



Designing with care for more-than-human worlds

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Designing With Care for More-Than-Human Worlds

Greg Sieber

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Abstract

This project builds on calls to decenter the human in design (Forlano, 2016; DiSalvo and Lukens, 2011; Galloway, 2017; Lenskjold & Jönsson, 2018; Smith et al. 2017). It explores how critical and speculative design practices situate designers as material-semiotic storytellers (Ward & Wilkie, 2009) that use design to highlight shared concerns (DiSalvo, 2013; Andersen et al., 2015) and materially (re)configure the normative ethical frameworks shaping design agendas (Bratteteig & Wagner, 2014). It builds on discourse in participatory design and draws on theories in science, technology and society (STS) to consider what it might mean to include non-humans as participants in the design process while remaining sensitive to calls for a bioinclusive ethic (Veselova & Gaziulusoy, 2019). This theoretical framework guides the development of a speculative design project which incorporates mimosa pudica plants as part of a living interface within a speculative Internet of Things. It serves as documentation of the research through design process and the practices of growing and living with the mimosa pudicas.

A Note On The Pandemic

Below is the documentation of my research through design process during the fall and winter of 2020. Following the COVID-19 pandemic, with school and studio closings I was unable to complete the final functional prototype. In what follows you will see the prototyping and experimentation up to the scale model which was completed right before the studios closed. After the closings, I began to rethink and rework the project. Initially, this was an attempt to find a way to complete something that reflected my aspirations for the project and allowed me to graduate. However, it turned into a reimagining of the entire project which entailed not only a redesign but a reworking of the theoretical framework. I had hoped to be able to include this new work as part of this document but with closings again occurring in the fall of 2020, it simply wasn't possible. The most recent iteration of the project will be self-published on my website in the spring of 2021. While I wish I was sharing this version with you now, I am happy to present this iteration as an important part of my process and an integral step in my journey as a designer and researcher.

Introduction

Design is an ongoing process which does not resolve when building plans get green lit or when products land on the shelf. It does not 'arrive' with an anticlimactic 'final revision. It's not confined to a studio and it doesn't result in a *thing*. 'Things' may be born of the process but their lives are entangled in a web of other beings existing across a spectrum of what we might call 'living'. These 'things' do not 'come to be' so much as they are sedimented through the continual unfolding of the world. But what is responsible for this sedimentation? On one hand, we might think of this process as a coalescence of the materialities which are concentrated and reconfigured in response to whichever force exerts the most pressure. Particles sedimented in fluid respond to centrifugal acceleration and electromagnetism. The forces sedimenting design are not so plainly material. Discursive constructs like hierarchies and value systems also act to sediment the things of design. Geologically speaking, sedimentation can occur from poor land management and if not appropriately addressed can destroy entire ecosystems.

The dominate forces ordering the sedimentation of designed things generally fall within normative frameworks perpetuating long-held beliefs about the

relational dynamics between humans and nature (Kransky, 2019) and humans and technology (Lenskjold & Jönsson, 2018). These normative frameworks guide design practices and process and perpetuate the value systems and hierarchies they are comprised of (Wajcman 1991; Weisman, 1994). It is perhaps unsurprising then that our cultural tendencies towards anthropocentrism and human exceptionalism (Ceballos et al., 2015; Watts, 2018) are pervasive in design discourse and practice (Forlano, 2017; Bardzell & Bardzell, 2015). This orientation reflects the tendencies of human exceptionalism to prioritize the needs of humans over those of other species (Kotzé, 2014). In a time of accelerating climate change and mass extinction caused by anthropogenic activity (Moore, 2017), there is a profound urgency to address the untenable trajectory of the unsustainable practices entangled with human exceptionalism (Ripple et al., 2017). Design is deeply implicated in this paradigm and is instrumentalized by many of the frameworks which advance these agendas (Light, 2007). There have been growing initiatives to imagine alternative value frameworks to guide design towards more tenable alternatives (Nelson & Stolterman, 2012).

This project builds on calls to decenter the human in design (Forlano, 2016; DiSalvo and Lukens, 2011; Galloway, 2017; Lenskjold & Jönsson, 2018; Smith et al. 2017). It explores how critical and speculative design practices situate designers as ‘material-semiotic storytellers’ (Ward & Wilkie, 2009) that use

design to highlight shared concerns (DiSalvo, 2013; Andersen et al., 2015) and materially (re)configure the normative ethical frameworks shaping design agendas (Bratteteig & Wagner, 2014). It builds on discourse in participatory design and draws on theories in science, technology and society (STS) to consider what it might mean to include non-humans as participants in the design process while remaining sensitive to calls for a bioinclusive ethic (Veselova & Gaziulusoy, 2019). This theoretical framework guides the development of a speculative design project which incorporates mimosa pudica plants as part of a living interface within a speculative Internet of Things. It serves as documentation of the research through design process and the practices of growing and living with the mimosa pudicas.

Critical Design

‘Critical design’ is generally considered a niche within industrial and interaction design which is strongly established and widely situated within design discourse. It was popularized by Dunne & Raby through early works like Dunne’s *Hertzian Tales* (1999), the duo’s aforementioned *Design Noir: The Secret Life of Electronic Objects* (Dunne and Raby, 2001) and the design work done under their renowned design firm Dunne & Raby. In *Design Noir*, Dunne and Raby coin the term and plainly proclaim the purpose of critical design as they saw it: “Its purpose is to stimulate discussion and debate amongst

designers, industry and the public about the aesthetic quality of our electronically mediated existence” (Dunne and Raby, 2001, p. 58). Critical design positions designers as materially and critically engaged practitioners whose outputs are artifacts which serve as “material theses” (Maze, 2009; Seago and Dunne, 1999).

Though critical design has proliferated within design discourse over the past two decades and stands as a codified framework used by many to discuss the political commitments embedded in designed artifacts, Dunne and Raby have called it an attitude more than a methodology (Dunne and Raby, 2007). They emphasize that many designers have critical and reflexive practices who likely have never heard the term or choose not associate it with their work. The impetus for naming it as such was a gesture towards making the practice more widely visible, especially in product design. The heavy emphasis on product design largely arose out of a reaction to the entanglements with the mass market and the pressure it placed on designers to create artifacts that needed to perform well commercially to be considered valid or viable. This friction was present long before Dunne and Raby coined critical design in the early 2000s. In the late 1980s, for example, John Thackara bemoaned the lack of criticality in product design, “Because product design is thoroughly integrated in capitalist production, it is bereft of an independent critical tradition on which to base an alternative” (Thackara, 1988: 21). It is thus an integral dimension

within general conceptualizations of critical design that the tight constraints and agendas of industry which typically direct normative design processes are suspended.

In an effort to create a clear delineation between normative design practices which support the conventions of industry and the subversive aims of critical design, Dunne dichotomizes design into of “critical” and “affirmative”.

