

Unpacking the Thinking and Making Behind a Slow Technology Research Product with Slow Game

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ABSTRACT

Motivated by prior work on everyday creativity, we adopt a design-oriented approach seeks to move beyond designing for explicit interactions to also include the implicit, incremental and, at times even, unknowing encounters that slowly emerge among people, technologies, and artifacts over time. We contribute an investigation into designing for slowness grounded in the practice of making a design artifact called Slow Game. We offer a detailed critical-reflective accounting of our process of making Slow Game into a research product. In attending to key design moves across our process, we reveal hidden challenges in designing slow technology research products and discuss how our findings can be mobilized in future work.

Authors Keywords

Slow Technology; Everyday Creativity; Design Research.

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INTRODUCTION

People’s everyday environments have become populated with digital devices and systems. With this shift, new concerns have emerged across the Design and HCI communities over the role, place, and pace of new technologies, and how they shape and structure people’s everyday lives. In this context, a strand of research in the Creativity and Cognition community has focused on describing and analyzing people’s actions to make technologies better suited to their evolving practices through what may be described as everyday creativity (e.g., [10,42]). Our approach builds on the assumption that creativity is at the heart of the dynamic changes of people’s everyday experiences and actions [29]. Our design attitude is highly influenced by the notion of Slow Technology that, Hallnäs and Redström argue, requires designers to create “technology that surrounds us and therefore is part of our lives over long periods of time” [18:161]. The design and HCI communities have seen a resurgence of interest in this area, with recent works exploring such areas as: how technologies can support moments of mental rest and creativity (e.g., [2,9,15,20]), different ways slowness can frame the design of interactive systems themselves (e.g., [16,19,26,28,31,32,37]), and, more generally, ways in which technologies can embody and enact more diverse expressions of time (e.g., [8,14,21,22,24,39,40]).

The recent emergence of works related to slowness is encouraging. Yet, researchers have also expressed struggles in creating technologies that sustain slower, longer-term experiences. Early works advocating for designing for slowness are somewhat abstract and there is a need to further address



how to design slow technologies on practical levels [18,24]. The infrequent yet ongoing computational action of slow technologies can make it difficult to establish a sensibility for when the temporal pacing is ‘right’ [28]. Others have reported difficulties in aesthetically manifesting subtly changing computational actions in a resolved physical form [11,35].

Collectively, these works highlight a need for more concrete examples of design inquires into slowness through design practice. Our pictorial aims to precisely contribute to this area. We offer a case study of the process of designing Slow Game -- a simple game whose gameplay slowly unfolds over long time periods. Slow Game is a design inquiry into the design qualities of computational objects that can be shaped and given meaning by people through everyday creative practices in a slower, emergent, and longer-term manner. Importantly, we adopt a designer-researcher approach to reflect on insights emerging through our first-hand creative practice of making Slow Game¹.

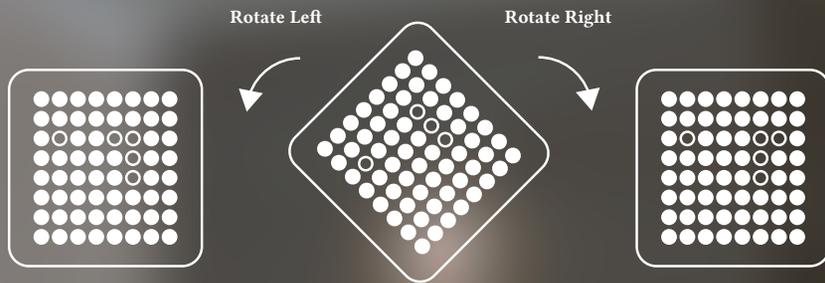
This approach gives prominence to the creation of real things that materially ground conceptual ideas through their actual existence—“a process of moving from the particular, general and universal to the ultimate particular—the specific design” [25:33]. Our approach is influenced by a range of works in HCI that are united in their emphasis on the importance of creating design artifacts as a means to uncover new insights that could not have been arrived at otherwise [1,12,13,33,36,43,45].

In this pictorial, we focus on the particularities of creative practice in transforming Slow Game into a highly finished research product (iterations of our process are visible in the images above). Research products are artifacts designed to drive a research inquiry and that have a high quality of finish such that people engage with them as is, rather than what they might become; and, that operate independently in everyday settings over time [30]. The requirements of research products in part set the confines of our design goals and the goals of our design process.

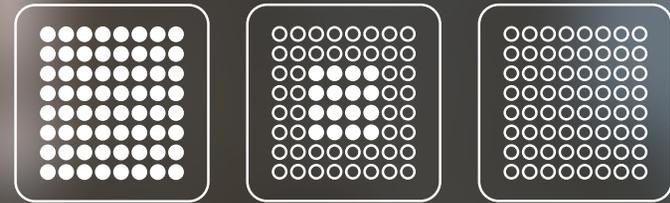
Interest in how designing research products is growing in the HCI community [5,6,7,23,43], yet detailed accounts of how they are created are sparse to date.

Against this backdrop, we attend to the key three points in our design process that required us to make moves in response to emergent tensions and hidden challenges along our trajectory to creating Slow Game as a research product: (i) transitioning from additive to subtractive fabrication, (ii) balancing trade-offs in conceptual and material form, and (iii) iteratively bridging form, materials, and electronics to create an object-like quality. The primary contribution of this pictorial is a detailed critical-reflective accounting of designing Slow Game and making it into a research product. Our goal is to reveal hidden challenges that can emerge when creating slow technology research products and to offer insights that illustrate how such challenges can be productively handled through design practice in the service of informing future design-oriented research in this area.

