences. In this way, the term 'embedded AI' can be seen to refer both to the fact that the AI processing is embedded on local hardware, and the fact that because of this, the AI functionality can become more embedded in the personal experiences of individuals. A simple demonstration of this is in the autocorrect and predictive text functions of phones that learn users' preferred words and patterns of speech (Apple, 2023). However, this type of personalisation could be applied to many other forms of creative functionality.

This type of personalisation and customisation of AI models on individual devices can be taken further by developers, with an increasing range of options for developing custom embedded-AI systems. Developers can quickly set up their own simplified versions LLMs similar to ChatGPT, by installing local models which run on devices without specialist hardware. This allows developers to create their own applications and interfaces incorporating AI, and personalise these for specific situations. These local, offline LLMs include versions from large technology companies such as Microsoft Phi-3 (Microsoft, 2024), Apple OpenELM (Mehta *et al.,* 2024) Google localllm (Anderson and Warwick, 2024), as well open source and community maintained versions such as LocalAI (Di Giacinto, 2024) and GPT4All (Nomic, 2024).

It's also possible for developers to create their own embedded AI hardware to support creative tasks. For example, Google's AIY Kits are billed as "Do-it-yourself artificial intelligence" (Google, 2024b), and are aimed at creative makers and 'tinkerers', allowing them to quickly prototype AI-enabled devices. The kits can recognise voices to create custom virtual assistants (the AIY Voice Kit (Google, 2024f)), or recognise objects, faces and gestures, in order to create devices which respond to visual prompts (the AIY Vision Kit (Google, 2024e)). Google also produces Coral (Google, 2024c) a line of more advanced embedded AI development boards and hardware which can be used to prototype and build custom, local, AI-enabled devices.

The increasing availability of embedded AI in the context of creativity support has a potential impact on the question of whether AI systems should be seen as supporters of human creativity or producers of creativity in their own right. It's possible that the privacy and energy benefits of embedded AI mitigate some of the concerns that surround the use of AI in a creative context, affecting attitudes towards its use. The model of an AI system which is more personal and private, and which has the ability to adapt to an individual, also suggests the potential for a different approach to AI creativity support, where the AI system works alongside a user, acting more as an assistant or collaborator, rather than producing creative outcomes instead of them. This collaborative approach to creativity support will be explored further in the next section.

2.3.7 Creativity and AI Literature Summary

The historical writing on Creativity and AI analysed in this section, presents two differing approaches to creativity support using AI. Lovelace's approach (Lovelace, 1843) supposes that computers are not capable of creative or original outcomes on their own, and their real value is assisting humans to be creative. Turing's approach (Turing, 1950) directly opposes Lovelace's writing, equating Creativity with the ability to combine existing outcomes in surprising ways, and claiming that computers have the ability to perform this on their own. Both approaches have been used by artists and designers working within Generative Art over the last sixty years.

My position in relation to this research is that Lovelace's approach represents a more valuable basis for supporting creative practice with AI, as it focuses on technology supporting individuals as part of a broader creative process, rather than replacing them for certain tasks. This aligns broadly with the position on personal creativity discussed in section 2.2.

In practical design terms, however, the difference between the Lovelace and Turing approaches equates to designers taking a position on how much of a creative task they want to hand over to an AI system. This is particularly relevant in the context of using more personalised, embedded forms of AI. Understanding designers' position on this issue relates directly to Research Questions 1 and 2, and will be explored through the research studies.

2.4 Creativity Support Tools

2.4.1 Defining Creativity Support Tools

The study of Creativity Support Tools (CST) was established as a subfield of Human Computer Interaction (HCI) in the early 2000s, primarily through the work of computer scientist Ben Shneiderman.

Applications which support creative tasks, particularly in the areas of graphics and music, had started to be developed throughout the 1960s, for example, Ivan Sutherland's Sketchpad (Sutherland, 1964), Max Mathew's MUSIC programmes (Roads and Mathews, 1980), and Pierre Béziers Unisurf CAD system (Bézier, Hawthorne and Edwards, 1971).

As personal computing developed during the 1980s and 1990s, creative tools were key features of the software which began entering people's homes and offices, for example, MacPaint (1984), PageMaker (1985), QuarkXpress (1987), Cubase (1989), Photoshop (1990). These tools supported creativity in the practical sense that they provided a means to produce creative outcomes using computers.

In defining the subject of CST, Shneiderman set out a broader role for creative software, where computers provided support across the whole creative process, rather than digitising particular creative tasks. What Shneiderman referred to as a ‘grand challenge for HCI’ (Shneiderman, 2009) is to “enable more people to be more creative more of the time” (ibid, p.1). Although an effective rallying call for the community, the wording of this challenge reveals some of the biases and preoccupation which have remained in CST research for many years.

Shneiderman’s definition originates from the point of view of computer science, and that domain influences the interpretation of creativity and the requirements for supporting it. The prospect of making ‘more people more creative more of the time’ implies an emphasis on efficiency and productivity. Shneiderman is clear about this lineage of the subject:

> “During the past half-century, computing professionals have developed potent productivity support tools that reduced manufacturing costs, tightened supply chains, and strengthened financial management. . . But now, a growing community of innovative tool designers and user interface visionaries is addressing a greater challenge and moving from the comparatively safe territory of productivity support tools to the more risky frontier of creativity support tools.” (Shneiderman, 2007, p.22)

The stated intention is that the skills gained in increasing productivity and reducing costs in information systems should now be used to improve creativity. While more efficient use of time might sometimes be desirable in aspects of commercial design, it is not necessarily the best measure of creativity. As Carroll *et al’s.* later analysis of CST design states, “[w]hile longer time spent on a task may normally indicate inefficiencies in a tool, spending more time on a creative task is more likely to indicate engagement with the activity” (Carroll *et al.,* 2009, p.127).

The emphasis on productivity is indicative of a narrow reading of creativity in this early period of CST research. Shneiderman’s initial paper on CSTs (Shneiderman, 2000) relies on a definition of creativity seen from the point of view of information systems, in particular the work of Boden (1990), Couger (1996), and Bush (1945).

Shneiderman identifies two types of creative activity: revolutionary and evolutionary. These roughly align with Boden's description of historical and personal creativity. Revolutionary creativity is defined by Shneiderman as "paradigm shifting", for example "Watson and Crick's discovery of DNA's double-helix, or Stravinsky's 'Rite of Spring'"(Shneiderman, 2000, p.118). Evolutionary creativity meanwhile includes "doctors making cancer diagnoses" and "lawyers preparing briefs" (ibid).

These evolutionary examples seem more akin to information processing or the simple application of professional knowledge rather than conventional creativity, as they arguably don't combine novelty and value. However, it is these evolutionary activities that Shneiderman focuses his attention on, for the reason that "it is most likely to be helped by software tools" (ibid).

In this analysis, the breakthrough moments of revolutionary creativity are associated with Shneiderman's definition of 'inspirationalist' creatives, who he imagines "travel to exotic destinations with towering mountains or peaceful waterfalls" (Shneiderman, 2000, p.116) in order to support their creativity. This idealised interpretation of creative inspiration understandably makes computational support seem much less achievable than the grounded activities described in evolutionary creativity. Presented as a choice between supporting either paradigm shifting creativity, or activities such as document analysis, then a focus on the later does seem reasonable. However, as described in section 2 of this chapter, more types of supportable creativity exist between these two extremes.

Shneiderman proposes eight types of creative activity that could be supported by CST. Of these, five are information processing or communication tasks (e.g, "searching and browsing digital libraries"), whilst only three involve behaviours which are clearly divergent or generative (e.g. "thinking by free association"). This contrasts with the many studies of creativity since Guilford (1950), which have reinforced the importance of divergent activities.

In his widely cited 2007 article for Communications of the ACM, (Shneiderman, 2007) Shneiderman stated that "while there has been extensive research on creativity in many disciplines, the topic is a relatively new one in computer and information science" (ibid, p.24-25). However, this view overlooks the significant role that creativity has played in the history of computing and AI (discussed in section 2.3), as well as the extensive use of computers by artists since the 1960s (Taylor, G., 2014), and the many creative software packages that have been used by the creative industries since the 1980s.

Supporting his view, Shneiderman cites the fact that "terms such as 'computer' and 'user interface' don't even appear in the index" of Sternberg's Handbook of Creativity (Shneiderman, 2007, p.25). However, this would appear to be a mistake, as Sternberg's book contains a chapter by Margaret Boden titled *Computer Models of Creativity*, and computers are mentioned extensively in Richard Mayer's chapter on *Fifty Years of Creativity Research*, and in Raymond Nickerson's chapter on *Enhancing Creativity*, which concludes with a debate about the role computer software might play in supporting creativity.

It is understandable that the preliminary discussion of CST from over two decades ago should base its approach on the methods which were most understood and achievable at the time. However, the limited engagement with existing creativity research, and a bias towards information processing techniques persisted in the CST research for several years.

2.4.2 Subsequent CST Research

Published research on CSTs tends to fall into two categories; those documenting the development and testing of new tools, and those offering meta-analysis of the field. The later category, continuing the work of Shneiderman, aims to facilitate tool development by defining terms and establishing methods of assessment. Notable contributions in this area are the *Creativity Support Index* from Carroll *et al*. (2009), and comprehensive surveys by Gabriel *et al.* (2016), and Frich *et al.* (2019).

The work of Carroll *et al.* aims to help researchers and designers "measure how well a particular system or tool supports the creative activity by creating a standardized instrument" (Carroll *et al.,* 2009, p.128). It attempts to address the lack of clear definition (at least in CST research) about what constitutes creativity by basing their evaluation criteria on previous creativity research, as well as their own studies on the characteristics of creativity. It defines six essential factors in creativity support - *Results Worth Effort*, *Expressiveness*, *Exploration*, *Immersion*, *Enjoyment*, and *Collaboration*. These factors were derived through testing sample CST with participants, and also a 300 person survey evaluating words associated with creative behaviour.

The same team went on to formalise these factors as the Creativity Support Index (CSI), and propose methods of using it to quantify how successful a tool is at supporting creativity (Cherry and Latulipe, 2014). They test the CSI in a collaborative writing task using Google Docs.

Carroll *et al.'s* research provides some much-needed structure to the design and testing of CST, and offers insights into the support requirements of general computer users working on creative tasks. However, the framing of creativity within the research aligns strongly with Shneiderman's work, framing creative activities through the lens of HCI and productivity. First by basing the evaluation method on one developed to measure the workload requirements of tasks and systems (NASA-TLX), and second by testing the evaluation tool exclusively on screen-based software tasks such as creating digital slideshows, rather than considering the broader roles creativity support tools could play during the creative process, for example during non-screen-based tasks such as sketching, or brainstorming.

The testing of the CSI measurement tool also highlights an issue with much of the research around CSTs, in that it was conducted with non-professional creatives (in this case people recruited from Amazon Turk) and the testing took place on an artificial creative task, performed under lab-conditions. This kind of context makes it much harder to assess the support against the kind of complex, social, distributed creativity which might normally occur in creative workplaces. This disconnect between CST development and testing, and the actual work environments where creativity takes place was noted again by the recent ACM Special Interest Group on Creativity and Cultures in Computing (Kato *et al.,* 2023), and also in a survey by Hwang (2022), which concluded by encouraging the developers of future AI co-creative tools "to take further consideration for how the creative work is attempted in actual workplaces and work scenarios" (Hwang, 2022, p.6).

A more expansive view of the role of support tools in the creative process is discussed by Gabriel *et al*. (2016) in their mapping of creativity support systems. They draw on Lubart's four metaphorical categories of creativity support (Lubart, 2005); *coach*, *pen-pal*, *nanny*, or *colleague*. Examples of existing support tools are mapped to these categories. It's notable that Gabriel *et al*. actually use the term Creativity Support System (CSS), rather than Creativity Support Tool. The two terms seem interchangeable, and the paper attributes the term CSS to Voigt, Niehaves and Becker (2012) who directly conflate it with Shneiderman's proposals for CST. In fact the term CSS was coined by Abraham and Boone (1994) in a paper on business management systems. They derived it from Decision Support Systems (DSS), which were a class of computational systems designed to support "organizational decision makers" in a business environment (Abraham, T. and Boone, 1994, p.111). This business-oriented provenance of the term is evident in the research of Gabriel *et al*., which emphasises the impact of creativity on innovation, and applied creativity within organisations.

The organisational perspective on creativity support that Gabriel *et al*. provide allows them to identify a lack of organisation-level, rather than task-level tools. They conclude by highlighting a lack of tools which support creativity across all phases of the creative process (which they define as "*problem analysis*, *ideation*, and *idea evaluation*"), and a lack of tools to support interpersonal aspects of "individual and collective use in a co-located and virtual collaboration" (Gabriel *et al.,* 2016, p.117).

They also raise the importance of integrating AI more into the development of CST. In their conclusion they note "the necessity to more properly orient the design of the CSS to cover the different phases of creativity across the different collaboration settings" (ibid). Given different approaches to creativity across disciplines and individuals, they stress that this kind of support would require "advanced functionalities, such as adaptation of the system to the behaviour and cognitive patterns of individuals, [which] implies the introduction of artificial intelligence into the creativity support" (ibid).

This kind of use of AI would suggest using ML techniques to observe a designer's creative behaviours or intentions, and adapt the support proactively to suit the individual or team. AI driven personalisation is an approach that is used within the design of Adaptive User-Interfaces (AUI) (for example Soh *et al*. (2017)), although is less commonly applied within creativity support.

The CST survey completed by Frich *et al*. (2019) is the most thorough to date, in terms of its mapping of existing CST projects, and its analysis of relevant creativity research. They reviewed a corpus of 143 CST projects presented in HCI publications, and from this produced a list of eight categories for evaluating CST. These include factors such as *Complexity*, to assess the amount of features the tool offers, *User Group*, to record the intended audience of the tool and their level of expertise, and *Part of the Creative Process*, which defines when the tool is intended to be used in the creative process. For this they provide six stages: *Pre-ideation/background research*, *Idea generation or ideation*, *Evaluation or critique*, *Implementation*, *Iteration*, and *Meta or project management* (Frich *et al.,* 2019, p.4).

This analysis of the stages of the creative process targeted by existing CST provides several useful insights for the development of new tools.

First, it reinforces the conclusion of Gabriel *et al*., that tools tend to focus on specific creative tasks rather than addressing the broader requirements of creativity. Although it's not clear from the survey whether the specificity of the tools is down to constraints in their development, or whether designers might prefer specific rather than universal tools.

Second, it also echoes the point that tools need to be developed to take into account the specific creative requirements of their users, noting that “many of the sampled publications (38%) do not in their research methodology take into account the level of creative experience or expertise of the target audience of the CST being presented. This runs counter to creativity research in which much critical attention is given to the specific level of expertise among the relevant users”.

Third, the survey highlights that CSTs tend to focus primarily on the implementation stage of the creative process (which they contrast with the focus of creativity research), and also the ideation stage. The pre-ideation stage, when important activities such as researching and mapping the problem space occur, is less consistently supported by tools. This links with their observation that, historically, CST have had “a heavily pronounced focus on divergent thinking”.

Uniting these three insights is the underlying issue that not much is known so far about the general attitudes of designers towards creativity support, and in particular support from AI systems. Given that the subjective nature of creativity means that attitudes and requirements may be diverse, addressing this diversity is likely to require intelligent systems, and therefore the application of AI technology.

2.4.3 Co-creativity with AI support tools

The use of AI in CST brings added significance to Lubart’s concept of roles within creativity support Lubart (2005), and also reflects the ongoing question of whether AI is best suited to producing creative outcomes itself, or supporting people to create their own creative outcomes.

One initial approach to using AI within creativity tools is simply to provide an aleatoric function, using the mistakes, misunderstandings, and glitches generated by AI outcomes as a prompt for creativity. This approach leverages the randomness of some AI outcomes in a similar way to early computational artists, by helping it inspire originality. The potential to support creativity by 'happy mistakes' is described by Epstein, Schroeder and Newman (2022) in the context of speculative design, and by Gero, Long and Chilton (2023) in relation to creative writing.

However, the increasing availability of AI tools that can perform tasks that would previously require a person to complete (e.g. creating images, writing text, editing images to add or remove objects etc.), suggests AI tools can take on a more sophisticated role than just aleatoric machines of chance. It raises the issue of agency, and how much control an AI could, or should, ideally have within a creative process.

A task such as generating an image requires multiple creative choices to be made throughout the process of creation. In handing these choices over to an AI system, a person is conferring a certain level of agency of control to the system (even if they are ultimately still deciding how, or if, the image is used). Conceptually, this conferring of agency may have an impact on how the AI systems are viewed within the creative process, altering the perception of them as a tool, and raising the question of whether they are performing a role conceptually similar to that of a collaborator, colleague, or assistant.

The concept of digital systems as creative partners has received more attention recently through the topic of "co-creativity" in arts and technology practice. Candy and Edmonds (2002) examined the concept of co-creativity in relation to cross-disciplinary digital art production. They noted the necessity for effective collaboration in this area where non-technical artists may need to work directly with technology experts and computer systems. They defined co-creativity as the process of collaborating on work "where the collaborator may be human, may be a computer, or may be both" (Candy and Edmonds, 2002, p.135).

Their initial research focused on collaboration between humans, rather than humans and computers. However, their insights into the conditions required for good collaboration in creative technology projects are also relevant when considering how AI-enabled CST might work alongside designers.

Subsequent work on co-creativity has gone further in directly exploring modes of collaboration between humans and computer systems, and creating frameworks to aid the design of tools. Davis (2013) defined an approach to ‘human-computer co-creativity’ which combines CST research with research into computational creativity. They identified the need for more research focusing on the role of CSTs as “colleagues that contribute as equals in the creative process” (Davis, 2013, p.12).

Through analysis of a co-creative drawing tool, they defined two categories of possible contributions by a computational tool; *elaboration* contributions which “refine an existing structure” and *catalyst* contributions which “introduce completely new themes and structures” (Davis, 2013, p.11). Some comparison can be made between these categories and the traditional distinctions of convergence and divergence. Beyond these categories, Davis does not address what kind of collaboration role a CST should play, or what cognitive, communication, or knowledge style it should possess.

In their definition of *Mixed Initiative Creative Interfaces*, Deterding *et al*. (2017) describe a ‘spectrum of agency’ which can be used to determine the level of participation between human and AI collaborators. At one end *Human Initiative* interfaces involve ‘Human as creator. Computer as tool’ which they characterise as the normal dynamic for CST. At the other end of the spectrum *Computer Initiative* interfaces involve ‘Human as audience. Computer as creator’, which is the domain of computational creativity. Their proposed category of *Mixed Initiative* interfaces sit across the centre of this spectrum with human and computer both acting as collaborator. They propose a dialogical approach in which “both sides take turns constraining, suggesting, producing, evaluating, modifying, or selecting creative outputs in response to the other” (Deterding *et al.,* 2017, p.629).

Spoto *et al*. created the Library of Mixed-Initiative Creative Interfaces (2017) to document and map examples of creativity tools which blend contributions from humans and AI. Traditional CSTs do not meet the criteria for the archive, as tools need to demonstrate that a creative ‘dialogue’ takes place between the computer and the human, so that inputs are mixed between the two. As the authors state “Both human and computer provide necessary inputs into the creative process – the computer could not produce artifacts or ideas without human input, nor the human without computer input.” (Spoto *et al.,* 2017, para. 2.1)

Spoto *et al.* use the term ‘computer’ rather than ‘AI’ to refer to the non-human collaborator, which allows the concept of mixed-initiative interfaces to be applied to digital systems which do not necessarily use AI or ML. However, the framing of mixed-initiative requiring agency and input on behalf of the computer is particularly relevant to the framing of AI support tools, and the way that co-creativity with AI may be imagined and measured.

The Library creates a map for each documented tool, which shows how creative activities are shared between the computer and the human across seven stages of the creative process (Ideate, Constrain, Produce, Suggest, Select, Assess, Adapt). This demonstrates the largely turn-based nature of the tools, with activity shifting sequentially between Human and Computer. However, a few tools are shown to involve overlapping activities, particularly in the ‘Produce’ and ‘Adapt’ stages.

Guzdial and Riedl (2019) also conceive of co-creativity around the structure of a turn-based system. They draw on the example of a turn-based video game editor (Guzdial *et al.,* 2019) to create an interaction framework for co-creative systems. Their model reinforces the asynchronous nature of turn taking in the co-creation of a design artefact, but they do mention the possibility of humans and computers performing “non-turn actions” such as observing the user, or exploring the artefact.

This expansion away from purely turn-based activities would appear to be important, as the strict sequencing of collaboration doesn't necessarily reflect the complex dynamics inherent in conventional human-human co-creativity. The multiple creative activities which make up projects within commercial design are difficult to structure in such a formal turn-based way. In this context collaboration can be complicated and more sophisticatedly social. As Fischer *et al*. (2005) highlight, creative outcomes are likely to "emerge from joint thinking, passionate conversations and shared struggles among different people, emphasizing the importance of the social dimension of creativity" (Fischer *et al.,* 2005, p.483).

The complexity of this emergent, social creativity is not easy to support through a rigid, turn-based model of co-creativity, and there is therefore an opportunity to expand the existing frameworks to think more about the roles and values represented by the human and computer collaborators, rather than just the sequence of their contributions and the level of agency they exhibit.

As Fulda & Gundry (2022) discuss in their paper on conversational AI as improvisational co-creativity, the act of conversation itself can be viewed as a form of complex co-creativity which is not adequately expressed as a simple turn-based sequence of information exchange. They state that "[a] truly empathetic conversation partner does not merely map input text to output text. Instead, it must understand the relationship between itself, its conversation partner, and the larger world, and use that knowledge to inform its response selections." (Fulda and Gundry, 2022, p.249) In a creative context, this suggests that the dialogue between collaborators is a creative outcome in itself, and requires the same kind of interaction between people, systems, and knowledge as other forms of creativity.

Recent work in the area of computational creativity has more directly referenced forms of distributed creativity in order to account for the role of creative AI using more complex models of human creativity. Jordanous (2016) highlights the question of whether computational creativity should be assessed within the product of a computational system, or within the process it follows.

In response to this question they recommend computational creativity researchers return to the Four P's of Rhodes (1961), in order to acknowledge and address the complexity of the creative process, and the need to assess creative outcomes across multiple contexts.

Similarly, Kantosalo & Takala (2020) draw on Rhodes' Four P's of creativity, as well as Glăveanu's Five A's (2013), in order to propose their own Five C's of Human Computer Co-Creativity. Their framework is designed to support the design and evaluation of systems where both humans and computers work together on creative outcomes. The Five C's represent different aspects that makeup creative activities. They are Collective, Collaboration, Contribution, Community and Context. These categories clearly position humans and computers working together collectively, with both of them acting as collaborators on the same outcomes.

Muller, Candello and Weisz (2023) develop this concept further, and test Kantosalo & Takala's framework by analysing a conversation between a person and a chat-based LLM. They attempt to determine where on the scale of Mixed Initiative Creative Interfaces (Deterding *et al.,* 2017) creative initiative occurs. Their research shows that whilst overall agency was retained by the human, control and initiative could be shared by either the human or the computer, depending on how questions were framed.

The recent work of Jordanous, Kantosalo and Takala, and Muller, Candello and Weisz, demonstrates that by drawing on concepts of distributed creativity, it's possible to position creative activities between humans and AI as a form of collaboration, with the AI system performing an active, creative role in order to support the human. While this provides a useful new framing for the relationship between humans and AI-enabled Creativity Support Tools, it doesn't yet reveal what specific role creatives want AI systems to play in their own creative processes.

2.4.4 The Role of AI Creativity Support Tools

Chung, He and Adar (2021) extend the work of Frich *et al*. (2019) with their updated survey of existing CST. They identify two broad types of roles that current tools perform, Resource Roles and Process Roles. Resource Roles include tools for supporting users with Vision and Skills. Process Roles include tools that support Idea Generation, Curation, Execution Assistance, Producing, Understanding and Critique. This provides a useful list of roles that can be performed at a task level, identifying the particular parts of the creative process that a CST might support. The survey covers existing CST, and therefore the proposed roles do not extensively address the rapidly developing functionality of AI-enabled systems. These AI systems raise the prospect of CST roles being defined more in relation to the kind of social, human, characteristics suggested by Lubart's *nanny*, *pen-pal*, *coach*, and *colleague* (Lubart, 2005).

Guzdial *et al*. (2019) suggest their own human-style roles that CST could play within the creative process. They don't reference Lubart directly, but propose their own four categories of role; *friend*, *collaborator*, *student*, and *manager*, which share some similarities to Lubart's categories. Given the breadth of values and attributes associated with creativity, these suggested roles appear slightly limited. They describe the general responsibilities that might be expected of the CST, but don't express the style of collaboration they would demonstrate (for example Candy and Edmond's cognitive and communication styles).

As with human creative teams, titles such as "manager" suggest a broad professional relationship, but don't tell you what type of manager they are (supportive, strict, trusting, etc.). Furthermore, these titles don't take into account how the role of CST might need to change between different phases and activities within the creative process (as described by Gabriel *et al*. (2016)).

Gero, Long and Chilton (2023) examine attitudes towards creativity support in the context of creative writing, investigating when and why writers might choose to receive support from an AI rather than a human. Their findings show that individuality is important in both human and AI collaborators. Reporting writers' attitudes towards individuality, they state that "not all people were the same, and the individual characteristics of a person (or computer program) impacted not only who they turned to for support, but what they did with the support provided" (Gero, Long and Chilton, 2023, p.8).

While this suggests some benefits of positioning AI systems as capable of human-style individuality, Gero, Long and Chilton also discuss the benefits of writers remaining conscious of the non-human nature of the support system, describing how writers report feeling less self-conscious about asking for certain types of support from an AI than someone they know. This aligns with previous research by the same authors (Gero and Chilton, 2019) which indicates that a user's sense of ownership over their creative outcomes can be impacted by whether they perceive the AI as a 'co-creative partner' or 'cognitive offloading tool'. The perception of whether the AI was seen as a tool or a partner affected whether the user would accept a suggestion, regardless of its perceived quality or usefulness. This suggests that a balance is required between anthropomorphising the role of the AI, and maintaining its status as a computer system.

Hwang (2022) avoids anthropomorphising the AI co-creative tools by suggesting more generic, functional titles. They suggest four different categories of co-creative AI tools, The Editors, The Transformers, The Blenders, and The Generators. The titles reflect the practical nature of the roles they represent, as the categories are derived from the functions performed by current AI-enabled creative tools, such as editing images, transforming images between different styles, and performing text-to-image generation. This provides a helpful summary of the current generation of creative AI tools, but the focus on function doesn't necessarily fully reflect the concept of 'co-creativity' described by Hwang. The principle of co-creativity with AI suggests the potential for the kind of social, collaborative, reciprocal, relationship that you might expect from a human creative partner, which isn't necessarily communicated through the more functional language of Hwang.

This contributes to the question of whether an anthropocentric framing of AI is helpful or not in the context of supporting human creativity. Waelder (2022) argues for 'post-anthropocentric creativity' in relation to collaborations between humans and AI systems, expanding on a concept from Stephensen (2019). The concept of post-anthropocentric creativity reflects the idea of distributed creativity, with creativity considered "the outcome of an interaction between a variety of actors, including humans, objects, systems, and environments" (Waelder, 2022, p.35). Framing these elements as non-human contributors to a creative process controlled by humans "allows artists to distance themselves from the specific output while retaining authorship of the process" (ibid).

The concept of AI as a post-anthropocentric creative collaborator is complex, and highlights a tension within AI creativity support. It positions AI not as a tool, but as a creative partner. This would traditionally be thought of as a human role, and that positioning may be helpful in defining the expanded role an AI could play in contrast with previous forms of computational creativity support. However, framing AI systems as performing human-style collaboration may also conflict with the idea of post-anthropocentrism, and a turn away from defining creativity purely in relation to human activity. This returns to Lovelace's question of whether AI is seen as a producer of creativity in its own right, or a supporter of creativity in humans.

The ambiguity created by this tension may help support the contradictory sense of distant authorship described by Waelder, where agency is indeterminately held between the human and the AI. Waelder references several artists working with AI who maintain this type of relationship between themselves and the AI. However, while this may work within the context of Fine Art, it's not clear whether designers would welcome the same ambiguity to agency and the role of AI systems in their work. The attitudes of designers towards their work may influence whether they prefer to view the AI in a specific collaborative role, or as a more functional support tool with less implication of agency.

2.4.5 Attitudes to AI CST

Given the diverse approaches to the use of AI CSTs, and the different conceptual roles they could play within individual creative processes, it would be helpful to have a clear understanding of the attitudes of creatives, and in particular designers, towards the use of AI within their practice. Currently, however, there is not a great deal of research investigating designer's views of AI, or capturing their feedback of AI CSTs within their normal working conditions.

The most significant surveys looking at attitudes towards AI technologies have focused on the general public. These have demonstrated mixed support for AI. A survey of 2000 Americans by Zhang and Dafoe (2019) indicates that while 41% of respondents are positive about the development of AI technologies, a significant amount, 22%, oppose it, and 28% remain neutral. The report also suggests that "subgroups that are more vulnerable to workplace automation express less enthusiasm for developing AI”. As AI-CSTs are predicated on a degree of automation of the creative process, this raises the possibility that any positive attitude towards AI tools from designers, may be counteracted by concerns about the impact of automation on their jobs.

Since the Zhang and Dafoe survey in 2019, the prevalence and functionality of generative AI has increased significantly. A more recent multiwave survey by the UK government, carried out with 4200 members of the UK public, tracks the changing attitudes towards AI between November 2021 and September 2023 (UK Department for Science, Innovation & Technology, 2024). This shows that support for AI amongst the public remains mixed, with participants recognising the potential benefits of AI, whilst remaining concerned about security implications and demonstrating increasing pessimism over the general impact of AI on society. Specifically the two largest risks perceived by the public are that “AI will take people's jobs” and “AI will lead to a loss of human creativity and problem-solving skills”. Both these concerns have direct implications for the use of AI in the creative industries, and may influence the attitudes of designers and creatives towards AI, although it is not possible to determine their opinions from the survey of the general public.

A two-wave study by researchers in Finland focused more specifically on attitudes towards AI in the context of creativity and arts (Latikka *et al.,* 2023). This revealed data similar to those in the UK study, indicating that participants were less positive about the use of AI within creative fields, as opposed to fields such as medicine. However, they note that opinions on AI and creativity are divided, and often influenced by individuals pre-existing attitudes towards technology. Whilst this survey focuses on creativity and art, it was not conducted specifically with participants in creative professions, but with 828 Finnish adults aged 18 to 80. It therefore does not specifically reveal the attitudes of designers towards AI in their work.

Some recent research has aimed to focus specifically on the attitudes of designers towards AI. Li (2024) conducted a study investigating designer's behavioural intentions towards using AI-generated content. This study was conducted with 404 design students or design professionals. The results again demonstrate mixed attitudes towards the use of AI, with positive attitudes towards the potential of AI counteracted by anxiety about the use of the tools. In particular the study highlights the impact of social pressures about the use of AI, suggesting that the competitiveness of design workplaces might encourage the use of AI. Against that, designers reported a significant level of perceived anxiety about the use of AI tools, in particular the legal and ethical consequences of using AI-generated content.

Another design focused study by Du, Li and Gao (2023) notes the different attitudes of designers towards the use of AI, specifically AI painting tools. The research with nine designers investigates the causes for these differing attitudes, noting that anxiety towards the technology is a significant issue in the decision to use AI tools, and that lower AI literacy may increase this anxiety.

Both the studies from Li and Du, Li and Gao use the Unified Theory of Acceptance and Use of Technology (UTUAT) for their research design. This method provides extensive quantitative analysis of the participants' responses, but does not afford more detailed insights into specific views expressed by participants, which might be provided by a qualitative study. In addition, the one-off nature of the studies does not necessarily capture the attitudes of interdisciplinary designers who may frequently be working across different types of task and context, and who may have differing attitudes towards the use of AI depending on the task they are working on.

Beyond these two recent studies, there is not a great deal of research looking specifically at the attitudes of designers towards the use of AI in the industry, and clearly more research is needed in order to guide the on-going development of AI creativity support tools. Public perception indicates anxiety and conflicted views about the use of AI in creative practice, at a time when generative AI is rapidly becoming more accessible and more sophisticated in its abilities.

Ultimately however, it is the attitudes and approaches of designers that will influence how these technologies are integrated into professional practice, and there needs to be better understanding of these factors in order to determine the role AI-enabled CST should play in the creative process.

2.4.6 Creativity Support Tools Literature Summary

Academic definitions of Creativity Support Tools, as established over two decades ago by Shneiderman (2000), have historically placed too much emphasis on productivity, and rely on a simplistic view of creative practice which often does not sufficiently take into account the distributed and collaborative creative processes of designers working in real world workplaces.

As generative AI tools introduce the possibility of the technology producing more sophisticated creative outcomes, the concept of CST needs to be reevaluated to include the possibility of the technology not just acting as a tool, but as a form of co-creative collaborator for a designer. Designers' attitude towards the role AI should play in their creative work (Research Question 1), and the factors that influence that attitude (research Question 2), need to be better understood. The existing suggestions in CST research about potential roles for AI (Lubart, 2005; Guzdial *et al.*, 2019) do not cover the complex range of collaboration that occur at different stages of the creative process, and therefore evaluation is needed of this issue.

2.5 Summary

The literature assessed in this review covers the specific fields relevant to the research of AI-enabled CST.

The analysis of creativity research demonstrates the breadth of definitions and contexts for creativity. It identifies a form of personal creativity, drawing on existing concepts of p-creativity (Boden, 2007), N-creativity (Still and d'Inverno, 2016), distributed creativity (Glăveanu, 2013), and Ingold's theory of creative 'undergoing' (Ingold, 2014). This form of personal creativity is shown to have particular relevance to the context of interdisciplinary design, and to the potential affordances of embedded-AI technology.

The analysis of AI and creativity shows the connections and shared principles between creativity research, and the development of AI technology. It highlights a tension in the early definitions and approaches to AI and creativity that exist between Lovelace's approach to computers supporting human creativity, and Turin's view of computers producing creative outcomes in their own right. The analysis of subsequent AI development shows that these contrasting approaches persisted in the field, and remain relevant to the development of generative AI and AI-CST today.

The review of CST research identifies some limitations in how creativity has historically been defined within the area of CST research, as defined by Shneiderman (2009). It shows CST research has frequently used definitions of creativity grounded in computation and productivity, and that there is a need to better integrate definitions and concepts from creativity research into the development and testing of CST. The literature analysis shows that a common limitation in CST research is the development and testing tools in lab-conditions, and that more real-word testing of CST is needed to address the complex and evolving needs of interdisciplinary designers.

The review of existing CST literature also highlighted the changing attitudes of creative professionals towards the use of AI within their work, and the prospect of collaborating creatively with AI agents. It also indicated that more specific research was needed in this area to understand what role designers in particular want AI to play in their creative work.

The above insights directly support and contextualise the three research questions, relating to the need to understand what role designers want AI to play in their personal creative process, what factors influence these attitudes, and what impact this may have on the development of embedded AI-CST.

Chapter 3 Methods

3.1 Introduction

The aim of this research project is to understand the attitudes and needs of those working in creative roles with regard to the use of AI to support their creative process. The research adopts a Mixed Methods ethnographic approach to capturing the attitudes of creatives, both in terms of incorporating qualitative and quantitative data collection and analysis methods (Johnson, Onwuegbuzie and Turner, 2007; Creswell and Clark, 2017), but also in terms of seeking to accommodate a way of thinking which, in social research, Greene (2007) defines as "an openness to multiple ways of seeing…and multiple standpoints on what is important and to be valued" (Greene, 2007, p.xii).

The multidisciplinary, collaborative context of commercial design and creativity creates a context for the use of AI technology where individuals may need to frequently use tools across multiple types of task, and shared with multiple collaborators, colleagues and clients. Attitudes towards the use of AI in the creative process may vary over time and in relation to changing tasks or social contexts. An approach to research was therefore required that was flexible enough to capture multiple standpoints, and differing attitudes, even among individual participants.

Mixed Methods research approaches have frequently been used within HCI research (van Turnhout *et al.,* 2014), where the need to capture complex user responses to novel and quickly evolving technologies is often required. (Schrader *et al.,* 2019).

This research therefore uses a range of individual research methods, as well as a combination of quantitative and qualitative analysis, to address the research questions.

An important consideration in choosing research methods for this project, was to try to avoid the problems associated with carrying out Creativity Support Tool research in 'lab-conditions' rather than the environments and contexts where creativity actually takes place (Kato *et al.,* 2023). Methods were therefore selected which allowed participants to engage in the research within the environments and workplaces where distributed creative activities may occur.

Another factor that influenced the choice of methods used within the research design, was the COVID-19 pandemic, which coincided with the research activities. Restrictions on the ability to work directly with participants within their workplace, as well as the changes that occurred within working environments and practices, meant that for some of the research activities, methods were required which did not necessitate in-person data collection.

There are four primary research activities that make up this project.

1. **A survey** of designers (n=45) asking about their attitudes towards their own creative practice, and AI technology.
2. **A diary study** of people working in creative roles at Google (n=30), asking about their barriers to creativity, and their type of creative support they desired, over a 4 week period.
3. **A workshop** for a group of academics researching the use of AI within creative practice, carried out at the ACM Creativity and Cognition conference.
4. **A digital probe study** for creatives working in the design industry (n=5), asking them about their barriers to creativity, and the types of support they desired, carried out in their workplace over 21 days.

3.2 Survey Method

The intention of the first research activity was to quickly capture a sample of attitudes from people working in creative roles within the design industry. At the time of this activity, generative AI was just emerging as a potential tool that could be used within the creative process, but had not yet become widely available to users. The aim was therefore to create a snapshot of attitudes at this time relating to participant's attitude towards the creative process, and what role they thought AI might play in this in the future. This data would then help establish priorities and directions for the next research activities.

As this study needed to be quickly administered to a broad range of respondents, an online survey was chosen as the preferred method. There are well documented limitations to sample surveys as a method, for example Robson (2024) notes that the ubiquity of surveys and questionnaires can diminish participant's full engagement, but also states that if care is taken to ensure internal validity (the quality and appropriateness of the questions) and external validity (the suitability of the sample) then surveys can provide one of the quickest and most efficient ways of capturing data from multiple participants (ibid).

The survey was designed as an easily accessible online web form. Participants were recruited from academic networks, and were primarily graduates and current students from Masters design programmes in the UK. This sampling was designed to ensure that participants had active experience of creative practice.

To enhance internal validity, the questions of the survey were organised into four separate sections: About You, Attitudes to Creativity, Attitudes to AI, and Attitudes to Creativity support. The separation of these sections allowed the participants' attitudes towards their own creative process to be analysed separately to their thoughts on AI, and the perceived strengths and weaknesses of AI to perform creative tasks could be compared with the participants' individual priorities within the creative process.

The survey was designed to produce primarily quantitative data through Likert style and multiple-choice questions, in order to allow relatively quick numerical analysis through application of the Mann-Whitney U test and other quantitative methods.

This survey resulted in initial snapshot data of the attitudes of designers, which helped identify suitable approaches for the next steps of the research.

3.3 Diary Study

Following the results of the survey, a second study was planned with the intention of providing richer data about the specific creativity support needs experienced by participants as part of their creative tasks, and how these might best be met by a colleague or collaborator. As the aim was to understand the needs of participants as they worked on specific tasks, and as it was anticipated that these tasks and needs might change across different periods of work, a method was required that enabled regular data collection over a multi-week period.

A form of diary study was designed for this purpose, as it allowed for the capture of the richer, qualitative data required at this stage of the research. The diary method invites participants to regularly self-observe behaviours and attitudes over an extended time period, in a similar way to keeping a personal diary or journal. In this method, the diary itself can take various forms, and does not need to be a written long-form self reflection as in the case of a personal diary. Alaszewski defines research diaries as "a document created by an individual who has maintained a regular, personal, and contemporaneous record" (Alaszewski, 2006, p.1).

The key factors of the method are therefore that the diary submissions should be personal to the individual, recording their own subjective reflections on events that occurred, rather than a simple log events; that the submissions should be regular so that conditions and attitudes can be observed and analysed over time; and that the submissions should be made contemporaneously with the events being described, so that “the record is not distorted by problems of recall” (Alaszewski, 2006, p.2).

The regular submissions of a diary study, means that they are less susceptible to the “generalised and idealised accounts” (ibid, p.vi), that can result from interviews which ask participants to recollect events and feelings from memory. The diary format also reduces the practical and methodological problems that can result from direct observation of participant behaviour. As Rieman (1993) notes, diary methods can provide a useful alternative to laboratory style studies, which may lack the insights gained from observing behaviour in real-world contexts, and also an alternative to direct observation of participant behaviour through shadowing activities in the workplace or engaging in forms of participatory design, where the presence of the researcher can influence the behaviours of the participant.

The ability of diary studies to provide qualitative data about events that “cross multiple technologies, multiple locations, and multiple environments” (Lazar, Feng and Hochheiser, 2017, p.138) makes it particularly well suited to HCI research, and the method been used widely in this field (e.g. Rieman (1993), Fan, Saaty and Mccrickard (2024), Jokela, Ojala and Olsson (2015), Mekler *et al*. (2014)).

Digital methods of diary keeping are common, particularly within HCI research, with Lazar, Feng and Hochheiser (2017) recommending the use of whichever form of media or device are most accessible for the contexts being researched. For example mobile platforms would be best suited for participants who are likely to be regularly in different locations, while desktop methods may be better suited for participants engaged in office-based work.

In addition to the above benefits, the choice of a diary method for this study was also influenced by the ongoing COVID-19 lockdown restrictions at the time. While face-to-face interviews and workshops with creatives had been originally planned for the second stage of the research, with physical activities such card-sorting to be used in facilitated sessions, these became impractical when restrictions were introduced. The self-observation activities of the diary study therefore offered a means of continuing the research without the need for face-to-face activities. The planned card-sorting activities were adapted for the diary format.

For this study, a Feedback Diary format (Lazar, Feng and Hochheiser,2017) was chosen, in which participants were asked to provide detailed reflections on their activities for later analysis. This is different to the Elicitation Diary format, also described by Lazar, Feng and Hochheiser, where simple data is recorded in the diary and then used as part of an interview process at the end of the study in order to elicit more detailed responses from the participants.

However, the final diary submission of this study did have an extended format which prompted participants to provide more detail about their attitudes specifically towards AI and creativity. All the preceding diary prompts were focused on creativity support without mentioning AI, and this separation allowed for a comparative analysis between participants' attitudes towards creativity support and their attitudes towards AI-enabled creativity support.

The diary study took place over four weeks, and was conducted with employees at Google (the industrial partner for this PhD studentship). Participants were prompted to respond twice during the working week. Data collection was organised through an online form, which posed a mixture of Likert-style and multiple choice questions, and open ended questions with written responses.

Different methods were used to analyse these different formats of responses. Likert-style and multiple-choice questions were analysed quantitatively, with the numerical data aggregated and visualised through graphs and charts in order to analyse patterns and differences in participant's responses. The participants' open text responses were reviewed using thematic analysis in order to determine key themes, ideas, and language used across the participant's responses.

Braun & Clarke's (2006) definition and methodology for thematic analysis formed the basis for the method used for the diary study. They state that "thematic analysis involves the searching across a data set…to find repeated patterns of meaning" (Braun and Clarke, 2006, p.86). They emphasise the adaptability of this broad definition, and identify several contrasting approaches that researchers can take to carrying out thematic analysis, depending on the context and the theoretical perspectives of the work.

The analysis in this research takes a broadly inductive, rather than theoretical, approach to the analysis of the participants' responses. Braun and Clarke define the inductive approach as data driven, where patterns and themes are strongly linked to the participant data, rather than attempting to impose categories or themes from existing theory.

The inductive approach was chosen as the most appropriate for two reasons. First, because the data being analysed was submitted in response to specific prompts and questions in the diary study (rather than data taken from a variety of existing sources such as interviews or social media content). The responses were therefore relatively well focused around question topics and the data itself afforded clearer categorisation. Second, because the data was partly concerned with speculative uses of new technologies, there were not necessarily existing theoretical categories to apply to the responses. The aim was to keep an open mind about emerging attitudes to the technology, and learn as much as possible from the participants.

Inductive analysis also aligns with the semantic approach to reading the data described by Braun & Clarke, where the explicit, surface meanings of the data are used as the basis for coding themes, rather than going beyond literal meanings to identify latent themes across the data set. A broadly semantic approach was taken in this research, as the scale and focus of the responses did not necessarily support deeper readings of latent meaning.

Although a bottom-up, inductive approach was chosen for this research, the analysis was completed with an awareness of Braun and Clarke's warning that themes and categories should not be thought to passively 'emerge' from the data. They are interpretations made by the researcher, as a result of active decisions made about the data, and that it is important to "acknowledge these decisions, and recognize them *as* decisions" (Braun and Clarke, 2006, p.80).

The six phases of analysis described by Braun & Clarke were therefore followed with the aim of ensuring the active, repeated, and recursive reading needed for effective thematic analysis. These steps are: familiarisation of the data, generating initial codes, searching for themes, reviewing themes, refining and naming themes, and reporting the outcomes.

In preparing the results of the analysis for reporting, additional steps were taken in this research to apply some quantitative analysis to the results, and produce charts and graphs to help identify occurrence of themes across different participants, and different role types. This further analysis and reporting is different to the outcomes suggested by Braun & Clarke, who situate their approach primarily within qualitative practices, and who describe the complexity of using measures such as the prevalence of a particular theme within qualitative analysis.

The additional quantitative analysis was used in this mixed methods research, initially as a response to research colleagues at Google, who were partnering on the research, and were keen to have quantified and visual outcomes to aid their own internal reporting. However, it proved useful for identifying patterns and differences between themes, and also allowed the results of the thematic analysis to be integrated more clearly with the quantitative data from the Likert-style and multiple choice prompts within the diary study.

The combined analysis from this study formed the basis for the next stages of the research, and in particular the digital probe study.

3.4 Workshop

In addition to the data collection which took place as part of the diary study and digital probe study, further feedback and testing took place as part of a workshop with academics at the ACM Conference on Creativity and Cognition 2022. A workshop proposal was accepted for this conference which included discussion of the themes of personal creativity support, and the role of AI in creative practice, as well as workshop activities which tested aspects of the diary study and digital probe study, including card sorting activities.

The workshop was designed to utilise creative methods within the activities. This included using AI tools and physical materials to complete creative tasks such as designing sculptures, writing poetry, and creating images. These creative methods were chosen primarily because the focus of the workshop and the conference was creativity, and therefore the inclusion of creative activities allowed practical elements of the topics being discussed to be tested and experienced first-hand.

The use of creative methods was also chosen in order to help facilitate discussion and help meaningfully engage members of the group. Kara (2020) documents multiple approaches to using creative methods within research activities, highlighting the potential for creative methods to lead to more flexible and inclusive data collection methods that can lead to richer research outcomes. The activities designed for the workshop combined four of the five areas of creative methods highlighted by Kara: arts-based research, embodied research, research using technology, and multi-modal research.

Tarr, Gonzalez-Polledo and Cornish (2018) highlight the importance of the ‘liveness’ of arts-based workshops, noting that the workshops may not lead to data collection or research outcomes in the traditional sense, but create spaces for ambiguity, participatory experience, and affective engagement, all of which can support the “broader research assemblage” (Tarr, Gonzalez-Polledo and Cornish, 2018, p.37). In this vein, the intention of the workshop was not necessarily to lead to the creation of further data, but to informed discussion which could help frame the next stage of the research, as well as supporting the ongoing research activities of the participants.

Feedback from the workshop was used to inform design decisions made during the construction of the digital research probes which were used in the next phase of the research.

3.5 Digital Probe Study

The final study of this research aimed to expand on the results of the diary study, testing the conclusions from that study with a different cohort of participants outside of Google, and capturing a richer set of data by changing the method of data collection from a diary format to a method which allowed participants to reflect on their creativity support needs in the moment that they performed creative tasks, rather than retrospectively at a later time.

This required a method of data collection which allowed participants to quickly and easily submit their reflections from their workspaces on a rolling basis over a multi week period, whenever they had the need for creativity support. The method needed to be easily accessible within their work environment, but should not distract or conflict with the work they were carrying out, as might have been the case with the desktop-based forms used in the diary study.

One approach that maintains the convenience and immediacy of digital data collection but re-centers the process away from existing digital activities, is to use bespoke digital devices to enable data collection. This approach can be seen in digital research probes such as ProbeTools (Boucher et al., 2019; Interaction Research Studio, 2020). These take the form of a series of adaptable digital devices that can be easily built by researchers and used to conduct qualitative research asynchronously with participants.

The ProbeTools kit includes ‘unconventional cameras and audio devices’ for recording participant responses. The TaskCam provides participants with a prompt or question via a small screen and allows them to take a digital photo in response. The VisionCam can record video or time-lapse over a longer time period. The Interviewer tool is an audio device which can be programmed to ask questions and record responses.

The privacy of participants is a clear concern when inviting them to use digital recording devices in their homes or workplaces. The designers of ProbeTools addressed this by designing privacy features into the devices, such as video filters which reduce the image to black and white outlines, and audio filters, which claim to anonymise the voice of participants.

The kind of custom research device represented by the ProbeTools demonstrated a potentially useful method for data collection in the final study, as they enable long-term remote data collection in a convenient and accessible format. However, in selecting this method of research, it is important to acknowledge that the ProbeTools were created as a development of the existing research method of Cultural Probes, that represents a particular approach to ethnographic research and participant interaction which are not fully utilised in this research.

Cultural Probes were developed by Gaver, Dunne and Pacenti (1999) as a form of research influenced by both art and design practice. The approach references The Situationists, borrowing aspects of *derivés* and psychogeography in the approach to mapping the “emotional ambience” of participants’ environments, rather than aiming to capture more literal or concrete features. The authors stated that their role as artist-designers was “openly subjective, only partly guided by any ‘objective’ problem statement. Thus we were after ‘inspirational data’ with the probes, to stimulate our imaginations rather than define a set of problems” (Gaver, Dunne and Pacenti, 1999, p.25).

The authors have been critical of subsequent applications of Cultural Probes, particularly in the HCI community, that have used them for more objective or scientific data collection, prioritising the generation of information over inspiration, and aiming for certainty rather than embracing the uncertainty that Cultural Probes can explore (Gaver *et al.,* 2004).

In referencing ProbeTools as part of this study, it was recognised that the aim of capturing specific data to validate observations made during earlier studies did not fully align with the original intentions of Cultural Probes. However, the form of ProbeTools, and similar digital research devices such as the Digital Question Box developed by the Helen Hamlyn Centre (Bichard *et al.,* 2015), and Datacatcher (Gaver *et al.,* 2016), provide a useful model for how custom devices can be used to engage research participants over extended studies.

A particular affordance of the probe devices is the ability to maintain a presence in a participant's environment as they complete activities relevant to the study whilst also remaining discrete from the devices and tools that are associated with those activities. The probe device represents a physical reminder to engage with the research, and the fact that it is only used for a single purpose means there are no distractions from other tasks. In the context of this research, that would mean the ability to have a device positioned in the workplace of a participant while they work on creative tasks, allowing them to record reflections on their support needs as they occur, or respond to prompts or questions at regular intervals. This created the potential for more spontaneous contributions than the diary study.

Separating the data collection interactions from existing work devices also meant that participants can still engage with the device during non-digital activities in their workspaces, for example, sketching or organising physical resources away from their devices. This made it possible for the devices to capture data related to ongoing physical or desk-based activities.

To analyse the data from the probe study, a similar approach was taken to that used in the diary study, with a combination of qualitative and quantitative methods, and thematic analysis being used on recorded responses. The use of mixed methods of analysis allowed the data from the probe study to be compared across participants, and also to be compared with equivalent data from the diary study. This enabled validation of the conclusion from the earlier study, in addition to new insights based on the richer data captured by the devices.

3.6 Summary

Mixed Methods approaches to data collection and analysis were used throughout this research to observe and understand the attitudes of people working in creative roles within the design industry. The selected methods of survey, diary study, and probe devices, were designed to capture increasingly detailed and context specific data about participant's needs and attitudes towards creativity and AI creativity support, outside of a laboratory-style research setting. These methods were supplemented by a conference workshop, which facilitated informed discussion on the topic of the research, and helped frame the final study.

The design, results, and analysis of each of these studies will be described in more detail in the following chapters.

Chapter 4 Survey Study

4.1 Introduction

This study aimed to sample the attitudes of designers to understand their feelings towards their creative process, and the potential use of AI to support this process. The study involved a survey of 44 designers, revealing their priorities relating to creativity, and their attitudes towards speculative AI collaborators. The survey revealed a pragmatic attitude towards AI creativity support amongst respondents, and a willingness to share some tasks with potential AI collaborators. The results indicated that respondents were more likely to accept AI support for tasks which they personally felt required lower creative abilities. However, how individuals defined creative tasks, and the type of support they needed, was more complex and required further data from designers. In response, a set of card-based research tools were proposed to investigate the types of creative collaboration desired by designers. These research tools were then utilised in the next phase of the research, where they were used to support the design of questions in the Google Diary Study (Chapter 5).

This initial study focused mainly on gathering data in relation to Research Question 1 - “What role do individuals working in creative roles in the design industry want AI to play in supporting their personal creative practice?”. To begin to address this question, the survey first investigated how respondents defined their ‘personal creative practice’, asking them, for example, which parts of their practice they felt required the most creativity, and what barriers to creativity they experienced. It then asked them about their knowledge of, and attitudes towards AI, and AI creativity tools. Finally, it asked them what approaches they currently use to support their creative practice, and what role AI might play in this in the future.

The overall research defines the subject of the studies as ‘individuals working in creative roles within the design industry’, in order to be inclusive of the broad range of creative roles within interdisciplinary design practices. However, the respondents in this survey identified themselves as designers, albeit from a broad range of disciplines (e.g. Graphic Design, UX Design, Fashion Design, Furniture Design). This chapter will therefore refer to the respondents as designers.

4.2 Context

Research Question 1 stems from the concept that AI-enabled Creativity Support Tools (AI-CST) have the potential to change the relationship between human creatives and their support tools. As discussed in section 2.4.4 of the Literature Review, the perceived ability of generative AI systems to produce creative outcomes in their own right raises the issue of agency, and the concept that AI-CST could play a co-creative role in creative processes. This would mean a shift in perception from CST as tools, to systems that play an active role in a creative project, more akin to a human collaborator or colleague.

This concept has been explored within CST research. For example, Lubart (2005) proposes that CSTs could assume the roles of nanny, pen-pal, coach, or colleague, and Guzdial et al. (2019) identify the roles of friend, collaborator, student, and manager. These types of proposed roles have helped provoke discussion about the technological potential for co-creative AI support tools. However, there are a number of interconnected issues not fully addressed by these proposed roles, detailed further below.

4.2.1 Real World Creativity

The proposed roles were based on theoretical creative and technological practices (Lubart), and specific observations of lab-based creative tasks (Guzdial *et al*). As such, they do not address the full complexity of working practices in relation to distributed creativity (Glăveanu, 2013), and the fact that the types of required support roles are likely to change and evolve across different types and contexts of work.

In the conclusions of their survey of creativity support systems, Gabriel et al note the problems associated with designing tools which support creativity across all phases and settings. They conclude that to address this, CSTs would need to start offering "advanced functionalities, such as adaptation of the system to the behaviour and cognitive patterns of individuals, [which] implies the introduction of artificial intelligence into the creativity support." (Gabriel *et al.,* 2016, p.117). The design of such systems would require a better understanding of how, or if, creatives want AI systems to adapt to their own behaviours.

4.2.2 Appeal of AI

While the proposed roles describe broad functions that an AI collaborator could play in a creative process, the authors do not fully explore whether creatives want AI to play these types of roles, or any role in their creative work. These kinds of attitudes are likely to be a significant factor in the adoption of co-creative systems, and may be influenced by a number of considerations, such as an individual's attitude to their own creative process, and their perception of AI technology.

It should not be assumed that designers want AI to play a co-creative role in their work, even if this is technically possible. Other forms of support from AI may be more desirable. For example, it could be considered that the most helpful way of allowing a designer to be creative might be to support them in their non-creative tasks (for example, answering emails, ordering materials or preparing invoices), or to support their use of existing creative tools (for example managing files or documenting ideation). These sorts of tasks do not require the CST to engage directly in creative work, but might allow designers to spend more time being independently creative.

4.2.3 Sense of Ownership

Related to the above, the concept of AI co-creativity represented by these roles may create issues related to perceived ownership of creative outcomes, and these are not explored in the existing research. Elsbach (2009) identifies the importance of ‘signature styles’ in the work of commercial designers, noting that the ability to express and recognise their own personal creative style in project outcomes, even within the constraints of branded work, allows them to affirm their creative identities and create a sense of ownership or affinity with the work. This sense of individual style may be impacted by co-creativity with AI.

Similarly, Gero & Chilton (2019) observe that writers' sense of ownership over their creative outcomes was negatively impacted by the use of an AI tool, with users sometimes not wishing to use the AI’s contributions, even if they deemed them suitable. This response varied depending on whether the user approached the CST as a "co-creative partner" or "cognitive offloading tool".

4.2.4 The Issue of Agency

The issue of agency is not fully explored in the role proposals by Lubart or Guzdial et al. The type of co-creativity suggested by the concept of an AI collaborator would likely involve a complex negotiation of agency and initiative within creative tasks. Understanding how this maps to models such as the mixed-initiative ‘spectrum of agency’ suggested by Deterding *et al*. (2017), would require a better understanding of the type of collaboration individuals wanted from an AI system.

4.2.5 Collaborator Characteristics

While the roles proposed by Lubart and Guzdial *et al*. provide a general indication of the type of function they will perform, they do not provide any detail about the quality of the collaboration, or the characteristics of the collaborator, which are normally important factors in a collaboration with another human. For example a colleague or a manager might be strict, enthusiastic, outspoken, affable, etc. Different creative contexts and approaches are likely to require different qualities of support, and if AI tools are to act as collaborators, more understanding is needed of these requirements.

In considering the characteristics that may be applied to a potential AI collaborator, it could be important to consider that not all qualities associated with creativity may be considered positive or conventional. For example Domino's (1970) creative adjective checklist contains 59 personal characteristics which are associated with creative behaviour. This includes qualities such as 'outspoken', 'cynical', 'enthusiastic' and 'rebellious'. Also, Epstein's essential competencies for creativity (Epstein and Phan, 2012; Epstein, Schmidt and Warfel, 2008), include behaviours such as 'challenging conventional approaches' and 'seeking out unusual stimuli'. It would be helpful to understand if these more complex creative characteristics are desired in AI collaborators, and if so, how they contribute to richer descriptions of AI collaborators than simple titles such as colleague, or manager.

4.3 Approach

The above issues indicate the need to gather and analyse data which is rooted in the real-world experiences and attitudes of people who might use AI-CST. Much research in this area has focused on the emerging capabilities of the technology, and the interactions with users at an interface level. However, less data exists on the attitudes of creative practitioners towards AI creativity tools, and the role they should play in the creative process. A better understanding of these attitudes could guide the development of intelligent CST, and avoid the design of tools which conflict with the values of creatives. This survey aimed to capture relevant data for this purpose.

As the scope and abilities of AI technologies was in rapid development at the time of the study, the survey did not aim to discuss specific tools or functionality as part of the questions to respondents. Instead it took a speculative approach, attempting to capture participant's general attitudes based on their current perception of the technology and its future abilities. The aim was to capture how the respondents felt about current and future uses of the technology, rather than looking to inform them about the current abilities.

By taking a speculative approach to the topic, this research did not ask respondents to assess the technical merits of whether or not an AI support tool can act creatively, but instead sought to answer the more fundamental question of what kind of role (creative or otherwise) designers wanted an AI tool to play in their creative process.

The survey examined these issues by querying whether designers perceive specific tasks within the design process as requiring high or low creativity, and comparing this with their perceptions of the capabilities of AI to support the task.

4.4 Survey Method

To test the attitudes of commercial designers, a survey was conducted of 44 individuals working in design disciplines. Respondents were asked to rate their knowledge of AI technology, but no specific technical knowledge was required for the survey. Questions were framed speculatively, inviting respondents to imagine how they might work with AI systems in the future, based on their current understanding of the technology.

Survey participants were recruited primarily from alumni and students of postgraduate design courses in the UK. The survey was distributed as an online form, and consisted of 19 questions split into four separate sections: Demographic Information, Creativity, AI, and Creativity Support. Question topics were aligned between the different sections to test where attitudes towards different concepts might be connected. The attitudes of respondents were measured using 1-5 Likert style questions.

The survey used the Double Diamond model (Design Council, 2024) of the design process as a basis for mapping the different stages of commercial creative work, and identifying common creative tasks.

The survey questions and responses are available in Appendix 1 and Appendix 2.

The survey was designed to reveal insights into the following specific areas:

What are the defining qualities of creativity for designers?
(Q5) - Respondents were asked to identify terms which they associated with creativity in order to test whether there was a common understanding of the topic of the survey, and to identify key qualities which could direct future CST development.

Do designers believe AI is capable of supporting creative tasks?
(Q8 & Q16) - Two linked questions in separate sections of the survey asked respondents to rate the level of creativity required for specific tasks in the design process, and later asked them to rate their perception of the capability of AI tools to support the same list of tasks. Comparing the responses to these two questions was intended to reveal attitudes towards the ability of AI tools to support creative vs. non-creative tasks.

How would the use of AI tools affect designers' sense of ownership over creative outcomes?
(Q18) - Respondents were asked how their sense of ownership over a creative outcome would be affected by the use of an AI support tool. This was designed to reveal whether personal emotional attitudes to creativity were likely to mean designers rejected the concept of collaboration or co-creativity with AI systems, or whether they felt they needed to modify suggestions in order to gain a sense of ownership.

What are designers' general attitudes towards AI technology?

(Q9, Q10, Q11, Q12) - A series of questions asked respondents to identify terms they associated with AI in order to reveal general sentiment towards AI technology, and also asked respondents to rate what impact they felt AI technology would have on their industry in the future. The results of these questions were used to reveal whether designers' attitudes to intelligent CST are consistent with a broader attitude towards AI.

What are common barriers to creativity?

(Q7) - Respondents were asked to identify common issues which prevented them from achieving creativity. This was intended to reveal common experiences of the creative process, and to indicate what manner of support a CST could usefully provide.

The question took the format of a multiple-choice checkbox list. Several potential barriers to creativity were provided to respondents, based on issues discussed in previous literature. For example, issues relating to Inspiration (Thrash *et al.,* 2014; Oleynick *et al.,* 2014), Distraction (Baird *et al.,* 2012; Collins, 2020), and Motivation or Interest in creative tasks (Kreitler and Casakin, 2009).

The question also contained an 'Other' option for respondents to add their own free text response if they felt that the provided options did not reflect the creative barriers they experienced.

When might help from an AI collaborator be appropriate?

(Q17) - Respondents were asked to identify which common tasks in the design process might be best suited for an AI system to perform.

The results of the survey were collated and analysed using a mixture of parametric and non-parametric methods.

4.5 Survey Results

The responses provided the following insights into the defined areas of enquiry:

What are the defining qualities of creativity for designers?

Respondents indicated agreement with the standard 'valuable novelty' definition of creativity. The qualities 'Novelty' and 'Purpose' were most frequently ranked as having high importance to creativity, being scored as 4 or 5 on the 5-point Likert Scale, running from Low Importance (1) to High Importance (5).

The term 'Purpose' was chosen instead of 'Value', to avoid the implication of financial value. It was given the description "it has a clear role or use". Novelty (31 scores of 4 or above) and Purpose (30 scores of 4 or above) were very similarly rated by participants, indicating that these two qualities shared similar prominence in their definitions of creativity.

Q5: "In your experience, what are the important qualities that make a design outcome 'creative'?" Number of respondents rating a quality as having high importance for creativity (Scoring >3 on 5 point scale). Ranked by count.	
Creative Quality	**Count**
Novelty (it does something new)	31
Purpose (it has a clear role or use)	30
Effectiveness (it fulfils its purpose well)	26
Surprise (it demonstrates unexpected methods or results)	26
Ingenuity (it demonstrates clever or complex problem solving)	22
Synthesis (it brings together existing ideas or approaches)	19

Table 4.1: Responses to Q5 showing high-importance qualities.

Q5: "In your experience, what are the important qualities that make a design outcome 'creative'?" Number of respondents rating a quality as having low importance for creativity (Scoring <3 on 5 point scale). Ranked by count.	
Creative Quality	**Count**
Surprise (it demonstrates unexpected methods or results)	9
Purpose (it has a clear role or use)	8
Effectiveness (it fulfils its purpose well)	7
Synthesis (it brings together existing ideas or approaches)	7
Ingenuity (it demonstrates clever or complex problem solving)	6
Novelty (it does something new)	4

Table 4.2: Responses to Q5 showing low-importance qualities.

The next two most frequently highly scored qualities were Effectiveness and Surprise (26 scores of 4 or above each). These two qualities also align with the standard definition terms of novelty and value. Their equal scoring again reinforces the shared importance of these qualities across respondents.

On an individual basis, only 12 respondents indicated that novelty and value shared exactly equal importance in their personal definition of creativity. The majority of respondents (32) scored either a 'novelty' aligned quality (Novelty, Ingenuity, Surprise) or a 'value' aligned quality (Purpose, Effectiveness) slightly higher than the other in terms of importance. Across all responses, however, these differences evened out to an overall equating of these two qualities.

Looking at the qualities which respondents scored as of low importance in their definition of creativity, combined with their high importance ranking, suggests that Novelty could hold marginally more significance as a creative quality, as that term had the highest frequency of high scores, combined, with the lowest frequency of low scores.

Do designers believe AI is capable of supporting creative tasks?

The design tasks that respondents perceived as most creative were the ones perceived as least suitable for an AI to support.

Comparing the answers to Questions 8 and 16 ("What level of creativity do you feel is required for each of the following areas of the design process?" and "From your understanding of AI, how capable do you feel it would be in supporting each of the following areas of the design process?") reveals a significant inverse correlation between a task's perceived creativity and an AI's perceived ability to support it.

Q8. What level of creativity do you feel is required for each of the following areas of the design process? (1 = Low Creativity, 5 = High Creativity)	
Task	**Average Likert Score**
Generating concepts	4.09
Translating concepts into final design outcomes	3.89
Reviewing and selecting concepts	3.61
Researching the problem	3.61
Testing / Gathering feedback	3.3
Project planning / management	3.07

Table 4.3: Responses to Q8 ranking creativity of tasks

Q16. From your understanding of AI, how capable do you feel it would be in supporting each of the following areas of the design process? (1 = Incapable, 5 = Very Capable)	
Task	**Average Likert Score**
Testing / Gathering feedback	3.52
Researching the problem	3.48
Project planning / management	3.3
Translating concepts into final design outcomes	2.75
Reviewing and selecting concepts	2.68
Generating concepts	2.55

Table 4.4: Responses to Q16 ranking capability of AI

Analysing the results first through a simple averaging of the Likert scores (Table 4.3 and Table 4.4) showed that the three tasks collectively ranked most creative (“generating concepts”, “translating concepts into final designs”, “reviewing and selecting concepts”), were also the three ranked bottom in terms of AI capability.

Reviewing the data on an individual basis showed that in 31 cases (70.45%), where a respondent indicated a high level of confidence in AI being able to perform a particular task, it was for a task that they felt required low creativity.

Testing the results using non-parametric methods revealed the tasks where there was the largest difference between the perceived creativity of a task, and the perceived ability of AI to support it. A Mann-Whitney U Test and a Wilcoxon Signed-Rank Test were carried out on the results of the two questions to test the distribution of answers. Both tests produced similar outcomes, showing that the largest difference between perceived creativity and perceived capability of AI was for the tasks "generating concepts", "translating concepts into final design outcomes" and "reviewing and selecting concepts". These tasks all had different distributions, indicating that they were unlikely to be rated highly for both creativity and the perceived capability of AI.

	Mann-Whitney U test	
	Statistic	**p-Value**
Generating concepts	1625.5	0
Translating concepts into final design outcomes	1459.5	0
Reviewing and selecting concepts	1403	0
Project planning / management	839	0.267
Testing / Gathering feedback	853	0.327
Researching the problem	1032	0.581

Table 4.5: Results of a Mann-Whitney U test for Q8 and Q16

	Wilcoxon Signed- Rank Test	
	Statistic	**p-Value**
Generating concepts	30	0
Translating concepts into final design outcomes	35	0
Reviewing and selecting concepts	47.5	0
Testing / Gathering feedback	153.5	0.38
Project planning / management	220	0.4
Researching the problem	207	0.59

Table 4.6: Results of a Wilcoxon Signed-Rank Test for Q8 and Q16

The tests also showed that the tasks "project planning/management", "testing/gathering feedback", and "researching the problem" had similar distributions of results, indicating that respondents rated the required creativity and AI capability of these tasks more evenly.

Taking these results together with those to Q17 (“*For the following list of design-related tasks, please indicate how much support you’d be willing to receive from an AI tool.*”), provided an indication of the design tasks which have the least and most potential to be supported by intelligent CST. At one end of the scale, with the least potential for AI support, was "generating concepts" which respondents rated as a highly creative task, but did not believe an AI was capable of supporting. At the other end, with high potential for AI support was "researching the problem", which designers were likely to rate as requiring at least medium creativity, which was then matched by their confidence in the capability of AI to support the task.

How would the use of AI tools affect designers' sense of ownership over creative outcomes?

Respondents to this survey did not perceive a significant issue with sense of ownership

Addressing the issue of perceived ownership of AI-supported work, Q18 asked "*If you used an AI tool to support your creative process, how would it affect your sense of ownership over the outcome?*". This was a multiple choice, checkbox format question, in which respondents could select multiple options to reflect their views, and also could use the “Other” option to submit their own text response.