“Design can be described as falling into two very broad categories: affirmative design and critical design. The former reinforces how things are now; it conforms to the cultural, social, technical and economic expectation. Most design falls into this category. The latter rejects how things are now as being the only possibility, it provides a critique of the prevailing situation through designs that embody alternative social, cultural, technical or economic values ... Critical design, or design that asks carefully crafted questions and makes us think, is just as difficult and just as important as design that solves problems or finds answers.” (Dunne and Raby, 2001, 58)

Early on, Dunne and Raby have emphatically and continually tried to differentiate critical design from art. They did not mince words, “It is definitely not art. It might borrow heavily from art in terms of methods and approaches but that’s it” (Dunne and Raby, 2007). While it does undoubtedly draw on the

creative legacies of artistic movements like Dada and Situationism, borrowing playful techniques of subversion and estrangement to jar viewers out of the everyday, Dunne and Raby maintain that the objects are still fundamentally rooted in the domestic world of design (Malpass, 2017). They feared that if the objects of critical design were labeled as artworks, they would be more easily dismissed and compartmentalized by viewers, becoming untethered from their relationship with designed objects in their lives. Striking this balance seems, to them, to mark a successful critical design project: a “slight strangeness” is key, they posit, “too weird and they are instantly dismissed, not strange enough and they’re absorbed into everyday reality” (Dunne and Raby, 2001., p. 63). These plausible “alternative nows” encompass just part of a spectrum of “alternative nows” from the banal to the fantastical that is widely traversed by critical design at large.

Projecting ourselves into the worlds these artefacts might exist in, and imagining how our lives might be subtly or radically different, is a way this practice endeavors to evoke critical reflection from its viewers. Ruminating on these alternative presents also suggests alternative futures. While critical design does concern itself in the futures implied by the artifacts of alternative presents, there have been other future-focused genres spawned by critical design that have developed a more nuanced vocabulary for attending to them.

Designing Futures

Bridging desired futures with the present is a central to many conceptualizations of design. Herbert Simon, for example, said “everyone designs who devises courses of action aimed at changing existing situations into preferred ones” (1996, p.130). Richard Buchanan considers the mechanisms behind prescriptive conceptualizations of design, such as Simon’s, by positioning design as political rhetoric (Buchanan, 1989).

“Rhetoric is an art of shaping society, changing the course of individuals and communities, and setting patterns for new actions. However, with the rise of technology in the twentieth century, the remarkable power of man-made objects to accomplish something very similar has been discovered. By presenting an audience of potential users with a new product – whether simple as a plow or a new form of hybrid corn, or as complex as an electric light bulb or a computer – designers have directly influenced the actions of individuals and communities, changed attitudes and values, and shaped society in surprisingly fundamental ways.” (Buchanan 1989, p.93).

By arguing that design is fundamentally oriented around shaping society, attitudes and values, Buchanan situates the artifacts produced by design as material arguments for a way the world ought to be: “all products – digital and analog, tangible and intangible – are vivid arguments about how we should lead our lives” (2001, p. 194). If we extend the political power that’s been afforded to the designer, and the act of design itself, to the artifacts and objects of design, we can begin to consider the ways in which their material presence might (re)enforce regimes, beliefs or political agendas. This is precisely what Langdon Winner argued in his seminal article “Do Artifacts Have Politics?” (Winner,1980).

Scholars have been critical of Winner’s assertions (Joerges, 1999; Donnelly, 1990), including Carl DiSalvo, who contends that Winner’s argument isn’t necessarily wrong, but that it is “too strong” (DiSalvo 2013, p.96). Instead, DiSalvo says more nuanced consideration of design processes and practices is needed to better understand how designed artifacts might “do” or “participate in” politics, rather than simply “objectifying some earlier political scheme” (Latour, 2004, p.50). DiSalvo goes on to argue that whether or not we concede that artifacts have politics, they are used towards political ends which, he says, are to “express beliefs, desires, and attachments that have political significance” (DiSalvo, 2013, p.97). If design is a gesture towards the future, whether or not it is made explicit, the “political ends” of designed things are

thus entangled with the “political ends” of the imagined futures they are situated within. The very act of identifying and negotiating possible futures has itself been called a political act, and an exercise of power, even if a preference for a particular future is not expressed (Mazé, 2016).

While the future may be debatably at stake in design at large, rhetoric of futurity is more salient in certain genres and sub-disciplines of design. Ramia Mazé (2019) notes that a number of future focused design genres have emerged only relatively recently and that some are still not clearly defined within design discourse. Further, some genres are more overtly politically reflexive than others. That is to say, practitioners in some genres are more actively contending with the political ends of the things they create and the futures they imply. ‘Concept design’, for example, is one of the more ill-defined genres Mazé points out. ‘Concept design’ reifies pragmatic projections of ‘dreams of industry’ (Dunne and Raby, 2001). Concept designs are the “future homes” or “future cars” you might find showcased on tradeshow floors in convention centers and have roots in the World Fairs of the mid-20th century. Mazé describes it as central to the ‘corporate imagination’ with the aim of “(re)producing cultural imaginaries for particular industrial futures” (Mazé, 2014, p.27).

Concept design is an extension of the political ends shared by the many design disciplines entangled with capitalist production. 'Concept design' in this context often materializes as techno-centric artifacts, like household appliances or automobiles, that become ambassadors for futures conjured by the corporate imagination (Herrera-Lima, 2016). These material ambassadors are generally produced under the broad umbrellas of industrial design or product design. Dunne and Raby tactfully articulate how this practice is implicated by the corporate imagination as an extension of capitalist values: "At its worst, product design simply reinforces global capitalist values. It helps to create and maintain desire for new products, ensures obsolescence, encourages dissatisfaction with what we have and merely translates brand values into objects" (Dunne and Raby, 2001, p.59).

Speculative Design

Speculative design is widely considered to have emerged from critical design but extends the practice with its own future oriented framework. In *Speculative Design: Crafting the Speculation* James Auger (2013) emphasizes that differentiating speculative design from critical design, and other similar practices such as discursive design (Tharp and Tharp, 2007) and design fiction (Bosch, 2012), is partly a historical and semantic issue. Both practices remove the pressures and constraints of commercial agendas, rely on models and prototypes as material theses and use fiction as a critical tool. The differences

may be semantic to those familiar with the practices, but play an important role in shaping how the work is received and understood by a broader audience. Auger argues that one of the core motivations behind speculative design is extending conversations happening in and around science and technology beyond experts in the field to the public.

Auger also situates alternative presents as a distinct category within speculative design practice, noting that the goal is not only considering technological futures but also providing a system for “analyzing, critiquing and re-thinking contemporary technology” (Auger, 2013, p.3). To clarify this further, he suggests this as one of two distinct categories within speculative design practice: alternative presents and speculative futures. Alternative presents, similar to critical design, imagines reconfigurations of current sociotechnical paradigms guiding product development. Speculative futures explore the way current sociotechnical paradigms might inform near future products and services through an “extrapolation of contemporary systems and product lineages” (Auger, 2013, p.3).