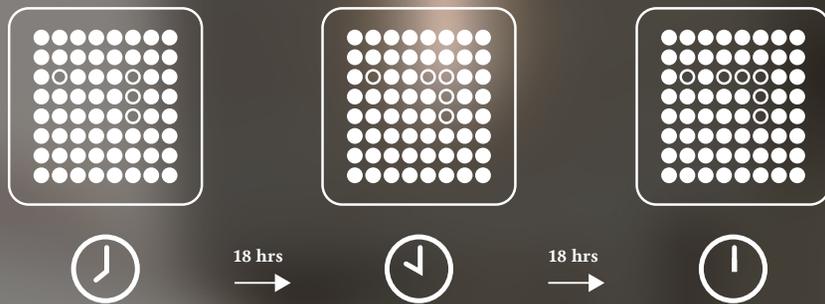
¹In [31,44], we have previously briefly reported on conceptual and theoretical aspects of the Slow Game research product. Beyond work that has come before, in this pictorial we closely examine the hidden challenges of making a Slow Technology Research Product and discuss key insights that illustrate how such challenges can be handled in the service of informing future design-oriented research.



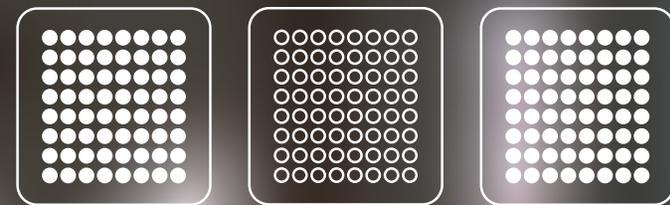
Slow Game Interaction (a): Rotation as Input



> Power on Animation



Slow Game Interaction (b): One move in every 18 hours



> End Game Animation: Slow Pulse for One Day

Slow Game Interaction (c): Animations

We designed Slow Game over an 18 month period. Our goal was to extend considerations of slowness to the everyday creative practices of long-term engagement, curiosity, and play. In its final research product form, Slow Game is a small 5cm cube, with a low-resolution display consisting of 64 tiny white lights that are muted through a thin veneer. Exploring various games (see [2]), we selected the classic mobile phone game ‘snake’, where the player maneuvers a line that grows in length, with the line itself being a primary obstacle. Our version of snake is played by physically rotating the cube, which turns the direction that the snake moves; the user can set the orientation of the next move, but it will only make the move about once per day. Whether or not the user interacts with Slow Game, it will

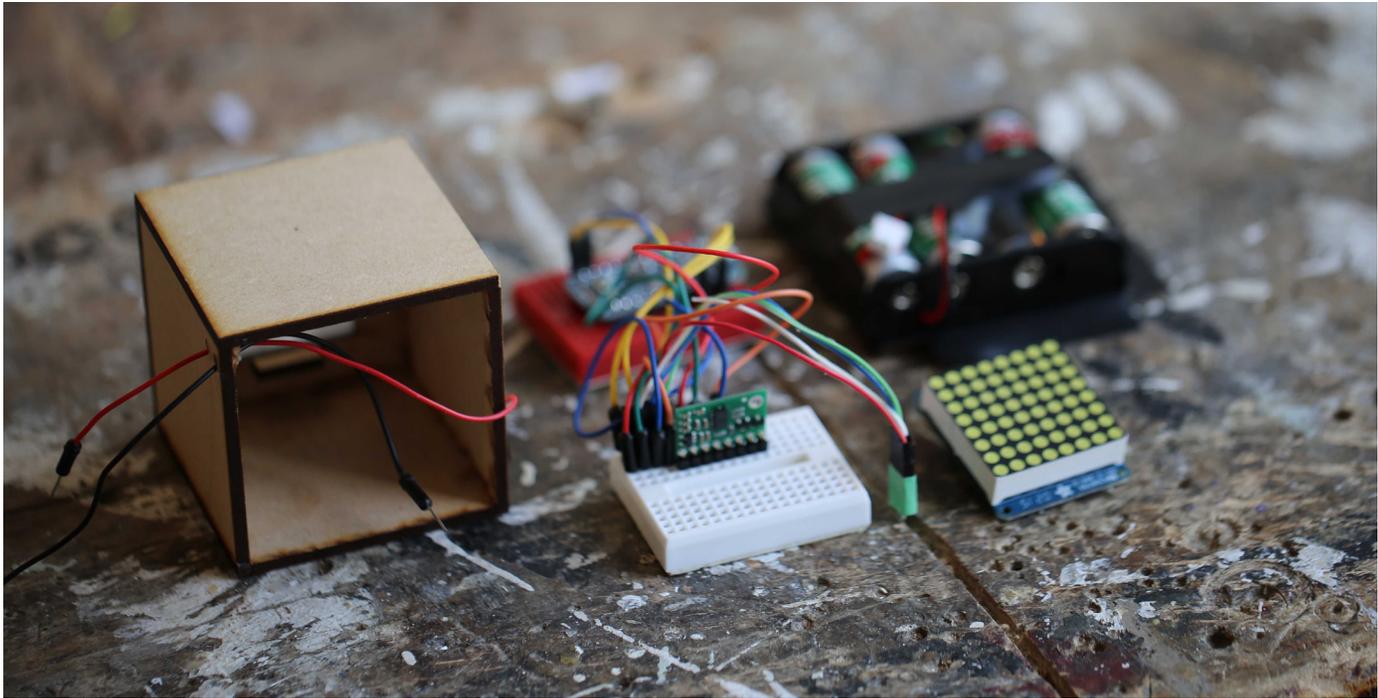
continue to slowly advance moves based on its current orientation; here, time is represented as slowly moving through the artifact in an indefinite manner. The pacing cycle of when a move is made is approximately 18 hours. This enables Slow Game to, over time, phase in and out of sync with a typical 24- hour cycle perpetually. If the user reaches 17 pixels— which can take several months (or longer)—Slow Game will enter into a ‘win’ mode, emitting a warm glow that slowly fades in and out. If the user loses, it will create a negative image of ‘game over’ plane (i.e., all pixels unlit will become lit and vice versa). In either case, after 18 hours the game starts again from the beginning. Slow Game cannot be paused or restarted. If it loses power (and the battery dies), it will always

remember its place in the game. By reducing the feedback loop to a frequency of slightly less than once per day, Slow Game challenges our memory, observation and patience. We batch produced fourteen Slow Game research products.

