Intersecting with Unaware Objects

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ABSTRACT
We adopt a design-oriented approach aimed at motivating and expanding the notion of everyday creativity beyond explicit interactions to also include the implicit, incremental and, at times even, unknowing encounters that emerge among people, technologies, and artifacts over time. We explore these ideas through the design and investigation of two interaction design research artifacts: the Photobox and table-non-table. Through analyzing and synthesizing insights that emerged across our studies, we describe a related set of concepts in support of a more implicit form of everyday creativity, which includes: unaware objects, intersections and ensembles. We conclude by interpreting findings in context of prior implications for everyday creativity and outline considerations for future work.

Author Keywords
Unremarkable Creativity; Unawareness; Interaction Design.

INTRODUCTION
Investigating people's practices of transforming and adapting design artifacts in everyday life is an important and ongoing focus in HCI and interaction design research. A range of observational studies over the past several years have revealed how people engage with everyday objects in creative, innovative, and emergent ways that often extend well beyond what they were originally designed for. These empirical works are diverse and grounded in different conceptual framings, such as appropriation [3], customization [12], everyday design [26,2], and organizing systems [24]. They nonetheless share the goal of describing and analyzing people's actions to make design artifacts better situated to their evolving practices and desires through what may be described as everyday creativity.

A core aim of this paper is to investigate further the idea of everyday creativity, a notion that has been of growing interest in the Creativity & Cognition community [e.g., 2,18,26]. Our approach builds on the assumption that creativity is at the heart of the dynamic changes of people's everyday experiences and actions [23,24]. However, in contrast to earlier efforts, we take a research-through-design approach [21,27] that explores everyday creativity through the making and situating of interaction design artifacts. Through this approach, we focus on a radically reconfigured understanding of the relations between users and design artifacts that finds creativity to be a quality shared in the emergent configurations among people, artifacts, and the environment they are situated in.

Our goal is to take a step toward expanding the notion of everyday creativity beyond explicit interactions or purposed manipulations to also include the implicit, incremental and, at times, unknowing encounters and relations that emerge among people, artifacts, and environments over time. In our view, investigating such considerations can contribute new insights into design strategies that might better support the meaningful and situated integration of interactive technology in everyday life.

To support our investigation of everyday creativity, we describe the design of a type of interaction design artifact that emphasizes actuality over functionality, which has neither an explicit interface nor computational awareness of its owners presence or actions. We refer to these interaction design artifacts as *unaware objects*. As a result of studying these objects in-situ we developed a notion of post-functional engagement with design artifacts, which we term as *intersections*. We found that as intersections accumulated around a unaware objects, unique and dynamic configurations of artifacts, contexts and human actions emerged, which we refer to as *ensembles*.

Specifically, we examine two interaction design research artifacts, named Photobox and table-non-table, which aim to explore the notion of a more implicit everyday creativity. We individually deployed and studied each artifact in several households to gain rich accounts of people's experiences of living with them over time. The ways in which unawareness manifested in Photobox and table-non-table differed, but nonetheless opened both artifacts up to being understood, resourcefully drawn on, and incorporated into people's lives on their own terms.

In the sections that follow we synthesize insights that emerged across our experiences of developing and studying these design artifacts. Based on our analysis, this paper concludes with a discussion of the key features of unaware objects as creative resources, unique ensembles, and unremarkable creativity. We also explore implications for emphasizing actuality and post-functionality as a means of creating new design artifacts to support everyday creativity.

BACKGROUND AND RELATED WORK

Related work falls into three areas: everyday creativity; human-technology relations; and emerging works in the materiality of interactive technologies.

Within the Creativity & Cognition community, the notion of everyday creativity is strongly rooted in prior research related to everyday design. The basic premise behind everyday design is that everyone is a designer and, in this way, people creatively and constantly appropriate and transform objects around them. The term everyday design originated from a study of families where a type of emergent, shared creativity supported household members' navigation of daily activities through the routine repurposing of common objects—a process described as *design-in-use* [26]. Here, the notion of 'design' is comprised of a shaping of their worlds in an ongoing fashion to better address their unique needs. Some aspects of this study resonate strongly with Taylor and Swan's [24] research on families' evolving development of domestic systems that bring order to their lives. They argue that technologies ought to be designed as resources to support the complex ways people socially organize their homes. Tolmie et al. [25] also observed the social organization of families at home and articulate the need to make technologies as unremarkable as the domestic routines themselves. These related concerns have also surfaced in movements in the humanities to conceptualize everyday life as an essential site for sociomaterial creativity [e.g., 23].

Later studies in everyday design expanded focus beyond routines to a diverse activities, such as analyzing the materials, meaning and competences that comprise everyday design [e.g., 2] as a form of social practice [20]. A range of other works also shares some of the same core commitments to supporting everyday creativity that everyday design holds. Dix [3] champions designing for appropriation, noting: "whilst you cannot design for the unexpected, you can design so that people are more likely to be able to use what you produce for the unexpected" (p. 28). Relatedly, Gaver et al. [6] articulate ambiguity as a worthwhile strategy for fostering personal relationships with technologies in ways that "provide rich resources for experience that can be appropriated by users" (p. 233).

We aim to extend this research further by articulating nuanced and often indirect or incremental forms of everyday creativity in relation to notions like ambiguity, appropriation, the unremarkable, and design-in-use.