World building and narrative are crucial dimensions of speculative design which can be as important to the legibility of an artifact as the way it is designed. This can often be seen on full display in science fiction movies, which, if done well, present immersive narratives encouraging viewers to

suspend their disbelief about the technoscientific realities of the depicted futures. His book *Lab Coats in Hollywood*, STS scholar David Kirby (2011) explores how scientists engage with filmmakers to disseminate new developments in technology and science to larger audiences. Kirby remarks on this in the interview:

“Film naturalizes scientific imagines and events within fictionalized worlds. Movies make it seem as if this is the state of the world, because it’s the state of the world in that fictional space. If it’s done well enough, people can suspend their disbelief. This means that movies can have an influence over audiences’ perceptions of science by legitimizing and contextualizing scientific depictions.” (Hiesinger et al., p. 162)

Kirby coined the term “diegetic prototype” to describe the placement of a speculative technoscientific artifact in a fictional world to naturalize and create interest around it (Kirby, 2011). The term was popularized in speculative design after Julian Bleecker used it to describe the prototypes set in design fictions in his 2009 essay *Design Fiction* (Bleecker, 2009). Bleecker expands on films ability “activate” designed objects through rich narratives and drama; “The diegetic prototype inserts itself into the film’s drama which activates the designed object, making it a necessary component of the story. The film itself becomes an opportunity to explore an idea, share it publicly and realize it, at

least in part and with the consistency necessary for film production rather than laboratory production” (Bleeker 2009, p. 39). In speculative design, this model of the diegetic prototype is often inverted, especially in a gallery space where the objects are less likely to be accompanied by a detailed website or publication outlining their context. On the inclusion of diegetic prototypes in museums and exhibitions, David Kirby remarks, “Instead of placing a desired technology in a fictional world in order to naturalize it, they are asking the viewer to extrapolate a fictional world out of a speculative object” (Kirby, 162).

Collaborations with scientists and technologists can also help designers create plausible narratives rooted in technoscientific realities, something many speculative designers strive for. Similarly to the way Dunne and Raby discussed the delicate balance between estrangement and familiarity in critical design, Auger says that carefully calibrating speculation is integral to the success of a speculative design project.

“If it strays too far into the future to present implausible concepts or alien technological habits, the audience will not relate to the proposal resulting in a lack of engagement or connection. In effect, a design speculation requires a bridge to exist between the audience’s perception of their world and the fictional element of the concept” (Auger 2013, p.2).

The taxonomy of futures is a simple and oft-cited diagram in speculative design literature which breaks futures down into probable, plausible, possible, and preferable. Dunne and Raby use it in their book *Speculative Everything* to help frame the realms of speculation they believe to be ideal for speculative design (Dunne and Raby, 2009). They argue that most design methodologies, processes and “acknowledged good practice” are oriented around the probable. They place plausible futures within the realm of planning and foresight, saying that it is not necessarily about predicting which futures are more likely, but exploring alternative futures as contingencies. The possible lies between the plausible and realms of wild speculation, or pure fantasy as the authors say. Possible futures should be within the scope of scientific possibility and within our capacity to imagine a path towards, even if difficult to imagine; “A believable series of events that led to the new situation is necessary, even if entirely fictional” (Dunne and Raby, 2009 p.4). The cone of preferable futures in this diagram intersects the probable and plausible. This is the realm many speculative designers directed their efforts towards. Though a pressing concern remains; who determines what preferable futures look like?

Participation and Speculation

Including diverse stakeholders in speculation has been an ongoing controversy and methodological concern in speculative design. A number of researchers and practitioners have attempted to address this through exploring on

participatory design methodologies in speculative practice (Forlano and Matthew, 2014; Lyckvi et al., 2018). In *Design and the Construction of Publics*, Carl DiSalvo explores how speculative design practices intersect with the formation of publics to impact public engagement of science and technology (DiSalvo, 2009). DiSalvo expands on the work of John Dewey, specifically *The Public and It's Problems*, to investigate how design can raise social awareness and encourage political action. DiSalvo remarks at designs tendency towards making things visible; “making visible and known the complex situations of contemporary society, so that people might take action on those situations, is a common objective (DiSalvo, 2009, p.49).”

DiSalvo discusses two design tactics which he argues make the implications and consequences of shared issues and concerns more apparent. He defines design tactics as “designerly means directed towards the construction of publics (DiSalvo, 2009, p. 52).” The first tactic, ‘projection’, is concerned with representing the potential future consequences related to an issue or concern. By presenting an array of potentialities, projections surface possible indirect consequences of sociotechnical trajectories through the aesthetic extrapolations of social and technical infrastructures. As many of the researchers and designers above have mentioned, DiSalvo notes the importance of persuasion and plausibility in projection as a means of capturing the imagination and suspending disbelief. ‘Tracing’ is the second tactic DiSalvo identifies,

describing it as “the use of designerly forms to detail and communicate, and to make known, the network(s) of materials, actions, concepts, and values that shape and frame an issue over time (DiSalvo, 2009, p. 55).” Tracing involves exposing the underlying structures of an issue and documenting the movement of an artifact or idea.

These design tactics draw attention to the ways that design can highlight shared issues and concerns. The question of which, and whose, concerns design its highlighting becomes a crucial part of understanding which futures it takes part in imagining. Frauenberger et al. (2015) argue becoming cognizant of the value systems informing the design process is the necessary precondition for understanding the way they shape it. Van der Velden et al. (2014) describe the design process as a contact zone through which certain values materialize through design phenomena and are configured through the design process (Verbeek, 2006; Pratt, 1998). If the value frameworks design exists within inform which issues and concerns guide the process, becoming aware of which concerns those systems privilege can help designers use these tactics to work towards more ethical alternatives.

Design and Human Exceptionalism

The scope of design and the role of the designer is continually expanding, engaging with larger and more complex sociotechnical systems (Forlano,

2016). Because design doesn't 'end' when the 'design project' concludes, these entanglements become with the world in unimagined and unforeseen ways (Redström, 2006). The anthropocentric values of the normative frameworks design is entangled with can thus become 'embedded' in the things of design (Luusua, et al., 2017) and continue into the world, perpetuating and materially reinscribing human exceptionalism. In a time of accelerating climate change and mass extinction caused by anthropogenic activity (Moore, 2017), there is a profound urgency to address the untenable trajectory of the unsustainable practices entangled with human exceptionalism (Ripple et al., 2017). Design is deeply implicated in this paradigm and is instrumentalized by many of the frameworks which advance these agendas (Light, 2007). There have been growing initiatives to imagine alternative value frameworks to guide design towards more tenable alternatives (Nelson & Stolterman, 2012).