The responses indicated that amongst designers there did not seem to be a problem with the perceived ownership of AI-supported work, and that it seems unlikely that support would be rejected out of hand.

Responses	**Count**	**%**
I'd still feel the outcome was my own	18	34.0%
I'd feel it was a collaboration with the AI	25	47.2%
I'd only feel ownership if I had modified or adapted the outputs of the AI	6	11.3%
I'd feel the AI had ownership	2	3.8%
Other	2	3.8%

Table 4.7: Results for Q18 showing impact of AI on perceived sense of ownership

The largest proportion of the respondents (25, representing 47.2% of the total) felt that if an AI tool had supported their creativity, they would view the resultant outcome as a collaboration with the AI. This suggests a positive view of the abilities of AI technology, and an inclusive view of its role. 18 of the respondents (34%) felt they would still have ownership of the outcome, even if they received support from an AI system. Only a small minority felt that ownership would belong to the AI tool, or that they would need to alter the outputs in order to feel a sense of ownership.

What are designers' general attitudes towards AI technology?

Respondents to this survey had a generally positive outlook on AI. The survey did not reveal any significant negative sentiment relating to AI technology. Most of the respondents (30, or 68.2%) predicted that AI technology would have a high or very high impact on their work. However, this is not considered a cause for concern as most of those surveyed (38, or 86.4%) were either optimistic or neutral about the nature of this impact.

Neither did respondents feel they had a poor understanding of AI technology. 81.8% felt their understanding was either average or good. Further testing would be needed to determine whether this perception of their own knowledge was accurate.

What are common barriers to creativity?

The most common obstacles to personal creativity were ranked as "distraction from non-creative tasks" (selected by 18 respondents (40.9%)), "too much fixation on task" (selected by 17 respondents (38.6%)), and “lack of interest in the problem” (selected by 16 respondents (36.4%)).

The issues selected by the smallest number of respondents were “difficulty in communicating vision” and “not enough fixation on task”.

Two respondents selected “Other” for this question, and submitted their own barriers to creativity. These were “restraining cognitive bias”, and “time-consuming to learn new tools”.

However, during the analysis of this question, it became evident that the scope and wording of the options given to respondents may have hindered responses to this question. For example, the use of the term ‘fixation’ in the options was intended to be synonymous with ‘focus’, and relate to issues of designers being detrimentally either over or under focussed on a task, requiring either a break from the task or more motivation to engage. However, fixation in this context could also refer to the concept of being overly reliant on existing design features or approaches. This definition is described more in Crilly (2015) and Crilly & Cardoso (2017).

Similarly the concept of 'communicating vision' could have been defined more clearly to provide more context. As these terms were not clearly defined in the survey question, there could have been ambiguity in the responses.

Therefore, whilst the results of this question potentially indicate interesting insights about a need for CST to be able to support personal and psychological requirements (such as motivation and focus), in addition to more practical or material needs, these insights cannot be reliably drawn from the responses to this question, and will be investigated further in future phases of the research.

Barrier to Creativity	Count	% of respondents
Distraction from non-creative tasks	18	40.9%
Too much fixation on task	17	38.6%
Lack of interest in the problem	16	36.4%
Lack of inspiration	14	31.8%
Lack of understanding of the problem	14	31.8%
Difficulty in communicating vision	11	25.0%
Not enough fixation on task	5	11.4%
Other	2	4.5%

Table 4.8: Results for Q7 showing barriers to creativity

When might help from an AI collaborator be appropriate?

The respondents to this survey indicated that they felt AI could most suitably support Research, Testing, and Project Management within a design project.

This can be seen in the respondent's answers to both Question 16 (“From your understanding of AI, how capable do you feel it would be in supporting each of the following areas of the design process?”) and Question 17 (“For the following list of design related tasks, please indicate how much support you’d be willing to receive from an AI tool.”). The results from these questions can be seen below.

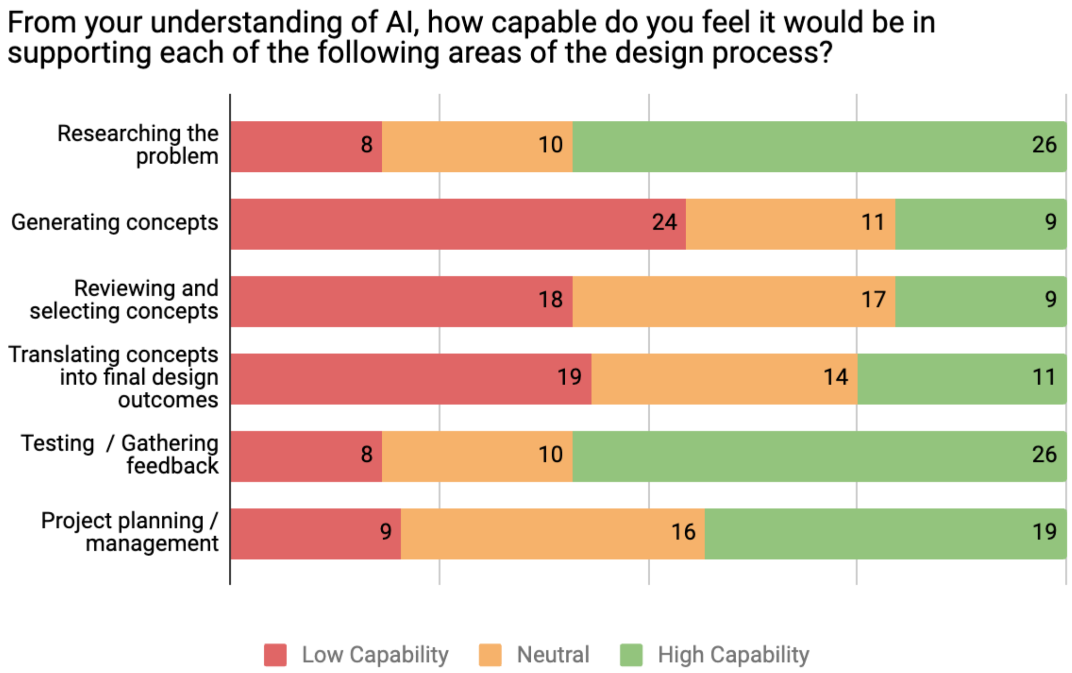

Figure 4.1: Responses to Q16 showing perceived capability of AI.
The chart shows the total number of responses for each task, divided by the perceived level of capability. (Low = 1-2 on Likert scale, Neutral = 3, High = 4-5)

The responses to both questions indicated that the parts of the creative process that respondents felt AI was least suitable to provide support were related to the generation and development of ideas, and included the tasks “idea generation / brainstorming”, “revising designs”, and “sketching”. The majority of respondents felt they wanted a low level of support from AI for these tasks, although there was also a significant number of respondents who indicated that they would be happy to share a task evenly with an AI.

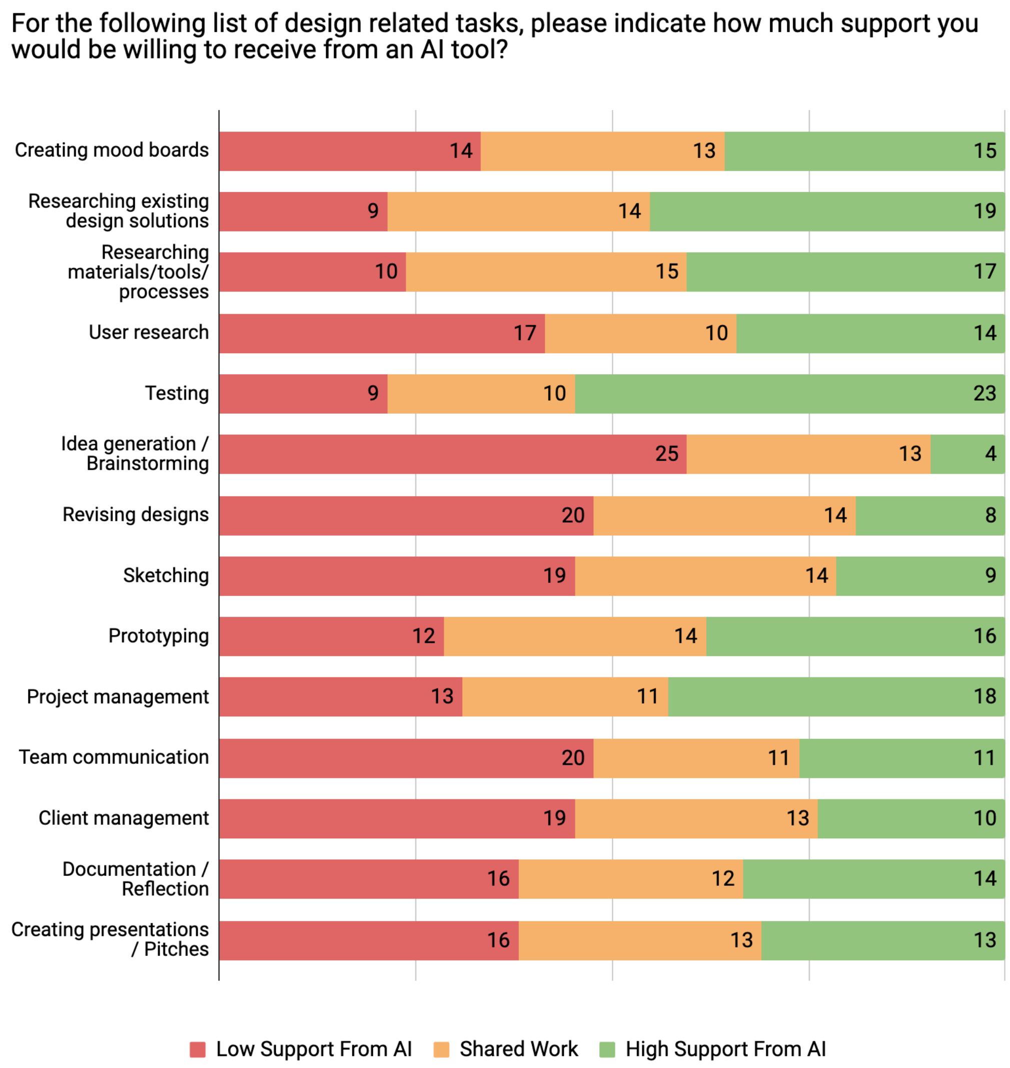

Figure 4.2: Responses to Q17 showing preferred support levels for tasks.

Chart displays responses to each option divided into Low Support From AI (1-2 on Likert Scale), Shared Work (3), and High Support From AI (4-5).

There was also a low level of confidence reported for AI to support tasks related to “team communication” and “client management”, indicating that most respondents didn’t want to involve AI in the process of communicating with others.

This is interesting to note in relation to the respondent's positive attitude towards AI-supported project management tasks. Project management was the task which the most respondents (8) indicated that they would like to entirely hand over to AI. As project management normally involves a significant amount of communication, it would be helpful to better understand what elements of management would be preferable for an AI to support.

While some of the results indicate a negative attitude towards AI supporting divergent creative tasks such as idea generation, and a positive attitude towards AI supporting convergent tasks such as testing, it is clear that respondents' attitudes towards AI support are not simply based on whether a task is divergent or convergent. Divergent tasks, such as researching and creating prototypes, were also seen as suitable for AI support, and convergent tasks, such as revising design, were seen as unsuitable for support.

These complexities in the attitudes towards categories of AI support, coupled with the relatively high level of respondents indicating that they would be happy to share work on a task with an AI system, indicated that more understanding was needed of how designers decide how much support or collaboration they want on a creative task.

4.6 Discussion

4.6.1 Research over concepts

The survey results indicated that language may be important in the context of designers' perceptions of AI technology and creativity. Notably, tasks which included the word "concept" (e.g. "generating concepts") were perceived as requiring the highest creativity, and not considered to be within the capabilities of AI. This creates the impression that conceptual work is still the domain of human creativity, and it may not be easy for computational intelligence to play a role in this part of design. Or it could be that these conceptual tasks were the ones that designers most wanted to engage with themselves, and not hand over to a collaborator.

On the other hand, tasks that contained the word "research" held an interesting middle ground. They were perceived as creative tasks, but there was also confidence in the abilities of AI to perform or support them. These research tasks, relating largely to the ‘discovery’ phase of the design process, therefore may offer the most potential for future AI-CST development.

Further research would be needed to understand how much of this perception directly relates to the language used. For example, if words such as "concept" were avoided in the description of a task, would it affect designers' attitudes towards it? The use of language may be an important factor in the description and positioning of AI-CST.

The perception of research tasks is also worth considering in relation to the significance of novelty in designers’ definition of creativity. If an AI-CST is able to support designers with discovery phase activities such as understanding the problem space of the brief, helping map existing solutions, or diversifying their sources of inspiration, then it could make it easier for them to achieve novelty in their outcomes.

4.6.2 AI Pragmatism

Analysing the responses to this survey in relation to the research question “What role do individuals working in creative roles in the design industry want AI to play in supporting their personal creative practice?” revealed indications that designers have a generally positive and pragmatic approach to the use of AI in their creative process.

Although the survey indicated a low confidence in the abilities of contemporary AI to play a role in ideation and generation tasks, with respondents reluctant to imagine AI successfully supporting the conceptual elements of a project, there were positive indications that designers were open to the concept of AI playing supportive or even collaborative role on creative projects. This may prove significant as the capabilities (and perceived capabilities) of AI develop.

The willingness to perceive an AI tool as a collaborator provides an alternative view to previous research such as Gero & Chilton (2019) which suggests the sense of ownership of creative tasks may be negatively impacted by AI tools. This could be due to the particular requirements and attitudes of commercial designers, as opposed to other creative practices such as fine art or poetry (the subject of Gero and Chilton's study). This pragmatic view of ownership was expressed in the free text response of one respondent who disagreed that sense of ownership would be an issue to them, as "design is in general a much more collaborative process than Art". Whether that is true or not (many art disciplines require extensive collaboration), designers' investment in the notion of collaboration may be a factor in their use of AI-CST.

Further research would be needed to understand the nature of the role designers want AI to play, beyond the type of practical tasks they could support. As respondents indicated that they were open to collaboration with AI, with a large number of responses indicating that they would be happy to share a creative task evenly between themselves and an AI system, then the question of what attitudes or qualities the AI should represent in the collaboration becomes more significant. The respondents' answers in relation to creative barriers seemed to suggest that there may be a need for more personal support, for example in assisting with focus or motivation on a task. However, more accurate data is needed in relation to this question. Similarly, the positive attitudes towards AI supporting project management aspects creativity may indicate a willingness for AI playing an organisational role in projects, in the nature of Lubart's 'Nanny' role, or Guzdial et al 'Manager'. This was to be explored more in the next phase of the research.

4.7 Next Steps

The survey enabled a limited snapshot of the attitudes of designers towards AI creativity support. It demonstrated that respondents had a pragmatic approach to the use of AI in their work, and also indicated that there were complexities in identifying the category of support that individual designers want, and the specific type of role that they would like AI to play in collaboration or co-creativity. Understanding what motivates the preferences for support reported by the survey respondents and what barriers to creativity are most likely to lead to seeking support would help define and predict the role AI should play in supporting creativity. Further research with more in-depth methods was required to gather more data related to these areas of inquiry.

The need to question designers more directly and extensively than in the survey meant that a different method was required. The intention was therefore to next run small group workshops or interviews with designers, where their attitudes towards creative tasks and the potential role of AI could be explored in more detail, with the chance to ask follow-up questions and discuss the motivations for their responses.

To facilitate discussion in these research activities, and to ensure consistent structure between different sessions, a specific set of research tools was required. It was decided that card sorting activities provided a useful method for meeting these needs, as they supported repeatable data capture activities such as ranking areas of importance or grouping concepts, but also provided a mechanism to provoke more general conversation with groups.

In response to the data gathered in the survey, it was decided that the most helpful subject of the cards would be creative roles or personas. If participants were given a set of cards which represented different types or characteristics of creative collaborators, then these could be used to help express their attitudes and preferences. Provided with different prompts, participants could use the cards to communicate their views on their own creative attitudes, the attitudes they value in others, and how their preferences change between different creative tasks.

Two sets of cards were planned: Persona Cards and Quality Cards. The Persona Cards would represent potential creative collaborators, each offering different types of support. These would facilitate discussions around the role that an AI collaborator could potentially play in daily creative practice. The Quality Cards would each show a single adjective describing different types of personality which a creative collaborator might demonstrate. Used together they could help participants communicate the form and style of support they desired from a potential collaborator.

4.7.1 Persona Cards

The Epstein Creativity Competencies Inventory for Individuals (ECCI-i) (Epstein, Schmidt and Warfel, 2008; Epstein and Phan, 2012), was chosen as the basis for the collaborator personas used on the cards. The reason for using these competency categories rather than other forms of creativity trait or skill set was that they covered a broad range of potential creative contexts, behaviours and actions, complementing the distributed definition of creativity described by Glăveanu (2013), rather than focusing on specific skills or abilities which might not be relevant to all contexts of interdisciplinary design. The mixture of practical and psychological competencies in the ECCI-i also complements the types of support needs recorded in the survey, which ranged from help creating outcomes, to help with motivation and focus.

The ECCI-i contains four competencies: Capturing (recording and documenting ideas), Challenging (working on open-ended and difficult tasks), Broadening (seeking new skills and knowledge) and Surrounding (seeking and adapting to new stimuli from the environment).

The personas used on the cards were based on representations of these four categories. In order to accommodate the concept of collaboration, however, a further level of categorisation was needed in the cards. The ECCI-i is designed for individuals, to test their personal creative strengths against the competency categories. In using the competencies to discuss the skills of a potential collaborator, or someone providing creative support, it was necessary to determine whether the competencies in question were intended to be demonstrated by the collaborator, or were competencies that the designer wanted help demonstrating themselves.

For example, if a designer chooses support from a collaborator representing the Capturing competency, do they want a collaborator who is competent at drawing, and could therefore document the ideas described by the designer, or do they want a collaborator who could help the designer draw the ideas themselves, for example by providing appropriate sketching tools or helping record or organise ideas?

To help define this distinction, two further categorisations were applied to the four ECCI-i competencies: Intrinsic and Extrinsic. When a collaborator uses a competency intrinsically, they apply it to their own creative outcomes. For example, a collaborator representing an *Intrinsic*-Capturing competency is competent at drawing, and uses this ability to create sketches on behalf of others. Whereas a collaborator representing an *Extrinsic*-Capturing competency is competent at drawing, and uses this ability to help others create their own sketches.

While both the Intrinsic and Extrinsic versions of a competency support the creation of the same type of outcome (e.g. a sketch), they represent different ways of achieving that outcome from a designer's point of view. This difference stems from the question of agency in AI-CST, and is dependent on how the designer wants to position a specific task on the 'spectrum of agency' (Deterding *et al.,* 2017) between human led creativity, and AI led creativity.

Creating two persona cards for each competency (Table 4.9), and allowing participants to understand the difference between the roles, provided a means of testing whether the participants wanted to retain control of a creative task themselves, or whether they preferred to hand it over to a collaborator to complete.

	Personas for Creative Collaboration Role Cards	
	Extrinsic	**Intrinsic**
Capturing	**Studio Assistant** Sets up your tools and materials and helps you get the best out of them. Ensures you have everything you need to capture your ideas.	**Visualiser** Helps get the ideas out of your head and onto the page or screen. Listens to your ideas and visualises them for you.
Challenging	**Motivator** Helps you keep to your targets. Challenges you to push yourself further. Provides encouragement and motivation when you need it.	**Go-Getter** Takes an idea and runs with it. Pushes concepts the extra mile. Seeks out new roles and challenges.
Broadening	**Guide** Points you towards new ideas and references. Teaches you new techniques, and sets you on paths of discovery.	**Guru** Knows everything so you don't have to. Constantly learning and always has the right answer ready. Fills in any gaps in your knowledge.
Surrounding	**Curator** Helps maintain a stimulating workspace. Suggests changes to your routines and surroundings to give you new perspectives.	**Wildcard** Regularly brings surprising new outlooks and approaches to their work. Takes concepts in interesting and unpredictable directions.

Table 4.9: Proposed roles for Persona Cards, based on ECCI-i competency categories, divided into Intrinsic and Extrinsic support types.

Cards were designed for each of the personas (Figure 4.3). An illustrative, tarot-style design was used for the cards, with the aim of increasing participant engagement, and communicating the nature of the role in a simple way during workshop activities.

Methodology Reflections

At this stage in the research, the use of creativity support personas in the form of human characters appeared to be an effective way of engaging participants with the novel concept of an AI tool as a collaborator, and encouraging discussion about the role designers wanted AI to play in their creative process.

However, following the results of the Google Diary Study (Chapter 5), and a shift away from data collection in facilitated research workshops and towards asynchronous online data collection, I reflected that the human-centric characterisation of the personas risked limiting the responses from participants about the ideal role for AI support. This reorientation of the research methods is discussed further in Chapter 6.

Figure 4.3: Images of the eight Persona Cards

4.7.2 Quality Cards

The second deck of cards designed for the workshops consisted of 50 small cards, each containing a single adjective that could be associated with creative personalities (Table 4.10). These adjectives are sourced from Domino's Creativity Scale (Domino, 1970), which is itself derived from Gough and Heilbrun's Adjective Check List (ACL) (Gough and Heilbrun, 1983). The cards would be used by inviting participants to select and rank the adjectives in order to identify desirable or undesirable creative qualities, and construct creative identities. Participants could also use the cards to identify qualities of their own creative persona, and discuss how this might be similar or different to what they desire in a collaborator.

Creative Quality Adjectives				
absentminded	careless	egotistical	intelligent	reflective
adaptable	clear-thinking	enthusiastic	intolerant	reserved
adventurous	complicated	humorous	inventive	restless
alert	confident	idealistic	logical	sarcastic
aloof	curious	imaginative	moody	sensitive
ambitious	cynical	impulsive	original	serious
argumentative	demanding	independent	outspoken	sharp-witted
artistic	disorderly	individualistic	quick	spontaneous
assertive	dissatisfied	ingenious	rational	tactless
capable	distractible	insightful	rebellious	unconventional

Table 4.10: Creative quality adjectives. These terms form the basis of the Quality Cards.

The adjectives describe a broad range of creative qualities, some of which are conventionally positive (such as 'imaginative' or 'artistic') whilst others have potentially negative connotations (such as 'demanding' or 'rebellious'). This variety of qualities is intended to prompt discussion, and to provide a richer set of responses from participants.

Used together, the Persona and Quality cards are designed to identify roles for AI collaborators which are more detailed, and perhaps more appropriate than simple categories such as ‘manager’ or ‘colleague’.

4.8 Conclusion

This survey study aimed to capture a snapshot of designer’s attitudes towards Creativity, AI, and Creativity Support from AI. The survey of 44 designers found a generally pragmatic approach to the use of AI in their work, with no significant indications that designers might reject the use of AI in their creative work, or might be concerned about their sense of ownership over the outcome of AI supported work. Respondents reported an openness to the concept of collaborating creatively with AI, with many respondents happy to share creative tasks equally with AI systems.

The survey identified Research, Testing, and Project Management tasks as being popular areas for AI support, while tasks involving the generation of concepts, or human communication were less popular. Tasks that individuals personally felt to be creative, were the ones they were less likely to want AI to work on. The survey results therefore indicated some tension between respondents' willingness to collaborate creatively with AI, and their lack of confidence in having AI support tasks which they felt are creative.

In addition, predicting the types of tasks that designers may be happy to accept AI support to complete is complex, as it appears to be linked to their personal perception of creativity, and may include tasks related to psychological support such as motivations and focus.

This study revealed the need to better understand how designers define the type of creative tasks that AI-CST could support, and what particular role they want an AI-CST to play in potential collaborations. There is a technological relevance to this issue, as the results of this survey suggested that the type of support that respondents were most negative about receiving from AI (generation and communication), are the tasks that emerging AI technology is increasingly capable of supporting through image and text generation.

In response to the results of the survey, a set of research tools were created in the form of Persona and Quality Cards. These have been designed to be used during workshop activities to capture richer data related to the role designers want AI to play in their creative process. This data capture will be the focus of the next phase of the research.

Chapter 5 Google Diary Study

5.1 Introduction

This PhD research was conducted as part of a studentship with AHRC and the National Productivity Investment Fund, which included a partnership with the industrial partner Google. This primarily took the form of research placements throughout the first three years of the PhD.

The three placements lasted around two months over the summers of 2019, 2020, and 2021. Each placement was based with the AIUX (AI User Experience) team at Google, in London. This team was focused on researching how future AI products might be used by customers and conducted a range of research activities, including user testing, prototyping, and speculative design. The focus of the placement research activities changed each year, but overall investigated how AI could be integrated into creative processes using digital products and the attitudes of users towards creativity and AI.

The nature of the placement with Google created some restrictions related to how the research conducted during these periods could be discussed or published outside of the Google organisation. To comply with Google's legal policies, for each of the placements, I was required to be employed as a researcher. I was therefore subject to their mandatory confidentiality and disclosure policies. This necessarily limited the extent to which the work carried out during the placements can be discussed as part of this research.

However, the final and most substantial body of research carried out as part of the placements was written up as a paper that was subsequently cleared for publication by Google. This forms the basis for this chapter. The full paper is included in full as Appendix 6, and a summary of the methods, data, and conclusions will be presented in this chapter.

5.2 Placements

5.2.1 Year 1

The first placement with Google covered two main subjects. The first focused on the technique of Concept Activation Vectors (CAVs) (Kim *et al.,* 2018), and the potential to use these to support the creative process. CAVs represent a Machine Learning technique which can be used to train a model to classify images according to subjective 'human-friendly' concepts. Rather than recognising low-level features that make up specific objects in photos, CAVs could be used to recognise more high-level, descriptive features such as 'stripy', 'porous', or 'professional'.

The potential to train an AI system to understand these subjective terms could have practical benefits in terms of supporting personal creativity. For example, if a designer could create their own personalised CAV-based AI tools which understood and could apply their own interpretation of subjective creative terms such as 'stylish', 'modern', or 'minimal', then this tool could be used for tasks such as searching and filtering reference images, generating sample sketches, and highlighting similarities and differences between different people's interpretation of a concept (e.g. the designer and their client).

Various concepts for CAV-based creativity support tools were discussed and designed as part of the placement process, and ideas were tested using prototype CAV systems. Although specific details of the placement work have not been cleared for publication, related work which was developed by the same Google team has been published online. For example, the CAV Camera was created as a collaboration between Nord Projects and Google (Nord Projects, 2022). It is a camera app that includes functionality for learning concepts set by the user, and can be used to create collections or mood boards of similarly themed images. The same team also continued exploring the use of CAVs to support moodboarding with a Mood Board Search tool (Google Research and Nord Projects, 2022; Kim, 2022). These CAV-based experiments were focused on testing whether training AI tools to recognise personal subjectivities, styles, and ways of seeing, could be used to support tasks within an individual's creative process.

The placement work undertaken during the first year focused on these same themes, exploring options for interfaces that could support different parts of the creative process, particularly collaborations and group activities during the early stages of defining a creative project.

The second focus of the placement in Year 1 was a discussion of the previously completed survey study (detailed in Chapter 4). The results of this survey were of interest to the teams I was working with at Google, and there were several opportunities to present the results and discuss potential relevance to the design of AI creative tools, with meetings across different teams working on AI products.

There were valuable connections between the findings of the survey, which suggested designers may be disposed to using tools during the early research phases of a creative project, and the potential for CAVs to assist with early research tasks such as moodboarding. Also, the focus of CAV applications on supporting personal and subjective interpretations of creativity, aligned constructively with the theories of personal creativity discussed in the Literature Review, and the use of embedded, rather than cloud-based, AI tools. The opportunity to explore and discuss the support of personal creativity was helpful for framing the future phases of this research.

5.2.2 Year 2

The second year of the placement with Google was initially intended to continue the research activities from Year 1. However, the COVID-19 pandemic and subsequent lockdowns precluded the placement taking place in the same way as Year 1. The Google offices were closed, and it was therefore not possible to collaborate on face-to-face research activities in the same way. Priorities within the Google teams had also necessarily shifted in response to the changed circumstances.

The research for the second placement therefore changed to focus specifically on the contents and analysis of the Literature Review. Insights from this review were helpful for the Google teams as they defined their developing research focus at this time. Themes and references from the review were presented remotely to Google teams, and some areas of interest were explored in more detail, and discussed with specific teams to better understand how the existing research might impact the concepts they were developing.

5.2.3 Year 3

The third placement also took place remotely due to ongoing restrictions from the COVID-19 pandemic. However, by this time working practices had adapted effectively to remote working, and it was possible therefore to conduct amended forms of primary research with the teams at Google.

Following the survey study, a set of research activities were planned using card sorting and workshop methods to collect data from designers relating to their attitudes and preferences for creative collaboration, and the type of supportive role they would like a collaborator to play in their creative projects.

The COVID-19 pandemic meant that these research activities could not take place as planned. As a result I was in the process of developing different approaches and research methods that would allow similar types of data collection with designers remotely. Designs and prototypes for probe style tools were being developed which might enable participants to interact with versions of the Persona Cards remotely. The third placement with Google offered the opportunity to test elements of these approaches, and gather further data from people working within roles which required creativity.

Google has well-developed processes in place for conducting primary research and testing with participants from within the Google organisation itself. This meant it was possible to recruit a group of participants for a further study investigating the attitudes of people working in creative and design related roles toward creativity support, and the role of AI. Recruitment and screening of the participants was managed through the internal Google research processes, and the study took place across the duration of the third placement. The results were analysed and shared with the teams at Google. The study was written up as a paper with support from colleagues at Google (Appendix 6), and approved for publication.

The design and analysis of this study are discussed further below.

5.3 Study Design

5.3.1 Aims

Following on from the analysis of the survey study, the study at Google aimed to investigate five questions, listed below. These questions were all relevant to Google's ongoing research priorities, and each one relates directly to the overall PhD Research Questions.

The following study questions relate to Research Question 2 ("*What factors influence the type of creativity support individuals working in creative roles in the design industry are willing to accept from AI systems?*")

- What are the common barriers to creativity experienced by people regularly working on creative tasks?
- What kind of support would alleviate these barriers to creativity?
  How do creative support requirements change across different tasks and contexts?

The remaining study questions relate to Research Question 1 ("*What role do individuals working in creative roles in the design industry want AI to play in supporting their personal creative practice*?")

- What kind of collaborator should ideally provide this creative support?
- What kind of collaboration do those working on creative tasks want from AI systems?

These questions were intended to reveal several types of insight from the study:

- To be able to map different support requirements to specific types of creative task
- To be able to map different types of creative requirements to specific support roles
- To observe any differences between the type of collaboration expected from human colleagues, and AI systems.

5.3.2 Diary Format

As discussed in section 3.3, a diary method was selected as the method for this study, as a means of achieving some of the planned research of the card and workshop activities, without the need for the face-to-face research sessions which were made impractical by COVID-19 restrictions.

The diary method afforded some of the same data capture as was planned for the workshops. This included querying participants in detail about their creativity support needs, and their attitudes towards collaboration, and the role of AI in creativity support. The diary method also had additional benefits, as the regular submissions from participants enabled their preferences to be mapped across different tasks and periods of work. The relative immediacy of responses, reflecting on creative tasks within a short time of working on them, also meant that recollections and feelings might be more clear than if work activities were being recalled in a workshop scenario.

The diary study was administered as a series of online forms, which were sent to the participants periodically during the four-week duration of the study and which they were asked to complete the same day. The participants were emailed a link to an online form twice a week, on Wednesdays and Fridays.

The first seven forms sent to the participants had identical questions, asking them to recall a time over the last day or two when they could have benefited from some help with a creative task, and to answer eight questions related to that instance. In each form the participants were reminded that the study's definition of 'creativity' was broad and included "any task where you needed to generate new ideas, or solve problems in imaginative ways". This was to encourage participants to describe all types of creative tasks which may have required support, not just those which resulted directly in obvious design outcomes.

The questions presented to participants in the first seven forms were:

#	Question Text	Response Type
1	What kind of creative task did you need help with?	Free text
2	Broadly, which of these best describes the type of task you needed help with?	Multiple choice radio button. Participants could select one of the following: • Research and discovery • Defining scope or focus • Generating or developing ideas • Implementing or delivering your ideas
3	What kind of support would have been helpful to you?	Free text
4	What actions did you take that helped you complete this creative task? You can include actions that weren't obviously part of the task, such as taking a break, going for a walk, talking to a friend etc.	Free text
5	What actions did you take that didn't help you complete this creative task? You can include distraction or diversion activities such as browsing the internet, doodling, etc.	Free text
6	If you could choose an ideal collaborator to help you with this task, who would it be?	Multiple choice radio button. Each option below was accompanied with an image of the relevant Persona Card:

		Studio Assistant: Sets up your tools and materials and helps you get the best out of them. Ensures you have everything you need to capture your ideas. **Visualiser:** Helps get the ideas out of your head and onto the page or screen. Listens to your ideas and visualises them for you. **Motivator:** Helps you keep to your targets. Challenges you to push yourself further. Provides encouragement and motivation when you need it. **Go-Getter:** Takes an idea and runs with it. Pushes concepts the extra mile. Seeks out new roles and challenges. **Guide:** Points your towards new ideas and references. Teaches you new techniques, and sets you on paths to discovery. **Guru:** Knows everything so you don't have to. Constantly learning and always has the right answer ready. Fills in any gaps in your knowledge. **Curator:** Helps maintain a stimulating workspace. Suggests changes to your routines and surroundings to give you new perspectives. **Wildcard:** Regularly brings surprising new outlooks and approaches to their work. Takes concepts in interesting and unpredictable directions. **Other** [enabled free text response] **None** (I'd prefer to work on it by myself)
7	Please briefly tell us why you chose this option for a collaborator.	Free text
8	How would you prefer the collaboration to work?	Multiple choice: - They complete the task entirely by themselves - They complete the task with some guidance from me - We share the task evenly - I complete the task with some guidance from them - I complete the task entirely by myself

Table 5.1: Questions asked in forms 1-7 of the 8 part diary study.

In keeping with the diary concept, the majority of the questions had free text responses. This allowed participants to describe their creative task and their preference for support in some detail. The consistent question format over the first seven forms was designed to allow participants to get used to the information they were required to provide each time, and could mentally prepare for this before responding to each diary form.

The first five questions asked participants to describe the task they needed help with, detail what types of assistance would have been helpful to them, and what would have been unhelpful. These questions were designed to capture a much more detailed picture of the type of support that would be considered appropriate for different types of problems than was captured during the first survey.

Questions 6 and 7 of the diary form were based directly on the Persona Cards described in section 4.7.1. Each card was shown graphically, and a text description of each potential collaborator persona was provided. Participants were asked to select the persona they most wanted to help them with the task in question. As the participants were answering with a specific task and issue in mind, rather than considering their support needs in general, a single selection was chosen over a ranking exercise to provide a more concise data set for this question.

Only the Persona Cards were chosen for this diary study, rather than the Quality Cards. The 50 options of the Quality Cards would have been harder to administer consistently in the short diary form, and therefore may not have produced reliable results. The Quality Cards were designed to act as talking points and interventions within longer, facilitated workshop tasks, and it would be difficult for them to act in this way in an online form.

The final question of the first seven diary forms asked participants to indicate how they wanted to share the task with a collaborator. This builds on a similar question in the survey study, and reflects the spectrum of agency defined by Deterding *et al*. (2017).

Throughout the first seven diary forms filled in by participants, the questions were all framed around general support for creativity, and the subject of AI was not mentioned at all. The forms were deliberately worded in this way to encourage participants to share their preferences for creative support, as they occurred within their normal work conditions with other people. By understanding the kind of support participants would ideally prefer in general, the responses could then be analysed in relation to what AI might be able to provide. However, if the questions were framed explicitly in relation to support from AI systems, the participants' responses were likely to be influenced by what they felt AI could or could not provide, and the ideal support they desired may not have been captured.

To address the research questions of the study it was still important to understand participants' attitudes towards AI, and their perception of the type of creativity it was capable of supporting. This could then be compared with the type of support the participants desired to understand whether they might perceive suitable opportunities for AI support within their tasks. The final diary form sent to participants therefore had a different format, and addressed the subject of AI and creativity support directly.

The questions presented in the eighth form of the diary study were as follows:

#	Question Text	Response Type
1	Thinking broadly about the creative tasks you work on, how helpful would you find each of these roles as a creative collaborator?	A five point likert-style ranking, running from ‘Very Unhelpful’ to ‘Very Helpful’. The titles of eight personas were listed and could be ranked using this scale.
2	If you were collaborating on a creative project with other people, which of these roles do you think you	Multiple choice radio button. Participants could choose one of the eight personas.

	personally would be able to perform best?	
3	Imagine if these roles were performed by Artificial Intelligence, rather than a person. How happy would you be for an AI collaborator to perform each of these roles on your creative projects?	A five point likert-style ranking, running from ‘Very Unhelpful’ to ‘Very Helpful’. The titles of eight personas were listed and could be ranked using this scale.
4	What kind of creative tasks would you be most happy for an AI system to help you with?	Free text.
5	What kind of creative tasks would you prefer to complete without any help from an AI system?	Free text.
6	How likely would you be to use the following features, if they could be performed by an AI system?	A five point likert-style ranking, running from ‘Very Unlikely’ to ‘Very Likely’. The following statements could be ranked using this scale: • You can describe an idea or a concept to the AI, and it automatically generates a version for you. • The AI understands what task you're trying to complete, and automatically sets up your preferred software, templates, and resources. • By observing factors such as your workspace, schedule, and physical actions, the AI knows how you work best, and helps you achieve this. • The AI system is aware of the latest trends, styles, and methods for your area of work, and can help you incorporate them into your work. • The AI system can provide you with regular feedback on your work, telling you how feasible / successful it is likely to be, and providing suggestions. • When you need inspiration for a creative task, the AI can remind you of ideal references from websites, media, or books you've previously viewed. • You can hand over a half finished creative task to the AI, and it will complete it, based on your previous work.

		• The AI knows when you're feeling unproductive, and sets you achievable challenges to keep you going.
7	The type of features described above would require the AI system to learn information about you and the way you work. What personal information would you be happy to securely share with the AI system? Please tick any that you're happy to give the AI system access to.	Multiple choice checkboxes. Participants could select as many of the following options as they wished: • Photos and videos (photos you've taken, or media you've saved) • Conversations with colleagues (voice data from work meetings) • Social media activity (what content you've liked or re-posted) • Posture or pose data via camera (whether you're standing, sitting, leaning, etc.) • Emails • 'Offline' work via camera (physical sketches, notes, models etc. in your work space) • Browser usage (what webpages you're visiting) • Software usage (what apps you're using / tasks you're performing) • Conversations with the AI (voice data from your interactions with the AI) • Streaming media activity (what music, film, TV shows you're streaming) • Physical movement via phone/watch (when you're sitting down, standing, moving around etc.) • Calendar
8	Do you have any other thoughts or comments on the topic discussed in this study?	Free text.

Table 5.2: Questions asked in the final form of the diary study.

At the beginning of the final diary form, participants were reminded of the persona cards they had been using in the previous forms. All eight cards were reproduced with the persona labels and text descriptions for reference. The first three questions then referred to the personas directly.

Participants were first asked which persona they preferred overall, to see how this compared with their selections over the previous weeks. They were then asked which persona they identified with most themselves. This was intended to allow further analysis of the type of support participants preferred, and in particular to try to identify whether the support needed to be different or similar to the participant's own skills or attitudes. The third question introduced the subject of AI, and invited the participants to imagine an AI system embodying each of the personas, rather than a human. They were asked to rate how helpful they thought an AI would be if performing each of the roles. When compared with their preferences for personas throughout the study, this was designed to give some indication of whether they would be happy for an AI to support their work or not.

Questions 4 and 5 were based on similar prompts from the survey study. They asked in general what type of tasks participants would be happy for AI to support, and what type of tasks they would prefer AI not to support.

Question 6 was primarily intended to help validate previous responses to the persona cards. One of the observations from the survey study was that the language used to describe support provided by AI systems could be an important factor in influencing participant's attitudes. As the persona labels and descriptions were necessarily generalised and concise, and intended to act as simple shorthand for different types of support represented by different creative competencies (Epstein, Schmidt and Warfel, 2008), it was helpful to confirm whether the type of support offered by each persona was fully understood by participants.

Question 6 therefore presented a more detailed example description of the type of support that each persona might provide, and participants were asked to rank each description using a similar scale to the one they'd used to rank the persona cards in Question 1. If there were significant differences between the results of Question 1 and 6, then this could indicate that the persona cards did not reliably communicate the type of support each could provide.

Question 7 was related in part to the level of participation and engagement participants were prepared to afford AI systems in order to facilitate creative collaboration. The answers to this question could be compared with Question 6 from the previous diary forms to help understand participant's attitudes towards sharing creative work activities with AI systems.

The other motivation for Question 7 was to help understand participants' attitudes towards privacy in the context of creative collaboration. This relates to the research focus on privacy-preserving embedded AI, rather than cloud-based systems, and the acknowledgement that any personalised form of AI creativity support would need to have access to a certain level of personal data in order to provide individualised support. The answers to this question could help indicate whether participants were concerned about sharing data with AI-CST.

The final question was a free text response which allowed participants to share any other opinions or information which had not been captured by previous questions.

5.3.3 Recruitment

Recruitment took place through the internal Google research systems. Participants responded to a call asking for people who regularly work on creative tasks to take part in a month-long study. Participation in the study was incentivised by providing employees who successfully completed the study with vouchers which could be exchanged for internal company benefits.

Before being accepted on to the study, participants completed a screening document which checked their availability during the study period, and also asked them to provide some examples of the creative tasks they worked on. One applicant was rejected at this stage because they were not able to provide examples of tasks they worked on which corresponded with the broad definition of "any task where you needed to generate new ideas, or solve problems in imaginative ways".

A group of 30 participants were successfully recruited. These participants all regularly worked on creative tasks related to digital product design, but were employed in different types of job roles. Around a third of the participants were in design roles, another third were in engineer roles, and the final third were in management or similar strategy and administration roles.

5.4 Study Outcomes

Below is a summary of the results and the insights revealed by the data in relation to the study questions.

What are the common barriers to creativity experienced by people regularly working on creative tasks, and what kind of support would alleviate these barriers to creativity?

There were two ways that participants' barriers to creativity were analysed within the results. The first was through participant's responses to the question "Broadly, which of these best describes the type of task you needed help with?". This question was asked in forms 2 to 7. Participants were asked to select from descriptions based on the four stages of the Double Diamond design model - Discover, Define, Develop, and Deliver. The results therefore indicated within which stage of the creative process participants were experiencing barriers to creativity.

	Broadly, which of these best describes the type of task you needed help with?				
	Designer	Engineer	Manager	Other	Total
Research and discovery	4	14	3	9	30
Defining scope or focus	5	9	5	3	22
Generating or developing ideas	19	20	3	7	49
Implementing or delivering your ideas	17	14	2	3	36

Table 5.3: Responses to Q2 of Forms 1-7 showing types of task requiring support. The number of responses for each phase of the creative process are broken down by the job role of the participant (Designer, Engineer, Manager, Other).

The responses to this question indicated that the stages of the creative process where support was required depended on the job role of the participant. These largely conformed with conventional activities within those roles. For example, Designers and Engineers most commonly wanted help with tasks related to generating and developing ideas, whilst managers were more likely to want help with tasks related to defining scope or focus. Across all job types, the later stages of the creative process were the ones where participants reported the need for creativity support. However, engineers and other roles particularly required support with tasks in the research and discovery phase of a project.

Theme	**Number of mentions**
More information	42
Conversation/Feedback	39
Templates/Examples	32
Direction/Guidance	28
Specialist Skill	17
Tool Improvements	17
Visualiser	14
Sharing task	13
Focus	7
Simulation/Foresight	6
Inspiration	6
Motivation/Supervision	3

Table 5.4: Thematic analysis of participants' descriptions of their support needs, showing the number of individual mentions of each theme.

The other way that common barriers to creativity were analysed was through a thematic analysis of the participants' explanations of the support they needed (responses to questions 3, 4, and 5 of the first seven diary forms). The free text responses to these questions were analysed to determine repeated keywords or themes in the answers. These were refined and consolidated through repeated analysis of the data, and instances of each theme were counted.

The results of this analysis showed that the most common forms of creativity support requests related to information. Participants reported that the most common type of support which would alleviate their creative barriers was ‘more information’. This was usually because they needed some specific piece of knowledge, such as the details of a brief, process instructions, feedback, or guidelines, in order to progress with their work. Similarly the second most requested form of support was conversation or feedback. This was because participants often wanted to discuss a creative problem with someone else, either to receive advice and reassurance, or to obtain a specific piece of information they were lacking. In addition, direction or guidance was the fourth most mentioned type of support.

The following quotes from participants were typical of the type of requests for informational support:

> “What I needed was more info. If I had that, the rest would be easy” (Participant 23, Designer)

> “[It] would be nice to have a person with detailed insight into the existing process to bounce ideas off of and get immediate feedback on what would or would not work and why.” (Participant 10, Engineer)

> “It would be nice to not need to reinvent the wheel all the time when I know resources exist, but finding them can take longer than starting fresh” (Participant 21, Designer)

These informational forms of support are not necessarily creative in their own right, but the frequency with which they were mentioned as a desired means of helping with creative tasks, demonstrated that information was commonly thought of as a solution to creative problems.

There was a significant social aspect to how participants wanted to receive information to help their creative process. In the responses to the question "What actions did you take that helped you complete this creative task?", nearly half of all responses mentioned talking to a colleague. In the context of increased remote working during the COVID-19 pandemic, creative collaboration was still occurring online. However, the inability to simply speak to collaborators socially and face-to-face was clearly seen as a barrier to creativity. This is typified in the following answer to the question "What kind of support would have been helpful to you?":

> "I wish I was working in the same room as the other illustrator! It's been nice to collaborate but wish we were able to talk it out in real time" (Participant 8, Designer).

Although information-based support was the most commonly requested by participants, there were also a significant number of requests for more practical support relating directly to creative production. For example, help with providing templates and examples, specialist skills or tools, and visualising concepts.

There were also a minority of requests relating to personal and psychological factors in creativity support, such as focus, inspiration, and motivation. These did not form a significant amount of requests across all participants, as was predicted after the survey study. However, they were still mentioned by a small number of people.

Motivation in particular seems to be a form of support that was unpopular with the majority of participants in the study. It was only mentioned three times in descriptions of the type of support participants desired, and the Motivator persona was only chosen as an ideal collaborator in nine responses.

However, a small handful of participants requested motivational support to help their creativity, with some of them selecting it on multiple occasions, and rating the Motivator persona "Very Helpful" on the final diary form. For these participants, personal and psychological factors such as motivation and focus were clearly important areas of support for some tasks, even if the majority of participants did not want this type of support. A better understanding of what influences this difference of attitude could be helpful for designing support solutions.

What kind of collaborator should ideally provide this creative support?

Persona	Number of selections	% of selections
Guru (Broadening-Intrinsic) Knows everything so you don't have to. Constantly learning and always has the right answer ready. Fills in any gaps in your knowledge.	37	23%
Guide (Broadening-Extrinsic) Points you towards new ideas and references. Teaches you new techniques, and sets you on paths of discovery.	28	17%
Visualiser (Capturing-Intrinsic) Helps get the ideas out of your head and onto the page or screen. Listens to your ideas and visualises them for you.	26	16%
Wildcard (Surrounding-Intrinsic) Regularly brings surprising new outlooks and approaches to their work. Takes concepts in interesting and unpredictable directions.	21	13%
Go-Getter (Challenging-Intrinsic) Takes an idea and runs with it. Pushes concepts the extra mile. Seeks out new roles and challenges.	18	11%
Studio Assistant (Capturing-Extrinsic)	12	7%

Sets up your tools and materials and helps you get the best out of them. Ensures you have everything you need to capture your ideas.		
Motivator (Challenging-Extrinsic) Helps you keep to your targets. Challenges you to push yourself further. Provides encouragement and motivation when you need it.	10	6%
Curator (Surrounding-Extrinsic) Helps maintain a stimulating workspace. Suggests changes to your routines and surroundings to give you new perspectives.	6	4%
Other	4	2%
None (I'd prefer to work on it by myself)	2	1%

Table 5.5: Number of times each Persona was chosen, ranked by popularity

	Studio Assist.	**Visual-iser**	**Motiva-tor**	**Go-Getter**	**Guide**	**Guru**	**Curator**	**Wild-card**	**Other**	**None**
Designer	4	7	2	6	12	13	0	7	3	0
Engineer	7	8	5	7	7	18	3	9	1	2
Manager	1	8	0	2	1	2	2	1	0	0
Other	0	3	3	3	8	4	1	4	0	0
	7%	16%	6%	11%	17%	23%	4%	13%	2%	1%

Table 5.6: Number of times each Persona was chosen, by job role of participant (Designer, Engineer, Manager, Other).

For each diary entry participants were asked to select a persona of an ideal collaborator to help them with their creative task. Across the study, participants' selections had clear alignment with the types of support they were requesting.

The most commonly selected personas were Guru with 37 selections (23%) and Guide with 28 selections (17%). Both of these personas relate to information, and align with the Broadening competency. This corresponds with participants' requests for support related to information, conversation, and feedback.

The next most popular category was Visualiser with 26 selections (16%). This again corresponds with the level of requests for practical production support. The three least requested personas were Studio Assistant, Motivator, and Curator. The unpopularity of Motivation as a feature of creativity support has been discussed above. It's also notable that all three of these personas relate to personal forms of support. Assisting with mental focus and productivity, and supporting activities related to an individual's own workspace, tools, and resources, all entail a higher level of personal support than activities focused primarily on creative outcomes, such as Visualiser.

Participants' choice of support persona appeared to be influenced by their own job role. The most popular personas changed depending on whether the participant was a designer, engineer, manager or other role. This was in line with the different tasks these roles were working on, and the barriers to creativity they were facing.

The most frequently requested persona for both Designers and Engineers was the information-based Guru. However, for managers, the most frequently requested persona was Visualiser. This difference seems likely to reflect the existing competencies and co-dependencies within creative teams. Designers and Engineers working on creative outcomes may rely on information and guidance from a manager, and therefore select information-based forms of support. Managers may be more likely to have access to project information, but rely on designers to create visual project outcomes and therefore select the Visualiser persona which performs this task.

Further testing would be needed to better understand whether people working on creative tasks are likely to desire the kind of support already provided by colleagues, or whether they want a collaborator who can augment their own existing skills. However, from this data it seems that the participants often wanted support that was already offered by colleagues, but which they were unable to access during their creative task.

Related to the question of what kind of collaborator participants wanted to support their creative work, is the question of how participants wanted to engage with that collaborator. The subject of agency, and how much control over their creative work participants wanted to keep themselves, and how much they were happy to give to a collaborator, was explored in the study using two points of analysis.

First, the participants' selection of persona provided an indication of how much creative agency an ideal collaborator should have. The personas were divided into intrinsic and extrinsic competencies, with the intrinsic descriptions indicating that the collaborator would use the competency themselves, and the extrinsic description indicating that the collaborator would support the participant to demonstrate the competency. This distinction between intrinsic and extrinsic roles was not made explicit to participants in the diary forms, which were randomly ordered in each form. However, the difference was implicit in each persona description.

The selection of an intrinsic persona therefore indicated that the collaborator would have more control, and the selection of an extrinsic persona indicated that the participant wanted to retain control.

	Extrinsic	**Intrinsic**	**Totals**
Capture	Studio Assistant	Visualiser	38
Challenge	Motivator	Go Getter	28
Broaden	Guide	Guru	65
Surround	Curator	Wildcard	27
Totals	56	102	

Table 5.7: Total number of selections of each persona, by competency and intrinsic/extrinsic qualities.

Across all responses, participants had a clear preference for personas in the intrinsic category. In each of the four competencies, the intrinsic version was selected more often than the extrinsic version. This indicates a general preference for collaborators with more creative agency.

The second method of determining how participants wanted to share a task with a collaborator was through their answers to question 8 of the initial diary forms ("How would you prefer the collaboration to work?"). In this question participants selected how much control they wanted to give to the collaborator, with the use of a scale running from "I complete the task entirely by myself" to "They complete the task entirely by themselves".

The responses to this question were slightly at odds with the selections of collaborator personas. While the majority of responses indicated a desire to share the task with a collaborator, rather than either the participants or the collaborator completing it entirely themselves, there was still an overall preference for participants retaining control of the work.

How would you prefer the collaboration to work?	Count
I complete the task entirely by myself	7
I complete the task with some guidance from them	64
We share the task evenly	40
They complete the task with some guidance from me	43
They complete the task entirely by themselves	10

Table 5.8: Responses to Q8 of Forms 1-7 showing collaboration preference. Preferences were scored on a 5 point scale from the participant having full control, to the collaborator having full control.

The highest number of responses were for the option "I complete the task with some guidance from them", with the second most popular option being "They complete the task with some guidance from me", and "We share the task evenly" slightly below that. Even when participants chose a collaborator with a description which indicated that the collaborator would perform the task themselves (for example a Visualiser), they still intended to retain control over the task.

The difference in these responses may have indicated a lack of understanding around the questions, or a lack of clarity relating to the persona descriptions. It may also have been the case that participants were conflicted about the role a collaborator should play in their creative work, or that there is more complexity about how designers perceive this kind of collaboration. Either way, the data indicated that further investigation of this subject would be helpful in future stages of the research.

In the final diary form of the study, Question 2 provided further data related to the type of creative collaborator participants preferred. This question focused on the participant's perception of their own abilities and asked "If you were collaborating on a creative project with other people, which of these roles do you think you personally would be able to perform best?". Answers to this question allowed some comparison between the type of skills the participants felt they possessed themselves, and the type of skills they wanted a collaborator to provide.

The results indicated that the participants often wanted a collaborator to have the same skills as themselves. In the final diary form, participants were also asked to rank each collaborator persona on a scale of 'Very Helpful' to 'Very Unhelpful', considering their support needs in general, rather than for a specific task. In every response to this form, the collaborator persona that a participant selected as best representing themselves was a persona that they had also ranked as Helpful or Very Helpful to their own practice.

Comparing the persona that participants selected as representing their own skills, with the personas they selected as ideal collaborators in the previous seven diary forms, also demonstrated a preference for collaborators with the same skills. 18 of the participants (69.2%) identified themselves as one of the personas that they had previously chosen to help them in one of their creative tasks.

This data indicated that designers may often require support from collaborators who are able to perform the same tasks as themselves, rather than collaborators who contribute different skills or abilities to a task. To provide effective creativity support to designers, it may be important to understand when they require a reproduction of their own skill sets, and when they require new and unknown skills to complete a task. Further testing would be needed to better define this distinction.

How do creative support requirements change across different tasks and contexts?

Participants were unlikely to stick with one type of collaborator throughout the four-week study. Instead, the type of task they were engaging with changed regularly and so did their choice of collaborator.

Participants were asked to identify the category of creative task they were working on, and in 78 out of 137 submissions (56.9%) participants selected a category of task which they had not previously selected. Furthermore, the nature of their tasks rarely followed a linear progression against established creative workflows - e.g. moving from research, to idea generation, to implementation and delivery. The data indicates that participants were working on multiple projects across the study and therefore were encountering a variety of creative tasks each day.

Consequently the type of collaborator they requested also changed frequently, with participants changing their selection between reports in 114 out of 164 submissions (69.5%). Even when their task remained the same, they were still likely to change their choice of collaborator.

What kind of collaboration do those working on creative tasks want from AI systems?

The final diary form focused specifically on AI and creativity, and provided some insights relating to participant's preferences for creative collaboration with AI. Participants were invited to review and rank the personas once more to rate their overall preferences for the different roles. They were then asked to rate the personas again, this time imagining that they were performed by an AI rather than a human collaborator. This provided some indication of whether the participants' perception of AI affected their preference for creativity support.

This data showed that participants' attitudes to all the collaborator personas was generally positive, whether they were performed by a human or an AI.

The data indicated that across all responses, all the personas were perceived as helpful, with all personas receiving more positive than negative or neutral ratings. Responses to these questions reflected the preferences expressed in earlier diary forms, with the information related personas, Guide and Guru, receiving the most positive rankings.

Across the majority of responses there was slight preference for humans rather than AI performing the collaborative roles, but there wasn't a significant rejection of AI support in any category. However there were two categories where participants actually indicated a greater preference for the persona if it was performed by an AI rather than a human. These were the roles of Studio Assistant and Curator.

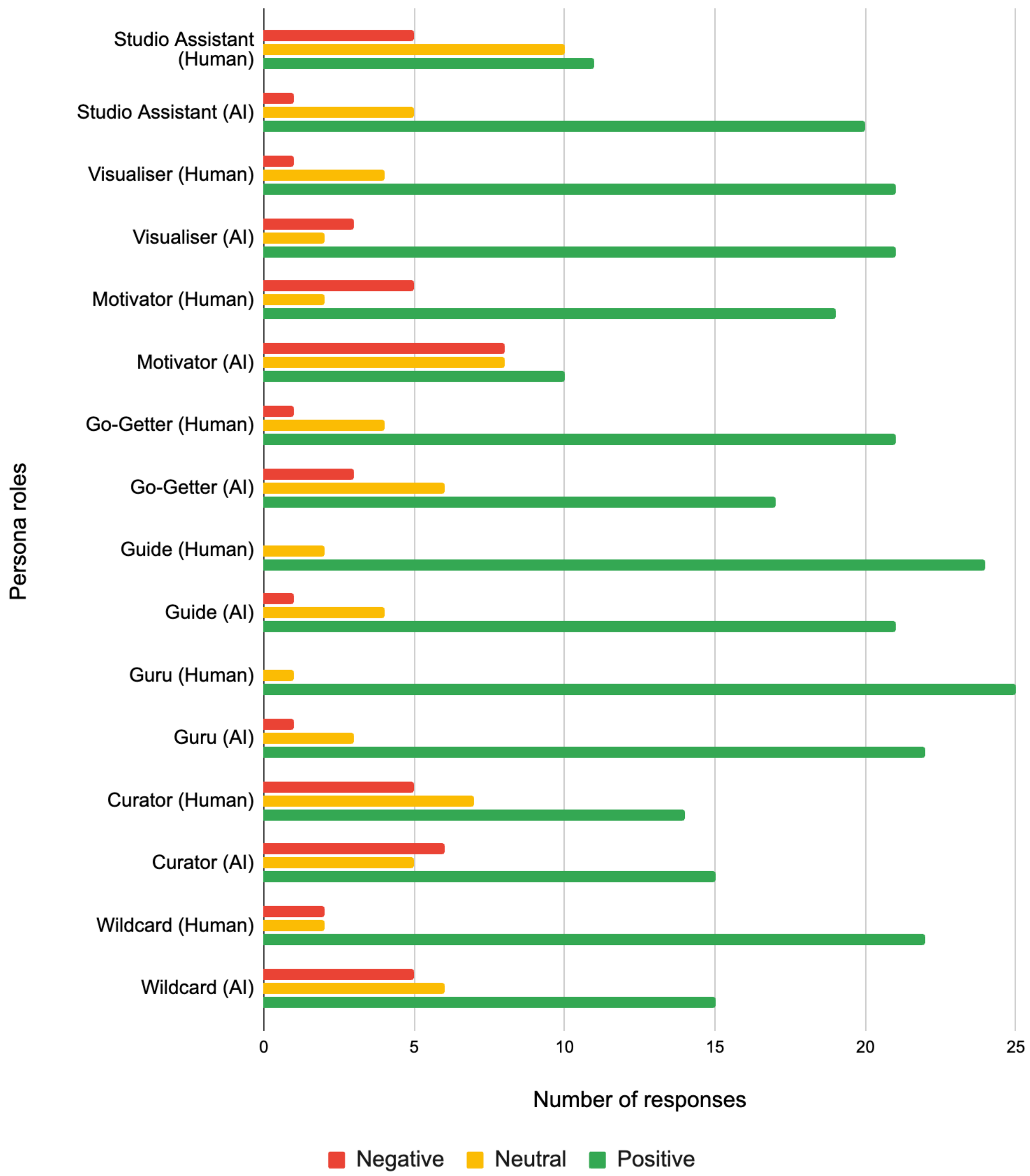

Figure 5.1: Comparison of attitudes towards AI and humans performing Persona roles based on responses to Q1 and Q3 of the final diary form.

More participants rated the Curator role positively when it was performed by an AI, although more also rated it negatively, with less people rating it neutral. This suggested that the use of AI in this support role is more divisive. The use of AI in the Studio Assistant role was rated more consistently, with more participants viewing the AI version of this role positively, and less rating it negatively.

What kind of creative tasks would you be most happy for an AI system to help you with?	
Finding/Suggesting references	12
Automate repetitive tasks	9
Visualisation	7
Knowledge repository	4
Organising resources	4
Guiding	3
Extend/Extrapolate work	2
Assist focus	2
Interpolate	1
Facilitate collaboration	1
Motivation	1

Table 5.9: Tasks that participants were happy for AI to support based on thematic analysis of free text responses. Each thematic label is shown, with the amount of times it was mentioned by participants.

In some ways the preference for the use of AI in these roles is surprising, as out of all the personas provided to participants, these two correspond most clearly with existing, human, job titles.

The difference in language between the occupational terms like Studio Assistant and Curator, compared with the more abstract terms like Wildcard or Go-Getter, highlights how far language and terminology may impact participants' responses to creativity support.

This was tested in Question 6 in the final survey, which asked participants to rate how likely they would be to accept support from an AI in a number of specific scenarios. Each scenario was based on one of the creativity support roles (e.g. "You can describe an idea or a concept to the AI, and it automatically generates a version for you." based on the Visualiser role), but the name of each role (e.g. Visualiser) was not included with the description.

This revealed some differences in attitude towards the roles compared with the questions which did not give specific scenarios. Notably, the examples given for Wildcard, Studio Assistant, and Visualiser all received more positive feedback than shown in previous questions, whilst the example for Guru received less positive responses. These results indicate that the role of language may play a significant role in the choice of support, and should be considered in future studies.

Methodology Reflections

The issue of language was raised in the discussion of the Survey Study (Chapter 4) and occurred again here in the Google Diary Study. As the research progressed it became clearer to me that the language used within the data collection methods, in particular the use of language that relates to human behaviours and characteristics applied to AI systems, had a significant impact on the responses of participants.

As a result of these reflections, the emphasis on written descriptions of collaborator characteristics was reduced as part of the reorientation of the research methods, discussed in more detail in Chapter 6.

It's also notable that the roles Studio Assistant and Curator both also describe personal forms of support, where the collaborator would be involved in setting up or configuring the designer's work environment, tools, or resources. These personal forms of support were also perceived negatively when considered in relation to human collaborators. It may be that having an AI involved in supporting personal aspects of creativity is seen as less intrusive or problematic than giving another person access to these areas.

What kind of creative tasks would you prefer to complete without any help from an AI system?	
Human/Emotional interactions	6
Motivation	5
Ideation	4
Managing	3
Expert/Guru	2
Critical Decisions	2
Finalising work	2
Research	1
Visualisation	1
Private/Sensitive Work	1
Organising tools/workspace	1
Personal Work	1

Table 5.10: Tasks that participants were not happy for AI to support based on thematic analysis of free text responses. Each thematic label is shown, with the amount of times it was mentioned by participants.

The participants' attitudes to AI providing forms of personal support were also shown in their answers to questions 4 and 5 of the final diary form. These asked "What kind of creative tasks would you be most happy for an AI system to help you with?" and "What kind of creative tasks would you prefer to complete without any help from an AI system?". Participants responded using a free text box, describing the different types of tasks they would, or would not, like AI to support. These text responses were then analysed using thematic analysis, in the same way as text responses earlier in the study.

The data from these questions not only reinforced the observation that information-related forms of creative support were most popular amongst participants, but also indicated that they were happy for AI to provide this informational support. The thematic category "Finding/Suggesting references" was mentioned most often in relation to the type of support participants were happy for AI to provide. Participants also mentioned AI acting as a form of knowledge repository in multiple responses.

Responses to these questions also showed that there was a certain amount of practical, production-based work which respondents were happy for AI to support. This was shown in multiple instances of the thematic categories 'automate repetitive tasks', 'visualisation', and 'extend and extrapolate work' in relation to work that participants felt that AI could support.

While there was general support for the idea of AI automating certain design production tasks which participants were not interested in completing themselves, there was also evidence that participants' attitudes in this area were conflicted, with no consistent sense of what type of design production tasks they were happy to hand over to AI.

For example, some participants were happy for AI to automate their individual design outcomes, and in particular tasks which they felt were mundane or routine. The following are samples of responses from Question 4, asking participants which tasks they'd be most happy for AI to support:

> "[I'd be most happy for AI to] do the mundane work to save human energy for novelty" (Participant 3, Writer)

> "Taking routine work off my shoulders" (Participant 9, Designer)

> "I'd also like help with automating some of my visuals without having to do so manually" (Participant 6, Designer)

The type of tasks which participants considered mundane or routine differed between responses. Some suggested that they occurred at the end of a design task, when designers had already established the concept and requirements. For example:

> “[I’d be most happy for AI to help with] tasks that can be automated such as perfecting designs” (Participant 17, Business Partner)

> “[I’d be most happy for AI to help with] tasks that can be completed when given clear and prescriptive instructions” (Participant 18, Engineer)

> “I would like them to take my inputs and spit out interesting variants and combinations” (Participant 8, Designer)

Other participants suggested they would prefer AI to start the creative task, and then they would take responsibility for finishing it to the correct standards, For example:

> “There are tasks I wouldn't exclusively leave to an AI system, such as tasks related to final production. These include tasks like design specs and copywriting; an AI can start these tasks, but I'd inevitably need to go back through it and edit as needed.” (Participant 11, Designer)

Some participants additionally shared that they would be happy for AI to help with any creative task. For example:

> “As long as the quality of the work is good, I couldn't be bothered whether it was a human or machine doing it” (Participant 23, Designer)

Motivation was mentioned frequently when participants were considering the types of support they did not want AI to provide. Their feedback in this area was generally very clear. For example:

> “I don't want to be motivated by bot.” (Participant 8, Designer)

> “I would not appreciate any automated ‘nagging’ - anything like motivational notifs [notifications], prompts, schedule reminders (‘time to take a walk’) etc...”(Participant 29, Researcher)

> "[I prefer] motivating myself. I don't want my job to be gamified" (Participant 30, Manager)

This negative attitude towards motivation was perhaps also related to the negative attitude towards other forms of support which were considered personal, or private. For example, participants frequently mentioned their unwillingness to have AI involved in any interactions which required human or emotional interactions, either with themselves, or with clients or colleagues. Participants also didn't want AI managing or supporting aspects of their creative work which they considered personal to them, including their schedule and workspace. For example:

> "[I would prefer AI not to] determine my schedule… define milestones" (Participant 22, Designer)

> "I wouldn't want my tools or setup to change based on AI. I like being in control of my space and workstation." (Participant 8, Designer)

While a majority of participants shared negative attitudes towards AI being involved in what they perceived as personal aspects of their creative process, there wasn't a consistent indication of what comprised personal aspects of the process. In some cases there was contradictory data about this.

For example, while many participants were negative about AI providing personal motivation or management of their time and workspaces, there were multiple instances of participants wanting AI to assist them with tasks such as organising their resources, optimising their workflows, or helping them to keep focused and avoid distractions. One participant also specifically requested motivation as the type of support they wanted AI to provide, a view that was the complete opposite of that expressed by the other participants.

These responses demonstrated complex and contradictory views about how participants defined the type of personal creative support which they did not want provided by AI. In fact, in several cases this contradictory position was expressed by individual participants in their answers to Question 4 and Question 5, stating both that they wanted AI to help organise or prioritise their work, but also that they did not want it to manage their workload or be involved in arranging their schedules or workspaces.

Given the overall clarity of these participants' responses, it seemed likely that the contradictory attitudes could be reconciled by better defining how they personally distinguish between support such as organising work, as opposed to managing work. Further data would be needed to better understand how designers define the personal aspects of their creative process.

5.5 Discussion and Outcomes

5.5.1 Summary of insights

The following insights were drawn from the diary study data:

- Information was of high importance to participants when working on creative tasks. Often a lack of information (e.g. data, references, or expert knowledge) was the primary barrier to completing creative tasks.
- In many cases participants wanted to get information conversationally from colleagues. They often wanted feedback or opinions on their work from people with different viewpoints.
- Participants wanted to share creative work with collaborators, but the degree to which they were happy to concede agency or initiative over a creative task to a collaborator was unpredictable.
- In general, participants were happiest to receive support for task-based requirements, rather than requirements which might relate to their personal working methods or approaches.
- Overall, participants expressed similar attitudes towards creativity support roles, whether they were performed by a human or an AI system.

5.5.2 Limitations

This study was carried exclusively with a group of employees at Google. Although the Diary Study method provided some depth to the results through the use of regular data collection with a consistent set of participants, there were still several limitations to the study which were considered in the analysis, and where possible addressed in later stages of the research.

First, the size of the sample was limited to 30 participants, which provided a range of opinions, but meant it was not possible to draw the kind of statistical conclusions a larger scale study might afford.

Second, the participants were all employees of the same company, albeit a very large company with participants in multiple countries across Europe and the USA. It's likely therefore that the culture and processes of the company, or the general nature of the work they were undertaking, may have led to biases or limitations in the scope of their responses. For example, it could be that the employees of a technology company have a more positive attitude towards technology than creatives in the general population. The conclusions from this study therefore required testing with a separate set of participants from outside of Google in order to check their applicability to other contexts.

Third, the diary study method allowed for regular data collection, with participants normally reflecting on their creativity support needs within one or two days of the requirements occurring. This provided fairly recent reflections, but it may have been helpful to have more in-the-moment reporting of their needs. A method that encouraged participants to discuss their creative tasks and requirements as they occurred could have provided more detailed insights and the ability to follow up on points raised by the participants. This was later addressed in the final study of the research.