The need to foster creative, self-determined uses of design artifacts reflected in the works above is emblematic of a broader shift in the HCI community toward taking more seriously the complex ways technology shapes everyday life and, ultimately, mediates between humans and their actions in the world. Various works have migrated to perspectives outside of HCI, such as the philosophy of technology [4,16], to critically explore the nature of relations that form between humans and technology. Drawing on the works of Albert Borgmann, Don Ihde, and Peter-Paul Verbeek, Fallman [4] advocates for the design of computational objects that are more open to people forming relations to them that reach beyond explicit purposes or utility. This imperative is well articulated through Maze and Redstrom's [13] assertion that crafting computational objects requires researchers to "investigate what it means to design a relationship with a computational thing that will last and develop over time—in effect, an object who's form is fundamentally constituted by its temporal manifestation" (p. 11). On a high level our work aims to generatively engage philosophical notions of human-technology relations in ways similar to Maze and Redstrom's proposal. We aim to explore how the design strategy of unawareness and the concepts of intersections and ensembles might offer constructive ways of expanding how researchers and designers approach creating interactive technologies that might persist in people's lives over long periods of time.

In parallel to growing interest in adopting philosophical and temporal framings to understand computational objects and their social effects, there has been a growing turn within the HCI community toward critically considering the material basis of interactive technologies. While these works are diverse and surface in and outside of the creativity literature, they are united by a central concern to unpack the complex ways that materiality—the things computational objects are made of—shape experiences and interactions with them. Jacucci and Wagner [10] reveal how material features of interactive technologies speak to people's "multiple senses" and shape the character of creative actions with them. Rosner and Ryokai [18] have illustrated that materials in technology can blur the boundaries between digital and physical interactions in the context of creative material practices, such as knitting. Gross et al. [8] have argued for the need to refocus attention on how materials mediate relations to tangible interaction artifacts in the service of better leveraging their creative potential in design. More broadly, there exists a growing number of works investigating how materiality shapes interaction with design artifacts [7]. Our work aims to modestly extend this discussion of actuality and materiality in computational artifacts by analyzing design exemplars, like the Photobox and table-non-table. These exemplars emphasize materiality to support lived-with qualities and emergent engagements that are implicit, incremental, direct and reflective.

CONCEPTS AND EXPLANATIONS

The concepts of unaware objects, intersections, and ensembles developed from our studies of the Photobox and table-non-table. Importantly, these are not *a priori* concepts. They emerged through critical reflection on the conceptualizing, designing, and analysis of our two design artifacts. Thus, this paper provides a space to consider findings emerging across the Photobox and table-non-table from a higher-level perspective to articulate these related concepts. However, for readability, we briefly describe each concept upfront to preface our subsequent reporting and analysis.

Unaware objects are intentionally designed to enact their respective behaviors without requiring nor demanding the attention of their owners. They execute preset computational processes and, in this sense, operate entirely unaware of their owner's presence or actions. These objects have no explicit output functions based on interaction with them and they lack any kind of traditional 'interface' or control mechanisms. Our use of the term unaware in this context owes specifically to the fact that these objects are designed to be computationally unaffected by direct interactions (unless of course if they were to be unplugged).

Intersections refer to people's ongoing incremental encounters with a design artifact in which a modification or transformation may or may not occur. While interaction often involves direct manipulation of an artifact, intersections can range from experiences of being mindful of the artifact, to subtle uses of the artifact that may be only briefly noticed (or go unnoticed), to piecemeal re-situations of the artifact within its physical context. Intersections can be treated as complementary to interaction, but are notably more general in their aim to account for the broader range of known and unknown, incremental and ongoing encounters that unfold with computational and non-computational objects alike in everyday contexts.

Ensembles manifest through cumulative intersections. As intersections accumulate, qualities emerge that go beyond the individual artifact, often becoming experienced among an ensemble of things and people within their local environment, such as the home. This concept is influenced in part by Alexander's [1] earlier discussion of the notion of ensemble, where he writes: "when we speak of design, the real object of discussion is not the form alone, but the ensemble comprising the form and its context." (p. 16). In this sense, the quality of everyday creativity is achieved at the level of ensembles through the holistic relationship of artifacts, contexts, and human actions. In this way, an ensemble is a dynamic collection of social and material elements within an environment that can become increasingly unique and nuanced over time.

THE PHOTOBOX AND TABLE-NON-TABLE

The Photobox and the table-non-table are two interaction design research artifacts developed through a research through design [21,27] approach that embodies *unawareness*. While they differ in terms of their materials and behaviors, they both draw on familiar forms of actual objects: a chest and a table. In conceptual terms, analogue objects like a chest or table can be seen as cousins of unaware computational objects. Like almost all analogue objects, a chest or a table does not have the computational processes to sense or detect data, nor do they provide interfaces or control mechanisms to interact with another thing (or a representation of another thing). Like most analogue objects, unaware objects are designed with people in mind and, so while unaware, they are not independent of people. However, unaware objects differ from their analogue cousins in that they have computational features. Furthermore, these features and their effects are often distinct from more traditional or common computational artifacts in that they offer people no control over the computational processes that are enacted. These design qualities may seem counter-intuitive to supporting everyday creativity. However, as we describe, the Photobox and table-non-table emerged as significant objects once they accumulated a range of intersections and became embedded within unique ensembles in people's homes.