To challenge the prevailing ethical frameworks informing design which favors human exceptionalism, typically at the expense of the needs and interests of non-humans, designers and researchers across a range of disciplines have begun to explore how the human might be decentered in design research and practice (Forlano, 2016; DiSalvo and Lukens, 2011; Galloway, 2017; Lenskjold & Jönsson, 2018; Smith et al. 2017). This effort does not negate the human or seek to deny human agency in the design processes, "the price in recognizing the agency of artefacts need not be the denial of our own (Suchman 2007b,

285).” Rather, it calls for more deliberately and ethically situating the human subject within a network of non-human agencies that accounts for the “asymmetrical power” which has been historically cultivated by human agencies (de La Bellacasa, 2017). Further, decentering human agency does not mean designers are not actively making choices or are somehow less accountable for the choices they make. As Karen Barad (2007) so powerfully put it; "Responsibility is not ours alone. And yet our responsibility is greater than it would be if it were ours alone (p.394)."

Design scholars have drawn heavily on theories and methodologies from science, technology and society (STS) to expand conversations around the entanglement of ethics, posthumanism and accountability in emergent and complex socio-technical systems. This long-standing engagement has helped design develop a more robust theoretical framework which has informed theory, practice and pedagogy (Forlano, 2016; Ward & Wilkie, 2009; Pierce et al. 2015). This engagement has proved fruitful across many design disciplines including product design (Verbeek, 2005; Shove, 2007) architecture (Yaneva, 2005), computer-supported cooperative work (Danholt, 2005; Jensen, 2001; Suchman, et al. 2002), IT design (Markussen & Olesen, 2007), and human-computer interaction (HCI) (Liu, Byrne & Devendorf, 2018). Given the focus of design on the generation of material artifacts, it has also helped STS explore the ways material practices can supplement knowledge projects and extend

philosophical discourse (Ingold, 2010; Yaneva, 2009; Latour, 2004). While design has drawn on many philosophical and methodological contributions from STS, one of the most significant and formative contributions has concerned the rejection of long-held dualisms marking western thought which separate, for example, nature and culture, humans and non-humans, the material and discursive, and subject and object (Forlano, 2016; Smith et al. 2017). This has brought into question delineations between designers and users (Redström, 2006), distinctions between humans and non-humans in urban design (Forlano, 2016; Luusua et al. 2017), in the creation agricultural technologies (Liu et al. 2019) as well as everyday objects (Kuijer & Giaccardi, 2018). Acknowledging the ontological and political agency of 'things' is also an area of productive engagement between design and STS (Van der Velden, 2010; Binder et al. 2011).

Feminist STS has been especially helpful for design researchers and scholars exploring responsibility and accountability in design and has been central to calls for including non-human agencies in meaningful and ethical ways. Feminism is heavily critical of the dominant dualistic frameworks which privilege human and patriarchal interests (Twine, 2010; Mies & Shiva, 1993; Plumwood, 1993) that design typically operates within (Suchman, 2002). Fox and Rosner (2016) note the seemingly diametrical relationship between the two; "design and feminism may seem at first oppositional frameworks: design

operating as normative change, and feminist theories oriented toward undoing normative, patriarchal views (Fox & Rosner, 2016).” Feminist researchers have pointed out these connections and the ways that design is implicated in these frameworks which perpetuate the production of technologies and systems embedded with masculinist values and perpetuate asymmetrical power relationships that limit the agency of marginalized groups (Alhutter, 2012; Matrix 1984; Cockburn, 1993; Fox & Rosner, 2016). For designers and researchers looking to challenge these frameworks and work towards more ethical and equitable alternatives, this friction is essential. Bardzell (2010), for example, has noted that the emancipatory aims of feminism makes it a “natural ally” to design in “all stages of the design process.” This has proved to be the case with feminist approaches continuing to emerge across a range of design disciplines including product design (Brandes, 2001; Ehrnberger, 2007), interaction design (Cassell, 2002; Oudschoorn, Rommes & Stienstra, 2004) IT design (Maass, 2007) and architecture (Brown, 2011; Ahrentzen, 2003).

Participatory design, which is more of a design framework than a design practice, shares roots with feminism and has also meaningfully engaged with what it means to ethically and responsibly include non-humans as participants in the design process. Emerging in Scandinavia in the 1970s, participatory design (PD) began as an initiative to include the voices of those affected by design in the design process (Simonsen & Robertson, 2012). Balancing

asymmetrical power relationships, supporting democratic design practices, mutual learning between designers and non-designers and imagining more equitable futures were all guiding principles for PD (Kensing and Greenbaum, 2012). The emancipatory aims of PD were rooted in early engagements with feminist calls to meaningfully include diverse knowledge and experiences (Brattegteig et al., 2012) amplify marginalized voices (Van Der Velds, 2014) and support bottom-up political action (Kyng, 2010). PD and feminism also shared in their efforts to concretely and constructively ground commitments to imagining democratic and equitable futures in the material practices which might bring them about (Bardzell, 2018). Bardzell (2018) suggests a further resonance between PD and feminist utopianism, noting PD's tradition of developing democratic and actionable design practices but suggests it may be lacking from rigorous theoretical and methodological frameworks (Bannon et al. 2018). She remarks that it is unsurprising that PD and feminism would be "fellow travelers"; "That feminism and participatory design would be fellow travelers is perhaps not surprising, given that both are committed to a view of democracy that foregrounds relations of power and that proactively seek to give voice to the marginal (Bardzell, 2018, p.6:3)."

PD has begun to respond to calls to address the delimitation of non-human agencies by normative design frameworks (Desai & Smith, 2018; Heitlinger et al., 2018; Veselova & Gaziulusoy, 2019; Avila, 2017). Veselova & Gaziulusoy

(2019) have argued that due to the emphasis on representation and participation, PD is uniquely situated within design to address the inclusion of non-humans. And, while the inclusion of non-humans has been relatively under researched in PD (Palmas and Busch 2015; Tolbert et al. 2016; Rice, 2018), there have been a number of researchers who have explored this concern in various ways, often incorporating posthumanist and performative theories from feminist scholars in STS. Jönsson and Lensskjold (2015) have, for example, drawn on Annemarie Mol's (2010) performative interpretation of actor-network theory to explore how birds might be considered 'co-designers'. Westerlaken and Gualeni (2016) build from Donna Haraway's notions of situated knowledge (1988) and becoming-with (2008) to investigate how dogs could be included in participatory design processes without instrumentalizing them. Rice uses actor-network theory (Latour, 2013) as lens to analyze the networks of humans and non-humans that are assembled through a participatory design project with a community garden and investigates how communication with non-humans challenges the democratic aims of PD (Rice, 2017).