Whilst acknowledging these limitations, the study still provided a number of insights that had the potential to help support future research and development in the area of AI-CST. The insights were therefore summarised as a proposed framework of factors that could be used to help define the creativity support needs of designers. This framework is presented below, and went on to be tested further in subsequent stages of the research detailed in chapters 7 to 9.

5.5.3 A Creativity Support Framework

In response to the aims of the study to define the types of task for which designers most often require support, and where the use of AI enabled support tools may be most appropriate, participants' responses across all parts of the survey were analysed and summarised. Through this, a proposed Creativity Support Framework was created which defines the three important factors raised by participants in their discussion of creativity support and AI. These are *Categories*, *Confines*, and *Competencies*.

5.5.4 Categories of Creativity Support

Three primary categories of creativity support were identified: *Information*, *Generation*, and *Situation*.

Support Category	Description
Information	Support for obtaining relevant information resources relating to the creative task, such as data, references, examples, and feedback.
Generation	Support for transforming ideas into finished creative outcomes, and the production work associated with the creative task.
Situation	Support for creating the right conditions for working effectively and productively on a creative task.

Table 5.11: Proposed categories of creativity support, in order of participant preference.

Within this study, *Information* was the most requested type of support, followed by *Generation*, then *Situation* (Table 5.11). All the different types of support requested by participants throughout the study can be mapped to these three categories. This ranking also reflects the participants’ preference for AI support, with the study data showing that participants were most happy with AI providing Information-related support, and least happy with it providing support related to their personal Situation.

There are some similarities between these proposed categories, and the creative competencies presented by Epstein, Schmidt and Warfel (2008). For example, the *Information* category corresponds largely with the *Broadening* competency. However, on the basis of this study, the three categories of Information, Generation, and Situation more effectively capture the types of creative support requested by participants, and therefore the different forms of support which would need to be exhibited by an AI creative collaborator.

These categories could be used to identify and plan the types of support provided by AI-CST, and may help in the development and testing of these systems. The categories can also be combined with the Confines element of our proposed framework in order to define more specific creativity support requirements.

5.5.5 Confines of Creativity Support

	Information	**Generation**	**Situation**
Task Support	• Project data • Examples • References • Simulation	• Automation • Visualisation • Auto-completion	• Organisation • Scheduling • Resource preparation
Personal Support	• Opinions • Feedback • Viewpoints • Predictions	• Conceptualisation • Sketching • Brainstorming	• Motivation • Focus • Prioritisation

Figure 5.2: Visualisation of the Confines element of the Creativity Support Framework. Examples of types of creativity support are given for each of the three Categories (Information, Generation, Situation). These examples are divided into Task Support and Personal Support. The dividing line between Task and Personal would be different for each individual.

The data from the diary study demonstrated that there was some complexity related to how participants defined ‘personal’ forms of support, in other words support that related more to their personal approaches to work and organisation. The perception of how personal a form of support might be affected whether a participant was likely to accept help in this area - particularly from an AI system.

The data suggested that there was a difference between support that was perceived as task-focused (e.g. suggesting useful references for a particular task) and support which was perceived as personal (e.g. setting goals or targets). While task-focused support was readily accepted, activities which intruded within the confines of a participant's personal creative practice were more likely to be rejected.

As the perception of what constitutes a personal form of support is subjective, the positioning of the boundary between task-focused and personal support appears to be specific to individuals, and not easily predicted.

Figure 5.2 provides general examples of the distinction between task-focused and personal support, mapped against the categories for support. In each case the personal activities involve communication with other people, or impact an individual's personal approach to creativity. While figure 5.2 gives general examples, the line between task-focused and personal is not fixed, but needs to be established for each person. For example, in this study, 'resource preparation', e.g. setting up tools and materials ready for a person to start their creative work on a task, was sometimes viewed as practical, task-focused support, but viewed by others as an undesirable form of personal support.

Finding ways of establishing where an individual draws the line between task-focused and personal creative activities could be an important step in setting up effective AI creative collaborators. Understanding this boundary could also help determine where on the spectrum of agency and initiative (Deterding *et al.,* 2017) a particular support system should be placed.

5.5.6 Competencies for Creativity Support

The final element of the proposed Creativity Support Framework addresses the abilities and knowledge required by a creative collaborator. This stems from the observation in the study that while participants often wanted specialist help from a collaborator who had information or skills that they did not have, they also frequently wanted help from someone who had the exact same skills or knowledge as themselves, either to act as a second pair of eyes on their creative work, or to complete tasks that they were capable, but unwilling, to complete themselves.

	Similarity	**Difference**
Knowledge	Knows what I know	Knows what I **don't** know
Ability	Does what I do	Does what I **can't** do

Table 5.12: The Competency Matrix for the Creativity Support Framework showing the types of knowledge and ability required by a creative collaborator, in relation to the designer's own knowledge and ability.

Creativity Support Tools already help users perform tasks which are beyond their own skills or knowledge - for example, photo software that allows users to edit images with more speed, accuracy than a person could perform themselves. However, the ability of a CST to replicate the existing knowledge and ability of a designer offers a different set of functionality, which is more unique to the abilities of AI-CST.

An AI-CST that was able to learn and reproduce the knowledge or skills of a designer could theoretically offer functionality such as finishing off incomplete design work, reproducing work in the designer's own style, or completing mundane or repetitive tasks to the same standard as the designer. These were all types of support requested by participants during the study.

The potential for AI tools to reproduce and automate elements of a designer's own creative practice could have practical benefits, but would also require a better understanding of designers' attitudes towards having their style learnt and copied, particularly as this would be likely to fall within the forms of personal support for which participants indicated mixed support.

The Competency Matrix shown in Table 5.12 defines the different combinations of knowledge and skills AI tools could demonstrate in relation to a user's own knowledge and skills. Defining the desired type of support through the use of this matrix could provide a means of better configuring creativity support for designers, particularly with AI-based tools.

5.6 Next Steps

The study revealed several insights related to the creativity support needs of the participants, particularly in relation to the potential support opportunities provided by AI tools. The proposed Creativity Support Framework summarises these insights, and may provide a resource for defining and addressing the creativity support needs of designers in future AI-CST development. Testing this framework with participants from outside of the Google organisation forms the basis for the Digital Probe Study, which is detailed in chapters 7 to 9. Before the Digital Probe Study took place, the Persona Cards and outcomes from the Google Diary Study were presented and tested further in a workshop at the ACM Creativity and Cognition Conference 2022. This workshop provided some further insights related to the Creativity Support Framework, which are detailed in the next chapter.

Chapter 6 Reorientation

6.1 Introduction

Following the Google Diary Study, and prior to the final Digital Probe Study, I had the opportunity to reflect on the findings to date and reevaluate certain elements of the research before continuing with the final study. This reflection and reorientation was aided by the experience of running a conference workshop at the ACM Creativity and Cognition Conference 2022. The workshop activities were based in part on the Persona Cards developed after the Survey Study, a version of which was used during the Google Diary Study. The conference workshop offered the opportunity to test the physical version of the persona cards in face-to-face activities. It also created a valuable forum for discussing the research to date with other academics, which provided insights and reflections which reorientated some of the research plans. This chapter briefly summarises the workshop discussion, and details the changes to research plan.

6.2 Conference Workshop Summary

The workshop was titled "Augmenting Personal Creativity with Artificial Intelligence". Further details of the workshop design and structure can be found in the conference proceedings (Main *et al.,* 2022), with an overview being presented here.

6.2.1 Workshop Structure

The overall aim was to facilitate discussions with other academics working in related fields, on the topic of how AI might support or enhance existing forms of personal creative practice. To incorporate a wide range of views in this discussion, including those of participants without knowledge of the latest technologies whose voices may otherwise be missing from AI discussions, workshop activities were run both before and during the conference, which introduced participants to generative AI tools and enabled them to explore ways of using them creatively in their work.

The themes and activities of the workshop were influenced by the observations from the existing studies (the Survey Study, and the Google Diary Study), as well as teaching that I had previously designed and delivered based on the themes of the research (ibid). Three broad themes were identified for discussion:

AI Collaboration

This topic was focused on the role that AI might play as a potential creative collaborator. This drew on the research and analysis presented in the Literature Review (Chapter 2) and the questions which led to the development of the Persona Cards (section 4.7.1). The aim was to use the Persona Cards to discuss whether broad roles of this sort, based on human archetypes, were suitable or desirable for creative practitioners, and how creative work might be shared with AI systems.

Serendipity

In the context of creativity support, the tendency of AI tools to generate unexpected or ambiguous outcomes could be treated as a benefit, as it could help designers achieve the ‘novelty’ part of novelty and value by guiding them to unexpected ideas, unconventional responses, or surprising juxtapositions. This was particularly relevant at the time of the workshop, as the tools which were freely available, for example Runway ML (Runway, 2024), DALL-E Mini (Dayma, 2022), and GPT-J-6B (Wang, 2021), were only capable of generating images and text of limited quality and accuracy. The theme of Serendipity therefore allowed these limitations to be explored in a practical way.

Creative Reflection

This theme explored the idea that the practicalities of the ML workflow could offer creatives unique opportunities for maintaining reflective practice, regardless of how the outcomes of the model are used. Two areas of the ML workflow were explored. The first was the training process, and the creative reflection involved in drawing together a large training data set. The second involved analysing the generated outcomes and identifying the ways in which an individual's creative style is reflected in the AI images.

Four activities were planned to facilitate discussion.

- **Pre-workshop Online Primer**
  A webinar held six weeks before the conference workshop introduced the main themes, and provided training videos for several free AI tools which participants could use to gain hands-on experience of creative AI processes before the workshop. The tools covered in the primer were GPT-J-6B for text generation (Wang, 2021), Runway ML Lab for text and image generation and model training (Runway, 2024), VQGAN+CLIP for image generation with minor training (John, 2021), and Wombo, for simple image generation (wombo.ai, 2022)

- **One Minute Sculptures**
  An ice-breaking activity at the beginning of the conference workshop. Inspired by the One Minute Sculptures of artist Erwin Wurm (Wurm,1997), participants were asked to stage quick, improvised sculptural arrangements using everyday objects and themselves. After creating their own sculptures they then used the GPT-J-6B text generator to create some instructions for a new sculpture. They then compared the AI inspired sculptures with their own.

- **Cut Ups**
  This activity was inspired in part by the Cut Up method of poetry generation, as well as aleatoric and Dadaist methods of collage and creative composition. Participants were provided with AI generated text which had been trained on a combination of their own writing. They then responded to various writing prompts by cutting up and arranging the text, whilst also considering how their own writing may have influenced the text

- **Ideal Collaborators**

The final activity invited participants to discuss the role that AI might play in creative practice, and the type of collaboration they would ideally like to establish with AI. The activity used the eight collaborative persona cards designed after the Survey Study (Chapter 4), and used within the Google Diary Study (Chapter 5). Participants worked in groups to rank their preferred collaborators on the cards, and then created a new card with an ideal collaborator who represented types of support not covered in the existing cards.

The workshop was open to all attendees of the Creativity and Cognition conference. The workshop subject and primer session were advertised through social media and academic networks. Eight participants enrolled, all with academic backgrounds related to creativity research and practice. All participants attended in person on the day of the workshop. I was unable to attend in person due to having caught COVID-19 in the week prior to the workshop, so ran the session remotely via video, with conference staff facilitating in person.

6.2.2 Workshop Outcomes

Figure 6.1: Three images from the One Minute Sculpture task, showing improvised balloon sculptures created by the participants, inspired by AI generated images.

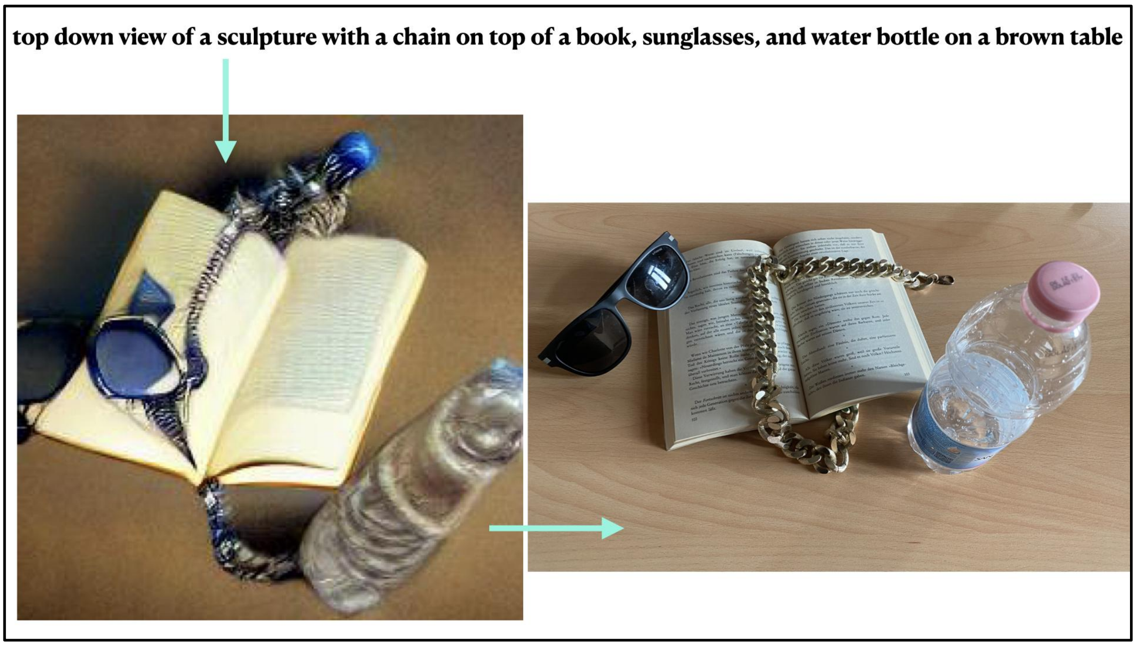

Figure 6.2: Participants' documentation of the One Minute Sculpture task.

A slide showing how their outcome moved from a text prompt, to an AI generated image, to a physical sculpture based on the generated image.

Each of the workshop activities facilitated useful discussion within the group about attitudes towards, and opportunities for creativity support with AI. In terms of reorientating the research, discussions that related to the One Minute Sculpture Task and Ideal Collaborator Task provided the most valuable insights.

The One Minute Sculpture task provoked conversations about the ability of AI to provide unexpected perspectives on creative tasks. In the workshop this usually occurred because the AI mistakenly suggested something that was seemingly impossible or based on a misunderstanding of the context. Within the creative task however, these mistakes inspired novel directions for the outcome.

For example, an instruction from AI to create an impossible 'infinite image' prompted one group towards a more imaginative outcome for their sculpture, involving using the workshop webcam and screen to create a recursive video effect.

> “[The GPT-J instruction] talks a lot about an ‘infinite sculpture’, and so that got us into thinking about this sort of recursive imagery, and we spent some time trying to get our little balloon sculpture onto the screen”. (Activity 1, Group 2)

Another group had chosen to use bananas in their sculpture, and reported that they were surprised when the AI generator instructed them to peel the bananas first. They hadn’t intended to use the bananas in this way, as they were treating them as whole objects. The instruction, perhaps inspired more by recipe data, led the group in a new creative direction for their work.

In another instance, the AI generated an image of a ballon sculpture for the group to recreate, but due to a misunderstanding of the text prompt, depicted the balloons made of transparent glass. This impossible for the group to recreate in the workshop, but did inspire them to plan a glass sculpture using local Venetian glass crafts.

These small examples of erroneous or surprising suggestions from the AI inspiring novel creative outcomes for the groups, prompted discussion about the value of having a radically different, non-human perspective on creative tasks. Although in this case the points of inspiration may be viewed as mistakes, the fact that they represent a different way of seeing or doing which may not naturally occur to human collaborator could be valuable in a creative project.

The possibility for AI to provide surprising perspectives on creative tasks was discussed further during the Ideal Collaborators task.

When the groups were asked to rank the Persona Cards, the most popular card with each group was the Wildcard persona (“Regularly brings surprising new outlooks and approaches to their work. Takes concepts in interesting and unpredictable directions.”). This was mentioned by each of the four groups as forming the basis for the new ideal collaborators they were designing.

Group 2 created a variant of the Wildcard persona that was specifically aimed at taking an idea from a human collaborator and making them, in their words, more “crazy”, as a way of inspiring further development. Group 1 also created a variant of the Wildcard persona, but combined this with the Guru persona to create Wildcard-Guru as their ideal creative collaborator. The rationale for this was that they discussed each of the eight cards and recognised that an ideal collaborator would depend on the individual. They felt that each person would require a set of skills that complimented their own, and therefore it was hard to create one perfect collaborator. However, in combining the Wildcard and Guru personas, their intention was to make a persona that covered the most important factors in a creative collaborator for most situations.

THE WILDCARD GURU

GPT-3 says: “A guru knows everything.
A wildcard has endless ideas.
A wildcard-guru is a person who has a lot of knowledge and is very creative.”

The Wildcard Guru is a creative collaborator that pushes you towards new unexpected directions that make sense since he is an expert in his field. He is a perfect advisor, mentor and creative inspiration.
He will generate new surprising outlooks that are well thought ought as he is really knowledgeable in his field. Will also be of help as one seeks for help during the implementation stage.

Figure 6.3*: “The Wildcard Guru” - Participants’ proposal for an ideal collaborator*

Group 3 also incorporated the Wildcard persona in their ideal collaborator, but applied a different concept to it. They reflected that an ideal AI collaborator did not have to be based on human-centric concepts of roles and personas. They therefore attempted to create non-human personas as their ideal collaborators, looking to the natural world rather than the technological world for inspiration.

They first proposed a Rhizome as a perfect creative collaborator. This was based on the observation that what was missing from the current personas was a “meaning maker” role, which could make connections between information and ideas, and help make sense of concepts. The second proposed non-human collaborator from this group was a Possum. This was suggested as it represented marginalised and subversive viewpoints. This was inspired by Australian possums, which the group characterised as animals that are sidelined in the urban environment, yet possessing unique skills such as enhanced night vision.

They described the possum as having “night vision not day vision” and that it therefore represented “‘other’ needs”. They believed it could strengthen creative practice by “providing another perspective, e.g. asking questions that bias towards a different norm”. While this imagined persona reflects some elements of the Wildcard persona, the focus on non-human references provides a more critical view on the role of AI, and creates the potential for more creative approaches to the collaboration concept.

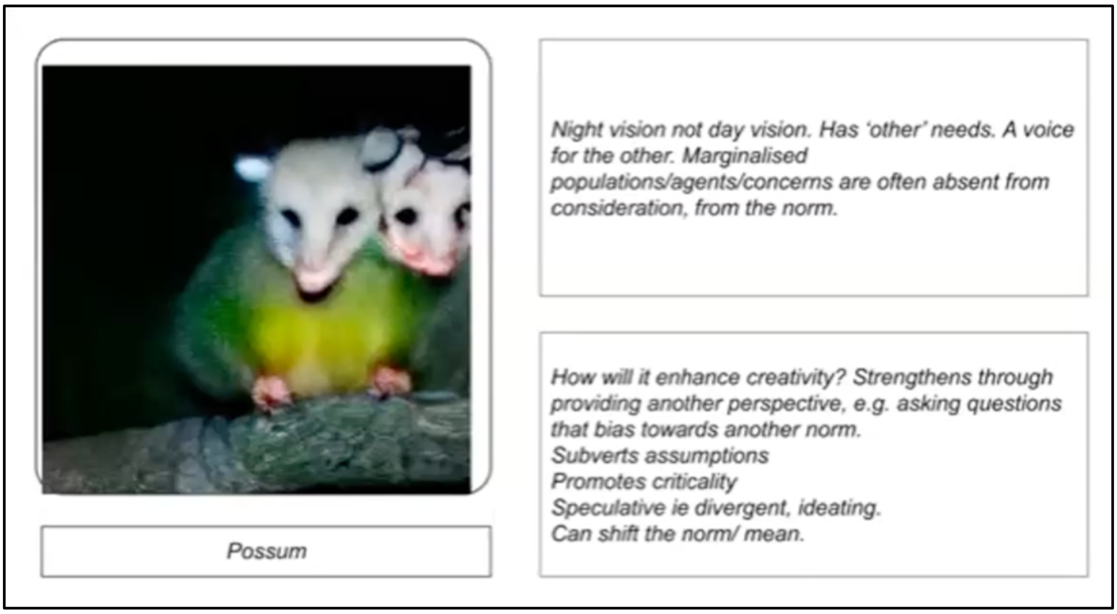

Figure 6.4: “Possum” - Participants’ proposal for an ideal collaborator

Through discussion of both the One Minute Sculpture task and the Ideal Collaborators task, the common observation was there was some creative value in the alternative and surprising perspective offered by AI. Even though this value was initiated by mistakes and limitations in the technology, and ultimately relied on the creative response to these mistakes by the groups, the flawed but unexpected perspective of the AI did help support creativity.

This approach to the AI acknowledges and leverages its non-human nature, and its ability to produce outcomes that from a human perspective may be unusual or counterintuitive. This is potentially at odds with the overtly human-centric framing of the potential AI support roles depicted on the Persona Cards, and within the language of the role descriptions. This issue prompted part of the reorientation of the research plan in the final study.

6.3 Conclusions

The reflections on the human-centric nature of the Persona Cards discussed in the conference workshop were also relevant to the insights related to language which were discussed in the Google Diary Study (Section 5.4), and the Survey Study (Section 4.6.1).

These sections note that the specific terminology used in the wording of descriptions of AI support may have a significant impact on designers' attitudes towards accepting the support. The results from the Google Diary Study in particular highlighted that terms that were associated with existing human roles and support types, such as the Studio Assistant and Curator terms in the Persona Cards, may have negatively impacted participants' attitudes towards chosing an AI to perform those roles.

Reflecting on the combined issues of human-centricity and over-specificity of language in the Persona Cards led to a revaluation of the value of the cards as research method, and a reorientation of the research plan as conceived at the Survey Study stage (Section 4.7).

While the creative competencies and categories represented by the Persona Cards are valuable, and helped analyse and categorise participants' responses in the Google Diary Study, the persona illustrations and descriptions themselves appear to be less helpful for eliciting reliable data about attitudes towards AI support. They may unnecessarily limit participants responses to forms of support associated with existing human characteristics, rather than considering the full opportunities, or weaknesses, of AI-based support.

The cards were originally designed to be used as part of facilitated workshops at a time when the development of AI-based creativity support tools was limited. At that time, positioning AI as a possible collaborator in a creative project was a relatively novel and thought-provoking provocation for discussing potential future roles for AI, as part of discursive, researcher-led workshop.

At this stage of the research, however, generative AI tools were becoming available to designers, and it was therefore less necessary to use the framing of an AI fulfilling the role of a human collaborator to initiate reflection on AI playing a part in the creative process. In addition, as the research methods had changed from in-person sessions, to regular asynchronous online data collection, the need to clearly communicate the options to participants without facilitation or discussion required a simplification of the language.

6.4 Next Steps

The reflections on language, and human-centric characterisations of AI support at this stage of the research prompted a reorientation away from the use of Persona Cards in their current form.

In the final study of the research, the data collection method would be amended to retain the categories represented by the Persona Cards, and the types of support included in the Creativity Support Framework, but the description and characterisations of the personas themselves would be reduced and changed with the aim of avoiding some of the limitations discussed in this chapter.

The redesign of the data collection method is discussed further in Chapter 7.

Chapter 7 Digital Probe Study: Device Design

7.1 Introduction

The analysis of data from the Google Diary Study, combined with observations from the Creativity and Cognition conference workshop, resulted in the following insights which will be investigated further in the final study.

- Support requirements for people working on creative tasks can be divided into three categories: Information, Generation, and Situation.
- Of these, Information-related support is most frequently required, and Situation-related support the least frequently desired.
- People working on creative tasks expressed willingness to allow AI to extend or complete tasks based on their existing work.
- Individuals have personal preferences relating to which creative activities they consider personal to them, and which they consider task-focused. This distinction has an impact on the level of support they are prepared to accept for the activity.
- The knowledge and ability of a creative collaborator can be defined in terms of similarity and difference from the individual. These qualities change depending on the individual and task.
- Framing AI collaborators as single human roles (e.g. 'Studio Assistant' or 'Curator') might restrict the type of support users expect to receive.

7.2 Aims

The final study aimed to investigate these observations further by testing them with participants from a different population outside of the Google organisation. A potential issue with drawing conclusions from the previous study was that, as all participants worked within Google, their creative priorities and methods of work may have been influenced by company culture or policy. This could limit how far conclusions from that study could be applied to a broader population.

Therefore, the final study aimed to conduct research with a second group of participants working in similar design-related roles but from different parts of the industry.

In order to enable a comparative analysis with the Google Diary Study (Chapter 5), the current study was designed to align to a similar format and method. A short longitudinal study would be repeated, with participants asked to report on specific occasions in their daily work when they might benefit from creative support. Additionally, further questions would be included which related specifically to the conclusions drawn in the Google Diary Study, allowing further data to be captured to test these results with a different set of participants.

These were the primary research aims of the study. In planning the research methodology required to meet these aims, a secondary set of aims emerged related to the methods of data collection required.

7.3 Methodological Considerations

An online diary study was chosen as the method for the Google Diary Study for two reasons: it provided a convenient and low-commitment way for participants to contribute to the study repeatedly over four weeks, and it meant that the study could be completed in multiple locations without being impacted by COVID-19 lockdown restrictions, which were in place at the time.

As noted previously, one potential drawback of the diary study was that participants were retrospectively reporting on their creativity support needs, recalling tasks they had completed earlier in the day or even on a previous day. This potentially meant that finer details about the support needs or less significant opportunities for support may not have been recalled by participants. To address this, the final study aimed to provide a method of allowing participants to submit responses on a continuous basis, whenever they were in need of creative support.

Ethnographic methods such as active or passive participant observation or ‘thinking aloud’ techniques (Robson, 2024) could have offered suitable approaches for this study, as they enable observation of participant requirements as they occur and also allow researchers to follow up with appropriate questions to expand the detail.

However, the high time commitment and engagement required by these forms of personal observation meant that the study could only realistically take place over short, focused periods of days rather than weeks. This would have reduced the scope of the study and reduced the potential range of creative activities observed for each participant. One of the observations of the Google study was that participants were engaged in varying types of creative work, with varying types of support needs over the four weeks of the study. Taking a snapshot of requirements on individual days would, therefore, not reveal the breadth of requirements for each participant.

Further to this, the ongoing restrictions of the COVID-19 pandemic made planning any type of face-to-face research activities difficult, as local travel and social distancing rules were subject to regular and short notice change at the time the study was being planned.

The intention, therefore, was to identify a data collection method which had the convenience of the digital diary study but which offered the real-time access and engagement of face-to-face research methods. A possible solution presented itself in the form of embedded AI technology, which is the subject of this research.

7.4 AI Assistant Tools

In the initial stages of the PhD placement with Google, the team was working with a product called AIY Kits (Google, 2024b) which later developed into Google Coral (Google, 2020). The initial AIY Kits were marketed as “Do It Yourself Artificial Intelligence” (Google, 2024b) for prototypers and hobbyists. They were produced in a “Voice” and “Vision” version. The Vision Kit allowed users to create customizable and programmable computer vision devices, while the Voice Kit could be used to create custom voice assistant devices. The kits were based on a Raspberry Pi Zero Single Board Computer, with the addition of a proprietary extension board (‘HAT’ or ‘bonnet’), which enabled certain machine learning tasks to be performed on the device without the need to access cloud-based AI services.

During the Google placements for this PhD, the Google team expressed an interest in the potential for AIY Kits, or similar embedded and personal AI devices, to be used as CST. The relatively limited functionality of the AIY Kits at that time restricted their ability to play an active part in the creative process, with their functionality focused on voice and object detection rather than media generation.

However, at the time of the final study, the voice assistant functionality offered by the AIY Voice Kit demonstrated that it might be possible to create a custom embedded AI voice device which performed some of the same data collection roles of an embedded human researcher - being present with the participant to observe and record activities as they occur, and able to prompt participants with context-specific questions. This suggested the possibility of using the technology to develop a research tool for Digital Ethnography.

7.5 Digital Ethnography Tools

The field of Digital Ethnography has grown significantly over the last decade as an approach to ethnography mediated by digital technology (Murthy, 2011). As with the related fields of Virtual Ethnography or Cyber Ethnography, Digital Ethnography is often used in order to study people's behaviour within online or digital environments, such as video games or social media platforms. It utilises digital methods of data collection within digital spaces, often leveraging features of a new technology in order to facilitate research related to its use.

Digital Ethnography, however, is not limited to studying purely digital activities and can also refer to digital methods of data collection being used within non-digital, offline spaces and activities, where researchers are "often in mediated contact with participants, rather than in direct presence" (Pink *et al.,* 2016, p.3). Digital Ethnographic methods often acknowledge that digital activities are embedded and embodied in physical environments and conversely that physical activities and behaviours are often supported, directly or indirectly, by some means of digital interaction (Hine, 2016).

The relative ubiquity of digital technologies within many contexts of study makes digital methods of data collection, such as digital surveys, online chat, and video recording, convenient and accessible approaches to engaging with participants. Several commercial organisations provide tools for digital ethnography, for example, Sago produces QualMobile (Sago, 2024), a mobile app that allows researchers to engage participants in the course of their normal activities using a range of different data collection techniques via their own phones. The company Indeemo markets a system which allows participants to record reflective journal-style responses in an interface similar to Instagram (Indeemo, 2024).

These commercial systems are advertised as being particularly suited to user experience research and product testing. Using digital devices as a means for researching activities that occur on digital devices could facilitate spontaneous data collection that enables reflection in action. However, using only virtual methods of engagement may not always provide the best methods of capturing participant responses. Pink *et al*. discuss the concept of "non-digital-centric-ness" within Digital Ethnography, noting a principle from media studies that “studying media in a way that always puts media at the centre of analysis would be problematic because it would pay too little attention to the ways in which media are part of wider sets of environments and relations” (Pink *et al.,* 2016, p.9).

7.6 Digital Research Probes

As discussed in Chapter 3, Digital Research Probes provide the opportunity to leverage some of the benefits of online digital ethnographic tools, combined with the physical presence and interactions seen in other probe methods such as Cultural Probes. The concept of combining probe devices with the type of embedded AI technology represented by the AIY devices, also suggested some specific opportunities for data collection. It offered the possibility of not just prompting participants with pre-set questions, but potentially, through the aid of voice or image detection, entering into a dialogue in which context-specific prompts or follow-up questions could be posed. An interactive probe of this sort also has conceptual similarities to the subject of the research, which could afford opportunities for using research devices to test participant attitudes towards embedded AI assistants and virtual agents.

7.7 Privacy and Ethics

There are clear privacy and ethics considerations to providing research participants with digital research probes which they keep in their workspace and which may record data such as audio or video. There is a risk that data may be recorded which is not directly related to the research, and that impinges on participant's privacy. This risk was increased by the context of the COVID-19 pandemic, which led to more home-working and a higher likelihood that the professional creative tasks being studied might take place in a private environment.

These risks are not unique to this project, and can be seen as a growing issue for research practices which involve recording using digital sensors. This includes cameras and microphones, but could also relate to other environmental sensors such as motion sensors, presence sensors, and proximity sensors. These kinds of sensors are common built-in features on the type of embedded AI tools that might be used to create digital research probes. For example, the Arduino Nicla Voice (Arduino, 2024b), Arduino Nicla Vision (Arduino, 2024a), Adafruit EdgeBadge (Adafruit, 2024a), and SparkFun QuickLogic Thing Plus (SparkFun, 2024b), are all embedded AI devices which also contain environmental sensors as well as microphones or cameras.

While these features make the devices potentially useful for creating ethnographic research tools which capture and respond to context-specific data from participants, they also make them potential surveillance devices, able to capture a rich range of data that could reveal information about participant's habits, movements, and behaviours, as well as those of other people who share their space. This a particular consideration for AI-enabled digital research probes, as they may be designed to operate near-continuously in a study location and may require constant monitoring of sensor data in order to recognise a significant event that needs recording - for example, processing microphone data waiting for a wake-word for voice interaction, or capturing camera data waiting for a specific object or movement. In the context of a research study, it is important to identify and mitigate these risks for several reasons.

First, because protecting privacy forms part of the researcher's basic ethical duty towards the participants. Researchers should ensure that only information relating directly to the specific study with the individual participant should be recorded or processed, and this would be monitored through any ethics approval process. Participants would need to consent to specific data being part of the study, and steps would need to be taken to make sure the technology did not record any extraneous data, or data relating to non-participants. In the case of digital research probes using embedded AI devices, this would require creating strict controls over how and when the digital sensors recorded data.

Second, the ethical considerations relating to data collection are also reflected in legislation such as GPDR in Europe (Regulation (EU) 2016/679), or the UK DPA (*Data Protection Act 2018*). These laws cover how the personal information of individuals should be stored and processed, and similar to the ethical approval process, set controls on capturing personally identifiable information and only capturing necessary data. Research using ambient digital recording devices could contravene this legislation unless specific controls were put in place. In addition, to maintain complete control over how data is processed and to ensure that participants' data is kept secure, any research device would need to store and process data locally, rather than share it with third-party platforms or services. This is potentially an issue with AI functionality, where cloud-based processing is common. However, with embedded AI applications, where processing is designed to happen on-device, these risks may be reduced.

Third, in order to maintain trust and engagement with participants, they must be confident in their understanding and control over how the research devices are sensing them and what data is being recorded or shared. As the digital research probes are designed to be placed in the participant's personal space and kept active for extended periods of time, participants may have understandable concerns or questions about how they are being monitored. Being able to share detailed information about how data is captured, and what privacy controls are in place, may increase participant confidence in making the decision to consent to the study, and support their active engagement in the research.

7.8 Research Design Requirements

As stated in section 7.2, the primary purpose of the probe device was to collect similar data to the Google Diary Study over a multi-week period, with a different cohort of participants. In addition to this, a set of privacy and security aims were introduced, for the reasons described in section 7.7. This led to the series of design requirements for the device stated below:

To meet the aim of providing enhanced privacy and security for the participant, the probe device needed to:

- Allow participants complete control over how and when they are observed by the device
- Store recorded data securely on the local device
- Operate without sharing data with online services or platforms

To meet the aim of carrying out a multiweek study, similar to the Google Diary Study, with a new set of participants, the probe device needed to:

- Be deployed for a period of up to one month
- Require minimal setup and maintenance by participants
- Regularly ask participants a short series of questions relating to their current work
- Remind participants to respond to questions on a regular basis
- Be able to be assembled from easily available and inexpensive components and materials

This last requirement was an important consideration to make it feasible to assemble several devices for the study, and also to make it possible for other researchers to reproduce the same kinds of devices if they proved useful as research tools. As with ProbeTools, designing the tools so they could become reproducible, customisable kits, makes it possible for any methodological insights gained in the study to be shared directly with other researchers.

The next section will describe the design process to develop a digital research probe to meet these requirements, as well as the design of the study itself.

7.9 Research Aims - Testing Collaborators

In the initial plans for the final study, the intention was to keep the design of the investigation largely aligned with the format of the Google Diary Study (Chapter 5). This meant asking a short series of questions related to specific instances where participants had required support with a creative task, capturing details about the nature of the task, the type of support required, and the type of creative collaborator who could best support the task.

Focussing on the nature of a potential collaborator was a priority in the design of that study. This was due in part to Google's interest in the persona cards that had been designed in relation to Epstein's Creative Competencies (Epstein and Phan, 2012), and their desire to test them in a research study.

Early designs for the digital research probe for the final study included functionality for participants to select and discuss their ideal collaborator using the same range of persona cards as the Google Diary Study. Examples of these designs are discussed below. However, following further analysis of the data from the Google study, and considering feedback gathered from the Creativity and Cognition Conference Workshop (Chapter 6), where the cards were tested with participants, the focus on specific collaborator personas within the study design was reduced.

When the persona cards were designed, the intention was to create roles for imaginary creative collaborators which could act as shorthand for the types of competency defined by Epstein. However, by this stage of the research it was recognised that those shorthand personas could be unhelpfully reductive, and worse, may actually be limiting the responses of participants. This was seen during the Google Diary Study (Chapter [6]) in relation to participants differing responses to personas that had names which clearly correspond with human job roles (i.e. 'Curator' and 'Studio Assistant'). It was also seen in the responses to the Creativity and Cognition Conference Workshop where participants highlighted a preference for non-human metaphors to be used in relation to AI.

The issues with aligning creativity support roles too closely with existing job types, combined with the critical approach to non-human roles discussed at the conference workshop, led to the personas being re-evaluated for the final study. During the development of the study it was decided to not use the specific personas represented by the persona cards, and instead base questions around the values and competencies that the personas represented. This would allow the same qualities to be investigated, without constraining responses by linking them to real-life job roles.

7.10 Device Design - Hardware

In order to identify suitable hardware to enable the functionality required by the digital research probe, an analysis of current devices and equipment available on the market was completed. From the design requirements outlined above, four were of particular relevance to the hardware designs:

- Allow participants complete control over how and when they are observed by the device
- Store recorded data securely on the local device
- Operate without sharing data with online services or platforms
- Be able to be assembled from easily available and inexpensive components and materials

The requirement for the device to operate offline, processing and storing any collected data locally on the device, was important to mitigate any privacy and data protection issues. However, it meant that any voice AI functionality used for capturing data, such as speech recognition or speech-to-text, would need to run on the device without connecting to cloud-based services. This limited the potential range of equipment that could be used to create the device. The device would need to utilise an embedded AI development board, which could run machine learning functionality, such as voice AI features.

The first hardware considered was the AIY Voice Kits produced by Google, which were available through the placement with them. The Voice Kit is designed as a customisable device with a microphone and speaker, which can be programmed to act as a Voice Assistant or perform other voice functions using a natural language processor. The hardware consists of a Raspberry Pi Zero single-board computer, with a proprietary Voice Bonnet (a custom hardware add-on) which facilitates the capture and processing of sound data. Initially, this kit seemed the ideal solution for creating a custom voice-enabled research probe, which could be adapted to suit the specific form and function needed for the study.

However, after testing the functionality of the device, it was found that the kit was designed for all voice recognition to be handled online by Google's cloud-based Voice Assistant service. While the camera-based AIY Vision Kit contains a Vision Processing Unit which can run ML code locally, the Voice Bonnet only provides microphones, speaker connections, and an audio processing unit for capturing sound data rather than performing ML analysis on it.

Relying on Google's online cloud service would mean that any data captured by the device would automatically be sent to Google servers for processing. This would have made it necessary for all data capture to be subject to Google's terms of service, and the automatic sharing of sound recordings via the Internet may have made it much harder to assure participants about the security of their personal data.

As the AIY Voice Kit is based on a Raspberry Pi single-board computer, it was possible to carry out basic voice recognition on this device without relying on any hardware acceleration of the Machine Learning processes. Several voice recognition models existed at this time that could be run on a Raspberry Pi device to provide simple voice analysis functionality (these are discussed further in section 7.11).

However, if the digital research probe was to use a Raspberry Pi to perform voice recognition and only use the Google Voice Bonnet to provide microphone and speaker functionality, then there were other hardware accessories available which would provide the same abilities without being proprietary to Google, and for less cost. The Google Voice Bonnet was therefore discounted for this study, and other hardware tested.

The Seeed Studio ReSpeaker 4-Mic Array (Seeed Studio, 2023c) and ReSpeaker 2-Mic Pi Hat (Seeed Studio, 2023b), and the Adafruit Voice Bonnet (Adafruit, 2024b), are all hardware add-ons for Raspberry Pi boards which provide similar voice capture and playback capabilities as the Google Voice Bonnet. Each contains multiple microphones optimised for capturing voice, as well as an audio processor. The ReSpeaker 2-Mic Pi Hat and the Adafruit Voice Bonnet also contain physical interfaces for connecting speakers or headphones.

The extra microphones on the ReSpeaker 4-Mic Array make it particularly suited for capturing voice commands at a distance - for example, from across a room. However, as the research probe was designed to be used primarily on a desktop next to the participant, this extended range was not necessary. The larger form factor and the lack of speaker interfaces therefore meant the 4-Mic Array was discounted.

The ReSpeaker 2-Mic Pi Hat and Adafruit Voice Bonnet had very similar specifications, also similar to the Google Voice Bonnet from the AIY Kit. In addition to the microphones and speaker interfaces, both boards also contained LEDs, and I2C interfaces for connecting additional hardware such as sensors, displays, or motors. This ability to extend the physical capabilities of the digital research probe was potentially useful, as it might make it possible for participants to respond to prompts using physical interfaces such as buttons, dials, or other custom input methods. The I2C interfaces meant that plug-and-play components and accessories, such as those sold as part of Adafruit's STEMMA range (Adafruit, 2024d), Sparkfun's Qwiic Connect System

(SparkFun, 2024a) or Seeed Studio's Grove Ecosystem (Seeed Studio, 2023a) could easily be added to the probe device, with minimal physical setup or installation.

The convenience of plug-and-play components would make it easier to set up and deploy multiple iterations of the probe devices for this study. It also made it more feasible for other researchers to create and adapt their own versions of the digital research probes, regardless of their technical abilities. This potential to make the digital research probes available to other researchers became an important consideration in the design of the probe, as it offered the opportunity to extend the value of the method design beyond this particular study.

Previous digital probes, such as ProbeTools, had used a similar approach to making their tool kits available for other researchers to use. Where ProbeTools uses custom circuit boards for their devices, however, the intention of this work was to allow similar devices to be made by others using easily accessible, off-the-shelf, plug-and-play components and technologies, which could feasibly be set up and adapted by researchers without advanced knowledge of electronics, and without access to resources such as soldering or electronics prototyping.

Both the Adafruit Voice Bonnet, and the Seeed Studio 2-Mic Pi HAT aligned with this approach, being affordable and easily obtainable from multiple retailers and based on the similarly low-cost and accessible Raspberry Pi system. After testing both devices, it was decided to use the Adafruit Voice Bonnet for several reasons: the setup and configuration of the Adafruit device were slightly easier to achieve, with extensive support and guidance available online; the Voice Bonnet contains multiple I2C connectors, and the range of plug-and-play components compatible with these connectors was larger than the equivalent on the Seeed device; the Voice Bonnet also features a privacy switch which allowed the microphones on the device to be physically deactivated if desired. This attention to privacy was a valuable aspect of the device, which might allow participants to feel more confident about the security of the data collection.

As the device would be operating offline, one additional component that was required was a Real Time Clock (RTC), in order to ensure that recorded data was logged at the correct time and date. This is because the Raspberry Pi does not have an internal battery, and therefore does not preserve the time and date when the power is switched off. Usually, the device would use an internet connection to update the date and time on start-up, but without this connection, a clock component would be required to store the date. The I2C connectors on the Adafruit Voice Bonnet meant that connecting a RTC module was relatively simple. Multiple I2C-based RTC modules are available, offering a range of functions and accuracy in timing. As millisecond accuracy was not required in this study, a simple module was chosen. The Adafruit PCF8523 Real Time Clock Breakout Board (Adafruit, 2024c) was selected due to its low cost and its compatibility with the Voice Bonnet made by the same manufacturer.

The core hardware of the digital research probe was therefore decided as a Raspberry Pi single board computer, coupled with an Adafruit Voice Bonnet, an Adafruit Real Time Clock, a small enclosed speaker, and any additional I2C components which facilitate data capture.

7.11 Device Design - Software

Once a hardware setup had been identified, a suitable software configuration was needed in order to enable the required participant interaction with the digital research probe. The software needed to be compatible with the Raspberry Pi, and support the following core functionality:

- A voice interface to allow participants to speak to the device in order to answer questions
- A means of recording and storing answers spoken by the participants

- A means of programming the interface to control how and when questions are asked, and to allow additional interface hardware such as buttons, screens, or sensors to be added if required.
- The ability for all functionality of the device to happen offline, with no access to online services for the duration of the deployment

The offline requirement was an important factor, not just for the privacy considerations stated above, but also to make the setup and configuration of the device as simple as possible for participants. If an internet connection was required then the participant would need to connect the device to their local Wi-Fi network, and further software and interface design would be needed to enable this. The Wi-Fi setup process would be an extra technical step that participants would need to go through before they could start the study, and any issues with this step would require more support and guidance, and could create a technical barrier to taking part in the study. An offline setup would mean participants could just plug in the device and start using it.

The biggest impact of the offline requirement was in identifying software that would enable voice interfaces without the use of cloud-based services. At the time of development, various applications were available that facilitate voice recognition on the Raspberry Pi, primarily for the purpose of creating voice assistants for home automation. Applications like Google Assistant (Google, 2024b) and Mycroft (MycroftAI, 2023) offered well-established services, but required an internet connection.

There were two systems that could support a more simple offline functionality, Jasper (Jasper, 2024) and Rhasspy (Hansen, 2024). Both these systems were open source, which was a benefit as they were freely accessible and also transparent in terms of how they capture and process voice data.

Through testing, Rhasspy was found to be more fully featured at the time, allowing a range of services such as voice synthesis, audio recording and playback, and voice recognition. It also included multiple well-documented methods of interfacing with the service through a range of APIs including an

HTTP interface for REST commands, command line tools, and a Node-RED interface (OpenJS Foundation, 2024) which provides a visual programming language for creating voice interfaces.

This breadth of programming options meant there was flexibility in how the final interface for the research probe was created. It also meant that the implementation of the device could be easily adapted and developed for future research projects. Rhasspy was therefore selected as the voice interface software for the research probe.

7.12 Device Design - Form and Function

During the development of the digital research probe, various approaches to the design of the device were considered, each representing a slightly different concept for how the probe device was presented to the participants. When the design of the device began, there was still an aim to use a version of the collaborative persona cards within the device interactions, and the early designs demonstrate this.

Initially, the concept was to emphasise the voice assistant technology by positioning the digital research probe itself as a potential collaborator. In this scenario, the device was to be presented as a character, with participants able to alter elements of its characteristics depending on their current needs. This configuration and reconfiguration of the device could be recorded along with participant's descriptions of their current creative tasks and support needs in order to capture data about their ideal collaborator at different stages of their work.

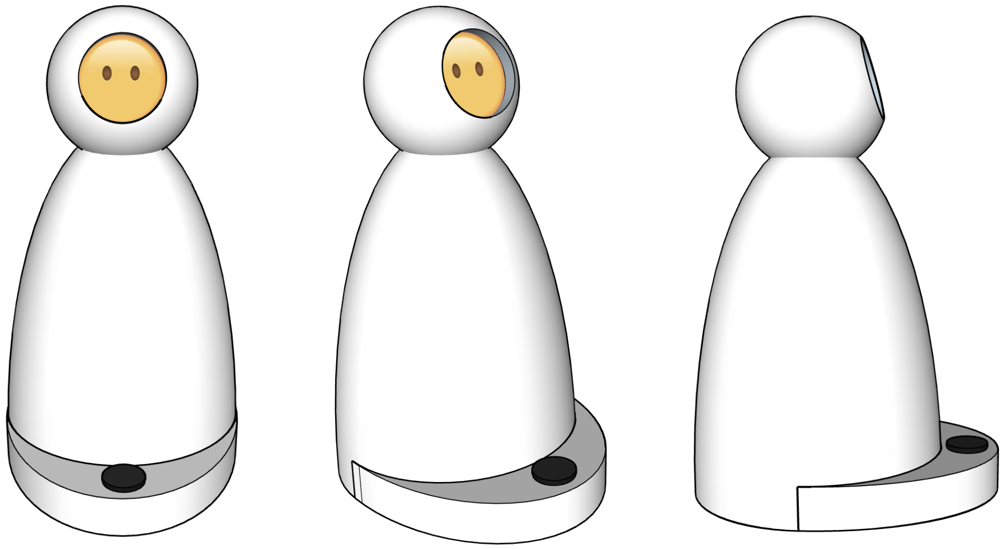

Figure 7.1: Design A. Probe Figure Design. Renders of an initial design for the digital research probe featuring a basic stylised form of a figure with a digital face.

Figure 7.1 shows Design A, an early concept for a 3D-printed probe device which depicts it as a character, with the form taking the shape of a simple head, face, and body. The body section would contain a Raspberry Pi Zero with the Adafruit Voice Bonnet, and a small speaker. The head section of the device would contain a small LCD display, showing a variety of emoji-style faces. The intention was that the face display would update to reflect the type of collaborator currently favoured by the participant, and this would be regularly updated by the participant by answering questions via the voice interface. The type of collaborator would be based on the persona cards.

A button at the base of the device would allow the participant to begin and end voice recording. This was added as an additional layer of privacy for the participant. The Rhasspy voice software supports ‘wake words’, which are predefined words or phrases that the software will listen for and use to initiate a dialogue with the user (similar to ‘Hey Google, or ‘Siri’). Using a wake word means that a microphone has to be constantly active, and audio processed in order to check for the instances of the predefined phrase. The software is designed to only recognise the wake word, and not to store any of the live audio it is processing. However, the need for a constant live microphone listening to conversations may have understandably concerned participants, even if the device was offline and not recording data.

In order to reinforce trust in the research device, a physical switch or button that would activate or deactivate the microphone was added to the design. This could take the form of a ‘push-to-talk’ intercom style button or a simple momentary button that physically performs the same function as the wake word, waking the device up and initiating the voice interface.

Reviewing this form of the device, and planning the specific ways it would support the data collection for the study, it was decided that the character form was not the most appropriate. This was primarily because positioning the device as a semi-anthropomorphised character and therefore framing the questions in the first person, may limit the types of responses given by participants. A more neutral and objective framing of the device may allow for a broader set of responses.

In addition, the face display could also be unduly restrictive. Although having a persistent representation of the speculative collaborator may be useful, possibly prompting the participant to update it whenever they notice that it no longer corresponds with their needs, the simplification of the collaborator to a emoji-style face or symbol would probably be overly reductive. It would most likely simplify the collaborator’s qualities to an individual emotion or attitude, rather than representing the types of skills or support the imagined collaborator could offer, and which it would be important to capture as part of the research.

Another design was therefore developed which was less anthropomorphic, and which allowed for better representation of the potential collaborator's skills and qualities.

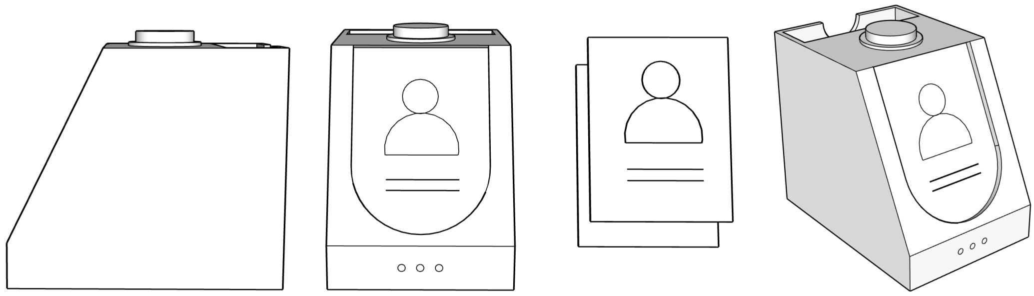

Figure 7.2: Design B. Persona Card Design. Renders of an initial design for the digital research probe, featuring a box design with slot-in character cards.

Figure 7.2 shows Design B, the next iteration of the concept, which took the form of a simpler, box-style desktop device, with the front face angled slightly upwards so that the object could sit on a desk and the face be clearly visible to participants. This version still used a Raspberry Pi Zero and Voice Bonnet connected to a small speaker. It retained the button for initiating voice interactions and placed it on top of the device in a manner similar to that of the Google AIY Voice Kit. This version did not use a small display to show faces or other representations of the potential collaborator. Instead, a physical card-based system was designed to allow participants to identify the type of collaborator they would like for a particular creative task.

This concept built on the persona cards used during the Google Diary Study. A set of persona cards depicting different types of creative collaborator, and detailing their different skills or abilities would be included with the digital research probe, and stored in a compartment at the back of the device. When participants required support on a creative task, they would be prompted to select a preferred collaborator card, and place it in the slot at the front of the device.

The card would be visible to the participant, providing them with a visual reminder of the type of collaborator they had currently selected and the quality of support they offered, and perhaps prompting to change this whenever the choice was no longer appropriate.

From a technical point of view, the device would be able to detect which card had been selected by the participant through the use of colour sensor component. A multi-channel light sensor mounted within the front card slot would be able to sense a specific colour printed on the back of the collaborator card. Each card would have a different colour on the back, and therefore the device could detect which one was currently in the slot, or if no card was currently selected. This data could be captured, and used to inform the questions asked via the voice interface.

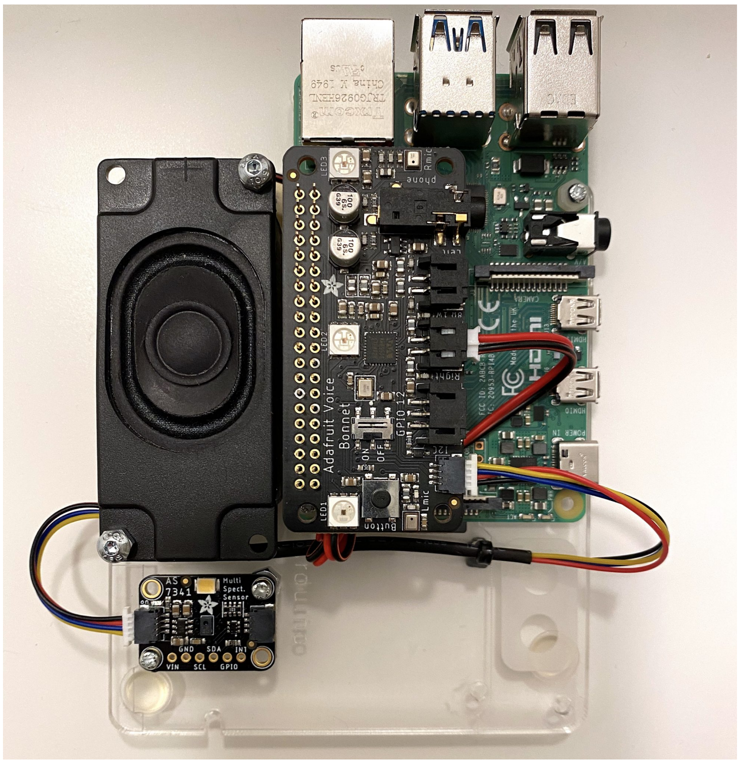

Figure 7.3: Photo of Prototype Probe Hardware Configuration.

A Raspberry Pi 4B, an Adafruit Voice Bonnet, a 3W enclosed speaker, and an Adafruit AS7341 10 Channel Colour Sensor

A photo of a prototype setup of this functionality can be seen in Figure 7.3. This shows a Raspberry Pi 4B, with an Adafruit Voice Bonnet mounted on top. Connected to this is a small 3W enclosed speaker, and an Adafruit AS7341 10 Channel Colour Sensor, wired via the connectors on the Voice Bonnet. This setup was able to detect the colour of a range of different printed cards, and update a data table with the result. In addition, the Raspberry Pi was running

Rhasspy, and could process voice commands via the microphones and speaker.

Although this version of the design was developed to the hardware prototyping stage, it was decided to develop the concept further before the manufacture and deployment of the device. The general design and functionality of the device seemed to be an improvement on Design A, with the card system offering a more detailed and objective way of selecting collaborator roles. However, during this phase of development, the plans to base the data collection around the concept of collaborator personas was changed significantly. Following the feedback from the Creativity and Cognition Conference Workshop discussed in Chapter 6, and further planning of the study questions, it was decided not to limit participants' responses to the selection of human-style collaborator roles.

It was therefore decided to not directly use the persona cards, and instead ask participants to select the types of creativity support they desired based on the categories of support defined through the Google study, without linking these directly to imagined personas.

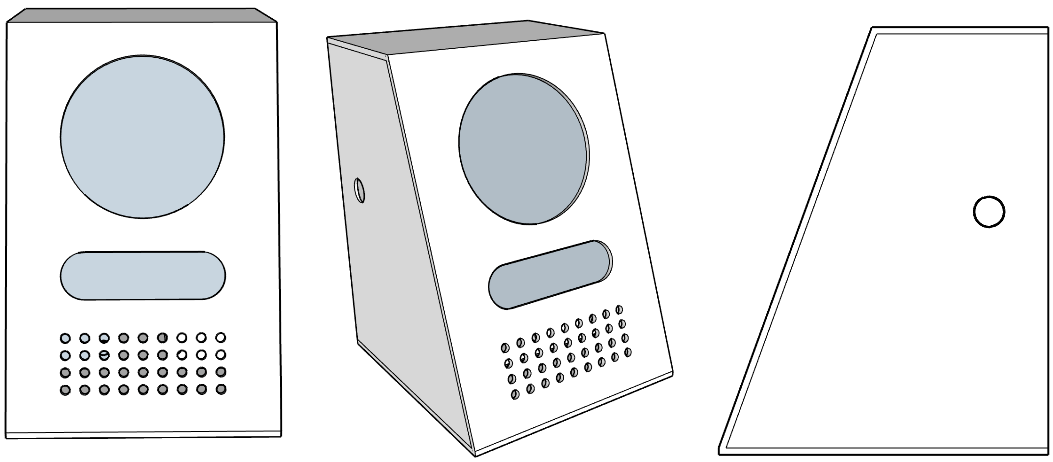

Figure 7.4: Design C. Probe Touchscreen Design. Renders of an initial design for the digital research probe, featuring a table-top device with touchscreen sections.

The next iteration of the research probe design (Figure 7.4) retained a similar angled box-style design, but removed the card-based interface and the physical button. These were replaced with a touch screen display, which was mounted behind a face plate with rounded holes, allowing only certain sections of the screen to be seen and interacted with.

A touch screen display was chosen as it offered a flexible interface for creating a range of interactions with the user. Although much of the interaction with the participant would still be achieved through a voice interface, prompting the participant with spoken questions and recording their answers, the removal of the persona cards as a shorthand way of referring to types of collaboration called for more detailed information to be captured about the specific type of support the participants desired.

Because of the inclusion of the touchscreen, graphical interface elements such as menus or virtual buttons and sliders could be included to help participants choose from ranges of options in a quicker and clearer way than a purely voice-based interface might allow.

Portions of the screen were masked with the device casing, only exposing certain rounded sections, which could then be used to display modal buttons, sliders, or textual information. This was intended to de-emphasise the screen within the device, and retain the sense that participants were interacting with an audio-based device. The grid of small holes prominently on the front of the device, coupled with the circular display spaces, were intended to evoke the style of a speaker, radio, or intercom, rather than a screen-based device. The aim was that this would encourage participants to speak with the device, providing rich descriptions of their tasks and support needs, whilst still being able to provide more focused data input through the touch screen.

Various touchscreen display modules were investigated for their suitability for the design. Eventually the Waveshare 4.3-inch DSI LCD for Raspberry Pi (Waveshare Electronics, 2024) was chosen as the best-suited option. This module is based on the dimensions of the Raspberry Pi 4B, allowing it to attach directly on top using supplied hardware. It uses the Raspberry Pi's dedicated Display Serial Interface (DSI) connector, meaning the GPIO header was free for connecting the Voice Bonnet. The touch interface is automatically configured as the Raspberry Pi's mouse input, making it simple to create Graphical User Interface interactions.

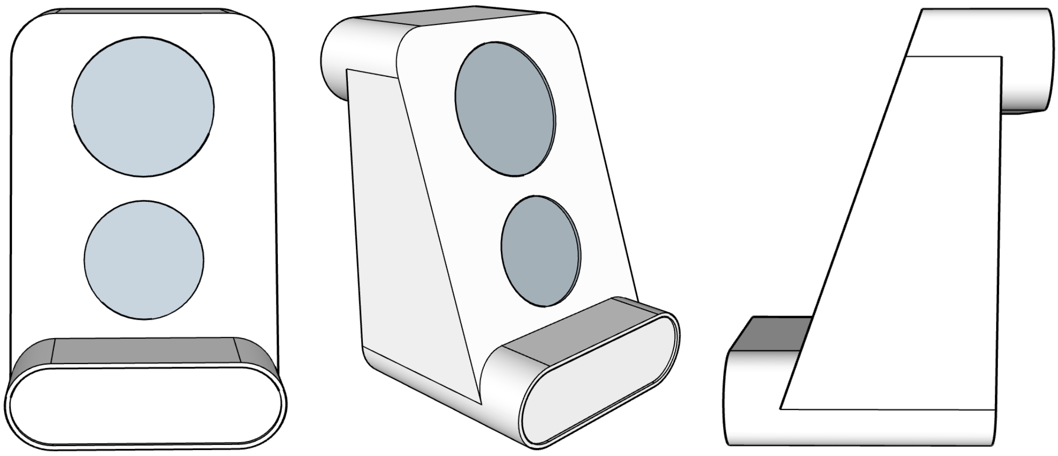

Figure 7.5: Design D. Probe Camera Design. Renders of an initial design for the digital research probe, featuring a table-top device that can also be picked up and used as a camera.

During the final stages of concept development for the digital research probe, a further iteration of the device design, which included a camera, was considered. The intention behind this was to allow participants to capture images of tasks they were working on, or provide more context for their current requirements. This could have been particularly relevant for tasks within the 'Situation' category of creativity support, where support might relate to an issue in their working environment or physical resources they were working with. The camera's emphasis on the physical may also have encouraged participants to report requirements relating to physical creative tasks (e.g. sketching, brainstorming, prototyping, etc.) in addition to digital creative tasks.

A version of the probe device was developed which was based on Design C, the touch screen device, but with the addition of a camera on the rear side of the device. The form of the device was updated to include extruded sections on the top of the back side, and at the base of the front. These held the camera and speaker respectively, and were designed to create an asymmetrical profile that was evocative of optical devices such as vintage Polaroid cameras or toy periscopes. The aim of this was to emphasise the optical nature of the device and encourage its use as a visual data collection tool.

In terms of hardware, the device would use the same setup as Design C, but with the addition of a Raspberry Pi camera module attached to the Camera Serial Interface (CSI). When answering questions about a task, participants would have the option of taking a picture. A preview would appear on one of the circular sections of the touch screen, and the participant could take a photo by touching the screen.

While the designs were completed for this version, and the configuration of the hardware within the device was fully planned, after further consideration of the study design it was decided not to include a camera within the device. Although photos could have provided some rich data to add context to participants' responses, in many cases, it may not have been relevant to take a photo. The vast majority of responses in the Google Diary Study related to digital-based tasks, which may not have been illustrated well by a photograph. Encouraging participants in the final study to focus more on the physical contexts for creative tasks may have given unnecessary prominence to this type of task, and reduced parity with the earlier study.

Further to this, the inclusion of a camera would potentially increase risks to participant privacy, making it more likely that personal data, or data not relevant to the study, might be recorded incidentally as part of data capture. It may also increase participants' concerns about the security and privacy of the device.

The camera functionality of Design D may be useful for separate future research projects, where the ability to capture images is more salient to the subject of the study, and where the privacy risks can be more easily managed. However, for this study, it was decided not to use the camera device, but to base the final digital research probe on Design C, the simpler touchscreen-based device.

To build the visual interfaces for the touch screen it was decided to create a web app using HTML, Javascript and CSS, and host this locally on the Raspberry Pi. When the device turned on, a browser window would automatically open in fullscreen mode, showing this browser-based interface. The p5.js Javascript library (p5.js, 2024) was used to create graphical interface elements. The interface was programmed to connect with the Rhasspy voice interface using its HTTP API, allowing the visual interface to update in response to voice commands and for physical interactions to trigger Rhasspy processes such as voice recording.

7.13 Device Construction

Two methods of manufacture were considered and tested for the body of the digital research probe - a laser-cut cardboard case, and a 3D-printed plastic case. Both methods were considered because they allowed multiple, identical instances of the device to be created relatively quickly and cheaply and because these methods could also be adapted easily by any other researchers wishing to create a device.

The cardboard version of the body was tested first. A cardboard device would be similar to the Google AIY devices, which come with a basic brown cardboard case, and the rationale for using cardboard within this study would be similar. Laser-cut cardboard would be a particularly cost-effective method of creating the case, and the accessible and easily adaptable material would be a clear way of making the form of the device modifiable for different research contexts.

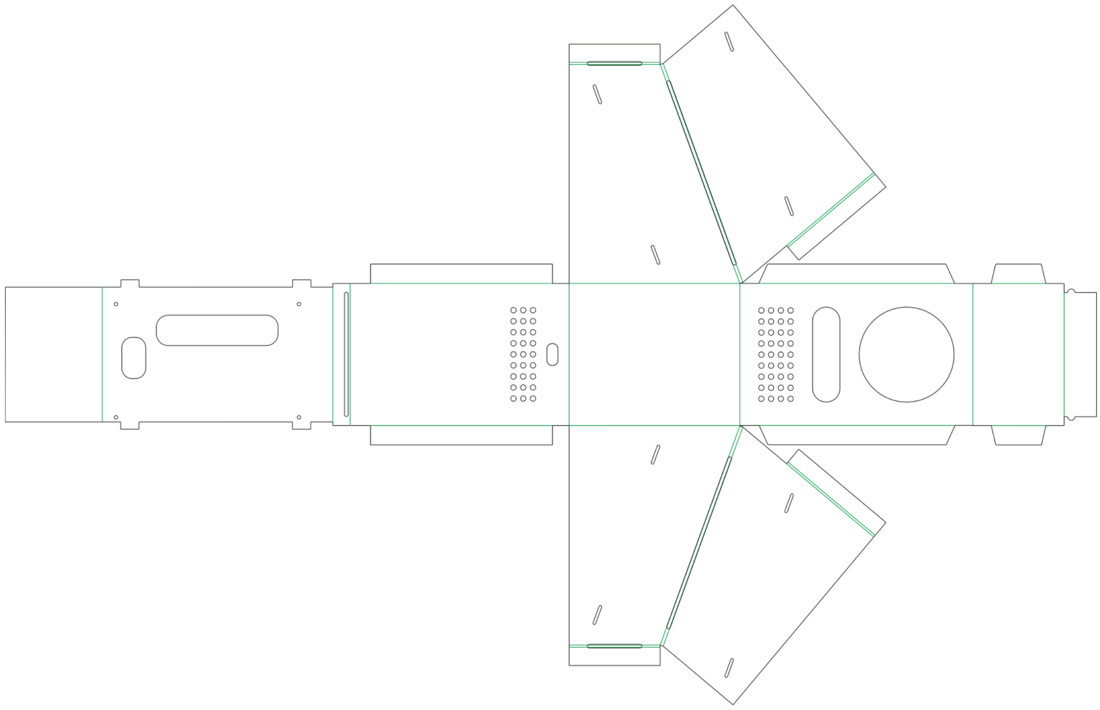

Figure 7.6: Design for a laser cut cardboard probe casing.

A design for a folded cardboard version of the probe device casing was created that could be laser cut from a single A2 sheet of 2mm corrugated cardboard (Figure 7.6). The design included a folded internal support which would hold the Raspberry Pi and attached hardware, ensuring that it was positioned securely against the face of the casing, which had holes cut to expose certain sections of the screen. Double-layered side walls kept the case rigid, and tabs were designed in to lock the various sections together. The tabs were secured with double-sided adhesive tape strips.

Several versions of the case design were cut and tested with the electronic hardware. Different densities and grades of cardboard were tested, with the most successful iteration using 150K/T-E 2mm cardboard sheet. However, none of the versions offered a completely rigid or durable casing for the device. The main electronics module, consisting of the Raspberry Pi 4B with the touch screen module attached with metal fixings, was too heavy for the cardboard supports to hold in place securely over an extended period. The module was prone to sagging on its fixings and dipping out of alignment with the front face of the case.

Furthermore, extended handling of the device, or movement during travel, was likely to cause slight distortion of the case walls, which in turn put pressure on the adhesive fixings, causing them to break or open up. Overall it was decided that despite the benefits of a cardboard case, the lack of durability made it unsuitable for the study. Therefore, a version of the same case design that could be 3D printed in ABS material was created.

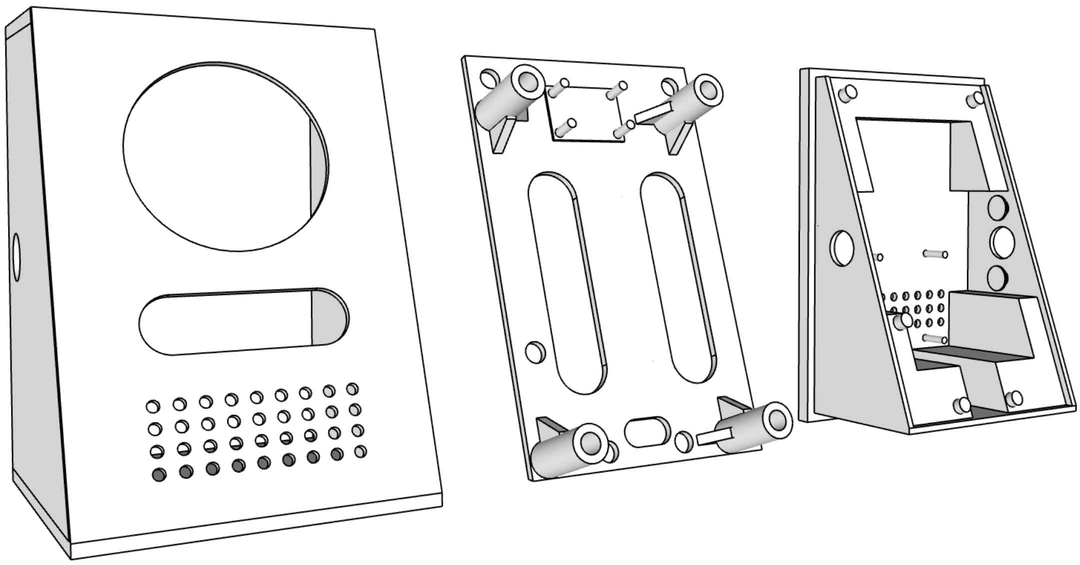

Figure 7.7: Renders for a 3D printed version of the digital research probe casing showing the 3 parts of the case, from left to right, the front case, the hardware cradle, and the back section.