Photobox

The motivation for the Photobox emerged from research on the rapidly growing generation and use of personal digital content to capture life experiences (e.g., photos and videos). This primarily included qualitative studies of people in their homes with an eye towards their practices and workarounds to construct meaning with these digital materials (see [15] for an overview). One overarching theme across the studies was that the rapid proliferation of digital materials was leading to experiences of overload. As digital archives grew larger, it became difficult for people to get a grasp on what they contained and how to engage with them as an everyday resource. A secondary motivation centered on the growing need to investigate designing new forms of technology that are potentially more capable of having a more enduring presence in everyday life [9,13,16].

Motivated by these observations and issues, the Photobox was developed as a conceptual artifact to theoretically and practically explore how a computational object could critically intervene in experiences of digital overload. We targeted digital photos because they remain one of the most enduring forms of digital content, and they continue to rapidly proliferate. Inspired by the *slow technology* design philosophy [9], we wanted to explore how slowing down the consumption of digital photos might support experiences of reflection on people's digital materials and also on the Photobox itself as a domestic technology. A portion of findings from research on the Photbox appears in an earlier article [14] that emphasized future opportunities for digital photo consumption. In this paper, we move beyond our original motivations to articulate how

intersections and ensembles were evident in people's experiences of the Photobox.

The design and deployment of Photobox

The two main components of Photobox are an antique oak chest and a Bluetooth-enabled Polaroid Pogo printer (which makes 2x3 inch photos). We decided to use an oak chest as it presents a familiar form with a simple interaction (i.e., it can be opened and closed; things can be kept inside of it and taken out). We decided to use a printer because it produced a simple material form (i.e., a paper photograph) that was open to a range of potential uses. All technological components were embedded in an upper panel in the chest. The printer was installed in an acrylic case that secured it to a small opening in the panel to allow a photo to drop onto the central platform of the box (see Figure 1).

Photobox's behavior is enacted through a .NET application, which runs on a laptop that wirelessly connects to the embedded printer via Bluetooth. At the start of each month, Photobox indexed its owner's Flickr archive and randomly printed four or five photos that month. In similarly random fashion, it selected four (or five) photos and generated four (or five) selected timestamps that specified the print time and date for each photo; at print time, the matching photo was printed. Photobox's behavior was designed to make it difficult for the owner to anticipate when it would 'act' next and what might be that action. The computational process never changes and Photobox as an interaction object is extraordinarily simple.

Figure 1. Clockwise from top left: An oak chest before it was augumented; Upper panel (open) where printer components are hidden; Photobox can be opened to see if a photo has been printed; Photobox lived in the corner of Samuel and Shelly's livingroom.

Three Photobox design artifacts were deployed in three households for fourteen months respectively. Household A consisted of a married couple in their mid-40s Tim and Britt; Household B of five roommates in their 30s: Heather, Zack, Thomas, Jenn, and James; and, Household C of a couple in their mid-30s Samuel and Shelly. Each Photobox was tied to a household member's Flickr account, which ranged from 2500-4500 photos. Few details were provided about the Photobox when it was installed other than it will occasionally print the owner's Flickr photos. Bi-monthly interviews were conducted with households to record participants' experiences with Photobox (during these times additional paper was loaded into the printer). All of the field data presented in this paper are taken from in depth final interviews when participants reflected in depth on the range of experiences they had with the Photobox.

Photobox: experiencing unawareness

After initially being installed and syncing with its owner's respective Flickr archive, the Photobox operated on its own, unaware of the actions of those around it. Nonetheless, it led to intriguing and unexpected experiences across households. When describing Photobox, participants often contrasted it to other digital technologies in their homes: "*It doesn't look like technology, I can't do anything to it, there's no buttons, but it is connected to Heather's* [Flickr] *account on the web and occasionally does something. It is very peculiar. It definitely grew on me over time.*" (Zack). Similarly, Samuel describes how the unawareness of Photobox gave it a sense of 'otherness' compared to more familiar devices: "*With technology, it's either on or off. If it's on, you're probably using it. ...When it's off, it's basically worthless. It's not doing anything. ...In the end* [Photobox] *never really seemed that way. Since it's doing what it wants when it wants. It's hard to even tell when it actually is printing. It feels different and that's what makes it easy to open up or forget about for a while. It stayed mysterious the whole time* [we had it]."

Additionally, Tim reflects on how unawareness produced a less constraining, even somewhat relieving effect: "*My Phone is always pinging me. ...someone's tagged me, or I got a new GroupOn. ...it keeps going and I do feel compelled to check so I don't miss anything. ...*[Photobox] *didn't try to change for us. No matter how many times I opened it, it's not going to affect it. ...It's awesome to find new photos, but* [Photobox] *doesn't make me crazy to run over and check it every time I get home. ...I can walk past it. I can come back later. ...in that way it has quite a different character.*"

Collectively, these reflections help illustrate how Photobox's lack of any control mechanisms paired with a difficult to anticipate yet ultimately enjoyable behavior helped distance it from the kind of relations its owners associated with other computational technologies in the home. Interestingly, Tim's statement highlights how Photobox could be noticed and interacted with, or fade into his material and perceptual background, which imbued it with a distinctly 'different character.' In the next section we expand more on how a variety of intersections to accumulated around Photobox.