Though non-human inclusion has been increasingly explored, researchers have noted that there is generally a strong dichotomy in PD which separates human and non-human participants (Andersen et al. 2015). Echoing the earlier calls from researchers to decenter and ethically situate humans in design

(Forlano, 2016; DiSalvo and Lukens, 2011; Galloway, 2017; Lenskjold & Jönsson, 2018; Smith et al. 2017), PD scholars have begun engaging more deeply with posthumanist and performative theories in feminist STS that have developed a robust vocabulary to address the ways that boundaries between humans and non-humans are iteratively reconfigured. The “ontological turn” in PD (Pihkala and Karasti, 2018) draws on these frameworks to understand design as a continually unfolding material-discursive practice that actively reconfigures the boundaries separating human/non-human, designer/non-designer, nature/culture, material/discursive. This way of thinking about PD expands it beyond the singular “design project” and acknowledges that design begins far before the project is defined and continues long after the ‘final revision’ (Bratteteig and Wagner, 2014; Redström, 2006). This means understanding design as a practice of becoming (Light & Akama, 2014) and explores how the constitutive nature of the material ‘things’ of design configure, and are configured by, design practice (Björgvinsson, Ehn & Hillgren, 2012; Eriksen, 2012). It also means considering the ways that normative ethical frameworks shape design practice and are then reinscribed through design ‘phenomena’.

Democratic Participation

Participatory design began in Scandinavia in the early 1970s as a way of balancing the agencies and power dynamics of trade unions workers and

managers through the design of information technologies in the workplace. As Bardzell (2018) notes, from the very beginning PD has had “emancipatory politics inscribed in it (p.6:3). Kensing and Greenbaum (2012) identify the core principles of PD as; equalizing power relations, democratic practices, situation-based actions, mutual learning, tools and techniques, and alternative visions about technology. Values and ethics are thus generally seen as the driving force behind PD and the PD process (Iversen et al. 2010, Bødker et al., 1988). Frauenberger et al. (2015) emphasize that these democratic ideals in PD are, in fact, “the main reason for PD's existence (p.99).”

PD has grown substantially over the last few decades to a broad range of design practices and disciplines and has also been implement within to larger and more complicated socio-technical systems. Researchers have expressed concerns that with PD extending across new disciplines, scales and geographies, it is becoming “spread to thin” (Bannon, Bardzell & Bødker, 2018, p.5) and may become too diluted (Bødker and Kyng, 2018; Bannon and Ehn, 2012). There have also been mounting concerns and critique that PD has been assimilated more overtly into normative design practices focused on usability and user experience (Bannon, Bardzell & Bødker, 2018). As it has grown and become more entangled with these frameworks, PD’s democratic aims have been called into question. Bratteteig and Wagner (2012) argue that design decisions are an exercise of power and there is concern amongst researchers

that PD risks reifying existing power imbalances (Bossen, 2006; Buscher et al., 2002). Manders-Huits and van den Hoven have even suggested that PD is “falling short of directly addressing values of moral import” (Manders-Huits and van den Hoven, 2009, p. 58)

Because participation is so deeply entangled with the democratic ideals of PD, it is central to the critiques that PD might be working against them and perpetuating power imbalances. Researchers have argued that participation has become de-politicized and risks exploiting and instrumentalizing participants (Beck's, 2002; Keinonen, 2010; Shapiro, 2010). It has been suggested that this may be due in part to the lack of consensus around how to define participation (Halskov & Hansen, 2015). It is also likely that it has been in part due to the expansion and diversification PD and its use in such variegated contexts and frameworks. Frauenberger et al. (2015) point out that as PD expanded, the range of stakeholders has grown which introduces new agendas and values within PD processes. That design happens in “messy and problematic situations” (Schön, 1938) further complicates facilitating participation. Acknowledging this complexity and looking to situate participation within the messy design contexts, Andersen et al. (2015) argue for looking at participation as a matter of concern.

Bruno Latour introduced “matters of concern” as a way of acknowledging and framing the co-constitutive nature of the sociopolitical agencies entangled with scientific and technological “matters of fact”. Taken as matters of fact, the ontological and epistemological ‘things’ of science and technology represent objective realities born of a Newtonian universe populated with pre-existing entities awaiting the development of sufficiently sensitive instruments to identify them. Matters of fact are beyond ethical and political reach, unaffected by agencies of humans and non-humans alike. Matters of concern reframe matters of fact as instead implicated with the social and political agencies of humans as well as the agencies of non-humans. Andersen et al. (2015) suggest that approaching participation as a matter of concern “persistently unsettles the nature and function of participation, as it brings into focus the multitude of relations mediating and transforming participation in specific and situated ways (P.254).”

Drawing from actor-network theory (ANT) (Latour, 2004; Latour 2008b) the authors suggest that participation is both partially existent and overtaken. As partially existent, phenomena according to ANT are not objective things with inherent qualities. Rather, they are configured and reconfigured through ongoing entanglements with other agencies within the networks they exist in. Phenomena thus ‘become with’ or emerge alongside the other actors in these networks (Mol, 2002). Participation as partially existent suggests that it is not a

fixed activity or qualification but that it can take on totally different meanings depending on the agencies interacting within the network it is part of. Participation as overtaken suggests that the acts and agencies of participants are not fixed but emerge as a 'network effect' through engagements with other actors, or designers and other stakeholder in the PD process.

Participation as a matter of concern expands it beyond the individual and contained design project (Andersen et al. 2015) and suggests that the agencies which constrain and enable what counts as participation are in motion long before the PD project is formally underway. Viewing participation as a matter of concern means acknowledging the ways that PD processes are shaped by values inherited from the normative frameworks they exist within (Van der Velden, 2014). Further, it would acknowledge the ways in which "structural arrangements", such as institutional priorities and the allocation of resources, affect participation and determine which voices and perspectives are granted the power to make design decisions (Bratteteig and Wagner, 2014). It would attend to the ways that values emerge and are co-constituted through the design processes (Iversen et al., 2012) and the ways those values change in response to participation (Halloran et al. 2009).

Non-Human Participation

If what constitutes participation, and who qualifies as legitimate participants, is configured by the normative ethical commitments of the frameworks that PD projects are entangled with, it is unsurprising that human exceptionalism has largely constrained the scope of what's considered 'genuine' participation. Veselova & Gaziulusoy (2019) have drawn on Freya Mathews (2011) bioinclusive ethical framework to argue for the expansion of ethical consideration in PD to include non-humans. In thinking of participation as a matter of concern, a bioinclusive ethic in PD aims to elevate non-human agencies and experiences, allowing them to shape design goals and decisions. If the agency to make design decisions is an exercise of power, a bio-inclusive ethic would be a step towards reconciling the asymmetrical power relations and the historical consolidation of human agency in design. Veselova & Gaziulusoy put forth seven key aspects which would serve as starting points for advancing a bioinclusive ethic in PD.

The first implication of a bioinclusive ethic in PD would challenge the boundaries of what constitutes a capable participant. The authors suggest that nonhumans could possess knowledge and insight that could shape design outcomes and processes. They echo Schweikardt's (2009) call to recognize other living beings as stakeholders in the design process and considerations in animal computer interaction (ACI) which consider non-humans as future users (Driessen, Alfrink, Copier, Lagerweij, & Peer, 2014; Wirman & Jørgensen,

2015), and potential contributors (Aspling, Wang, & Juhlin, 2016). Further imagining what this might look like, they propose a spectrum of non-designer participation that includes non-humans.

