"Clay to Play With": Generative AI Tools in UX and Industrial Design Practice

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ABSTRACT

Generative artificial intelligence (GAI) is transforming numerous professions, not least various fields intimately relying on creativity, such as design. To explore GAI's adoption and appropriation in design, an interview-based study probed 10 specialists in user experience and industrial design, with varying tenure and GAI experience, for their adoption/application of GAI tools, reasons for not using them, problems with ownership and agency, speculations about the future of creative work, and GAI tools' roles in design sensemaking. Insight from reflexive thematic analysis revealed wide variation in attitudes toward GAI tools – from threat-oriented negative appraisals to identification of empowerment opportunities – which depended on the sense of agency and perceived control. The paper examines this finding in light of the Coping Model of User Adaptation and discusses designers' metacognitive skills as possible underpinnings for their attitudes. Avenues for further research are identified accordingly.

CCS CONCEPTS

• **Human-centered computing** → **Field studies**; • **Computing methodologies** → **Artificial intelligence**; • **Social and professional topics**;

KEYWORDS

generative AI, design, industrial design, UX design, coping model of user adaptation, metacognition

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1 INTRODUCTION

Astonishingly quickly, developments in artificial intelligence (AI) have altered the possibilities by which individuals can generate content: text, images, even video and audio. This is largely due to generative AI (GAI) tools built around large language models with an interface whereby users prompt the AI, in natural language, to generate content. Text-to-image generators (TTIGs) such as Midjourney, Dall-E2, and Stable Diffusion, have demonstrated impressive abilities to produce vast volumes of realistic-looking and speculative outputs alike that display characteristics of semantically sensible content, applicable to many creative domains. This development has raised questions as to whether creative tasks, traditionally considered a domain that only humans can master, could be tackled by AI, even if only partly. That possibility is no longer confined to science fiction: at the time of writing, TTIGs are being adopted in such professional fields as fashion design [43], game development [51], collaborative design in a consultancy setting [50], and architecture for hospitals [55].

Especially prominent among the creative fields that may end up affected by the emergence of GAI tools is *design*: human inquiry and action aimed at changing the state of the world [16, 30, 32, 38, 44]. Recent studies of creative professionals' attitudes, perceptions, and experiences [27, 34, 51] highlight generative AI as a potentially dominant force in the future of design.

How GAI tools might affect design work is not yet understood well, however. An especially important question accompanying its rise is whether they are truly democratizing design [51] or might ultimately render professional designers less necessary than before.

As explored in this article, the notion of GAI encompasses technology that automatically generates visual or written content based primarily on text prompts [e.g., as 24, describe], developed on such foundations as machine learning and neural networks, with large language models. Reflecting GAI's presence in popular consciousness, the study presented it to participants in forms such as ChatGPT and Midjourney, which meshed well with their interpretation of GAI.

While creative professionals may display commonalities in thinking patterns and characteristics across multiple domains, thus permitting general studies to shed light on how GAI tools affect design work, dedicated studies with designers should draw together the disparate views. Here, we address this gap by focusing on the following research question:

RQ: How do designers in the industry view generative AI's impact on them and on their work?

The findings presented in this paper, based on reflexive thematic analysis of 10 interviews with user-experience (UX) and industrial designers, spotlight connections between generative AI and the abductive sensemaking processes fundamental to design. By analyzing GAI tools' implications for design work from this standpoint, we complement the growing body of knowledge surrounding their increasing adoption in design. Situating the emerging thematic structure in a suitable established framework contributes to practitioners' efforts to assess the introduction of GAI to their field and supports organizations' attention to their practices accordingly. The findings may also inform system developers of both the promise and pitfalls accompanying GAI in the design domain.

2 BACKGROUND

2.1 Human-Centered AI

While the development of AI has largely been technology-driven, the growing adoption of AI systems across a broad range of domains has attracted increasing attention also from human–computer interaction (HCI) researchers, thereby sparking the emergence of the human-centered AI (HCAI) discipline. Calling on the HCI community to assume a more prominent role in the design of AI systems, Xu [54] proposed a preliminary HCAI framework comprising three components: ethics-aligned design, technology that fully reflects human intelligence, and human-factors design. Later, Shneiderman [45], who questioned conventional thinking that holds human control and computer automation to be mutually exclusive, recommended an alternative HCAI framework that separates the two. In their recent comprehensive overview and analysis of HCAI research to date, Capel and Brereton [11] identify four key research areas under this umbrella: explainable and interpretable AI, human-centered approaches to design and evaluation of AI, humans on teams with AI, and ethical AI. Within that general framework, our work focusing on human–AI collaboration and co-creation falls primarily into the third area: human teamwork with AI.

The allocation of roles between humans and digital systems has been a perennial topic of discussion ever since Licklider's seminal work on human–computer symbiosis [35]. Licklider recommended that humans active in a symbiotic partnership fill the role of setting goals, formulating hypotheses, determining criteria, and performing evaluations. Digital systems, meanwhile, would carry out routine work. These general tenets have prevailed in reflections on human–AI interactions too, with writers having stressed the importance of complementary operations. In partnership, each agent's strengths offset the other's weaknesses. From this angle, AI's role should not be to supplant humans' input to epistemic tasks that require analysis and high-level decision-making. Pragmatic tasks that involve acting on decisions are more amenable to AI-based automation [42].

As for the "how" of all this, scholars have offered numerous human-centered methods, approaches, and guidelines to serve design and evaluation of AI systems and human–AI interactions [11]. For example, Amershi et al. [2] stated 18 design guidelines, grouping them under four stages/timeframes of interaction: "Initially" (e.g., clearly express what the system can do), "During interaction" (e.g., mitigate social biases), "When wrong" (e.g., support efficient and appropriate overruling), and "Over time" (e.g., remember recent interactions). While collaborative interaction in the design field can derive clear benefit from applying general methods and guidance of this sort, detail-level recommendations suited specifically to GAI-related practices have not been published thus far, to the best of our knowledge.

2.2 Use of GAI Tools in Design Practice

Beyond the relatively general work on human–AI interaction reviewed above, there is a growing corpus of scholarly enquiry into creative designers' use of GAI systems. Though this work remains scattered, it represents a starting point.