In order to facilitate 3D printing, as well as making it easy to fix the electronics hardware within the casing while still making it accessible for maintenance, the case was designed in three interlocking pieces.

The front case comprises the five exterior walls of the device, including the face with holes cut to expose parts of the touch screen and act as a speaker grille. The back section slots into the rear of the front case, sealing the box. It is secured in place by two plastic lugs, which can be pressed to release and slide the back section out again. This allows researchers to access the hardware when necessary.

The hardware cradle snaps onto the front of the back section, and is designed to hold the Raspberry Pi, Real Time Clock, and position the touchscreen module firmly against the front of the case. Metal standoffs screwed into the Raspberry Pi can be pushed into corresponding tubes on the hardware cradle, allowing the hardware to be simply attached by pushing it into the cradle.

Finally the small enclosed speaker is fixed to the rear section of the case using plastic lugs, where it aligns with an array of small holes forming a second speaker grille on the rear of the device.

Multiple versions of the case design were printed, using different materials and print settings in order to find the configuration that was most robust, and had the most consistent quality of finish. During this configuration, various details, such as wall thickness and the layout of lugs and connection points were modified in order to refine the design and strengthen the overall structure.

At the end of this process, a final design was produced that was much more robust and reliable than the cardboard case and which was of sufficient quality for participants to have on their desks and use regularly over the extended duration of the study.

With the design of the device complete, the specific interactions and research design required for the study could be finalised. This is discussed in the next section.

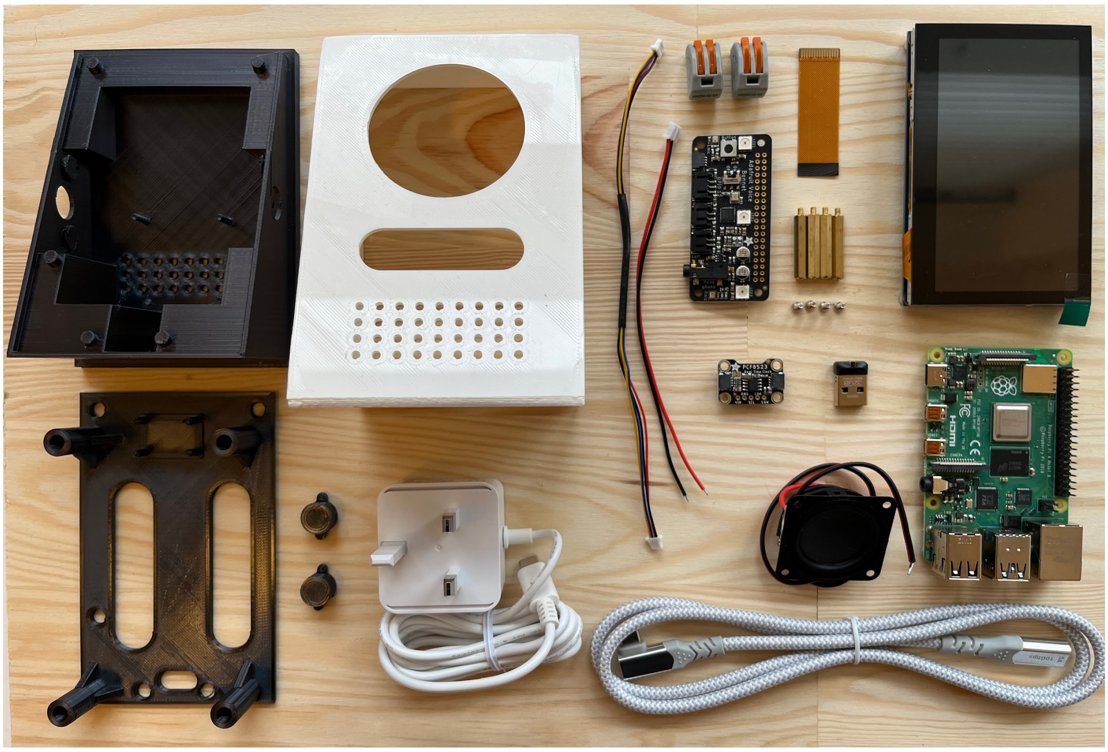

Figure 7.8: Photograph of all the components which make up a probe device.

Figure 7.9: The Digital Probe Device on a desktop in stand-by mode.

*Figure 7.10: The Digital Probe Device on a desktop, powered on.
A prototype version of the graphical interface is shown.*

Chapter 8 Digital Probe Study: Study Design

8.1 Introduction

The final fieldwork for this research involved conducting a multi-week study with a small group of participants, using the digital research probe as a data collection tool, with the aim of investigating their creativity support requirements across a range of creative tasks, and comparing this with results from the earlier Google Diary Study. This section will describe the specific research design considerations for this final study, including study design, participant recruitment, ethics requirements, and study deployment.

8.2 Research Aims

Following the insights from the Google Diary Study (Chapter 5), and in light of the methodological considerations that emerged from the process of designing the digital research probe devices, the final study aimed to investigate a range of questions aligned to three interconnected research aims.

8.2.1 Study Aim 1

To investigate the same creativity support role questions as the Google Diary Study (Chapter 5), with a different cohort of participants from outside of that company. Those questions related directly to the Research Questions 1 and 2 of the PhD, in the following way:

Questions related to Research Question 2 (“*What factors influence the type of creativity support individuals working in creative roles in the design industry are willing to accept from AI systems?*”)

- What are the common barriers to creativity experienced by people regularly working on creative tasks?
- What kind of support would alleviate these barriers to creativity?

How do creative support requirements change across different tasks and contexts?

Questions related to Research Question 1 ("*What role do individuals working in creative roles in the design industry want AI to play in supporting their personal creative practice*?")

- What kind of collaborator should ideally provide this creative support?
- What kind of collaboration do those working on creative tasks want from AI systems?

8.2.2 Study Aim 2

To compare the results of the current study with the results and conclusions of the Google Diary Study. This would be addressed with the following questions:

- To what extent are the results from the Google Diary Study reproduced in the current study?
- To what extent can the proposed Creativity Support Framework (*Categories*, *Confines*, and *Competencies*) be applied to the results of the current study?

8.2.3 Study Aim 3

To assess the suitability of using digital devices with embedded AI within long-term ethnographic research studies. This would be addressed with the following question:

- What are the advantages and disadvantages of using embedded AI digital research probes with participants over a multi-week research study?

As well as analysing the use of embedded AI tools as a data collection tool, this final question also related to Research Question 3 of the PhD ("*What opportunities exist for creativity to be supported by personalised, embedded AI systems?*") as it would provide insights into how designers responded to an AI tool in their creative workspace.

8.3 Changes from Diary Study

With the basic form and functionality of the digital research probes established, the next step was to design the specific questions and interactions that would enable the data collection with participants and program the devices to facilitate these.

Although the general aims of the data collection were similar to the Google Diary Study (to inquire about participants' creativity support needs and the types of collaborative support that might meet these needs), the different context for this study created some opportunities for changing the format of the questions.

The fact that participants would not necessarily be answering questions about their creative tasks at the end of the day, as with the diary study, but instead discussing them in the moment, meant that the way data collection was prompted or initiated would need to change.

In addition, as the final study aimed in particular to test whether the framework proposed at the end of the Google Diary Study was relevant to the new set of participants, the focus of the questions could be updated to specifically capture data related to this.

Finally, as the methods of data collection with the device could involve screen-based interactions, voice interactions and voice recording, the format of the questions could be adapted to take best advantage of these different forms.

8.4 Initiating Data Collection

To maximise the occasions when participants could share data about their creative tasks, two general approaches to prompting them to initiate data collection were considered.

First, an approach similar to the diary study, where participants were automatically invited to reflect on their creativity support needs at regular times within the day or week. This would have the advantage of prompting regular data capture but might mean that more spontaneous reflections were missed. There was also a risk that too frequent reminders might become annoying to participants and put them off continued engagement with the study.

The second approach was to allow participants to initiate data collection sessions at their own pace, whenever it occurred to them that they would benefit from creative support. This could encourage more natural and spontaneous reflection, and could be less frustrating for participants, but the risk would be that participants might forget to initiate regular data collection.

To gain the benefits of both these approaches, it was decided to incorporate both of them into the prompting strategy for the study. The device, which would be positioned on the participant's desktop in their normal place of work, would normally be in sleep mode with the screen off, but it would be programmed to initiate a data collection session whenever the participant chose to trigger one by either touching the screen of the device, or by saying a ‘wake word’. Both triggers would wake up the device and display a home screen, asking whether participants needed any help with creative tasks and giving them the option of proceeding to questions, putting the device back to sleep, or accessing device settings (Figure 8.2).

So as to avoid participants forgetting to engage with the device on a regular basis, the device would also be programmed to wake up at pre-set times twice a day. When waking up the screen would turn on and the device would make a subtle sound to prompt the participant's attention. If they did not want to engage with it, it would simply turn off again and wait for the next interaction. The act of briefly turning on and subtly reminding the participant of its presence would hopefully be enough to prompt the participant to use the device without becoming annoying.

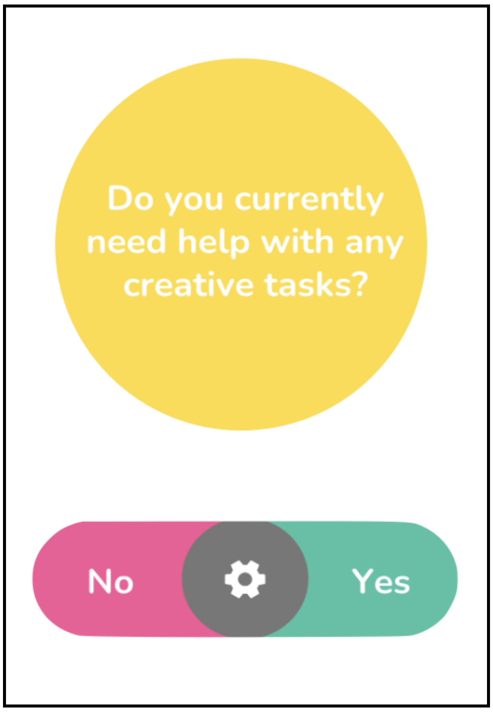

Figure 8.1: Screenshot of the device Home Screen.
This was displayed whenever a participant woke the device up by touching the screen or saying the wake word.

The use of a wake word to initiate interaction with the device was chosen to make data collection as accessible as possible for the participants. The aim was that in moments when they needed creative support, they could start a conversation with the device in the same way that they might ask voice assistants such as Siri or Alexa to help with a task. This could be done verbally, even whilst they were engaged with practical work.

However, including wake word functionality would introduce some privacy issues related to the fact that the microphone would need to constantly actively listen for the specified phrase (as discussed in the previous chapter). Whilst the actual privacy risks from this were relatively low, given that the wake word system does not record microphone data, and the whole device would be offline to avoid the risk of data being exposed, there was still an issue that if participants knew that the device was constantly listening to them, they might feel reluctant to have the device present in their workspace.

Addressing this perception of surveillance was important to establishing trust with the participants. Therefore, a method of deactivating the wake word interface was also built into the device, so participants could turn the microphones off until they chose to physically initiate a data collection session by pressing the touchscreen, and choosing to progress with questions. (Figure 8.2)

8.5 Study Design - Questions

Once a participant had initiated a data collection session, they would then be asked a short series of questions which would gather the necessary information on the creative task they were currently engaged in, and the type of support they would like to receive in order to assist with the task.

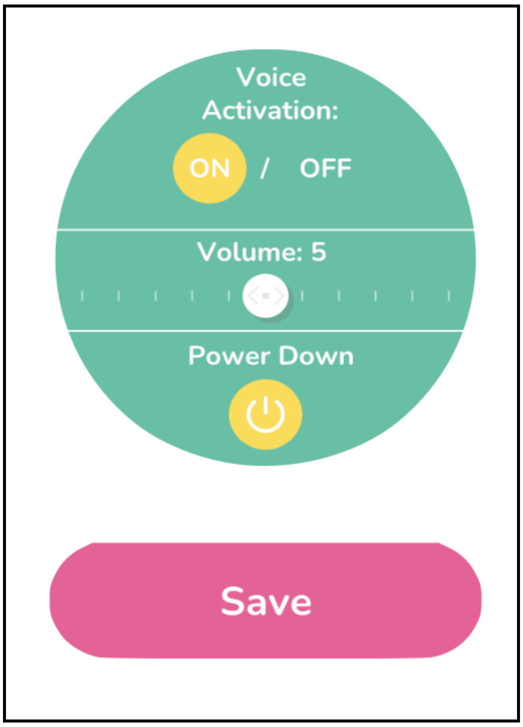

Figure 8.2: Screenshot of the device Setting Screen.

This was displayed if participants pressed the cog icon on the Home Screen.

The aim was to keep this series of questions short, so that participants knew that each interaction with the device would only take a few minutes, and also that the questions should be consistent each time, so the participants would understand what information was expected from them each time, and could get into the habit of preparing and sharing the necessary information.

Six questions were created to capture the data needed to help address the research aims.

Question 1.

"Please describe the creative task you're working on."

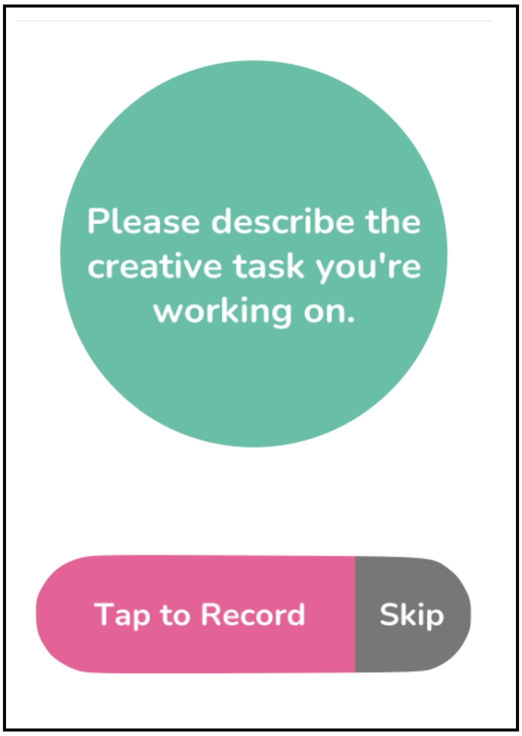

Figure 8.3: Screenshot of Question 1 Screen

This open-ended question was intended to capture descriptive responses from the participants which provide details about the task they were working on and the nature of the challenges they faced. This question is similar to the one used in the Google Diary Study. The data from this could be used to analyse what types of support are required for different types of tasks.

To capture descriptive data, participants were invited to answer by recording a voice response. This recording was stored on the device as an audio file which could be analysed after the device was returned at the end of the study.

Two features were added to this question screen in order to help protect participant privacy. First, audio recording was only initiated when participants chose to tap the Record button, and the button graphic updated to clearly indicate that audio recording was in progress. This was designed to reassure participants that audio was only recorded when they actively chose to initiate it.

Second, a Skip button was added to provide the participants with the option of not recording audio at all, but still progress with the remaining questions. This was added as it was recognised that participants may not always be in a position to make an audio recording for practical or privacy reasons. For example, if they were working in a shared space it might not be possible to record without capturing other people's conversations as well, or it might not be an appropriate time for them to talk to the device about their work. Skipping the recording automatically moved the participant to the next question, which still allowed them to provide some information about their support needs.

Question 2.

"Which category best describes the help you need?"

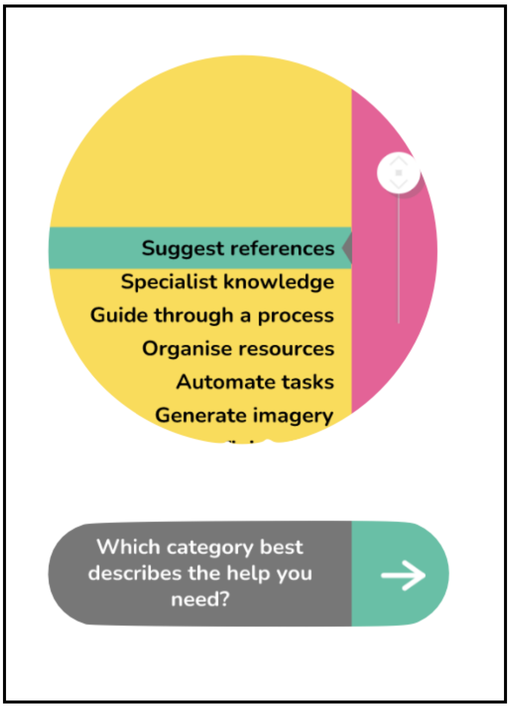

Figure 8.4: Screenshot of Question 2 Screen

The second question asked participants to categorise the type of creative support they required. To do this, they were provided with a scrollable menu of eleven options:

- Suggesting references
- Specialist Knowledge
- Guiding through a process
- Organising resources
- Automating tasks
- Generating imagery
- Extending/Completing work
- Facilitating collaboration
- Assisting focus
- Motivation
- None of the above

These options were taken directly from the Google Diary Study, and were the categories of creativity support determined through thematic analysis of all the study responses. They divided up into the three categories determined through the previous study; *Information*, *Generation*, and *Situation*.

Asking participants to map their requirements to this list of categories would make it possible to determine how well the categories gained through the Google Diary Study could be applied to a different context. A 'None of the above' option was added to capture instances where participants didn't feel any of the categories applied to their requirements. Question 3 would then enable participants to provide more detail about what their needs were.

Question 3

"How would an ideal collaborator help you with this task?"

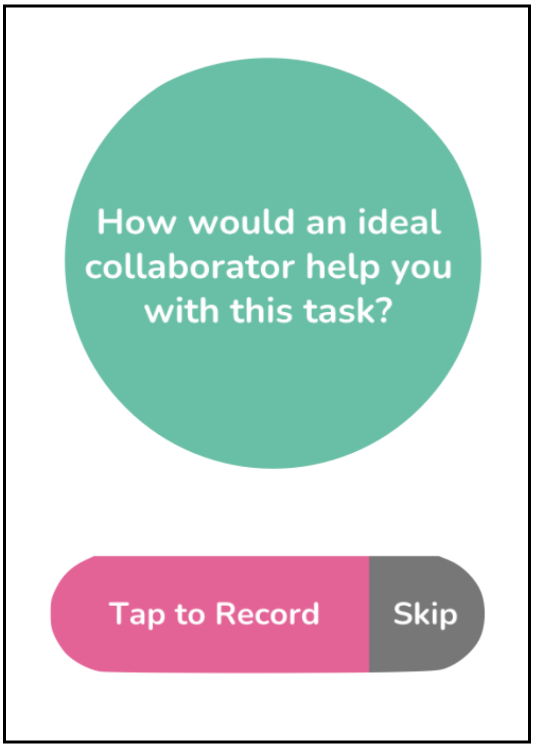

Figure 8.5: Screenshot of Question 3 Screen

Question 3 also invited participants to record a voice response, this time describing how an ideal collaborator would help them with the task in hand. The primary aim of this question was to gather data about the nature of the specific support they desired for the creative task. This could be compared with the category selected in Question 2, in order to build a fuller picture of the participants' needs, and also so as to be able to compare the self-selected support category and the participant's description of the requirement.

The question was framed from the point of view of an imagined 'ideal collaborator'. This framing was partially a legacy of the persona cards used within the Google Diary Study. However, the idea of an ideal collaborator was kept for this study for two reasons. First, to encourage the participant to think of external sources of support for their task, rather than just describing actions they would perform themselves. Second, to introduce an element of speculation into the question which might encourage more imaginative and revealing responses, which might not be technically possible but might better communicate the participants' attitudes towards the required support.

The question screen offered the same interface options as Question 1. Participants could choose to initiate recording by physically pressing the button, or could skip on to the next question if they did not want to record audio.

Question 4.

"What knowledge or ability should your collaborator have?"

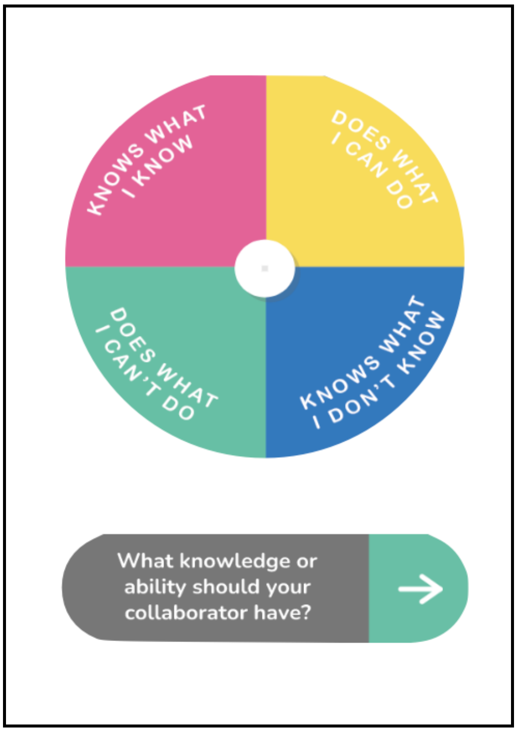

Figure 8.6: Screenshot of Question 4 Screen

Question 4 aimed to capture data relating to the 'Competencies' part of the creativity support framework proposed after the Google Diary Study. This covered what skills or knowledge an imagined collaborator would need to have in order to complete a task, evaluated in relation to the participant's own skills and knowledge.

Data from this question would enable analysis of how far the proposed Competency options were relevant to this group of participants, and would allow mapping of the variety of tasks to the type of competency desired by participants.

To capture this data, a different format of question was presented to the participant, which took the form of a circle divided into 4 equal quadrants, with a small marker that could be dragged freely around the screen and placed in one of the four quadrants, or if desired positioned in between two of the quadrants. Each quadrant was labelled with one of these options:

- Knows What I Know
- Knows What I Don't Know
- Does What I Can Do
- Does What I Can't Do

The options were allocated in such a way that participants could select any combination of skill and knowledge options by placing the marker in between the adjoining quadrants. However, combinations which did not make logical sense (e.g. Knows What I Know and Knows What I Don't Know) could not be selected together.

Participants could leave the marker in the centre of the circle if they did not wish to give a preference, and press the Next button in order to progress to Question 5.

Question 5.
"How would you like to divide the work between you and a collaborator?"

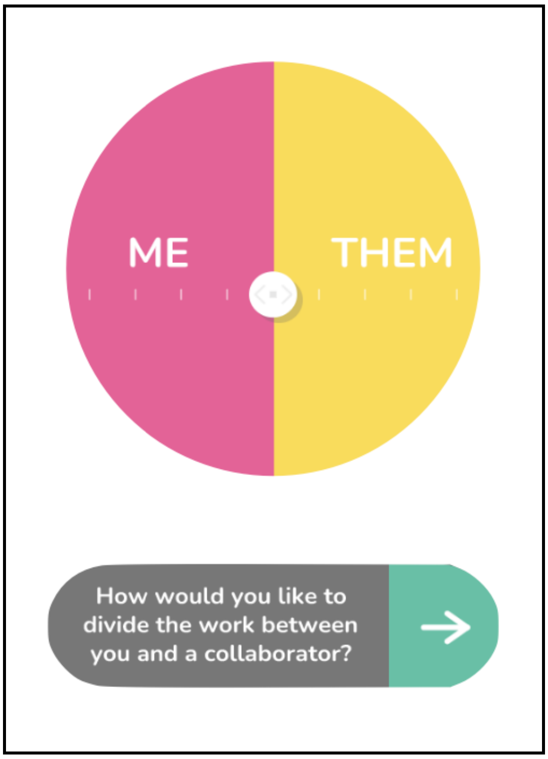

Figure 8.7: Screenshot of Question 5 Screen

Question 5 repeated one of the questions from the Google Diary Study, which asked participants to consider how they would like to share a task between a collaborator and themselves. This was designed to establish how much interest the participants had in performing the task themselves or how much ownership they wished to retain over the task. In the Google Diary Study this question prompted a variety of responses, with preferences towards sharing tasks apparently subject to individual perceptions about whether a task was purely task-focused, or a more personal activity. This question was designed to test this observation further.

The format for this question screen was a slider interaction. This worked in a similar fashion to a Likert scale. The screen was divided vertically, with each side labelled ('Me' and 'Them'), and a drag handle positioned in the centre between the two sections. Participants were invited to drag the handle left or right to increase the size of either the 'Me' section, or the 'Them' section, depending on who they wanted to have more control over the task. Alternatively, they could leave the handle in the middle to indicate that they wanted to divide the responsibility equally.

The handle could be moved into one of nine positions, so the interaction effectively worked as a nine-point Likert-type scale, with position one representing the collaborator taking full responsibility for the work, position nine representing the participant taking full responsibility, and position five representing an equal division of responsibility between the two. The interim positions indicated commensurate degrees of sharing.

Question 6

"Would you prefer a human or AI collaborator for this task?"

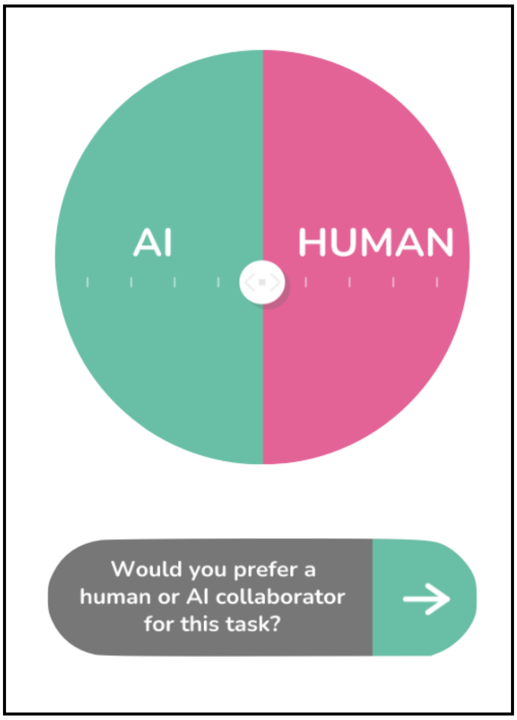

Figure 8.8: Screenshot of Question 6 Screen

The sixth and final question focused on their attitudes towards collaborating with AI. As with the Google Diary Study, the subject of AI was not explicitly mentioned in the earlier questions (although participants were aware that it was a theme of the study). This was to encourage the participants to think generally about the support they ideally needed, rather than relating it to their understanding of the capabilities of AI.

In the final question AI was addressed directly in order to understand how far they would be prepared to collaborate with an AI system on this specific task. This data would allow the results to be compared with the Google study in order to see how far the *Confines* element of the proposed creativity support framework applied to this separate set of participants. It would also make it possible to observe if preferences for AI support could be mapped to specific categories of task.

All six of the probe questions were designed to provide data relating to the probe study questions, and therefore also information relating to the overarching PhD Research Questions. The first two Research Questions were addressed in the following way through the probe study.

The first two questions provided information about the nature and context of the required creative support, and therefore helped address Research Question 2 ("*What factors influence the type of creativity support individuals working in creative roles in the design industry are willing to accept from AI systems?*")

- Probe Q1: "Please describe the creative task you're working on."
- Probe Q2: "Which category best describes the help you need?"

The remaining four questions provided more information about the role the participant wanted a collaborator to play in the task, and therefore helped address Research Question 1 ("*What role do individuals working in creative roles in the design industry want AI to play in supporting their personal creative practice?*")

- Probe Q3: "How would an ideal collaborator help you with this task?"
- Probe Q4: "What knowledge or ability should your collaborator have?"
- Probe Q5: "How would you like to divide the work between you and a collaborator?"
- Probe Q6: "Would you prefer a human or AI collaborator for this task?"

8.6 Ethics and Safety

Before proceeding to participant recruitment for the study, the research design was subject to an ethics approval process and Ethics and Safety risk assessment (Appendix 8), in line with university policy. Issues relating to ethics and data protection had already been considered in the design specifications of the device and the study, as discussed above, and these formed part of the ethics application, along with processes for obtaining informed consent, anonymising participants, and for enabling participants to withdraw from the study.

The health and safety risk assessment identified minor risks related to the safe use of the electrical equipment, and these were mitigated by producing safe systems of work for participants using the devices.

As a result of these processes, three documents were produced to help manage risks within the study:

- An information sheet for potential participants (Appendix 7), informing them of the nature and purpose of the study, the type of data that would be collected, the privacy protections that were part of the device, and the ways that their data would be used. It also informed them of their role in the study and how they could withdraw participation at any time.
- A consent form (Appendix 7), for them to formally acknowledge their consent to take part in the study, and include their data in its results.
- A user handbook (Appendix 9), which accompanied the devices and which clearly informed the participant how to set up and use the device in a safe way, and to deactivate voice recording or turn off the device for privacy. It also talked them through each question, guiding them how to record their responses.

8.7 Study Recruitment

The aim of the study was to recruit a small number of participants from a similar area of industry as the Google Diary Study, but who were not employed by Google, in order to test the results of the previous study against a set of participants with similar professional needs, but outside of that organisation.

As this required testing existing results from the previous study, and because the digital research method potentially produced a richer data set, with participants able to record unlimited responses across the study period, the preferred number of participants was set at six.

Participants were recruited from industries related to digital product and experience design. This was chosen as it broadly aligns with the type of work participants in the Google study were engaged in and covers the same cross-disciplinary mixture of design, engineering and project management.

Recruitment was conducted through existing academic networks of the supervisory team, and participants were graduates from postgraduate Interaction and Experience Design programmes, currently employed in roles related to those subjects. All participants responded to a call for volunteers, which asked for them to take part in a multi-week research study investigating creativity support tools.

Eight people responded to the call, and were invited to fill out a screener questionnaire that asked them about their work environment, their work pattern, and the type of creative tasks they normally worked on. The purpose of this screener was to ensure that potential participants were going to be working in an environment where it would be practical to use the device and that they were likely to be working regularly on creative tasks in their workplace over the duration of the study.

During the recruitment process, two volunteers asked for more information about the sound recording functionality of the device, citing concerns about using the device in shared office spaces, and during work on confidential client projects. Details of the research device were shared with them, including information about privacy features such as being completely offline and only activating recording when manually prompted. After reviewing this information, the volunteers were happy to proceed, and went on to fill out the screener document.

Following the screener, one volunteer was found to be unavailable for the study period, but the remaining seven were eligible and proceeded to the next stage of recruitment, where they received the study information sheet and consent form.

8.8 Study Deployment

A total of four devices were constructed and sent to the seven participants in a rolling program over the duration of the study. Each participant had the device for 21 days. At the end of this period, the device was collected, the data extracted from the device, and the memory reset so the device could be sent, where necessary, to another participant.

During the study deployment, two participants got in contact to say they had to travel away from their workplace for a short period for work or personal reasons. In these cases, the collection of the devices was delayed in order to ensure the participants still had access to the devices for a total of 21 days.

Participants received the devices and user manual through the post, along with a follow-up email the next day to confirm that they could set up the device OK and check whether they had any issues or questions. Participants were also provided with a contact email and phone number in case they encountered any technical problems during the study. All devices operated correctly during the study and were collected successfully.

Figure 8.9: A photograph of the device ready to be sent to a participant, in a plastic case with power supply.

At the point when participants returned their devices, they were also sent a final follow-up survey (Appendix 11), which asked questions about their experience of using the device, and also captured some broader information about their knowledge and attitudes towards AI technology. Responses to this questionnaire were considered along with the participant's device data as part of the data analysis.

Chapter 9 Digital Probe Study: Results and Analysis

9.1 Introduction

This chapter will detail the deployment, results, and analysis of the Research Probe Study.

Following the development of the probe form and functionality, devices were sent to the seven volunteers selected for the study. During the study, two volunteers found that, due to changing work commitments, they did not have the time to set up and use the device regularly during the research period, and therefore did not continue with the study. They returned the devices without any data being recorded and were not sent the follow-up questionnaire.

In total five participants took part in the study, recording data about their creativity support needs and completing the follow-up questionnaire at the end. While this is less than the original aim of six participants, the data captured still supported valuable comparisons with the results from the Google Diary Study, and provided valuable insights into multiple instances of creativity support requests.

For the purposes of this analysis, participants were anonymised by allocating them a letter label (A-E). Each time a participant initiated a session to record a set of answers, the session was given a numerical ID. Each set of responses in the results has therefore been identified with an alphanumeric ID. For example, response A3 refers to the third set of responses from Participant A. The full data can be found in Appendix 10.

All participants recorded multiple submissions on the device, completing the full set of questions for each instance. The amount of times each participant used the device varied considerably, with the most active participant (Participant A) using the device for 11 separate sessions and the least active (Participant D) only using it for two sessions. As participants were instructed to make recordings only in the moments they required creativity support, rather than on a regular schedule as with the Google Diary Study, this variance in the frequency of recordings was to be expected. As each instance contains details of creativity requirements recorded in the moment of need, each one provides valuable data.

In total participants submitted information about 27 instances when they desired creativity support, totalling 162 separate question responses. These covered a variety of different tasks, including writing up concise analysis of research (A3), making adjustments to image layouts (A11), creating new images from a description (B2), analysing outcomes from creative workshops (C6), and checking 3D designs prior to printing (E1). This variety reflected the different roles of the participants, but also the different types of task undertaken by each participant. No participant consistently reported the same type of task across their recordings.

The data from the participants will be analysed below in relation to the Creativity Support Framework, which was proposed after the Google Diary Study (*Categories*, *Confines*, *Competencies*), as well as their general attitudes towards collaborating with AI, and their feedback on the experience of using the research device.

9.2 Probe Study Results

9.2.1 Categories

Each recording submitted by the participants was analysed to determine whether it mapped to the categories of support defined during the Google Diary Study. These categories are *Information*, *Generation*, and *Situation*.

In the first instance, this mapping was achieved by the participants' response to Question 2, which asked them to select a label for the type of support they required from a menu of options. Each option corresponded with one of the three categories, with an additional “None of the above” option.

Category	Subcategory
Information	Suggest references
	Specialist knowledge
	Guide through a process
	Organise resources
Generation	Automate tasks
	Generate imagery
	Extend or finish work
Situation	Facilitate collaboration
	Assist focus
	Motivation
	None of the above

Table 9.1: Creativity support categories and subcategories included in Q2.

All participants selected one of the provided options to categorise their requirement, with no participants selecting ‘None of the above’. Participants were just shown a list of the subcategory labels, the right-hand column in Table 9.1 without being shown the overall category names (*Information*, *Generation*, *Situation*).

Through their voice recordings for Question 1 and 3, participants also provided details about the type of task they were working on, and the type of support they desired. Using this data it was possible to conduct thematic analysis on their descriptions, and categorise them using the same method employed in the Google Diary Study (Chapter 5). Following this analysis, a separate researcher-allocated subcategory was applied to each submission from the participants. In 13 out of the 27 responses the allocated subcategory was different to the one selected by the participant.

Examination of the responses suggests that this relatively high number of mis-categorisations by the participants may be due to ambiguity of the language of the question and subcategory names. For example, in response A1, the participant selected the subcategory “Facilitate collaboration”, because the task they were working on involved “a workshop to do with the vision of a product”. The participant was trying to design a workshop activity for “one part where we want to generate some sketches” and reported that they were having trouble choosing between two different approaches to the activity, saying that “I'm not sure if I want to do a round or a pin style where I have someone do the start and then someone takes the middle and another person takes the end, or if someone just does a complete set and they build on top”.

When describing how a collaborator could help them in this task, the participant said they wanted someone who could “help me talk through the problem and maybe we could even help organize like a quick test and or even offer me an alternative… I'm sure there's maybe a better way that I haven't thought of yet”.

The support subcategory they were allocated for this submission was “Specialist knowledge”, because they described wishing to receive advice and support from someone with knowledge of running the activities in question. In selecting their subcategory for Question 2, the participant had clearly identified the type of outcome they were working on, rather than the type of support they required from a collaborator in order to complete that outcome.

This kind of ambiguity could also be seen in response D2, where the participant requested creative support for a task writing copy that “has to be a little bit fun but also functional". They selected "Guide through a process", but their description of the support they requested referred directly to "Specialist knowledge", as they stated that "the best collaborator would be people who are specialised in copywriting, both UX functional, but also creative, and also have the knowledge of what our brand tone of voice and guidelines are supposed to be". This indicates a lack of clear definition between the subcategories "Guide through a process" and "Specialist knowledge".

Additionally, in response A6, the participant acknowledged that their initial choice of the subcategory "Assist focus" was probably not the most appropriate to describe their needs relating to an information design task. In their description of the type of support they required, they said "my collaborator would probably have some bit more knowledge than me actually, so maybe, I know I said this is [Assist focus], but maybe it also would probably lie a little
bit in towards…specialist knowledge and just understand[ing] this space a bit more"

The issues participants experienced when selecting subcategories for Question 2 are also reflected in their responses to the follow-up questionnaire (discussed further below). As the language and definition of subcategories in Question 2 were obviously not always clear to participants, preference in the analysis was given to the researcher-allocated categories, which were based directly on the participants' descriptions, and reflected the method used in the Google Diary Study.

Whether viewing the participant-selected subcategories, or the researcher-allocated ones, all responses aligned with the overall categories defined in the Google Diary Study. All the reported requests for creativity support could be categorised as either *Information*, *Generation*, or *Situation*, with no additional categorisations being required.

In addition, the preference for categories of support also matched the data from the Google Diary Study, with the different categories being reported with very similar frequencies across the two studies. As with the Google Diary Study, although participants requested various types of support across their responses, *Information*-related support was the most frequently requested, followed by *Generation*-related support.

In this study, *Situation*-related support (help with organising and arranging the methods and settings for creative work) was not requested in any of the responses. This is similar to the Google Diary Study, where *Situation* was by far the least requested support category. The fact that it was not reported at all in this study may be due to the different scales of the studies.

It's notable that although none of the participant's support requests fell within the *Situation* category, some participants did select "Assist focus", which is a subcategory of *Situation*, when they categorised their support needs. All the instances of "Assist focus" were reassigned during the analysis, as the descriptions of the support needed did not actually mention focus or avoiding distraction, but did relate to support in one of the other subcategories. In four out of the five cases where "Assist focus" was selected, it was reassigned to "Specialist knowledge", as the description of the desired support related to talking the problem through with someone and getting informed advice.

For example in response A7 the participant stated that the ideal collaborator "would most likely just sit with me and help just come up with ideas with me", and in A3 they stated that "the ideal collaborator would talk me through - with me, I should say - all the… different elements that I found within the competitor analysis". Similarly in response C2 the participant wanted a collaborator who could help them "brainstorm different considerations and user needs".

In these cases, it seems that there was a difference in the participant's perception of the problem, and the practical support they requested in order to complete their task. It could be that in these cases, a practical issue such as a lack of knowledge related to a task caused a barrier to progress that contributed to a sense of lack of focus on the task. Or it might be that participants did lack focus, and felt this was best resolved through some form of social interaction with another person or colleague. In any case, the differences reported in this subcategory suggest that further research and development of the category definitions may be required.

As well as *Information* being the most requested overall support category, the "Specialist knowledge" subcategory was the most requested individual subcategory by some margin, with ten out of the 27 responses aligning with this category. The frequency of responses in this category may be partially due to the broad definition of the term, which allowed it to be aligned with many different types of support. However, it also reflects the view expressed across multiple responses (for example, A1, A3, A10, B4, C1, D2) that participants desired an expert colleague who could talk them through a problem, or provide them with a second opinion. This also reinforces the attitude observed in the Google Diary Study, that participants frequently just wanted to talk their creative problem through with someone with appropriate knowledge (section 5.5.1).

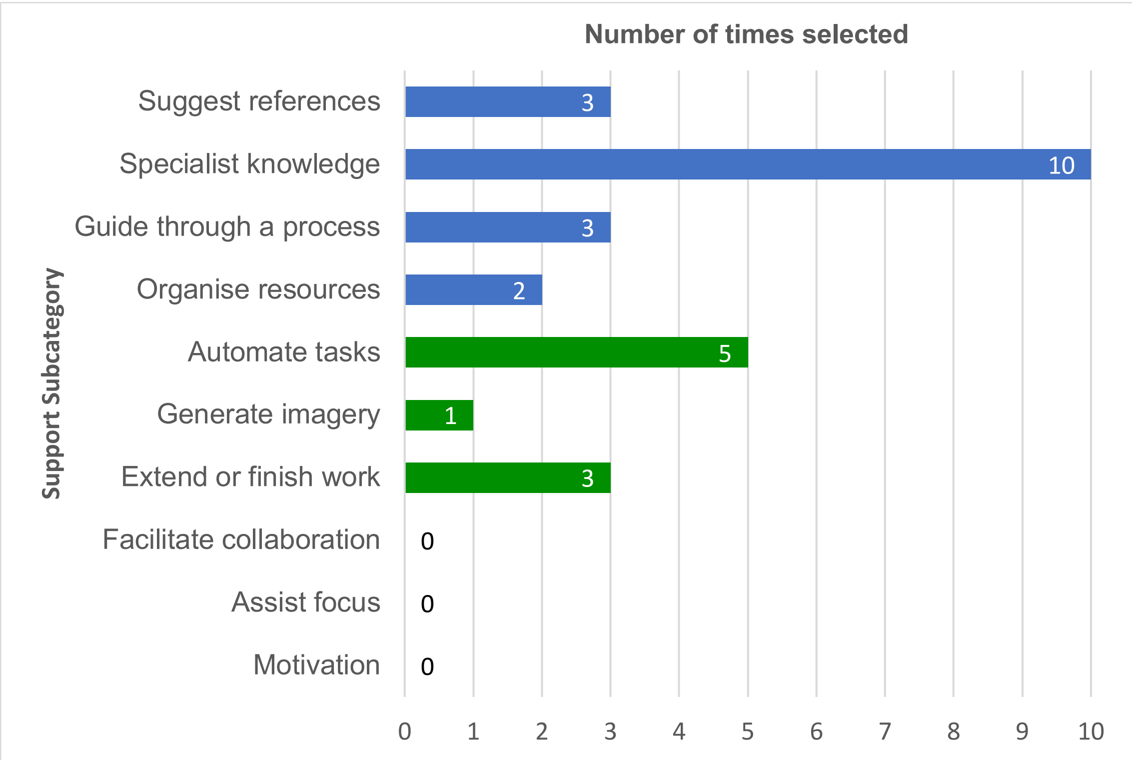

Figure 9.1: Subcategories of support request (researcher allocated).
The blue bars correspond with the Information category, and the green bars with Generation.
No requirements for the Situation category were reported.

Study	Categories	Number of times selected	% of times selected
Digital Probe Study	Information	18	67%
	Generation	9	33%
	Situation	0	0%
Google Diary Study	Information	23	51%
	Generation	18	40%
	Situation	4	9%

Table 9.2: Comparison of support category requests in Digital Probe and Google Diary Studies

9.2.2 Competencies

For the Competencies element of the proposed framework, responses from Question 4 were analysed to understand what skills and knowledge participants required in an ideal collaborator for their task, in relation to their own skills and knowledge. For this question, participants were provided with a matrix covering four key options - ‘Knows What I Know’, ‘Knows What I Don’t Know’, ‘Does What I Can Do’, and ‘Does What I Can’t Do’. Participants could also combine two different knowledge/skill states, which provided 8 possible answer combinations, as seen in Figure 9.3.

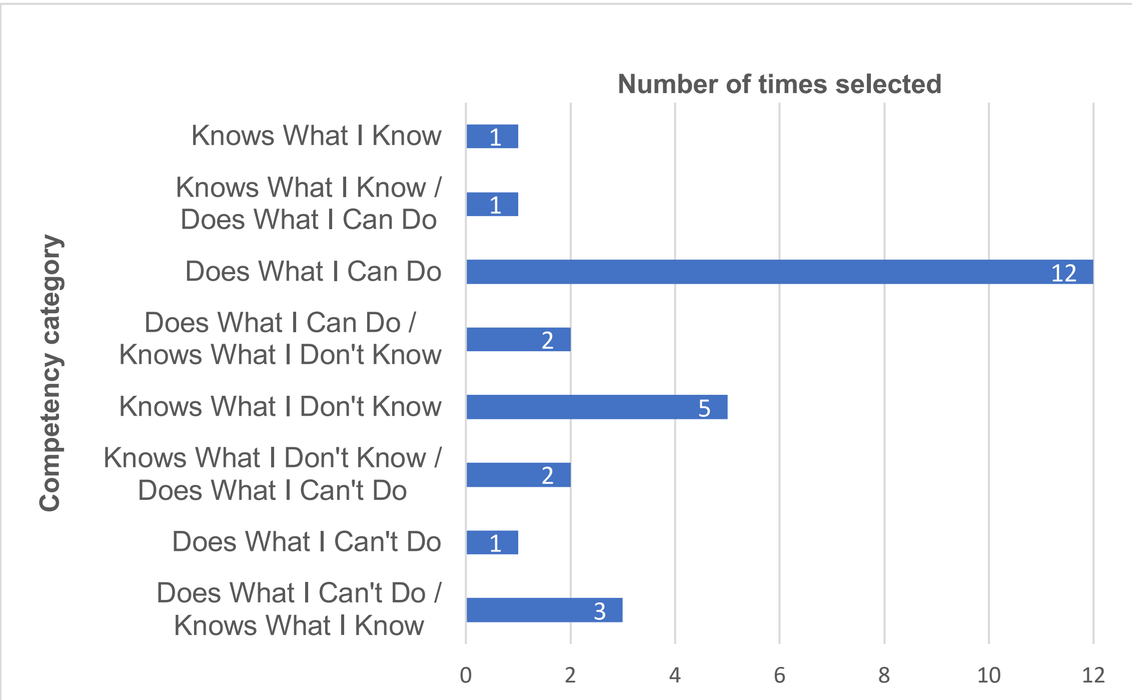

Figure 9.2: Collaborator competency preferences

showing instances where participants selected two options together as separate 'joint answer' categories.

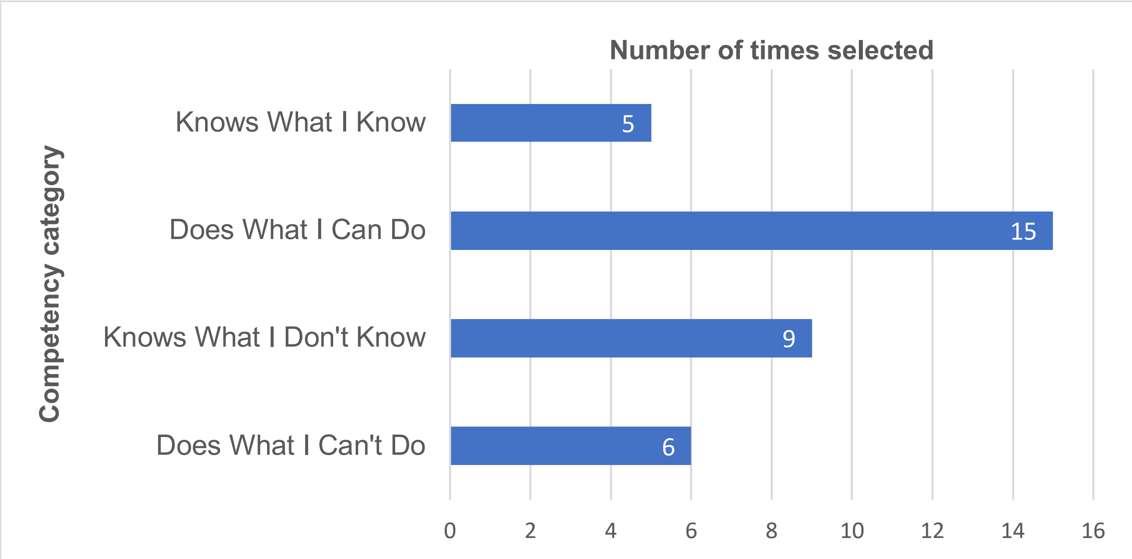

Figure 9.3: Collaborator competency preferences, aggregating all answers, and not showing joint answers as separate categories

Figure 9.4 shows the aggregated responses to Question 4. Overall, participants most frequently requested collaborators who had the same skills as themselves ('Does What I Can Do'), but different knowledge to themselves ('Knows What I Don't Know'). These preferences correspond with participants' desire for support in the *Information* and *Generation* categories, and the most frequently requested subcategories of support "Specialist knowledge" and "Automate tasks".

All participants who selected types of support within the *Generation* category indicated they wanted a collaborator who "Does What I Can Do". This suggests that participants were not looking for a collaborator who would create outcomes that they were unable to create themselves. Rather, they were looking to offload creative tasks which they could complete themselves, but would prefer not to. This is also reflected in the participant's description of the tasks, which usually relate to repetitive, laborious, or time-consuming work, for example, responses A11, E2, E3. This provides some insight into how participants were defining the quality of collaboration in this context.

The skills-related option “Does What I Can Do” is a logical competency choice when desiring a collaborator who can complete or extend work on a participant’s behalf. Likewise, the knowledge-related option “Knows What I Don’t Know” is a logical competency choice when desiring a collaborator who can provide expert opinion or suggestions. However, in several cases (A4, A8, A10, B4, C4), participants chose the option “Does What I Can Do” for types of support in the *Information* category, such as “Specialist knowledge” and “Suggest references”. These allocations account for the fact that the skills-related option “Does What I Can Do” was selected more frequently than “Knows What I Don’t Know”, even though knowledge-related support was most frequently requested by participants.

This could suggest that in some cases participants felt that they had the ability to obtain the information themselves, but would prefer a collaborator to do it on their behalf. It may also reinforce the observation that some participants primarily wished to talk through a problem with someone else. In some cases this may have been in order to get a second opinion, but not necessarily a better-informed opinion. This is reflected in the responses of Participant A, who described wanting a collaborator who “would talk it through with us just get fresh pairs of eyes on it” (A10), and in a separate response wanting a collaborator so that they could “just talk to each other, really, I guess, and go back and forth and ideate” (A4).

Analysing the responses of individual participants shows that they sometimes had changing opinions about the type of knowledge or skills they required from a collaborator, even when the type of support they desired remained the same. This can be observed when comparing the researcher-assigned categories. For example responses A2 and A4 were both assigned the “Specialist knowledge” category and relate to talking through visual design options with a collaborator. However the participant selected “Knows What I Don’t Know / Does What I Can’t Do” for one, and “Does What I Can Do” for the other. This inconsistency is also present when looking at the support categories that the participants selected themselves. For example, A9 and A10, and C2 and C5.

The inconsistency may be due in part to the ambiguity over the category terminology, as discussed above. However, as the overall results show a logical consistency between categories and competencies, it could be that on an individual basis participants occasionally changed their perception of how their ideal collaborator's skills and knowledge compared to their own for specific tasks.

9.2.3 Confines

The Confines element of the proposed framework for creativity support, which relates to how far a participant wishes to share individual tasks with a collaborator, was addressed in Question 5. In this question participants indicated how they wanted to divide responsibility for a task between them and the collaborator by moving a sliding scale between “Me” and “Them”. Responses were recorded on a scale of 0 to 10, mapping to the following indications of preference.

The question elicited a range of responses from the participants, with the majority indicating some preference for either the participant or the collaborator taking on slightly more of the work. Only one response indicated an equal division of the task.

Overall, participants were more likely to want to hand over a task, with slightly more responses indicating that the collaborator should take on more of the work on a task (14 responses) rather than the participant retaining more of the work (12 responses). Participants were also more likely to let a collaborator have full responsibility for a task than retain full responsibility themselves. Two responses indicated that the collaborator should have High or Very High responsibility for the task, while no participants indicated a preference for retaining High or Very High responsibility for a task themselves.

Position	Preference	Number of responses
0	Them (Very High)	1
1	Them (High)	1
2	Them (Medium)	1
3	Them (Low)	3
4	Them (Very Low)	8
5	Equal Division	1
6	Me (Very Low)	7
7	Me (Low)	3
8	Me (Medium)	2
9	Me (High)	0
10	Me (Very High)	0

Table 9.3: Preferences for dividing work on a task.
"Me" represents the participant, "Them" represents their collaborator. A response of 0 indicates the collaborator should be completed fully by the collaborator, a response of 10 indicates it should be fully completed by the participant. 5 indicates that the task should be divided equally.

Participants not wishing to complete a task fully by themselves is perhaps a logical consequence of the framing of the study questions, where participants were only asked to record responses about creative tasks where they felt they could benefit from being supported by a collaborator. However, participant's preference for handing over large amounts of the task to a collaborator indicates that they did not feel it was necessary to retain a sense of personal control or ownership of these tasks.

			Preference for division of task										
			Them					=	Me				
			High				Low		Low				High
			0	1	2	3	4	5	6	7	8	9	10
Support Category	Information	Suggest references,	0	1	0	1	1	0	0	0	0	0	0
		Specialist knowledge,	0	0	0	1	2	1	4	2	0	0	0
		Guide through a process,	0	0	0	0	1	0	0	1	1	0	0
		Organise resources,	0	0	1	0	1	0	0	0	0	0	0
	Generation	Automate tasks,	1	0	0	1	1	0	2	0	0	0	0
		Generate imagery,	0	0	0	0	1	0	0	0	0	0	0
		Extend or finish work,	0	0	0	0	1	0	1	0	1	0	0
	Situation	Facilitate collaboration,	0	0	0	0	0	0	0	0	0	0	0
		Assist focus,	0	0	0	0	0	0	0	0	0	0	0
		Motivation,	0	0	0	0	0	0	0	0	0	0	0
		None of the above	0	0	0	0	0	0	0	0	0	0	0

Table 9.4: Preferences for the division of task between participant and collaborator. The table shows the number of responses for each of the possible points on the scale of work division between "Them" and "Me", shown in relation to the category of support required.

Table 9.3 shows the participant's responses to Question 5, sorted in relation to the category of support required by the participant. It shows that across both the *Information* and *Generation* categories, participants indicated a spread of preferences for both retaining control of a task and handing it over to a collaborator.

For Information related tasks, there are indications of a split in preferences between the four subcategories. For the subcategories “Suggest references” (which related to the collaborator providing links to existing examples, case studies, best practice etc.), and “Organise resources” (which related to the collaborator organising notes, preparing data etc.), participants reported a clear preference for the collaborator completing more of the task. No participants expressed a preference for retaining more of the work on these tasks themselves.

For the *Information* subcategories “Specialist knowledge” (which related to the collaborator providing expert advice and feedback) and “Guide through a process” (which related to the collaborator providing guidance as participants completed a specific process or workflow), participants expressed a clear preference for retaining control of the task themselves, rather than handing it over to a collaborator.

This division in the *Information* category can also be understood in relation to the participants’ responses to Question 4, regarding the Competencies required by a collaborator. Table 9.4 shows the knowledge and skill preferences expressed by the participants for each category of support. This demonstrates the same split within the *Information* category, with participants indicating that the subcategories “Suggest references” and “Organise resources” were more likely to require a collaborator with the same knowledge or skills as themselves, while the subcategories “Specialist knowledge” and “Guide through a process” were more likely to require a collaborator with different knowledge or skills.

The difference within the *Information* category therefore seems to be linked with the perceived competencies required by the collaborator, in comparison with the participants' own competencies. “Specialist knowledge” and “Guide through a process” were perceived to require a level of expertise not possessed by the participant, and this appears to be linked to a desire to retain a level of control over the task.

Conversely, “Suggest references” and “Organise resources” are perceived to be within the existing knowledge or skill set of the participants, and they expressed a preference to hand more of the work on these tasks over to a collaborator.

Support Category			Preference for collaborator knowledge / skills			
			Same Knowledge / Skills		**Different** Knowledge / Skills	
			Knows What I Know	Does What I Can Do	Knows What I Don't Know	Does What I Can't Do
Support Category	Information	**Suggest references,**	0	3	1	0
		Specialist knowledge,	2	2	7	4
		Guide through a process,	1	0	1	2
		Organise resources,	1	1	0	0
	Generation	**Automate tasks,**	1	5	0	0
		Generate imagery,	0	1	0	0
		Extend or finish work,	0	3	0	0
	Situation	**Facilitate collaboration,**	0	0	0	0
		Assist focus,	0	0	0	0
		Motivation,	0	0	0	0
		None of the above	0	0	0	0

Table 9.5: Preferences for collaborator knowledge / skills requirements for supporting a task. The table shows the number of responses for each knowledge / skill option in relation to the support category for the task.

The same preferences can be seen in Table 9.5, which shows the participants' preferences for dividing a task with a collaborator mapped against their responses relating to the knowledge or skills required for a task. This shows that across the different competency options, there is in general a very even spread of preferences between participants working on a task themselves, and handing over work to a collaborator. However, for the competencies where the participant already has the knowledge or skills to complete the task ("Knows what I know" and "Does what I can do") there is a preference for handing over the work to a collaborator. This is particularly clear for the "Does what I can do" category.

		Preference for division of task										
		Them					**=**	**Me**				
		High				Low		Low				High
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Preference for Skills / Knowledge	**Knows What I Know**	0	0	0	1	2	0	1	1	0	0	0
	Does What I Can Do	1	1	1	2	4	0	5	0	1	0	0
	Knows What I Don't Know	0	0	0	1	3	1	2	2	0	0	0
	Does What I Can't Do	0	0	0	1	2	0	1	1	1	0	0

Table 9.6: Comparison of preferences for collaborator competency, and task sharing. Shows preferences for division of task between participant and collaborator, in relation to their preference for a collaborator's skills/knowledge.

This combination of preferences could be seen as slightly counterintuitive, as it might be more logical for participants to retain control of tasks that are within their own abilities, while handing over tasks outside their abilities to a more knowledgeable or skilled collaborator.

This attitude is mentioned directly in the Follow Up survey which participants completed at the end of the study (discussed further below). When asked about the type of work that AI collaborators would be best suited for, one participant stated that AI systems would be most capable of “[a]utomating tasks such as I know how to do, but are too tedious and time consuming like cropping images, adjusting colour values, suggesting colour palettes”.

This participants’ response clearly positions personal knowledge of the task as a part of the rationale for an AI system completing it on their behalf. Further research would be required to better understand the motivations related to this attitude. It may be that tasks which offer the opportunity for participants to gain an understanding of new skills or areas of knowledge might be perceived as having higher intrinsic value to participants than tasks which require them to reuse familiar skills or knowledge. Additional data could help draw out the distinctions between the different *Information* categories, and better understand the motivations for support in each one.

Data from the *Generation* category also provides evidence for participants choosing not to work on tasks where the skills and knowledge are already well known to them. For every response in the Generation category participants indicated that the collaborator required the same knowledge and skills as themselves in order to complete the task. Participants' preferences for dividing work on tasks within the *Generation* categories were generally fairly evenly split between "Them" and "Me". However, across all responses they were slightly more likely to choose to hand over control to a collaborator for these tasks, and in one case chose to hand over full responsibility for the task to the collaborator.

These results from the *Generation* category demonstrate two points. First, in all cases in this category participants were looking for help with creative tasks that they believed they already had the ability to complete themselves. Nevertheless, in the majority of cases they wished to hand over the task to a collaborator. The participants in this study were therefore not looking for collaborators who could perform creative generation tasks that were out of their abilities, but instead wanted to hand off tasks that they could complete themselves but chose not to. This is different to the Google Diary study, in which some participants desired a collaborator who could generate creative outcomes which they did not have the skills to do themselves (Chapter 5). This perhaps highlights differences in the skills of the participants in the two studies. It also reinforces the observation from the *Information* category that participants may be more confident or willing to hand over tasks they are confident in performing themselves.

Second, although in the majority of cases participants wanted to hand over most of the task to the collaborator, there were still several situations where the participants wanted to retain more of the work on the task themselves. This is most clear with the "Extend or finish work" subcategory, where it might be anticipated that participants would have a significant role in starting the task or setting the boundaries. However, even in the "Automate tasks" subcategory, where less responsibility for the participant might be implied, on two of the five responses the participant chose to retain more of the work on the task.

This is different to the responses in the *Information* category, where the subcategories in which participants believed they already had the required knowledge or skills to perform the task were associated with a much clearer preference for being handed over to a collaborator. Within the *Generation* category the division of work is more complicated, with participants wishing to retain overall control of a task, even for situations where they describe not wishing to perform the work.

For example, in response E3 the participant described the help they required as "ideally the collaborator would take all these logos and would add white backgrounds… so I don't have to". Although this seems to be a clear description of the collaborator performing a mundane task which the participant didn't want to have to do themselves, they selected "Me" at a medium level when choosing who should complete more of the task.

Other responses in the Generation category where the participant wished to retain overall control shared similar descriptions. Participants normally wanted a situation where they were setting up a process for the collaborator or where the participant was responsible for checking and selecting outcomes from the collaborator. For example, E2 describes a task where "the collaborator would follow the templates and design guidelines that I will establish and convert all the old PowerPoint presentations according to new guidelines". Similarly, in response A5 the participant describes a situation where "the ideal collaborator would genuinely just give me good layout options…, I provide like all the imagery and the text [that] needs to go with it, and they can just lay out very nicely and simply [in a way] that is visually pleasing". These responses describe a situation where the participant wishes to retain a level of control over the generative process, by taking responsibility for some of the creative decision-making, either at the beginning of the task or at the end.

This kind of active control or management is also described elsewhere in the *Generation* category, even in responses where the participant wanted the collaborator to take on the majority of the work. For example, in response B2 the participant states that “it would be nice if I could explain briefly, verbally, what it is, what I want the layout to be, and [it] automatically generated a few different options for me to look at before I choose one of the directions”. In response B5 the participant states “it will be quite useful if a collaborator could help me with kind of creating the initial standard template with all the default information or section included, and I think [I’ll] just go in and tweak each section based on the context”.

This lack of confidence in the collaborator to produce a fully satisfactory or completed generative outcome is evident in participant’s responses despite the fact they were asked to imagine an ‘ideal’ collaborator who could perform whatever tasks they wished. This might suggest that the participant’s desire to retain an active role in generative tasks is not entirely about a lack of confidence in the collaborator’s abilities, but instead related to a desire to retain a level of creative ownership over the outcomes of the task.

The equivocal attitude towards collaboration described in the *Generation*-related responses is slightly different to that described in the *Information*-related responses. When participants wanted to hand over a task to a collaborator in the *Information* subcategories “Suggest references” and “Organise resources”, their responses did not describe setting guidelines for the collaborator, or selecting and amending their work. In the *Information* category the responses indicate that the participant had more trust in the collaborator producing a satisfactory final outcome. For example in response A8 the participant states that the best collaborator “would be able to point you towards the correct different examples of good use of iconography”. This suggests that the participant felt that there is a definitive set of information that they require, and an ideal collaborator would be able to produce this without guidance or confirmation from the participant.

Similarly in B4 the participant states that “if I say I would like to see a flow diagram of someone using Google to do an image search and then the collaborator could just provide me with a flow diagram that shows the key points of interaction”. This description does not include any secondary act of checking or editing on the part of the participant. Neither do responses within the “Organise resources” subcategory, such as response C6, where the participant expects the collaborator to simply “make notes and organise them after workshop”, without mentioning any guidance or discussion from the participant.

The differences in these attitudes towards the division of work suggests a level of complexity related to the *Confines* element of the proposed Creativity Support Framework. It could be that individuals define their preferences in this area in relation to their attitudes towards creativity, and their sense of creative ownership over the tasks they are working on. Further data on participants’ perception of the relative ‘creativity’ of a task may help this to be defined more accurately.

9.2.4 Human vs AI Collaborators

Question 6 asked the participants whether they would prefer a Human or AI collaborator for the task in hand. The previous questions asked the participants about their preferences for an “ideal collaborator” to support the task, without stipulating whether this might be another person, or an AI-based tool. The participants were told from the beginning that the study was related to AI support for creativity, and were shown all six questions in advance of using the research device, so when imagining their ideal collaborator they may possibly have had AI collaboration in mind. However both possibilities were kept open within the questions. Question 6 was intended to address this directly, in order to understand how far participants would be willing to work with AI on their creative tasks.

The results show that in 16 out of 24 submissions (59%), participants actually preferred to have an AI collaborator for their task over a Human collaborator, which was only requested in 7 submissions (26%). In 4 submissions (15%) participants did not have a preference for either Human or AI

The preference for AI rather than Human collaborators was strong across nearly all of the reported support categories and participants. Only one participant (participant A) expressed a preference for a Human collaborator more often than an AI collaborator. All the other participants had a clear preference for an AI collaborator across the tasks they reported, with three participants not choosing a Human collaborator at any point in the study.

	Human	**Equal**	**AI**
Participant A	6	1	4
Participant B	0	2	3
Participant C	0	1	5
Participant D	0	0	2
Participant E	1	0	2

Table 9.7:Individual participant's preferences for human or AI collaborators
Total number of times each participant expressed a preference for Human collaborator, an AI collaborator, or an equal preference for both.

This general preference for an AI collaborator might be anticipated to some extent within the *Generation* category of support, where participants were requesting for tasks to be automated or completed on their behalf. However, the positive attitude towards AI also covers most of the *Information* categories of support, including tasks where the participant wanted an expert collaborator to guide or advise them, such as in responses A8, A9, and D2.

Participants preferred an AI collaborator in all the reported subcategories apart from “Specialist knowledge”, where there was a strong preference for a Human Collaborator. The difference in this particular category is largely due to the results from Participant A, whose responses frequently combined the

"Specialist knowledge" subcategory with a preference for a Human collaborator.

Taking the multiple results from Participant A into account, the responses from other participants also indicated that there was slightly less preference for AI collaborators in the Information support subcategories "Specialist knowledge" and "Guide through a process", with participants either choosing a human collaborator for these tasks (e.g. response E1), or expressing no preference for an AI or Human collaborator (e.g. responses B1 and C2). This is in contrast with the much stronger preference for AI collaborators in the other subcategories.

			Preference for Human or AI Collaborator										
			Human					=	AI				
			High				Low		Low				High
Support Category			**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	Information	**Suggest references,**	0	0	0	0	0	0	0	2	1	0	0
		Specialist knowledge,	1	0	0	2	3	3	0	0	1	0	0
		Guide through a process,	0	0	1	0	0	0	1	0	0	1	0
		Organise resources,	0	0	0	0	0	0	1	0	0	1	0
	Generation	**Automate tasks,**	0	0	0	0	0	1	0	2	1	0	1
		Generate imagery,	0	0	0	0	0	0	0	0	0	1	0
		Extend or finish work,	0	0	0	0	0	0	0	1	2	0	0
	Situation	**Facilitate collaboration,**	0	0	0	0	0	0	0	0	0	0	0
		Assist focus,	0	0	0	0	0	0	0	0	0	0	0
		Motivation,	0	0	0	0	0	0	0	0	0	0	0
		None of the above	0	0	0	0	0	0	0	0	0	0	0

Table 9.8: Preferences for human or AI collaborator, mapped to support category.

These preferences indicate that the same split within the *Information* category of support which was observed in the participant's responses to Question 5, may also apply to the participants' attitudes towards collaborating with AI. The subcategories “Specialist knowledge” and “Guide through a process” were the subcategories participants were more likely to perceive as requiring expert skills or knowledge that they did not possess, and were more likely to want to work on themselves rather than hand over to a collaborator. They also appear to be the subcategories in which participants are less confident to involve an AI collaborator.

		Preference for division of task										
		Human					**=**	**AI**				
		High				Low		Low				High
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Preference for Skills / Knowledge	Knows What I Know	0	0	0	0	0	0	1	0	0	0	0
	Knows What I Know / Does What I Can Do	0	0	0	0	0	0	0	1	0	0	0
	Does What I Can Do	0	0	0	0	1	1	0	3	4	2	1
	Does What I Can Do / Knows What I Don't Know	0	0	0	0	1	0	0	1	0	0	0
	Knows What I Don't Know	1	0	0	0	1	2	0	0	0	1	0
	Knows What I Don't Know / Does What I Can't Do	0	0	0	1	0	0	0	0	1	0	0
	Does What I Can't Do	0	0	1	0	0	0	0	0	0	0	0
	Does What I Can't Do / Knows What I Know	0	0	0	1	0	1	1	0	0	0	0

Table 9.9: Preferences for human or AI collaborator, mapped to the skills/knowledge required.

Table 9.8 compares the participants preference for Human or AI collaborators with their preference for the skills and knowledge of the collaborator. From this it can be seen that tasks requiring the same skills or knowledge as the participant are more often associated with AI collaborators, whilst tasks requiring different skills or knowledge are more often associated with Human collaborators. Tasks which require a combination of same and different competencies, e.g. “Does What I Can Do / Knows What I Don’t Know” and “Does What I Can’t Do / Knows What I Know”, have an even distribution of preferences between Human and AI collaborators.

9.3 Follow-Up Survey

After each participant's study period had ended and the device had been collected, they were asked to complete a final follow-up survey online. This survey was designed to collect data related to two areas. First, to find out more information about the participants' knowledge of AI to provide context for their answers to Question 6 of the study. Second, to gather feedback about the experience of using the digital device during the study.

All the questions provided data about the participant’s use of embedded AI in the creative workplace which helped inform Research Question 3 from the overarching research (“*What opportunities exist for creativity to be supported by personalised, embedded AI systems?*”).

9.3.1 Attitudes to AI

To gain a better understanding of each participant’s level of experience relating to creative AI, Question 8 of the follow-up survey asked whether participants had any knowledge or experience of using the type of generative AI tools which were publicly available at the time of the survey.

The results from this question (Table 9.9) showed that participants reported good overall knowledge of the capabilities of the AI tools specified, with two participants having used them multiple times, two having used them once or twice, and only one participant who hadn't used the tools but had seen examples of what they could do.