The authors put forth four reasons for the inclusion of non-humans as design participants; political/moral, pragmatic, innovation and commercial. The political reason echos the democratic origins underlying PD which suggest people should have a say in the design decisions that will influence their lives (Bannon & Ehn, 2012; Kujala, 2003; Simonsen & Robertson, 2012). A bioinclusive ethic in participation suggests that this should not be different for non-humans. That they should also be able to inform the trajectories of the processes that will shape their relationship to the world. The pragmatic reason extends a general sentiment in PD that including non-designers in the process has practical implications on design outcomes that affect usability (Hyysalo & Johnson, 2015; Kristensson & Magnusson, 2010; Lundström, Savolainen, & Kostiainen, 2016; Steen, 2011). The authors suggest sustainability and “alignment with natural systems” (p.1578) is itself a practical reason for including non-humans as participants. They also suggest reasons related to innovation and commercialization, which are to a similar effect. They essentially suggest that including non-humans could lead to novel ideas which are more commercially viable.

Flora Introduction

In what follows I will share my attempt to, on a small scale, explore non-human participation in the context of speculative design while remaining sensitive to calls for a bioinclusive ethic. The project took place over approximately six months, during the fall and winter of 2020. It started as an attempt to envision a 'living' Internet of Things which was meant to continue with themes addressed earlier challenging the long-held bifurcations of biology and technology in design. The result of this effort was Flora, which draws on work in informatics and HCI exploring the inclusion of plants in digital interfaces. I worked with mimosa pudica plants, growing and living with them throughout the course of the project. Much of the documentation of this part of the project was lost amidst studio closures following the pandemic but is forthcoming and will be present in the subsequent iteration, which will be self-published and available on my personal website. This iteration of the project was crucial to learning how to properly care for the mimosas and proved to be an engaging

research through design process. In this section, I will document more of the thinking that went into the project and the design process at various stages.

Background

Flora, at its core, is a semiautonomous watering system. It uses soil moisture sensors to detect when plants in the system may be in need of water, then uses a water pump to deliver the appropriate amount of water from an internal reservoir to the corresponding plant. While the microprocessor, the soil moisture sensors, and the water pump are responsible for monitoring the plants and delivering the resources necessary for survival, a human caretaker is still tasked with making sure the whole system has water in its reserves. Thus, it is important for the system to alert the human caretaker when it is in need of water. By leveraging the thigmonastic properties of the sensitive mimosa, and the use of electrodes to turn leaf surfaces into capacitive touch sensors, Flora relies on a living interface that entangles 'biological' and 'technological' signaling.

Flora serves as a fulcrum between human and non-human care-taking practices. I sought to balance the inclusion of biological and technological agencies within the interface in an effort to highlight the webs of interdependence that emerge through semi-autonomous systems of care. In recent years, there have been initiatives in HCI and informatics to include non-humans in the design of digital interfaces which engage with their unique morphologies and behaviors. While this began largely in animal computer interaction (ACI), it has expanded to include considerations of plants as ‘users’, interfaces, and collaborators (Aspling et al., 2016). Designers centering the inclusion of plants face a unique challenge, since often the temporal scale at which plants respond to stimuli appears asynchronous. This works against the immediate feedback we often expect from digital interfaces. Designers have tried to account for this by incorporating technologies that can respond rapidly to user input as a substructure or scaffolding for plants. This has been done, for example, using mechanical exoskeletons which rely on actuators that give the plant the appearance of movement and offers immediate, synchronous feedback (Sawaki et al., 2012; Degraen et al., 2019). Other projects have engaged creatively with the limitations of asynchronous feedback, forgoing mechanical augmentation and relying instead on the unique morphological affordances of the plant to communicate on behalf of a digital system (Kimura & Kakehi, 2014; Kuribayashi & Wakita, 2006).

The inverse relationship is also present in many applications, wherein technological components are responsible for representing and communicating information on the plants behalf. Using constellations of digital sensors, such as soil-moisture sensors, light sensors or temperature sensors, it can be relatively straightforward to triangulate what the needs of a plant may be with striking granularity. The task of representing and communicating these needs thus becomes a core consideration when designing interfaces for these systems. A straightforward approach designers and researchers have used to represent the needs of plants to human caretakers has been simply and flatly offering a status update (Cho et al., 2015; McCalley & Mertens, 2007; Ayumi et al., 2011). While these initiatives often strive to deepen connections between plants and people, they often risk caricaturing or anthropomorphizing the plant, which is also not uncommon in HCI (Westerlaken & Gualeni, 2016). This might be through a pixilated face on an LED screen that smiles or frowns, or more subtly through intricate digital representations on our digital devices.

I began looking for a plant that could interface with digital information and respond synchronously to it. My search brought me the *Mimosa pudica* plant, also known as the sensitive plant or the shy plant. The *mimosa pudica* is a seismonastic plant, meaning its leaves will close and its stems will wilt when exposed to Jagadis, 1926; Jagadis, 1928). Further, this rapid actuation can be

stimulated chemically or electronically. This thigmonastic response occurs in three stages; stimulus perception, electrical signal transmission and induction of mechanical response (Volkov et al., 2010). Researchers have leveraged this unique affordance to experiment with techniques of integrating the mimosa as an output for digital information. By leveraging commercially available microcomputers, such as the Arduino Uno, designers have successfully simulated the thigmonastic response through the 5V output available on the devices (Kurihara et al., 2017; Kurihara et al., 2019). Projects such as Plantxel have also had success prototyping visual display systems using the mimosa *spiegazzinii*, a plant closely related to the *mimosa pudica*, by stimulating actuation using compressed air (Gentile et al., 2018). The rapid response time of the *mimosa pudica*, and ability to simulate this motion electronically with an Arduino controller make it well suited as a living output.

After finding a reliable output mechanism, I sought to identify a living input that would also interface with the Arduino platform. This proved to be relatively straightforward in comparison and afforded the use of essentially any plant. By placing the electrodes onto the surface of a leaf, plants can register as conductive objects that can interface with microcontrollers such as Arduino. Changes in conductance, such as the spike that occurs when a human comes into contact with the leaf, can be detected and used to trigger events in digital systems, thus creating a simple touch interface using the plant

as an input device. Further, the flexibility of this solution is notable since these sensors can be placed on any leaf surface. After successfully identifying the plants I could use as components of the living interface, I set out to design the artifact that would house the system.

Design and Fabrication

The research through design process for Flora relied heavily on hybrid fabrication techniques and a range of physical and digital design tools. Much of the preliminary form exploration was done through sketches and clay models. After narrowing down a formal language, I began digitally modeling in Fusion 360, relying heavily on T-Splines to achieve the organic contours necessary to capture the geometry. I created preliminary renderings to get a better idea of how the form would read at scale and started preliminary experimentation with texture and materiality. These renders were created with Fusion 360 and were then taken into Photoshop for further editing and compositing. I then moved on to small scale physical prototyping with various 3D printers to explore its materiality before moving on to creating functional prototypes and the scale model.