Intersections with Photobox

Intersections with Photobox ranged from simple material actions (e.g., opening and closing the chest, or rearranging in relation to other domestic artifacts or places) to purely reflective actions (e.g., contemplating the Photobox as a

thing and its meaning in one's life, or simply glancing at it and moving on). These actions occurred on a mundane basis, and as Photobox became absorbed into its local environment, it would shift in and out of perceptual view of household members. For example, Tim described how, after returning from a trip, his Photobox became obscured by various objects on and around it: "*I set down a stack of magazines on it. …it* [Photobox] *had become just another thing. …Three, four weeks later we finally moved everything back to their proper places. All of a sudden I realized I should check it and I found three photos. …from different times in our life. …It was delightful to happen across it like that*." Later Shelly remarked: "*…we can leave it for a while and stumble across it and then there's these snapshots. …It's surprising* [that] *the feeling of living with it is really pretty natural.*"

What we want to highlight here is how the Photobox emerged as a computational object capable of triggering a spectrum of experiences. These ranged from simple, at times unrecognized, actions that happened on and around the design artifact to extraordinary direct encounters. This range of intersections supported the Photobox's emergence as a fixture that could be resourcefully drawn on within households when desired. Eventually, it developed into a computational object with natural, lived-with qualities, like "just another thing" in the home.

Figure 2. From left to right: Britt's Photobox brought an ensemble of artifacts "into harmony." Heather reflected on Photobox in relation to other domestic technologies in her home.

Another important dimension of the concept of intersections is that as they accumulate, the computational object itself can become embedded within an ensemble. One of the most striking examples of an ensemble involved Britt's eventual actions to move and arrange a ceramic pitcher made by her father and a framed picture of her parents close to the Photobox (see Figure 2). She described the ritual that emerged around these things: "*Whenever it'd* [sic] *print a photo of them* [parents]*, I'd take a little time, look at it and the* [framed] *photograph and put* [the printed photo] *in the pitcher Dad made. Kind of as a ritual to remember them and to keep all those memories together. …it brought all these things that belonged together into harmony for a moment. …Getting one of them* [a printed photo of parents] *was always wonderful. …But, after a few months all of them* [objects] *together, just being there, made that part of the living room much more significant than it was before. …over time it came together into something that left quite an imprint on our home.*"

This instance is exemplary of Photobox's emergent capacity to draw other artifacts into relation within an ensemble, which in Britt's case, led to an emergent ritual that was well situated within her home.

Photobox also led to intersections with ensembles in less direct, unexpected ways. In this example, Heather described how the Photobox's juxtaposition to gaming systems provoked her to consider her relation to them: "*…the GameCube itself doesn't matter that much. There's no value in it aside from playing games. …Sometimes, sitting in here, I'll be thinking* [Photobox] *is unusual around these systems. …Like, it being there can be inviting, I can look in it. …or sit on the couch, think about what already* [printed] *or what could* [be] *printed. …Or that it's a bizarre thing but also a very intriguing thing. Sometimes it catches my attention and I get lost thinking about this stuff. …The point is that it's not used in the same way like the* [GameCube]. *It can't be. …it feels like it can settle in down there. The other stuff around it, feels like they'll be gone sooner than later.*"

Heather's reflection helps illustrate how Photobox became integrated into an ensemble in her living room. Its unawareness and material presence opened it up to be mindfully intersected with, which led Heather to curiously consider her relations to other devices in the ensemble. On a deeper level, her statement revealed how, once situated within the ensemble, Photobox started to be perceived as a distinct computational object—one that she could imagine persisting beyond other technologies whose value was largely associated with their utility.

table-non-table

The motivation for the table-non-table emerged from research on everyday design, which primarily included ethnographic studies of people in their homes and various other everyday practices [e.g., 26,2]. In an attempt to move beyond this empirical work, the table-non-table was developed to theoretically explore, from a design perspective, what could comprise an everyday design computational artifact and what its effects might be. The design of the table-non-table was also informed by theories of social practice [20]. Given this, we aimed to create a computational artifact that could be aligned with the competences, materials, and motivations of everyday home life practices. Stacked paper was used as a core design element due to its familiarity as a material, its flexibility in terms of potential uses, and because the simple practice of stacking paper were extremely simple assembly and disassembly techniques. Lastly, we aimed to explore how computation embedded within this simple artifact could help mediate the resourcefulness and social practices of people—everyday designers—in their daily lives.

The design and deployment of the table-non-table

The table-non-table is a slowly moving stack of paper supported by a motorized aluminum chassis. The paper is common stock (similar to photocopy paper). Each sheet

measures 17.5 inches by 22.5 inches with a square die cut in the middle to allow it to stack around a solid aluminum square post that holds the sheets in place. There are approximately 1000 stacked sheets of paper per table-non-table, which rest on the chassis about one half-inch from the floor. The chassis itself rests on four small steel balls. Set toward the center of the chassis hidden from view are two wheels attached to motors that are connected to and controlled by a customized Arduino board. The chassis and motors are strong enough to support stacking heavy objects on it including a person sitting or standing on it. The paper sheets can easily be removed and manipulated like any sheet of paper. We experimented with several variations of movement from a continuous and slow movement (1 revolution per minute) to short periods of movement (5-12 seconds) occurring once during a longer period of time (a random selection between 20 to 110 minutes). We settled on the latter version for its final form. The movement pattern is random yet it stays within an initial radius of less than half a meter square. The movement can be almost imperceptible, taking up to several days to a week to notice.