Across our design process, members of the design team lived with different Slow Game prototypes to ‘dial in’ its computational pacing. We initially implemented Slow Game with a pacing of one move per day; an unwavering cycle that started exactly when it first powered on. Over time, we found this choice produced a methodical, ‘clock-like’ quality. Through iterative experiments, we lived with versions of Slow Game to explore different pacing cycles (e.g., 8, 12, 18, 28, 30,

50 hours, etc.). These experiences revealed that shorter phases (e.g., 8-12 hours) were too fast and multiple moves could easily occur before we noticed, while longer phases (30- 50 hours) tended to feel ‘too long’ and, over time, caused the artifact to not be attended to for days or to be forgotten. Eventually, we arrived at the 18 hour pacing cycle. We found it created a dynamic, yet balanced quality of experience and evoked a rhythm that enabled Slow Game to operate on its ‘own time’, while remaining inviting and intriguing.

Next, we visually describe and detail key tensions and design decisions in our process of making Slow Game into a research product, starting from the very beginning.

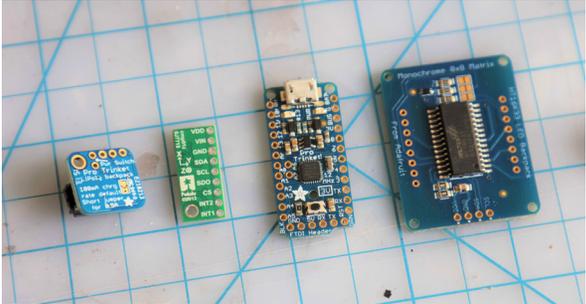


EARLY PROTOTYPING OF SLOW GAME’S FORM AND IMPLEMENTATION

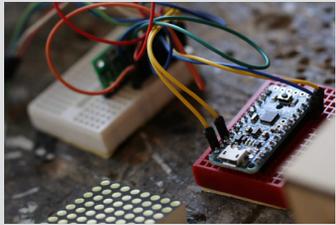
We initially considered several forms for Slow Game, but decided on a cube because we could leverage the simple affordance of rotating it from one side to another as the primary input for the game. This meant we did not have to include buttons or interface control mechanisms. We also felt this small, familiar form could easily be manipulated in relation to other things and places in a home over time.

This prototype was implemented with an 8x8 LED matrix (with driver backpack), Adafruit 5V Trinket Pro microcontroller, AA battery pack, and a 3D compass/accelerometer (for sensing rotation). An early challenge emerging through early testing when it was revealed that the balls inside of analog tilt sensors could easily become stuck and, thus, would not hold up over long-term use. This represented an instance that, despite the simplicity of analog tilt sensors, we needed to integrate more sophisticated digital sensors to support the research product quality of independence – long-term, uninterrupted functionality; even if Slow Game might be only occasionally directly interacted with.

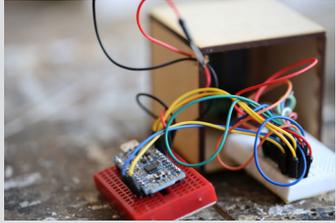
We then created a cube with MDF and carefully back-loaded the components. This design move revealed that the rotational interaction worked well with the form,



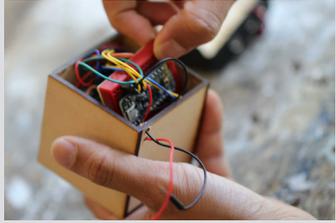
but the enclosure was disproportionately large in relation to the LED matrix, giving it an unresolved aesthetic; at ~8cm the cube was too large. Thus we had arrived on an appropriate general form. Yet, a new challenge emerged that centred on the need to tightly integrate the components and physical enclosure into a unified, holistic form in order to achieve the highly resolved, object-like quality that is so crucial to creating a compelling research product.



Initial exploration of electronic hardware was conducted with breadboards and jumper wires.



A enclosure made out of laser cut MDF panel to house the prototype electronics and work towards an early physical form.



We initially fit the electronics inside the enclosure with double sided tape and hot glue to ensure their solid placement.



Due to a lack of space in the enclosure, we attached a battery pack to test its computational pacing over time in our studio.



The assembled prototype was used as a prototyping platform to explore the interaction and programming of the game.

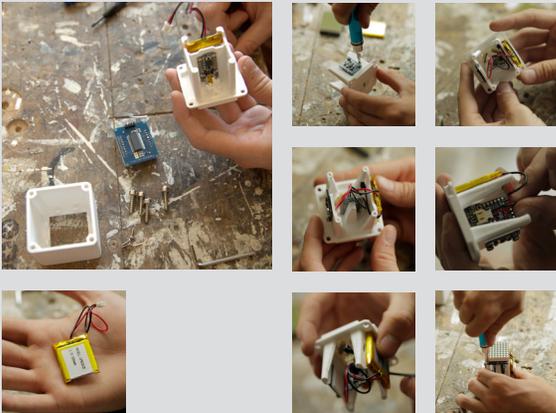
FORM DEVELOPMENT THROUGH ADDITIVE EXPLORATIONS

To address this new challenge, our next move was to utilize additive fabrication to scope Slow Game's physical form to precisely fit with its components. We also integrated a mini-USB LiPO charger and battery to reduce the overall size needed for the enclosure. We created a two-part 3D printed design with an inner core that was attached to the back of the device and a front bezel and external sleeve that slid over the front (display-side) of the enclosure (see figure below). The inner core included a chassis that all components would screw or snap into. This provided added security that was essential to ensure the 3D compass/accelerometer remained in place for long-term reliable sensing and safeguarded the components from bumps and falls that could occur over time. This decision represents how choices in technical components and physical form design came together to ensure long-term reliability and reinforce Slow Game's quality of independence.

