THE PSYCHOLOGICAL EXPERIENCE OF USER OBSERVATION

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ABSTRACT
While scholars have studied what design practices accomplish, few have considered the psychological experience of practicing design and the implications for completing their work. An eighteen-month ethnographic study of a high-tech firm examined the psychological experience of design work, specifically how people experience user observation. The study finds that when people observe others in context, they engage in a state of exploration. Regular observation supports curiosity, or the tendency to focus attention and seek answers to unanswered questions. Focused attention fosters commitment to the design problem. Results suggest how design work practices can be designed to help employees to reduce anxiety about the unknown, an inherent feature of the design process.

Keywords: Psychology of design; user observation; design practice; design cognition; job design

1 INTRODUCTION
Scholars describe design as a learning process [1-3]. People construct new knowledge through user observation that yield insights; insights support frameworks, which inspire ideas that lead to innovative solutions [3]. Through this process, people construct knowledge [4], moving back and forth from the analytic phase of design, which focuses on finding and discovery, and to the synthetic phase, which focuses on invention and making [1]. Building on Kolb's experiential learning theory, Beckman and Berry [3] describe knowledge creation through the design process as movement between concrete experiences and abstract conceptualization, reflective observation, and active experimentation. Kolb's experiential learning theory [5] focuses on how knowledge is created by transforming experiences - when a person carries out a particular action in a particular setting, reflects on the effects of that action, attempts to understand those effects, and then modifies actions to accommodate new ideas. Inductive and deductive practices support the construction of new knowledge that designers use to shape the environment in ways that did not previously exist.
Given that design is a learning process, scholars have studied what knowledge is gained when people engage in popular design practices such as user observation [6, 7], brainstorming [8, 9], sketching [10-12] design documentation [4] and low-fidelity prototyping [11, 13, 14], yet few scholars have considered how people feel when engaging in these popular design practices. Even fewer have investigated how people feel when engaged in design practices in a work context, as opposed to a laboratory study. Understanding what work is accomplished and how workers feel about the work is critical for organizations that rely on motivated and satisfied workers to complete the work outcomes necessary for success [15, 16]. This paper explores the experiences of a thirty-five member team at a large high-tech firm as they practiced user observation to design and develop globally-distributed digital products. More broadly, this study is concerned with **how people psychologically experience the construction of knowledge while enacting design work practices.**
When people construct new knowledge, they initially experience uncertainty, or a state of being in doubt, because the final outcomes are not yet known [17]. The experience of uncertainty is mediated by perceptions of control and fear of failure. Peoples' experience of uncertainty depends on their perception of their ability to control the uncertain conditions [18]. In uncertain conditions which promote high control, individuals experience increased intrinsic motivation, greater interest, less pressure and tension, more creativity, more cognitive flexibility, better conceptual learning, higher self-esteem, more trust, and greater persistence [19, 20]. In these environments, they are more likely to be proactive and take action in the face of setbacks [20]. In contrast, in uncertain environments that promote low control, they are less likely to experience these positive outcomes and engage in productive creative work in the face of setbacks [21].

Design scholars find that designers embrace the uncertainty to create new solutions not yet identified by others [22], but what they do to embrace the uncertainty is not clear. More recently, researchers propose that designers adopt design practices such as low-fidelity prototyping to promote control in the face of uncertainty [23]. When prototyping, practitioners break larger tasks into modest size tasks, allowing them to take frequent action. By taking frequent action on manageable tasks, practitioners experience small wins by observing their impact and attributing success to their actions. This paper similarly employs a psychological lens to understand the how people feel when observing others in context and how this practice may help to reduce anxiety about the unknown while designing.

2 METHODS

The mid-range theory is grounded in an eighteen-month ethnographic study of 35 member team in a large software firm, "Big Tech," and in pertinent behavioral science. Big Tech's product development efforts are multi-national and the firm's products and services are sold throughout the developed world. This study focused on the "Green Team," a team charged with working with a diverse set of teams throughout the company to apply a design process which emphasized user observation as a way of quickly realizing insights about users to inform design decisions.