The table-non-table became part of one household for five months, became part of two households for six and three weeks respectively, and became part of two households in a preliminary deployment for several days. The households included thirteen people in total (eight male and five female) ranging in ages from early teens to mid-50s. In the longer deployments, households were recruited by word of mouth and knew nothing of the project. In the preliminary study, households had some prior knowledge of the project. In the longer deployments, participants were given the table-non-table and a card with instructions on how to post photos and comments about their experiences to a blog on tumblr.com. In the table-non-table deployment we adopted a speculative approach rather than a formal user study or evaluation. Our aim in the deployments was to bring our concept artifact into existence in lived-in environments. Methodologically, our interests were in the reporting of people's subjective encounters with the table-non-table. We were less interested in conducting an analysis of their behaviors with the artifact. As a result, our interpretations rely on photos of encounters and commentary that participants shared with us on tumblr.com and also in home interviews. The table-non-table deployment differed to some extent from the Photobox study in terms of methodology, yet mirrored many of the findings in terms of unawareness, intersections, and ensembles.

table-non-table: experiencing unawareness

The table-non-table required no attention after finding a place for it in participants' homes and plugging it in. Regardless if its movement was noticed, it continued to move as it was programmed. The stacked paper was free to be removed, however this too had no impact on its behavior. This apparent incongruity between the materiality of the table-non-table and its computational features emerged in a participant's attempt to connect the stacked paper with an interface function: "*The whole electricity feature is pretty strange. The thing is after all a pile of paper. Paper involves a type of use that is somehow incompatible with being electric. ...It's almost like removing a sheet of the pile 'unplugs' the piece of paper. Which doesn't make much sense.*"

This statement highlights how the table-non-table's materiality created ambiguity and a sense of unfamiliarity around its expected behavior and, more generally, around it as a computational object. In an attempt to make sense of the table-non-table, the participant speculates, although doubtfully, that the stack of paper could be a tangible interface to turn the table-non-table on and off. On a higher level, the rejection of the table-non-table as a tangible interface can be attributed to the perceived unequivocal actuality of the table-non-table in which it is "after all a pile of paper." This helps illustrate that the table-non-table is an unaware object in that its qualities are independent of human attention, and further, the actuality of its material composition problematizes its potential role as a user interface in any kind of traditionally recognized sense.

Similar to the Photobox, the table-non-table has no awareness of its environment. It has no sensors and no input functions. Its movement is very circumscribed in terms of area, which prevented it from colliding with furniture and walls. In essence, the table-non-table was a benign and unintelligent object. Despite this, participants assigned it with distinct and unique perceived qualities. For example, in one household when it was found under furniture the participants described it as "*The thing slowly hiding under the couch.*" In another instance, when the table-non-table was placed under a Christmas tree: "*The prototype is pretending it's a gift under the Christmas tree.*"

What we want to draw attention to in these statements is that while the table-non-table was unaware of its environment in having no computational sensing capabilities, and it was designed to not require human attention, it developed a deeply textured relationship within households as it was perceived to have abilities such as to "hide" and "pretend". Like the Photobox, the table-non-table's unawareness counter-intuitively created qualities of interactions, perceptions, and relations that were rich and, at times, distinctly different in comparison with other computational objects.

Intersections with table-non-table

The table-non-table led to several intersections in terms of simple material actions and everyday reflections. The table-non-table was particularly open to simple actions that people may not have been fully aware of when the intersection occurred. Many instances emerged that consisted of simply placing objects on top of it. For instance, the simplicity of stacking a glass and ceramic mug in Figure 3 is a good example of this common intersection.

Unaware objects are designed with intersections in mind rather than being incidental outcomes. In this way, both in form and behavior the table-non-table easily accommodated simple actions like objects being placed on top of it.

Similar to the Photobox, as intersections accumulate over time, the artifact may become embedded in an ensemble of artifacts. For example, figure 3 illustrates how intersections emerged among the ensemble of things brought together by the table-non-table, which included a stack of books, and a coffee thermos. In this simple ensemble, removing a book or shifting the thermos to one side was as much an intersection with the book, thermos and table-non-table together. Within ensembles, the computational artifact is seen in relation to other things, including analogue objects.

Figure 3 (from left to right). Stacking a glass and mug on the table-non-table is a simple intersection; A collection of objects considered together within an ensemble.

These documented examples help further illustrate the material nature of intersections, which are simple and demand little attention, and that the table-non-table achieved its goal of supporting these kinds of simple actions. Like the Photobox, intersections with the table-non-table also cumulatively developed into intersections with ensembles of things. The examples above show an ensemble in which the table-non-table directly interacts within an ecology of objects that must be considered and made sensible together.

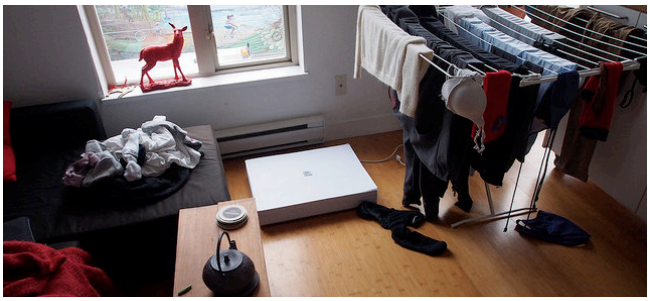

Figure 4. The table-non-table within an ensemble that triggered mindful consieration of its relation to other artifacts in the home.