This exploration revealed that the smaller 5cm form evoked a more complete 'object-like' feel and the importance of the component chassis is a key design feature. Yet, this stage also revealed a new challenge. While standard 3D printing (fused deposition modeling with a 0.4mm nozzle) was useful for prototyping, the plastic material and striated surface quality was lacking as a refined research product – especially one that focused on slowness and time as a core design principle. However, the compact physical form and integrated support features for ensuring long-term accuracy in sensing rotation enabled us to easily live with the 3D printed versions of the Slow Game to develop its software and explore variations in its pacing. These experiences revealed an additional challenge: that the exposed LEDs were simply too attention grabbing. Even when on a dimmer setting, we still found it hard for Slow Game to fade into the background. Collectively, these challenges made it clear that Slow Game needed to be embodied in a warmer, more 'natural' material and we needed to develop a technique to 'mute' the brightness of its display while still remaining intelligible to the end user. Collectively, these challenges appeared essential to successfully creating a Slow Technology research product that could achieve a high quality of fit in people's everyday environments and fade in and out of perceptual view in everyday life.



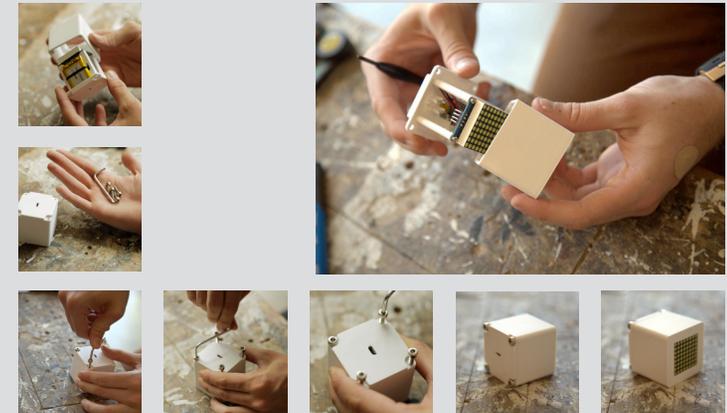
Step 1. Put electronics in



Step 2. Align the two parts



Step 3. Insert

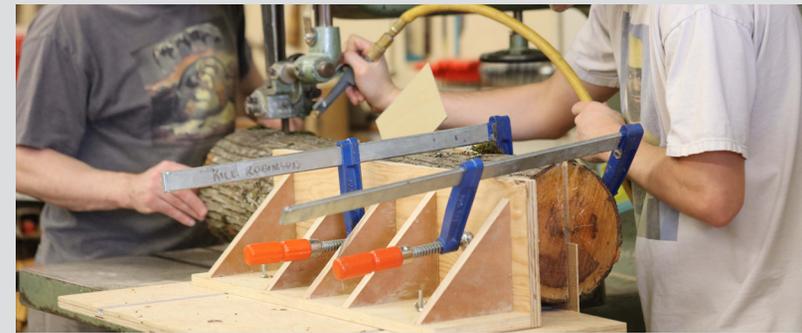


ENGAGING TEMPORAL MATTERS IN WORKING WITH WOOD



After considering numerous materials to address the challenges raised in our prior stage, wood emerged as a better choice than 3D printed plastic on both practical and conceptual levels: wood evoked the concept of time with its growth rings, its fit in with other durable domestic objects like furniture, and was relatively forgiving and flexible compared to machining the enclosure out of a metal like aluminum. The surface of an FDM 3D printed enclosure could have been filled with spot putty, sanded, and painted, but the object would have still had a plastic-like quality each time the user interacted with it, which could detract from its longer-term perceived durability [26].

We initially hand-sourced the wood for Slow Game from a maple tree felled during a windstorm in Vancouver, Canada. This choice did not provide the easiest or most efficient path forward. It was motivated by our desire to engage with the temporal qualities of the material. Our process involved sawing the ends of the large log; treating and sealing it with heated beeswax; and, leaving it to dry for several months. After this drying period, we cut and planed several pieces to eventually be used as material to fabricate wooden enclosures for Slow Game with a CNC Mill.

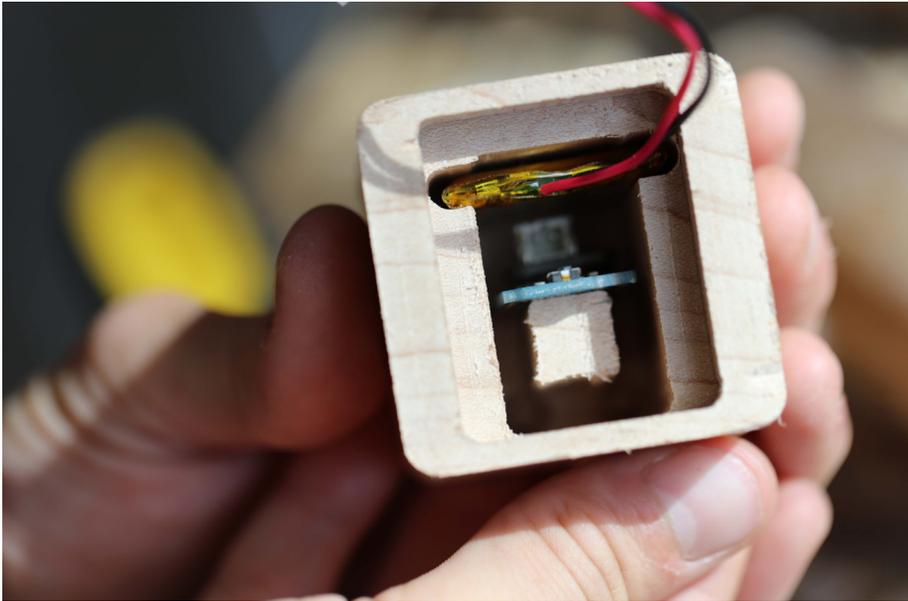


A piece of maple was recovered on the street following a wind storm (pictured above). Our team carried into our studio, and began to work with it by first cutting down to smaller pieces to prepare it for the drying and curing process.



Process of heat treating and drying the maple with pentacryl. This involved significantly cutting the pieces down to size, coating with beeswax, and then firing the exposed surfaces with a butane torch to seal them and begin the curing process.