The Green Team initially formed in September 2004 due to senior management concerns about product usability and development time. For the first three months, I observed the members of the corporate strategy team researching and preparing for the development of the team. A design consultancy firm specializing in the user-centered design process taught a six-member team through active hands-on coaching with the expected outcome of innovation, a process called, participant innovation [23]. The hands on nature of participant innovation stood in contrast to an innovation consulting engagement typically delivered by traditional management consulting firms in which consultants either present power point decks on process or manage work independently of the client so the client is less actively involved in learning new skills.

After this initial three-month trial and training period, the board officially approved the creation of the team to use the user-centered design process to positively impact the company's revenue generating products, processes and services. I spent the remaining 15 months of my study observing the Team develop its 35 member team, solicit projects upon which to apply their design process, and coach internal teams through their user observation based design process to drive innovation throughout Big Tech. During the observation period, the team worked on eight distinct projects, however no products made it to market during the observation period. While the team's stated goal was to create at least 3 user-centered designs to positively impact revenue in the first year, by the end of the observation, no products had been introduced to the market. However, during user-testing products, users described products as more user-friendly than existing products offered by the firm. In this way, the user observation practice did influence the products pre-production, however market impact was not unknown. Despite not meeting the stated goal, the Team remained committed to enacting the user-centered design process.

2.1 Research Design

As is typical with grounded mid-range theory building, which are inspired by an empirical phenomenon and then blend theoretical research to formulate a theory {Merton, 1957 #486}, I initiated this study with open data collection, rather than specific hypotheses about what was to be found [4]. After initial data collection, I searched for emerging patterns and followed the most interesting and promising patterns [5]. I collected data from the time the team was introduced to the design process and observed them applying the process to over 15 products and services. Primarily, case studies are conducted retroactively, relying on reflection. The advantage to this research approach is the ability to collect real-time longitudinal data; the disadvantage is that biased is introduced through participant observation [6]. I observed the Team one day a week over the 18-month period (September 2004-March 2006), writing detailed transcripts of conversations I heard and interactions I observed between the Team's members, its users, clients, partners, and stakeholders. A typical visit entailed informal and formal conversations with team members as well as observation of formal and informal meetings about design projects throughout the day. I watched the teamwork on projects at different stages of development and asked questions about how and why they were using various work practices such as user observation, prototyping, and brainstorming. Throughout the observation, I cultivated relationships with all team members – discussing the development of the

team and adoption of design practices. I was welcomed to observe all meetings throughout the 18-month period except for three meetings pertaining to employee compensation; moreover, the company provided me with space in the Team office area, allowing me to observe the naturally occurring team interactions, work practices, and day-to-day activity. The office area had an open office plan with making it easy to observe most interactions and the outcomes that resulted from their work. Throughout the observation period, I understood the majority of the technical content discussed by the team as I had worked in a related industry prior to becoming a researcher.

I began this study with a broad research question: "What is the psychological experience of practicing design?" I chose qualitative methods to explore this question because I did not want to unnecessarily constrain my emergent framework by precisely identifying and operationalizing variables before data collection began. Following guidelines for inductive research [7], I wrote descriptive accounts of my observations of team members both engaging in the practice of user observation and discussing observations with colleagues until major themes emerged such as, curiosity, control, and uncertainty. Following guidelines for developing well-grounded theory [7], I clustered these phenomena into larger conceptual categories determining strength of the evidence by frequency of occurance. Simultaneously, I read pertinent literature to understand existing theory and to uncover related phenomena. Moving between inductive and deductive thinking, I began to develop my emerging conceptual framework, linking the work practice of user observation to the observed phenomena. This iterative process allowed me to develop initial inferences about the psychological experience of enacting user observation. I continued to validate my theory against the data by reviewing all relevant data and compiling evidence and evaluating the strength of my evidence to inform whether I should modify or abandon my inferences based on insubstantial evidence. Following Strauss and Corbin's [7] guidelines, I flip-flopped between data and theory to construct an evidence-supported theory of how people experience control in the face of uncertainty through the enactment of the user observation practice.

2.2 Data

Throughout the study, I used qualitative methods to gather data from multiple sources to inform my inferences about the informants' experiences of observing users in context. By gathering data from multiple sources, I had multiple measures of the same phenomenon, avoiding the potential problem of construct validity within a single case [24]. The framework was strongly supported by the convergence of multiple, independent observations. These sources can be divided into six categories: observed meetings, observed strategic off-sites, observations of employees observing users in context, semi structured interviews, team generated materials, and externally generated materials related to the practice of user observation. When my data collection ended, I had accumulated 484 research hours.