Many other examples of ensembles emerged as the table-non-table settled into an easy cohabitation with other material artifacts in the home (Figure 4). While there was an understandable peculiarity about the table-non-table, participants reported it generally called no more nor less attention to itself than the other objects nearby. Here, we describe the table-non-table within an ensemble to show not only the nature of this type of intersection, but also to further emphasize that intersections are as much reflective in nature as they are action-oriented. For example, it was within the broader context of an ensemble that caused one participant to notice for the first time that the table-non-table moves. He noted that his "*architect eyes were unhappy to see that the thing was always crooked and not parallel to the couch!*" He soon realized that despite his efforts to align the table-non-table parallel to the edge of the couch, it would move itself out of alignment.

Interestingly, intersections emerged among non-human members of households too. For example, a family's cat found the surface of the table-non-table inviting and familiar, making good use of it as a bed. Yet simultaneously it became an artifact of curiosity and worthy of exploration (see figure 5). One participant noted that the "*cat noticed before us*" that the table-non-table moved. Soon after the cat played with the table-non-table, family members used the paper to make large snowflake Christmas decorations.

Figure 5. The family cat uses the table-non-table as a bed; The cat plays with the paper in the table-non-table; A large paper snowflake is made from table-non-table.

This example illuminates several key aspects of intersections. First, we saw in our households that intersections with unaware objects are not exclusively by humans. This particular instance is exemplary in how it shows simple intersections by a cat catalyzed richer and more involved intersections and, ultimately, creative actions by people in the home. Despite the simplicity of intersections, the cumulative and collective experiences of them can lead to rich complexities. Further, in this example, we can see how simple computation, like the random movement of the table-non-table mediated a level of curiosity that led to a chain of intersections, first by the cat and then by people that grew in richness and complexity with each link in the chain.

DISCUSSION AND IMPLICATIONS

Through a design-oriented approach we aimed to build on and extend prior research on everyday creativity by exploring how it emerges over time as a type of implicit relationships, incremental encounters and engagements.

While we acknowledge the broader context of research on everyday creativity, we found the implications for interaction design articulated in earlier works on everyday design and creativity [e.g., 2,25] to be a useful point of reference for further analysis of our findings. The relevance of this approach is that these earlier works resulted from empirical analyses that anticipated the challenges and opportunities in designing interaction design artifacts that better leverage everyday resourcefulness and creativity. In our own design efforts, we found resonance with key aspects of these implications including artifacts as creative resources, uniqueness, and the unremarkable. Our current work extends these implications through a generative, design-oriented perspective with added precision, nuance, and utility for interaction design.

Unaware objects as creative resources—The quality of unawareness paired with careful choices in form and materials set the stage for intersections to accumulate around our design artifacts and for ensembles to emerge. The lack of an interface and control mechanisms in our design artifacts catalyzed broader concerns that reveal how they operated as creative resources. We found unaware objects led to direct creative engagements, such as the ensemble Brit created in configuring a framed photo and an ceramic pitcher near the Photobox to commemorate her father, or the chain of encounters that resulted in the making of snowflakes from the paper of the table-non-table.

In other cases, reflective engagements that were interpretive illustrated a form of creative rethinking of everyday encounters, such as Tim's reflections on the relief he found in how Photobox's subdued background quality produced a distinctly different character compared to his phone that frequently "pings" him and demands a level of constant attention. Or, how a participant curiously queried the electronic aspect of the table-non-table's stack of paper, which had no obvious switch or interface. We also found mindful intersections led to considerations of creative juxtapositions and self-determined understandings in interpreted relationships among things, such as Heather's momentary attentive reflections on the differences between the Photobox and the nearby gaming consoles. Or, participants' acts of endowing anthropomorphized qualities to the table-non-table as a thing 'hiding' under a couch or 'pretending' to be a present under the Christmas tree.

Ultimately, the unaware nature of Photobox and table-non-table enabled them to be lived-with yet remain open-ended over time. These resulting higher-level qualities appeared crucial to their ability to facilitate routine intersections that eventually accumulated into creative actions and encounters. In earlier empirical work, we saw that common objects could be recast as creative resources to be appropriated [26]. Through our design-oriented approach we have articulated engagements with our design artifacts that go beyond appropriation in ways that are more nuanced and multi-dimensional including creativity that is reflective, mindful, direct, and emergent across complex connections of things and things, and things and people.

Unique ensembles—The creation of ensembles in themselves are a series of intersections that can lead to a unique ecology of computational and analogue things within the home. This occurred as design artifacts became situated to other people, things and the environment through ongoing reconfigurations. We highlighted several such ensembles with the Photobox and table-non-table that were distinct and particular, whether momentary or longstanding. These ensembles exemplified how everyday creativity developed over time as social systems, routines and practices emerged around design artifacts and, in several cases, they became sedimented fixtures in daily life.

Earlier work has focused on a more human-centric notion of uniqueness in which systems and routines formed uniquely as a result of *explicit* human actions [2,16,24,26]. We see our work as expanding this perspective by incorporating the complexities of ensembles and a more distributed set of relations that gives equal prominence to artifacts and the surrounding contexts they help construct and occupy, as it does to human actions. More broadly, the notion of unique ensembles extends works illustrating the value in crafting interaction design artifacts that can drift in and out of perceptual view in the home as relations to them evolve slowly and subtly over time [5,9,14].