TENSIONS IN MOVING TO SUBTRACTIVE FABRICATION



During the period that the maple log dried, we acquired a hardwood rock maple slab to begin our process of developing a 5cm wooden cube enclosure that was relatively similar to our 3D printed version. Shifting the design from a 3D printed object to a CNC-cut wood enclosure was not a simple undertaking, however. Although 3D printing requires a level of skill and craft – especially keeping a 3D printer calibrated and running smoothly – CNC machining has more variability as a result of the subtractive manufacturing process that we were not prepared for. Due to our reliance on 3D printing in the past, we knew much more about CAD – computer aided design that involved the 3D modelling of the product – than CAM – computer aided manufacturing of the physical object.

After redesigning the enclosure to be milled out of a single piece of hardwood, we discovered that our CAD design required special long-reach end

mill bits to be sourced from a foreign specialty CNC supplier. In addition, the relatively deep pocket (~50mm) that we had to mill out with the long-reach end mill bits created a number of problems: excessive sawdust could build up in the pocket and tool vibration can cause too much cutting friction and reduce cutting performance that led to a tool breakage.

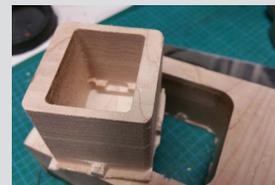
These frictions brought into focus the complexities of merging ‘slower’ creative, craft-based hard work with machines designed and engineered for rapid prototyping. It pushed us to ‘dial in’ the CNC through repeated iterations to avoid key levels of friction in the tool path that could potentially break the end mill. This reveals an unavoidable friction that researchers can be aware of and better prepared for: when the competing aim of crafting a highly resolved slow technology design artifact meets the goal of creating a batch production of research products.



An initial attempt using a short end mill on a large format CNC.



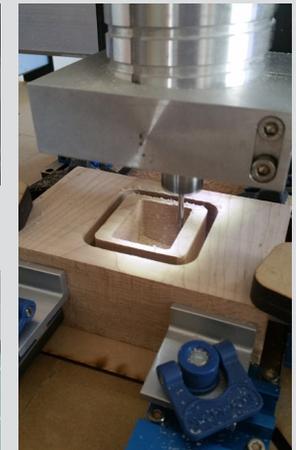
We discovered the endmill was too short operate robustly.



Final enclosure developed through numerous iterations.

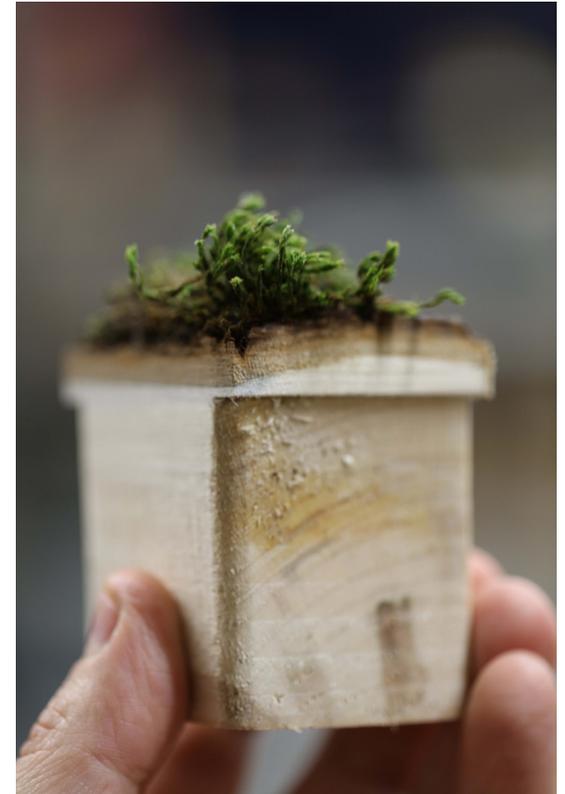


Through this process we broke several endmill bits.



Deep slotting and pocket operation posed further challenges to milling the enclosure with a CNC.

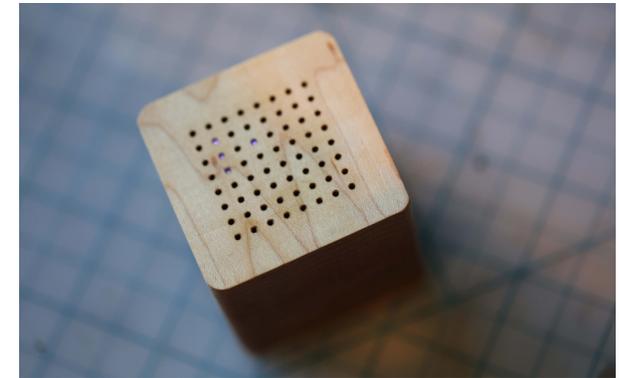
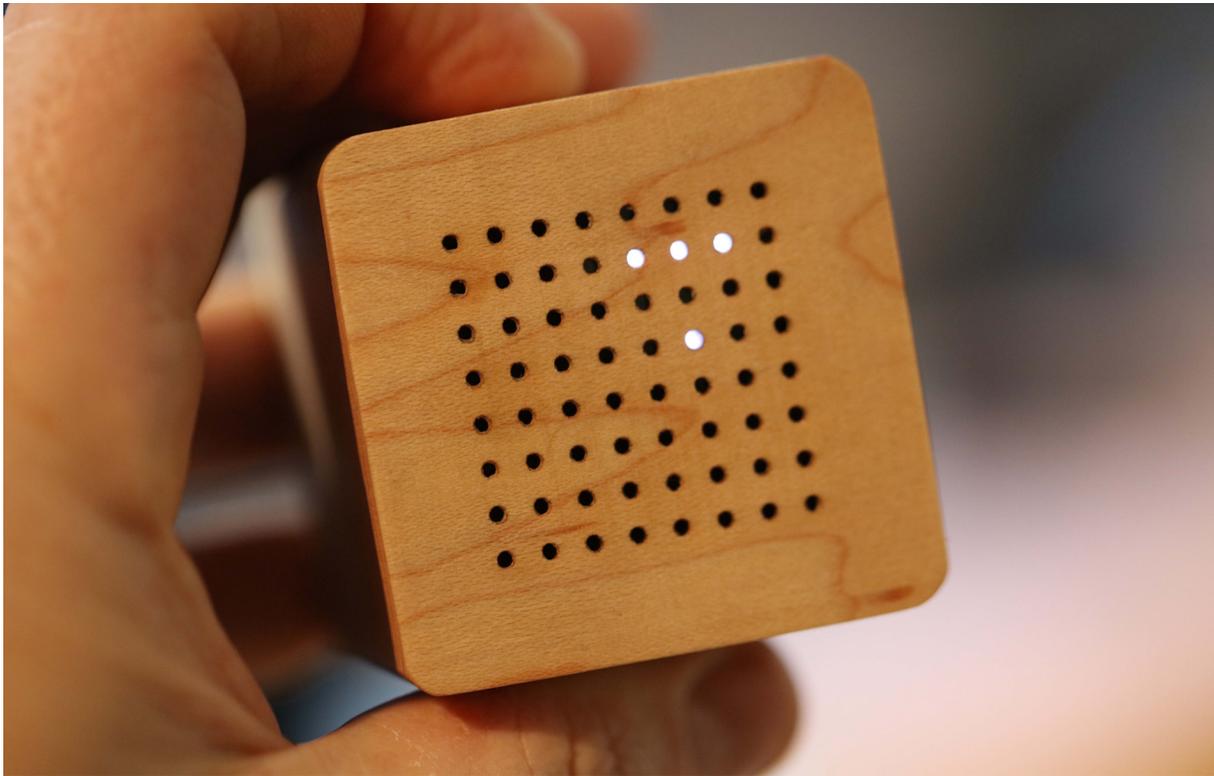
BALANCING TRADEOFFS IN CONCEPTUAL AND MATERIAL FORM