3 DESIGN PRACTICE: USER OBSERVATION

Design researchers have identified user observation, or the observation of people in context, as a critical activity in the design process [25]. User observation allows practitioners to inform ideas based on real human activity in context. When observing users, practitioners create new knowledge about the most appropriate solution for the identified problem at hand [26]. Researchers distinguish user observation from user testing which is concerned with ideas before they are fully formed rather than testing ideas ready for production. With user observation, individuals construct new knowledge quickly by observing users in their actual context rather than bringing them into an artificial laboratory to discuss their habits and preferences. The aim is to spend time with users rather than in time in isolation of users generating ideas [26] These insights are used to inform the next steps of their design process. For practitioners, much is understood about the role of user observation in helping individuals and teams make decisions about future directions throughout the development process. However, few academic studies consider the individual's psychological experience of rapidly realizing insights and constructing new knowledge through user observation.

Consistent with the research on user observation, Green Team members described the usefulness of user observation in gaining information to inform the next steps in their design process. One team member described user observation as "the source of innovation" in their design process because demonstrated explicit and implicit user needs.

4 PSYCHOLOGICAL EXPERIENCE OF USER OBSERVATION

Drawing on psychological research, I present a mid-range theory to explain how the practice of user observation allows practitioners to remain committed to the design process despite uncertainty about final outcomes. I propose that curiosity is triggered through regular exploration supported by the user observation. Regular exploration exposed practitioners to new information and alerted them to the presence of gaps in their knowledge. Exposed to gaps in their knowledge, individuals were motivated to use the work practices to continue to explore, seeking knowledge in order to close these knowledge gaps. I propose that by using user observation to satiate curiosity, the practitioners' anxiety about the unknown was reduced.

The curiosity mechanism is largely informed by Loewenstein and Litman's conception of curiosity. According to Loewenstein [27], curiosity is a form of cognitively induced deprivation. This deprivation arises when an individual perceives a gap in his or her understanding of a situation or when "one's informational reference point in a particular domain becomes elevated above one's current level of knowledge" [27: 87]. In this state, individuals are motivated by a desire to know, see, or experience. According to Litman [28], this desire motivates "exploratory behavior directed towards the acquisition of new information" (793). People are motivated to act in ways that close the information gap to experience the pleasurable anticipation of closing the gap [29].[1] Practitioners of the user observation practice exemplified this knowledge gap conception of curiosity.[2]

Practitioners often initiated a project using the user observation practice. Through this practice, practitioners routinely perceived gaps in their understanding of human behavior and used the practices to gather information to close these knowledge gaps. Nancy, a member of a four-person team, enthusiastically described her first experience of identifying a knowledge gap and seeking knowledge to close the gap through the user observation work practice.

> "The first time … we observed a team meeting in their conference room. We watched the team as they interacted/collaborated about product and content issues. We watched what they did and…recorded with videos and photos. We were flies on the wall this time. So we came in not knowing anything. We were excited to be there, though throughout the observation we constantly came up with questions we just wrote down. This first meeting left us curious with lots of questions that we later asked in interviews. This experience generated a lot of questions for us that we needed and wanted to answer to understand our 'users'. We felt the need to know more."

In the description of her experience observing users in context, Nancy described her transition from "not knowing anything" to seeking answers to her team's newly formed questions. She described the first observation as raising questions, or identifying knowledge gaps. These questions motivated her team to return to the site to conduct follow-up interviews to answer their questions or to close the knowledge gap. Nancy's team "needed and wanted" to gather more information. This behavior supports the knowledge gap theory of curiosity in which individuals are motivated and gain pleasure closing knowledge gaps [28].

Nancy and her team's initial exposure to unknown information through the user observation practice triggered an initial devotion to the practice. Nancy then expected the work practices by which the questions were raised and knowledge gaps were identified to also close the gaps by providing answers to her questions. For this reason, I propose that Nancy's reliance on the user observation practice to both open and close knowledge gaps reduced her anxiety about the unknown.