As the participants were self-reporting their own experiences, their level of knowledge of AI technology is not objectively verified through this survey. However, by reporting their experience in relation to their use of existing tools, the results are more grounded than if the participants were just asked to rate their own understanding. Based on their experience of these tools it's possible to see that the participants had some first-hand experience of the current creative capabilities of AI tools, and their attitudes towards working with AI collaborators can be assessed in the context of this experience.

Recently, some Creative AI applications have become available which use AI to automatically generate or modify media such as text, images and video (for example, Dall-E, ChatGPT, Midjourney, Craiyon, Runway ML). Please select the option which best describes your knowledge of these kinds of Creative AI applications.	
Experience of Creative AI Applications	**Number of responses**
I have no knowledge of Creative AI applications at all	0
I have seen examples of what they can do, but have never used them	1
I have used them once or twice	2
I have used them multiple times	2

Table 9.10: Participants' existing knowledge of generative AI tools

Questions 6 and 7 of the follow-up survey asked participants, based on their knowledge of AI, what creative tasks they felt AI systems would be most and least capable of performing. When considering the tasks that AI would be most capable to perform, participants reinforced the views expressed during the rest of the Digital Probe Study by referencing a range of both *Generation* and *Information* related tasks.

All participants mentioned generative or image-based work when considering the creative tasks which AI would be capable of performing. These types of tasks generally reflected the functionality of current AI tools such as Midjourney (Midjourney, 2024) and ChatGPT (OpenAI, 2022), which all participants reported having knowledge of in Question 8 of the survey. The tasks mentioned by participants included creating illustrations and layouts (Participant A), generating imagery, 3D models, and wireframes (Participant C), or editing or enhancing current images (Participant E). Participants also mentioned text-based generative tasks such as writing emails (Participant A), problem statements (Participant C) and research questions (Participant D).

Participants didn't just think that AI tools were limited to the generative functionality offered by the existing image-based AI tools. They also reported that they thought AI was capable of more information-related, analytical or knowledge-based tasks, such as organising and finding patterns based on existing data (Participant B), competitor analysis (Participant C), creating research plans and advising on the best approach to designs (Participant D). These reported opinions support the preferences expressed in Question 6 of the device study, showing that participants are confident in allowing AI to provide knowledge-based and analytical support for their creative work.

When asked about the types of support that AI would be least capable of supporting, participants gave a range of views that at first seemed slightly at odds with their views on what AI would be most capable of supporting, indicating some nuanced opinions in this area. For example, both Participant A and D expressed concerns with the ability of AI to work on communication tasks, whilst also stating that they felt AI would be capable of supporting some communication related tasks. Participant A felt that AI would struggle to "parse language" or "understand contextual work", but was confident that AI could write initial drafts of emails or reports. Participant D stated that they thought AI would be least capable of supporting tasks "that require communication skills" such as conducting workshops and meetings, but was confident it was capable of communication related tasks such as writing research questions and interview scripts.

Clearly there are distinctions between the different types of communication tasks these participants had in mind, for example the ability to communicate one to one with people in a research workshop, and the ability to write scripts in advance for that workshop. This illustrates that communication in relation to creative activities requires different types of support, and this difference might reflect the split in the *Information* category of creativity support seen elsewhere in the study.

There were other minor contradictions in opinions about what AI would be most and least capable of supporting. Participant B stated that AI would be least able to “comprehend and assign meaning to data”, but also that AI would be most capable of “finding patterns based on existing data”. Participant C stated that they believed AI was least capable of “facilitating the discovery stages of the design process”, but also that it would be most capable of tasks such as “competitor analysis”, and considering the “research or background of the design in question”.

Considering the consistency of these tensions between responses to questions 6 and 7 of the follow up survey, and the otherwise generally clear and informed responses to questions relating to AI, it seems that the contradictory elements of these positions are most likely related to a complexity of attitude towards the abilities of AI. This could be drawn out with further research. The survey method did not allow for follow up questions, or open discussion of attitudes, and this might be useful in order to understand participants' positive and negative views of AI in more detail.

Novelty was another factor which participants raised when considering the elements of creativity which AI would be least able to support. Participant B stated that AI would be least able to “create new concepts or ideas of seemingly unrelated information”. Participant C stated that they felt that, for AI, “coming up with new more novel ideas and especially design methods is currently a difficult task and would be in the future as well”.

This focus on novelty conforms with the standard definition of creativity combining Novelty and Value, as discussed in section 2.2.1. Participants placing importance on the concept of Novelty may also align with the observations related to Question 5 of the study, where participants were more likely to delegate tasks which they were familiar with performing themselves, and more likely to want to personally work on tasks where the knowledge or skills were novel to them. This may indicate that for these participants the values used to assess creative outcomes are similar to the values used to assess creative work experiences, and that this in-turn may help define the type of support they require.

A final concern that was expressed by participants when considering what tasks AI would be least able to support related to interactions with humans. Several participants stated that they felt AI would not be suited to creative tasks where knowledge of human experience was required.

Participant A stated that AI would struggle with tasks related to user research, where it was useful to be able to understand contextual information, for example, to be able “to read someone's body language”, or “understand contextual work and complexities of life”. They also expressed similar views in their response to Question 10 of the follow-up survey, which asked participants about their general feelings about using AI to support their work. Here, Participant A stated that “I fear that if people see it as being useful in every aspect of the creative process then we will lose that human touch that makes things such as art, literature, film making, and design so special”.

Participant C was concerned that AI may not always produce outcomes that were appropriate to humans, so that perhaps “[the] role of designer would shift more to ensuring AI outputs aligned to people's needs”. Similarly, Participant E stated that AI would be least capable of providing feedback on “whether the final output of your project will be well received by the client”.

Participant D stated that AI would not be able to replace them for parts of the creative process which required communication with other people, such as “conducting workshops, meetings, aligning goals with different teams etc.”. They also reinforced this view in their response to Question 10 of the follow up survey, stating that “AI is still not human enough to handle tasks that need to put human[s] at the centre”.

These statements provide a clear sense that human collaborators were required for parts of a creative project where knowledge of human experience was necessary, and that the closer an outcome or activity of a creative task interfaced with other people, the less suitable it was to be performed by an AI. This view corresponds with the views expressed by participants in Question 6 of the study, where the “Specialist knowledge” subcategory was often associated with types of support involving talking to other people to get advice or expert opinion, and participants usually wanted human collaborators for this support.

Even though there was a clear attitude across multiple participants that AI was not suited for tasks involving knowledge of human communication, there was still some complexity of attitude apparent in participants’ responses between different questions of the follow up survey. For example, although Participant D stated that they did not think AI could handle tasks that need “to put human[s] at the centre”, they still felt that they would be well suited to helping with “user research”, and when asked if they had already used AI applications to support their work (Question 9 of the follow up survey) they stated that they had used ChatGPT for help “writing emails, and leaving cards for ex-colleagues”. It therefore seems that, as with knowledge-based support, participants’ definitions of what constitutes human-centred communication might be complex, and require further research to help understand how these distinctions are made.

9.3.2 Attitudes to the Digital Research Probe

The other questions in the follow-up survey aimed to capture feedback about the use of the digital research probe as part of the study. In particular they asked participants about their positive and negative experiences of using the device (Questions 1 and 2), their feelings about talking to the device about their work (Questions 3 and 4) and any concerns they had relating to privacy (Question 5).

In general, participants reported positive attitudes towards using the device during the research. Practically, participants found it easy to set up and use. For example, Participant A stated that “the instructions were clear and [I] had little problems around technical setup”, and also that “it was easy to record and go through the process” of using the device.

Participants were also generally positive about the physical, visual, and audio design elements. Participant D noted that it was a “small device with minimalistic design that can be placed seamlessly on your work desk”. Participant E stated that they “liked [the] colours of the interface (reminded of candy)” and also that they “liked the interface itself especially the sliders and the round screen”. Similarly, Participant C was positive about the slider interface, stating that they “liked [the] layout of choosing [the] level of human vs. machine for a particular task”. Several participants also mentioned the subtle sounds that the device made when it woke up, for example, Participant E reported that they “loved the wake-up sound” and that they “really enjoyed recording voice messages and reflecting on the tasks”.

This last point was repeated by other participants, who were also positive about the process of verbally reflecting on their creative tasks as part of the study, indicating that this in itself helped them in their creative process. For example, Participant B was positive about the fact that using the device “encouraged me to stop and reflect on my ways of working and process”, and Participant A stated that “the device helped me talk through my problems I was having with a task and did sometimes help clarify what creative task I was trying to complete and how I could go about completing it”. The participant also compared this process to the concept of “rubberducking” in coding and debugging practices (Hunt and Thomas, 1999, p.95).

When considering the negative aspects of using the device, the most common concern related to how participants selected categories for the type of support they required (Question 2 of the study). For example, Participant A stated : “I did struggle with trying to place where my creative problem was in the categories or I felt that I was repeating the same categories”. Similarly, Participant C noted that “I didn't seem to use most of the suggested categories for the task I was explaining”.

There may also have been issues with the design of the interface of the support category question, with Participant D noting that “the text [is] a bit too small, especially on the screen with the list of tasks”, and Participant E noting that “the screen could have been bigger, I imagine someone with dexterity issues might found it difficult to use”. The reported issues with the design and content of this question screen reflect the issues with participants' responses to this question (described above), and the need to re-assign some of the support categories selected by the participants, based on their descriptions. Clearer naming of subcategories and a more accessible interface for selecting them would be required for any future versions of the study.

	The research device asked some questions which required you to record your voice. On a scale of 1 to 5, how comfortable did you feel talking to the device about your creative tasks?				
	Very Uncomfortable			**Very Comfortable**	
	1	2	3	4	5
Participant A				x	
Participant B				x	
Participant C					x
Participant D		x			
Participant E					x

Table 9.11: Participants’ attitudes towards voice recording.

In Question 3 of the follow-up study, participants were asked to rate how comfortable they were talking to the device about their creative tasks, using

Likert-style scale from one to five. This question, in addition to Question 4, was intended to understand how suitable the voice interface of the device was for capturing data about the creative process.

Overall, participants were positive about the experience of talking about their creative tasks to the device. Four out of the five participants rated their attitude as Comfortable or Very Comfortable. In their written responses to Question 4, which asked for more detail about the positive or negative experiences of describing tasks to the device, some participants explained their preference for talking to the device. Participant A stated : “I was comfortable for the most part in talking to the device… I found it easy to jump into talking about the creative task”. Participant E stated “I find it difficult to do surveys with very standardized questions. My mind goes numb and I have 0 motivation to fill it in. But when I can record my messages, I can share my thoughts easier, [and] give nuance”.

Participant D rated their experience of talking to the device about their creative tasks as ‘Uncomfortable’. Within their response to Question 4 they related this to their concerns about sharing sensitive information. They stated “most of the time I'm working on things that are too sensitive - I found it hard to describe the task without much details”. This reflects the shorter answers that Participant D gave compared to other participants.

The perceived privacy of the participants, particularly in relation to sharing commercially sensitive information, was an issue that was anticipated during the design of the study, and resulted in the various privacy features which are incorporated into the design and functionality of the device. The response of Participant D, in addition to the feedback of other participants in response to Question 5 of the follow-up survey, indicates that the privacy concerns were correctly anticipated and the additional privacy functionality was necessary.

Question 5 specifically asked participants whether they had any privacy concerns related to using the research device in their workspace. This revealed that multiple participants were mindful of privacy issues when using the device.

For example, Participant A was concerned “if you say the keyword to wake the device it will record and store that instance of the device waking”. The participant was particularly concerned about this as they worked in a home office, and were therefore worried that the device might accidentally capture conversations outside of work hours.

Participant B was concerned that the device sometimes woke up, even when the wake word was not spoken, or the voice activation was turned off. This may have been due to the device being programmed to light up twice a day as a prompt to remind participants to use the device. The device didn’t record any audio on these occasions unless the participants chose to proceed, but the functionality may have been confusing.

Some participants reported mitigating any concerns related to privacy, either by turning off the voice activation functionality (Participants B and C) or additionally turning the device off completely when they weren’t working (Participants A and C).

Apart from being mindful of these concerns, participants also reported being satisfied with the privacy features which were designed in to the device. For example, Participant D reported their privacy concerns, saying “my work desk is located at my bedroom so at first I was worried to have a device with built-in microphone at my room, especially during meetings and non-working hours”. However, they went on to say “but soon enough it's pretty clear that the device wouldn't record before I press the button”. Participant E reported that they had no privacy concerns, stating that “I knew the device was not connected to the internet. It felt like a black box that I talked to in the morning”.

The final issue reported by participants about their use of the research device during the course of the study, related to the challenge of concisely summarising their creative problem. Question 1 of the study asked the participants to describe the task that they were working on, and Question 3 asked them to describe the type of support they required. For both these questions, they were able to record a maximum of one minute of audio as a response. While participants' responses rarely needed all of this time (only one response used the full minute), participants reported that articulating their task or problem as a single concise statement was difficult. For example, Participant B noted that "sometimes, it can be a bit hard to explain the task without giving too much contextual information in a 1 min audio [recording]". Participant C expressed the same concern, stating that "it was very difficult to describe the creative task in a short concise manner without explaining the context behind [it]". They added that "it was difficult to describe my tasks only using words since as designer, I generally use both verbal and visual formats to describe what I am working on".

The constraint of verbally describing the context and details of a creative task within one minute was partially due to the practical limitations of the research device, and the need to manage the storage, transcription and analysis of the participants' recordings. The upper limit of the recording time could easily be extended, although given the participants feedback, it might not be that more time is the only thing that is needed in order to communicate the context and intentions of a creative task.

The challenge of concisely summarising a creative task or support request for the research device illustrates an issue relevant to how designers may use future AI-based CST. The research device was designed as a voice interface, in part to emulate the voice or chat interfaces of current AI tools and assistants. Therefore it is likely that generative AI tools or creativity support systems using this approach to interfaces will face similar issues of enabling users to explain the creative task they are working on, and the specific support that they currently need. Explaining the context of a task is likely to be complex, and may not easily be achieved with a simple problem statement. Also, as Participant C mentioned, the explanation of a design task may require visual as well as verbal communication. Therefore, understanding the support needs of a designer may require more complex interface mechanisms than just voice or text.

9.4 Conclusions

The Digital Research Probe study provided an opportunity to successfully address the three aims of this stage of the research, and to make a series of new observations which extend the insights from the Google Diary Study, and point to potential new areas of research and development for AI creativity support tools.

This section will address each of the three aims of the study, and summarise the conclusions resulting from each one.

9.4.1 Study Aim 1

The first aim of the study was to investigate the same creativity support role questions as the Google Diary Study, with a different cohort of participants from outside of that company.

This was achieved through the development and deployment of the digital research device, which posed a set of questions based on those used in the Google Diary Study, as well as further questions that followed up on observations from the Google study.

The multi-week study allowed participants to respond to questions over an extended time frame, as with the Google study, meaning participants submitted data relating to multiple different tasks and periods of work.

Participants were recruited from digital interaction and experience design disciplines, and were therefore working on comparable digital design and user focused tasks as the Google participants.

These factors allowed data from this study to be compared with the data from the Google Diary Study, and valuable similarities and differences to be observed (summarised below). However, the scale of this study was a limitation which slightly restricted the conclusions which could be drawn from the data.

This study was always intended to be a small sample size in order to test observations from the larger Google Diary Study, and it was never intended to be able to draw broader statistical conclusions from the data. However, the small study size meant that there was limited breadth in the variety of roles and tasks performed by participants. This may account, for example, for the lack of responses within the *Situation* category of support, which was represented by a minority of responses in the Google Diary Study.

The small sample size, coupled with the fact that participants were instructed to submit responses as and when the need for support occurred, rather than on a regular schedule as with the Google Diary Study, meant that whilst the quality of the responses was good, the overall number was limited. A larger number of participants could have allowed the same 'as and when' approach to reporting which encouraged in-the-moment data collection, whilst potentially gathering a larger range of responses from participants.

The semi-automated nature of the reporting, and the ability to scale the study by deploying multiple research devices, does make it possible to extend the study with further participants in the future if the research was to be taken further.

9.4.2 Study Aim 2

The second aim of this stage of the research was to compare the results of the current study with the results and conclusions of the Google Diary Study. This was in order to determine the extent to which the results from the Google Diary Study were reproduced with different participants, and to be able to test how far the Creativity Support Framework proposed at the end of the Google study (*Categories*, *Confines*, and *Competencies*) could be applied to the latest results.

To what extent are the results from the Google diary study reproduced in

the current study?

Overall it was found that the challenges and attitudes reported by participants in this study were very similar to those reported in the Google study. The types of creative support requested by participants aligned with those reported in the previous study, with a similarly high proportion of participants requesting information-based support to help them complete their creative tasks.

There was also an equivalent preference for support which took the form of talking through a problem with an informed colleague. This study also identified complexity and unpredictability in how individual preferences for how a task should be shared with a collaborator, although the additional questions in this study allowed further insights to be gained in this area (discussed further below).

Participants in this study also reported a generally positive attitude towards the use of AI in their creative work, which was an attitude shared with participants in the Google Diary Study. This was notable, as it was possible that participants working within a technology company might have exhibited an unrepresentative bias towards new technologies. However, participants in the latest study, who did not work within the technology industry, still presented this positive attitude towards AI. In fact, their attitude could be viewed as more positive than that of those in the Google study, with participants in this study choosing to use AI in a large majority of cases. This apparent increase in popularity may be partially due to the rapid development in generative AI tools in the period between the two studies, and the resulting increase in the availability and sophistication of these tools to participants. All participants had either personally used or seen the results of generative AI tools by the time of the latest study, and this may account for a higher level of acceptance of their practical use in the creative process.

There were no significant differences between the results of the Google study and the latest study, except for the fact that no participants requested support within the *Situation* category of the proposed framework. However, this still reflects the general preferences reported within the Google study, where motivational support, or help with the personal contexts and arrangements for creative work represented by the Situation category, was by far the lowest requested category of support. As discussed, the lack of requests in this study may be a statistical consequence of the small size of the participant group.

To what extent can the proposed Creativity Support Framework (*Categories*, *Confines*, and *Competencies*) be applied to the results of the current study?

Within the limited context of this study, the framework for creativity support proposed at the end of the Google study proved to be a useful way of probing the creative collaboration preferences of the participants, resulting in data which supported observations from the Google study, as well as suggesting new insights. The observations relating to each of the three areas of the framework are summarised below.

Categories

- The participants' responses could be mapped to the existing categories, and in very similar proportions to the Google study. No participants indicated that none of the categories suited their task.
- However, frequent mis-categorisation of support by participants indicates some confusion or complexity related to the subcategory definitions, and the ability of participants to self-categorise the type of support they need.
- Definitions within the *Situation* category may require development, as some participants made support requests in this category which required reassigning. It may also be that some support requests in other subcategories - in particular "Organise resources" may fit better into this category.
- Across several of the questions in the study, there was a clear division in the *Information* category with the subcategories "Specialist knowledge" and "Guide through a process" in one group, and "Suggest references" and "Organise resources" in another group.

- The “Specialist knowledge” subcategory was most selected, and this was reflected in the participants' descriptions of their task, but this subcategory also covered a broad range of tasks, and the definitions of this subcategory might require better definition.
- The “Specialist knowledge” subcategory was often associated with participants' request to talk through a creative challenge directly with a collaborator. The desire to engage socially with someone was common within this subcategory, although the type of task being discussed was varied.

Competencies

- Participants often wanted a collaborator who had the same skills as themselves. They less frequently wanted a collaborator who had skills which they did not possess themselves.
- This represents a slight difference with the Google study, as some of the participants in that research were managers who were working on creative tasks, and wanted access to the creative production skills of designers or engineers. If the current study had also included participants from management roles it is possible there may have been more requests for collaborators who had different creative skills.
- Participants often chose a collaborator with the same skills or knowledge for support requests within the *Information* category. This suggests that the requests weren’t always about sourcing new knowledge, or completing research that they couldn’t do themselves. Participants’ references to talking to collaborators suggest that within this study there was a social element to support related to information.

Confines

- Overall, participants were not protective about keeping control of the creative tasks that they reported. They indicated that they were happy to hand over the majority of tasks to a collaborator in all but three of the support subcategories.

- The same division of subcategories was seen within the *Information* category of support, with participants more likely to want to have personal control over tasks within the “Specialist knowledge” and “Guide through a process” subcategories, and to want to hand over control of the tasks within the “Suggest references” and “Organise resources” subcategories.
- The desire to maintain personal control over the subcategories “Specialist knowledge” and “Guide through a process” suggests that participants may have found more personal value in working on these subcategories themselves
- As participants associated these subcategories with skills or knowledge that they did not already have, it might be that any higher sense of value participants placed in these subcategories derives from an expectation of learning new skills or knowledge.
- Participants were less keen to keep control of tasks that they easily knew how to perform, often characterising these tasks as laborious or less interesting, and treating them as less valuable.
- Participants were more confident in handing over tasks which they knew how to perform themselves. This may indicate that a participants’ self-confidence in the skill or knowledge for a task may extend to confidence in a collaborator performing it on their behalf.
- A slight variation to this could be seen in the Generation category where participants were still inclined to keep control of some elements of the task themselves, and described closer involvement and checking of the results than they did in the Information category.

Attitudes towards AI

- All participants had experience of generative AI systems according to the follow up survey, either having used them directly or being familiar with their outcomes

- Participants were generally happy to work with AI collaborators for their creative work, favouring them over human collaborators for many different types of support.
- In the follow up survey participants expressed concern about the ability of AI to produce original or novel outcomes. This was reinforced in their responses within the main study, where they most often reported wanting AI to work on tasks that did not require them to produce original outcomes or insight, such as suggesting existing references, automating repetitive tasks, or extending existing work
- The other concern participants raised about AI in the follow up survey was its ability to understand challenges or issues from a human perspective. Again this was reflected in their answers to the main study, where the subcategories in which participants described desiring personal insight ("Specialist knowledge" and "Guide through a process") were the ones for which they were more likely to request human collaborators
- Participants were more likely to choose an AI collaborator for tasks which they had the knowledge or skill to perform themselves

9.4.3 Study Aim 3.

The final aim of the study was to assess the suitability of the Digital Probe method of data collection.

What are the advantages and disadvantages of using embedded AI digital research probes with participants over a multi-week research study?

The benefits and drawbacks of using the digital research devices were assessed by eliciting participant feedback on the devices through the follow up survey, and through reflection on the process of conducting the research.

In general, it was found that participants were positive about the process of using the devices, reporting that they were happy with the design and functionality of the device, and the practicalities of setting it up and using it.

The hybrid graphical and voice interface was effective at capturing a range of inputs from the participants. Detailed descriptions of tasks and support preferences were captured through the voice recording functionality, and these proved valuable in determining participants' preferences when category selection methods proved less reliable. The touchscreen enabled graphical sliders allowed simple data to be captured quickly, and participants were positive about the design of these screens.

The more complex menu selection screen for the subcategories question (Question 2 of the study) was less successful. This was partially because the definitions of the options provided were not always clear to participants, and this list of subcategories would need to be developed further and the language better defined for any further studies. However, issues with the screen also stemmed from the density of information on the screen and the need to scroll on a small circular screen. From an interface design perspective, better methods of presenting multiple choice questions should be considered for further studies.

During the design of the research device, a lot of consideration was given to privacy, and in particular to ensuring that the device could operate offline, without a Wi-Fi connection. This influenced many factors in both the software and hardware design, as well as how the study was deployed and managed. It would have been possible to reduce some complexity in the design process by making a connected version of the device. This also would have provided some advantages for managing the study, as it may have been possible to remotely monitor the progress of the data collection in real time, for example checking how regularly participants were using the device, identifying and troubleshooting any technical issues, and beginning the evaluation of the data sooner. However, all these administrative advantages would have come at the cost of privacy.

The approach taken to prioritising privacy on behalf of the participants seems to have been justified, based on the feedback in the follow up survey, and also the questions related to privacy which some participants asked prior to agreeing to take part in the study. Participants were mindful of privacy issues, reflecting on their concerns about how and when the device was recording sound. In the follow-up survey, several participants reported using the built-in controls, such as disabling the voice activation, or closing down the device outside of work hours. If the security measures were not in place, and participants were not made aware of them before the study began, it may not have been possible for participants to have engaged in the study to the same degree.

According to their feedback, the built-in security measures satisfied most participants, and allowed them to take part fully in the study. It's notable that the participant who expressed the greatest concerns about privacy before and after the study, supplied the briefest responses during the study. They still felt able to take part due to the knowledge that their data was protected, but their concerns still impacted their engagement. Without being able to reassure participants about the privacy measures that were in place, it seems possible that others may have been in this position too, and it may not have been possible to capture the same level of data.

One consideration related to privacy is the value of utilising a voice interface within the design of the device. Some participants associated their privacy concerns with the "wake word" functionality of the device, where participants could activate a data collection session by saying a specific phrase to wake the device up, and proceed with the questions using voice commands.

As noted in the design phase, the privacy disadvantage of this functionality is that a microphone has to be active on the device in order to recognise the wake word when it is spoken. The data from this active microphone is not stored, and the lack of internet connection means it can not be remotely accessed. However, some participants were aware of the privacy considerations in relation to this, mentioning it directly in the feedback, and choosing to deactivate the voice command functionality in order to mitigate any perceived risk. Participants particularly associated this concern with the fact that they were using the device in home offices, and shared live/work spaces.

A voice interface was chosen for this study, partly because it offered some convenience for participants when initiating a data collection session, allowing them to begin the process without having to stop any physical tasks they were engaged in. It was also chosen because that style of interface to some extent mirrored the subject of the study. It potentially established a conversational mode of interacting with the device, which orientated and prepared participants for the voice recording sections of the data collection, and also broadly reflected the kind of reciprocal, collaborative interactions the participants were being questioned about.

Requiring participants to speak effectively to the device about their creative requirements was analogous to the process of speaking to a collaborator about their needs. The fact that the participants were also conducting a creative conversation with a digital device rather than a person, also provided them an opportunity to reflect on the specific differences between talking to an AI system about creative tasks, and talking to another human.

The extent to which these benefits impacted this study was limited slightly by the relative simplicity of the voice interface on the device. An important reflection on the design of the device was that as a result of the privacy requirements of the design, coupled with the technical limitations of embedded AI chat interfaces at the time of the study, the final version of the device only utilised basic AI-enabled voice recognition such as wake word and predefined command recognition. This meant that it wasn't possible to test a more advanced, responsive, and conversational interface which could have been offered by online AI chat interfaces.

However there were still benefits of establishing the voice mode of interaction in this study, and some of the participants' feedback did stem from this verbal method of interacting with the device. For example, participants reflected on the difficulty of contextualising their creative task in a succinct way for the device, and also the difficulties of AI understanding the context of human creative challenges. They also spoke positively about the experience of talking a creative problem through with the device, and expressed a desire that the device could have responded more and provided feedback on the problem.

Furthermore, while the version of the device in this study may not have been able to support more advanced conversational voice AI, it did enable the testing of some methods related to the privacy of voice interfaces and AI enabled research devices. This may help support good practice in the development of these devices in the future, as embedded AI technology advances, and the ability and accessibility of AI-enabled research devices increases.

9.5 Recommendations

9.5.1 AI-Enabled Digital Research Probes

As noted above, the voice interface functionality of the devices is something that could be reconsidered for future research. While it is possible to say that including the voice interface helped enhance elements of the data collection in this context, it's also evident that it heightened privacy concerns for some participants. For future research, it's therefore worth considering whether the voice interface functionality is a worthwhile addition to the research device. A more practical approach may be to keep the voice recording functionality for answering questions, as this provided valuable data for the study, but to remove the voice interface and just relying on touchscreen interactions.

This approach to privacy may present a better model for using digital research probes in future studies. Beyond this issue however, the study demonstrated that using such devices can be beneficial for multi-week studies. The devices were deployed for an extended period without any technical issues or failures. The physical presence of the device in the participants' workspace enabled the collection of rich 'in the moment' data relating to their ongoing work activities, in a way that would have been very challenging to achieve with human researchers or online data collection software.

As embedded AI tools become more advanced, and the data analysis that can be achieved on device, rather than in the cloud, enhances, more useful data collection methods could be included within the device. For example, analysing and responding to participants' responses in a more active way, prompting them with follow-up questions, or questions related more specifically to their context. The data from this study suggests that this kind of AI functionality may enable valuable, scalable, and long-term data collection that would benefit researchers and designers, as long as the security benefits of embedded AI systems are utilised in a way that clearly maintains participant privacy.

9.5.2 Framework For Creativity Support

The framework for creativity support proposed at the end of the Google study (*Categories*, *Confines*, *Competencies*) was shown to also be relevant to the participants of this study, and a useful basis for defining the participants' creative support requirements within the context of this limited study. Each of the different parts of the framework could be applied to the tasks that were reported by the participants. The consistency between the results for the two cohorts, suggests that the framework could be useful focus for future research into the design and testing of AI-enabled CST.

However, observations from this study indicate that there are several areas where the details of the framework could be developed further, in order to address complexities within the participants' responses.

Fig 9.5 presents a new diagram to represent the *Categories* part of the framework, which also incorporates a version of the *Confines* element of the framework, in order to address the following observations from the study:

- The specific subcategories within the *Categories* element were confusingly worded, and caused some ambiguity amongst participants
- There was a clear split within the *Information* category of support, with participants apparently ascribing more personal value to the subcategories labelled “Specialist knowledge”, and “Guide through a

process”. They were more likely to want to be involved in these tasks themselves, and less likely to want to involve an AI collaborator.
- Across all categories, participants preferred to work personally on tasks where they didn’t already have the necessary knowledge or skills. They were more likely to want to hand over tasks which they already had the knowledge and skills to complete.
- Participants valued social aspects of creativity support, often wanting to talk through problems or get a second opinion, even if the opinion wasn’t better informed than their own.

The values represented by these last observations could be an important factor in determining what kind of support an individual wants on a creative task, and in particular whether a task might offer an appropriate opportunity for AI support. Individuals seem to be more likely to want to personally work on parts of the creative process that they perceive as creative. In other words, the activities that offer novel and valuable experiences for individuals. This doesn’t necessarily relate to whether the outcome of the activity is perceived as creative, but is more a question of whether the work itself offers opportunities for original experiences from the individual's perspective.

This emphasis on the activities of a task needing to be creative, rather than the outcomes themselves, echoes process-centred rather than product-centred definitions of creativity proposed by Still and d’Inverno in their ‘N-creative’ concept (Still and d'Inverno, 2016), as well as Glăveanu’s 5 A’s of creativity (Glăveanu, 2013).

In addition to participants' preference for tasks involving novel and valuable experiences, there are some tasks where individuals have a specific desire for social, conversational, experiences in order to obtain feedback, or to reassure them about their creative direction. Participants’ desire to discuss existing knowledge and creative approaches with collaborators on these tasks, rather than having them provide them with new and original outcomes, evokes Lovelace’s view that machines might support creativity best by “making available what we are already acquainted with” (Lovelace, 1843, p.722).

The model in Figure 9.5 is a proposal for an updated framework which reflects the observation that within each category of creativity support participants in this study perceived a hierarchy of support types, running from high-value to low-value. The higher-value types of support are those which individuals are motivated to be personally involved in completing, and they are less likely to want to involve an AI collaborator. These higher-value types of support are characterised by requiring social connections with others, and by offering opportunities to gain new knowledge or original experiences.

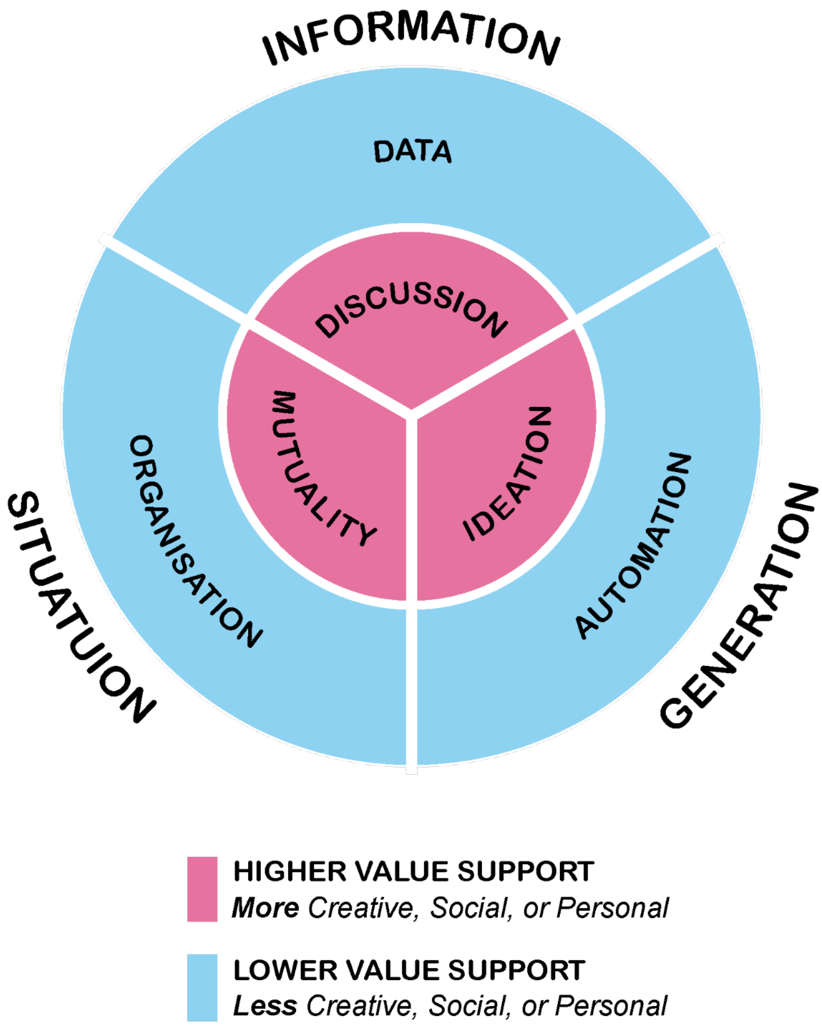

Figure 9.4: Revised Categories model for Creativity Support Framework. Shows how each Category of creativity support can be divided into higher and lower-value support. Higher-value support is perceived as more creative, social, or personal than lower-value support, and is less desired to be performed by AI

Lower-value types of support are those that individuals are less motivated to be involved in personally, and more likely to want to involve an AI collaborator. The lower-value types of support are characterised by not requiring social connections, and not offering opportunities to learn any novel skills or knowledge to the individual.

As with the previously proposed version of the *Confines* element of the framework, this hierarchy of perceived value of creative support activity can be seen as a continuum, where individuals establish their own dividing line between higher and lower-value types of support. This may be based on subjective and personal perceptions of the value of a type of support. However, unlike the previous version of the *Confines* element of the framework, which suggested that individuals evaluated types of support based on whether they perceived the required support as task-related or personal, this latest version suggests that the distinction between high and low-value support is also influenced by the social aspect of the support, and whether the support is creative, in that it offers novel and valuable experiences for the individual. The addition of these factors may make it easier to predict how an individual may define high or low-value support.

In Figure 9.5 the three parts of the *Categories* element of the framework are represented as three equal sections of the circle. Each section is divided into an outer and inner ring. The outer represents the lower-value class of support, and the inner represents the higher-value class of support. For simplicity in this representation, the two sections have been clearly delineated, and each section contains just one representative example of support. However, it could also be imagined that each *Category* contains a continuum of value rather than two clearly divided classes, with multiple examples of support mapped across the continuum in relation to their perceived value. It may also be imagined that certain examples of subcategory sit across the dividing line between *Categories*. For example, a task like ‘organising meeting notes’ may sit across the Information and Situation categories, within the lower-value support class.

The examples in this diagram illustrate the different qualities of support associated with both high and low-value. In the *Information* section the low-value version of support is “Data” and the high-value is “Discussion”. As illustrated in both the Google study and the current study, data is often requested by individuals as a means of supporting their creative work, and a lack of specific data is often a barrier to progressing with a creative task. For example, this might be sourcing the colour palette for a client's brand guidelines, or the correct settings for a 3D printer. Sourcing this data does not represent a valuable, creative or social experience for the individual. They are unlikely to gain any new skills as part of the support, or learn new knowledge beyond the specific data itself.

The higher-value version of the Information category is Discussion. This still represents an individual gaining information that will help them progress with their creative task. However, this doesn’t take the form of a simple set of data, but a discussion with a colleague, collaborator, or expert. In this context a discussion is social, and does represent an opportunity to gain new knowledge beyond simple data. A discussion might reveal insight, or raise questions, or provide opinion, feedback or reassurance which may be valuable beyond the current task. This is a type of support that individuals are likely to want to be personally involved in, and are less likely to want to receive from AI.

Similarly, in the *Generation* category, the lower-value example is “Automation”, and the higher-value example is “Ideation”. Automation represents help with completing the kind of repetitive, or simple tasks which participants in the study characterised as laborious or boring. Individuals already know how to complete these tasks, so the support will not teach them anything new, and no social aspect of this support is required. It is therefore lower-value, and more likely to be delegated to AI. The higher-value Generation example is “Ideation”, for example brainstorming ideas, pitching or developing new approaches to a creative challenge. Support in this area is likely to be social, as communal activities like brainstorming benefit from collaborative action. The experience is inherently creative, and will lead to new knowledge or skills. It’s therefore less likely AI will be requested to provide this support.

In the *Situation* category, the low-value support is “Organisation”. This is where an individual requires help arranging resources or contexts for creativity, such as helping to arrange meetings, recording and organising notes after a workshop, or setting up digital materials. This type of support does not offer the individual the opportunity to learn new skills and knowledge, and does not need to be a social activity. It is therefore suitable to be performed by an AI. The higher-value example is “Mutuality”.

This is where an individual may want to spend time with a collaborator who can provide personal support, encouragement, or observation in order to help them progress with a creative task. This was seen in the study when participants requested a collaborator ‘just to chat to’, not necessarily to provide expert knowledge or skills, but to be a second pair of eyes, critical friend, or companion. This support is inherently social, personal, and represents an opportunity to gain new insights or opinions. It’s therefore a type of support that individuals are more likely to currently seek from a human rather than AI.

The concept of Mutuality has links to emerging research related to neurodiversity and working practices (Eagle, Baltaxe-Admony and Ringland, 2023), and it’s possible therefore that there may be some connections between neurodiversity and some of the observations related to preferences for Mutuality in this study. This will be discussed further as part of the Conclusions chapter (chapter 10).

The updated Categories model of the Framework shown in Figure 9.5 is a proposal for analysing and predicting types of creativity support, which could represent a valuable direction for future research. It is based on observations from the Google Diary Study and the Digital Probe Study, but given the size of these studies, further testing would be needed to refine and validate the model.

Chapter 10 Conclusions and Recommendations

10.1 Introduction

The aim of this research was to better understand the attitudes of individuals working in creative roles in the design industry towards the use of AI within their personal creative process. The three studies presented in the preceding chapters contribute a number of insights related to the contexts in which designers are happy to accept the support of AI systems in their creative work, and the type of support they prefer.

These insights are represented through the Creativity Support Framework, which is a research contribution that has been developed and tested throughout the different phases of this PhD. The framework provides an original method of assessing and addressing the creativity support needs of designers, which has potential value for anyone developing AI-enabled Creativity Support Tools, in particular the personalised forms of AI support offered by embedded AI systems.

Furthermore, the final study of this research demonstrates a method of using embedded AI tools within ethnographic research probes whilst preserving the privacy of participants. The approaches developed for this method of data collection represent novel methods of probe design which may be valuable to researchers using this type of technology in the future.

10.2 Contributions

There are two contributions made by this research: the design and testing of the embedded AI digital research probes, which indicate potentially valuable design requirements for future research probes; and the development and testing of Creativity Support Framework, which could enable future designers of AI-enabled CSTs to plan and test their designs.

10.2.1 Embedded AI Digital Research Probe

As discussed in Chapter 7, the Digital Research Probe was designed to enable the specific data collection required for the final study, but it was also designed from the start to be replicable for future research if the tool proved successful. Through the implementation and analysis of the study, several features of the devices were tested and shown to be potentially valuable for future research scenarios (as discussed further in section 9.4.3 and 9.5.1).

Privacy and Security

A primary goal of the probes was to act persistent data collection tools in participants workplaces, with various sensing and recording abilities, and to simultaneously ensure the highest level of privacy possible for the participant. Establishing robust approaches to privacy is important in the context of digital research devices having increased sensing abilities, as discussed in Section 7.7.

The design of the device in this research included privacy features such as

- not requiring an internet connection,
- storing all data locally,
- allowing users to disable sensing features like the microphone,
- being clear about when participants enable recording sessions,
- allowing users to skip parts of the data collection which involve recording,
- allowing the whole device to be switched off by the participants when they require.

The feedback from the participants showed that these features were valued by them, and played a significant role in them feeling confident to take part in the research. This approach to privacy therefore may be of importance to other research using digital devices.

Adaptability

Unlike other digital probe devices, the device in this study was designed to be made from off the shelf materials, that could easily be replicated and adapted by other researchers. The use of the Raspberry Pi computing system, and accessories that utilise standardised methods of connection and setup, allowed multiple devices to be quickly and cost-effectively made for this research, and would similarly allow them to be made for other studies in the future.

The wide availability of components and sensors as part of this computing and electronics system means that different sensors could easily be added if required for different forms of data capture (e.g. cameras, motion detection, object detection, etc.) This, along with the ability to change the 3D printed form of the device makes it easily adaptable for new research requirements.

Physical Presence

A physical digital device was chosen over online data capture facilitated through an existing device such as a phone or laptop, as the physical presence of the device itself served as a reminder of the data collection exercise (and therefore a visual prompt to engage with the process), and also allowed users to engage with the data collection separately from the devices they were using for their work. This separation was practical, in the sense that participants could engage with the device without having to alter any of their interactions with existing devices, and also psychological in the sense that the probe was seen as separate and unrelated to the devices they were using for work. Participants commented that this made using the device more enjoyable and increased their engagement with the research.

Embedded AI Features

The final probe device in this research used limited embedded-AI features, due to restrictions with the technology at the time of development. However, the AI voice features that were part of the device enabled enhanced interaction and engagement with the data collection process. Participants reported feeling positively about speaking to the device, and desired more interaction. The embedded AI functions therefore made data collection more engaging, and led to a richer set of data than a simple form or survey could have achieved.

The design of this probe device indicates that the use of embedded AI agents within probes could be a valuable approach to explore in the future.

10.2.2 The Creativity Support Framework

The framework consists of three elements: *Categories*, *Confines*, and *Competencies*.

These three elements emerged from the analysis of each of the studies, and the relevance of each element has been tested against data from the Google Diary Study (Chapter 5) and the Digital Probe Study (Chapter 9).

The framework represents a summary of the original insights gained across this research, which are discussed further in section 10.3. Positioning these insights as a framework provides a practical way of communicating them to other researchers and the designers of AI-CST. Applied as a tool for planning and testing forms of creativity support, it contributes a method of assessing whether support tools meet the creative needs of designers

Categories

This element of the framework relates to the different types of creativity support commonly requested by participants. It was found that requests fell into three categories of support:

- ***Information*** - where participants required information such as guidelines, feedback, or project data in order to progress with their creative task. This category of support was the most popular, being more frequently requested by participants than types of support more directly related to the production of creative outcomes.

- ***Generation*** - where participants required direct support with the production of creative outcomes. Often this related to completing work that a participant had already started, or automating some part of the production tasks which participants found repetitive or unrewarding.

- ***Situation*** - where participants required support related to their working arrangements or environment. This could be helping to organise workspaces or schedules, providing motivation, or assisting with focus. This category was the least popular, with motivation-related support only requested by a small minority of participants.

Each of these categories could be divided into higher-value and lower-value types of support, as shown in Figure 9.5, and described in the *Confines* element of the framework.

Confines

This element of the framework relates to the distinction that participants made between tasks which they perceived as being of high personal value to themselves, and tasks which they perceived as being of lower personal value.

Analysis of the Google Diary Study data (Chapter 5) indicated a general distinction between areas of their work which participants viewed as personal to themselves, and other areas of work which they viewed as non-personal, or task-related.

The Digital Research Probe data (Chapter 9) expanded this distinction, indicating that as well as perceiving some types of support as *personal*, rather than task-related (in that it impacted their personal choices in relation to their workspace, schedule, priorities etc.), participants also placed higher personal value on support related to types of work that they viewed as being *creative* (in that the process offered them novel and valuable experiences, regardless of the creative quality of the outcome), and *social* (in that it afforded or required communication with other people).

The relative personal value that participants placed on tasks directly affected the type of support they sought. Participants were more likely to want humans to provide support related to higher-value tasks, and preferred to be more directly involved in those tasks. They were more likely to want AI to provide support for lower-value tasks, and were happy to be less involved in these tasks.

It was found that the distinction between higher and lower-value types of support was subjective to each individual, and not easily predictable. It related to how the knowledge and skills required to perform the task aligned with the individual's existing knowledge and skills, as described in the *Competencies* element of the framework.

Competencies

This element of the framework related to participants' perception of the similarities or differences in knowledge and ability required by creative collaborators. The type of creative support requested by participants was found to relate to whether they thought the task required skills or knowledge that they possessed themselves, or required a collaborator with different skills or knowledge.

Participants were more likely to want to work themselves on tasks which required skills or knowledge that they did not possess. They were more likely to want to hand over tasks which they already had experience of. This reinforces the observation that the desire for original and instructive experiences may be a factor in participants' preferences for creativity support, discussed in relation to the higher-value and lower-value types of support described in the *Confines* element of the framework.

10.3 Insights

10.3.1 The Role of AI in Creativity Support

The first research question asked "What role do individuals working in creative roles in the design industry want AI to play in supporting their personal creative practice?".

The primary insight in relation to this question was that the participants across all studies were very positive about AI playing a role in their creative process. Responses to all three studies showed that participants were happy to choose an AI collaborator for a creative task, and in some cases preferred to have an AI collaborator over a human collaborator, particularly for tasks such as carrying out repetitive actions and finding and suggesting references.

The initial Survey Study (Chapter 4) revealed a pragmatic attitude amongst designers towards the use of AI in their creative work, with participants not reporting any particular concerns or reservations relating their sense of ownership of creative work completed in collaboration with AI. They were happy to use the support of AI systems if it helped them complete a creative task.

This pragmatic, positive attitude to AI was demonstrated consistently across the next two studies, with participants reporting a positive attitude towards AI performing a creative collaborative role on their tasks across all categories of support. Similarly, the results of the Digital Probe Study (Chapter 9) revealed that participants actually preferred an AI collaborator to a human collaborator in every category of support except one (providing specialist knowledge).

This positive attitude to the use of AI by designers provides a valuable counterpoint to contemporary concerns about the impact of AI on creative industries. Recent studies discussed in the Literature Review (section 2.4.5) highlighted anxieties about the use of AI in creativity, and concerns about the impact on jobs (UK Department for Science, Innovation & Technology, 2024;

Latikka *et al.,* 2023; Li, 2024; Du, Li and Gao, 2023). The data from these studies suggests that designers do not share these concerns in the specific context of creativity support.

There could be several factors influencing this more positive attitude amongst designers.

First, previous research has framed AI's creative abilities from an artistic perspective, for example in the fields of music and visual art (Latikka *et al.,* 2023), and painting (Du, Li and Gao, 2023). In this context it is possible that attitudes reflect the popular narratives relating to the possibility (or impossibility) of AI assuming the artistic capabilities of humans, and the resultant impact this may have on the roles of humans. The studies presented in this research were related directly to the existing processes of professional designers, and therefore may have revealed more pragmatic attitudes than research which evoked more complex concepts of artistic ability.

Second, and relatedly, this research was focused specifically on creativity *support*, rather than creativity more generally. Throughout each of the studies participants were asked how AI might help them complete their creative tasks. The implicit dynamic in this line of questioning was that the participant was in control of the creative task. It was their task, which they could choose to hand over to an AI collaborator if they wished. Even when participants chose to hand over a task completely to an AI system, there wasn't necessarily a negative implication that AI was taking over the participant's role, because the study placed the choice in the hands of the participant on a task-by-task basis. The framing of AI explicitly as a support tool or collaborator may perhaps have led to more practical and utilitarian attitudes than those expressed in relation to the role of AI in other creative contexts.

Third, the rising prevalence of generative AI tools throughout the course of this research may also have had an impact on participants' attitudes. While generative tools were relatively inaccessible and low-quality prior to the Survey Study, at the time of the Digital Probe Study, tools such as Midjourney and

ChatGPT had become well known within creative contexts, and all participants reported having had experience of using them or seeing their results. This increased personal awareness of AI tools, and participants' existing use of them in elements of their work, may have led to more informed and pragmatic attitudes towards their use.

Further investigation would be needed to confirm whether these three factors had a direct influence on the attitudes of designers towards AI support. However, it's possible that the clear framing of AI-CST as supportive and design-focused may help elicit more positive attitudes towards their use.

In terms of the specific roles that designers would like to play in their creative work, this research found that aligning the functionality of AI systems with existing, human-style roles may not be conducive for framing support from AI-CST.

Participants across all three studies were happy to view working with an AI system on creative tasks as a form of collaboration, where they still retained overall control and ownership of the task. Inviting participants in the studies to consider specific collaborative roles that an AI could play in their work was a valuable method of getting them to think beyond the concept of AI fulfilling the utility of a simple tool, and using this framing in the future may assist with the implementation of AI-CST tools.

However, the Google Diary Study and Creativity and Cognition Conference Workshop (Chapter 6) revealed that the use of existing, human-style roles such 'Studio Assistant' or 'Curator' may unduly limit discussion around the role of the AI. This was partly because the language of these kinds of titles may add complex associations to the framing of the collaboration, for example evoking existing biases or limitations of human job titles. It was also due to the fact that existing human roles do not necessarily communicate the potential scope of new AI roles. The fact that AI support tools can afford different types of support and interaction to human collaborators means that the use of broader and more imaginative metaphors for non-human collaboration may be helpful.

Aside from this observation, participants were able to use the provided personas to indicate the kinds of support that preferred AI collaborators to provide. In terms of popularity and potential for future support applications, these fell into the three categories identified in the Creativity Support Framework as *Information*, followed by *Generation*, then *Situation*.

Collaborators that could perform informational roles were most popular across all three studies. This included support related to guiding designers through information, offering expert knowledge, and suggesting references. These informational types of support were the most frequently requested in the Google Diary Study and the Digital Probe Study. They were popular with participants whether they were performed by a human or an AI system. The fact they represented the most requested form of support, and the form of support that participants were happiest to receive from an AI, makes them particularly suitable for future AI-CST applications.

Participants in the studies also wanted AI to support them on generative tasks, which directly involved the production of media and other creative outcomes. This is an area where publicly accessible generative AI tools already offer functionality to creatives. Perhaps because of the increased awareness and experience of these kinds of generative tools, participants were keen for AI to perform production support roles on tasks. In particular they wanted AI collaborators to work on completing repetitive or tedious tasks, or production tasks that the participants either started or finished.

Across the studies, participants also expressed some support for AI providing situation-related support. This was support related to the circumstances in which they were working, such as organising tools and work environments, providing motivation, or helping participants focus on creative tasks. However, this type of support was the least popular, and only requested in a minority of cases. It is therefore unlikely to be as well suited for general AI support applications than *Information* and *Generation* types of support.

It may, however, form the basis for more specialist types of creativity support. This is because a small number of participants reported a specific need for personal forms of support such as motivation and focus assistance which was at odds with the attitudes expressed in the majority of responses. Comparing the data from these participants in the Google Diary Study and Digital Probe Study, with emerging research from the field of neurodiversity support, and in particular ADHD support, suggests that there may be some connection between these subjects and the small minority of requests for socialised motivational, and focus-related support. As specific data was not collected in relation to this subject it is not possible to draw conclusions as part of this research, but it may be a useful area of future study.

10.3.2 Support Factors

The second research question was “What factors influence the type of creativity support individuals working in creative roles in the design industry are willing to accept from AI systems?”

The studies revealed several factors that influenced participants’ attitudes towards the type of support they desired from creative collaborators in general, and AI collaborators in particular.

Personal Support

The most significant factor related to whether the task in question was one that was considered personal to the participant. As described in the *Confines* part of the Creativity Support Framework, participants appeared to make a distinction between support which they considered of high personal value to them and their methods of working, for example setting up their tools or scheduling their work, and support which was not of high personal value to them but related to the creative task in hand, such as finding references, or completing production work. Participants were more likely to accept help for this task-related support, and were less positive about support which might be perceived as personal.

Determining how individuals define which types of support they consider too personal for AI support could be important for the planning and design of future AI-CST. The examples provided in this research, along with the Creativity Support Framework, give some guidance to how the designers may make these distinctions, but extending the kind of in-the-moment data collection used in the Digital Probe Study to a larger sample of designers could provide further detail about what affects these decisions.

Social Support

The second factor influencing participants' attitude to support was sociability. Across the Google Diary Study and the Digital Probe Study, participants frequently described a desire to talk about a problem face-to-face with a colleague. Sometimes this might be a specific, existing colleague. Sometimes it might be an unknown person with specialist insight. In many cases, however, participants didn't want someone with better knowledge than themselves, they just wanted another person to talk through the problem with.

Presence, mutuality, and sociability were important elements of this attitude. In the Google Diary Study, even when a participant could contact a colleague through email and online meetings, they still desired to be in the same room as the colleague in order to support their creative process. In the Digital Probe Study participants reported just wanting to sit with someone to talk through ideas.

The conversational part of this kind of social support was also significant, as participants in the Digital Probe Study reported benefiting from the opportunity to explain a creative problem verbally. Although the need to do this spontaneously and concisely for the probe device was also a challenge for some participants, their responses showed that it also helped them reflect on the problem in hand, and think about the causes of their issues. This in itself was helpful for addressing their creative problems, and was seen as an enjoyable part of the creative process. This reflects the findings of Fuldra and Gundry (2022), which situate conversation as a collaborative co-creative outcome in its own right, and links with the ‘creativity of tasks’ support factor discussed below.

The social factor in creativity support is one where the use of AI is more complex. On one hand social support represents the kind of human, emotional, interaction that participants in all three studies reported feeling that AI could not provide. On the other hand, participants in the Google Diary Study reported that they were happier for an AI to complete some of the roles that they had indicated were intrinsically human and personal, such as Studio Assistant and Curator. This may indicate that in some cases participants were happier sharing personal information and activities with an AI than with a human colleague.

The ability of AI, and in particular personal, embedded AI to provide feedback and advice that is specific to an individual’s experiences and preferences, whilst remaining private, may provide an opportunity for valuable forms of creativity support in the future. Further investigation would be needed to better understand the complex attitudes in relation to this kind of conversational, social creativity support.

Knowledge and Abilities

The third support factor highlighted by this research relates to the *Competencies* part of the Creativity Support Framework. Across the Google Diary Study and the Digital Research Probe study, participants' responses indicated that a collaborator's knowledge and abilities in relation to the participants' knowledge and abilities played a part in the type of support they desired.

In some cases participants wanted a collaborator, human or AI, who had different knowledge or abilities to themselves in order to perform some role in their task that they were not capable of performing themselves. However, in a large number of cases participants wanted a collaborator who had the same knowledge or abilities as themselves in order to effectively complete a task in the same way that the participant would.

In some cases the participants' preferences for different or similar knowledge and ability was slightly counterintuitive, for example with participants desiring support from collaborators with the same knowledge as themselves even when the support they wanted was researching some specific information or knowledge they did not have. This preference for similar competencies in a collaborator echoes the observation relating to the social factor, that participants often didn't want a conversation with someone with specific knowledge, they just wanted to talk to someone with complimentary viewpoints to themselves. It may also reflect the desire for control that was mentioned above in relation to participants' positive view of AI design support in general. An AI collaborator with the same knowledge and abilities as the designer may be perceived as less of a threat to the creative control of a task than an AI collaborator with specialist knowledge and abilities beyond the competency of the designer.

Creativity of Tasks

The study data relating to the desired *Competencies* of potential collaborators also highlighted the final factor that has an influence on attitudes towards creativity support, which is the *perceived creativity of a task.*

The creativity associated with completing a task is not necessarily related to the creativity of the outcome. The competency-related data from the Google Diary Study and the Digital Probe task revealed that participants were keen to work personally on tasks which they did not have existing knowledge of, or the abilities to perform. A rational response may be to hand these tasks over to an informed or capable collaborator, if one was being offered. The participants preference for maintaining control of these tasks themselves, and not handing them over to another human or AI to complete, indicates that the novelty of the task itself, and the implied opportunity to experience or learn something new, may have been seen as valuable by the participants. The novelty and value of the process effectively makes it creative in its own right.

The desire of designers for creative experiences as part of their work, separate to the creativity associated with the outcomes they produce, aligns with the process-focused, rather than product-focused definitions of creativity represented, for example, by the 5 A's (Glăveanu, 2013), or N-Creativity (Still and d'Inverno, 2016), or Dewey's assertion that the process of creativity should bring "refreshment and growth" the individuals that perform it (John Dewey, 1948, p. ix). It also resonates with Ingold's description of creativity as a process of 'undergoing', in which individuals "reach out from places already held, or prehended, towards the horizons of their present awareness" (Ingold, 2014, p.135).

The data from these studies indicates that these process-focused and experience-focused definitions of creativity, which recognise the importance of learning and novelty to creatives, are significant and valuable in the context of designing AI-CST.

10.3.4 Embedded AI

The third research question was "What opportunities exist for creativity to be supported by personalised, embedded AI systems?".

The effective use of embedded AI within CST is primarily a future focused requirement at this time. The majority of generative AI tools and systems are currently cloud-based, as they require more advanced hardware and power resources than can be provided by embedded AI hardware at this time.

This research has therefore aimed to investigate the opportunities for supporting creativity with the kind of personalised, private, AI tools represented by embedded AI. The intention was to explore principles of personalised creativity support which could inform the design of future embedded AI support tools, as the technology develops and further creativity-related functionality becomes available to developers. The three studies highlighted several areas of opportunity for creativity support with embedded AI.

The most requested type of support by participants was not related to the technologically demanding area of media generation, but focused on information. Participants wanted to find the right information that would help them proceed with their creative work. This included feedback, data, references, process guidance etc. While social feedback may be complex for AI to provide effectively, as participants reported preferring human collaborators for this type of support, there are many other elements of informational support that embedded AI could already provide.

For example, finding and providing suitable reference material, providing the correct data when it's needed, or offering guidance and instructions for tools and processes. With embedded AI this type of information could be provided conversationally and responsively through chat interfaces. The information could potentially also be personalised and private to the individual, with the system learning from their previous references, outcomes, and styles.

Personalisation represents a key area where embedded AI tools may be able to provide creative support to designers. The ability to know an individual, and respond with information that is specific to them, underpins many of the factors for choosing creativity support identified above. For example, a personalised AI system could learn a designer's preferences related to the type of support they perceive as personal, and the support they view as non-personal or task-focused. It could also learn and keep track of the knowledge and abilities that designers already have, so as to better assess the types of tasks they are likely to find creativity rewarding and want to be involved in directly.

While participants in both the Google Diary Study and the Digital Probe Study reported having less positive attitudes towards AI replacing the kind of human interaction required for the social feedback and support they desired, there still may be some opportunities for embedded AI to play a role in this process.

Many participants desired conversation and feedback with a collaborator with the same knowledge and abilities as themselves, in order to receive reassurance, or gain clarity through the process of articulating and reflecting on their problem. It may be possible that personalised, conversational AI systems trained on the knowledge and experience of an individual may be able to perform this role. This would represent AI performing the same type of role that Lovelace recommended that machines could play in the creative process, in that it could “assist us in making available what we are already acquainted with” (Lovelace, 1843, p.722). At the very least, a private conversational AI system could facilitate personal reflection in the same way that the Digital Probe did for some of the participants.

A further opportunity for the use of embedded AI in creativity support relates to how designers articulated their creative needs. Participants in the Digital Probe Study commented on the challenge of explaining the problem they were facing, or the task they wanted completing, in a short verbal description. One participant in particular reflected that as a visual designer they would prefer to be able to communicate their requirements visually.

It’s possible that more advanced interfaces with AI could facilitate clearer communication of design needs, and more personalised support. This might include, for example, digital sketching interfaces, as well interfaces that allow the system to respond to physical artefacts in the designer’s environment such as sketchbooks, moodboards, or physical objects. This might be an area where camera and computer vision functionality provided by existing embedded AI interfaces could assist with enabling personalised AI-CST.

The type of personalisation involved in the opportunities described above could be achieved through cloud-based AI systems. However, the Digital Probe Study demonstrated that privacy was a very important consideration for participants. Concerns about personal privacy, and the handling of commercially sensitive information, meant that an offline, embedded AI tool was required for the research probe, and even with this some participants required reassurance and the presence of additional privacy features in order to feel safe discussing their work with the AI device. To achieve the type of personalisation that may facilitate new methods of AI-enabled creativity support, privacy will need to be an important design requirement, and embedded AI may be best placed to meet this requirement.

10.3.5 Understanding Creative Requirements

In addition to the insights related to each of the three research questions, the analysis from each of the studies highlighted further observations which could have relevance for future work which aims to understand the changing creative requirements of designers, and other people working on creative tasks.

The reflections on the specific methods of data collection used in this research could be applied within future creativity research, but also as part of the functionality of future AI-CST. This is because to a large degree the ethnographic research methods used across these studies reflect the kind of methods that would be required by an AI-CST in order to detect and understand the personal support requirements of a designer. Just as the research methods in the study needed to capture the moment when a participant was in need of creative support, and collect data about the type of personal support that would be most helpful, so an AI-CST would benefit from having the same abilities to facilitate the providing of support.

The studies in this research used a range of data collection methods, which became more immediate and detailed throughout the research. The online survey method provided a useful overview of attitudes across different respondents, but lacked detail about the support needs associated with specific tasks.

The diary method enabled participants to record the details of specific tasks, which revealed a higher level of detail and allowed for the comparison of differing support needs across different tasks. However, the delay in recording responses meant that the data lacked detail about the task that participants might be able to record if the data collection happened in the moment of need.

The conference workshop enabled the kind of face-to-face group discussion of creativity support needs that was planned for one of the studies, but could not take place due to lockdown restrictions. The discussion and reflections in this session were helpful for considering the themes of the research, however it was not intended to reveal the same level of detail about an individual's personal creative requirements as the studies provided.

The digital probe method provided the most spontaneity and detail about individual creative support needs, as they occurred. The combination of voice recording and graphical interfaces allowed relatively rich data to be gathered from a small group of participants over an extended period of time.

This regular, extended data collection was essential for recording the kind of data needed for this study, and this may not have been possible with other forms of data collection. Researcher observation and interviews would be challenging to achieve over a multi-week timeline, and the presence of a person would likely have had an impact on the type of data shared. Online forms may not have recorded such regular and spontaneous data, and may not have allowed for the rich format of voice recording. The digital probe device proved a valuable tool for this research, and it is likely that it would also be helpful for ethnographic data collection in other contexts.

As noted in sections 9.3.2 and 9.4.3, there were some limitations relating to the process of voice recording. The first related to privacy, and the fact that even with privacy features, in a shared workspace it might not be possible or desirable to record voice for a number of reasons. The second is that, although many participants enjoyed the opportunity of discussing their creative issue, some felt that in this context, visual methods of discussing a problem could be helpful, and that sketching and references to existing media and materials may be helpful to include in the interfaces of AI tools.

It is possible for embedded AI devices such as the Digital Probe device, to include more methods of environmental sensing and data collection. Earlier versions of the probe device included cameras and colour sensors in order to facilitate different types of data collection. Ultimately, these sensors were not considered necessary for this research, but they, or similar types of sensor or user input, could easily be included on future probe devices if required. This could benefit further research into creativity support needs, or could be used within AI-CST themselves. Alternatively, it could also be of benefit to different types of ethnographic data collection, in different research contexts.

10.3.6 Mutuality and Neurodivergence

Analysis of the final Digital Probe Study suggested a further insight related to possible connections between creativity support and neurodivergence.

Neurodivergence was not a theme of this research, and no data was specifically collected relating to this in any of the studies. This observation is therefore presented as a recommendation for future research, rather than a conclusion of the current research.

It is notable that the kind of mutuality requested by some participants as a form of creativity support, is also a strategy associated with supporting individuals with neurodivergence, in particular ADHD.

Mutuality in ADHD support is often associated with a technique called “body doubling”, which “involves using the presence of others to stay focused on or accomplish tasks” (Eagle et al., 2023, p.1). A body double doesn’t need to provide advice or practical support, they just need to present in order to help motivate the individual.

While research in this area is relatively new, the concept of body doubling is well established as a recommended focusing strategy within ADHD support organisations (ADDA, 2024; Quinn, 2024), and has been reported as a distinct subculture within online communities (Ables, 2022). Body doubling has emerged as a popular feature on online video platforms such as TikTok and YouTube, where many users offer online body doubling, either live-streamed or pre-recorded. There are also popular animated versions of body doubling (Lofi Girl, 2024), which combine animated characters with playlists of lo-fi music conducive to work or studying. The popularity of these videos has also led to the launch of several commercial body doubling apps and services (Deepwrk, 2024; Flown, 2024).

The productivity benefits of online, streamed companions, had been noted before the activities became particularly associated with neurodivergence and ADHD, for example Taber *et al* (2019). More recently, research such as Eagle, Baltaxe-Admony and Ringland (2023) has studied the phenomenon specifically with neurodivergent participants, and has better defined behaviour in this area. Eagle, Baltaxe-Admony and Ringland's study presents a spectrum of mutuality, which maps different reported body doubling activities on a continuum from Ambient Companionship, where individuals may benefit from activities such as watching pre-recorded body doubling videos or working in a social environment like a cafe, to Accountability, where individuals may seek more active body doubling companions who periodically discuss their progress, check in on tasks, or provide reminders etc.

The Accountability end of Eagle, Baltaxe-Admony and Ringland's spectrum of mutuality seems particularly relevant to some of the responses to this study, where participants wanted collaborators who they could 'sit with' or "talk with", but didn't need to provide any expertise or knowledge beyond their presence. Viewing it in this context may also explain why several of these responses were categorised by the participants as "Assist focus", even though the description of the task did not mention focus, but instead mentioned sitting or talking with a colleague.

The issue of accountability may also have a bearing on the small minority of participants in the Google study who reported wanting a collaborator who would perform the Motivator role (section 5.4). While this role was generally unpopular, a few participants did request a collaborator who could help them focus and stay on a task, and would provide some degree of encouragement and accountability for completing work.

Productivity strategies related to mutuality, such as body doubling, may help give context to some of the responses in the studies where non-expert social connections were what participants desired from a collaborator. If this type of support has particular relevance to individuals with neurodivergence, then further research with these communities may help identify and understand specific opportunities for creativity support in this area.

While support requests related to mutuality were normally associated with human rather than AI support in the current study, it's notable that many digital-enabled and automated versions of body doubling already exist. It may therefore be that AI-enabled tools could play a role in providing this type of support in the future.

10.4 Limitations

The limitations of this research primarily relate to the scale of each study. More participants in each of these would have led to a broader range of responses and higher confidence in the conclusions of each individual study. As each study expanded on the last, and focused on a common line of enquiry, the insights from each study supported each other. However, further testing of the proposed Creativity Support Framework with a larger sample of designers from different backgrounds would be helpful to providing more robust data about the attitudes of designers across different contexts.

The issue of context is another potential limitation of this research. As discussed in the Literature Review, the contexts for creativity are broad, with even the subject of design containing a multitude of sub-disciplines, styles, and applications. This research has focused on design and creativity within the context of digital product and user experience design, as this was the context of the industrial partner, Google. This area of design is multidisciplinary, with designers working across different media and materials, and requiring frequent collaborations with colleagues from different fields. This makes it a useful context of study, as the variety of work may correspond with a number of different disciplines. However, further research with a broader range of designers from a variety of different job roles would help test the insights across different contexts of design.

A further limitation to the research was related to the subject matter of generative AI. This has been an area of rapid growth over the course of this research, with new tools and functionality being released to the public on a constant basis over the last 6 years. At the beginning of this research it required specialist hardware and programming for AI to generate a low definition thumbnail size image. At the current time it's possible for anyone to access simple tools to generate a high-definition video clip from a text prompt.

This rapid development has meant that awareness and attitudes towards AI in creative contexts have also changed rapidly over the course of this research, and therefore the attitudes being investigated may have changed and evolved between each study. This is true of any ongoing research into public attitudes, particularly related to emerging technologies. But the speed of the change with generative AI should be considered, particularly in applying the insights presented here to AI applications in the future.

However, the focus of each study was primarily on creativity rather than AI, with participants reporting their creative issues and their support preferences first, and then reflecting on the use of AI in this context as a follow up. As attitudes to creativity are likely to change less rapidly than attitudes to AI, this means that the observations that form the basis for the Creativity Support Framework are likely to remain relevant as AI technology develops further.

10.5 Future research

In light of the conclusions above, the following areas of investigation are recommended for future research.

Applied use of the Creativity Support Framework

A new version of the Creativity Support Framework was proposed in Chapter 9. These new additions would benefit from testing in future research projects. Deploying a similar Digital Probe Study with additional questions to test the high and low value elements of the framework could help confirm the relevance of these elements to a different set of research participants. It would also be useful to test the framework with designers of AI-enabled to see how it might help in the design and evaluation of applied creative AI tools.

Testing of AI-enabled research probes in different contexts

The devices were designed to be modular, and easily reproducible using standard parts. This was with the intention that they could be utilised in different research projects if they proved useful. It would be particularly valuable to further test the embedded AI functionality of the devices for data capture, for example more advanced voice recognition, or camera-based computer vision.

Privacy standards for AI-enabled research probes

The digital probes were designed to enable data to be captured in a way that did not compromise the participants' personal or commercial privacy, and that met ethical and regulatory standards for data collection. The privacy functionality went further than was required by current research standards, through a general recognition that research using sensor-enabled, and AI-enabled devices represented a growing set of methods which would benefit from clearer examples of best practice in relation to privacy.