In this research, scholars depict AI's role as assistive, conceiving of it as a creative partner and an augmentive apprentice, not necessarily an independent creator in the design process [21, 24, 26, 34, 53]. They have also perceived its potential as a tool aiding with inspiration and providing ideation support [23, 24, 26, 36]. In contrast, their views on productivity diverge sharply. While AI has been hailed as improving productivity [21, 23, 24, 26, 27], with the opportunities it might afford in relation to manual/repetitive work receiving special appreciation [21, 26, 34], others perceive potential inefficiency, stemming from lack of control [27, 51]. Likewise, what is expected from – or deemed acceptable in – AI's effect on design quality varies [24, 53]. Other critical views center on the credibility of the results that AI may provide [24, 34]. In addition, there are concerns about predictability (raised partly in connection with the control issue) and about limited interfaces. While scholars have cited additional interaction modes as one way to help alleviate these [23, 27, 51], methodical study of the design process could advance GAI-focused inquiry much further [48]. That said, design processes differ greatly by field, organization, constraint environment, etc. [6].

2.3 The Design Process

The role of GAI tools in the design process can influence the designer's way of approaching and conceptualizing design problems, as well as the strategies for addressing them. Awareness of this constellation of factors has formed the heart of *design cognition* research. Hay et al. divided the higher-order cognitive processes in conceptual design into problem structuring, evaluation of concepts, decision-making, reasoning, generation of concepts, and synthesis of concepts [20]. Of these, GAI tools have shown the greatest potential to contribute to concept generation [27, 51], within certain limits.

Houde et al. claim that design encompasses a multitude of micro-tasks where AI could provide augmentation [21]. If this is true, then GAI tools (and AI generally) could play an important part in all the stages listed by Hay et al.. From the perspective of design cognition, the most interesting question might be whether GAI deployments can function as genuine cognitive tools rather than merely expedite repetitive tasks. Whether GAI tools can help practitioners manage and deal with the *open-ended, divergent nature* of design work is a crucial factor in this [13].

For Kolko, the goal of design is synthesis, an abductive sensemaking process wherein designers manipulate and prune heterogeneous datasets, thereby producing information and knowledge

[28]. According to Dorst, design abduction demands creating the operation principle and the thing (object, service, or system) in parallel [13]. In the divergent portions of the design process, designers seek inspiration and abductively draw inferences. With *sensemaking*, meanings are assigned and connections among data get revealed. Kolko clarified that "Synthesis requires a designer to forge connections between seemingly unrelated issues through a process of selective pruning and visual organization."

GAI tools, when based on large language models, possess some competence in making associations that prove fortuitous. By affording serendipity when the designer evaluates these links, GAI tools may be able to support some of design's higher-order cognitive processes. This wider setting entails designers' continuous sensemaking that involves judgments [38] based on actions, knowledge, skills, and disposition cultivated through their training and experience [15, 52]. The judgments constitute validation when conceptually oriented propositions develop toward conjectures and sometimes knowledge [19].

Designers rely on their experience in strategizing for effective sensemaking. In this connection, design-education scholars have recently highlighted the importance of metacognition [4]: a complex of processes that continuously monitor and control cognition such that effective strategies get maintained whereas ineffective ones are pruned away [1]. Reflection on action [44] supports enhancement to metacognitive skills and facilitates attending to a wide array of design desiderata – a broad-based set of criteria encompassing users, stakeholders, societal factors, engineering mechanics, etc. [38]. Designers with well-honed metacognition can monitor their processes critically and constructively. They develop a flexible understanding of the problem space wherein the framing for the task – the articulation of the possible solution and also of the problem itself – may well evolve [12, 14, 17, 37].

It is at these levels, in design cognition, where GAI tools could make their most profound impact. Though research into human–AI co-creation provides relevant frameworks [e.g., 25], we have not uncovered any reports analyzing GAI tools' utility for design in that "meta" realm. This gap, probably due to the tools' recent emergence, motivated us to conduct a study investigating GAI tools' use in design practice.

Of the relevant frameworks identified, the Coping Model of User Adaptation (CMUA) emerged as the best for this aim. A model explaining how users adjust to new technologies in their work settings [5], the CMUA has functioned in studying users' responses to technology events of various sorts. Since this model supplied the underpinnings for our analysis once the thematic structure had been developed, we describe the CMUA in detail in the "Discussion" section.

3 THE STUDY

Our study was informed by the background literature outlined above. There was a noticeable lack of empirical data on uses of GAI tools in real-world design work: either the participants in the work reported upon merely speculated about possibilities for GAI (as in Knearem et al.'s study [26]) or the sample represented a much wider population than designers (with Ko et al.'s study [27] being one example). Therefore, questions of where and how current GAI tools fit practicing designers' work remained especially in need of attention. We conducted our study with this starting point in mind.

While research into GAI tools with design work has been largely speculative and not anchored in studying designers' genuine practices, the range of expectations captured in participating designers' views serves as a baseline for judging the experiences of our informants. Also, the earlier studies usefully spotlighted mixed attitudes to GAI among creatives, and we were interested in probing these with our sample.

This section describes the study method, analysis approach, and set of participants. We collected data via a pre-interview questionnaire, then interviews held in May–June 2023.

3.1 Participants

A broadly scoped group of visual artists took part in Ko et al.'s project [27], where the authors, in addition to meeting with visual artists such as painters, interviewed an architect, an industrial designer, and an app designer. Li et al. [34] focused on a particular design discipline, UX, with its established processes and tools. Our sampling criteria homed in on designers and their design work in research and development organizations, which involves tasks with relatively extensive constraints [6]. Our intent was to cover GAI use among practicing designers in two fields, with some distinction between the processes. Accordingly, we recruited 10 industrial and UX designers, who worked either as in-house designers (P1–P8) or in a design consultancy (P9–P10). The participants' countries of origin in alphabetical order were Finland, Canada, the Netherlands, Spain, and Sweden. Three identified as female and seven as male. Table 1 breaks down the profiles of the participants, stating their job descriptions and the role of their organizational unit within the company at which they were working. The table also reports the extent to which the participants had employed GAI tools.

3.1.1 Recruitment. Participants 1–7 all worked within a single global technology company, but they differed in roles, job profiles, and lower-level organizations.

P1 was recruited from the research organization of the company, while we secured P2–P7's participation via an invitation e-mail (containing a consent form and the pre-interview questionnaire) to the heads and members of two design teams within the company, which were responsible for industrial design and UX (from nine responses to the mail, seven led to successful scheduling of interviews). In contrast, P8 and P9 joined the study through personal/professional networks. Apart from interaction by e-mail for arranging the interviews, they had not engaged personally with the interviewer before. Only one of the respondents (P10) was well-acquainted with the interviewer prior to the study. He and P5 had met once or twice before, a decade ago.