The work practice served as a means for both realizing and satiating curiosity. Loewenstein posits that people are likely to expose themselves to curiosity-inducing situations if they feel they will gain pleasure from the experience of gaining information and satiating their curiosity [27]. He describes this voluntary exposure to curiosity-inducing situations as a gamble because in these situations, it is not necessarily clear that once curiosity is piqued, new information will be identified to satiate one's

[1] A major distinction between Loewenstein's (1994) and Litman's (2005) model is that Loewenstein proposes that curiosity is motivated by an adversiveness to not having information whereas Litman suggests that people derive pleasure from seeking information to satiate curiosity. Litman's claim is most consistent with my data.

curiosity. In this way, Nancy and her team gambled with their approach. Through the practice of user observation, Nancy and her team could have only identified gaps in knowledge and not been able to generate solutions to close the gap. As was regularly the case with the user observation practice, the payoff was greater than the knowledge deprivation initially experienced during the initial observation. Researchers explain this need for closure as motivated by a desire to reduce cognitive demands allocated to searching for the answer. The need may be heightened when the perceived benefits of closure are positive (such as under time pressure to meet a deadline or when the process is arduous) and weakened when the perceived benefits of closure are negative (such as fear of making a costly judgmental mistake) [30].

4.1 Curiosity Inducing Stimuli

Awareness of information is an antecedent to experiencing curiosity [27]. Exploration supports an awareness of new information [17]. During data collection, the user observation practice supported regular exploratory behavior, continually exposing practitioners to new information. For example, during user observation, practitioners discovered how people, other than themselves, felt and behaved in a natural context.

The user observation practice also revealed new information and made practitioners aware of the information they do not know. Practitioners were exposed to knowledge gaps through regular exploration, combating the tendency for them to become overconfident and underestimate the extent of the gaps in their knowledge [e.g. 31, 32].

Researchers propose several conditions under which individuals are exposed to curiosity-inducing situations. In these situations, curiosity inducing stimuli alert people to the existence of an information gap [27, 33]. My data suggest that the user observation practice supported two of these identified conditions and alerted practitioners to the existence of an information gap. The first condition occurred when an individual was posed a question that made him aware of the information he was missing. And the second condition occurred when an unexpected event occurred and unexpected information was revealed [27, 33]. In my data, these conditions regularly occurred through exploration.

4.1.1 Awareness of Missing Information

Next, I offer specific examples in which the user observation practice exposed practitioners to each of the curiosity-inducing situations described above, although in reality, the conditions more often occurred simultaneously. In the first condition, questions are raised making individuals aware of the information they are missing [27, 33]. Unable to answer a question, individuals become aware of their knowledge gap and seek information to fill it. Curiosity researcher, Berlyne [34] referred to these questions as “thematic probes.”

When practicing user observation, the Green Team developed “thematic probes,” raising specific questions about how people behaved and how related products and services were designed to fit their needs. The questions made practitioners aware of missing information and motivated them to seek information to answer the questions. During a project related to improving the subway navigation for first time users, the Green Team members gathered information through user observation in context. The team spent the day in teams of three observing passengers locating, entering, travelling on, and leaving the subway. Armed with new information about the situation, the Green Team returned to their office to post their observations from the subway system. The participants noted their observations on post-it notes and stuck them on the walls of the room in which they were brainstorming ideas. Based on these insights, team members began to generate ideas. With each additional insight and idea posted, participants became aware of the breadth of possible ideas by raising new questions. Over the course of one hour, the participants generated approximately one hundred ideas by building off of each other’s ideas. The brainstorms elicited ideas the participants called “wild” and “surprising” ideas. The user observation combined with the brainstorming practice allowed my informants to answer outstanding questions as well as generate new questions to be answered. In this example, curiosity was strengthened by the public nature of the work practices. By getting people to publicly commit their ideas, individuals become more engaged and curious in the outcome [35, 36].

When individuals make hypotheses and receive accurate feedback to confirm or deny their hypotheses, curiosity increases [27]. If individuals did not receive accurate feedback, individuals would not experience the satisfaction of reducing cognitive deprivation. Members of the Green Team often made hypotheses about how people would behave and then tested their hypotheses using the user observation practice. When observing elderly at the shopping mall, Greg, a Green Team member, described his satisfaction with the experience of testing hypotheses and receiving feedback about his ideas.