After the maple log completed drying, we created numerous experimental enclosures that situated the exposed tree bark on the cube's backside to connection point where the charging cable is inserted. We wanted to foreground the diverse and complex materiality of the felled log. Conceptually, we aimed to evoke a poetic contrast between the natural and artificial. Despite our best efforts, these enclosures ultimately felt more like an artistic showpiece and less like a mundane domestic object. Using the CNC mill to fabricate an enclosure with exposed bark required us to create a deeper form that was no longer a cube.

Collectively, these issues made Slow Game look and feel too extraordinary, which would complicate its capacity to

settle in and find its place as an object among other domestic things, people, and places. In balancing these trade-offs and to support our goal of creating a slow technology research product that could become woven into people's everyday creative practices and domestic settings, the following takeaway became clear: we needed to move to a minimal material aesthetic, while still leveraging the warmth of the wood material and retaining an actual cube form. This insight highlights the need to balance a sense of familiarity and unfamiliarity when creating a design artifact that is intended to not overtly attract attention and fitting in and among people's everyday objects and environments over time.



ITERATIONS AND TENSIONS IN CRAFTING A RESOLVED OBJECT-LIKE QUALITY

Our next major design move focused on CNC milling a wooden enclosure from a hardwood maple slab. In this iteration, we milled the cube from the back towards to front face, leaving only 5 millimeters of material. We then milled 64 small holes to precisely correspond with the 64 LEDs in the matrix display of Slow Game. Here, our goal was to address the need to ‘mute’ the brightness of the LED display through leveraging the materiality of the wooden enclosure. We then sanded and oiled the enclosure to further accent its warm material qualities. Members of the design team then lived with this version of Slow Game for several weeks at a time. Through these experiences, we arrived at two important insight that pointed toward new challenges that would need to be address.

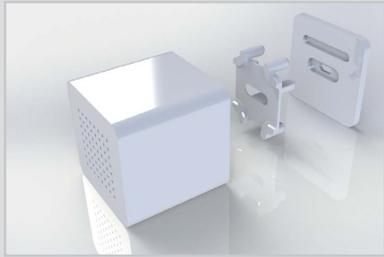
First, the milled holes forming the front-facing display were

too ‘good’ at muting the LEDs, which made Slow Game feel too unobtrusive. Not only did the milled holes mute the brightness too much, the depth of the holes highly restricted the their viewing angle. In other words, if you did not directly face the cube, the light was barely visible (as seen in the barely visible light emitting from the Slow Game prototype featured in the top right image). These design choices made the Slow Game fade too deep into the background where it could very easily go unnoticed for long periods of time.

Second, the design iteration required us to fit the electronics in the rear of the enclosure, which in turn required another piece of wood to be affixed (with screws in our case) to seal the back. While useful for reaching the internal components, this feature highly disrupted the uniformity and material cohesion of Slow

Game. It projected a prototype-like unresolved feel, rather a research product with a distinct object-like quality.

Collectively, these issues pushed us to reconsider and critically reflect on how we could address the challenges of front-loading the electronics as well as creating a different technique for muting the LEDs that made them more visible, while still not attention grabbing. On a higher level, these challenges highlight key issues bound to designing slow technology research products: (i) the need to delicately and subtly balance how the design artifact’s expression in everyday life (e.g., whether it is light, sound, motion, etc.) and (ii) the need to evoke an object-like quality (i.e., one that does not ‘look and feel’ like a prototype).