3.1.2 The pre-interview questionnaire. The Web-form questionnaire completed before the interviews covered the following topics: how many years' experience the interviewees had as designers; what kinds of design artifacts they produced during a typical week; how often they were using specific GAI tools at work (daily / weekly / monthly / "I have tried them but not considered using them" / never); whether they had downloaded AI components, trained AI model, or otherwise explored GAI, and, if so, in what way; use

of GAI outside work; their impression of GAI ("A valuable tool already" / "An equal partner" / "A gimmick for playing"); and their availability for an interview.

3.2 Interviews

The paper's first author interviewed the participants over Microsoft Teams with the support of an interview guide and the background from the pre-interview questionnaire. The interview guide was structured with the following discussion topics: 1) participants' background and work history and a query about their role in the organization, alongside the role their team or unit played at the company; 2) the nature of their design process, for information on practical context and on the motives/intentions behind their design work; 3) their concrete experiences with GAI tools, if any, and uses of design artifacts in the participants' work; and 4) expectations of their future work and how they saw the development of AI. As is common in qualitative interviews [10], the discussion was of a conversational nature and did not always follow the template rigidly.

One hour was allocated for each of these semi-structured interviews, with the shortest coming in at 36 minutes (with P7) and the longest at 64 (P2's and P5's). In addition to conversations, we collected visual examples for analysis – some participants used screen-sharing to illustrate their current processes and objectives or to present/discuss a particular GAI output. The Teams software enabled convenient screen-sharing, recording, and initial transcription, which was checked and corrected prior to the analysis.

No rewards were provided to participants for their time. All had volunteered to take part in the study and were allowed to use their work hours for this. Although using English, a non-native language for all but one participant, may have affected the depth of the thoughts expressed [49], it should be noted that this choice reflected the working language of the informants' current and past employer organizations. Furthermore, we did not observe any language-related challenges during the interviews.

3.3 Reflexive Thematic Analysis

We analyzed the data by following Braun and Clarke's instructions for *reflexive thematic analysis* (RTA), which represents an elaboration [8, 10] on their widely used thematic analysis technique [7]. The RTA approach calls for reflexivity, subjectivity, and creativity in the researchers' knowledge production. In comparison to the more general method, it emphasizes abductive inference and active knowledge construction based on the data gathered. Considering the constellation of the researchers' background, interests, and knowledge, we characterize our positionality below, as is essential in reporting on studies of this sort [10].

For the pillars of the study we applied the principles of constructive design research, wherein the researchers' primary responsibility is to design practice [29]. Approaching it from backgrounds in industrial design, cognitive science, computer science, information technology, HCI, and electrical engineering, coupled with many years of experience in the technology industry and academia, we recognize the importance of design theory and processes, and we could relate to the context in which the respondents were situated. All the researchers were familiar also with GAI through work-related applications and their research endeavors both. As for the human level, seven participants worked at the same company as two of the paper's authors but in separate organizational units. It bears mentioning also that the first author was employed by that company part-time for this study, which guaranteed that those seven designers could speak without fear of breaching their non-disclosure agreements. With regard to the remaining three, we had to be mindful that some uses of GAI tools might have gone unmentioned.

We followed the six-step process developed for RTA, which progresses from data collection through generation of codes for topics to defining themes and reporting [7, 8]. The next section presents the findings, using *Initial capitals and italics* for the topics and codes. We then discuss a key thread woven through the story constructed from the data [9], a fitting theoretical framework, and the implications of the study. Finally, the paper examines limitations and potential for future work.

4 FINDINGS

To present our findings from the RTA methodically, this section is arranged in line with the topics cohering from the code groups. Figure 1 presents the inductively developed codes and the resulting topics.

4.1 Adoption of GAI Tools

At the time of the interviews in June 2023, seven of the participants had used GAI tools in *Actual work-related tasks*. The three who had not (P2, P3, and P6) were working in considerably constrained roles, performing design tasks primarily for the embodiment design (stage 4 in Table 1) and later stages. Of those seven with experience of using GAI for work, one (P4) was acting in a junior role and had made some use of ChatGPT to find information but not to generate output for deliveries. P2, who was keenly aware of recent developments in AI, had twice paid fees for a one-month Midjourney license from his own pocket. He described a compelling use case for Midjourney in his line of work, with GAI supporting creation of boundary objects [46] to bridge gaps between professionals from different fields, to improve storytelling and expedite turnaround. He had not, however, adopted it for his work practice. The reasons he cited – clarity issues with company policy and confidentiality, in combination with unavailability of a paid license – resonated with the situation of P5 and P8, who had begun using the tool for their freelance work but not their day job. The five others had used GAI directly for work duties.

Outside a work context, eight participants' use of GAI addressed *Recreational or self-expression* purposes. Trying it out in their free time was the most common starting point: exploring the potential of the systems in a safe environment with no possible compliance issues (see Subsection 4.3, on rationale for non-adoption). Two informants, P3 and P6, had not yet gained either work- or leisure-time experience of GAI. They had monitored discussion of it but not experimented at all.