> "We went to the shopping center… [it was] eye-opening. Eye-opening. I remember it was hot out there, and I was talking with people, strangers that I never thought I'd ever talk to. [He laughs.] And I was amazed how much information they would share. So, I had elderly people, and my hypothesis was how can you make it a better shopping experience for elderly people? Well, you get onramps for their wheelchairs and stuff, and easier parking, and I couldn't be further from the truth. These guys are not going there for shopping, they're going there to hang out at a classy place. So, what you got to do, you got to make it a more classy place to hang out. It's not about shopping, it's really about, you know, little yellow benches and shade trees and stuff where people can hang out and spend their time and buy an occasional coffee. They're not there to go to Bloomingdale's only. We even saw people, you know, the body language. They would have their hands stuck, you know, pushed into their belts so they couldn't even touch anything there. Kind of solely window-shopping, but don't buy anything. [He laughs.] Eye-opening. I was thinking, wow…I thought I knew it all and you learn something new."

In this excerpt, Greg described his excitement of asking questions and seeking answers for why people behave as they do. Rather than being embarrassed about making false assumptions, Greg proudly acknowledged that his assumptions about how and why people behave the way they do was inaccurate. His excitement was around the process of discovering new information in response to a question being raised rather than knowing all of the answers. In this way, curiosity-inducing situations, as fostered through the user observation practice, supported pleasurable experiences. Empirical research supports this finding. When an individual is confronted with unexpected, new information, he or she often experiences pleasantness followed by curiosity [37].

4.1.2 Violation of Expectations

A second way in which curiosity is induced is when individuals experience a violation of expectations. This violation of expectations makes people aware of the information they are missing - leading them to search for explanations to make sense of their environment [33]. Drawing on work by cognitive psychologists, Hastie [33] explains that unexpected events are processed differently than expected events and that the unexpected events will be recalled more easily than expected events [38]. This is because unexpected events will be linked to relevant scripts, or knowledge structures [39]. These links are connected with distinctive tags which are shown to be more easily remembered on recognition tests [33].

Frequently when enacting user observation, practitioners experienced curiosity when their expectations were violated. User observation routinely set up situations for practitioners, who may have been familiar with a situation, to have their expectations violated. Before observing users in the field, team members publicly stated all of the things they thought they knew about the project to be completed. By making their assumptions about the project explicit, they identified the personal bias of their assumptions. Through this activity, the team members aimed to clear their minds of their expectations for what they'd observe so that they could observe "as if they were seeing something for the first time." In this way, participants were more likely to have their expectations violated when they were observing unfamiliar topics. Practitioners were encouraged to pretend as if they were from another planet visiting earth for the first time. The logic behind this advice was that if a participant had little knowledge of human behavior, they would have fewer schemas upon which to rely and their awareness of new information would increase. When overconfident, individuals underestimate the extent of what they do not know [e.g. 31, 32]. With this approach, the practice of user observation made the mundane seem novel even to practitioners who were intimately familiar with the situation being observed.

For example, when the Green Team observed users in a familiar setting, they were continually surprised by how users behaved. After spending the morning observing people use the subway ticket purchasing system in a metropolitan center, members of the Green Team collaborated with an internal team at Tech Co. to generate ideas about how to improve this experience for subway users. Together, they shared their findings from the user observation practice. Examples of observations recorded in the notebooks they carried included: "Travelers with luggage – hard to keep an eye on luggage and look for money, purse, grab change, etc.," "Pick-up window is too small. Ouch! Hands get stuck in ticket drawer," "Exit Turnstile – suit case a problem. It's too narrow – more time required to get through turnstile," and "Ticket machine asking for 'Credit Card or ATM' but machine takes ATM only." Each observation illustrated the ways in which the participants' expectations were violated. This violation of expectations led the participants to identify gaps in their knowledge about how people engaged with the ticketing purchasing system. They generated questions about how people engaged with a system that was difficult to use. Although participants initially predicted the observation site would be uninteresting as many were familiar with the location and didn't perceive the ticket machine as problematic, the site became a subject of great interest during the three-hour observation period. They were quickly captivated by their initial observation that first time subway users were challenged when purchasing tickets. They remained in the subway, observing users and interviewing subway facility managers to learn more about how and why the system worked as it did – or to close the gaps in their knowledge. The time passed quickly and when they were asked to return to the office to generate ideas about how they could improve current conditions, some were hesitant to leave the observation site because they felt they could still learn more about why people behaved the way they did. The data suggest that the presumed familiarity with the observation site enhanced the sense of expectations being violated.