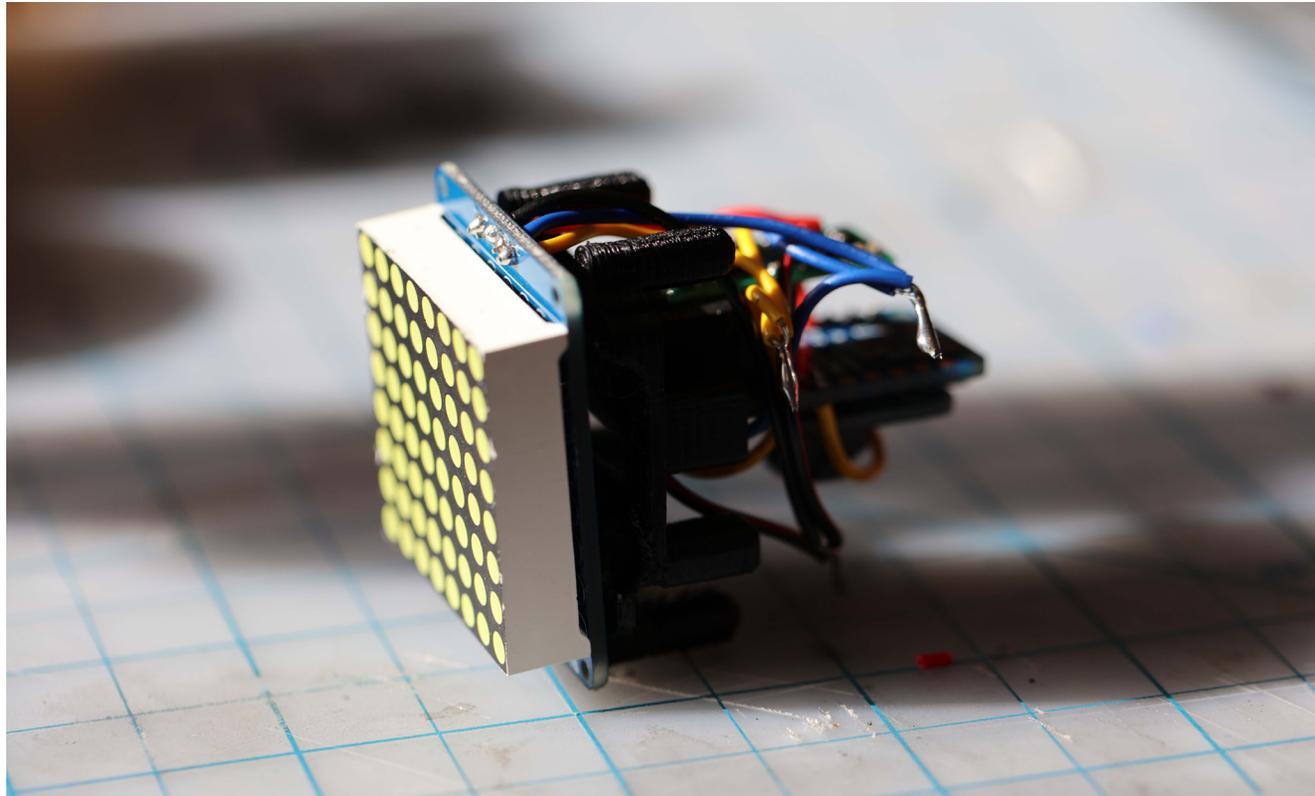
We redesigned the 'pin-hole' Slow Game variation and subsequent variant using a bracket design that allowed us to assemble the electronic as a module and inserted into the various wooden form.



The design of the bracket serves two purpose: First, to precisely align the components with different openings on the enclosure. Second, to robustly hold each of the components in place.



We iteratively improved the bracket design in responses to different variants of the enclosure design to optimize the fit of the electronic within the enclosure.

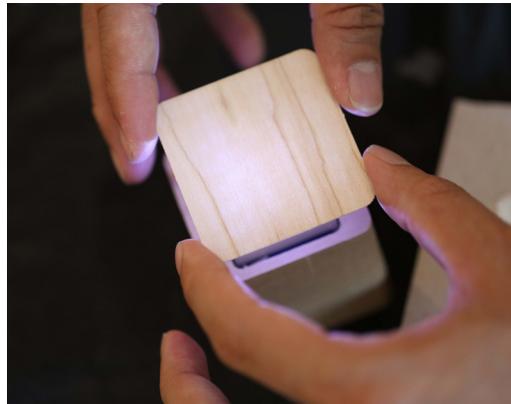
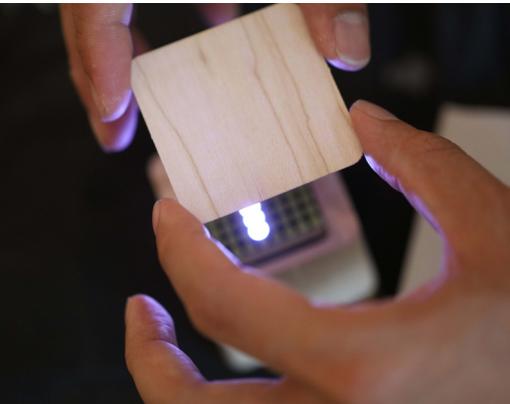


CRAFTING A FORM TO INTEGRATE ELECTRONICS FOR LONG-TERM USE

When developing the 'pin-hole' Slow Game variation (described on the previous page), we simultaneously designed an electronics chassis that, while radically different in form, resembled qualities similar to the chassis in our much earlier 3D printed enclosure. Due to form factor constraints of the 5cm wooden cube (with ~4.5 cubic cm of usable space), there was not much of a tolerance to work with and the electronics had to be tightly integrated, calibrated, and capable of operating without maintenance or intervention over a long period of time. These requirements are bound to supporting the independence, finish, and fit [30].

We had previously extensively tested the hardware components and software for long-term reliability. Now, through several phases of iterations and tests, we developed a 3D printed chassis to mount and securely affix the suite of electronics (i.e., microcontroller, LED Matrix, USB LiPO charging backpack, and 3D compass/ accelerometer) to tightly fit into the cube. This also required careful consideration for the wiring of the electronics assembly to ensure its stable fit and enduring performance.

While a seemingly mundane detail, we see this advance in our design process as an important point in the successful making of Slow Game as a research product. Through numerous cycles of reflection and design action across our design process that involved form variations and material constraints, we eventually arrived at technique that enabled the slow game's components to stably and perpetually operate over long time periods. This capability is especially essential for slow technologies and important for support slow, implicit, emergent everyday creative practices.