Unremarkable creativity—Combining the quality of unawareness with relatively common forms and materials enabled the Photobox and table-non-table to oscillate between being perceived as alien and familiar. Striking this balance was essential in enabling people to creatively speculate on and determine the meaning(s) of these things and their situation to everyday life in an ongoing, unselfconscious manner. Unremarkable creativity in this case led to a range of intersections that spanned the unknowing, the mundane, and the extraordinary.

This feature relates strongly to earlier work that referred to unremarkable affordances as an implication to follow in interaction design [26]. In this prior work the term 'unremarkable' was borrowed from Tolmie et al. [25], who argue for unremarkable computing for everyday routines. The difference with our current work is that while we can design unremarkable attributes into unaware objects, the *unremarkability* often extends beyond the artifact to include the intersections and ensembles that exemplify the type of implicit everyday creativity we aimed to explore and develop. We see the broader relational nature of unremarkable creativity as a means to catalyze future design efforts where choices in form, materials and behavior can be framed in terms of their capacity to be situated to and resonate in a lived-in environment over time.

DESIGN CONSIDERATIONS

Collectively, our findings suggest several considerations for the design of new interaction design artifacts. In what

follows, we detail two opportunity areas that emphasize actuality and post-functionality as higher-level strategies to guide future generative work aimed at supporting everyday creativity in the interaction design community.

Emphasizing the actuality of computational objects– As a result of this research we found that designing to emphasize the *actuality* of computational objects presents an intriguing and underexplored strategy for supporting everyday creativity. In referring to the actuality of computational objects we aim to emphasize the material existence of an object. Here the object is not an interface to something else, but an actual thing itself. In fact, unaware objects point to the incompatibility of viewing an artifact simultaneously as an actual thing and as an interface. This was evident in one participant's perception that it was nonsensical for a "pile of paper" to require electricity. Without knowing at the time that the table-non-table moved (hence the electricity), he considered the stack of paper as an interface to turn it on and off. However, this made no sense to him since the table-non-table already existed as an actual thing, "a pile of paper" that did not mediate a reference to anything else. It was also clear that Photobox's lack of a traditional interface shaped its emergence as a distinct material entity that, across households, attained a unique character often perceived as qualitatively different from other domestic technologies.

These examples and others illustrate how emphasizing the actuality of computational objects extends the potential for various kinds of human-technology relations to emerge and shift over time. In our view, a key reason for this is that as a computational object is recognized as a distinct thing in-and-of-itself, the nature of a person's relation to it may extend beyond being predicated solely on its utilitarian value or practical purpose. Over time a person might leverage her competences to draw on the design artifact as a creative resource by putting it to use, or mindfully appreciate the history it's accumulated, or merely consider how it situates within the home, or, forget about it entirely as it fades out of perceptual view within an ensemble.

In designing for the actuality of computational objects we found it was crucial to integrate analog and computational components into a cohesive whole. Our decisions to use common materials and forms were successful in enabling the Photobox and table-non-table to stay relatively within the realm of their familiar analogue cousins, the chest and table. They also catalyzed a range of intersections and engagements that other computational objects in our participants' homes often fell short of achieving.

Collectively, these findings suggest there is a strong need for future research to investigate various ways in which emphasizing actuality in the design of unaware objects (and other interaction design artifacts) can enable them to be drawn on as creative resources over time. Strongly resonant with this direction are recent works that foreground the careful crafting of computational objects such that they bring attention to the objects as distinct material entities [e.g., 5,11]. There is a significant opportunity to build on this research and others that explore materiality more generally [e.g., 8,7, 18] to articulate further the role of actuality as a generative framing mechanism for designing computational artifacts. Our hope is that these related threads of research will nurture future investigations into how materials, form, interaction, and computation come together into fully realized things that mediate relations among objects, environments, and humans (and even non-humans) in rich and ongoing ways. On a deeper level, this opportunity area explores the material basis of computational objects that might lead to more critical consideration for the complex and dynamic nature of human relations to technology in contexts of everyday life and, as we explored, everyday creativity.

Leveraging post-functionality in unaware objects–The design of contemporary domestic technologies is often tied to their functional means to support people, often in terms of circumscribed purposes or applications. While unaware objects are designed with people in mind, their functionality differs significantly and is not dependent on human interaction, attention or presence. They do function, yet in ways that provoke people to work towards their own understandings or uses of unaware objects within their own everyday lives and environments. In this way, they exhibit a type of post-functionality that critically contrasts more traditional human-centric approaches.

Nonetheless, the post-functionality embodied in our unaware objects produced complex effects as evidenced by how they were intersected with, contemplated, reconfigured, and drawn on in implicit yet growingly unique and creative ways. The decision to create design artifacts devoid of any discernable interface that inhibited people's control over their computational behaviors proved to be a viable strategy. It provided a means for avoiding over-determining the artifacts' computational use, purpose, or place among the households they were situated in.

Additionally, the conceptualization of computation as intermittent and infrequent in our unaware objects brought issues of temporality to the forefront—it emphasized that 'functionality' was emergent over time rather than on demand. As intersections accumulated, our design artifacts were continually reconfigured and their character became expressed through their temporal form [13]. Unaware objects take a modest step toward giving shape to the design space of post-functionality as a resource for everyday creativity. We see this opportunity area as in parallel to other critical approaches in interaction design, including counterfunctionality [17] and zensign [22] and, more broadly, the rich history of leveraging ambiguity as a resource for provoking dynamic, varied, and speculative interpretations of a design artifact [6,19]. The works on ambiguity and openness reveals how usability is independent of the meaning of artifacts similar to how

functionality in unaware objects can serve indeterminate variations of everyday creativity.