This approach proved valuable, as participants were privacy-aware, and looked for assurances that their data was not being shared via the internet. Further researching and testing methods of privacy protection when using sensor-enabled and AI-enabled probes, and formalising these methods into examples of best practice, could facilitate more ethical and effective data collection in the future.

Creativity Support Tools in the context of neurodiversity

As with any form of professional support, CST should be designed to be accessible and applicable to all, and should take into account the full diversity of people's needs and abilities.

This research identified an area of support related to motivation and focus, where needs may differ in relation to neurodiversity. No specific data was gathered in relation to this area of research, so definite conclusions can not be drawn from these studies. However, as new neurodiversity research emerges, in particular in relation to ADHD and motivation, it would be valuable to further research the implications on the design of CST.

Continued application of N-Creativity to Creativity Support Tools

The final recommendation of this research returns to the concept of N-Creativity, and the related concepts of distributed creativity (Glăveanu, 2013), Ingold's definition of creativity as a process of 'undergoing' and 'reaching out towards the horizons of present awareness' (Ingold, 2014), as well as Lovelace's view of machines supporting creativity (Lovelace, 1843). All these concepts reference a process-focused, rather than product-focused definition of creativity, which emerges from human experiences distributed across multiple contexts, disciplines, and skills.

This definition of creativity is not necessarily the one which is commonly used in the design of CST, which historically has favoured product-focused methods of defining and measuring creativity. The emergence of generative AI, as a technology that creates products without any apparent process, may risk further diminishing the importance of the human process and experience of creativity.

However, this research has highlighted that the *experience* of creative activity is still integral to how designers prioritise and approach their work, and should therefore be considered carefully when designing CSTs.

This research therefore concludes, by repeating the research recommendations from two of those process-focused references.

First, Still and d'Inverno's recommendations to "adopt an N-creative approach to designing systems supporting being in the world; enhancing and supporting human creative activity in all of its forms” and to “use human experience as the starting point for future system design” (Still and d'Inverno, 2016, p.153).

And finally, with the 180-year old quote from Lovelace, that is still relevant in the current age of generative AI. This research has highlighted the ways that AI tools may be able to inspire and support the innate, personal creativity in humans, rather than producing creative outcomes of their own. The ideal creative role for AI therefore, like the Analytical Engine, may not be to “originate anything” but instead “to assist us in making available what we are already acquainted with” (Lovelace, 1843, p.722).

Chapter 11 Bibliography

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Chapter 12 Appendices

- **Appendix 1**: Survey Study - Form
- **Appendix 2**: Survey Study - Data
- **Appendix 3**: Google Diary Study - Day 1-7 Form
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Appendix 1: Survey Study - Form

Design Creativity and AI Survey

You are being invited to participate in a research survey titled Design Creativity and AI.

This survey is being conducted by Angus Main from the University of the Arts London. The answers your provide may help inform the outcomes of the associated PhD research degree titled "Design Approaches to Creativity Support with Imbedded Artificial Intelligence Kits”.

The purpose of this research study is to discover how designers think about creativity, and the potential impact of Artificial Intelligence (AI).

The survey will take you approximately 6 minutes to complete. Your participation in this study is entirely voluntary and you can withdraw at any time.

We believe there are no known risks associated with this research study; however, as with any online related activity the risk of a data breach is always possible. The survey is anonymous unless you choose to share contact information and to the best of our ability your answers in this study will remain confidential.

If you have any questions then please email a.main0920181@arts.ac.uk

If you would like to participate please press Next.

* Indicates required question

About you

1. 1. Please indicate your age *

Mark only one oval.

- Under 18
- 18 - 24
- 25 - 34
- 35 - 44
- 45 - 54
- 55 - 64
- Over 65

2. 2. What is the highest level of education you have undertaken? *

Mark only one oval.

- GCSE or equivalent
- A-Levels or equivalent
- University undergraduate programme
- University post-graduate programme
- Doctoral degree
- None of the above

3. 3. How many years have you been employed in a design related role? *

Mark only one oval.

- 0
- 1-4
- 5-9
- 10-14
- 15-20
- 20-24
- 25 or above

4. 4. What is your design discipline? *

Mark only one oval.

- Architecture
- Graphic Design
- Illustration
- Fashion Design
- Industrial/Product Design
- Interior Design
- Furniture Design
- Ceramics Design
- Interaction Design
- Other: __________

Creativity

5. 5. In your experience, what are the important qualities that make a design outcome “creative”? *

Mark only one oval per row.

	1 (Not Important)	2	3	4	5 (Very Important)
Novelty (it does something new)	⬭	⬭	⬭	⬭	⬭
Purpose (it has a clear role or use)	⬭	⬭	⬭	⬭	⬭
Effectiveness (it fulfils it’s purpose well)	⬭	⬭	⬭	⬭	⬭
Ingenuity (it demonstrates clever or complex problem solving)	⬭	⬭	⬭	⬭	⬭
Surprise (it demonstrates unexpected methods or results)	⬭	⬭	⬭	⬭	⬭
Synthesis (it brings together existing ideas or approaches)	⬭	⬭	⬭	⬭	⬭

6. 6. Within your design process, where are you most likely to draw your inspiration from? *

Mark only one oval.

- Information from the specific domain for which you are designing
- Information from separate but related domains
- Information from completely unrelated domains

7. 7. What are the most common obstacles to your personal creativity? (not including external factors such as budget or material restrictions) *

Check all that apply.

- [ ] Lack of inspiration
- [ ] Lack of understanding of the problem
- [ ] Lack of interest in the problem
- [ ] Distraction from non-creative tasks
- [ ] Too much fixation on task
- [ ] Not enough fixation on task
- [ ] Difficulty in communicating vision
- [ ] Other: ____________________

8. 8. What level of creativity do you feel is required for each of the following areas of the design process? *

Mark only one oval per row.

	1 (Low Creativity)	2	3	4	5 (High Creativity)
Researching the problem	◯	◯	◯	◯	◯
Generating concepts	◯	◯	◯	◯	◯
Reviewing and selecting concepts	◯	◯	◯	◯	◯
Translating concepts into final design outcomes	◯	◯	◯	◯	◯
Testing / Gathering feedback	◯	◯	◯	◯	◯
Project planning / management	◯	◯	◯	◯	◯

Artificial Intelligence (AI)

9. 9. How would you rate your understanding of AI (Artificial Intelligence)? *

Mark only one oval.

	1	2	3	4	5	
Poo	◯	◯	◯	◯	◯	Excellent

10. 10. How much impact do you think AI will have on your area of design in the future?

Mark only one oval.

	1	2	3	4	5	
No i	◯	◯	◯	◯	◯	High impact

11. 11. Are you broadly optimistic or pessimistic about any impact of AI on your area of design?

Mark only one oval.

	1	2	3	4	5	
Pes:	◯	◯	◯	◯	◯	Optimistic

12. 12. What words do you associate most with AI? *

Check all that apply.

- [ ] Automation
- [ ] Dystopia
- [ ] Opportunity
- [ ] Creativity
- [ ] Robotics
- [ ] Control
- [ ] Assistance
- [ ] Efficiency
- [ ] Fantasy
- [ ] Accuracy
- [ ] Unpredictability
- [ ] Other: ____________________

Creativity Support

13. 13. Within your design process, is there a particular tool (digital or physical) which you feel supports or enables your creativity? *

Mark only one oval.

- Yes
- No

14. 14. If yes, what is the tool?

15. 15. And how does it support or enable your creativity?

16. 16. From your understanding of AI, how capable do you feel it would be in supporting each of the following areas of the design process? *

Mark only one oval per row.

	1 (Incapable)	2	3	4	5 (Very capable)
Researching the problem	⬭	⬭	⬭	⬭	⬭
Generating concepts	⬭	⬭	⬭	⬭	⬭
Reviewing and selecting concepts	⬭	⬭	⬭	⬭	⬭
Translating concepts into final design outcomes	⬭	⬭	⬭	⬭	⬭
Testing / Gathering feedback	⬭	⬭	⬭	⬭	⬭
Project planning / management	⬭	⬭	⬭	⬭	⬭

17. 17. For the following list of design related tasks, please indicate how much support you'd be willing to receive from an AI tool.

Mark only one oval per row.

	1 (No support from AI)	2	3 (Even sharing between you and AI)	4	5 (Full automation)
Creating mood boards	⬭	⬭	⬭	⬭	⬭
Researching existing design solutions	⬭	⬭	⬭	⬭	⬭
Researching materials/tools/processes	⬭	⬭	⬭	⬭	⬭
User research	⬭	⬭	⬭	⬭	⬭
Testing	⬭	⬭	⬭	⬭	⬭
Idea generation / Brainstorming	⬭	⬭	⬭	⬭	⬭
Revising designs	⬭	⬭	⬭	⬭	⬭
Sketching	⬭	⬭	⬭	⬭	⬭
Prototyping	⬭	⬭	⬭	⬭	⬭
Project management	⬭	⬭	⬭	⬭	⬭
Team communication	⬭	⬭	⬭	⬭	⬭
Client management	⬭	⬭	⬭	⬭	⬭
Documentation / Reflection	⬭	⬭	⬭	⬭	⬭
Creating presentations / Pitches	⬭	⬭	⬭	⬭	⬭

18. 18. If you used an AI tool to support your creative process, how would it effect your sense of ownership over the outcome? *

Check all that apply.

- [ ] I'd still feel the outcome was my own
- [ ] I'd feel it was a collaboration with the AI
- [ ] I'd feel the AI had ownership
- [ ] I'd only feel ownership if I had modified or adapted the outputs of the AI
- [ ] Other: ______________________

19. 19. Finally, if you were to design the ideal intelligent tool to support your creativity, what would it do?

____
____
____
____
____

Thank you!

Thanks for taking part in this survey.

As part of this research project, in the future we will be running workshops to experiment with creative uses for the latest AI technology. If you would be interested in taking part in these events then please submit your email address below.

If you would prefer not to take part and to keep these answers anonymous, then there is no need to enter your email address.

20. Email address (if you are interested in taking part in future events)

____

Google Forms

Appendix 2: Survey Study - Data

Survey Study Data

What is your design discipline?	In your experience, what are the important qualities that make a design outcome “creative”?						Within your design process, where are you most likely to draw your inspiration from?
	Novelty	Purpose	Effective-ness	Ingenuity	Surprise	Synthesis	
UX Design	4	3	3	4	2	4	Information from separate but related domains
Graphic Design	4	5	4	3	3	5	Information from the specific domain for which you are designing
Interaction Design	4	5	3	4	4	3	Information from the specific domain for which you are designing
Interaction Design	4	3	5	4	3	5	Information from separate but related domains
Industrial/Product Design	3	5	4	2	3	3	Information from separate but related domains
Illustration	3	3	3	2	1	2	Information from completely unrelated domains
User Experience	4	5	5	4	4	4	Information from separate but related domains
Graphic Design	2	3	2	1	1	2	Information from completely unrelated domains
Interaction Design	5	5	5	5	5	5	Information from completely unrelated domains
Industrial/Product Design	3	5	5	5	4	5	Information from separate but related domains
Ux	4	5	4	4	3	3	Information from separate but related domains
Graphic Design	3	4	5	4	3	4	Information from separate but related domains
Interaction Design	4	3	3	4	4	4	Information from separate but related domains
users experience	3	3	1	2	3	2	Information from separate but related domains
Web designer	5	4	4	4	5	5	Information from the specific domain for which you are designing
Graphic Design	4	5	4	4	3	2	Information from separate but related domains
UX design	4	4	4	4	4	5	Information from completely unrelated domains
Interaction Design	2	2	3	4	3	4	Information from separate but related domains
Industrial/Product Design	4	3	4	2	3	4	Information from separate but related domains
Interaction Design	5	3	3	5	5	4	Information from separate but related domains
Interaction Design	4	3	2	2	4	3	Information from separate but related domains
Interaction Design	4	4	5	3	3	4	Information from the specific domain for which you are designing
Interaction Design	4	2	2	3	4	4	Information from the specific domain for which you are designing
Interaction Design	3	5	5	5	1	2	Information from separate but related domains
Interaction Design	3	3	3	3	3	3	Information from separate but related domains
Interaction Design	5	4	4	4	3	2	Information from the specific domain for which you are designing
Fashion Design	5	2	3	3	3	3	Information from separate but related domains
Graphic Design	4	4	5	2	3	3	Information from separate but related domains
Interaction Design	4	3	3	4	2	4	Information from separate but related domains
advertising/digital design	4	3	4	4	4	4	Information from separate but related domains
Interaction Design	2	4	4	5	4	3	Information from separate but related domains
Experience Design	5	4	5	5	5	4	Information from completely unrelated domains
information	4	3	5	3	3	5	Information from separate but related domains
film making/image maker	4	3	3	4	4	3	Information from separate but related domains
Furniture Design	5	3	2	4	4	5	Information from separate but related domains
Graphic Design	3	2	1	4	5	2	Information from separate but related domains
Picture Editor	2	5	5	4	1	4	Information from the specific domain for which you are designing
Graphic Design	4	5	5	5	3	4	Information from separate but related domains
UX	5	5	4	2	1	1	Information from completely unrelated domains
Interaction Design	5	4	5	5	4	4	Information from completely unrelated domains
Interaction Design	4	2	1	4	4	2	Information from separate but related domains
Experience Design	3	4	4	4	5	5	Information from separate but related domains
Fashion Design	4	3	4	5	3	4	Information from separate but related domains
Graphic Design	4	1	3	5	3	5	Information from separate but related domains

What are the most common obstacles to your personal creativity? (not including external factors such as budget or material restrictions)	What level of creativity do you feel is required for each of the following areas of the design process?						How would you rate your understanding of AI (Artificial Intelligence)?
	Researching the problem	Generating concepts	Reviewing and selecting concepts	Translating concepts into final design outcomes	Testing / Gathering feedback	Project planning / management	
Lack of understanding of the problem, Lack of interest in the problem, Distraction from non-creative tasks	4	4	3	3	3	4	2
Lack of inspiration, Lack of interest in the problem, Distraction from non-creative tasks, Too much fixation on task	2	3	3	5	4	4	2
Lack of inspiration, Lack of understanding of the problem	5	3	3	3	3	4	4
Not enough fixation on task, Difficulty in communicating vision	3	4	3	3	3	3	2
Lack of interest in the problem, Too much fixation on task	3	5	4	4	4	2	3
Lack of inspiration, Lack of understanding of the problem, Too much fixation on task	3	1	1	1	2	3	2
Distraction from non-creative tasks	3	4	5	5	3	3	3
Lack of understanding of the problem, Distraction from non-creative tasks	1	3	3	2	1	1	3
Lack of inspiration, Distraction from non-creative tasks	5	5	5	5	5	5	3
Lack of interest in the problem, Distraction from non-creative tasks, Too much fixation on task, Difficulty in communicating vision	5	5	5	5	5	5	3
Lack of understanding of the problem	4	4	4	5	4	3	3
Lack of inspiration, Lack of understanding of the problem, Lack of interest in the problem, Difficulty in communicating vision	2	5	4	5	5	4	3
Lack of inspiration, Lack of interest in the problem, Distraction from non-creative tasks, Not enough fixation on task	4	4	4	4	4	4	4
Lack of inspiration, Lack of understanding of the problem	3	3	3	3	3	3	3
Lack of inspiration, Distraction from non-creative tasks, Too much fixation on task	3	5	4	5	4	3	3
Lack of inspiration, Lack of understanding of the problem, Lack of interest in the problem, Distraction from non-creative tasks, Too much fixation on task, Difficulty in communicating vision	4	5	5	5	4	2	2
Lack of understanding of the problem, Distraction from non-creative tasks, Difficulty in communicating vision	4	4	3	4	3	3	3
Lack of understanding of the problem	3	4	4	4	3	3	3
Lack of understanding of the problem, Too much fixation on task, Difficulty in communicating vision	4	3	2	4	4	3	2
Distraction from non-creative tasks, Too much fixation on task, Not enough fixation on task	3	4	3	3	2	2	3
Lack of inspiration, Lack of interest in the problem, Too much fixation on task	3	3	4	3	4	2	2
Lack of interest in the problem	5	4	4	5	5	5	4
Lack of interest in the problem, Too much fixation on task	4	4	4	5	3	5	3
Too much fixation on task	5	4	4	5	5	3	3
Lack of understanding of the problem, Distraction from non-creative tasks	2	3	2	3	2	2	4
Lack of understanding of the problem, Lack of interest in the problem, Too much fixation on task	5	3	4	3	4	3	4
time consuming to learn new tools	3	5	4	5	2	2	3
Distraction from non-creative tasks, Too much fixation on task, Difficulty in communicating vision	4	3	5	4	3	2	4
Lack of interest in the problem	4	3	4	3	3	3	4
Lack of inspiration, Not enough fixation on task	5	4	5	4	5	5	3
Lack of understanding of the problem, Lack of interest in the problem	2	5	4	3	1	1	4
Lack of inspiration, Too much fixation on task	5	5	5	5	3	2	3
Lack of interest in the problem	5	5	5	5	5	5	4
Distraction from non-creative tasks, Too much fixation on task, Difficulty in communicating vision	2	3	2	3	2	2	3
Lack of inspiration, Lack of interest in the problem, Distraction from non-creative tasks	5	5	3	4	2	2	3
Lack of interest in the problem, Not enough fixation on task	3	4	3	3	2	3	2
Lack of inspiration	5	5	5	5	5	5	4
restraining cognitive bias	4	5	5	5	4	4	4
Distraction from non-creative tasks	4	5	2	2	3	2	4
Too much fixation on task	2	5	5	4	3	3	4
Distraction from non-creative tasks	2	4	3	2	1	1	3
Difficulty in communicating vision	3	5	2	5	4	3	4
Distraction from non-creative tasks, Difficulty in communicating vision	4	5	2	4	1	4	3
Too much fixation on task, Difficulty in communicating vision	5	5	2	3	4	2	4

How much impact do you think AI will have on your area of design in the future?	Are you broadly optimistic or pessimistic about any impact of AI on your area of design?	What words do you associate most with AI?	Within your design process, is there a particular tool (digital or physical) which you feel supports or enables your creativity?	If yes, what is the tool?
4	4	Creativity, Robotics, Assistance, Efficiency	Yes	Research methods
5	2	Control, Efficiency	No	
4	3	Creativity, Efficiency, Accuracy	No	
2	3	Efficiency, Accuracy	No	
2	2	Automation, Dystopia, Robotics, Assistance, Accuracy	No	
3	1	Control, Unpredictability	No	
3	3	Automation, Opportunity, Robotics, Control, Assistance, Efficiency, Unpredictability	No	
5	4	Opportunity, Creativity, Control, Efficiency, Accuracy	Yes	paper & pencil
5	4	Automation, Dystopia, Opportunity, Robotics, Control, Assistance, Efficiency, Accuracy, Unpredictability	Yes	quick brainstorming/testing
5	3	Automation, Dystopia, Opportunity, Creativity, Robotics, Control, Assistance, Efficiency, Fantasy, Accuracy, Unpredictability	Yes	communication
5	4	Automation, Robotics, Efficiency, Unpredictability	Yes	Both digital and physical
3	5	Automation, Opportunity, Robotics, Assistance, Efficiency, Accuracy	No	
4	3	Automation, Opportunity, Robotics, Assistance, Efficiency, Unpredictability	No	
4	4	Automation, Opportunity, Control, Assistance, Efficiency, Accuracy	No	
5	3	Automation, Opportunity, Robotics, Assistance, Efficiency, Unpredictability	Yes	Pinerest
4	3	Automation, Dystopia, Opportunity, Robotics, Control, Assistance, Efficiency, Fantasy, Accuracy, Unpredictability, Weaponisation	No	
4	3	Automation, Dystopia, Opportunity, Creativity, Efficiency, Unpredictability	No	
5	3	Automation, Dystopia, Opportunity, Creativity, Efficiency, Accuracy, Unpredictability	No	
4	4	Automation, Opportunity, Creativity, Control	Yes	
5	4	Automation, Robotics, Control, Efficiency, Accuracy	Yes	
3	4	Opportunity	No	
5	4	Automation, Opportunity, Control	Yes	programming based software
5	4	Automation, Robotics, Efficiency, Accuracy	No	
4	4	Automation, Control, Efficiency, Accuracy, Unpredictability	Yes	Adobe Creative Cloud
5	4	Dystopia, Robotics, Efficiency, Unpredictability	Yes	Programming
4	4	Automation, Efficiency, Accuracy, Unpredictability	No	
5	5	Automation, Creativity, Robotics, Assistance, Efficiency, Fantasy, Unpredictability	Yes	robotics
4	3	Fantasy, Prediction	Yes	Nature
5	3	Automation, Creativity, Assistance, Fantasy, Unpredictability	No	
4	4	Automation, Robotics, Assistance, Efficiency, Unpredictability	Yes	adobe creative suite
4	3	Automation, Control, Efficiency, Accuracy, Unpredictability	No	
2	4	Automation, Dystopia, Opportunity, Assistance, Fantasy, Reflection	Yes	Pen and paper
4	3	Automation, Opportunity, Assistance, Efficiency, Unpredictability	Yes	internet
2	4	Automation, Robotics, Efficiency, Fantasy	Yes	Smartphone
2	2	Automation, Dystopia, Eerror 404	Yes	pen and sketching
3	4	Automation, Assistance, Efficiency	Yes	Going to exhibitions
5	3	The unknown. What does it mean to be human?	Yes	Myself
5	4	Automation, Opportunity, Creativity, Robotics, Control, Assistance, Efficiency, Accuracy, Unpredictability	Yes	pencil
3	1	Automation, Assistance, Efficiency, Machine Learning (ML)	No	
4	3	Assistance	Yes	Pencil and sketchbook
4	2	Automation, Unpredictability	No	
3	4	Assistance	Yes	Sketches
2	3	Automation, Robotics, Efficiency, Accuracy	Yes	pencil
3	4	Automation, Opportunity, Robotics, Control, Assistance, Efficiency, Accuracy	Yes	Design software, image manip

And how does it support or enable your creativity?	From your understanding of AI, how capable do you feel it would be in supporting each of the following areas of the design process?					
	Researching the problem	Generating concepts	Reviewing and selecting concepts	Translating concepts into final design outcomes	Testing / Gathering feedback	Project planning / management
Allows me to explore and research creatively	4	2	3	3	4	2
	4	1	4	1	3	2
	5	4	4	3	3	3
	3	3	3	2	4	3
	4	2	4	4	3	4
	1	2	2	2	1	1
	4	4	4	3	4	3
sketches	3	1	2	3	1	3
they help catch instant ideas, reactions and feedback from life in an abstract way	5	5	5	3	5	3
Enables feedback, which enables development and creative critique	2	2	2	5	3	3
Let the idea start to build up	3	5	4	4	4	4
	4	2	2	2	3	4
	4	3	3	3	4	3
	5	2	4	1	5	5
Getting more inspiration	4	3	3	3	5	4
	5	2	3	2	4	5
	4	4	3	4	4	3
	3	4	4	4	3	3
	3	2	2	2	4	2
	3	2	3	3	4	4
	4	2	3	2	2	3
visualized my idea in a way, gives more opportunity for creative concepts	4	3	3	5	4	3
	4	2	1	1	4	4
	5	3	3	5	5	5
Programming give an extended space for lots of applications and physical devices like phthon which used in machine learning and arduino used in robotics.	3	2	3	3	2	3
	4	3	4	2	5	4
	4	3	3	3	5	2
	3	4	1	1	3	5
	4	3	3	3	3	3
generating the digital visuals and interactions	4	2	3	2	3	3
	4	1	1	5	4	4
Mapping out ideas, translating concepts into reality	4	2	2	1	2	3
exposure, education, resources, community, inspiration, platform	2	1	1	4	5	4
Instant record and search info	2	1	1	2	3	2
generating many ideas and iterating on these	3	5	3	1	1	3
It helps put the work in the back of my head and gather inspiration	4	2	2	3	4	4
Instinct, intuition, creativity	4	3	3	3	5	5
It enbles me to envisage my thoughts and ideas	4	3	2	3	4	5
	3	1	2	2	4	4
Producing rapid and rough sketches of ideas allows you to discard them and to move on quic On a further note, writing down notes and connecting them with lines – i.e. making maps – is	4	2	3	2	4	4
	2	3	2	1	1	1
Through sketches ideas come into existence	1	1	2	2	2	1
by visualising ideas, to generate evolving development and remembering	2	4	2	4	5	4
Saves time for me to sketch and prototype an idea	2	1	1	4	4	2

For the following list of design related tasks, please indicate how much support you'd be willing to receive from an AI tool.

Creating mood boards	Research-ing existing design solutions	Research-ing materials/ tools/proces	User research	Testing	Idea generation / Brainstorm-ing	Revising designs	Sketching	Prototyping	Project manage-ment	Team communicat ion	Client manageme nt	Documentat ion / Reflection	Creating presentatio ns / Pitches
3	3	4	3	4	2	2	3	3	1	2	4	4	2
2	3	4	4	3	1	2	1	2	2	2	3	3	1
1	1	4	1	4	3	4	4	4	4	4	4	4	3
3	2	2	2	4	2	2	4	4	2	2	2	2	3
2	2	2	1	4	2	2	1	4	4	5	3	2	3
3	2	1	1	2	2	2	3	1	1	1	2	1	1
4	4	3	4	4	4	3	3	3	3	4	4	4	4
1	2	2	2	2	1	1	1	2	2	1	2	1	2
5	5	5		3	3	3	2	3	5	5	5	5	4
1	3	3	1	4	1	3	4	4	3	4	4	4	4
3	5	3	3	3	2	2	3	3	3	3	3	4	2
3	3	4	4	4	2	3	2	1	3	1	2	3	4
3	4	4	4	4	3	3	3	4	2	2	2	4	4
4	3	4	5	4	3	4	3	1	4	5	4	3	3
4	4	4	3	5	3	4	5	5	3	3	3	3	5
4	5	5	4	4	3	3	3	3	5	3	3	4	3
4	4	4	4	4	3	4	4	4	4	3	3	4	4
2	3	3	2	3	2	2	2	3	2	3	3	2	3
5	3	3	4	5	3	4	3	3	3	3	3	3	3
4	5	5	2	3	2	2	3	4	3	2	2	2	3
2	4	2	1	2	1	2	2	4	3	1	2	3	4
3	4	3	4	4	4	3	4	4	4	4	4	2	4
1	2	1	2	2	1	1	1	1	1	2	1	2	2
5	5	5	5	5	4	4	5	5	5	4	5	4	4
4	3	3	5	5	3	3	3	3	5	3	3	3	3
3	4	1	1	1	2	1	2	3	4	4	4	4	5
3	3	3	3	3	3	3	3	3	3	2	2	2	3
4	4	4	2	3	2	2	2	4	3	2	2	4	2
2	2	2	3	4	1	1	2	2	5	3	3	2	1
4	4	4	3	4	1	3	1	1	3	2	1	1	2
2	4	5	5	4	3	4	3	4	4	4	3	4	4
1	2	2	2	2	2	2	1	2	2	2	2	2	2
4	5	5	3	1	4	3	4	5	2	1	1	2	1
3	3	3	3	5	2	2	3	3	4	3	2	5	3
4	4	5	5	5	1	3	3	5	5	1	1	3	2
5	4	3	2	3	3	2	1	3	5	2	2	3	3
3	3	3	2	3	2	3	4	4	5	4	4	3	3
1	3	3	3	2	1	1	1	1	4	3	3	3	2
2	2	1	1	2	3	4	1	1	1	1	1	1	1
3	3	3	2	3	2	2	2	3	2	1	1	2	2
3	4	3	5	5	1	3	1	3	4	3	3	3	4
2	3	3	3	4	2	2	2	2	1	1	1	1	1

If you used an AI tool to support your creative process, how would it effect your sense of ownership over the outcome?	Finally, if you were to design the ideal intelligent tool to support your creativity, what would it do?
I'd still feel the outcome was my own	
I'd still feel the outcome was my own	
I'd feel it was a collaboration with the AI	more relative knowledge
I'd feel it was a collaboration with the AI	Familiar with the way I think
I'd feel it was a collaboration with the AI	
I'd still feel the outcome was my own	help people on the stage of project researching
I'd feel it was a collaboration with the AI	Personalised inspiration, automating boresome tasks, etc
I'd still feel the outcome was my own	
I'd feel it was a collaboration with the AI	data collecting and analysis
I'd still feel the outcome was my own, I'd feel it was a collaboration with the AI	Simplify documentation and synthesis of work
I'd feel it was a collaboration with the AI, I'd only feel ownership if I had modified or adapted the outputs of the AI	Outcome can be generated by imagination from brainwave or signal
I'd feel it was a collaboration with the AI	assist with my design skill development
I'd feel it was a collaboration with the AI	
I'd feel the AI had ownership	
I'd still feel the outcome was my own	Generate inspiration
I'd feel it was a collaboration with the AI	
I'd feel it was a collaboration with the AI	I would like it to work on the areas that are more time consuming
I'd feel it was a collaboration with the AI, I'd feel the AI had ownership	
I'd still feel the outcome was my own	
I'd feel it was a collaboration with the AI	
I'd feel it was a collaboration with the AI	a tool that can generate prototype quickly. Sometimes I feel that it's a waste of time
I'd feel it was a collaboration with the AI	data analyzing and organizing, great prototyping function and help to organized my ideas and research.
I'd still feel the outcome was my own, I'd only feel ownership if I had modified or adapted the outputs of the AI	
I'd feel it was a collaboration with the AI	
I'd feel it was a collaboration with the AI	It would help me with the related essay and report hunting for the research stage, help analysis the keypoint of the essays maybe. And also help with documenting all the design process.
I'd feel it was a collaboration with the AI	
I'd still feel the outcome was my own	
Design is in general a much more collaborative process than Art. In Design, an emphasis has always been placed on Process over Product, thus rendering this argument an old one.	
I'd still feel the outcome was my own	Stop time. No, a generalist.
I'd still feel the outcome was my own, I'd feel it was a collaboration with the AI	Mainly for gathering visuals and other project references
I'd only feel ownership if I had modified or adapted the outputs of the AI	
I'd still feel the outcome was my own	Project management
I'd still feel the outcome was my own, I'd feel it was a collaboration with the AI	design something that listens, learns, and asks questions.
I'd feel it was a collaboration with the AI, I'd only feel ownership if I had modified or adapted the outputs of the AI	Intelligent phychic
I'd still feel the outcome was my own, I'd feel it was a collaboration with the AI	assist usefully with CAD drawing
I'd still feel the outcome was my own, I'd feel it was a collaboration with the AI	
I'd still feel the outcome was my own	Predict the outcome.
I'd feel it was a collaboration with the AI	Remove all areas of resistance and friction in making real new experiences that benefit humanity using design
I'd still feel the outcome was my own	mind-map interdisciplinary info-spaces
It depends on the responsibilities of the AI; as long as the AI does not create the practical output (or is not dominantly involved in any task), I still feel that I have the ownership	Giving me a categorised overview of processes or materials and possibilities of combinations in terms of material attributes and efforts in the manufacturing process, incl. the possibilities of filter, sort, and receiving new relevant input if a selection has been done
I'd only feel ownership if I had modified or adapted the outputs of the AI	
I'd feel it was a collaboration with the AI	
I'd only feel ownership if I had modified or adapted the outputs of the AI	rapid prototyping, checking facts and support interdisciplinary communication
I'd still feel the outcome was my own	A mood board where you can input two different topics, and scale the level of similarities/overlap of connections

Appendix 3: Google Diary Study - Day 1-7 Form

Creativity Support Roles

Hi!

Thank you very much for taking the time to complete this first questionnaire about creativity support.

In these questionnaires we'll be asking you to think of moments when you needed a hand with a creative task. Our definition of 'creativity' here is pretty broad - any task where you needed to generate new ideas, or solve problems in imaginative ways

There are eight questions in this form, and it should only take five to ten minutes to complete.

If possible please aim to write at least a couple of sentences for each answer - the more detail you can give us the more helpful it will be.

[redacted] Switch account

* Indicates required question

Email *

Your email

Please think of a time in the last couple of days when you needed some help with a creative task.

What kind of creative task did you need help with? *

Your answer

What kind of support would have been helpful to you? *

Your answer

What actions did you take that helped you complete this creative task? *

You can include actions that weren't obviously part of the task, such as taking a break, going for a walk, talking to a friend etc.

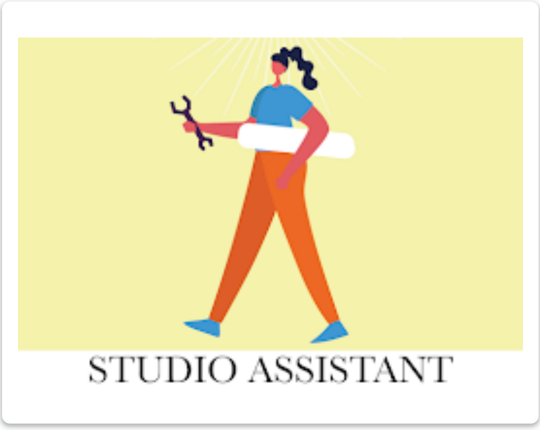
Your answer

What actions did you take that didn't help you complete this creative task? *

You can include distraction or diversion activities such as browsing the internet, doodling, etc.

Your answer

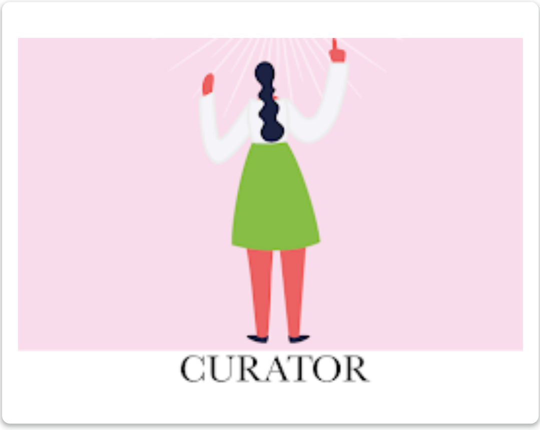
If you could choose an ideal collaborator to help you with this task, who would it be? *



- ○ Studio Assistant: Sets up your tools and materials and helps you get the best out of them. Ensures you have everything you need to capture your ideas.
- ○ Visualiser: Helps get the ideas out of your head and onto the page or screen. Listens to your ideas and visualises them for you.

- ○ Motivator: Helps you keep to your targets. Challenges you to push yourself further. Provides encouragement and motivation when you need it.
- ○ Go-Getter: Takes an idea and runs with it. Pushes concepts the extra mile. Seeks out new roles and challenges.

- Guide: Points your towards new ideas and references. Teaches you new techniques, and sets you on paths to discovery.
- Guru: Knows everything so you don't have to. Constantly learning and always has the right answer ready. Fills in any gaps in your knowledge.



- Curator: Helps maintain a stimulating workspace. Suggests changes to your routines and surroundings to give you new perspectives.

- Wildcard: Regularly brings suprising new outlooks and approaches to their work. Takes concepts in interesting and unpredictable directions.
- Other:
- None (I'd prefer to work on it by myself)

Please briefly tell us why you chose this option for a collaborator. *

Your answer

How would you prefer the collaboration to work? *

- ◯ They complete the task entirely by themselves
- ◯ They complete the task with some guidance from me
- ◯ We share the task evenly
- ◯ I complete the task with some guidance from them
- ◯ I complete the task entirely by myself

Submit

Clear form

Appendix 4: Google Diary Study - Day 8 Form

Creativity Support Roles

Hello

This is the final questionnaire in the study, and the format is a bit different this time.

Rather than thinking about a specific task, we just have a few general questions about creativity support, and the collaborator roles we've been discussing in the previous questionnaires.

As usual the questionnaire should only take five to ten minutes to complete.

[redacted] Switch account

* Indicates required question

Email *

Your email

Here's a reminder of the Creativity Support Roles

STUDIO ASSISTANT

Sets up your tools and materials and helps you get the best out of them. Ensures you have everything you need to capture your ideas.

VISUALISER

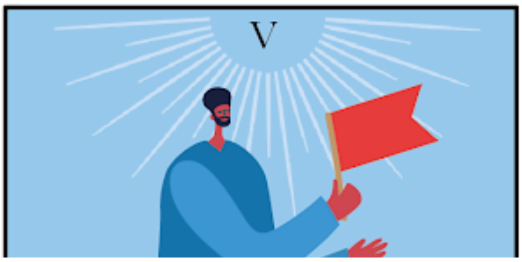
Helps get the ideas out of your head and onto the page or screen. Listens to your ideas and visualises them for you.

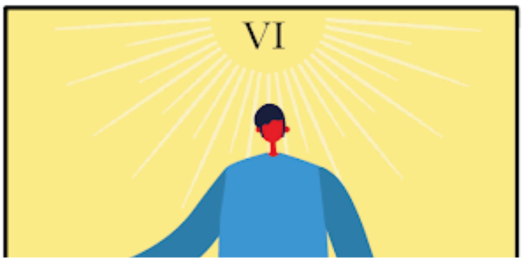
MOTIVATOR

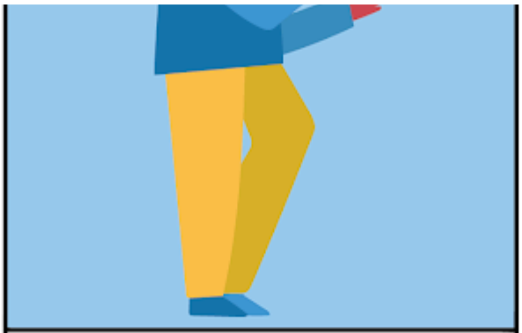
Helps you keep to your targets. Challenges you to push yourself further. Provides encouragement and motivation when you need it.

GO-GETTER

Takes an idea and runs with it. Pushes concepts the extra mile. Seeks out new roles and challenges.







GUIDE

Points you towards new ideas and references. Teaches you new techniques, and sets you on paths of discovery.

GURU

Knows everything so you don't have to. Constantly learning and always has the right answer ready. Fills in any gaps in your knowledge.

CURATOR

Helps maintain a stimulating workspace. Suggests changes to your routines and surroundings to give you new perspectives.

WILDCARD

Regularly brings surprising new outlooks and approaches to their work. Takes concepts in interesting and unpredictable directions.

Thinking broadly about the creative tasks you work on, how helpful would you find each of these roles as a creative collaborator? *

	Very Unhelpful	Unhelpful	Neutral	Helpful	Very Helpful
STUDIO ASSISTANT	○	○	○	○	○
VISUALISER	○	○	○	○	○
MOTIVATOR	○	○	○	○	○
GO-GETTER	○	○	○	○	○
GUIDE	○	○	○	○	○
GURU	○	○	○	○	○
CURATOR	○	○	○	○	○
WILDCARD	○	○	○	○	○

If you were collaborating on a creative project with other people, which of these roles do you think you personally would be able to perform best? *

- Studio Assistant
- Visualiser
- Motivator
- Go-Getter
- Guide
- Guru
- Curator
- Wildcard

Imagine if these roles were performed by Artificial Intelligence, rather than a person. How happy would you be for an AI collaborator to perform each of these roles on your creative projects? *

	Very unhappy	Unhappy	Neutral	Happy	Very happy
STUDIO ASSISTANT	◯	◯	◯	◯	◯
VISUALISER	◯	◯	◯	◯	◯
MOTIVATOR	◯	◯	◯	◯	◯
GO-GETTER	◯	◯	◯	◯	◯
GUIDE	◯	◯	◯	◯	◯
GURU	◯	◯	◯	◯	◯
CURATOR	◯	◯	◯	◯	◯
WILDCARD	◯	◯	◯	◯	◯

What kind of creative tasks would you be most happy for an AI system to help you with?

Your answer

What kind of creative tasks would you prefer to complete without any help from an AI system?

Your answer

How likely would you be to use the following features, if they could be performed by an AI system?

	Very unlikely	Unlikely	Neutral	Likely	Very likely
You can hand over a half finished creative task to the AI, and it will complete it, based on your previous work.	○	○	○	○	○
When you need inspiration for a creative task, the AI can remind you of ideal references from websites, media, or books you've previously viewed.	○	○	○	○	○
By observing factors such as your workspace, schedule, and physical actions, the AI knows how you work best, and helps you acheive this.	○	○	○	○	○
The AI understands what task you're tyring to complete, and automaticaly sets up your preferred software, templates, and resrouces.	○	○	○	○	○

The AI system is aware of the latest trends, styles, and methods for your area of work, and can help you incorporate them into your work.	○	○	○	○	○
You can describe an idea or a concept to the AI, and it automatically generates a version for you.	○	○	○	○	○
The AI system can provide you with regular feedback on your work, telling you how feasible / successful it is likely to be, and providing suggestions.	○	○	○	○	○
The AI knows when you're feeling unproductive, and sets you achievable challenges to keep you going.	○	○	○	○	○

The type of features described above would require the AI system to learn information about you and the way you work. What personal information would you be happy to securely share with the AI system?

Please tick any that you're happy to give the AI system access to.

- [ ] Streaming media activity (what music, film, TV shows you're streaming)
- [ ] Conversations with the AI (voice data from your interactions with the AI)
- [ ] Calendar
- [ ] Browser usage (what webpages you're visiting)
- [ ] Conversations with colleagues (voice data from work meetings)
- [ ] Photos and videos (photos you've taken, or media you've saved)
- [ ] Physical movement via phone/watch (when you're sitting down, standing, moving around etc.)
- [ ] 'Offline' work via camera (physical sketches, notes, models etc. in your work space)
- [ ] Posture or pose data via camera (whether you're standing, sitting, leaning, etc.)
- [ ] Software usage (what apps you're using / tasks you're performing)
- [ ] Social media activity (what content you've liked or re-posted)
- [ ] Emails

Do you have any other thoughts or comments on the topic discussed in this study?

Your answer

Submit

Clear form

Appendix 5: Google Diary Study - Data

DAY 1

Participant	What kind of creative task did you need help with?	What kind of support would have been helpful to you?	What actions did you take that helped you complete this creative task?	What actions did you take that didn't help you complete this creative task?	If you could choose an ideal collaborator to help you with this task, who would it be?	Please briefly tell us why you chose this option for a collaborator.	How would you prefer the collaboration to work?
1	[redacted]	Examples, direction	[redacted]	procrastinated a bunch	Go-Getter	Seems the most productive; tangible benefits	We share the task evenly
2	[redacted]	[redacted]	[redacted]	[redacted] I tried to look for templates for my doc, but then decided to use a blank page.	Visualiser	I'm faster (and wilder) at thinking than writing. I would love for somebody to help materialise my thoughts onto "paper".	They complete the task with some guidance from me
3	[redacted]	[redacted]	Meetings with stakeholders to discuss what's possible given current limitations	[redacted]	Guru	I was leaning toward "studio assistant" but a "guru who knows everything" sounds better!	They complete the task with some guidance from me
4							
5							
6	[redacted]	[redacted]	[redacted]	[redacted]	Guide	I chose guide, b/c I feel most fulfilled overall when I've worked for my knowledge. While it's also great to get information immediately from gurus, I often find that I retain knowledge better when I've done something to actively learn it.	I complete the task with some guidance from them
7	Designing presentation slides.	Useful meme searching tools and graphing tools	Collaborated with team members and revised the graphs / pictures found	[redacted]	Visualiser	[redacted] Visualization is often a good tool for explanation / instruction.	I complete the task with some guidance from them
8	[redacted] Between me and another illustrator, we were creating the keyframes for the storyboard. Particularly there was one storyboard I wasn't quite sure what to do or how it would connect to the previous one.	[redacted]	[redacted] instead of pushing through I stopped and went for a walk.	I should have reached out and just chatted with the other illustrator to bounce ideas off of but I didn't [redacted] I think that often talking it through with someone else helps me but because I was alone I didn't reach out to anyone else.	Wildcard	I felt stuck in my thinking, I think a wildcard would spark some new directions for me.	We share the task evenly
9	[redacted]	[redacted]	Reviewing previous materials and research, engaging with teammates' existing comments and questions.	Distraction from core work [redacted]	Go-Getter	In this task, I'm looking for partnership, engagement, and collaboration. Having a self-motivated collaborator would make the asynchronous work process go more smoothly.	We share the task evenly

10	Creative troubleshooting	Appropriate tooling	Conversation with coworkers to brainstorm new tactics	[redacted]	None (I'd prefer to work on it by myself)	The solution that ended up working best didn't follow any of the recommended approaches for working with the platform, needing to be constantly updated for each problem being worked on. I feel having an active collaborator would have slowed things down further.	I complete the task entirely by myself
11	Explaining a design through a formal presentation.	A better tool for presentations [redacted]	Finishing the design mocks, planning how I'd tell the story, copy-pasting the appropriate designs into Slides, adjusting each slide to be consistent, discussing with teammates, iterating.	The process was fairly long so I did other projects and went about regular life in between, like eating, playing with my kids, etc..	Studio Assistant	[redacted] A studio assistant could perhaps help me streamline the workflow to get more out of Slides.	We share the task evenly
12	[redacted]	reference of how other teams did their if any.	brainstorming, research [redacted] earning what other teams did to their charter, review team org structure, my roles and responsibility to the team	Not identified yet	Guru	I debated a visualizer and Guru. Because I expect myself to be that Guru eventually but it good to have a Guru now so that if I have any question I have a one stop shop	I complete the task with some guidance from them
13	[redacted]	immediate simulation support for design viability, software tool that would have made the design process of 3D modeling the part simpler	drew out many preliminary designs, chatted with a coworker for brainstorming alternates, 3D modeled some options	distractions, doing this task over multiple days so didn't have a solid focus block time	Motivator	The motivator can helps keep me focused to execute and finish the work that I need to do. Often times I know the creative task at hand and the things that I need to do and want someone there to be a sounding board and encouragement.	I complete the task with some guidance from them
14	Creating supporting graphics/diagrams [redacted]	Not sure what this question is asking... Inspirational examples maybe?	Large block of uninterrupted heads-down time	General workday related distractions - answering urgent emails, chat messages, required meetings	Go-Getter	Only Studio Assistant, Visualizer and Go-getter fall into a "doer" group. Out of three, Go-getter seems to be more aligned with my idea of a collaborator. The other two (Studio Assistant and Visualizer) imply that the relationship will be hierarchical.	We share the task evenly
15	Planning for the data management	Data extraction from Data Analyst	[redacted]	Many meetings and chats and follow-up actions from the meetings and chats.	Studio Assistant	I need the correct tools to perform the tasks.	They complete the task with some guidance from me
16	[redacted]	A guided tutorial or FAQ would have really helped me with my task.	I asked a colleague for help. She has more experience with creating these reports.	I spent a lot of time experimenting in the tool; however, this was not very helpful for me.	Guide	A guide would not only help me stay on top of my goals, but would also help to keep fresh ideas/techniques at the forefront, reducing workplace staleness!	We share the task evenly
17	[redacted]	Graphic designer, logo library, branding guidelines	I reached out to the branding team for guidelines on where we can place logos and reached out to swag supplier for mockups. [redacted]	[redacted]	Guide	Guidance on branding restrictions, options, and inspiration would have been helpful. And then the rest of the creativity can be left to me after that.	I complete the task with some guidance from them
18	Brainstorm solution for a customer challenge	Talking with a colleague about the problem	Talking with a colleague about the problem and see if he/she has experienced a similar challenge	n/a	Go-Getter	Helps pressure test your idea	We share the task evenly
19							
20	testing plan for new product	get understanding of resource constraints, and testing requirements	chat with [redacted] teams regarding resource, and request supplier to increase their support for testing	NA	Motivator	Cross functional team pushed me for higher goal of testing plan, which motivate me to try to find better way to do it.	I complete the task with some guidance from them
21	Thinking about how to visualize data [redacted]	Templates	Got a small group together to work it out over meet	went after easier tasks on my to do list, watched TV, browsed the internet	Studio Assistant	It would be nice to not need to reinvent the wheel all the time when I know resources exist, but finding them can take longer than starting fresh	I complete the task with some guidance from them
22	Building a prototype [redacted]	Feedback early and often	Listed ideas, sketched different concepts, drank tea, listened to music and designed in Figma.	Browsing the internet, going to meetings, looking for snacks (even when not hungry).	Motivator	Task was mostly self driven so having a collaborator for accountability would have made things move faster. Also someone who challenges helps me go further than my comfort zone.	I complete the task with some guidance from them

23	[redacted]	Ability to sit down with people who are familiar with that space so that we can use our collective expertise to figure it out	1. I reached out to SMEs. I didn't think they would know the answer, since I know there isn't an *obvious* characteristic, but I suspected they might have an understanding that I don't that combined with what I know could drive towards a solution 2. I worked out and thought about it 3. Did some things I knew wouldn't get me results, but would get me more familiar with the problem space	answered emails, did other work for a while, left it and came back the next day,	Guide	Having someone who has all the answers (guru) would be great, they'd already know the answer. I don't think that person exists. At best, a Guide would be helpful, someone who knows their way around the problem space and would have helpful pointers	I complete the task with some guidance from them
24	I needed to design a new workshop	Panel of ideas on how to make it more interactive online, different from the usual chat, Jamboard etc interactions	Researching, jotting down ideas on a notebook, taking a walk, gardening, getting back in front of the laptop creating a frankenstein deck, having a good night sleep, polishing it in the next 2 days, getting it done just in time.	Stressing out because I need to get it done and feeling the deadline pressure, distracting myself on the internet, eating sweet stuff from my kitchen, drinking too much coffee	Visualiser	I'd love someone that can pick my brain and turn the ideas I have into something beautiful, streamlined, summarized and graphically amazing.	They complete the task with some guidance from me
25	[redacted]	Working on a focused task instead of getting distracted by other day to day activities and tasks.	Blocked off focused time, validating one of the approaches with an external teammate, creating post it notes for the ideas.	Working on other trivial tasks, too many distractions via Chat which I couldn't turn off due to other project priorities (other teammates needing help)	Motivator	I chose the motivator because the constant distractions tend to make me lose focus and procrastinate. It then becomes easier to solve the smaller problems. A motivator would keep me focused on the important task and not worry too much about the other smaller problems.	I complete the task with some guidance from them
26	[redacted]	[redacted]	I did troubleshooting myself and was able to identify the strange behavior myself and find a work around	none	Guru	As a Guru, I would anticipate that they have the know-how of troubleshooting either from first hand experience or from tribal knowledge	I complete the task with some guidance from them
27	Finding fix for a new issue not very common to fix	Reading related studies	Taking a break and working again	Not seeking help from anyone	Guide	Guide can help me discover new ways and help me solve issue out of the box	I complete the task with some guidance from them
28	[redacted]	Google sheet and doc to document existing process flows	[redacted]	data issues are caused by various reasons so it's not possible to find a solution that is one-size-fit-all	Guide	I needed someone to bring new perspectives and think out of the box.	They complete the task with some guidance from me
29	[redacted]	Hard to say. This stage of work feels like diving into a cave and surfacing at the end of the day, confused, and without any sense of how so much time has passed...it's a draining stage!	cleared the calendar as much as humanly possible to allow for hours-long sessions (me + my design partner)	not having enough discipline to make sure I give myself enough time to do things outside of work (eg get up early enough for a healthy, complete morning routine)	Curator	this is exactly what's missing because of WFH and also what goes out the window during intensive synthesis phases (I'm too engrossed during long collaborative days, and too exhausted at the end of the day, to do this for myself)	They complete the task with some guidance from me
30	[redacted]	Some guidance on how humans view and interpret visual data	Sketched ideas in a note pad/white board, pulled all my Tufte books off the shelf and looked at the pictures,	Googled for ideas, went to the gym, worked on other tasks	Guide	For creative tasks, I'd like a guide who can point me in the direction of resources and then allow me to self-learn so I build up new skills, rather than just be told the answer.	I complete the task with some guidance from them

DAY 2

Participant	What kind of creative task did you need help with?	What kind of support would have helped your creativity?	What actions did you take that helped your creativity on this task?	What actions did you take that didn't help your creativity on this task?	If you could choose an ideal collaborator to help you work more creatively on this task, who would it be?	Please briefly tell us why you chose this option for a collaborator.	How would you prefer the collaboration to work?	Broadly, which of these best describes the type of task you needed help with?
1	Designing a new service	more context about the problem space	read, ask questions, look at examples	procrastinate, watch TV	Guide	Would help me get started, provide some guidance	I complete the task with some guidance from them	Defining scope or focus

2	[redacted]	[redacted]	[redacted] I also set up a meeting with the vendor to go through the process with me.	I experienced some sort of a blank page syndrome. For a moment, I didn't know where to start, until I started putting anything down that I already knew, then adding new ideas. In these blank moments, I get discouraged and unmotivated, so I have to remind myself that the task is easier than I think. I tried to multi-task, but that detached me even more from engaging with the task	Visualiser	To bypass the bank page feeling. Talking about my ideas is sometimes easier than "forcing" them onto a document.	I complete the task with some guidance from them	Implementing or delivering your ideas
3	[redacted]	Clarity on impact of name change (eg, number of users affected)	Internal conversations	started filling out this survey instead :) (move on to other work/tasks)	Wildcard	Looking for new ideas on how to manage API behavior vs naming	We share the task evenly	Defining scope or focus
4								
5								
6	[redacted] We received some concerns about an aspect of the design, so I worked on alternative approaches, including mocks and a list of pros/cons for different options.	Ability to quickly create realistic app prototypes, including motion and animation	Creating static mocks helped to communicate the different options with the team, including visualization of the pros/cons	I didn't take time to create motion/animation, but if it were faster this would have been a good reference when debating which option to move forward with	Visualiser	In my imaginary scenario, my visualizer would help me quickly prototype the options into realistic prototypes that we could share with other people	They complete the task with some guidance from me	Generating or developing ideas
7	Writing design documents	External voices who do not understand the idea and who can provide feedback to make the documents more understandable	Talked to team members who did not work on similar projects for review and expand sections	Code writing in between and adding proto definitions	I think I need someone to provide an outsider opinion	When writing a design doc you are trying to talk to people outside of your group or to explain a new idea which you are familiar with. In this situation it is easy to be concise about concepts, backgrounds, importance in the doc as you know it well yourself. Therefore it's important to have an outsider opinion tell you what is confusing.	I complete the task with some guidance from them	Implementing or delivering your ideas
8	[redacted]	A bit more time to research and pull from existing UI patterns	Sent to the other designers on my team for a quick review	I was context switching a lot. Working between multiple different projects	Guide	I think because I was rushing I didn't push beyond the first solution. Guide would help me find other paths	We share the task evenly	Research and discovery
9	[redacted]	Engagement of other team members in co-creation.	I reviewed existing presentations from past cohorts and played with internal themes to best present the work.	Distractions on this task primarily included other meetings and work for my core team.	Go-Getter	I find I do myu best work on presentations when I'm rapidly, synchronously iterating with a peer... so having a go-getter alongside me would encourage me to be more productive as well.	We share the task evenly	Implementing or delivering your ideas
10	[redacted]	Allocated design headcount for the task	Browsing internal and external sites to review other implementations for inspiration, syncing with member of design team for primary use-cases they're considering.	Chipped away at email inbox, reviewed and edited my daily task list, resupplied "desk snacks".	Visualiser	I have a pretty strong idea of the use-case I'd like to focus on, but specifically could use input on how to best address that use-case while keeping in sync with the existing design system.	They complete the task with some guidance from me	Generating or developing ideas
11	Creating new designs for a project [redacted]	A partner designer who was on the same page and could generate work at the same pace.	Created designs in figma, chatted with teammates and stakeholders, iterated, made screencast videos of some of the designs to get feedback from non-project related designers.	[redacted]	Wildcard	The problem I was solving for had a lot of requirements and constraints. With that narrow scope it was challenging finding a "perfect" solution, so having a Wildcard would've been great as they could've done some broader explorations simultaneously while I worked.	They complete the task with some guidance from me	Generating or developing ideas
12	suggested a functionality in a tool that I support to improve user access	team support	talking to teams involved	N/a	Visualiser	my idea was a process so it would be clear to map it out visually	We share the task evenly	Implementing or delivering your ideas
13	Creating some fun images and photoshops for a team meeting	More time and better understanding of computer software tools to use to edit	Didn't end up being able to execute any ideas as I just ran out of time before it was due	Being too busy with other tasks at work	Studio Assistant	In this case, I needed help translating ideas to images so someone who is an expert at the tool could help make those images quicker	They complete the task with some guidance from me	Generating or developing ideas

14	Creating visual assets for highly ambiguous problems	Finding reference decks or related information easily	Carve out some time to make a spreadsheet of all the related materials/decks	Switching gears and jumping in and out of another project	Studio Assistant	For this particular task, gathering background materials and having an easy access to them were important.	They complete the task with some guidance from me	Defining scope or focus
15	Data visualization and data extraction	Data visualization and data extraction	Meeting with Data Analyst	Idling	Visualiser	To transform the raw data into meaningful messages to resolve potential issues	They complete the task with some guidance from me	Research and discovery
16	[redacted]	[redacted]	My colleague and I bounced ideas off of each other and critiqued each other.	Creating a laundry list of accomplishments for the Perf cycle.	Curator	Getting new perspectives would really help with creativity in writing a self-assessment doc. Often we get stuck in a mental rut and seem to overlook some accomplishments because they are not perceived to be meaningful, even though they are, if properly re-framed.	We share the task evenly	Implementing or delivering your ideas
17	Coordinating a well-being day activity for a research team.	A teammate to throw out ideas at, a list of past events/activities done, resource list	put a 1:1 on calendar to brainstorm ideas with a teammate, searched through moma for well-being resources	talking to my teammate about other projects or personal things in the 1:1 as a brief distraction	Guide	Resources and ideas would've helped. I could've picked one from the list or built on that idea, figuring out which one I like best for my team.	I complete the task with some guidance from them	Generating or developing ideas
18	Create a new pitch collateral	Support from a visual designer	Looking at other good examples	Distractions from moma	Studio Assistant	Would be great to have an expert in visuals to help	We share the task evenly	Implementing or delivering your ideas
19								
20	[redacted]	understand the goal of the initiative [redacted]	[redacted]	[redacted]	Visualiser	[redacted]	We share the task evenly	Generating or developing ideas
21	Ideating a way to socialize an integrate my project into larger initiatives	Other minds	reached out to others who could help me solve the puzzle	general procrastination due to blockages	Visualiser	I often need help in making my pitch ideas clear so I can socialize them. I can design deliverables if its someone elses content - no problem!	I complete the task with some guidance from them	Generating or developing ideas
22	UX Writing	Collaboration with a UX writer	I looked into documents of previous solutions [redacted] we brainstormed together	N/A	Guide	I'd like to learn more UX writing so I can have more autonomy in this task	They complete the task with some guidance from me	Implementing or delivering your ideas
23	same as last time, trying to find ways to determine how changes have propagated across our codebase	talking more with users [redacted] who actually implemented changes to see if there were unique characteristics about these changes	Tried out a bunch of stuff I knew wasn't going to work, but that would provide more info about the space.	Went to a wedding this weekend, so got distracted by that	Guide	Again, need someone who knows the space well, even if they don't have all the answers	I complete the task with some guidance from them	Research and discovery
24	Learning design	Stimulus for ideas, Help in structuring them in a coherent form, gentle reminders to get down to it and not postpone the work	Jotting down things on pen and paper, taken a walk in nature, researched on Google	distracting myself on the phone, Youtube, social media, house chores...	Visualiser	I'd love someone that could structure and visualize my ideas for me.	They complete the task with some guidance from me	Generating or developing ideas
25	[redacted]	Whiteboarding and being in office discussing this with coworkers would have made this significantly faster.	Talking to a coworker outside the team helped.	Sent email and waited for review comments. [redacted]	Visualiser	[redacted]	They complete the task with some guidance from me	Defining scope or focus
26	[redacted]	Collaboration with other UXD on the team [redacted]	Set up work sessions with other UXD on the team to discuss what was needed, identify who would own the design work for each screen, and discuss design solution ideas as a group before each of us went off to design what we were responsible for	none	Go-Getter	[redacted]	They complete the task with some guidance from me	Generating or developing ideas

27	Create a presentation	Create presentation with good diagrams and animations for better understanding	Explored various features of slides, checked out some slides used in some earlier people's presentations	Initially I was more inclined with old way of making presentation with basic formats that made the presentation boring	Curator	To help me present my ideas in better way	I complete the task with some guidance from them	Implementing or delivering your ideas
28	[redacted]	End to end process flows, best practices in the industry	Deep dived into existing system functionality to understand the pros and cons	Looked into data tables that I was not familiar with to seek opportunities in possible data that I was looking for	Go-Getter	Go-Getter can help me run with the new idea and put theory into practices by looking into multiple options for the best outcomes	They complete the task with some guidance from me	Generating or developing ideas
29	continued deep synthesis work (same as referenced in survey #1)	magical deck-making wizards...	1) taking a break to attend a training that my manager suggested - which was refreshing, inspiring, and ended up being directly relevant [redacted]	I felt pretty focused and on a roll by this point; it's just a draining phase of work in which I know (from many projects' worth of experience...) that I just need to trust the process, and push through :)	Visualiser	[redacted]	We share the task evenly	Implementing or delivering your ideas
30	[redacted]	More feedback from colleagues, and a better understanding of how this fits into my PAs overall objectives	[redacted]	Working on my own	Go-Getter	I chose go-getter because I have about some thoughts about how to do this piece of work effectively, but would be open to being pushed outside my comfort zone to expand my thinking	I complete the task with some guidance from them	Defining scope or focus

DAY 3

Participant	What kind of creative task did you need help with?	What kind of support would have helped your creativity?	What actions did you take that helped your creativity on this task?	What actions did you take that didn't help your creativity on this task?	If you could choose an ideal collaborator to help you work more creatively on this task, who would it be?	Please briefly tell us why you chose this option for a collaborator.	How would you prefer the collaboration to work?	Broadly, which of these best describes the type of task you needed help with?
1	Designing a new system	Context, direction	read docs, read through code		Guru	would help to have an easy and reliable knowledge source	I complete the task with some guidance from them	Defining scope or focus
2	[redacted]	[redacted]	[redacted]	I had to click through quite a few results, before I decided to stick to a PDF.	Studio Assistant	In the end, this was a trivial task that I would have want to delegate to an assistant.	They complete the task entirely by themselves	Research and discovery
3	Brainstorming improvements to internal tool	Understanding how other users use the tool, so that the design ideas work for them, too	Conversation	Time boxing (it helps ensure we don't spend too much time on the task)	Wildcard	I chose "wildcard" to help see beyond my own opinion.	I complete the task with some guidance from them	Generating or developing ideas
4	Designing a software architecture	I don't know	Bought a whiteboard since it helps me with complex creativity tasks. I was thinking of the task for at least a few weeks. Every time I get a good idea, I make sure to document it. [redacted] Have had several conversations with other engineers to talk through ideas.	all other distractions.	Go-Getter	I tend to have a broad idea of how all the pieces should work together. The idea here is to add depth to the breadth to make sure all aspects are taken care of.	I complete the task with some guidance from them	Generating or developing ideas
5								
6	[redacted]	For longer running projects, I have trouble keeping my designs organized and updated [redacted]	[redacted]	[redacted]	Guide	In this case, I'm curious to know how others tackle organization of their design decks and Figma files esp for long running projects which need flexibility to change but also ability to sync quickly across assets.	I complete the task with some guidance from them	Implementing or delivering your ideas
7	Designing group logo	Art designer or people with artsy insights	Went online and got idea from different other logos	Looking at other team's logos which limited the idea	Visualiser	This person will help with designing a visualization	They complete the task with some guidance from me	Generating or developing ideas

8	[redacted]	I wish I was working in the same room as the other illustrator! It's been nice to collaborate but wish we were able to talk it out in real time	I looked to his work and pulled techniques and styles into mine so they felt cohesive	I started responding to emails which was kind of a nice break but also distracting	Visualiser	This to me sounds like working in the same room as another illustrator. Would love to talk through and play around with ideas at the same time	I complete the task with some guidance from them	Generating or developing ideas
9	I needed guidance on how to take another designer's Figma file and adapt it successfully for new purposes.	Clear explanation of how the designs were built and/or standardized guidance on how the team uses the tool.	Self-directed exploration of the existing assets and files.	Diving down rabbit holes of other files in Figma that are less directly relevant to my work.	Guide	I needed someone to explain how they used the tool so I could be more efficient—i.e. a guide.	I complete the task with some guidance from them	Implementing or delivering your ideas
10	[redacted]	Some input from sources aware of how much flexibility is available in existing processes [redacted]	Reflecting on currently implemented handling of existing use-cases that have a high degree of overlap, reviewing and reorganizing the existing feature road-map	Rehashing reasons why these new convoluted use-cases shouldn't exist at all.	Wildcard	Would prefer to find solutions that pull the new use-cases closer to the expected use-cases, rather than simply addressing them straight-forward and literal.	I complete the task with some guidance from them	Defining scope or focus
11	[redacted]	[redacted]	[redacted]	[redacted]	Guide	A guide could help me try new techniques and ideas for presenting creative questions. My interviewing hat was execution and contextual thinking, so it was all about imagining new scenarios for the candidate's past work.	I complete the task with some guidance from them	Generating or developing ideas
12	[redacted]	helpful to have similar document done as reference to benchmark and determine metrics	talking to team, take a walk	N/A	Visualiser	I like to be able to visualise my ideas on screen	I complete the task with some guidance from them	Defining scope or focus
13	[redacted]	I bounced ideas off another coworker as we tried to brainstorm what was technically happening and what types of failures would cause that	[redacted]	[redacted]	Guide	because I was working with a cross-functional coworker on this creative task, it was great to have his expertise in a different realm so we could bounce ideas off each other and give input from our areas of knowledge	We share the task evenly	Generating or developing ideas
14	Creating Visual Mocks	Peers who can brainstorm ideas together	Putting in a large amount of heads down time	Switching gears to perform admin tasks with deadlines	Wildcard	Sometimes you get stuck and your explorations hit a dead-end. It's helpful to consider wildly different approaches which might help you pivot from your own way of thinking	We share the task evenly	Generating or developing ideas
15	Data extraction and analysis for the failures	May need specialist's help	Tried to ask the management level for the help	[redacted]	Guru	Need the expert's help	They complete the task with some guidance from me	Implementing or delivering your ideas
16	Devising a creative solution for a custome [redacted]	Guidance from executive teams [redacted]	I had a brainstorming session with my team to come up with ideas for out-of-the-box solutions. We listed as many ideas as possible, regardless of how easy/difficult they would be to implement.	[redacted]	Guru	An individual with relevant experience in navigating the same challenges would be extremely beneficial in getting us out of this blocker.	I complete the task with some guidance from them	Generating or developing ideas
17	[redacted]	second opinion / confirmation from teammates on my idea, help creating an order form	getting second opinions on final design, asking to attend a leads meeting to poll the team leads [redacted]	asking too many people for qualitative feedback as it was all mixed. (having a simple poll was better)	Guru	I like the "filling gaps in your knowledge" portion. Someone who has done swag orders before knows the best process	I complete the task with some guidance from them	Implementing or delivering your ideas
18	Design a new solution for CRM process	Tools to help with brainstorming	browsing the internet of ideas	sitting down for deep thinking	Guru	Would be great to have a person who knows about this area and may help spark some ideas	We share the task evenly	Research and discovery
19								
20	understanding of a module mass breakdown	clarify of the scope of work	asked stake holder to double check on how much details are really required for certification of comliance	shared what is available, and checked with supplier on what they can provide	Guru	in this case, supplier is the guru, and I asked the supplier on how much details they can share.	I complete the task entirely by myself	Defining scope or focus
21	ideating a program outline	input from others in collaboration	got together with others [redacted]	[redacted]	Visualiser	i often have a hard time visualization for socialization of ideas	We share the task evenly	Generating or developing ideas
22								
23	[redacted]	Collaborators who were knowledgeable about the area who could generate ideas or critique existing ones	I reached out to someone on the team [redacted]	[redacted]	Guide	I would love to have someone who could teach me how to be more persuasive	I complete the task with some guidance from them	Generating or developing ideas
24	Creating a presentation of my work	motivation, space and no distractions	lots of tea, going for a walk, taking note on paper, trying (not really succesfully) to clear out my calendar	[redacted]	Curator	I would have loved someone to help me getting unstucked, and giving me suggestions on how to move forward	I complete the task with some guidance from them	Defining scope or focus
25								

26	[redacted]	[redacted]	I didn't have anyone to delegate this to so I had to do it myself	none	production designer	This role requires some creativity in terms of understanding of design systems and patterns thinking but relies heavily on the ability to organize and optimize a library set of a design mocks	They complete the task with some guidance from me	Implementing or delivering your ideas
27	To explain my idea to new team and mangers	Support to better present my idea in a way that point is sent across in the best way	I tried to talked to friends and colleagues and tried to understand the ways about how to engage the wide audience	Putting too many technical details	Guide	I wanted guide to help me understand the mindsets of wider audience and how to engage better so that I can send my point across in efficient way	I complete the task with some guidance from them	Generating or developing ideas
28	[redacted]	SQL guru	Tried various SQL logic to try for simplification	None	Guru	A guru knows something that I don't know of and can fill the knowledge gap	They complete the task entirely by themselves	Research and discovery
29	designing research activities & the assets to support them	"sounding board" (less-formal, generative discussion to help me build on my initial ideas) + critique (focused feedback on my current version so I can make specific improvements to iterate)	[redacted]	was pretty focused on this task, actually (but due to short time frame to turnaround a plan, I didn't spend anywhere near as much time as I'd like to really think through things)	Guide	I have a strong baseline in this particular type of research; I know I can do a decent job on my own, but a much better job developing these activities / tools with input from someone more experienced than I am (and with fresh perspective to bring)	I complete the task with some guidance from them	Generating or developing ideas
30	Designing dashboards	being able to run some face to face workshops	screen shared and presented drafts of the dashboards	going for a walk, iterating multiple times on my own	Wildcard	I chose wildcard because it would be good to push the limits and challenge the thinking in this space	We share the task evenly	Generating or developing ideas