The scale model was made using polystyrene which was cut on a 3-Axis CNC. Because the machine had only three axis, areas with undercuts were blocky and in further need of sculpting. As it was modeled, the geometry had very intricate curves, especially around the planter areas. Using a hot knife and an electric sander, the foam sculpted further until the curves were continuous. After the model was properly shaped and sanded, I sealed everything with Smooth-On Epsilon and polystyrene spray. I then used various primers and paints to get a smooth surface.

After completing these initial cuts, studio closures began due to the pandemic. So, in light of being able to finish the model and continue with prototyping, I used Blender to create higher fidelity models to communicate the final design ideas..

While much of this documentation and experimentation was cut unexpectedly short, I believe it serves as a valuable snapshot of the development at this particular stage of the project. The subsequent book will include documentation of the mimosa experiments and the design iterations that occurred after COVID along with the concurrent developments to the theoretical framework.

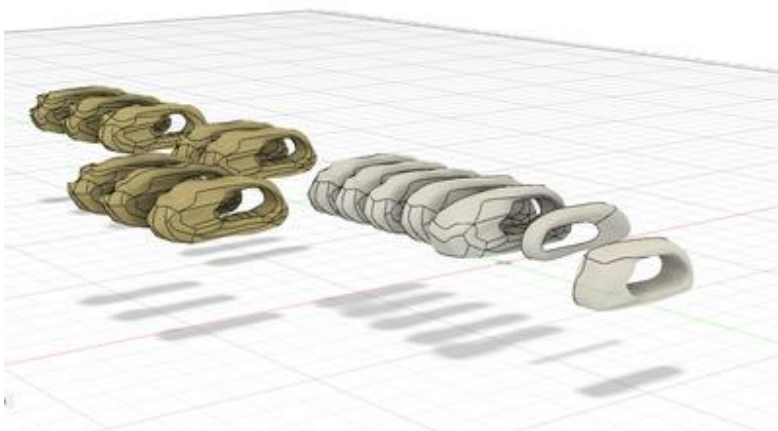
Fabrication & Experimentation

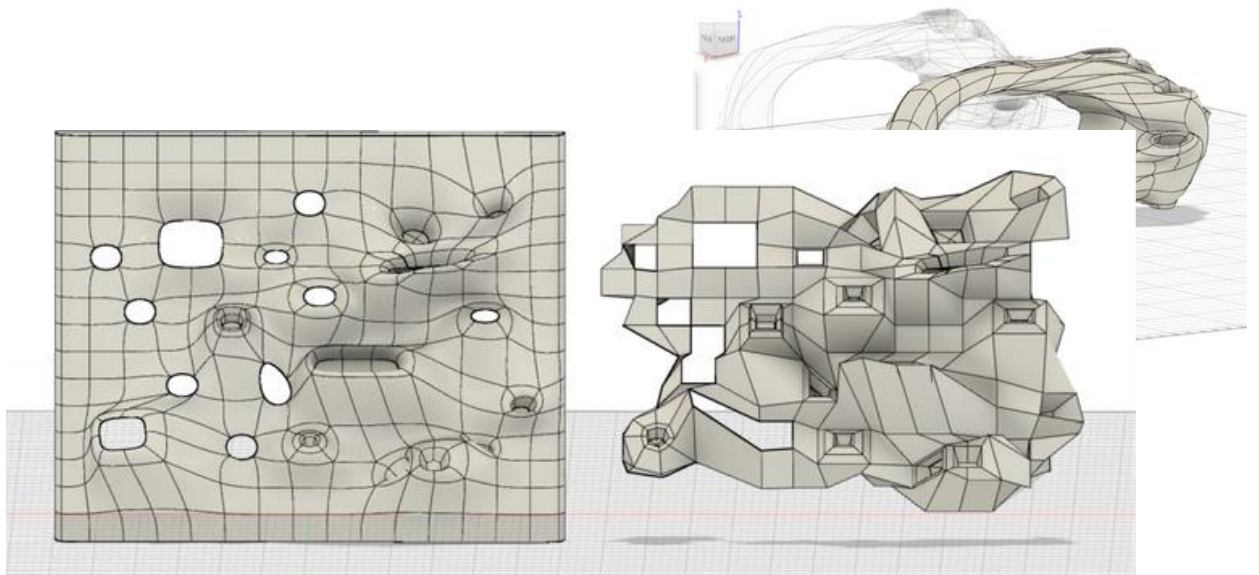
Form Exploration



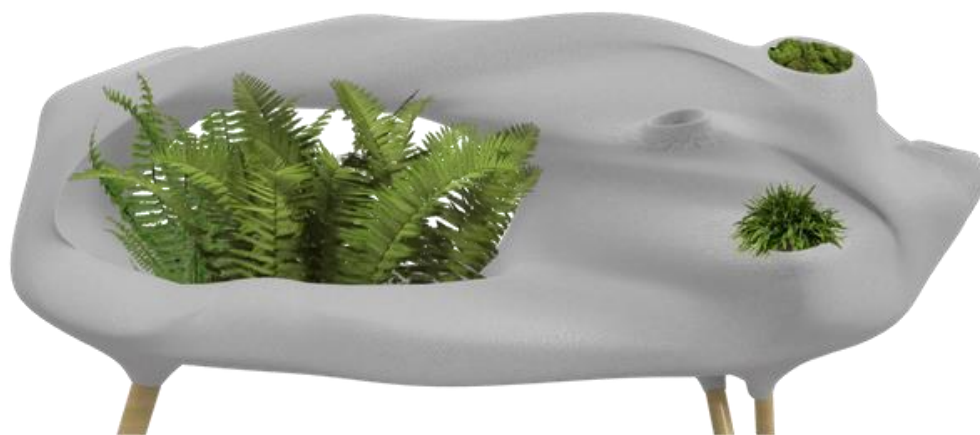


Digital Modeling



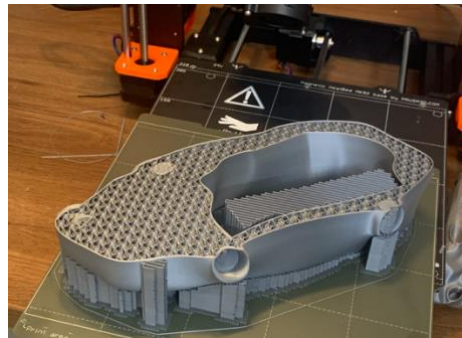


Preliminary Renderings

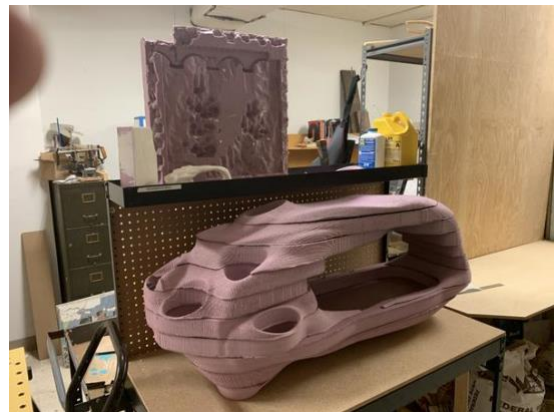
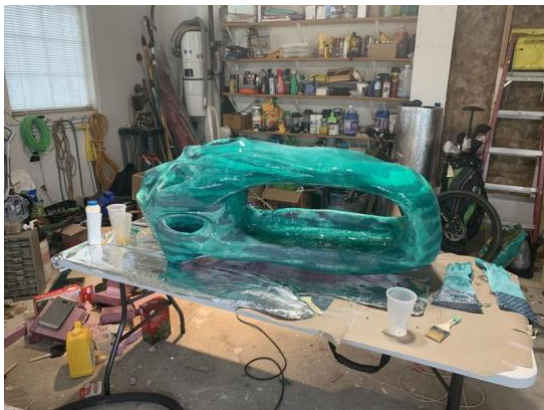




3D Printing



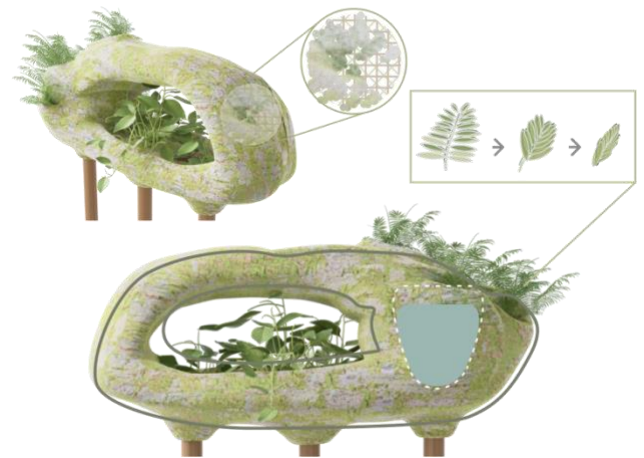
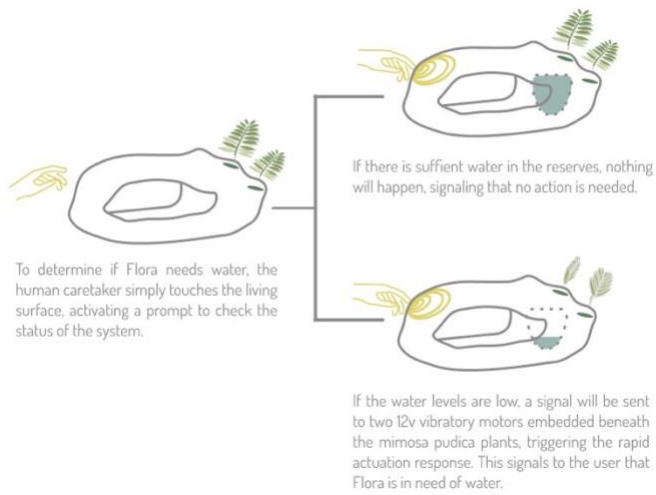
Scale Model Fabrication







Final Renders and Diagrams



Final Poster

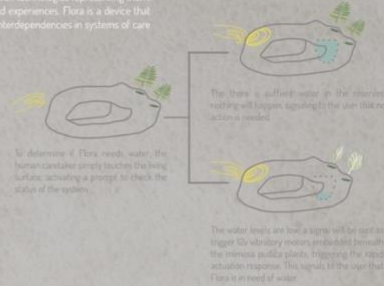
Designing Living Interfaces More Than Human Assemblages of Care Greg Sieber

Technologically mediated interactions between human and more-than-human worlds are ubiquitous. These mediated relationships unfold in domestic spaces and on sprawling infrastructural scales. They play out in environmental monitoring practices, food production at almost every scale, in resource management and in contexts of care. These deep entanglements have left virtually no engagement with non-human "others" untouched. As non-humans become more deeply enmeshed with technologies representing them, designers building these technologies are increasingly faced with questions of how to best translate and represent non-human needs and experiences. Flora is a device that imagines how we might build living interfaces that blur the line between nature and technology while exploring what it means to design interdependencies in systems of care for non-humans.



Designing Systems of Care