Research finds that individuals experience surprise, or a sharp increase in neural stimulation [40] when their anticipation of an experience differs form the actual experience [41]. This situation may be characterized by a high degree of pleasantness and self-assurance [37]. Members of the Green Team frequently reported being pleasantly surprised by unexpected events that occurred when practicing user observation. When observing a man using an electric ticket machine, Mary, a member of the Green Team, was surprised when she saw that the man's hand was too large to retrieve his change from the return bin. Mary excitedly motioned for her observation partner to come to the machine to observe the man's behavior and the machine's design. Mary was surprised by this unexpected event so much so that she became solely focused on this unexpected situation. Research suggests that when a familiar schema for how things are supposed to work is broken, individuals try to make sense of the situation [33, 42]. The need for closure is motivated by a desire for the eschewal of ambiguity [30]. When making sense of a situation, surprise serves to void ongoing emotion and cognition so individuals can respond to the stimulus situation [40].

Empirical research finds surprise often leads to curiosity because surprise clears the nervous system of ongoing activity in order to explain the stimulus situation [40]. This finding supports a Green Team manager's observation about the role of user observation in stimulating interest in the methodology. Despite the costly nature of the practice, the Green Team manager described the practice of user observation as being critical to fueling people's devotion to the methodology because the process made them aware of "how blind they are to the world around them" and inspired people to open their eyes and look more closely at what they take for granted. As a long time member of Tech Co., he believed that he and his colleagues were so familiar with the internal perceptions of Tech Co.'s products that exposure to external perceptions of Tech Co.'s products routinely surprised them. He argued that the "magic" of the user observation practice came from paying attention to unexpected user behavior and being intrigued enough to want to learn more. Another informant described surprise leading to curiosity when he saw "old things in new ways." According to him, "It [the observation practice] awakens people that this is the world we live in, which we are often ignorant of." The informant's observation is supported by empirical research that surprise is associated with exploration, curiosity, and knowledge-seeking [43, 44].

4.2 Seeking out Curiosity Inducing Experiences

Voluntary exposure to curiosity inducing experiences is described as a type of gamble [27]. Before exploring, a person must guess the likelihood that his or her curiosity will be satiated. If a person

expects to be left in an aversive state, exposing him or herself to the curiosity inducing experience may not be worth the gamble. If a person expects to experience a satisfying closure, exposing him or herself to the curiosity inducing experience may be worth his or her while. When people voluntarily seek out seek out experiences that initially create information gaps, they have a high expectation that they will be able to derive pleasure from satisfying their curiosity [27]. During a semi-structured interview about how and why the informant engaged in user observation, a Green Team member explained, "…by conducting generative end-user research, the information … will feed into the design in a way that it provides value add above and beyond what you think you know." The assumption was that the practice of observing people in context would inevitably reveal knowledge gaps and lead to satisfying discoveries. In this way, user observation strongly supported both knowledge seeking and fulfilling behavior described by Loewenstein [27].

Cialdini [45] offers the example of mystery and cliffhanger novels as voluntary exposures to curiosity inducing experiences. Mysteries are powerful because they "initiate the wonder," creating a need for closure and then creating the opportunity for closure. "All of us have heard of the famous 'Aha!' experience," Cialdini notes, "Well, the 'Aha!' experience becomes much more satisfying when it is preceded by the 'Huh?' experience." The process of setting up and resolving mysteries is similar to the process of scientific investigation: people identify a question or pose a mystery, generate hypotheses, and test the implications or consider alternatives to explain the mystery, collect evidence or provide clues to inform the proper explanation for the mystery, and derive a satisfactory resolution or resolve the mystery [45:24-27]. During a training workshop for user-centered software products, Green team members explained to attendees that they should expect to be extremely confused when first observing people in context – as if they were "visiting an alien planet." Further, they explained after iterating through the practice, they should expect to experience distinct and satisfying moments of insight and control over what was previously perceived to be an ambiguous problem.