DAY 4

Participant	What kind of creative task did you need help with?	What kind of support would have helped your creativity?	What actions did you take that helped your creativity on this task?	What actions did you take that didn't help your creativity on this task?	If you could choose an ideal collaborator to help you work more creatively on this task, who would it be?	Please briefly tell us why you chose this option for a collaborator.	How would you prefer the collaboration to work?	Broadly, which of these best describes the type of task you needed help with?
1	Designing a slide deck	examples	look at similar slide decks me and others have made	browse the internet	Motivator	needed help motivating to get started	I complete the task entirely by myself	Implementing or delivering your ideas
2								
3	HC planning	Crystal ball to predict the future and rationalize HC asks	n/a	gave up	Guide	I suspect my lack of experience is a problem. A guide might help me calibrate the goals and effort so I can make sufficient progress with fewer doubts.	We share the task evenly	Research and discovery
4	Writing a piece of software	I don't know	Left my apartment everyday to make sure I am in a different environment. It felt helpful to be physically in a new space	N/A	Studio Assistant	in order not to spend time developing tools, and focus more time on the creative task	They complete the task with some guidance from me	Implementing or delivering your ideas
5								

6	[redacted]	Ideas from a motion guru who has both design and eng knowledge	[redacted]	[redacted]	Guru	Being able to consult with someone who has both design and eng knowledge about options for animation a collapsible UI with an iframe would be greatly beneficial to me, since I don't have the technical knowledge to know what's possible.	They complete the task with some guidance from me	Implementing or delivering your ideas
7	Designing presentation slides	Expert telling me how to convey ideas better to novel audience	[redacted]	Showing the presentation draft to teammates	Visualiser	Visualizer could help me turning ideas into visualization to better present to audience	They complete the task with some guidance from me	Defining scope or focus
8								
9	Revising design mockups [redacted]	[redacted]	I contacted the project leader to discuss various options and paths, and then I implemented his recommendations.	I first went down a rabbit hole of exploring other designers' related work—while it was useful to see past explorations, it was also a bit paralyzing.	Guru	My project leader helped focus and channel my creative energy into a productive outcome.	I complete the task with some guidance from them	Defining scope or focus
10	[redacted]	[redacted]	[redacted]	Ping design team for availability. Review my current crypto holdings.	Go-Getter	Since the feature will impact multiple teams and products, it's an ideal case where pushing the idea and implementation to its limit should have a compounding positive impact.	We share the task evenly	Generating or developing ideas
11	[redacted]	I think I had everything I needed, except long chunks of focus time to write.	[redacted] In between working sessions, I had a chat with my manager and did other work/life.	Listened to music. Filling out this survey was even a diversion from getting back to writing my assessment.	Guru	I want a guru to help me with the constant task of framing my work in new and effective ways. Perhaps they can offer new choices of words and phrasings, or they can help me curate what content to highlight. The challenge of perf is strategically framing explanations over and over in a way that highlights my job ladder expectations.	They complete the task with some guidance from me	Implementing or delivering your ideas
12	skills mapping for resource headcounts	knowing what we have inhouse	talking to teams	working on other project	Visualiser	essentially need to be able to visualise them on paper	I complete the task with some guidance from them	Defining scope or focus
13	Coming up with a concise and compelling way to summarize key accomplishments	examples of statements that well conveyed technical challenges while being easy to understand	Going back through past documents and reviewing examples of what was written in the past	getting distracted checking emails or messages	Visualiser	in this case, I need someone who can help me creatively piece together in concise words the many different thoughts and statements I have in my head	I complete the task with some guidance from them	Implementing or delivering your ideas
14								
15	[redacted]	Some tools can access many various databases and create tables.	To request data analyst and software engineers for help	Idling	Guru	Need expert's help	They complete the task with some guidance from me	Research and discovery
16	[redacted]	[redacted]	Explored all the report options that were available to me.	[redacted]	Guide	It would be helpful to think out of the box in order to come up with a solution to my problem.	They complete the task with some guidance from me	Implementing or delivering your ideas

17	Planning a team trip	Knowledge from someone who has planned a trip before, resources on guidelines, budget information	[redacted]	A lot of search results weren't helpful so spending time reading / looking into those wasn't helpful.	Guru	[redacted] a guru could teach me everything. I want to learn how to do this task but need a guru to teach me and answer all my questions.	I complete the task with some guidance from them	Research and discovery
18	Creating new sales collaterals	Aesthetic edits on the slide layout and visuals	Obtain slide template and build material from there	Searching online for relevant logos and images	Go-Getter	End product would be much more professional looking.	They complete the task with some guidance from me	Implementing or delivering your ideas
19								
20	solve multiple problems with limited resources and time	know what are the constraints, and what are ok to be relaxed	quickly thinking, and had discussion with teammate	NA	Go-Getter	think through about the options available, run it with teammates, and quickly execute it.	We share the task evenly	Generating or developing ideas
21	Ideation for new measurement plan	More minds	Group jamboard session	Tv, made crafts	Go-Getter	Because we need someone to implement what we need. Lack of resources	They complete the task with some guidance from me	Generating or developing ideas
22	Writing proposals	Someone to bounce ideas back and forth, having the right data available right away.	Reached out to peers. Read previous similar documents. Taking breaks.	N/A	Guru	Someone to get information on data.	I complete the task with some guidance from them	Defining scope or focus
23	[redacted]	I needed more details about what was causing the error	I reached out to someone who was better able to interpret the error. They did some research on it and pointed me in the right direction	I tried "rubber ducky debugging", coming back to it the next day, and they day after that	Guru	This is exactly the person I reached out to. They elaborated on the error. This allowed me to find and fix the issue.	I complete the task with some guidance from them	Implementing or delivering your ideas
24								
25								
26	Brainstorming session	Gathering a wide variety of cross-functional partners who would provide unique perspectives to the problem space	[redacted]	none	Wildcard	It would be good to bring someone into the mix to help out in the brainstorm who would add new fresh perspectives that the day-to-day team members who are extremely close to the problem might overlook due to their familiarity, which may carry self-imposed constraints founded from that intimate knowledge (timeline, feasibility, difficulty, etc.)	We share the task evenly	Generating or developing ideas
27	I had to plan team bonding activity	Wanted some fun activities , [redacted]	Analyzed opinion reactions towards various options	NA	Wildcard	I was looking for not so common ideas to raise team's interest	We share the task evenly	Defining scope or focus
28	[redacted]	[redacted]	Talked to business partners to find out source of truth	[redacted]	Motivator	A Motivator can help me focus on my target and provide motivation when I'm frustrated with data integrity.	We share the task evenly	Research and discovery
29	Outlining a research presentation	"Sounding board" / talking through my idea with (1) a colleague who knows the material and (2) one who knows the audience and the usual format of the forum I'll be presenting in	1. Talking with two different colleagues 2. Making an overall outline (I did this in a doc, but I wish I had just done it on paper or stickies)	Honestly, starting in a digital forum (for the outline). I feel like working digitally for creation (vs. production stage of this work) is always less creative and makes me feel drained - but it's really hard to break the habit/momentum of screen-based work	Visualiser	I struggle with this aspect the most (and tend to lean on design partners for it, at least when it comes to presentations or visual aids...I need/want to uplevel my own skills and confidence here)	I complete the task with some guidance from them	Defining scope or focus
30								

DAY 5

Participant	What kind of creative task did you need help with?	What kind of support would have helped your creativity?	What actions did you take that helped your creativity on this task?	What actions did you take that didn't help your creativity on this task?	If you could choose an ideal collaborator to help you work more creatively on this task, who would it be?	Please briefly tell us why you chose this option for a collaborator.	How would you prefer the collaboration to work?	Broadly, which of these best describes the type of task you needed help with?
1	designing a new integration with another system	pointers to resources explaining the current state of the world	[redacted]	procrastinate, watch tv, snack	Guru	would help to have all the answers on how things work today	I complete the task with some guidance from them	Research and discovery
2								
3	Organizing documentation around user journeys	More insight into most common user journeys. More insight into actual user behavior.	Asked SMEs, asked UXR, brainstorm, meetings, discussions	Asked SMEs, asked UXR, brainstorm, meetings, discussions	Guide	Feels like we're spinning our wheels. Could use a guide to push us to next steps, even if those steps are imperfect	We share the task evenly	Generating or developing ideas
4								
5								

6	[redacted]	[redacted]	[redacted]	[redacted]	Guru	Since I needed realistic content examples to convey my point, I'd like a guru who has a vault of different translation queries I can use to support my design flows.	They complete the task entirely by themselves	Defining scope or focus
7	I needed help with writing an impact doc	Information about the partner team and its impact	Talking to partner teams	Trying to copy the format from other impact docs	Guru	Guru could help me getting impact numbers and calculations from the partner teams	They complete the task with some guidance from me	Research and discovery
8								
9	[redacted]	Having a guide for the mountainous volumes of documentation that exist.	Reviewed documentation [redacted]	Went down a rabbit hole on the Reach UX library, which—while thorough and well documented—is not relevant to my PA.	Guide	I could have used someone who could short circuit the process of learning and told me the most important things to review and implement.	I complete the task with some guidance from them	Implementing or delivering your ideas
10	Updating an old presentation to incorporate new progress, milestones and resources.	I'm not really sure. The desired outcome is to educate and impress the audience that the presentation is intended for, and having some sort of access to their response ahead of time would help (but I'm not sure how that would be accomplished).	Created a new music playlist, walked the dog, reviewed other presentations given to the same or similar audience.	Stopped to maintain my movie and music collections, made some nachos, side-tracked by email and another unrelated task.	Motivator	The hardest part in working on a presentation (for myself) is simply moving through the slides and creating the initial content even when you aren't sure what the final product will/should look like. It's far easier to go back and see the changes that need to be made than seeing the finished content from a blank canvas.	I complete the task entirely by myself	Research and discovery
11	Creating design specifications for engineers.	Examples/precedents/guides that have been helpful for these engineers. This is my first time creating specs for this specific product and, when that's the case, I'm always unclear about what specific redlines engineers need vs what's already built into the product or component library. The engineer I'm working with is also new, so they weren't sure either.	Looking back on successful specs I've created in the past, and looking up some public best practices for inspiration.	Creating specs is often a tedious task, but I want them to be comprehensive and valuable. Getting started is often the hardest—i procrastinate by doing other work, checking email, browsing the web, etc..	Visualiser	Since creating specs is a tedious task, and I'm dealing with a product I've never produced specs for, it's hard to just get started. I've got a lot of details in my head that I need to visualize but it's hard to start. A visualizer would help lay out a good framework and get the ideas out of my head more quickly.	They complete the task with some guidance from me	Implementing or delivering your ideas
12								
13	coming up with critical measurements to take in a system that would produce a result that would help us understand how something is being assembled	being more familiar with the system to be measured, knowing what measurements were already taken, knowing what testing was already done	reviewing prior documentation for this assembly, reading over past emails to understand the context	feeling rushed to finish the task since there was something else that I had to get to soon after	Guru	in this case it would have been helpful to know what testing and analysis was already done so I could come up with the proper measurements. It would be helpful to have someone who has might insight and knowledge about the part and the assembly who could help provide ideas for the best measuring methods	I complete the task with some guidance from them	Generating or developing ideas
14	Design exercise to create modular, adaptive layouts	Ideation with peers who have either subject matter expertise, or an aptitude for analytical thinking	Researching related work, previous attempts, etc.	Being side-tracked by another project that needed attention	Guru	Task required a high degree of technical knowledge which I lacked	We share the task evenly	Generating or developing ideas
15	[redacted]	Software engineer and Data analyst	Asked for help in the meeting with my manager	Tried to use the existing tools	Guru	There should be some experts in the field	They complete the task with some guidance from me	Research and discovery
16	[redacted]	Training on this topic would be very helpful for those who are not well versed.	I reached out to my peers for assistance, drawing from their collective experience.	Trying to get up to speed on AI/ML on my own in a very limited time window.	Guru	I would bring in a guru to help present this topic, rather than attempting to learn it myself in a very short time span.	They complete the task with some guidance from me	Research and discovery

17	Well Being Newsletter	Graphic Design / Newsletter Design support / Images	I looked into other team's newsletters for ideas	Procrastinated / put off the task since I have never done this before. Started doing other tasks, answering emails	Visualiser	I have drafted the text for an email newsletter but I need someone to take that and run with making it look nice with some images or re-formatting.	They complete the task with some guidance from me	Generating or developing ideas
18	[redacted]	a template that I can use to copy from	moma, asking other colleagues	meetings that didn't focus on the subject	Studio Assistant	would be helpful to have someone to help build a template to frame the discussion	We share the task evenly	Defining scope or focus
19								
20	update design drawing file	summarize what have been changed or updated since last revision of drawing	looked through emails and documents of change list	NA	Studio Assistant	ensure that I get all the change list that will go into the new revision of drawing file	I complete the task with some guidance from them	Research and discovery
21	Ideation for 2022 planning	Someone to take notes	Got together with others on jamboard	Answering the door on the middle	Wildcard	Ideation needs a wild card	We share the task evenly	Generating or developing ideas
22	UX Writing	UX Writer working on it at the same time	Reached out for help	Procratinated	Guru	I'm not interested in learning UX Writing, I'd rather have a specialist to collaborate.	I complete the task with some guidance from them	Generating or developing ideas
23	How to communicate a complicated situation effectively to leadership	A better understanding of leadership's current understanding so that we could address their concerns and efficiently update them on new developments	[redacted]eached out to people who are better informed and asked them for guidance	Ignored the task and did work to make other workflows more efficient	Guru	What I needed was more info. If I had that, the rest would be easy	I complete the task with some guidance from them	Implementing or delivering your ideas
24								
25								
26	[redacted]	A person who could point me to all the historical design artifacts and documents for the product and provide me some context	I read the historical design artifact (slides deck) that my manager (also new to the product space) sent me and clicked on every link within it, and then all the links within those docs and so on, to find a huge trail of UXD and UXR docs to read up on	none	program manager	This collaborator would know the history of the product and hopefully kept track and organized of all the team's output	They complete the task with some guidance from me	Research and discovery
27	I was trying to develop tool to transfer data from one storage to another with some custom operations.	Need some guidance to explore various option and decide	I tried to combine best features of couple of existing internal tools	Looked on various available options on internet and google internal tools	Guru	Guru could help me understand pros and cons of each option I would be exploring	I complete the task with some guidance from them	Research and discovery
28	To help create a new forecast methodology on manual adjustment revenues	Asking for clarification on the granularity of forecast level	Alignment on the scope and granularity of line items	deep dive into the details without an alignment on the big picture	Go-Getter	Go getter can help put ideas into practice quickly	They complete the task entirely by themselves	Research and discovery
29								
30								

DAY 6

Participant	What kind of creative task did you need help with?	What kind of support would have helped your creativity?	What actions did you take that helped your creativity on this task?	What actions did you take that didn't help your creativity on this task?	If you could choose an ideal collaborator to help you work more creatively on this task, who would it be?	Please briefly tell us why you chose this option for a collaborator.	How would you prefer the collaboration to work?	Broadly, which of these best describes the type of task you needed help with?
1	design a new API	input from others	reach out to others via email, chat, etc	procrastinate	Wildcard	would be helpful to hear new ideas i hadn't thought of	I complete the task entirely by myself	Implementing or delivering your ideas
2								
3	Finding very efficient ways to improve KPIs	Clarity about how KPIs are calculated; insight into prioritized issues that affect KPIs	Meetings; reviewing docs and dashboards	Work on something else	Wildcard	Wildcard might help me think of the task differently; maybe help generate different approaches	They complete the task with some guidance from me	Research and discovery
4								
5								
6	[redacted]	Ideally, it would help to have final decisions on all of the launch scoping, so that I can finish the specs with confidence, they won't need to be re-spec'd. This is challenging, b/c it depends on backend data, analysis by our team, and approvals by leadership.	I still continued working on specs, however I made a list of the issues that need to be decided, so that the UX can be finalized. We also discussed the launch scoping at our core team meeting.	With specs, I prefer to have large blocks of focus time to concentrate. I was mostly able to do this, but I also had to juggle a few different meetings (and perf) throughout the day, so these interruptions decelerated my momentum.	Guru	Oftentimes, when I'm working on specs, I discover corner cases that I need to work through. I'd like to have a guru who can tell me what the different options are and how technically feasible they are. (In practice, these are often my eng counterparts.) By gaining this knowledge, it helps me to make an informed proposal for the UX approach.	We share the task evenly	Implementing or delivering your ideas
7	Planning team's next fun event	Someone knows the policy of fun events and what fun events are being offered	Talking and generating idea with the team	Doodling	Wildcard	They can generate new ideas to plan a novel event	They complete the task with some guidance from me	Generating or developing ideas
8								

9	[redacted]	Having access to an expert who could point me in the right direction of which documentation is most valuable/where to get started.	Explored documentation [redacted]	[redacted]	Guide	[redacted]	I complete the task with some guidance from them	Implementing or delivering your ideas
10	[redacted]	Access to a preexisting tool or set of tools for this specific task, but my use-case isn't considered normal and so tooling hasn't been built.	Learn more about what tooling does exist and how it works, asked questions about the serving architecture, submitted a change that was rejected but the reason for rejection provided some insight into a workable solution.	Blindly running performance tests anyway, eating lunch	Guru	Would be nice to have a person with detailed insight into the existing process to bounce ideas off of and get immediate feedback on what would or would not work and why.	I complete the task with some guidance from them	Generating or developing ideas
11	[redacted]	A writer who's very good at quickly honing in on what's perceived as valuable.	I looked at my notes and looked at a great perf tips deck that my director made a while back.	Getting caught up in other work tasks and looking through interesting slide decks that weren't necessarily relevant.	Guide	A guide could help me quickly distill what's important and provide techniques for presenting my work with the most bang for the buck.	They complete the task with some guidance from me	Implementing or delivering your ideas
12	Discovery experience to improve support experience	past cases	talking to collegues	meeting	Curator	changes brings about new ideas and improvement of current process	We share the task evenly	Research and discovery
13	[redacted]	more knowledge of what is the market trends for what consumers like, new tech that other companies may be looking at, bouncing ideas off others, clearer head space to focus on new ideas	had a brainstorming session with coworkers to share my idea and hear their ideas, sectioned the brainstorm into several major categories to help get thinking, had 10 minutes of quiet time to actually think and not cluster my mind from other work	been busy and distracted with work and personal things for a while so it was hard to fully get focused on being creative	Wildcard	For this particular task, it was so great hearing other coworkers ideas that were so different and extreme compared to mind. This was a very open ended brainstorm but I was still thinking in my box so having new outlooks spurred me to think differently and more creatively	We share the task evenly	Generating or developing ideas
14								
15	[redacted]	[redacted]	None	None	Wildcard	this might help	They complete the task entirely by themselves	Generating or developing ideas
16	[redacted]	Guided interaction from the support teams and product experts	I spoke with Technical support engineers to understand the reason for the escalations and got to the bottom of the issue.	Chatting with my colleagues (outside of the Support org) was not very helpful	Guru	It would be best for a support specialist to handle the case and its root cause analysis, since this is outside of my role.	They complete the task entirely by themselves	Research and discovery
17	Planning Team trip	Speaking with others	[redacted] other abps for advice, looked into previous trip websites, Googling hotel rates	Distractions - it is easy to get distracted if I am wandering aimlessly trying to look for resources	Guide	I enjoy this task so I would want to do a lot of the work but a guide would help steer me towards the right direction instead of aimlessly searching through docs and asking lots of admins for help.	I complete the task with some guidance from them	Defining scope or focus
18	Implementing new customer solution	Developer who can translate the technical requirements to implementation	Searching for existing code base on code search	N/A	Go-Getter	It would be ideal to leverage a vendor developer to develop and maintain the solution in the future.	They complete the task with some guidance from me	Implementing or delivering your ideas
19								
20	[redacted]	tips from guru	google it online and find tips	NA	Guru	someone who is already very familiar with the new device can help me to get used to it quicly	I complete the task with some guidance from them	Research and discovery
21								
22	Putting together a deck	Better templates	Copied examples from the past	Opened too many tabs in Chrome	Studio Assistant	Someone to provide tools to speed up processes	They complete the task with some guidance from me	Implementing or delivering your ideas
23	[redacted]	Criticism of two different kinds 1. Someone familiar with the project to review the ideas I put down on paper and poke holes. 2. Someone not familiar with the project to review the project proposal overall and make sure that it's worthwhile/meeting needs etc	I sat down and just vomited everything I could think of on the page, then refined it. I stepped away and did laundry while thinking about it and came up with a few more ideas.	I stopped working on it.	Wildcard	The wildcard would be great because they'd provoke new ideas and thought. This is still pretty early stage, so that kind of disturbance is super useful	We share the task evenly	Defining scope or focus
24								
25								

26	[redacted]	A resource to help gather the device brand usage metrics across the target countries and put together a visual matrix of the top brands per country	Asked manager for documentation of the team's target countries. [redacted]	none	Production designer	Needed someone to organize the data into a chart	We share the task evenly	Research and discovery
27	Present my technical solution/idea to non technical audience	To present my idea in a way it is well understood by audience without any prior knowledge	Discussed my idea with colleague who was from entirely different skillset to check if he is able to follow	Assuming the some facts are too basic and could be known to everyone	Wildcard	Collaborator can help me think out of the box ways to deal with general audience to present my idera	I complete the task entirely by myself	Generating or developing ideas
28	To think of a better source of truth to track revenue recognition on Professional services projects redeemed out of master credit projects	Understanding existing system data flows and system limitation	Creating SQL query to pull data from various systems and consolidate the data sets	simply relying on one single source for data consolidation	Wildcard	New outlook and approaches are always welcomed when I try to think out of the box to create a workaround solution due to system limitation	They complete the task entirely by themselves	Research and discovery
29								
30	Updating our business case slides format	Some more ideas on how other Googlers put slides together	[redacted] seeing how other slide decks look and feel	Trying to do it on my own	Visualiser	Visualizer would have helped me get the ideas from my brain into a slide format	We share the task evenly	Defining scope or focus

DAY 7

Participant	What kind of creative task did you need help with?	What kind of support would have helped your creativity?	What actions did you take that helped your creativity on this task?	What actions did you take that didn't help your creativity on this task?	If you could choose an ideal collaborator to help you work more creatively on this task, who would it be?	Please briefly tell us why you chose this option for a collaborator.	How would you prefer the collaboration to work?	Broadly, which of these best describes the type of task you needed help with?
1	make dinner	deciding what all to make for dinner	browse the fridge, internet, brainstorm	have a snack	Guide	would be helpful to have someone opinionated help give direction to the meal	We share the task evenly	Generating or developing ideas
2	[redacted]	[redacted]	Took ownership, collected material to evaluate, from different sources, outlined desired outcome, send out email to expert to solicit help.	Material selection was difficult because of our lack of clear documentation. I spent quite some time trying to understand what material matched which profile to validate, and that created frustration and delays.	Guru	I'd like something/somebody to be a repository of the historical info I need to do my job.	I complete the task with some guidance from them	Research and discovery
3	[redacted]	Scientific advice for how to lift my mood and energy, plus sufficient resources to implement	Read books, internet. Went for a walk, bike.	Went to bed	Motivator	Feeling demotivated, so I could use motivation :)	They complete the task entirely by themselves	Generating or developing ideas
4								
5								
6	[redacted]	[redacted]	I referred to past greenlines and did some web searches to check for a11y best practices. I also scheduled an upcoming sync with eng to ask about tech feasibility for things like keyboard navigation and screen readers	[redacted]	Guru	I'd like my guru to help me run through the a11y checklist for my greenlines. Ideally, they'd know how the Translate app is structured and could tell me what will be feasible given the code structure.	I complete the task with some guidance from them	Implementing or delivering your ideas
7	Write instruction docs	Someone with a fresh perspective	Taking lots of breaks	Creating shipping labels for swags	Wildcard	[redacted]	I complete the task with some guidance from them	Research and discovery
8	I need help figure out illustration and style and execution for a vision deck	Someone just to help me make a decision! Mostly I'm just unsure about which way to go	I did a couple of different sketches and options but still having trouble landing on one	Mostly just my indecision. At this point I need to just choose and execute	Motivator	Motivator would definitely help me get going and not overthink it. I would love if someone could come and make an executive decision for me :)	I complete the task with some guidance from them	Generating or developing ideas
9	[redacted]	[redacted]	[redacted]	Distraction of other work.	Wildcard	I think this is the first time I've picked Wildcard, but idea generation, it would be great to have a collaborator who brought a ton of new ideas to riff on.	We share the task evenly	Generating or developing ideas
10	[redacted]	An up-to-date catalog of existing questions to pull from.	Read through questions as though they were being asked to me to evaluate for clarity, reordered questions looking for loose narrative thread, rephrased questions a couple of times.	Changed music playlist, stopped for lunch	Wildcard	I appreciate approaching interview questions from unusual angles, and having already zero'd in on the signals I would like to hit, having a wild-card type available to generate out-of-the-box ideas about how to get to those signals would be ideal.	I complete the task with some guidance from them	Generating or developing ideas

11	I needed to revise some design mocks based on a new requirement.	A visual designer or an information designer.	I explored a few design options and then shelved it b/c I needed to address other priorities. I haven't touched it in 24 hours but will look at it again later today.	I simply didn't finish and took care of other things.	Visualiser	The problem I'm tackling is ultimately a visual/informational one. It doesn't require crazy graphic creativity, it just needs the right level of detail. A visualizer would probably be good at taking the requirements and creating the right visual solution.	They complete the task with some guidance from me	Generating or developing ideas
12	[redacted]	reference points and information related to the program	speaks to related custodian and did some research on my own	other meetings	Go-Getter	when I reach a bottleneck in my ideas it will give me an extra push	I complete the task with some guidance from them	Generating or developing ideas
13	[redacted]	[redacted]	[redacted]	[redacted]	Guru	In this case, having someone very knowledge about the failure symptom and what the next steps to test to understand the root cause would be very helpful. Right now it feels like a game of telephone to get information, but having someone already who is knowledgeable about the issue would speed up the process	I complete the task with some guidance from them	Generating or developing ideas
14								
15	A universal tool to easily pull data from various internal databases and create tables	I need a better universal tool to pull data from various databases	I use various tools and they are not compatible	Doing nothing	Guru	I need experts to help	They complete the task with some guidance from me	Generating or developing ideas
16	Compiling a newsletter for my regional team.	Sourcing relevant content from the region proactively, instead of reaching out to the team and requesting content.	Involving a team member to assist me with sourcing content for the newsletter, and asking specific individuals to volunteer some content.	Casting a wide net for people to submit their content proactively.	Curator	A curator would have helped to source the right content from the right people, at the right time for the newsletter. This would prevent me from having to look for content and instead, focus on editing the newsletter.	They complete the task entirely by themselves	Implementing or delivering your ideas
17	Planning an in-person event/meeting	Since I am in the initial stages, resources on what is possible within covid restrictions and what activities are safe would help.	Ask my executive what he wants to plan ideally, search on moma, ask colleagues if they have planned events in person yet	putting this task off, doing other work	Guide	A guide with information on guidelines is the most helpful and will set me on the right path.	I complete the task with some guidance from them	Research and discovery
18	Creating an automated system to alert account managers of new ads accounts being created	Tool that would help me sketch out the design of the solution	Jamboarding the solution design	N/A	None (I'd prefer to work on it by myself)	This can be done as a stand alone project.	I complete the task entirely by myself	Implementing or delivering your ideas
19								
20	optimization of resources	review and understand details of constraints of resources	think through the task lists and limitation of available resources and schedule	NA	Studio Assistant	it will be helpful they can provide the tools to uncover resources, so we can have better optimization.	I complete the task with some guidance from them	Defining scope or focus
21								
22	UI Design	Someone to talk about the ideas in person	Looked at similar examples, put some music on	Online chat	Guru	Someone who could answer my open questions	I complete the task with some guidance from them	Generating or developing ideas
23	[redacted]	Feedback and input from teammates	There was a team of us working on the deck. We generated ideas, critiqued each others' ideas, and discussed what the message needed to be	screwing around on the internet	Go-Getter	This person went and did the things we were talking about doing so that we could react to it and make sure it worked as intended	We share the task evenly	Generating or developing ideas
24								
25	Writing a design doc for a way to map individual tests inside a container test to test cases and requirements	Just brainstorming with few cross functional leads on a whiteboard would have made this process faster.	Doodling on a whiteboard, simply doing a braindump of all ideas irrespective oh how bizarrre/infeasible each sounded.	Regular project work and other higher priority items. Chat was the biggest distraction.	Guru	For this one, I was starting blind and I had no idea where to start. A guru tool would identify other areas which have seen this problem or even similar designs/approaches.	They complete the task with some guidance from me	Research and discovery
26	Organizing and visualizing my research data and recommendations into a clear info graphic to share with the rest of the UX team	A visual designer to take all the data and results from my research	A organized all my research data and findings into a sheets matrix and added annotations	none	Visualiser	This person could help translate all my research data into a visually appealing and easy to understand data chart that would be easier to scan than a spreadsheet matrix	They complete the task with some guidance from me	Implementing or delivering your ideas
27								
28	[redacted]	[redacted]	understood the existing workflow [redacted]	Started to work on details without understanding the big picture	Motivator	A motivator can help provides encouragement and motivation when needed.	They complete the task entirely by themselves	Research and discovery

29	[redacted]	I had this - a collaboration partner to bounce all ideas around as we revised the presentation (design lead built initial draft; I edited/updated and helped refine overall flow & key content reflecting user needs & other research insight)	sadly, not much - we just worked on it in full collaboration for about 5hours straight. following that, a midday break was essential, as well as review/input with our manage[redacted]	nothing in this case (which is not really to my credit, there was just literally zero time to lose)	Go-Getter	This isn't really my ideal - in this case I'd be seeking a complementary collaborative partner: someone who's equally invested in the project as I am, but can uplift the areas of work I'm less adept at (and vice versa). In this case, I have this, due to a unique working model on my team (research / design strategist pods partner to co-lead 6-month intensives)	We share the task evenly	Implementing or delivering your ideas
30								

DAY 8

Participant	Thinking broadly about the creative tasks you work on, how helpful would you find each of these roles as a creative collaborator?								If you were collaborating on a creative project with other people, which of these roles do you think you personally would be able to perform best?	Imagine if these roles were performed by Artificial Intelligence, rather than a person. How happy would you be for an AI collaborator to perform each of these roles on your creative projects?								What kind of creative tasks would you be most happy for an AI system to help you with?	What kind of creative tasks would you prefer to complete without any help from an AI system?	How likely would you be to use the following features, if they could be performed by an AI system?								The type of features described above would require the AI system to learn information about you and the way you work. What personal information would you be happy to securely share with the AI system?	Do you have any other thoughts or comments on the topic discussed in this study?
	STUDIO ASSISTANT	VISUALISER	MOTIVATOR	GO-GETTER	GUIDE	GURU	CURATOR	WILDCARD		STUDIO ASSISTANT	VISUALISER	MOTIVATOR	GO-GETTER	GUIDE	GURU	CURATOR	WILDCARD			The AI understands what task you're tyring to complete, and automaticaly sets up your preferred software, templates, and resrouces.]	You can describe an idea or a concept to the AI, and it automatically generates a version for you.	The AI knows when you're feeling unproductive, and sets you achievable challenges to keep you going.	You can hand over a half finished creative task to the AI, and it will complete it, based on your previous work.	When you need inspiration for a creative task, the AI can remind you of ideal references from websites, media, or books you've previously viewed.	The AI system can provide you with regular feedback on your work, telling you how feasible / successful it is likely to be, and providing suggestions.	By observing factors such as your workspace, schedule, and physical actions, the AI knows how you work best, and helps you acheive this.	The AI system is aware of the latest trends, styles, and methods for your area of work, and can help you incorporate them into your work.		
1																													
2	Helpful	Very Helpful	Very Helpful	Helpful	Helpful	Very Helpful	Neutral	Helpful	Guide	Very happy	Unhappy	Neutral	Happy	Neutral	Very happy	Happy	Happy	knowledge repository, template suggestions, autocompletion/automation of recurring/menial tasks, idea generation, visualisation and tracking, tweaking working style so to avoid distractions	human connections, bonding with colleagues and stakeholders, privacy-sensitive tasks	Very likely	Very likely	Very likely	Very likely	Very likely	Very likely	Very likely	Very likely	Emails, Calendar, Physical movement via phone/watch (when you're sitting down, standing, moving around etc.), Software usage (what apps you're using / tasks you're performing), Conversations with the AI (voice data from your interactions with the AI), Browser usage (what webpages you're visiting), 'Offline' work via camera (physical sketches, notes, models etc. in your work space)	This is all so fascinating, thanks for your work!
3	Helpful	Helpful	Very Helpful	Helpful	Very Helpful	Very Helpful	Helpful	Very Helpful	Guide	Happy	Happy	Happy	Happy	Happy	Neutral	Happy	Happy	Stimulation toward new directions; bring new perspectives to the table; do the mundane work to save human energy for novelty	I'd be a bit skeptical or anxious asking AI to do tasks that require direct human interactions including empathy.	Very likely	Likely	Likely	Very likely	Neutral	Very likely	Likely	Very likely	Calendar, Emails, Software usage (what apps you're using / tasks you're performing), Conversations with the AI (voice data from your interactions with the AI), 'Offline' work via camera (physical sketches, notes, models etc. in your work space), Conversations with colleagues (voice data from work meetings), Streaming media activity (what music, film, TV shows you're streaming), Photos and videos (photos you've taken, or media you've saved), Browser usage (what webpages you're visiting), Physical movement via phone/watch (when you're sitting down, standing, moving around etc.), Posture or pose data via camera (whether you're standing, sitting, leaning, etc.), Social media activity (what content you've liked or re-posted)	One worry about AI is programmed bias. How do we know how biased our AI is?
4	Unhelpful	Helpful	Unhelpful	Neutral	Neutral	Helpful	Helpful	Very Helpful	Wildcard	Happy	Happy	Very unhappy	Very happy	Very happy	Very happy	Very unhappy	Neutral	I mostly deal with creativity in software. I feel I'd always be happy to get some help from an AI system for something software related.		Neutral	Very likely	Very unlikely	Very likely	Unlikely	Neutral	Likely	Likely	Social media activity (what content you've liked or re-posted), Posture or pose data via camera (whether you're standing, sitting, leaning, etc.), Browser usage (what webpages you're visiting), Software usage (what apps you're using / tasks you're performing), Conversations with the AI (voice data from your interactions with the AI), Conversations with colleagues (voice data from work meetings), Physical movement via phone/watch (when you're sitting down, standing, moving around etc.), Calendar	
5																													

6	Neutral	Helpful	Neutral	Helpful	Very Helpful	Very Helpful	Neutral	Helpful	Go-Getter	Very happy	Very happy	Unhappy	Neutral	Very happy	Very happy	Unhappy	Unhappy	It would be amazing if my tools and files could be organized better structured and organized without me having to take time to design the organization and manually do this myself. I'd also like help with automating some of my visuals without having to do so manually. Furthermore, I'd like to be able to ask a guide or guru for information to help unblock me, so that I have sufficient data to make well informed decisions.	I want to have access to information, but I want to use my own mind to think critically about the options, weigh the pros/cons, and make critical decisions.	Likely	Likely	Unlikely	Neutral	Very likely	Likely	Likely	Likely	Browser usage (what webpages you're visiting), Calendar, Conversations with the AI (voice data from your interactions with the AI), Photos and videos (photos you've taken, or media you've saved), Software usage (what apps you're using / tasks you're performing), Emails	[redacted] It would also be great if design tools could automate some of the prototyping effort—everything from manually comping the screens, adding animation, and exporting to an externally secure platform. D[redacted]
7	Helpful	Helpful	Very Helpful	Helpful	Very Helpful	Helpful	Very Helpful	Very Helpful	Wildcard	Very happy	Very happy	Happy	Happy	Unhappy	Happy	Unhappy	Unhappy	Visualization and answering questions	Writing / coming up with new ideas	Likely	Likely	Neutral	Neutral	Likely	Neutral	Likely	Likely	Conversations with the AI (voice data from your interactions with the AI), Physical movement via phone/watch (when you're sitting down, standing, moving around etc.), Software usage (what apps you're using / tasks you're performing), Emails, Social media activity (what content you've liked or re-posted), Conversations with colleagues (voice data from work meetings), Streaming media activity (what music, film, TV shows you're streaming), 'Offline' work via camera (physical sketches, notes, models etc. in your work space), Calendar, Photos and videos (photos you've taken, or media you've saved)	
8	Neutral	Very Helpful	Very Helpful	Very Helpful	Very Helpful	Helpful	Neutral	Helpful	Visualiser	Unhappy	Neutral	Unhappy	Happy	Very happy	Very happy	Neutral	Very happy	I would like them to take my inputs and spit out interesting variants and combinations. For illustration it would be cool if I could put in multiple references and have them create a combination to spark ideas for me. Maybe it could also look at what I'm doing and pull references from other artists that apply.	I wouldn't want my tools or setup to change based on AI. I like being in control of my space and workstation. I also wouldn't want any sort of reminders to get back to work or anything. Reminders to take breaks would be ok	Very unlikely	Very likely	Very unlikely	Very likely	Very likely	Neutral	Neutral	Likely	Offline' work via camera (physical sketches, notes, models etc. in your work space), Streaming media activity (what music, film, TV shows you're streaming), Social media activity (what content you've liked or re-posted), Conversations with colleagues (voice data from work meetings), Conversations with the AI (voice data from your interactions with the AI), Calendar, Software usage (what apps you're using / tasks you're performing)	

9	Unhelpful	Helpful	Helpful	Neutral	Very Helpful	Very Helpful	Helpful	Helpful	Guru	Neutral	Very happy	Unhappy	Neutral	Happy	Happy	Neutral	Happy	Taking routine work off my shoulders; providing helpful suggestions at the right moment; allowing me to visualize connections without needing to create the visualization from scratch.	Motivation... I don't want to be motivated by bot.	Likely	Likely	Neutral	Unlikely	Very likely	Likely	Likely	Neutral	Offline' work via camera (physical sketches, notes, models etc. in your work space), Photos and videos (photos you've taken, or media you've saved), Software usage (what apps you're using / tasks you're performing), Conversations with the AI (voice data from your interactions with the AI), Browser usage (what webpages you're visiting), Physical movement via phone/watch (when you're sitting down, standing, moving around etc.), Emails, Calendar, Streaming media activity (what music, film, TV shows you're streaming)	
10	Unhelpful	Neutral	Unhelpful	Neutral	Helpful	Very Helpful	Unhelpful	Helpful	Wildcard	Happy	Happy	Neutral	Unhappy	Very happy	Happy	Unhappy	Happy	Available to provide live or on-demand guidance while designing a new interface or developing new interactions.	Bringing an idea from a highly abstract place to something formally structured in some particular way.	Likely	Very unlikely	Very unlikely	Unlikely	Neutral	Very likely	Likely	Neutral	Conversations with the AI (voice data from your interactions with the AI), Emails, Browser usage (what webpages you're visiting), Software usage (what apps you're using / tasks you're performing), Calendar, Conversations with colleagues (voice data from work meetings)	
11	Helpful	Very Helpful	Helpful	Very Helpful	Very Helpful	Very Helpful	Helpful	Helpful	Go-Getter	Very happy	Happy	Unhappy	Neutral	Very happy	Very happy	Very happy	Very happy	I'd be happy with an AI system to help me as a Guide on creative explorations. Sometimes I get creatively stuck and need fresh perspectives and ideas to help point me in new directions while addressing the project constraints. It's sometimes hard to get a person for this if they haven't been involved in the project.	I'd be open to AI help in any task, I think. But there are tasks I wouldn't exclusively leave to an AI system, such as tasks related to final production. These include tasks like design specs and copywriting; an AI can start these tasks, but I'd inevitably need to go back through it and edit as needed.	Likely	Very likely	Likely	Very likely	Very likely	Very likely	Very likely	Very likely	Offline' work via camera (physical sketches, notes, models etc. in your work space), Social media activity (what content you've liked or re-posted), Software usage (what apps you're using / tasks you're performing), Streaming media activity (what music, film, TV shows you're streaming), Conversations with colleagues (voice data from work meetings), Conversations with the AI (voice data from your interactions with the AI), Photos and videos (photos you've taken, or media you've saved), Calendar, Browser usage (what webpages you're visiting), Physical movement via phone/watch (when you're sitting down, standing, moving around etc.)	
12	Helpful	Very Helpful	Very Helpful	Very Helpful	Very Helpful	Very Helpful	Helpful	Helpful	Visualiser	Very happy	Very happy	Very happy	Very happy	Very happy	Very happy	Very happy	Very happy	visualiser taking my idea and place in a visualised format	motivator	Very likely	Very likely	Very likely	Very likely	Very likely	Very likely	Very likely	Very likely	Conversations with the AI (voice data from your interactions with the AI)	N/A
13	Neutral	Neutral	Very Helpful	Helpful	Very Helpful	Very Helpful	Neutral	Helpful	Motivator	Happy	Happy	Unhappy	Neutral	Happy	Happy	Neutral	Unhappy	Something like the studio assistant or visualizer would be something that AI can help in since i see that more as a software/tools role. That role can be more impersonal (as I view AI is) so it seems like the most natural role for AI to take.	Something like the motivator or wildcard I see more as another human being to bounce ideas off and give encouragement. I imagine the role to be more dynamic and personal in conversation so I would rather this not be AI.	Neutral	Unlikely	Neutral	Unlikely	Likely	Unlikely	Likely	Likely	Calendar, Emails, 'Offline' work via camera (physical sketches, notes, models etc. in your work space)	
14																													
15	Very Helpful	Helpful	Helpful	Helpful	Helpful	Helpful	Neutral	Neutral	Guide	Very happy	Very happy	Very happy	Very happy	Very happy	Very happy	Happy	Neutral	GURU	WILDCARD	Likely	Very likely	Neutral	Likely	Very likely	Very likely	Likely	Likely	Software usage (what apps you're using / tasks you're performing), Emails, Conversations with colleagues (voice data from work meetings), Calendar, Conversations with the AI (voice data from your interactions with the AI), Photos and videos (photos you've taken, or media you've saved)	I need AI to help on my daily to-do list and perf: Roles, Contributions, Achievements, Impacts, Summary and Writing. AI needs to analyze all meetings on my calendar, discussions, my documents, spreadsheets, work photos, work traveling, buganizers, tool usage, document sharing and to-do list.
16	Neutral	Neutral	Helpful	Helpful	Very Helpful	Very Helpful	Helpful	Helpful	Guide	Very happy	Very happy	Happy	Very happy	Very happy	Very happy	Very happy	Happy	Curation of data/ideas, provide recommendations/guides	Personalized work that is out of the norm	Very likely	Very likely	Very likely	Very likely	Very likely	Likely	Likely	Likely	Physical movement via phone/watch (when you're sitting down, standing, moving around etc.), Calendar, Browser usage (what webpages you're visiting), Streaming media activity (what music, film, TV shows you're streaming), Posture or pose data via camera (whether you're standing, sitting, leaning, etc.), Software usage (what apps you're using / tasks you're performing), Emails, Conversations with the AI (voice data from your interactions with the AI)	This was a very insightful exercise!
17	Neutral	Helpful	Unhelpful	Helpful	Very Helpful	Very Helpful	Unhelpful	Neutral	Guru	Neutral	Happy	Unhappy	Unhappy	Happy	Unhappy	Happy	Neutral	Tasks that can be automated such as perfecting designs	Brainstorming tasks	Likely	Very likely	Unlikely	Very likely	Likely	Neutral	Likely	Very likely	Calendar, Emails, 'Offline' work via camera (physical sketches, notes, models etc. in your work space)	
18	Neutral	Neutral	Unhelpful	Helpful	Neutral	Helpful	Unhelpful	Unhelpful	Go-Getter	Neutral	Neutral	Neutral	Happy	Neutral	Happy	Unhappy	Unhappy	Tasks that can be completed when given clear and prescriptive instructions	Tasks that involves collaborating with another real person	Likely	Very likely	Unlikely	Likely	Neutral	Neutral	Neutral	Neutral	Conversations with colleagues (voice data from work meetings), Calendar, Conversations with the AI (voice data from your interactions with the AI), Browser usage (what webpages you're visiting), Emails	

19																													
20	Helpful	Helpful	Helpful	Very Helpful	Very Helpful	Very Helpful	Helpful	Helpful	Motivator	Happy	Happy	Neutral	Happy	Very happy	Happy	Happy	Happy	something personal and prefer privacy	if I need emotional engagements and support in the project	Likely	Likely	Very likely	Neutral	Likely	Likely	Likely	Likely	Calendar, Posture or pose data via camera (whether you're standing, sitting, leaning, etc.), Browser usage (what webpages you're visiting), Emails, Software usage (what apps you're using / tasks you're performing), Conversations with the AI (voice data from your interactions with the AI), Physical movement via phone/watch (when you're sitting down, standing, moving around etc.), Streaming media activity (what music, film, TV shows you're streaming)	
21	Helpful	Helpful	Very Helpful	Neutral	Helpful	Very Helpful	Neutral	Helpful	Go-Getter	Happy	Happy	Neutral	Neutral	Happy	Happy	Happy	Neutral	Finding reference materials, processes and procedures, nudges	building things out, ideation	Likely	Likely	Likely	Neutral	Likely	Neutral	Neutral	Likely	Photos and videos (photos you've taken, or media you've saved), Browser usage (what webpages you're visiting), Software usage (what apps you're using / tasks you're performing), Conversations with the AI (voice data from your interactions with the AI), 'Offline' work via camera (physical sketches, notes, models etc. in your work space), Calendar, Emails	interesting project
22	Neutral	Very Unhelpful	Helpful	Very Helpful	Helpful	Very Helpful	Unhelpful	Helpful	Go-Getter	Very happy	Very unhappy	Happy	Very happy	Happy	Happy	Neutral	Happy	Knowledge base, Organizer, Design system, Repetitive tasks, Style presentations,	Determine my schedule, visualize concepts, define milestones.	Neutral	Unlikely	Very unlikely	Likely	Very likely	Very likely	Very unlikely	Very likely	Emails, Calendar	N/A
23	Unhelpful	Helpful	Helpful	Very Helpful	Very Helpful	Very Helpful	Helpful	Very Helpful	Go-Getter	Very happy	Very happy	Very happy	Very happy	Very happy	Very happy	Very happy	Very happy	All of them! I'm trying to automate away as much of my job as possible. As long as the quality of the work is good, I couldn't be bothered whether it was a human or machine doing it	None. I like computers!	Very likely	Very likely	Very likely	Very likely	Very likely	Very likely	Very likely	Very likely	Conversations with colleagues (voice data from work meetings), Calendar, Emails, Conversations with the AI (voice data from your interactions with the AI), Software usage (what apps you're using / tasks you're performing), Posture or pose data via camera (whether you're standing, sitting, leaning, etc.), Physical movement via phone/watch (when you're sitting down, standing, moving around etc.), 'Offline' work via camera (physical sketches, notes, models etc. in your work space), Browser usage (what webpages you're visiting)	I'm happy to share lots of information, if I can control how it's used. If I knew with certainty that the info I shared would *only* be used for this, I'd share more. If I didn't know that, then I'd probably not share anything.
24	Very Helpful	Very Helpful	Very Helpful	Helpful	Helpful	Helpful	Helpful	Very Helpful	Wildcard	Very happy	Very happy	Happy	Happy	Neutral	Neutral	Very happy	Happy	visualizing, motivating, finding efficiencies in my work, take care of all the bureaucracy	I am not sure I would trust AI as a guru.	Likely	Very likely	Very likely	Very likely	Neutral	Neutral	Very likely	Likely	Calendar, Emails, Software usage (what apps you're using / tasks you're performing), Browser usage (what webpages you're visiting)	
25	Neutral	Very Helpful	Very Helpful	Helpful	Helpful	Neutral	Very Helpful	Very Unhelpful	Visualiser	Neutral	Very happy	Very happy	Happy	Happy	Very happy	Happy	Neutral	Writing boiler plate for design docs, Setting up a shared workspace to collaborate, gather relevant documents in one place.	Searching for new outlooks.	Very likely	Neutral	Very likely	Unlikely	Likely	Very likely	Very likely	Likely	Emails, Streaming media activity (what music, film, TV shows you're streaming), Conversations with the AI (voice data from your interactions with the AI), Calendar, Physical movement via phone/watch (when you're sitting down, standing, moving around etc.), Posture or pose data via camera (whether you're standing, sitting, leaning, etc.), Photos and videos (photos you've taken, or media you've saved)	
26	Neutral	Helpful	Neutral	Very Helpful	Helpful	Very Helpful	Neutral	Helpful	Go-Getter	Neutral	Unhappy	Neutral	Unhappy	Happy	Very happy	Neutral	Unhappy	Answering technical, best practices, and process questions, for example how to do "X" in Figma or pointing me to a play book of different approaches and examples of designing for example a service design map or infographic	Designing systems and frameworks that require a lot of historical, contextual, or tribal knowledge in order to produce a solution that synthesize many complicated sets of inputs and requirements, some of which may be in flux in order to be able to make decisions of where to even start and when and where to iterate on the proposed solution	Likely	Neutral	Neutral	Neutral	Likely	Likely	Very likely	Likely	Emails, 'Offline' work via camera (physical sketches, notes, models etc. in your work space), Conversations with colleagues (voice data from work meetings), Browser usage (what webpages you're visiting), Software usage (what apps you're using / tasks you're performing), Calendar, Conversations with the AI (voice data from your interactions with the AI), Photos and videos (photos you've taken, or media you've saved)	Looking forward to seeing how this progresses and what AI solutions get explored!
27	Helpful	Very Helpful	Very Helpful	Helpful	Very Helpful	Very Helpful	Helpful	Helpful	Motivator	Very happy	Very happy	Neutral	Happy	Very happy	Happy	Very happy	Neutral			Very likely	Likely	Very likely	Likely	Likely	Likely	Very likely	Very likely	Conversations with the AI (voice data from your interactions with the AI)	
28	Unhelpful	Very Helpful	Helpful	Very Helpful	Very Helpful	Very Helpful	Unhelpful	Helpful	Go-Getter	Very happy	Very happy	Very happy	Very happy	Very happy	Very happy	Very happy	Very happy	Research financial reporting and analysis benchmark in the same industry and help set up the best practice	establish a process once we have an idea	Unlikely	Very likely	Unlikely	Very likely	Neutral	Unlikely	Unlikely	Very likely	Browser usage (what webpages you're visiting), Conversations with the AI (voice data from your interactions with the AI), Calendar, Emails	

29	Helpful	Very Helpful	Very Helpful	Helpful	Very Helpful	Very Helpful	Helpful	Helpful	Guide	Happy	Happy	Very unhappy	Neutral	Neutral	Neutral	Unhappy	Happy	optimizing workflow by removing or minimizing the tasks that take up a lot of cognitive "space" but are not actually productive for the creative work itself, just required to do it (eg assembling materials--in my case, this often means finding and sifting through tons of past work). caveat that I have limited understanding of what "AI" means or can do in terms of creative tasks...	I imagine I would not appreciate any automated "nagging" - anything like motivational notifs, prompts, schedule reminders ("time to take a walk") etc...	Likely	Very likely	Unlikely	Unlikely	Likely	Likely	Very unlikely	Likely	Software usage (what apps you're using / tasks you're performing), 'Offline' work via camera (physical sketches, notes, models etc. in your work space), Photos and videos (photos you've taken, or media you've saved), Conversations with the AI (voice data from your interactions with the AI)	With further information and provided there are strict parameters / constraints I can put in place, I would *potentially* be willing to share a few more categories of information: emails, browser usage, and calendar.
30	Neutral	Helpful	Unhelpful	Unhelpful	Very Helpful	Very Helpful	Helpful	Helpful	Guide	Very happy	Very happy	Neutral	Very happy	Very happy	Very happy	Very happy	Very happy	Finding ideas from a large range of internal and external data sources	Motivating myself - I don't want my job to be gamified	Very likely	Very likely	Very unlikely	Very likely	Very likely	Likely	Neutral	Very likely	Conversations with the AI (voice data from your interactions with the AI), 'Offline' work via camera (physical sketches, notes, models etc. in your work space), Software usage (what apps you're using / tasks you're performing), Conversations with colleagues (voice data from work meetings), Browser usage (what webpages you're visiting)	I love the idea of AI that can help with creative tasks, I don't want to be physically monitored or have my non-work information - such as social media - tracked or monitored to make me a more efficient employee.

Appendix 6: Google Diary Study - Paper

Creativity Support Roles: Understanding the Role AI Should Play in the Creative Process.

Recent advances in Artificial Intelligence (AI) technology have opened up the ability for AI tools to support people in everyday creative tasks such as writing and generating visual content. This has created opportunities for new modes of interaction with creativity support tools. This paper reports the results of a four week diary study conducted with 30 participants working in creative roles which investigated the ongoing creativity support needs of the participants, examining their barriers to creativity, their preferences for creative collaborators, and their attitudes towards AI systems acting as creative collaborators. The results of the study identified three categories of creativity support required by participants: Information, Generation, and Situation. Of these, Information was the most popular type of support. In this paper we present the study and key insights, and propose a framework which addresses the complexity of shared agency when interacting with creativity support tools.

CCS CONCEPTS • Human-centered computing~Human computer interaction (HCI)~Empirical studies in HCI • Computing methodologies~Artificial intelligence • Applied computing~Arts and humanities

Additional Keywords and Phrases: Artificial Intelligence, Creativity Support

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1 INTRODUCTION

1.1 AI and Creativity

Historically, creativity has always been an important test of Artificial Intelligence (AI). Since Turing imagined computers writing sonnets [29], and McCarthy et al [25] proposed creativity as one of AI's founding themes at the 1956 Dartmouth Workshop, creativity has been positioned as one of the defining characteristics of 'intelligence', and consequently a requirement of AI.

The long standing association between creativity and AI has not only fueled the development of creative AI systems, but also impacted public attitudes towards AI. The recent increase in accessibility and capability of creative AI applications has led to widespread discussion in the press about AI adopting creative roles such as Artist [30, 11], Graphic Designer [32, 10], or Writer [31, 33].

Our goal for this work is not to debate the relative creative value of what these AI systems produce, but to explore how these types of creative AI systems could be practically utilised in the context of everyday creativity in design-related professions. In doing so we acknowledge, as others have done [12, 22], that AI can play a broad range of roles within the creative process.

1.2 A spectrum of agency

Deterding et al [12] describe a "spectrum of agency and initiative" on which creative AI applications could be positioned, with full human agency at one end, full AI agency the other end, and various forms of human/AI collaboration occupying the centre. The scope of this spectrum is already apparent through the AI applications available to artists and designers. While the archetype of the 'AI Artist' may capture the public imagination, arguably the real impact of AI on creativity is emerging in much more subtle and pragmatic ways. For example, editing images [1] producing video effects [26] and generating stock photography and graphics [16].

These AI enabled tools are currently positioned at the "Human Initiative" end of the Deterding et al [12] spectrum. Although AI methods such as Machine Learning might power the functionality, the tools are fully controlled and directed by the human user.

However, elsewhere in the working environment, AI enabled tools are making their way across the spectrum, demonstrating aspects of initiative and agency in interactions with human users. AI enabled productivity tools can already perform tasks on behalf of human users, such as composing replies to emails, setting priorities, and scheduling calendar events. [34, 9].This kind of functionality positions AI as an agent for the user, making decisions and suggestions on their behalf, and under their supervision. They demonstrate a move towards the centre of the spectrum, with the AI acting as a colleague or collaborator, fulfilling roles which could potentially otherwise be performed by human colleagues.

This shift in initiative and agency could easily be replicated by creative AI tools. AI experiments and emerging methods [17, 8, 23, 27] demonstrate AI agents performing creative roles in collaboration with humans - finishing sketches, extrapolating concepts, blending styles, building prototypes, and suggesting creative directions.

With it seemingly possible that AI *could* perform a collaborative role with human creatives, we aim to understand whether those working in creative roles *want* AI to collaborate with them, and if so what kind of collaborator would they like AI to be?

1.3 The Role of AI

The idea of an intelligent computational agent supporting human creativity through collaboration has been explored and tested in the past [5, 28, 35, 21, 13].

Lubart [22] suggests four broad roles for a computer as creative collaborator - Nanny, Pen-Pal, Coach, and Colleague. Guzdial et al [19] added the categories of Friend, Collaborator, Student, and Manager. While these suggested roles define general archetypes of collaboration, and go some way to suggesting the nature of the interaction between the AI and the human, they still leave a great deal of ambiguity when designing specific examples of creative collaboration. For example, if an AI is to be a colleague, what type of colleague? A supportive superior, an ambitious subordinate, a passive equal?

In the context of human collaborators, it is likely of course that such preferences will vary between individuals, and depend on task, or professional setting. In the context of potential AI collaborators, what complicates this further is understanding how attitudes towards AI might impact the type of support individuals might expect or accept from an AI system. Are there differences in the type of creative support a person would accept from an AI as opposed to a human colleague?

2 RESEARCH AIMS

To help us understand the kind of role AI creative collaborators should play in the creative process, we considered the following questions:

- What are the common barriers to creativity experienced by people regularly working on creative tasks?
- What kind of support would alleviate these barriers to creativity?
- What kind of collaborator should ideally provide this creative support?
- How do creative support requirements change across different tasks and contexts?
- What kind of collaboration do those working on creative tasks want from AI systems?

These questions were designed to allow us to gain several types of insight from the study:

- To be able to map different support requirement to specific types of creative task
- To be able to map different types of creative task to specific collaborative roles
- To observe any differences between the type of collaboration expected from human colleagues, and AI systems.

3 STUDY DESIGN

We ran a diary study over a period of four weeks, with 30 employees of a large technology firm working in roles which regularly require creative work. Participants completed a questionnaire twice a week, which asked them to recall a recent creative task where they could have benefited from support or collaboration. Participants were asked about:

- Details of the creative task they were undertaking
- Details of the of the particular problems they faced
- What actions they took which helped them creatively
- What actions they took which did not help them creatively
- What kind of ideal creative collaborator they would have chosen to support them with the task.

A month-long diary study was chosen as the data collection method in order to help understand how participant's needs changed over time, and across different types of creative task.

3.1 Creativity Support Roles

	Extrinsic	Intrinsic
Capturing	**Studio Assistant.** Sets up your tools and materials and helps you get the best out of them. Ensures you have everything you need to capture your ideas.	**Visualiser.** Helps get the ideas out of your head and onto the page or screen. Listens to your ideas and visualises them for you.
Challenging	**Motivator.** Helps you keep to your targets. Challenges you to push yourself further. Provides encouragement and motivation when you need it.	**Go-Getter.** Takes an idea and runs with it. Pushes concepts the extra mile. Seeks out new roles and challenges.
Broadening	**Guide.** Points you towards new ideas and references. Teaches you new techniques, and sets you on paths to discovery.	**Guru.** Knows everything so you don't have to. Constantly learning and always has the right answer ready. Fills in any gaps in your knowledge.
Surrounding	**Curator.** Helps maintain a stimulating workspace. Suggests changes to your routines and surroundings to give you new perspectives.	**Wildcard.** Regularly brings surprising new outlooks and approaches to their work. Takes concepts in interesting and unpredictable directions.

Table 1: A list of the imagined collaborative roles presented to participants

To understand what kind of ideal collaborator the participants favoured for their tasks, we used eight archetypal roles based on those suggested by Main & Grierson [24]. These roles draw on pre-existing definitions of creative competencies [15, 14]. Using competencies as the key differentiator was thought to be useful for this study as they provide a confined range of creative attributes drawn from human characteristics. Also, as competencies can be defined and learned more easily than personality traits, they are potentially a more valuable basis for AI based systems.

The eight suggested roles represented the four key competencies defined by Epstein et al - Capturing, Broadening, Challenging, and Surrounding.

To account for the different types of collaborative agency described by Deterding et al [12], two roles were created for each of these competencies. One represented an intrinsic mode, where the imagined collaborator demonstrated the competency themselves (for example, generating visualisations of concepts described by the user), and the other represented an extrinsic use, where the imagined collaborator supported the user to demonstrate the competency (for example, providing suitable tools, materials, and guides to the user so they can visualise their ideas easily). The resulting roles can be seen in Table 1.

We also allowed participants to suggest their own role definitions to capture any qualities not covered by the eight suggested roles.

3.2 AI as Collaborator

The study aimed to first establish the type of creativity support participants required from collaborators in general, and then more specifically focus on their support expectations from AI collaborators. Our intention was to keep these two areas of enquiry separate so that the participants' attitudes towards creative collaboration could be assessed separate to their attitudes about AI. Comparing any differences between the two sets of attitudes could allow us to assess the challenges of positioning AI agents as collaborators, rather than tools, in the creative process.

We therefore did not mention AI in the recruitment or briefing for the survey. Neither was AI mentioned in the first seven questionnaires sent out as part of the diary study. In these questionnaires the archetypal collaborator roles were presented as if human collaborators, and illustrated with human figures. It was only in the final questionnaire that we introduced the subject of AI and asked specific questions about the participants' attitude and expectations of AI.

3.3 Sharing with AI

To help understand how the relationship between human and AI collaborators should work, we asked several questions related to how participants wanted to share information and responsibilities with their collaborator.

For each creative task the participants reported, we asked which archetypal collaborator they would prefer support from, and how much they would like the collaborator involved in the task. This was framed on a scale similar to Deterding et al [12], with the participant having full control of the task at one end, and the collaborator fully completing the task at the other. In the final questionnaire of the study, which focused on AI collaboration, we also asked participants about the type of tasks they would not be happy to share with an AI collaborator, as opposed to a human collaborator, and how much information related to their work and personal behaviours they would be prepared to share with an AI system in order to facilitate collaboration.

3.4 Recruitment

30 participants based in the US and UK were recruited at a large technology firm. Each responded to a call for participants who regularly work on creative tasks. We defined creativity for the participants in fairly broad terms, referring to creative

tasks as those which required them to "generate new ideas, or solve problems in imaginative ways". We chose this definition in order to broaden the scope of participants beyond traditional creative roles such as designers and writers, into roles such as engineers and managers, who might not primarily define their roles as creative, but who could still benefit from creativity support, or collaboration with creatives.
Out of the 30 participants, there were nine designers, 11 engineers, six managers, and four from other roles.

3.5 Methods of Analysis

The month-long study resulted in 215 individual questionnaires submitted by participants. Quantitative analysis was applied to the results where participants had responded to multiple choice and Likert-style questions. Thematic analysis [7] was conducted on participant's free text responses to identify key themes across the scope of the study.

4 RESULTS

4.1 Quantitative Analysis

	Studio Assistant	Visualiser	Motivator	Go-Getter	Guide	Guru	Curator	Wildcard
Participant's Job								
Designer	4	7	2	6	12	13	0	7
Engineer	7	8	5	7	7	18	3	9
Manager	1	8	0	2	1	2	2	1
Other	0	3	3	3	8	4	1	4
Totals	8%	16%	6%	11%	18%	23%	4%	13%

Table 2. Popularity of each proposed collaborator role across all survey responses, broken down by the job type of the participant

4.1.1Preferred Roles

Across all responses the most popular collaborator roles were the ones which provided informational support to the participant. Guru was the most popular role, and was selected as the preferred collaborator 23% of the time, and Guide was second most popular being selected in 18% of responses. Both these roles represent knowledge-based collaborators. Guru is described as always having the correct answer, and being able to fill any gaps in a participant's knowledge - essentially an expert system. Guide is described as leading the participant towards new resources and references, helping them discover information - essentially a recommender system. This preference for information based creativity support was repeated throughout the study.

Other popular roles were Visualiser (16%), which was described as a collaborator who could help participants get ideas out of their head and onto the screen or paper, and Wildcard (13%) which was described as a collaborator who brings surprising and unpredictable approaches to their work.

Although participants were given the option of selecting no collaborator, or defining their own type of collaborator, they very rarely chose to do this. Out of the 164 responses about preferred collaborators, there were only six instances of participants not choosing one of the suggested collaborator roles.

4.1.2 Preferred competencies

Guru and Guide were roles based on the same creative competency - Broadening. This competency relates to the ability to broaden horizons, find new inspiration, and discover relevant resources. Throughout the study this competency was by far the most requested by participants in their choice of collaborator. Capturing was the next most popular choice. This refers to the ability to externalise concepts and ideas, translating them from thoughts to tangible outcomes.

The remaining competencies, Challenging (the ability to set ambitious goals, take on unfamiliar tasks, and push concepts in new directions) and Surrounding (the ability to establish creative environments and situations for working) were less popular.

It’s notable that the most popular competencies - Broadening and Capturing - relate directly to the creative work itself, and how it is conceived and realised, while the least popular - Challenging and Surrounding - relate more to the creative worker and how they personally organise their work. This preference for forms of collaboration which are task-focused rather than personal was repeated throughout the study, and was evident both when discussing human collaboration and collaboration with AI.

4.1.3 Differences between job roles

The job role of the participant impacted their preferences for creative collaborator. The informational roles of Guru and Guide were most popular with participants who were Designers, Engineers, or in other creative roles. They were not so popular with Managers. Instead managers had an overwhelming preference for Visualisers who could manifest their ideas for them.

This difference in preference could reflect the existing competencies and inter-dependencies within the participant’s teams. Designers and Engineers reported that they needed project related information held by colleagues such as managers or clients, whilst managers requested the skills to manifest ideas which Designers and Engineers possess.

This data suggests that to a certain extent the participant’s ideal collaborators already exist within their workplace, but difficulties in connecting with the right colleague at the right time leads to barriers in realising creative work.

4.1.4 Changes in support requirements

Participants were unlikely to stick with one type of collaborator throughout the four week study. Instead, the type of task they were engaging with changed regularly and so did their choice of collaborator.

Participants were asked to identify the type of creative task they were working on, and in 60% of cases, they changed the type of task they were working on between reports. Furthermore, the nature of their tasks rarely followed a linear progression against established creative workflows - e.g. moving from research, to idea generation, to implementation and delivery. The data indicates that participants were working on multiple projects across the study and therefore were encountering a variety of creative tasks each day.

Consequently the type of collaborator they requested also changed frequently, with participants changing their selection between reports in 72% in cases. Even when their task remained the same, they were still likely to change their choice of collaborator.

4.1.5 Collaboration and Agency

Collaboration option	**% of responses**
The collaborator completes the task entirely by themselves	6
The collaborator completes the task with some guidance from the participant	26
The task is shared evenly with the collaborator	24
The participant completes the task with some guidance from the collaborator	39
The participant completes the task entirely by themselves	4

Table 3. Preferences for sharing a creative task with a collaborator

There were two ways in which participants indicated their preferences for how much agency they wanted to retain with the potential collaboration, and how much they wanted to hand over.

First was their selection of ideal collaborator. The proposed collaborators were divided into two groups - those which helped the participant demonstrate a certain competency (extrinsic collaboration) , and those which demonstrated the competency themselves (intrinsic collaboration). This division was not made explicit to participants in the presentation of the roles (which were randomly ordered in each questionnaire), however the difference was implicit in each collaborator description.

Intrinsic collaborators, where the collaborator demonstrated the competency themselves rather than supporting it in others, were the most popular choices. They were chosen in 65% of submissions. In every competency, the intrinsic version of the role was chosen more frequently than the extrinsic, indicating that given the choice, participants preferred collaborators with more agency.

This result is slightly at odds with the data gathered through our second method of testing agency preferences. For each task we asked participants how they wanted to share the task. The options and results can be seen in Table 3.

In the majority of cases participants reported that they wanted to keep control of the task. In 43% of submissions participants stated that they either wanted to complete the task entirely by themselves or with some guidance from the collaborator. Even where participants chose a collaborator with a description which indicated that the collaborator would perform the task themselves (for example a Visualiser), they still intended to retain control over the task.

Further testing would be needed to establish whether the differences in these results indicates a lack of understanding around the questions, or whether participants are conflicted about the role a collaborator should play in their creative work. From this data however, it seems that the issue of agency and initiative in creative collaboration could be complex.

4.2 Thematic Analysis

4.2.1 Information as Prerequisite of Creativity

Theme	Number of mentions
More information	42
Conversation/Feedback	39
Templates/Examples	32
Direction/Guidance	28
Specialist Skill	17
Tool Improvements	17
Visualiser	14
Sharing task	13
Focus	7
Simulation/Foresight	6
Inspiration	6
Motivation/Supervision	3

Table 4. Thematic analysis of responses to the question "What kind of support would have helped your creativity?"

The concept that participants sought out primarily informational collaborations was reinforced in our thematic analysis of participants' free text responses.

We asked participants to provide a description of the kind of support which would have helped their creativity on each reported task. The analysis of the keywords used in each response can be seen in Table 4. The types of support needed divided broadly into two types - informational and practical. Informational support was most popular, with the themes "More Information" and "Conversation/Feedback" being mentioned most frequently across all submissions . Typical responses in the area included:

"What I needed was more info. If I had that, the rest would be easy" (Participant 23, Designer)

"[It] would be nice to have a person with detailed insight into the existing process to bounce ideas off of and get immediate feedback on what would or would not work and why." (Participant 10, Engineer)

"It would be nice to not need to reinvent the wheel all the time when I know resources exist, but finding them can take longer than starting fresh" (Participant 21, Designer)

This last quote was typical of many others which stated the need for examples or templates, which was the third most frequently mentioned theme. This theme combines both informational and practical support, with participants often requesting resources which could either inspire them, or provide them with a practical starting point for their creative work.

Overall, practical support from collaborators with a specific skill was mentioned less frequently than the need to be able to gain information from a collaborator with expert knowledge.