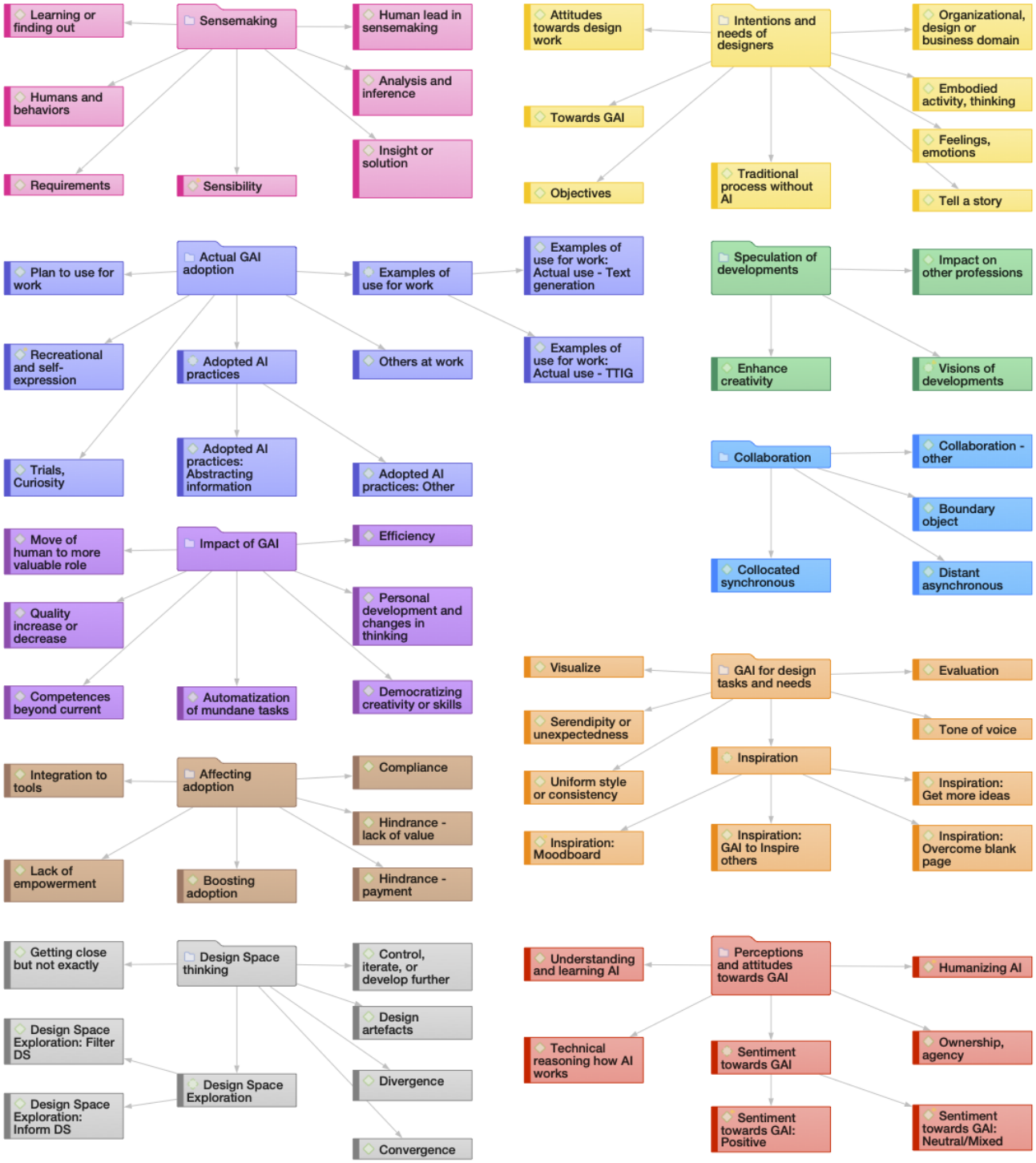

Figure 1: A depiction of the codes from the study and the resulting topics (code groups). Arrows from each topic identify the constituent codes. This structure was exported from ATLAS.ti, the software utilized for the RTA.

Table 1: The participants

ID	Role	Education/ degree	Experience (years)	Unit's role in the company	Process stages*	GAI use**	
						Images	Text
1	UX designer	BSc (SW eng.)	20+	Technology and UX research	3,4	+++	+++
2	Industrial designer	MA (indust. des.)	3	Horizontal unit offering design resources	3,4,5	+	++
3	UX designer	BA (edu.), MA (graphic des.)	3	Horizontal unit offering design resources	4,5,6	-	-
4	UX designer	BSc studies (UX), 4th-yr	<2	Product-line R&D	4,5,6	+	+++
5	Industrial design lead	MA (indust. des.)	20+	Horizontal unit offering design resources	3,4,5	+++	+++
6	UX designer	Self-taught	20+	Product-line R&D	(3) 4,5,6	-	-
7	Snr. interaction designer	Incompl. MSc (eng.) studies	20+	Technology intelligence and exploration	1,2,3	+++	+++
8	Lead UX designer	MA (indust. des.)	20+	3D engineering software development	2,3,4,5,6	++	++
9	Design researcher	PhD (anthropology)	15+	Digital and strategic design consulting	1,2,(3)	-	+++
10	Industrial design lead	BA (indust. des.)	20+	Design and engineering consulting	2,3,4,5 (6)	+++	-

* The participant's primary responsibilities in design, per Howard et al.'s [22] product-development model: 1 = identifying a need, 2 = task analysis, 3 = concept design, 4 = embodiment design, 5 = detail design, 6 = implementation.

** Adoption of image- and text-generation tools, as noted in the pre-interview questionnaire and interview: + = has tried them, ++ = has used them outside work, +++ = has used them for professional purposes.

4.2 Uses of GAI Tools

Participants reported using GAI tools for a wide variety of purposes and tasks. Below, we discuss the reported uses in detail.

4.2.1 Learning. Three participants described cases wherein they had put GAI tools to use for *Learning and finding out* information. Describing ChatGPT's value in learning about a new topic, P7 said that

> part of the designer's job is to be an expert at becoming an expert quickly, because many people have to switch projects quite often [...] there's no longer a day or a week of reading up for the project; instead I collect a bunch of materials and pretty much dump it into GPT-4.

In addition to finding raw information, P9 used text-based GAI tools to reveal connections between pieces of information, for reminding of works read earlier on in P9's dissertation project, and to support sensemaking. This facilitated efficient user research and concept development, that informant's primary work tasks.

4.2.2 Telling a story. While most uses mentioned in the interviews were at the level of speculation, four informants described actual cases of having applied GAI for *Telling a story*. This was a frequently identified *Intention and need of designers*. Design artifacts such as demos often function as explanation media and provide reference frames in collaborative processing, where they support multidisciplinary sensemaking. The following example referring to a joint workshop with partners illustrates this:

> So we described: What are the, uh, demonstration building blocks we have at hand? What kind of data do we have? Who is our intended audience? And [...] how might we formulate a day in life for this [persona] – what kind of statistics they might look up in the morning? (P7)

While P7's team applied textual output for persona generation, P5 offered a graphically oriented example. He described enthusiastically using Midjourney in creating visuals for user personas for a freelance project. Visual material gives room for interpretations and storytelling. In fact, three industrial designers each noted GAI's potential in that area. One of them, while sharing a CAD-generated scenario image of a maintenance worker lifting material onto a van, said,

> I'm not designing the car. I'm not designing the person. I'm not designing the tool. But maybe I'm designing, um, the package, [...] and I want to describe why should we have these graphics at this place in this packaging or why should it be like this. (P2)

Telling a story was pinpointed as essential in *Collaboration*. In their project work, all participants acted as members of larger, multi-discipline organizational units interacting daily with such

stakeholders as developers, marketers, clients, and engineers. The example of P2 explaining and advocating a specific design proposal with the aid of a visual is not unique. Many interviewees highlighted the benefits GAI offers as an efficient alternative to searching through stock images, one with high-quality, tailored results. In connection with developing a visual brief jointly with clients and the design team for projects he led, P10 used the term "visual manuscript." Midjourney showed value in generating such boundary objects. The storytelling nature of visuals was stressed with regard to later stages too. It was evident that the semantics described, at least for P10, resemble a prompt for GAI:

> (Showing a picture made for a client) It's an early promotion image or images, and the design is far, far from ready. So, I tried to create a high-tech, modern... sort of... [...] it would reflect that it's a high-end product and it's well-made.