CRAFTING FINISH IN THE SLOW GAME RESEARCH PRODUCTS

In re-thinking how to mute the LED display, we began experimenting with veneer. Initial, quick-to-hand, creative experiments with veneer salvaged from a local wood library were promising, but the material was usually too thick, which obscured (or 'muted') the LED display too much. This insight prompted us to revisit what we had left of the felled log (which was well-aged at this point) and hand cut custom pieces of veneer. Through this process we created very thin veneer that enabled the LED display to project a warm and inviting quality that remained subtle.

We CNC milled a batch of 14 cubes enclosures, each of which had an open face to front-load the electronics and a small slot for the micro-USB power connector (on the rear). Then we laser cut our veneer to conform to the cube's front face, affixed the veneer to the front of each cube, and sanded and oiled the cubes to produce a quality finish. In its final form, Slow Game's hardwood enclosure seamlessly integrates with the veneer to reveal flat grain lines developed over the tree's growth. It subtly expresses the temporality of the material in a robust physical enclosure. The LEDs warmly glow through the veneer face, evoking an inviting but not demanding quality. This final set of decisions highlights how we arrived at a seamless integration of materials, form, and electronics that was required to create a highly resolved slow technology research product.

To achieve a polish finish the Slow Game with increasing grit of sandpaper from 300, 600, 800, 1000 grit through iterative sanding sessions.

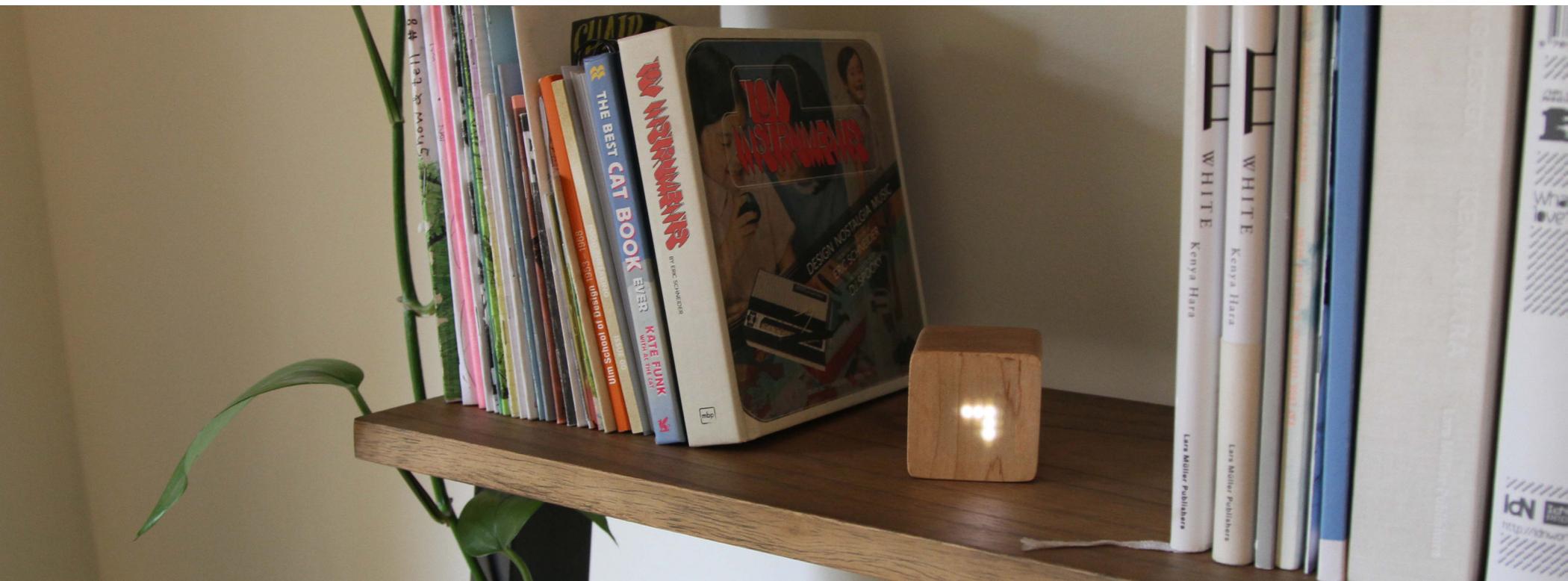


The sanded cube were then coated with multiple layers of linseed oil to generate a sense of polish and material cohesiveness.



We repeated the process for the remaining sets of cubes in our small batch production.





CONCLUSION

While there is growing interest in the HCI and Design communities in designing for everyday slow and emergent forms of creativity, specific case examples articulating the tensions, trade-offs, and processes involved in design practice within this space are sparse. In this pictorial, we have described, illustrated, and critically reflected on our practice of designing and making a low volume batch of slow technology research products with Slow Game. Our goal is to reveal hidden challenges that can emerge when creating slow technology research products and to offer insights that illustrate how such challenges can be productively handled through design practice.

We have attended to key points in our design process that required critically considered (and, at times, re-considered) design moves in response to hidden challenges that emerged as we worked toward supporting qualities of independence, finish, and fit in the Slow Game research product. In this, we attended to key challenges that emerged in oscillating between additive and subtractive fabrication, balancing trade-offs in conceptual and material form, and working toward seamless, balanced integration of materials, form, and electronics to evoke an object-like quality and character that would hold up over time. Our pictorial also reveals key insights into the subtle and nuanced

process of balancing familiarity, unfamiliarity, and intelligibility of slow technology research products. We also see our work as a modest step that responds to the call for making and reflecting on new design artifacts as a means of developing a theory and practice of slow technology [18].

Importantly, our aim is not to be prescriptive or conclusive. A multiplicity of approaches is needed to open up new ways of conceptualizing and designing for more idiosyncratic, emergent, and ongoing forms of everyday creativity as technology increasingly becomes embedded in everyday life. We hope our work will inspire future research and practice in the HCI and

Design communities into creating for slow technology research products. More generally, we hope the critical reflective reporting of design research case can be appreciated as in line with other recent efforts [1,3,4,12,33] to better support visual- reflective forms of knowledge production in the HCI and Design communities.

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