4.3 Continuous Curiosity

The data suggest that the Green Team's curiosity was typically sustained throughout a project by the quick iterations between the work practices, allowing participants to gather new information and adjust their informational reference point. Curiosity was often captured upon initial initiation of the observation work practice. The Green Team experienced curiosity as generated by the violated experiences realized when enacting the process. When questions raised by the novel experiences were not immediately resolved, Green Team members repeated the work practices to find explanations for the questions initially raised. Project typically began with team members leaving the Tech Co.'s campus to visit unfamiliar users in their work environments. This practice of leaving Tech Co.'s campus violated the normative expectation that all "work" be completed on campus. As described earlier, by leaving the office, the Green Team members were more likely to encounter unexpected situations because they were in an unfamiliar context observing the routines of people they didn't know.

This initial violation of expectations was sustained during the actual observation. Practitioners continued to have their expectations violated as they observed either the familiar in an unfamiliar context, or the unfamiliar in a familiar context. In either case, the contrast of the familiar with the unfamiliar heightened what they did not know. Throughout an observation, members of the Green Team asked themselves questions like, "Why do people do what they do?" and "How could their life be improved?" highlighting specific knowledge that they were missing. Observations revealed novelty in human behavior that may have been previously viewed as mundane. The first observation teased participants about what they didn't know, identifying knowledge gaps and causing them to continue to observe in order to gather more knowledge. Subsequent observations gave practitioners at Tech Co. the sense that they were making progress to close their knowledge gaps.

For example, David's experience collecting new information changed the perceived size of his information set and led to continuous curiosity. David, a Green Team member, described his experience of observing colleagues struggling to get useful feedback on the graphic designs they created. The experience raised questions for David about how people gave feedback, leading him to further observe how people gave feedback to his colleagues. He observed people printing out hard copies of the graphic designs and sticking post-it notes on the printouts. He reported being surprised by this behavior because he expected them to make their edits directly on the soft copy. He reported

becoming curious about why people behaved in this way. In other words, he identified a gap in his knowledge about why people behaved in the way they did. This gap in knowledge led to further observations in which he learned that the people giving feedback liked the affordances of post-it notes. This initial curiosity led to his interest in Tech Co.'s technical capability to make a tool that made giving feedback to Tech Co.'s user interface design work easier. Although not formally sponsored by Tech Co., David continued to work on the project. He began prototyping ideas for how to get feedback on graphic designs quickly. He searched for ways in which other systems elicited feedback and observed how people used a popular web site called "Hot or Not" to vote on people they thought were attractive. He also observed how people used sticky notes to make their comments on hardcopy written drafts. In response to this knowledge gathering experience, he and a colleague made several prototypes to test possible solutions. One prototype he made allowed individuals to make extensive comments on line – similar to the way in which sticky notes were used to offer comments on written drafts. Another prototype allowed individuals to just give a positive or negative rating of their idea - similar to the way he observed users voting for their preferences on the "Hot or Not" website. David described his extreme interest in manipulating components of the prototype to see which design would most successfully satiate the need. He tried many ways, eager to figure out which method would be most effective. In this example, David experienced multiple curiosity stimulating conditions including a violation of expectations and question raising [27, 33].

David's behavior is supported by empirical research that suggests that as people gain knowledge, rather than becoming less curious due to fewer gaps, people may become more curious [27]. Later in the year, David reported observing watching senior management printing out reports from their computers and saving them in paper files rather than filing the reports in folders on their computers. He reported being surprised by their paper based system because Tech Co. emphasized paperless work processes for employees. Although the user observation practice was typically scheduled at the beginning of a project, people were encouraged to always be observing people's behavior and in particular, people were encouraged to be attuned to unexpected behaviors. In this case, David was not formally "observing" senior management, however this surprising behavior caught his attention. He had identified a knowledge gap: he knew his company advocated paperless work, yet senior management often printed out hard copies of their online reports. Noticing this behavior, he continued to observe how senior management and others interacted with online and offline interfaces. At the time of writing, this Green Team member continued to collect data and make notes about people's use of online printouts, building his knowledge about this type of behavior – a behavior previously unfamiliar to him.