The language in which designers describe objectives for the products they design is reminiscent of prompts generally. The semantics of the product refers to the messages the products convey [31], and the contemporary GAI tools seem to align with this aspect of design, while functional aspects fall into the backseat.

4.2.3 Inspiration. References to needing to find *Inspiration* were peppered throughout the transcripts, and we even detected some subtypes. Almost all participants mentioned potential or actual use of GAI for *Getting more ideas*. Most also identified GAI as advantageous for *Overcome the blank page problem*, with three explicitly recounting exploiting GAI tools to that end. There were also specific references to moodboards, a tool that many design fields often employ for generating associations/analogies and developing the direction of ideation. Indeed, GAI tools can serve these needs:

> When I start ideating the product, I use Pinterest quite a lot. Just to get all kinds of things that are out there and maybe surface finishes – coloring and so forth – and so I started using Midjourney the same way early on. (P10)

This designer's approach of picturing cues about the solution space early on by using GAI, so as to understand the problem and move forward, dovetails with designerly thinking of experienced designers: Ball and Christensen [4] articulated that experienced designers may fluidly advance toward solution generation (even from a highly limited sense of the problem) via conjectures that they generate early on. The extract in which P10 likens Midjourney's value in this to Pinterest's illustrates that flow. Regarding GAI's role in her own work, P9 described liking to use an analogy in which she states

> that I use it as *clay to play with*. I don't have the blank-page fear anymore, [...] I can use it [GAI] to try to understand even complex themes. For example, how to use anthropological ritual theory in a design project focusing on theme X, for example, and it's giving me ideas and not Wikipedia answers.

Later, P9 returned to the analogy between clay and GAI tools, this time in the context of the potency of GAI for *democratizing creativity or skills*, a contribution mentioned by three other interviewees too. These musings also expressed a nuanced view of human impact on the output – since

> everybody has the same amount of clay [the result is] about the way you start forming it. It's gonna look totally different for everybody else.

While GAI can provide inspiration, the bulk of designers' job is still to solve practical problems. Other AI-based approaches may hold greater promise for this than diffusion-based TTIGs. After all, designers operate in conditions that substantially restrict the strategies available to them [6]. Indeed, many interviewees faced highly constrained design environments and assignments:

> I'm not looking for inspiration for the design. Actually I'm just trying to... How can I make this as simple as possible? And there's a lot about, you know, "where are these cables going?" and so on. And at this point I don't see actually the benefit of the AI tool for helping me with that. (P2)

4.2.4 Direction of style. Nearly all participants cited GAI's potential for creating and maintaining a *Uniform style or consistency* of design output, whether textual or visual tone of voice. Pinpointing concerns more specific to our sample, many of the UX designers mentioned design systems and what GAI's inclusion might offer these. While Figma represented a *de facto* standard among tools for UX design and for communicating with clients, with integration into it receiving mention, none of the participants had investigated Figma's GAI plugins at the time of the interviews.

Many mentioned conveying *Feelings and emotions* by means of GAI tools. Although not using Midjourney for his work as a senior UX designer, P8 found benefit in it for his side job as a successful freelance concept artist, portraying it as especially strong in semantic respects:

> If I want to make something that looks like it's from the 1970s and it's a bit, like, depressing or something, I think I can do that pretty well with Midjourney [...]. So if it doesn't have to be so exact but I need to, like, communicate the feeling, I think that that can be done pretty well.

P8 delineated areas where GAI shines and where it does not. He did not consider GAI to work well for convergence toward a synthesized design output, in terms of product architecture; however, his comments above attest that Midjourney can support converging toward a particular style rather well.

4.3 Reasons for Not Adopting GAI Tools

Importantly, the interviews also elicited opinions about GAI tools' restricted utility in design tasks. These limitations hamper their adoption.

4.3.1 Confidentiality issues. Most informants brought up uncertainty about *Compliance* risks as affecting their adoption of GAI. Of the remaining three, two (P1 and P9, who were among the most advanced GAI users), however, had made deliberate efforts to avoid compliance issues. The comments below typify the concerns of the many interviewees who had taken measures to circumvent potential issues. Obfuscating the input was one such mechanism:

> I don't wanna write anything confidential in there, because you don't know where the information goes. (P2)

Some informants had established a practice of redacting sensitive elements of the original text, then developing a draft via text-generating AI, and performing final editing manually – in line with the "clay to play with" approach described above. Another strategy was to exercise care in choosing when to apply GAI, for what purpose. Designers P5 and P7, who had successfully used GAI tools to develop visual and textual descriptions of design personas, opted for fairly generic input to avoid breaching company confidentiality. This often necessitated keeping the scenarios very simple:

> I won't go there, because you never know where it – the content – lands.[…] [Y]ou need to remember that always – That's why it's general stuff like personas. (P5)

Many had tried out GAI systems, with their own money and time, and P10 was the only one with an employer-provided use license. The seven participants working at the same large corporation displayed differences in their practices and among their respective units. Most were reticent to use GAI in light of the compliance risk. On the other hand, P7 freely utilized any system he deemed beneficial, since new technology was central to his responsibilities, which supported appropriation of novel tools. Eagerness was evident also in P6's situation: waiting for the company to provide access to GAI, in awareness that assessing the systems outside one's regular work might not reveal their full potential. While P2 found his leisure-time experiments valuable, he too was waiting for clarity in the company's policies and licensing before embarking on GAI tools' fuller adoption.

4.3.2 Lack of control in convergent phases. Inspiration is characteristic of design's divergent phases, which involve exploring the design space. In convergent phases (which alternate with these), the design space is studied more closely, often in an iterative fashion [32]. Design tools can benefit both, albeit differently [18]. As fruit of black-box processes, GAI tools' output is better suited to the former: in divergent phases, non-explainability may not be an issue, so long as they promote serendipitous insight. The work of many participants concentrated on convergent phases, however – stages in which synthesis from design is expected (see the "Process stages" column of Table 1). Tools centered on GAI face decisive limitations here. One of the most prominent challenges, identified by several other researchers [27, 48, 51], is that they may lack the precision and control mechanisms required for efficient iteration. Our study supports the conclusion that this factor may pose a clear hindrance. All interviewees who had used GAI, either outside work or professionally, described problems with its use in iterative-mode work:

> I […] give some freedom to Midjourney because, of course, you can't control that. […] [T]here are some subjects that I just can't make Midjourney do. I've tried everything, and it's like, for some reason, Midjourney just won't do those. (P8)

4.4 Ownership and Agency

The topic of ownership, at the heart of much discourse surrounding GAI tools, featured in the interview guide in the specific context of the ideas and outputs generated.