CONCLUSION

This paper has described and synthesized details of the design and deployment of the Photobox and table-non-table. Our aim was to build on and move beyond prior empirical works on everyday creativity through the making and situating of these interaction design research artifacts. An array of tightly related concepts were surfaced and articulated through our analysis in support of this goal. These include *unaware objects*, *intersections*, and *ensembles*. We interpreted these notions in the context of prior works' implications for everyday creativity, which highlighted how, over time, unaware objects can function as creative resources, accumulate intersections, manifest unique ensembles, and, ultimately, support unremarkable creativity. We concluded with two opportunity areas that emphasized *actuality* and *post-functionality* as strategies for critically framing future design-oriented research in the HCI and interaction design communities. As focus in the C&C community increasingly expands to everyday life, we hope this research will inspire future investigations into a more implicit and incremental type of everyday creativity.

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REFERENCES

1. Alexander, C. (1964). Notes on the synthesis of form. Harvard University Press.
2. Desjardins, A., Wakkary, R. (2013). Manifestations of everyday design: guiding goals and motivations. *Proc. of C&C '13*, 253-262.
3. Dix, A. (2007). Designing for Appropriation. *Proc. of BCS-HCI '07*, vol 2., 27-30.
4. Fallman, D. (2011). The new good: exploring the potential of philosophy of technology to contribute to human-computer interaction. *Proc. of* CHI '11, 1051-1060.
5. Gaver, W. et al. (2013). Indoor weather stations: investigating a ludic approach to environmental HCI through batch prototyping. Proc. of CHI '13, 3451-3460.
6. Gaver, W., Beaver, J., Benford, S. (2003). Ambiguity as a Resource for Design. *Proc. of CHI '03*, 233-240.
7. Gross, S., Bardzell, J., Bardzell, S. (2014). Structures, Forms and Stuff: the materiality and medium of interaction. *Pers Ubi. Comput*, *18*, 637–649.
8. Gross, S., Bardzell, J., Bardzell, S. (2013). Touch Style: Creativity in Tangible Experience Design. *Proc. of C&C '13*, 281-290.
9. Hallnäs, L., Redström, J. (2001). Slow technology–designing for reflection. *Pers. Ubi. Comput.*, *5* 201-212.
10. Jacucci, G., Wagner, I. (2007). Performative Roles of Materiality for Collective Creativity. *Proc. of C&C '07*.
11. Jarvis, N., Cameron, D., Boucher, A. (2012). Attention To Detail: Annotations of a Design Process. *Proc. of NordiCHI '12*, 11-20.
12. Marathe, S., Sundar, S. (2011). What drives customization? control or identity? *Proc. of CHI '11*, 781-790.
13. Maze, R., Redström, J. (2005). Form and the computational object. *Digital Creativity*, 16, 1, 7-18.
14. Odom, W., Sellen, A., Banks, R., Kirk, D., Regan, T., Selby, M., Forlizzi, J., Zimmerman, J. (2014). Designing for Slowness, Anticipation and Re-visitation: A Long Term Field Study of the Photobox. *Proc. of CHI '14*, 1961-1970.
15. Odom, W., Zimmerman, J., Forlizzi, J. (2014). Placelessness, Spacelessness, and Formlessness: Experiential Qualities of Virtual Possessions. *Proc. of DIS '14*, 985-994.
16. Odom, W., Pierce, J., Stolterman, E., Blevis, E. (2009). Understanding Why We Preserve Some Things and Discard Others in the Context of Interaction Design. *Proc. of CHI '09*, 1053-1062.
17. Pierce, J., Paulos, E. (2014). Counterfunctional things: exploring possibilities in designing digital limitations. *Proc. of DIS '14*, 375-384.
18. Rosner, D., Ryokai, K. (2009). Reflections on Craft: Probing the Creative Process of Everyday Knitters. *Proc. of C&C,* 195-204.
19. Sengers, P., Gaver, W. (2006). Staying open to interpretation: engaging multiple meanings in design and evaluation. *Proc. of DIS '06*, 99-108.
20. Shove, E., Pantzar, M., Watson, M. (2012). *The Dynamics of Social Practice and How it Changes*. Sage.
21. Stolterman, E., Wiberg, M. (2010). Concept-driven interaction design research. *HCI Journal*, *25*(2), 95-118.
22. Tatar, D., Lee, J., Alaloula, N. (2008). Playground games: a design strategy for supporting and understanding coordinated activity. *Proc. of DIS '08*, 68-77.
23. Tanggaard, L. (2013). The sociomateriality of creativity in everyday life. *Culture and Psychology, 19*, 1, 20-32.
24. Taylor, A., Swan, L. (2005). Artful Systems in the Home. *Proc. of CHI '05*, 641-650.
25. Tolmie, P., Pycock, J., Diggins, T., MacLean, A. and Karsenty, A. (2002). Unremarkable computing. *Proc. of CHI '02*, 399-406.
26. Wakkary, R., Maestri, L. 2007. The resourcefulness of everyday design. *Proc. of C&C '07*, 163-172.
27. Zimmerman, J., Forlizzi, J., Evenson, S. (2007). Research through design as a method for interaction design research in HCI. *Proc. of CHI '07*, 493-502.