Despite repetitive engagement with the methodology over the course of a year and half, the Green Team remained committed to the process for knowledge seeking and satiation. Their interest in the process was sustained when coaching internal team members and learning how they interpreted the work practices. In one example, the Green Team accompanied a team of Tech Co. developers in Beijing onto the streets to observe how individuals use transportation software. Upon their return to the office, both the Chinese developers and the Green Team reported their findings. The Chinese developers reported intriguing findings about the people they observed on the streets of Beijing, and the Green Team, who were coaching the Chinese developers through the methodology, reported their surprise about the Chinese developers' approach to the practice. The Green Team members who were culturally American were surprised by how easily and comfortably the Chinese developers approached strangers on the street to ask them about their use of transportation software. The team members revealed a cultural knowledge gap between how they expected the developers to behave versus how they behaved. In this case, the Green Team members shared new insights about what they previously conceived of the user observation practice, a practice about which they thought they knew a great amount. They shared new insights about the cultural differences in approach behavior and suggested ways that the Green Team could learn about how other cultures initiate conversations with strangers. The knowledge gap revealed the extent to which the Green Team members assumed all cultures behaved similarly around strangers. After realizing their assumption, the Green Team was motivated to close the knowledge gap by learning more about cultural differences in this domain. After this experience, the Green Team demonstrated increased curiosity and attention to noticing different cultures' comfort interacting with unfamiliar people and places. Through teaching the user

observation practice to others, the team increased their commitment to the process as a way of overcoming uncertainty.

5 DISCUSSION

This paper offers an explanation for how individuals manage the uncertainty inherent when designing – or creating new knowledge and shaping the environment in new ways. This paper proposes that individuals who engage in user observation encourages regular exploration. Regular exploration gave practitioners the opportunity to become aware of information – specifically providing opportunities for knowledge gaps to be created and filled. The information-gap perspective of curiosity purports that individuals seek out information that closes the knowledge gap [27] and that the elimination of the gap in knowledge is inherently satisfying [28]. Individuals continually realized and satiated their curiosity through interactions with users. In this way, individuals managed the uncertainty of the design process.

This lens is unique in the design literature supports a growing stream of research that considers studying the psychological experience of enacting design practices in a work context [21]. When the design process is viewed as a learning process in an organizational context and from the perspective of the practitioners, questions are raised and how the practices are experienced and additional outcomes are realized – such as reducing anxiety and commitment to the design process in the face of uncertainty. This study suggests that when enacting the user observation work practice, user feedback and decision-making may not be the sole effectiveness outcome. While user observation may not always be resource efficient, as it may demand costly resources to enact, it may be effective at accomplishing other organizational objectives such as commitment to a design process and giving control in a highly ambiguous situation.

Identifying outcomes beyond the traditional effectiveness outcomes is consistent with Sutton and Hargadon's [46] study of brainstorming that found six additional consequences of practicing brainstorming not previously examined in the experimental literature. In addition to the expected outcome of generating ideas, brainstorming supported the organization's memory of solutions, provided skill variety, supported an attitude of wisdom in and outside the session, created a status auction that maintained a focus on designing products, and impressed clients and generated income. Together, this research contributes to a growing body of work that explores how psychological outcomes are supported at work [22] and also highlights the importance of studying work practices in an organizational context, rather than in a laboratory setting. Finally, it extends research on the user observation practice beyond a consideration the role of user observation in eliciting user feedback and in decision making. By extending the research on this design critical activity, user observation, we can better understand the design process at large.

5.1 Implications for Design Management

This research study suggests ways in which individuals can manage design work in uncertain conditions. The design process, like other innovation processes, does not systematically result in marketplace innovation, and when it does, this feedback comes long after the design process has been enacted. Although employees may initially be persuaded to pursue an innovation process because of successful implementation of the process in other organizations and interest in doing "something new," this motivation may not be sustainable [47]. Over time, employees may express uncertainty about the effectiveness of the innovation process if they do not benefit from the day-to-day enactment of their work practices. As first intimated by Hackman and Oldman's work on job redesign [16], managers may actively design employee work experiences by using behavioral science theory to evoke cognitive, emotional, and behavioral reactions from employees. User observation is an important and useful work practice that delivers immediate knowledge to employees who are tackling challenges with great uncertainty. Increased knowledge about work increases worker satisfaction and motivation, reducing likelihood for costly worker turnover [48]. Managers may adopt and design work practices, such as user observation, to which employees are committed so they experience intermediate benefits before formal outcomes are realized. While adoption of such practices may initially face resistance due to barriers such as existing corporate culture or the skills of the workforce, the appeal of the psychological outcomes: reducing anxiety, increased control, self-efficacy are broad and may potentially mitigate resistance. More research is needed to understand the psychological experience of the practices across cultures.

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