We also asked participants what actions they ended up taking which they found helpful. The results of this question also reinforced the observation that information was the most valued factor for supporting creativity. The most frequently mentioned helpful actions were seeking out conversations and feedback from colleagues, and researching existing work. These were considerably more popular answers than what might be thought of as traditional creative activities such as sketching or brainstorming, or behaviours which might increase creative focus such as exercise or listening to music.

4.2.2 Conversation and Creativity

The question about helpful actions also illustrated that there was an important social aspect to how participants wanted to find information. There was a clear preference for talking to colleagues over searching for information digitally. Talking to colleagues was mentioned in nearly half of all the responses about helpful actions, and was frequently mentioned in response to other questions. Conversation was discussed as an important requisite of creativity and of collaboration. For example:

"I wish I was working in the same room as the other illustrator! It's been nice to collaborate but wish we were able to talk it out in real time" (Participant 8, Designer).

This response highlights that although collaboration can feasibly take place without direct, social conversation, it isn't as preferable, and it isn't as conducive to creativity.

4.2.3 Unpopularity of Motivation

While informational support was clearly the most popular factor in creative collaboration for participants, motivation was the least popular type of support mentioned in responses.

The Motivator role was chosen in only 6% of responses, making the second least popular role after Curator. In response to the question about what kind of support they were looking for, participants only mentioned motivation three times in 164 responses, making it the least popular theme. The Designer and Engineer participants didn't request it at all.

The unpopularity of motivation reflects the observation that participants preferred collaboration which focused on the task rather than their personal working methods. It was also emphasised further when participants considered collaboration with AI in particular.

Despite its general unpopularity, motivational support was requested by a minority of participants throughout the study, indicating that it was still a valuable form of support for some.

4.2.4 Preferences for AI Collaboration

Theme	Number of mentions
Finding/Suggesting references	12
Automate repetitive tasks	9
Visualisation	7
Knowledge repository	4
Organising resources	4
Guiding	3
Extend/Extrapolate work	2
Assist focus	2
Interpolate	1
Facilitate collaboration	1
Motivation	1

Table 5. Thematic analysis of responses to the question "What kind of creative tasks would you be most happy for an AI system to help you with?"

Theme	Number of mentions
Human/Emotional Interactions	6
Motivational	5
Ideation	4
Managing	3
Expert/Guru	2
Critical decisions	2
Finalising work	2
Research	1
Visualisation	1
Private/Sensitive work	1
Organising tools/workspace	1
Personal Work	1

Table 6. Thematic analysis of responses to the question "What kind of creative tasks would you prefer to complete without any help from an AI system?"

In the final questionnaire of the study we asked participants about their attitudes towards AI, and their opinions about the role it could play in their creative process (table 5 and 6). This revealed similarities and differences in participants' preferences for creative collaboration between humans and AI systems.

First we asked participants to rate how helpful they would find each of the proposed creativity support roles in general, across all their creative work rather than in relation to a specific current task. We then asked them to rate how happy they would be for an AI system, rather than a human, to perform the same roles. This allowed us to analyse how the participant's attitudes towards AI impacted their attitudes towards the roles.

The data reveal several insights. First, participants were broadly positive towards all of the roles, whether they were performed by a human or an AI, indicating all forms of proposed support were welcomed by participants.

Second, although the participant's attitudes towards most of the roles remained broadly similar whether they were performed by a human or AI (the roles of Guru and Guide were the most popular for both human and AI support), the participants did express slightly less positive attitudes towards the AI version of the collaborator in most of the roles. This indicates that there does not seem to be a significant bias against AI, although there remains a preference for human collaborators

Third, there were two roles where participants were more positive towards the role if it was performed by an AI - Studio Assistant and Curator. It's notable that both these roles are described as making suggestions relating to the participant's personal workspace or tools. It could be that while participants were reluctant to have human colleagues affect these personal arrangements, they were happy for an AI to play a role in them.

Fourth, the Motivator role was the least popular role when it was performed by an AI system, although it fared slightly better when it was performed by a human.

This preference against motivation by AI was reinforced when we asked participants to describe tasks that they would be happy to be supported by AI systems, and tasks which they would prefer AI not to support. Here participants expressed their concerns relating to AI and motivation:

"I don't want to be motivated by bot." (Participant 8, Designer)

"I would not appreciate any automated "nagging" - anything like motivational notifs [notifications], prompts, schedule reminders ("time to take a walk") etc…"(Participant 29, Researcher)

"[I prefer] motivating myself. I don't want my job to be gamified" (Participant 30, Manager)

Finally, there was a high frequency of responses expressing a desire for AI to automate repetitive or uninteresting tasks. For example:

"I'd also like help with automating some of my visuals without having to do so manually" (Participant 6, Designer)

"[I'd be most happy for AI to help with] tasks that can be automated such as perfecting designs" (Participant 17, Business Partner)

From responses such as these it seems that the participants were happy for AI to complete or develop work that they had started themselves, or follow examples that they had set. The AI is not necessarily being asked to be original, but to continue with ideas established by the participant. This form of support seems to be less akin to collaboration, and more like delegating to an apprentice or an extended version of themselves.

4.2.5 Testing Role Scenarios

In the final questionnaire we asked participants to rate how likely they would be to accept support from an AI in a number of specific scenarios. Each scenario was based on one of the creativity support roles (e.g. "You can describe an idea or a concept to the AI, and it automatically generates a version for you." based on the Visualiser role), but we did not include the name of the role (e.g. Visualiser) with the description.

This revealed some differences in attitude towards the roles compared with the questions which did not give specific scenarios. Notably, the examples given for Wildcard, Studio Assistant, and Visualiser all received more positive feedback than shown in previous questions, whilst the example for Guru received less positive responses.

This seems to demonstrate that beyond the broad competencies and support offered by each role, participant's attitudes are likely to be significantly affected by the specifics of how the support is provided.

4.2.6 Sharing Data With AI Collaborators

Type of data to be shared	% of participants happy to share this data with AI
Conversation/Feedbacks with the AI	85%
Calendar	85%
Emails	73%
Software usage	69%
Browser usage	62%
Offline' work via camera	50%
Conversation/Feedbacks with colleagues	42%
Physical movement via phone/watch	38%
Photos and videos	38%
Streaming media activity	31%
Posture or pose data via camera	23%
Social media activity	19%

Table 7. Responses to the question "What personal information would you be happy to securely share with the AI system?".

The roles proposed in this study suggest forms of collaboration which respond personally to an individual's working environment, methods, styles, preferences, and current needs. In practice these would require observation of significant amounts of data about the user and their context. We therefore questioned participants about the forms of data they were willing to share, in order to understand more about how they viewed the collaborative relationship with the AI, and what practical obstacles might be created by privacy concerns (table 7).

Here again we can see a distinction between task focused support, and personal support. Participants were more happy to share information directly related to their work such as their calendar, email, or software usage. They were less happy to share personally originated information such as conversations, physical movement, posture, personal media streams, or social media activity.

5 DISCUSSION

5.1 Summary of Insights

In summary, the study provided us with the following key insights:

- Information was of high importance to participants when working on creative tasks. Often a lack of information (e.g. data, references, or expert knowledge) was the primary barrier to completing creative tasks.
- In many cases participants wanted to get information conversationally from colleagues. They often wanted feedback or opinions on their work from people with different viewpoints.
- Participants wanted to share creative work with collaborators, but the degree to which they were happy to concede agency or initiative over a creative task to a collaborator was unpredictable.
- In general, participants were happiest to receive support for task-based requirements, rather than requirements which might relate to their personal working methods or approaches. This varied slightly in the case of support from AI systems where participants expressed willingness for the AI to reproduce or extend work based on their own existing work.
- Overall, participants expressed similar attitudes towards creativity support roles, whether they were performed by a human or an AI system.

Looking across all these insights, we have proposed a framework for creativity support which incorporates the key concepts emerging from the study. This framework contains three different factors relating to creativity support - Categories, Confines, and Competencies.

5.2 Categories of Creativity Support

Support Category	Description
Information	Support for obtaining relevant information resources relating to the creative task, such as data, references, examples, and feedback.
Generation	Support for transforming ideas into finished creative outcomes, and the production work associated with the creative task.
Situation	Support for creating the right conditions for working effectively and productively on a creative task.

Table 8. Proposed categories for creativity support

By analysing the categorisations which emerged from our thematic analysis of participant’s responses, we were able to consolidate the themes into three key categories of support for creative tasks - Information, Generation, and Situation (Table. 8).

The various support needs reported by the participants can all be mapped to these three categories. They are presented here in order of participant preference. Information was the most requested category, followed by Generation and Situation.

These categories overlap with the types of creative competency presented by Epstein et al [15](for example Information corresponds with elements of the Broadening competency), however on the basis of this study, these three categories more effectively capture the types of creative support requested by participants, and therefore the abilities which would need to be exhibited by an AI creative collaborator.

Combinations of these categories could be used to design future creativity support roles, and plan the type of training data and resources which would be needed by collaborative AI systems. They can also be combined with the Confines element of our proposed framework in order to define more specific areas of support.

5.3 Confines for Creativity Support

	Information	Generation	Situation
Task Support	Project data Examples References Simulation	Automation Visualisation Auto-completion	Organisation Scheduling Resource preparation
Personal Support	Opinions Feedback Viewpoints Predictions	Conceptualisation Sketching Brainstorming	Motivation Focus Prioritisation

Table 10. Examples of creativity support mapped against ‘task’ and ‘personal’ contexts. The dashed line indicates the subjective borderline between support that might be considered task-focused by an individual, and support that might be viewed as personal. The line would be positioned differently for different creatives.

While the above categories capture the types of support requested by participants, they don’t entirely reflect their preferences for certain types of support, or the varying attitudes towards agency and initiative expressed in responses. Participants' responses showed that they often imposed boundaries or limits to the type of creative activity they were prepared to accept support for. We observed a difference between support that was perceived as task-focused (e.g. suggesting useful references for a particular task) and support which was perceived as personal (e.g. setting goals or targets). While task-focused support was readily accepted, activities which intruded within the confines of a participant’s personal creativity were rejected.

The positioning of this boundary appears to be specific to individuals, and not easily predicted. Table 10 provides general examples of the distinction between task-focused and personal support, mapped against the categories for support.

In each case the personal activities involve communication with other people, or require or impact an individual’s personal approach to creativity. While the table gives general examples, the line between task-focused and personal is not fixed, but needs to be established for each person. For example, in our study, ‘resource preparation’, e.g. setting up tools and materials ready for a person to start their creative work on a task, was sometimes viewed as practical, task-focused support, but viewed by others as an undesirable intrusion into the confines of their own methods and approaches.

Finding ways of establishing where an individual draws the line between task-focused and personal creative activities could be an important step in setting up effective AI creative collaborators. Understanding this boundary could also help determine where on the spectrum of agency and initiative [12] a particular support system should be placed.

5.4 Competencies for Creativity Support

	Similarity	**Difference**
Knowledge	Knows what I know	Knows what I **don't** know
Ability	Does what I do	Does what I **can't** do

Table 11. Proposed creativity support matrix, illustrating types of support.

The final element of our proposed framework addresses the abilities and knowledge required by a creative collaborator. One clear observation from the study was that participant's often wanted support from colleagues with different knowledge or skills than their own, either to provide them with new information, or to help with a part of creative production which they were not skilled at completing themselves.

In addition to this, participants also frequently requested support from a colleague with a similar set of knowledge or skills to themselves - someone with their own skills or knowledge who could help them finish off tasks, or reproduce work in their own style. This was particularly discussed when considering potential AI collaborators.

The different possibilities of similar or different collaborators is illustrated on the competency matrix in Table 11.

In the context of AI creative collaborators, there is a possibility that systems could be trained by users to share their knowledge or abilities, and use these to produce creative outcomes on behalf of the person, rather than in collaboration with them. Understanding when a user wants a collaborator to act like them, and the appropriate methods that could be used to achieve this, is another factor which varies between individuals.

As with defining the personal confines of creative work, finding methods of establishing these preferences could be an important step in designing future AI collaborators.

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Appendix 7: Digital Probe Study - Info & Consent Form

Creativity Support Study
Participant Information and Consent Form

Thank you for your interest in this research study. You are invited to take part in this investigation into the creativity support requirements of designers. This study is being conducted by Angus Main, as part of his PhD research at the University of the Arts London, Creative Computing Institute.

Purpose of this research
The research is investigating how designers can be best supported whilst performing creative tasks. It is looking at the role collaborators and support tools play within the creative process. The information you provide through this study will be used to help understand the requirements of creative professionals and their attitudes towards creative collaboration. This may help inform the design of more effective creativity support systems.

For this study you will be using a custom digital device which has been designed to allow you to provide answers to a series of questions at regular intervals over the duration of the study. At the end of the study we will also invite you to answer a few questions about your experiences of using the device. This may help inform the design and use of digital devices in future research studies.

Duration
The study will last 21 days. You will be invited to answer a short series of questions once or twice a day, but only on days when you are working on creative tasks. The questions will only take around 2-3 minutes to answer.

What you will be asked to do
The device you will be provided with is a microcomputer with a touch screen, a microphone, and a speaker. At the beginning of the study you will be invited to place the device on a desktop in your normal workplace, and connect it to a mains power supply. You will be asked to keep the device in your normal place of work throughout the study so that you can answer occasional questions about your creative process, when convenient to do so. To answer questions you will use the device's touchscreen, and also have the option of recording spoken responses using the device's microphone. At the end of the study we will arrange to collect the device from you.

What information will be recorded
The device will invite you to answer questions about any creative task you are working on, and what kind of support would help you. These questions relate to your individual preferences for creativity support. You will not be required to provide any information which is personally or commercially sensitive. You do not have to answer questions if it is not a convenient or appropriate time, or if you do not wish to share details of the current task you are working on. If a question allows you to provide a spoken response, audio recording will only occur if you specifically choose to initiate it using the touch screen interface. You always have the option to skip recording if you wish. All your responses will be stored locally on the device.

Privacy
Your privacy is a primary consideration throughout this study. Any data you share via the device or questionnaires will be anonymised prior to analysis, and you and your business will not be identified in any resulting research publication. All data received from you will be stored securely. Any voice recording you share will be transcribed and anonymised, and original

recordings will be deleted when the research has been published. If you record a response to a question and then wish to withdraw it because of privacy or confidentiality concerns, you can request for it to be deleted before the data is analysed.

Who to contact
If at any stage you have any questions about this study, or wish to raise any concerns, you can contact the following people:

Angus Main PhD Candidate a.main0920181@arts.ac.uk	Mick Grierson Director of Studies m.grierson@arts.ac.uk	UAL Research Office researchdegrees@arts.ac.uk

Consent
You only need to complete this section if your participation in the study has been confirmed, and if you are happy to proceed.

To take part in the research you need to provide your informed consent. We ask you to read and consider the above information, and if you are willing to take part in the described study, sign and date the form below. You have the right to withdraw your consent to be part of the study, without disadvantage and without needing to provide a reason, at any point before publication of the research.

- I understand that I have given approval for any information I provide as part of this study to be included in academic outcomes and publications relating to this PhD research, although the data will be anonymous.

- I understand what the study involves and why it is being done, and I have had the opportunity to discuss the details and ask questions.

- Having given this consent I understand that I have the right to withdraw from the study at any time without disadvantage to myself and without having to give any reason.

- I hereby fully and freely consent to participation in the study, which has been fully explained to me.

Participants Name	Participants Signature	Date

Investigators Name	Investigators Signature	Date

Appendix 8: Digital Probe Study - Ethics Form

ual:

RESEARCH
DEGREES

Post-Registration Research Ethics Approval Form

Guidance:

- **Please ensure that you have read the '*UAL Guidance for Research Ethics Approval'* and '*UAL Code of Practice on Research Ethics'* before completing this form**. All supporting documentation on research ethics can be found in the UAL Research Degrees section on Moodle
- Please complete this form electronically
- **Section A and Appendix 1** (if applicable) are to be completed by the student and supervisors
- **Section B** is for UAL Committee use only
- Once Section A (and Appendix 1 if necessary) has been completed, including all necessary signatures, the form should be submitted to researchdegrees@arts.ac.uk by the student
- Incomplete forms, including any that are missing signatures, will be returned to the student for completion

SECTION A — TO BE COMPLETED BY THE STUDENT

Name:	**Angus Main**
College:	**CCI**

1. Please provide a 100-word summary of your proposed research. Explain in terms appropriate to a layperson.

A 21 day, diary-style study, using a custom designed digital research probe device to collect responses from participants.

The aim of the study is to learn about the specific creativity support needs of the participants over an extended period of work. It follows on from a previous diary study with employees at Google, testing conclusions related to categories of support required by creative professionals, and their attitudes towards collaborating on creative tasks with people and AI systems.

It will be conducted with 5 participants, who are professional creatives working in the design industry. The participants will each be sent a digital research probe which has been custom designed for this study. Over the course of the study they will be prompted to answer a short series of questions once or twice a day. Responses will be stored locally on the device, which will be returned at the end of the study.

2. Does your research involve participants

	No*
X	Yes

***If you answer 'No', you do not need to complete Questions 3 to 12, instead please go to Question 13 and continue from there.**

3. Who will the participants be? Please tick as appropriate.	
	Students at the University
	Staff at the University
X	Other*

*If you answered 'Other' please specify below
Professional creatives working in the UK design industry.

4. How will participants be recruited and how many will be involved?
Participants will be recruited via a request for participants email distributed to professional networks of myself and the supervisory team. Respondents will be checked for research suitability via a screening form. 5 participants will be selected for the final study.

5. What will participants be asked to do? Explain in terms appropriate to a layperson.
Participants will receive a small digital device that has been designed and produced as part of the research. This device will act as a research probe. It is designed to be placed on a desktop in the participant's workplace, and to occasionally prompt the participant to answer a short series of questions related to their creative practice. Participants will be prompted to record responses to these questions on a daily basis over the course of the study (21 days). The device is based on a Raspberry Pi microcomputer. It has a small touch screen, a microphone, and a speaker. Questions will be displayed to the participant via the screen and voiced through the speaker. Participants can respond to questions through the touchscreen interface, and by recording spoken responses via the microphone. At the end of the study the participants will return the device, along with the recorded data. They will also be asked to complete a final survey reflecting on their use of the device.

6. What potential risks to the interests of participants do you foresee and what steps will you take to minimise those risks? A participant's interests include their physical and psychological well-being, their commercial interests; and their rights of privacy and reputation.
Privacy ***Risk*** The device is has a microphone attached, and is designed to record audio under specific conditions. There is a risk to privacy and confidentiality with any audio recording. As the device could be used in the participants home, or in shared workspaces, this could include the unintentional recording of personal, or commercially sensitive information.

Mitigation

The device has been specifically designed to protect the privacy of the participants and other people in their environment. The risk of unintentional voice-recording is limited as recording is only triggered when the participant completes a series of screen-based interactions, and presses a button confirming they want to begin recording. When recording is in progress, a message appears on the screen alerting the participant. The device can act as a smart-speaker, allowing the participant to interact with it using simple voice commands. This functionality requires the microphone to remain active, but no audio is recorded as part of this functionality. Voice commands can also be disabled by the participant, and they have the option of not using any of the audio features of the device. All data recorded on the device, including audio recordings, stays on the device at all times and is not shared online or processed by third-parties. The device is entirely offline to simplify deployment and ensure privacy of the participants. Data is only shared when the device is physically handed back. During the data analysis all recordings will be securely stored, and only accessed by myself for transcription and analysis. All data will be anonymised for publication. As per the participant consent form, all participants will have the ability to withdraw consent to use any of the recorded data at any time, and can request for specific data to be deleted during the handover process.

Electrical equipment

Risk

The research probe is a custom electrical device, which run of mains power via a 12V DC power adapter. With custom electrical components there could be a risk of malfunction leading to safety issues such as overheating or electrical shock.

Mitigation

To mitigate this risk, the device has been designed entirely with off-the-shelf, branded parts from recognised manufacturers, which come with their own safety guarantees. There are no custom-made electrical components or circuits. All component parts of the device are being used according to the manufacturer's guidance. In addition, participants will receive an information sheet detailing appropriate use of the device, and how to turn it off safely when not in use.

7. What potential risks do you foresee to yourself as the researcher and what steps will you take to minimise those risks? E.g. does your research raise issues of personal safety for you or others involved in the project, especially if taking place outside working hours or off University premises.

None

8. Please attach a copy of proposed written consent form and information sheet to be given to participants. If you are not obtaining written consent or supplying an information sheet, please explain the reasons for this.

X	Please tick here if the written consent form and information sheet are attached

9. Does your project involve children or vulnerable adults? E.g. a person with a learning disability.	
X	No. Go to Question 10
	Yes*
***If you answer 'Yes', you must refer to Section 4 in the '*Guidance for Research Ethics Approval*' <u>AND</u> obtain a Disclosure and Barring Service (DBS) check (formerly known as a CRB check).**	
	I confirm that I have obtained a DBS check

10. Does your research concern groups which may be construed as terrorist or extremist?	
X	No. Go to Question 11
	Yes*
***If you answer 'Yes', you must refer to Section 5.5 in the '*Guidance for Research Ethics Approval'* <u>AND</u> complete the questionnaire at Appendix 1 of this form.**	

Please Note:

It is a presumption of academic research that, wherever possible and feasible, the information on which the research is based should be preserved, so that it can be made available to future researchers. However, the privacy of participants must be respected. Please refer to the guidance note on data protection before answering Question 11.

11. Will you be obtaining personal information from any of the participants? E.g. name, personal opinions, address, recorded images or audio, date of birth, notes and observations.	
	No. Go to Question 12
X	Yes*
***If you answer 'Yes', please give details. In your response, please consider:** How will you store and use this information during the course of your research? What parts of this information will need to be confidential and how? Will you exhibit or publish the information? Will you retain information after the research is concluded? If information is to be destroyed, explain why this is appropriate.	

As detailed in section 6, audio will be recorded on the device as part of the research. Audio will remain on the device until it is handed back at the end of the study. At this point the audio files will be stored securely on a password protected drive. The audio files will be transcribed, and the transcriptions will also be stored on a password protected drive. On publication of the research the original audio files will be deleted, but the transcriptions will be stored to allow future reference. To facilitate delivery and collection of the devices, it will be necessary to request the name and address of the participants. These will be stored securely until the end of the study, at which point they will be deleted,

12. Will payments to participants be made?	
X	No. Go to Question 13
	Yes*
***If you answer 'Yes', please state amount and whether payment is for out-of-pocket expenses or a fee.**	

13. If the project is to receive financial support from outside the University, please give details. Include any restrictions that have been imposed upon the conduct of the research. Please discuss this with your Director of Studies. Both financial propriety and the protection of commercial rights are important for you, the University and other third parties (e.g. sponsors, participants etc.)

14. Will any restrictions be placed on the publication of results?	
X	No. Go to Question 15
	Yes*
***If you answer 'Yes', please state the nature of the restrictions, e.g. details of any confidentiality agreement.**	

15. Have you attached a detailed outline of the research project to this form?

X	Yes, the detailed outline is attached
	No

Student Declaration:

16. I confirm my responsibility to deliver the project in accordance with the Code of Practice on Research Ethics of the University of the Arts London (the University). In signing this form I am also confirming that:

a) The form is accurate to the best of my knowledge and belief.

b) There is no potential material interest that may, or may appear to, impair the independence and objectivity of researchers conducting this project.

c) I undertake to conduct the project as set out in the application unless deviation is agreed by the University and to comply with any conditions set out in the letter sent by the relevant College Research body and/or the University's Research Ethics Sub-Committee.

d) I understand and accept that the ethical propriety of this project may be monitored by the relevant College Research body and/or the University's Research Ethics Sub-Committee.

Signature of Student:	
Date *(dd/mm/yyyy):*	31/03/2023

Director of Studies Declaration:

17. I support this project and have reviewed it with the applicant.

Name:	
Signature of Director of Studies:	
Date *(dd/mm/yyyy):*	

Completed forms should be sent to researchdegrees@arts.ac.uk

SECTION B FOR UAL COMMITTEE USE ONLY

Approval of Post-Registration Ethics (CRDSC):

- The College Research Degrees Sub-Committee (CRDSC) recommends that:

☐ This student's Post-Registration Ethics Approval Form is approved as **minimal ethical risk.** This decision and a copy of the form will be sent to RESC for noting at their next meeting.

☐ This student's Post-Registration Ethics Approval Form is approved as **more than minimal ethical risk** and so will be forwarded to RESC for final approval

☐ This student's Post-Registration Ethics Approval Form must be resubmitted, and the following **required** modifications should be made (*see below*)

Required Modifications List *(if applicable)*	1)		
Suggested Modifications List *(if applicable)*	1)		
Name		**Date** *(dd/mm/yyyy)*	
Signature *College Associate Dean of Research or Chair of CRDSC*			

Approval of Post-Registration Ethics (RESC):

- The Research Ethics Subcommittee (RESC) recommends that:

☐ This student's Post-Registration Ethics Approval Form is approved as **minimal ethical risk**

☐ This student's Post-Registration Ethics Approval Form is approved as **more than minimal ethical risk**

☐ This student's Post-Registration Ethics Approval Form must be resubmitted, and the following modifications should be made (see below)

Completed forms should be sent to researchdegrees@arts.ac.uk

Required Modifications List *(if applicable)*	1)		
Suggested Modifications List *(if applicable)*	1)		
Name		**Date** *(dd/mm/yyyy)*	
Signature *Chair of RESC*			

Appendix 1 - Post-Registration Research Ethics Approval Form

Please note – you only need to complete this *Appendix 1 – Post-Registration Research Ethics Approval Form* if you answered 'Yes' to Question 10 in Section A

The Terrorism Act (2006) outlaws the dissemination of records, statements and other documents that can be interpreted as promoting or endorsing terrorist acts. The University supports its researchers in undertaking research using security sensitive material, but takes seriously the need to protect them from the misinterpretation of intent by authorities, which can result in legal sanction. It is therefore important that the University is aware of the research before it begins and can ensure proper data management and oversight.

1. Does your research involve the storage on a computer of any such records, statements or other documents?	
	No
	Yes*
***If you answer 'Yes', you must respond to Question 3**	

2. Might your research involve the electronic transmission (e.g. as an email attachment) of such records or statements?	
	No
	Yes*
***If you answer 'Yes', you must respond to Question 3**	

3. If you answered 'Yes' to Questions 1 or 2, you are advised to store the relevant records or statements electronically on a secure university file store. The same applies to paper documents with the same sort of content. These should be scanned and uploaded. Access to this file store will be protected by a password unique to you. You agree to store all documents relevant to Questions 1 and 2 on that file store:	
	Yes

Completed forms should be sent to researchdegrees@arts.ac.uk

3a. You agree not to transmit electronically to any third party documents in the document store:	
	Yes

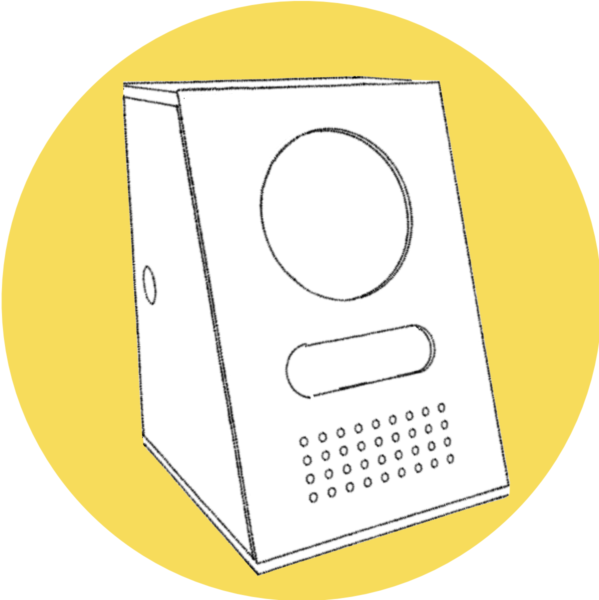
4. Will your research involve visits to websites that might be associated with extreme or terrorist organisations?	
	No.
	Yes*
***If you answer 'Yes', you must respond to Question 5**	

5. If you answer 'Yes' to Question 4, you are advised that such sites may be subject to surveillance by the police. Accessing those sites from university IP addresses might lead to police enquiries. **Please acknowledge that you understand this risk by putting an 'X' in the 'Yes' box.**	
	Yes

6. By submitting to the ethics process, you accept that University Research Ethics Sub-Committee (RESC) will have access to a list of titles of documents (but not the contents of documents) in your document store. The titles will only be available to RESC. **Please acknowledge that you understand this risk by putting an 'X' in the 'Yes' box.**	
	Yes

Appendix 9: Digital Probe Study - Handbook

Creativity Study



Participant Guide

About this study

Thank you for taking part in this research which investigates how designers can be best supported whilst performing creative tasks. It is looking at the role collaborators and support tools play within the creative process. The information you provide through this study will be used to help understand the requirements of creative professionals and their attitudes towards creative collaboration.

You have been provided with a digital device which allows you to provide answers to a series of questions at regular intervals over the duration of the study. At the end of the study we will also invite you to answer a few questions about your experiences of using the device. The study will last 21 days. You are invited to answer a short series of questions once or twice a day, but only on days when you are working on creative tasks. The questions will only take around 2-3 minutes to answer.

The device is a microcomputer with a touch screen, a microphone, and a speaker. Please keep the device in your normal place of work throughout the study so that you can answer occasional questions about your creative process, when convenient to do so. At the end of the study we will arrange to collect the device from you.

What information will be recorded
The device will invite you to answer questions about any creative task you are working on, and what kind of support would help you. These questions relate to your individual preferences for creativity support. You will not be required to provide any information which is personally or commercially sensitive. You do not have to answer questions if it is not convenient, or if you do not wish to share details of the current task you are working on. If a question allows you to provide a spoken response, audio recording will only occur if you specifically choose to initiate it using the touch screen interface. You always have the option to skip recording if you wish. All your responses will be stored locally on the device.

Privacy
Your privacy is a primary consideration throughout this study. Any data you share via the device or questionnaires will be anonymised prior to analysis, and you and your business will not be identified in any resulting research publication. All data received from you will be stored securely. Any voice recording you share will be transcribed and anonymised, and original recordings will be deleted when the research has been published. If you record a response to a question and then wish to withdraw it because of privacy or confidentiality concerns, you can request for it to be deleted before the data is analysed.

Who to contact
If at any stage you have any questions about this study, or wish to raise any concerns, you can contact the following people:

Angus Main (Project Lead, PhD Candidate) gusmain@gmail.com 07789221186	**Mick Grierson** (Supervisor) m.grierson@arts.ac.uk

Why does the device sometimes wake up without me touching it?

If Voice Activation is enabled (see section 9) then it might be that the device has heard (or think it's heard) you say the Wake Word. It might occasionally mistake other words for the Wake Word. You can disable Voice Activation if you are in a noisy environment, and the Wake Word is regularly being detected by mistake.

In addition, the device is programmed to briefly activate two times a day as a gentle reminder to consider responding to questions. If the device activates and you do not want to respond, then you can ignore it or press or say "No", and the device will return to sleep mode.

What should I do if I record audio by mistake, or want to change one of my answers?

Make a note of the date and time of any answers you record in error, and let the researchers know via email on or before the device collection This will allow us to delete the specific data before it is analysed.

What should I do if the device stops working?

Contact Angus Main as soon as possible (contact details on page 1)

What happens at the end of the study?

At the end of the 21 day study we will be in contact to arrange collection of the device as soon as possible. We only receive the data when we physically collect the device, so please keep it safe until then!

If you have any questions at any point during the study, please do not hesitate to get in touch by email or phone.

Setting up the device

Please follow these instructions to set up at the device at the beginning of the study. If you have any trouble setting up the device, then please don't hesitate to get in touch.

1. Equipment

You should receive a package containing:

- The **Research Device**, with connected power cable
- A USB-C **Power Adapter**

Please retain the packaging of the device so it can be used during collection.

2. Connecting the power supply

- Before plugging the USB-C Power Adapter into the mains, plug the end of the power cable into the cable that is attached to the back of the Research Device

3. Positioning the Research Device

The aim of the device is to allow you to record your reflections about creative tasks you are performing during your working day. The device is therefore best located wherever you work most often - e.g. on your desk in your office.

If you work in multiple locations you can just place the device in the location where you are likely to be most often. You do not need to take the device with you as you move between different workplaces.

Find a space such as a desktop, work surface, or shelf, where you can easily access the device while you are working, and within reach of a mains power socket.

The device may not work well if exposed to excessive vibration or moisture, so if you need to use it in that kind of environment please get in contact first.

4. Turning on the Research Device

To power up the device simply turn it on at the mains. The device doesn't have its own physical On/Off button. To turn the device off, please follow the instructions in section 10. **Please do not disconnect the power while the device is on, as information may be lost.**

After the power has been turned on, please wait a few seconds while the software loads up. The screen may flash a few times. Wait until **Start Screen** appears (see below).

Using the device

5. Waking up the Research Device

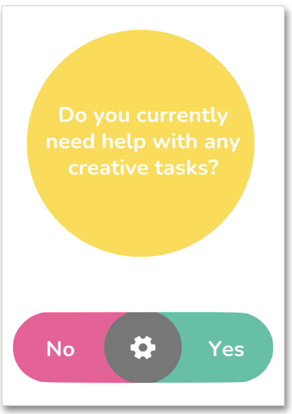
When not in use, the device will go to sleep and the screen will go blank. You can wake the device up in two ways:

- Touch the screen on the front of the device
- Say the wake word. The wake word for your device is:

"BUMBLE BEE"

When the device wakes up the screen will turn on and the Start Screen will appear.

6. Start Screen



The Start Screen appears whenever the device wakes up. It asks if you currently need help with any creative tasks.

- If you are currently working on a creative task and feel you could benefit from some support, or help from a collaborator press or say "**Yes**" to continue to answer questions
- If you do not wish to answer any questions at this time, press or say "**No**", and the device will go back to sleep.
- If you want to change any device settings, or shut the device down, then press the ⚙ Settings Button (see section 9)

11. Turning the device back on

The device does not have a power on button. Once the power has been turned off at the mains, simply turn it back on again to automatically start the device.

F.A.Qs

What counts as a creative task?

Any task that you feel requires creativity to complete. This might include tasks that involve general problem solving, or coming up with new ideas. You don't have to be creating artwork. You might be composing an important email, or planning a presentation. If it feels creative to you, and you could do with some help, then it would be great to hear about it.

How often should I use the device?

As often as you can! It would be very helpful to hear about a broad range of creative tasks and support needs, so the more you can use it the better. If you can aim to answer the questions once or twice a day (on the days you are working) that would be great. Even if you're still working on the same task, it's useful to know if your needs have changed.

You don't have to use the device everyday (for example if you work away from the office a day a week), but if you think you're going to be away from your desk for 4 or more consecutive days, then please let us know.

When does the device record what I'm saying?

The device only records sound during the two questions which prompt you to record a voice note ("*Please describe the creative task you're working on*." and "*How would an ideal collaborator help you with this task?*"), and only if you choose to press the record button. A maximum of 1 minute of audio is recorded for each of these questions.

If you have Voice Activation enabled (see section 9), then the device will use the microphone to listen for the Wake Word in order to turn on. However, the device does not store any sound data as part of this process. If you do not have Voice Activation enabled, then the microphone is disabled until you choose to record a voice note.

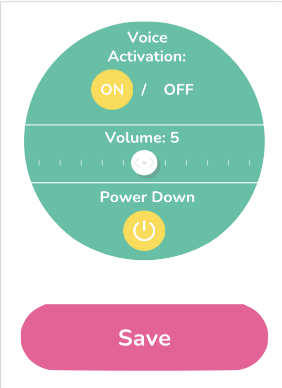
Is the device connected to the Internet?

No. The device is not online, and does not share any data via the Internet. All the data you record is stored locally on the device, and is only shared with us when the device is returned.

8. Completing the questions

When you have answered the final question, a “Thank You” screen will appear. The device will then return to sleep mode until you next activate it.

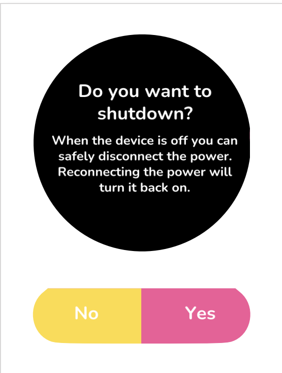
9. Changing the device settings



From the Start Screen, pressing the ⚙ Settings Button displays a screen which allows you to configure some of the device settings.

- **Voice Activation** allows you choose whether the device listens to voice commands to wake it up and proceed with questions. Selecting “Off” means the device will not listen for commands, and the microphone will only be used during the voice note questions, if you choose to record.
- **Volume** sets the volume of the alert that plays when the device wakes up. Setting it to 0 will mute the device.
- **Power Down** allows you to safely turn the device off (see below)

10. Turning off the device



From the settings screen, pressing the Power Down button will allow you to shut down the device safely. A message will appear checking you’re ready to shut down.

- Press “Yes” to shut down
- Press “No” to return to the Settings page.

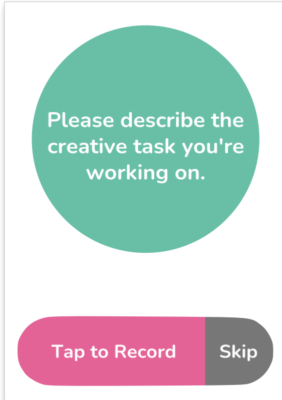
If you press yes, the screen will flash for a couple of seconds and then go black. It is now save to turn the power off.

It is advised to shut the device off over night, or on days that you are not going to be able to use it.

7. Questions

If you answer “Yes” on the Start Screen, the device will then ask you 6 questions about the task you are working on, and the type of support that might be helpful to you. These are detailed below:

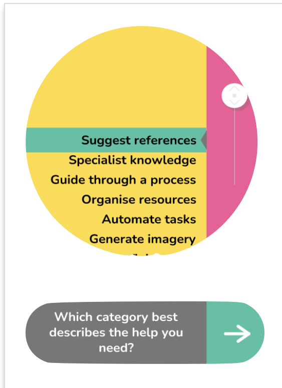
Please describe the creative task you’re working on.



You are invited to record a short voice note (1 minute maximum), describing the kind of task you need help with. (e.g. *“I’m creating a presentation and need some new illustrations”*)

- Tap the Record button to begin recording your voice.
- Tap the button a second time to stop recording and move to the next question
- Tap Skip if you are not able to record a voice note at that time e.g. for privacy reasons. (Please record a note whenever possible)
- When recording has finished the device will take a few seconds to save the recording before proceeding to the next question.

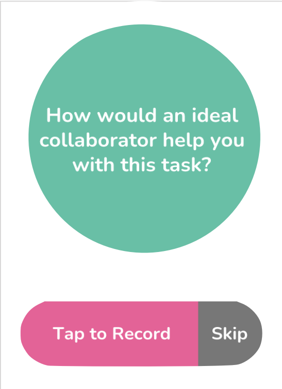
Which category best describes the help you need?



Please use the menu to select the category which best represents the kind of support that would be helpful for your task.

- Use the slider on the right to scroll through the list of options.
- If none of the options represent the type of help you want, then select “None of the above”
- When you have selected your preferred option by highlighting it in green, touch the green arrow button to proceed to the next question.

How would an ideal collaborator help you with this task?



This question asks you to imagine an ideal collaborator who could do anything to help you with your task. What would you ask them to do? Describe your ideal support in a short voice note.

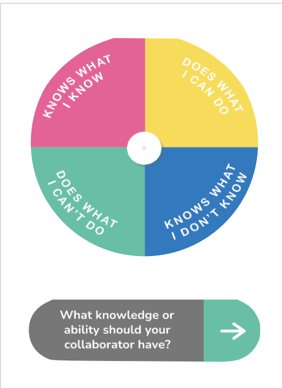
•Tap the Record button to begin recording your voice.

- Tap the button a second time to stop recording and move to the next question

- Tap Skip if you are not able to record a voice note at that time e.g. for privacy reasons. (Please record a note whenever possible)

- When recording has finished the device will take a few seconds to save the recording before proceeding to the next question.

What knowledge or ability should your collaborator have?



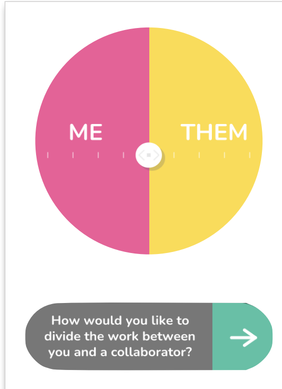
Think about what skills or knowledge an ideal collaborator would need in order to help you.

- Drag the white circle to the relevant coloured segment to answer the question:

Knows What I Know (pink) means the collaborator needs the same knowledge as you.
Does What I Can Do (yellow) means the collaborator needs the same skills as you.
Knows What I Don't Know (blue) means the collaborator needs knowledge you don't currently have.
Does What I Can't Do (green) means the collaborator needs skills you don't currently have.

- You can position the white circle between two segments if necessary.

How would you like to divide the work between you and a collaborator?



Who would you prefer to complete the work on your current task - you or a collaborator? Would you prefer to keep control of the task yourself, have them take over, or divide the work equally?

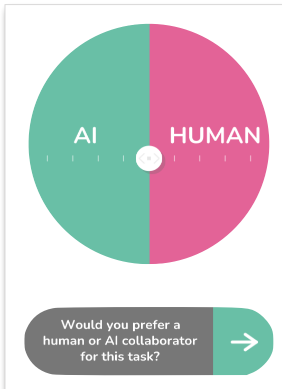
- Drag the white circle to left or right to indicate how you would prefer to divide the work.

- Dragging to the right makes the "Me" (pink) side larger, indicating you want more control over the task.

- Dragging to the left makes the "Them" (yellow) side larger, indicating you want the collaborator to take on more of the task.

- You can leave the circle in the middle to indicate that you want to divide the work equally, or only move it a small amount to indicate a smaller level of control.

Would you prefer a human or AI collaborator for this task?



Do you feel the support you need could be provided by an AI system, or would you prefer a human collaborator?

- Drag the white circle to left or right to indicate your preference for an AI or Human collaborator.

- Dragging to the right makes the "AI" (green) side larger, indicating you would prefer an AI collaborator.

- Dragging to the left makes the "Human" (pink) side larger, indicating your preference for a Human collaborator

- The amount you drag the circle indicates the strength of your preference for either side.

- Leaving the circle in the middle indicates you have no preference either way.

Appendix 10: Digital Probe Study - Probe Data

Digital Probe Study Data

Participant		Q1: Please describe the creative task you're working on.	Q2: Which category best describes the help you need?		Q3: How would an ideal collaborator help yo	Q4: What knowledge or ability should your collaborator have?		Q5: How would you like to divide the work between you and a collaborator? (0 = Them, 10 = Me)		Q6: Would you prefer a human or AI collaborator for this task? (0 = Human, 10 = AI)	
		text	User Selected Category	Researcher Assigned Category	text	x,y	text	num	description	num	description
A	**A1**	I'm currently working on a workshop to do with the vision of a product we're working on and there's one part where we want to generate some sketches and I'm not sure if I want to do a round or a pin style where I have someone do the start and then someone takes the middle and another person takes the end or if someone just does a complete set and they build on top of it and I'm much what the best way to go about it is at the moment	Facilitate collaboration	Specialist knowledge,	They would help me talk through the problem and maybe we could even help organize like a quick test and or even offer me an alternative because maybe I'm not thinking, like maybe I'm thinking of running the two but I'm sure there's maybe a better way that I haven't thought of yet for this new type of task for this collaboration with the different team members or participants I should say in the workshop.	312:166	Knows What I Don't Know	6	Me (Very Low)	4	Human (Very Low)
	A2	So, it's to do with synthesizing of a workshop. So we ran a workshop today and we've got a bunch of data and a bunch of generative outcomes as well and it is wondering about how do we present this, how do we show it in a way or refine it in a way that can help people understand what the outcomes were because at the moment it was very abstract imagery that we've asked them to create and to destill that into something that's more tangible and I guess it's just thinking about what's the best way to do that and also we have another workshop coming up and it's thinking about how we then take that forwards and present it to the stakeholders in a way that helps us build on top of it and refine even more into it even further.	Organise resources	Specialist knowledge,	The ideal collaborator with the task would be to give you suggestions on how we could generate new refined ideas and also how to best organise all the different data points we have and present them in a way that tells a story and then also maybe help me refine it and basically share the load or work for it .	369:248	Knows What I Don't Know / Does What I Can't Do	4	Them (Very Low)	3	Human (Low)
	A3	I'm currently working on a competitor analysis looking at different broadcasting and streaming services that deal with live TV and I've captured a bunch of screenshots but it's now an annotated and interesting part, it's now just distilling them into some of the key takeaways and strengths but I'm just trying to think about how would I write it in a way that's concise and comes clear, clearly across and also if I have enough to write because you know sometimes I won't have to write if I'm not adding the right details in.	Assist focus	Specialist knowledge,	The Ideal Collaborator would talk me through, with me, I should say, all the different concepts, or not concepts I guess, but the different elements that I found within the competitor analysis. So for example, I'm looking at Channel 4's live area, like their live TV, so maybe it's just walking through, like, talking together, like, what we think is working and what's not working in that way, it can help, you know, then bring out those strengths and weaknesses for me. But it's a lot easier to do it when you get someone to talk to you rather than just yourself.	196:342	Does What I Can't Do / Knows What I Know	7	Me (Low)	3	Human (Low)
	A4	I'm working on a design project to do with an internal system that will also be going outwards towards some certain clients, a niche project I'm working on, and I'm wondering how I should, I've been asked to make some edits to the system where we have some tabs and there's some information layouts and I'm thinking about how do I best separate them. It's really simple, it's just thinking about like do I have, do I split them in one, so like on the left hand side I have a certain selection on the right hand side I have these different set of buttons but they could also fit together. I'm not entirely sure, as for navigation I should say, I'm not entirely sure if that makes sense, it makes sense to me but I need someone to like sense check it for me I guess.	Organise resources	Specialist knowledge,	They would just, we could just talk to each other, really, I guess, and go back and forth and ideate on the best ways of disseminating information, like, you know, i.e. do we have left and right split, or do we just have them together, and seeing what makes sense, and maybe trying a different couple of other versions, or maybe, you know, thinking of different ways of going about it as well, and just really pushing that a little bit.	172:171	Does What I Can Do	6	Me (Very Low)	4	Human (Very Low)

Digital Probe Study Data

Participant		Q1: Please describe the creative task you're working on.	Q2: Which category best describes the help you need?		Q3: How would an ideal collaborator help yo	Q4: What knowledge or ability should your collaborator have?		Q5: How would you like to divide the work between you and a collaborator? (0 = Them, 10 = Me)		Q6: Would you prefer a human or AI collaborator for this task? (0 = Human, 10 = AI)	
		text	User Selected Category	Researcher Assigned Category	text	x,y	text	num	description	num	description
	A5	I've been tasked with creating a slide, just one slide, but I have to fit in a bunch of information onto the slide, a lot of information, and I'm thinking about how we organise it and also do we have enough time, because I also have to talk to one of the managers on this one as well, and he's providing the material, such as the visuals as well, but he wants this done by Thursday, so it's only a few days and I've got some other things to manage, so I guess two creative tasks is one, communication towards the different stakeholders within this, but also composition and layout of the design and stuff and just making sure it all can fit neatly and be visually communicable.	Extend or finish work	Extend or finish work,	The Ideal Collaborator would genuinely just give me good layout options, just I provide like all the imagery and the text needs to go with it and they can just lay out very nicely and simply that is visually pleasing.	128:131	Does What I Can Do	6	Me (Very Low)	8	AI (Medium)
	A6	I'm currently doing the redesigns of a, um, I think I talked about this before as well, but I've got, and it's around this, uh, do the certification, resolve the information they've changed with their schema, and, um, not a lot of it's too bad, but I'm just kind of, basically there's this little tricky part where I'm having to think around how, because some of them have multiple tests but separated, but are kind of the same, and usually how I've done, and how it was originally done was that it would have them, it would be, they'd be separated, but I'm thinking, is that a bit, would that get too many, like, because then you have a lot of duplicates of certain information because some of them overlap, so I'm just thinking, does that need to be redesigned as well now? Um, and I'm guessing, yeah, that's just the, the crazy problems like, my crazy problem is like, what's the best solution like to place everything on?	Assist focus	Specialist knowledge,	And then my colaborator would probably have some bit more knowledge than me actually, so maybe, **I know I said this is focused, but maybe it also would probably lie a little bit in towards our specialist knowledge** and just understand this space a bit more because it's to do a lot of like, it's based on partners and their tests, they're doing a test which are not really well versed in, because I'm a designer, so it's probably like having a bit more specialist knowledge of what would they want, what would make sense to them, rather than just kind of at the moment I'm just kind of gut feeling it and just intuiting it off patterns I know. So yeah, I do clarify, it's probably going to be someone who knows a lot more than I do about this space.	364:163	Knows What I Don't Know	4	Them (Very Low)	0	Human (Very High)
	A7	So, I'm taking, we're doing this activity called 'from/to shifts', and the idea behind it is we've got a bunch of these different, oh, we've crafted it pretty much, so we have these different froms, these different tos, so like it's going from A to B, so that, and my colleague has like collated a bunch of post-it notes from our previous workshops, that we did, that we got this data from, and just like grouped them together in the froms and the tos, and then like correlate, and now I need to like put them into like sentences that actually describe them, and I guess I'm just, it's the writing part, the creative writing, like condensing a lot of these post-it notes that say similar things, but also a bit different in some of them, and like make them one cohesive sentence, but that is all	Assist focus	Specialist knowledge,	Ideal collaborator would most likely just sit with me and help just come up with ideas with me, generate different ways of taking the different inputs in the from area and generating a sentence from that that connects to them in the to and that makes it sort of synced and then also for the third part which is the so that and just making sure it all fits together. But yeah, it's giving me different options because I think you can go different directions with them and just seeing what sounds the best.	250:364	Does What I Can't Do / Knows What I Know	6	Me (Very Low)	5	No Preference
	A8	It was actually to do with a workshop, I'm looking for... someone asked me to prep before their workshop and they want me to find some examples of designs that use like iconography that like talk about that show off like artists and stages and special moments and also like different designs in the backgrounds like what's unique ways of showing off like to bring the eye towards it and then when you find some examples I'm struggling I'm trying to find thinking of some good examples.	Suggest references	Suggest references,	Best collaborator would be able to point you towards the correct different examples of good use of iconography to highlight maybe certain shows like like music events and like how they've been used to guide users through like I don't know looking through content or something like that.	253:139	Does What I Can Do / Knows What I Don't Know	4	Them (Very Low)	7	AI (Low)
	A9	I'm working with a colleague to condense down these sentences that we made yesterday to further refine them into like even shorter sentences where it's only a few words long and it's really difficult and we're both kind of struggling to how to condense them and even combine some of the different categories we have in different sentences.	Guide through a process	Guide through a proc…	They would be able to work with us to help generate the new sentences that are more condensed and guide us through that process, maybe they would talk back to us or help us recognise if we're looking too much into one area.	249:371	Does What I Can't Do / Knows What I Know	4	Them (Very Low)	6	AI (Very Low)

Digital Probe Study Data

Participant		Q1: Please describe the creative task you're working on.	Q2: Which category best describes the help you need?		Q3: How would an ideal collaborator help yo	Q4: What knowledge or ability should your collaborator have?		Q5: How would you like to divide the work between you and a collaborator? (0 = Them, 10 = Me)		Q6: Would you prefer a human or AI collaborator for this task? (0 = Human, 10 = AI)	
		text	User Selected Category	Researcher Assigned Category	text	x,y	text	num	description	num	description
	A10	currently ideating on this user journey or vision piece where we're having to think about like a live event and what's happening before, during and after and we've done them before and during now on this after part and we're thinking like what would someone want to do on a streaming service after a live event and we're coming up with ideas like the future what could be like three years or so and it's a bit and we're just it's just at the moment we're just trying to get some good ideas going that could be really interesting and inspiring	Guide through a process	Specialist knowledge,	would talk it through with us just get fresh pairs of eyes on it really and just make sure we're not missing out on anything obvious because I've been working this for a while now and after a while you kind of tend to like gravitate towards your own biases so I think just another person with a fresh pair of eyes is having a look and see if we missed any like really big ideas or interesting ideas that we might have thrown aside and just forgotten about.	215:133	Does What I Can Do / Knows What I Don't Know	6	Me (Very Low)	4	Human (Very Low)
	A11	I'm making refinements to a design to do around information, like it's a static page that has these tables, where each one gives you a test to do for a certification of an application. And I'm going to go over to some of the product managers and engineers around this and then make some adjustments to the layout or at least the schema of the data and it's still required for me to make some adjustments and I'm just having to do that now.	Extend or finish work	Extend or finish work,	They could quickly just do the adjustments I need to do, because it's very tedious. It is just literally changing some components around, like there's not a big creative design thing. It's creative in some extent, but it's more just like refining by moving some pixels across the screen. So some collaborator who could help me do that very quickly.	127:131	Does What I Can Do	4	Them (Very Low)	7	AI (Low)
B	B1	I'm looking at a subject of study and I want to know a bit more about different viewpoints around how this works.	Specialist knowledge	Specialist knowledge,	So, ideally I'd like something or someone to kind of be able to aggregate a selection of the relevant articles or concepts that's related to what I'm interested to investigate and kind of help me to comprehend the most relevant information and sift through the information that's less relevant.	338:144	Knows What I Don't Know	7	Me (Low)	5	No Preference
	B2	Currently I'm trying to design some graphics for a piece of internal communication work.	Generate imagery	Generate imagery,	So clearly it would be nice if I could explain briefly, verbally, what it is, what I want the layout to be, and could it be automatically generated a few different options for me to look at before I choose one of the directions.	171:141	Does What I Can Do	4	Them (Very Low)	9	AI (High)
	B3	So I'm working on creating a visual dashboard for an overview of many kind of initiatives, the progress and the statuses, so I'm trying to work out what's the best visual representation for each element in this dashboard and how I can figure out what's the best combination for each element quicker.	Suggest references	Automate tasks,	It would be nice to input some of the attributes that I'm looking for, and then the collaborator can provide me with a couple of options of the potential visual representation of each attribute, and I can, or either the collaborator or myself, can play around with a different combination to see what's the best result.	169:152	Does What I Can Do	4	Them (Very Low)	5	No Preference
	B4	So I'm trying to create a future user flow for a service I'm working on, so it's not super complicated process, but I kind of needed to collect information from those different applications and replicate that in a more simple visual way, so it would have been nice to have some help from someone or some device to kind of summarise the key points of the journey from different applications and create the flow diagram instead of being built into that and manually recreate those flows.	Automate tasks	Suggest references,	I would be ideal if a collaborator knows roughly what are the kind of points of interaction with certain kind of famous or widely used systems when you kind of describe a scenario. For example, if I say I would like to see a flow diagram of someone using Google to do an image search and then the collaborator could just provide me with a flow diagram that shows the key points of interaction and the kind of decision points.	168:114	Does What I Can Do	1	Them (High)	8	AI (Medium)
	B5	I'm trying to create a user testing plan for a tool that, or a prototype, that we have created. The plan itself is not...	Guide through a process	Automate tasks,	So, as mentioned earlier, it will be quite useful if a collaborator could help me with kind of creating the initial standard template with all the default information or section included and I think I'm just go in and tweak each section based on the context.	146:234	Knows What I Know / Does What I Can Do	3	Them (Low)	7	AI (Low)
C	C1	Ecosystem Map	Guide through a process	Guide through a proc…	Tell me what it is and how to do it and an example.	331:133	Knows What I Don't Know	7	Me (Low)	9	AI (High)
	C2	strategy for customer help in app.	Assist focus	Specialist knowledge,	brainstorm different considerations and user needs.	339:89	Knows What I Don't Know	5	No Preference	5	No Preference
	C3	Analyzing page performance.	Automate tasks	Automate tasks,	Do the analysis for me using my Desired Choice program.	127:186	Does What I Can Do	0	Them (Very High)	10	AI (Very High)
	C4	Doing some competitor analysis for help within apps.	Suggest references	Suggest references,	Suggest best-in-class app experiences.	115:102	Does What I Can Do	3	Them (Low)	7	AI (Low)
	C5		Assist focus	Automate tasks,	Generate some example questions for the survey.	115:167	Does What I Can Do	6	Me (Very Low)	7	AI (Low)

Digital Probe Study Data

Participant		Q1: Please describe the creative task you're working on.	Q2: Which category best describes the help you need?		Q3: How would an ideal collaborator help yo	Q4: What knowledge or ability should your collaborator have?		Q5: How would you like to divide the work between you and a collaborator? (0 = Them, 10 = Me)		Q6: Would you prefer a human or AI collaborator for this task? (0 = Human, 10 = AI)	
		text	User Selected Category	Researcher Assigned Category	text	x,y	text	num	description	num	description
	C6	Conducting stakeholder discovery workshop.	Organise resources	Organise resources,	make notes and organize them after workshop.	120:136	Does What I Can Do	2	Them (Medium)	9	AI (High)
D	**D1**	So I'm in the process of creating some screens based on the feedbacks that we've received from the stakeholders and also from the user testing.	Organise resources	Organise resources,	I would say someone who is logical and to be able to help me group and theme the feedbacks together and also someone who is creative that we could brainstorm what I do together based on the feedbacks that we've got.	204:333	Knows What I Know	4	Them (Very Low)	6	AI (Very Low)
D	**D2**	I'm working on some copywriting for a campaign so that the copy has to be a little bit fun but also functional.	Guide through a process	Specialist knowledge,	I think the best collaborator would be people who are specialised in copywriting, both UX functional, but also creative, and also have the knowledge of what our brand tone of voice and guidelines are supposed to be.	380:234	Knows What I Don't Know / Does What I Can't Do	3	Them (Low)	8	AI (Medium)
E	E1	I am currently making 3D models for a speculative design task and those models will be used to generate discussion in a university.	Guide through a process	Guide through a proc…	The models I am making have to be 3D printed. It would be helpful if the collaborator could check how well the models are made and show me what improvements need to be done so it prints easily or it makes those improvements itself.	304:293	Does What I Can't Do	8	Me (Medium)	2	Human (Medium)
	E2	I have to create assets for PowerPoint presentations that included graphics, illustrations, organize all the layouts and decide how, for PowerPoint presentaitons, what the templates will be for future use.	Automate tasks	Automate tasks,	Ideally, because a lot of old presentations will now have to be redone according to the templates I create, will have to be done by me, which is a very monotonous and time consuming task. So ideally, the collaborator would follow the templates and design guidelines that I will establish and convert all the old PowerPoint presentations according to new guidelines.	184:198	Does What I Can Do	6	Me (Very Low)	8	AI (Medium)
	E3	I have created a very detailed PNG logo, it uses lots of black lines and some colour, but now every single shape needs a white fill and because there are several versions of it I will have to go through each file and add white fill to lots and lots of different shapes.	Extend or finish work	Extend or finish work,	Ideally the collaborator would take all these logos and would add white backgrounds or white fills to the shape so I don't have to.	191:187	Does What I Can Do	8	Me (Medium)	8	AI (Medium)

Appendix 11: Digital Probe Study - Follow-up Form

Creativity Support Study - Follow Up Survey

Thank you very much for completing the Creativity Support Study using the research device.

This follow-up survey is the final part of the study. It has two sections, the first contains questions about your experiences using the research device, and the second section contains questions about your attitude towards using AI technology to support creativity.

There are 10 questions in total, and it should only take about 10 minutes to complete.

* Indicates required question

1. Your name *

Your experience of the research device

Thinking about your overall experience of using the research device during the study, please let us know about any positive and negative feedback you have.

2. Positive experiences of the device: *

3. Negative experiences of the device: *

4. The research device asked some questions which required you to record your voice. On a scale of 1 to 5, how comfortable did you feel talking to the device about your creative tasks? *

Mark only one oval.

	1	2	3	4	5	
Very	◯	◯	◯	◯	◯	Very Comfortable

5. Please tell us more about how you felt describing your creative task to the device, noting anything you found particularly easy or difficult. *

6. Did you have any privacy concerns related to using the research device in your workspace? If so, please describe them here: *

Creativity and AI

Some of the questions in the study related to AI (Artificial Intelligence) technology supporting creativity. This section aims to find out more about your experience of AI and Creativity.

7. Given your current understanding of AI technology, what kind of creative tasks do you think AI would be **most capable** of supporting now or in the near future? *

8. Given your current understanding of AI technology, what kind of creative tasks do you think AI would be **least capable** of supporting now or in the near future? *

9. Recently, some Creative AI applications have become available which use AI to automatically generate or modify media such as text, images and video (for example, Dall-E, ChatGPT, Midjourney, Craiyon, Runway ML). *

   Please select the option which best describes your knowledge of these kind of Creative AI applications.

   Mark only one oval.

   - I have no knowledge of Creative AI applications at all
   - I have seen examples of what they can do, but have never used them
   - I have used them once or twice
   - I have used them multiple times

10. If you have used creative AI applications before, have you ever used them to support your work? If so, please describe how. *

11. In general, how do you feel about using AI tools to support your creativity? *

Other feedback

12. If you have any other comments related to this study then please share them here.

Appendix 12: Digital Probe Study - Follow-up Data

Participant	Positive experiences of the device:	Negative experiences of the device:	The research device asked some questions which required you to record your voice. On a scale of 1 to 5, how comfortable did you feel talking to the device about your creative tasks?
A	The positive experiences I had with the device was that it was easy to record and go through the process. I also found that the instructions were clear and had little problems around technical setup.The device helped me talk through my problems I was having with a task and did sometimes help clarify what creative task I was trying to complete and how I could go about completing it.	I did struggle with trying to place where my creative problem was in the categories or, I felt that I was repeating the same categories. I also found that whilst sometimes it did help talk through a problem (a la rubber duck debugging), sometimes it felt frustrating not having advice given to me on how I could proceed.	4
B	It encouraged me to stop and reflect on my ways of working and process.	It sometimes activates itself late in the evening despite the voice activation is turned off.	4
C	Voice search allowed me to express my creative problem quickly. I also liked layout of choosing level of human vs. machine for a particular task.	I didn't seem to use most of the suggested categories for the task I was explaining. I would hope it could determine what help I needed based off of what I had mentioned when describing my creative task. Essentially I feel like it might be a lot of steps/inputs before getting an answer.	5
D	It's a small device with minimalistic design that can be placed seamlessly on your work desk. The sound it made when it was active was pretty subtle and the interface and controls are pretty easy to use.	The text are a bit too small especially on the screen with the list of tasks	2
E	Loved the wake up sound, really enjoyed recording voice messages and reflecting on the tasks I had to do and thinking what support I would like, liked colours of the interface (reminded of candy), liked the interface itself especially the sliders and the round screen	The screen could have been bigger, I imagine someone with dexterity issues might found it difficult to use, would have been interesting to see more experimental shapes of the box. What if it was a blob fish? Overall very positive experience	5

Participant	Please tell us more about how you felt describing your creative task to the device, noting anything you found particularly easy or difficult.	Did you have any privacy concerns related to using the research device in your workspace? If so, please describe them here:	Given your current understanding of AI technology, what kind of creative tasks do you think AI would be most capable of supporting now or in the near future?
A	I was comfortable for the most part in talking to the device and I was mostly concerned with talking longer than 30 seconds as mentioned in the manual. I found it easy to jump into talking about the creative task as I would of thought through in my head about what I was doing and what I was going to say.	The only privacy concern I would have is similar to Alexa, where if you say the keyword to wake the device it will record and store that instance of the device waking. I did sometimes, by accident, leave the device on after work hours in my home office and would be concerned if it captured conversations outside of my work.	I think AI would be great for tasks in generative work. For example, having to create some illustrations or quickly make some a layout that can then be refined for the task at hand. Also, AI would be useful for quick emails or reports where you want to get the structure and main points down and then you can go over and edit till it fits your voice/ coherence.
B	Sometimes, it can be a bit hard to explain the task without giving too much contextual information in a 1min audio.	Yes, a little. As mentioned previously, the voice activation was turned off but the device still self activated a few times late in the evening.	Generate, organise and finding patterns based on existing data.
C	It was very difficult to describe the creative task in a short concise manner without explaining the context behind. If I saw the device was not able to understand or help me with the current issue I described I would probably start to give longer descriptions and more context. Additionally, it was difficult to describe my tasks only using words since as designer, I generally use both verbal and visual formats to describe what I am working on.	Yes - I tend to turn the voice activation off in the off chance the device might be listening or catch on to other conversations. Generally when I would turn the device off when I stopped using it.	My understanding of current AI technology is that it has generative capabilities which can make our workflows quicker, such as generating imagery, 3d modeling and even UI screens and wireframes etc.. Currently, I also use Chat GPT quite often to look into competitor analysis, formulate problem statements or customer needs. (Of course there is always a need to check them to see if they correspond/ make sense) In the future I would imagine AI to be much more integrated into our design apps and processes and take into consideration the research or background of the design question. We would be able to use its AI to automate the tasks in several stages of the process such design ideation, automate designing wireframes, design delivery specs etc... Of course always still including a human perspectives as well. There could also be great benefits in generative AI in ensuring and cross checking that designs are accessible.
D	Most of the time I'm working on things that are too sensitive - I found it hard to describe the task without much details.	My work desk is located at my bedroom so at first I was worried to have a device with built-in microphone at my room, especially during meetings and non-working hours. But soon enough it's pretty clear that the device wouldn't record before I press the button	I'd say the tasks that requires more logical thinking, like coming up with research plans, writing research questions, interview scripts etc. Also in the UX design, products world, with numerous amount of companies have conducted different kinds of user research, I'd say the data base should be large enough for AI to learn the best approach with certain designs. For example, I reckon there should be an answer for what the easiest, well-tested and validated flow for an e-commerce website. I also think when it comes with copy writing, a lot of companies already have a set of guidelines ,dos-and-donts that AI can follows and do the job.
E	I find it difficult to do surveys with very standardized questions. My mind goes numb and I have 0 motivation to fill it in. But when I can record my messages, I can share my thoughts easier, give nuance and I also imagine it might be more interesting to the ones collecting the data	No. I knew the device was not connected to the internet. It felt like a black box that I talked to in the morning	Automating tasks such as I know how to do, but are too tedious and time consuming like cropping images, adjusting colour values, suggesting colour palettes

Participant	Given your current understanding of AI technology, what kind of creative tasks do you think AI would be least capable of supporting now or in the near future?	Recently, some Creative AI applications have become available which use AI to automatically generate or modify media such as text, images and video (for example, Dall-E, ChatGPT, Midjourney, Craiyon, Runway ML). Please select the option which best describes your knowledge of these kind of Creative AI applications.
A	I think AI would struggle with highly contextual strategy setting and being able do research. These could be things such as vision setting or conducting user research where it's useful to be able to parse language, read someones body language, or understand a highly specific reference. Whilst AI can come across as conversational I believe it still struggles to understand contextual work and complexities of life.	I have used them once or twice
B	Create new concepts or ideas of seemingly unrelated information, comprehend and assign meaning to data.	I have seen examples of what they can do, but have never used them
C	I believe AI is least capable of facilitating the discovery stages of the design process. Although it may be able to generate ideas, I would assume it needs a data set to work off of so coming up with new more novel ideas and especially design methods is currently a difficult task and would be in the future as well. Perhaps role of designer would shift more to ensuring AI outputs aligned to peoples needs & design principles. Maybe designer would even start to help in the creation of AI & training models specific to the design process.	I have used them multiple times
D	I think most of the tasks I do on a daily basis are not replaceable with AI - things that require communication skills, conducting workshops, meetings, aligning goals with different teams etc.	I have used them multiple times
E	Providing feedback on how something looks or whether the final output of your project will be well received by the client	I have used them once or twice

Participant	If you have used creative AI applications before, have you ever used them to support your work? If so, please describe how.	In general, how do you feel about using AI tools to support your creativity?
A	I have not used them for work as if I need assets for designs I can use pre-existing assets to illustrate my designs.	I feel that it can be used in the right situation to speed up work such as creating quick imagery specific to your needs or getting the basic structure of something and then being able to add the fine details. I fear that if people see it as being useful in every aspect of the creative process then we will lose that human touch that makes things such as art, literature, film making, and design so special.
B	Not yet.	Could be helpful as long as I'm aware of the pros and cons.
C	Mostly Chat GPT to get competitor analysis, ask any design & accessibility related questions and understand best practices.	It would be very useful to automate certain processes in terms of design execution giving designers more time to focus on strategy and design synthesis. I think designers would still always need to be there to have a more holistic view of the project and cross check if AI outputs actually align to customer/user need and always still include peoples perspectives throughout the design process. We also need to ensure erradicate/minimize bias creeping into data sets or built into algorithms which might be reflected in future AI design outputs.
D	Rarely, I did use ChatGPT a few times on writing emails, and leaving cards for ex-colleagues. I decided to use AI instead only because I'm not the best writer and it could help saving a lot of time.	I'm not entirely sure but I feel like when it comes to executing final designs (branding, ads, app designs), copyright could eventually become an issue. My general thoughts on AI is still a bit conservative - I do think AI is still not human enough to handle tasks that needs to put human at the centre of heart.
E	I have used new Photoshop beta version to generate images of microscopic close ups in nature, images of sliced onion, snails house, tree roots	I can use them when I am very short on time or the project budget is very tight. I can also use them for mind numbing, repetitive tasks that no one wants to do like cropping images or correcting colour values. But I do not want to see anyone relying on AI to do the creative work

Participant	If you have any other comments related to this study then please share them here.
A	As mentioned before, I found that it did help give me a better understanding of what I was trying to complete with my creative task. However, I feel that it could of given me some resources or advice at the end to help guide what I was trying to accomplish.
B	It's a very interesting topic, great research method. Wish all goes well with the rest of the project!
C	
D	
E	