4.4.1 Progressive ownership. Most of our informants initially expressed doubt that the GAI output would be "theirs" even if they were responsible for the prompt that triggered the content generation. However, when elaborating on this matter, they indicated that in the course of manipulating the output significantly for sensemaking and for communication-enhancing design artifacts, they started to assume more ownership of the outcomes, and that ownership would start migrating to them.

> If it's an image directly from Midjourney, I don't feel like I own it. It's generated from something that somebody else has done or photographed or whatever. But when I add something of my own to it, my own design, or I manipulate it so that it's just right for the purpose, then the feeling changes. (P10)

The analogy of GAI output being "clay to play with" expresses how, for example, P9 considered it mere material for manipulation to create a valuable output. Pragmatic views too were offered, with accomplished industrial designer P5 saying that the output of the entire project is what matters, not the designer's personal contribution. That is, focus should be placed on the world changing for the better rather than on the designer's contemplation of personal agency and ownership. Current GAI tools has not yet reached such a level as merits reconsidering this ideology:

> If it's like an amazing idea, [ownership] doesn't really matter, but [GAI outputs' quality] isn't at that level yet. (P5)

4.4.2 Peer learning. Ownership of GAI outputs could grow diffused also through technical means. Citing the organization-internal success of a technique not noted by any other participants, P10 mentioned Midjourney's inherent property of having access to the prompt behind every resulting image. This facilitated peer learning among the personnel:

> Everybody can see everybody's prompts. We have a company [Midjourney] license that everybody uses, so I can see every single picture that people are generating and the prompts.
> *Interviewer: Have you learned anything from others?*
> Yeah, yeah, all the little bits and pieces. How to improve the image. And we have also, of course, Teams discussion, which is active all the time, that [addresses] how/what the people are doing and how they are doing [it].

In this collaboration, the prompts of the others in the organization get incorporated into the group-level intellectual work. Simultaneously, they contribute to the quality and uniqueness of the GAI's output.

4.5 Attitudes and Expectations

Next, we consider designers' attitudes and perceptions related to current GAI, along with how they view the future in the design context.

4.5.1 Overall Attitudes and Perceptions towards GAI. In their *Sentiment towards GAI*, nearly every designer manifested both *Positive* and *Neutral or mixed* feelings about GAI tools. Negative emotions were always accompanied by contemplation of the tools' advantages. On balance, participants focused more on the development of technology than on any investment in a negative stance to GAI. Some of them (P1, P7, P9, and P10) had already applied GAI tools in their main job, and P5 had used them for commissioned freelance work. Special enthusiasm was displayed by P1, who concluded that GAI had altered his career track for the better: he had found his budding creativity flourishing after he had obtained his supervisor's support and mastered applying GAI tools. In consequence, he was encouraging others in the organization to apply such systems. The extract below crystallizes sentiments connected with many factors highlighted in our analysis – the nature of creativity and design as bricolage, needs for efficiency, design-space exploration and judgments, storytelling, and understanding of organization-level and other priorities:

> Right now I can make those same composites in half an hour. And I can make another one and another one, and then I can see which one is the best and I can do... I can even ask a few people, right? [...] So for the storytelling part it makes a huge difference, and I think for our department that's an essential part of the research. We spend a lot of time on the storytelling. (P1)

P3, whose job role was more constrained than P1's and who had intentionally steered clear of exploring GAI systems thus far, located her worries in developments toward draconian business realities. Her comments exemplify informants' navigation between positives and negatives as they strove for an emotionally satisfying outcome:

> I'm curious, I can say. I am curious. I will love really to work with something that is going to empower my workflow [...]. Maybe there are companies that – sorry, but... – don't give a **** about that. And then they are like, "OK, just get some, um, computers with AI, and let's do the work and 'Done!'" You know? And... but I don't know. I'm kind of curious, but, yeah, let's see. (P3)

4.6 Speculation on the Future

Many participants' visions of potential applications for GAI demonstrate well-articulated speculation. The *Visions of developments*, thoughts on *Neutral or positive developments*, and less enthusiastic attitudes (about *Risk, worry, or concern*) presented mirrored their general disposition toward GAI tools. With these too, participants were seeking a balanced position. Several of the neutral or positive opinions about developments were directly anchored in practical work tasks, as this comment from industrial designer P5 illustrates:

> [N]ow we get words, we get, like, sentences, we get images. But the day when you start getting 3D data... that changes everything. And if the 3D data is something you can 3D print or use in manufacturing, then it changes everything. (P5)

The designers speculated about several facets of the *impact of GAI*, among them *Democratizing creativity* (cited by 8 participants), *Efficiency gains* (also mentioned by 8), *Competences beyond current skills* (6), *Move of human to more valuable role* (4), and *Automatization of mundane tasks* (4). Improvement opportunities were identified at micro and macro levels both: informants hoped for micro-level quality/efficiency improvements via communication benefits arising from more polished language or better sketching, and they anticipated macro-level output-quality improvements arising from how automation could free time from tedious low-value tasks and redirect it for better use in sensemaking and other areas where humans can most bring value (a possible outcome posited also by Inie et al. [24]). Many of these reflections pertain to *Sensemaking*, *Human lead in sensemaking* in particular. They spotlight the importance of demarcating the roles in the co-creative design dyad of human designer and AI partner.

4.6.1 Concerns. On numerous occasions, informants explicitly referred to GAI tools harming designers' future employment prospects. Their concerns are encapsulated well by these remarks, from a junior participant (a UX intern due to graduate within a year) and an experienced UX designer, respectively:

> I'm kind of worried... [...] there's this really strange market going on right now, and everyone around me who's graduating is kind of stressed 'cause [...] we kind of graduate, they are graduating to, like, a period where a lot of people are unable to find jobs. [...] [H]opefully in the future it would be something that will help us but not replace us. (P4)

> [H]ow would you make this basic flow a bit more, like, inspiring? I think, "Hey, it could work there too." So maybe I'm out of work [laughs], so I don't know. (P8)

Participants also indulged in speculation about GAI tools' *Impact on other professions*, with four suggesting that GAI will exert a negative influence on work life in other fields while their own is going to remain safer. Reflecting on the design field, they often depicted the human contribution to sensemaking as too important to be left to GAI. This seemed to alleviate their concerns.

> It's a hard, hard world, because you need to still sell your service and it takes time to do illustration [...]. Why would you pay for the photographer? (P5)

The two participants with the least design experience were the ones most concerned about their role in the future. In contrast, designers with more seniority cast the human's role in sensemaking as hard for current AI tools to take over. As noted above and discussed below, they perceived this as shielding them from GAI's negative impact.

Many interviewees perceived other, more fundamental risks – to individuals and society – arising from development of AI in general:

> [F]or example, somebody junior to me, in their twenties or something, they don't have this experience.

> They don't have the skills to evaluate the responses in that sense. (P9)

> I think the worst fear is that no one controls the algorithms. No one knows what's actually going on, because it's getting more and more complicated all the time.[…] [I]t will be a super-helpful tool, but, of course, there will be huge risks, so let's see. (P8)

Some of these worries and risks, in the context of *Compliance*, have been touched upon in subsection 4.3.1's discussion of *Confidentiality*.

4.7 Sensemaking

Our interview guide (see Subsection 3.2) helped elicit participants' thoughts on their role and organization, motivations, and processes. The depth of many interviewees' elaboration on what drives their design work attests to a strong aptitude for design metacognition [4]. Their characterization of the desiderata for design sensemaking, among which they included honoring organizational culture, design's legacy, users, and human-centric design principles while not forgetting technological and other constraints, highlights the human designer's role in making sense of an immensely heterogeneous set of design criteria. In the extract below, a senior industrial designer describes that role:

> In [industrial] product design, making some innovative stuff still needs human brains. [GAI] is still new to this, like, emotional connection, […] behavior or something, that you have certain rules [for] how you behave. Your body is working a certain way […]. So I think it's still needed, this kind of, like, experience of what makes sense. (P5)

Almost all participants identified a responsibility in creating designs suitable for *Humans and behaviors*. This is in line with how Núñez-Pacheco and Loke conceive of embodied considerations within desiderata [40]: their analysis found sensibility and somatic understanding incorporated into the design process, for creating meaningful, engaging interaction experiences. Proceeding on the assumption that the human's role is important for designers' line of work (at least for the time being), P5 supplied solid grounding to support *Human lead in sensemaking*. All participants took up this argument in one context or another, without the interviewer asking.

4.7.1 Collaboration. The nature of sensemaking as a social negotiation effort [52] ties in also with the *Collaboration* theme. Indeed, all informants cast their role in a team and organization context, with most referring to their design artifacts as outputs that support team sensemaking. In the extract below, an industrial designer heralds the potential of GAI for improving collaboration in that setting, from the vantage point of a particular disposition toward design:

> To give that communication tool – text-to-image GAI – to collaborators is also a liberator and, of course, something that breaks down this barrier and allows a lot more people to be in the discussion, which is very important. And we're not designing for ourselves in this particular case, as we're designing for other people and other humans. So the more feedback we can get and the better we can understand each other, I think, the better. (P2)

4.7.2 Sensibility. In the context of design, "sensibility" denotes the practitioner's ability to perceive, understand, and work with the needs, preferences, and emotions of the intended users as well as the broader social and cultural context in which the design will be used [15]. Grappling with a wide scope of desiderata, designers apply sensibility to meet people's needs with what is technologically feasible and strategically acceptable. They must, then, develop a sensibility attuned to the design process's many nuances and complexities, to support variability, creativity, and uniqueness in their work [47]. With this plea for other professionals to develop corresponding sensibility, a junior UX designer accentuated the breadth of scope involved:

> [W]e are getting more into this, having more sensibility into these, like taking into account how the user will feel in the different stages of the product. […] [F]or my side and my teammates', we are working hard on this, but it's work with the line managers also. It's, like, non-educational but they kind of have to have this sensibility also. (P3)

Developing somatic sensibility as a design skill can also enhance design by drawing out elements that GAI alone cannot readily reach. Incorporating embodied content into the process and considering the role of the senses in technology [40] meshes with the aims expressed in P5's musings above.

5 DISCUSSION

By studying adoption and adaptation of GAI tools for the design field, we sought to explore topics connected with these tools' application in designers' work, their role in design practice, and designers' attitudes to them.

As we explored the topics identified, an important cross-cutting pattern emerged, related to designers' uneasiness about the tools and how they should engage with the developing technology. In essence, while GAI tools seemed to promise our informants new means for creative design, they entail compliance issues and a need for entirely new kinds of skills. Building on the findings presented in the previous section, we reflect on this double-edged sword below.

5.1 Opportunity vs. Threat

Bringing GAI tools into the design domain demands willingness on designers' part to adapt the methods to the new technology, and it requires them to re-learn some of the profession's core skills. Potential complicated dynamics wrought by such a transformation manifested themselves in several ways in relation to *Actual GAI adoption*, *Speculation of developments*, *Perceptions and attitudes towards GAI*, *Impacting adoption*, *Impact of GAI*, and other codes and topics pinpointed by our analysis.

Our discussion of designers' adaptation to GAI is anchored in the Coping Model of User Adaptation, which has recently been applied to analyze, for example, health-care workers' views of AI [39] and students' adaptation to deployment of digital devices in academic assessment [41]. We found this framework ideally suited to addressing adjustment in the design profession. Grounded in a

transactional model of stress and coping [33], the CMUA captures two distinct reactions, aligned with the user's perceptions of the given technology. Namely, if users see it as a barrier to reaching their goals, a negative response follows and they might choose to avoid (or at least distance themselves from) the technology, but if they view it as a route to desired outcomes, they are likely to embrace it unreservedly in pursuit of anticipated advantages.

According to the CMUA, users conduct primary and secondary appraisal processes when a technology is introduced. These are continuous and recurring. Primary appraisal, wherein users assess the personal and professional implications, results in seeing the technology either as an opportunity or as a threat. Secondary appraisal is focused on the individual's level of control. Beaudry and Pinsonneault, who introduced the model, presented four adaptation strategies that users may adopt through this process: *benefit-maximizing*, *benefit-satisficing*, *disturbance-handling*, and *self-preservation*. The resulting behaviors vary in how much a focus on problems vs. emotions prevails, and the range of possible effects for the individual shows great variety: efficiency improvements, minimization of negative consequences, restoration of emotional stability, and (in extreme cases) even exiting. [5]

5.1.1 Appraising GAI as an opportunity. Participants differed in their primary and secondary appraisals of GAI. Several leaned toward perceiving it as a threat (especially P2, P3, and P6), while most saw it as an opportunity. As is commonplace [5], appraisals of the impending change were not binary: the interviewees weighed up both sides of the picture. As the CMUA predicts, those who saw themselves as possessing greater control – designers with more seniority or demonstrating well-articulated design metacognition (P1, P5, and P7–P10) – had made the effort to develop in relation to the technology independently. They exhibited primarily problem-focused coping behavior [5]; i.e., they attempted to manage the disruptive event itself, by learning and applying the technology. Having experimented with GAI and its capabilities, they became less worried about it, and they embraced what efficiency/effectiveness potential they saw in GAI. Benefit-maximizing behavior prevailed among these users (especially P1, P7, P9, and P10), whereas P5 and P8 exhibited satisficing, by actively developing their GAI skills/awareness in private while hemmed in by concerns about compliance and a lack of employer-provided tools.

Though neatly categorized under the model, these appraisals were nuanced: the assured, experienced designers joked sarcastically about their future in the long run as human designers, suggesting that perceptions of both short-term opportunities and long-term looming threats informed their primary appraisal. Furthermore, any one interviewee's perspective may fluctuate, through the recurring reassessment at the appraisals' heart.

5.1.2 Appraising GAI as a threat. The designers lowest on the totem pole, whether by experience or by role, expressed anxiety induced by the changes. And, indeed, none of the three (P3, P4, and P6) had tested out the technology beyond very limited practical trial use, if at all. Monitoring developments from the sidelines, they were taking a self-preservation strategy to adaptation, aimed at restoring personal emotional stability. For example, P3's contemplation of her concerns (see section 4.5.1) identified both opportunities and threats but ultimately led to self-preservation behavior focused on controlling her emotions: she sought colleagues' opinions and read content on the Web while gaining no first-hand experience. According to the CMUA, negative primary appraisal rarely culminates in personal-efficiency gains. It can lead even to "signing out." Relatively inexperienced but articulate industrial designer P2, who was concerned about the technology, demonstrated an alternative approach. Where P3, P4, and P6 engaged in primarily emotion-focused behaviors in their response to the impending changes, P2's reaction was more problem-oriented. His strategy mixed disturbance-handling and self-preservation, in that he had evaluated the systems' development over time (even paying for a Midjourney trial license twice), identified concrete use cases for GAI in the interview setting (see section 4.2.2), and actively read even philosophical works on AI yet still fell short of embracing the technology fully, citing the employer's lack of the necessary guidance, policies, and tool provision – which had led to a reduced sense of control. Not attempting to reap efficiencies by applying the technology at work, and considering the organization, underutilized motivation and potential, is an unsurprising outcome here.

Some interviewees who were apprehensive of GAI had felt motivated to join our study by a desire to develop their views of the technology in their efforts to restore their emotional stability.

5.2 Sense of Control As a Pivotal Factor

In secondary appraisal, the individual's control over the situation is judged with respect to work, self, and technology [5]. In the event that the user perceives sufficient control over the event, significant potential exists for positive outcomes. We argue that mature ability to describe one's role, skills, and contribution to the profession (i.e., metacognitive skills) may affect this appraisal as much as formal position does. With the advent of GAI, compliance concerns, murky policies, and lack of access to the evolving tools might well exacerbate a sense of eroding control and, thereby, cast shadows over even appraisals by those who, by dint of their skills and attitudes, could be valuable change agents for their organization. Under the CMUA, detrimental adaptation strategies may follow, as witnessed to some degree in our study. Our findings "rhyme with" those of Li et al. [34], in whose study senior UX designers did not perceive GAI as a major threat on their own account but did see risks for inexperienced peers. In a recommendation consistent with our view of metacognition's role, Li et al. proposed that training could help mitigate any potentially negative impact of GAI on the intrinsic motivation so crucial for design – and for well-being. As the assessment of situation by users is recurrent, learning should be continuous, and timely. The employer of P10 demonstrated one fruitful technique for organic learning for organizations: creating a company-wide peer-learning environment by supplying Midjourney licenses and making all prompts and output accessible to every designer. On the other hand, when left to their own devices, some interviewees had actively explored GAI on their own initiative while the three most worried (junior designers) had not.

With the unfolding of a potentially revolutionary technology event – which introduction of GAI most definitely is – organizations that delay their decision-making push employees toward emotion-focused behavior and less active adaptation strategies. Sub-optimal outcomes are bound to arise. Hence, other studies of AI's adoption

in the workplace have identified clear support from the organization as vital [41]. Temporal developments at the time of our study proved revealing in this regard: in mid-2023, the companies were scrambling to prepare policies/guidelines and beginning to seek suitable GAI software providers, and their employees were reacting. Some, especially the more junior ones, were already growing anxious, while senior designers felt restricted by the organization's unclear situation. We witnessed how, irrespective of this lack of official support and clarity, GAI-based systems can form effective, inexpensive foundations for peer learning and inspiration. Such structures decrease anxiety and can unlock the doors to efficiency benefits from GAI in design.

5.3 Limitations and Future Work

Sample size of ten interviews suits reflexive thematic analysis pending on sampling principles, the level of analysis, and the objectives of the study [10]. However, it does not allow for making exhaustive conclusions between the different subgroups of participants. A further study applying CMUA to a larger data would allow for this. The insights of this study and e.g., that of Li et al. [34] could reveal insights of this aspect relevant for also other emerging technology events.

Knowledge building via reflexive thematic analysis, as many other qualitative approaches, depends on researchers' disposition, experience, and epistemological choices. We have aimed at openness about our dispositions, following the recent practices regarding RTA, describing the grounding of findings openly, while avoiding confusing the reporting with quantitative reporting due to our selected qualitative approach. In Figure 1 we present the resulting codes and code-groups from our coding.

Our study took place when GAI had not been widely applied by designers, while the potential was already much debated, in public and professionally. CMUA can be used to assess situation prior, during, and after technology-events [5], and it should be interesting to apply the model to a study after some further adoption of GAI has taken place.

Research on use of visual artefacts in design has a potential to add granularity to understanding on designers' use of text-to-image GAI systems for abductive sensemaking. Ashrafganjouei and Gero found that visual constraints can lead designers to focus more on solution, and that they spend time in interpreting the visual constraints as parts of a design solution [3]. Biskjaer et al. explored how task constraints influence the strategies used in searching for inspiration identifying focused search, exploratory search, and opportunistic search [6]. Our selected study method does not provide sufficient data to analyze in detail the use of visual constraints, but it can be addressed with e.g., applying a protocol study.

6 CONCLUSION

Our contribution to design scholarship and practice coheres around the results of our exploratory study applying RTA to interviews with 10 practitioners working in the industry. The constellation of topics that we identified, concentrating on strategies in designers' adaptation to GAI, opens paths to rich discussions. Our analysis of the findings under the Coping Model of User Adaptation points to the importance of increasing designers' sense of control via cultivation of a stronger metacognition of their work and practical exposure to emerging AI tools. Clarity of company policies and guidelines, access to software, and the creation of a constructive peer-learning culture can form a solid support structure that fosters sense of control and agency.

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