Flora, at its core, is a semi-autonomous watering system designed for plants in domestic spaces. It uses soil moisture sensors to detect when plants in the system are in need of water, then uses a water pump to deliver the appropriate amount from an internal reservoir to the corresponding plant. While the microprocessor, the soil moisture sensors, and the water pump are responsible for monitoring the plants and delivering the resources necessary for survival, a human caretaker is tasked with ensuring the system has water in its reserves. Flora is meant to challenge the paradigm emerging in semi-autonomous gardening systems that are designed to be as streamlined as possible. While the human is entrusting the soil moisture sensors to detect the needs of the plants on a more granular level than naked observation affords, there remains a need to attend oneself to the behaviors of the plants in other ways. It is meant to make the interdependencies more explicit between the human and the non-human, both biological and technological, agents in this small ecosystem of care.



Designing Multispecies Intimacy

Using a porous 3D-printed conductive substrate, the moss covering the surface of Flora is able to translate human touch into signals that communicate directly with the microprocessors powering the watering system. By touching Flora's living surface, the human caretaker is checking the status of the system to determine if it has the resources, in this case water, it needs to sustain itself. In *Touching Visions*, Pug De La Bellacasa describes touch technologies as "material and meaning producing embodied practices entangled with the very matter of relating-being" (24). This kind of sensorial embodied interaction is meant to counter automated systems of care that may simply notify a human caretaker when the needs of non-humans are not being met. While automated systems are often designed to maximize efficiency and eliminate ambiguity about the needs of non-humans, Flora aims to cultivate a more intimate awareness of the plants' needs and design towards Anna Tsing's call to nurture our response-abilities, or our abilities to notice and respond to the lives of non-humans.

Designing Interdependency



The mimosa pudica is a seismosensitive plant, meaning its leaves will close and its stems will wilt when exposed to environmental stimuli such as wind or touch as a defensive mechanism (3). Researchers have shown that this rapid actuation can be stimulated chemically or electronically. Further, they have leveraged this unique affordance to experiment with techniques of using the mimosa pudica as an output for digital information. Flora builds on this research and leverages the mimosa's rapid response by embedding 15 vibratory motors beneath them that activate when the system is signaling to the human caretaker that water levels are low. This creates a unique interdependency in which the technology embedded in Flora is relying on the mimosa to transmit information to the human caretaker. Just as the biological agents in Flora are depending on the technological agents to tend to their needs and distribute resources, the technological agents are depending on the biological ones to communicate on their behalf.



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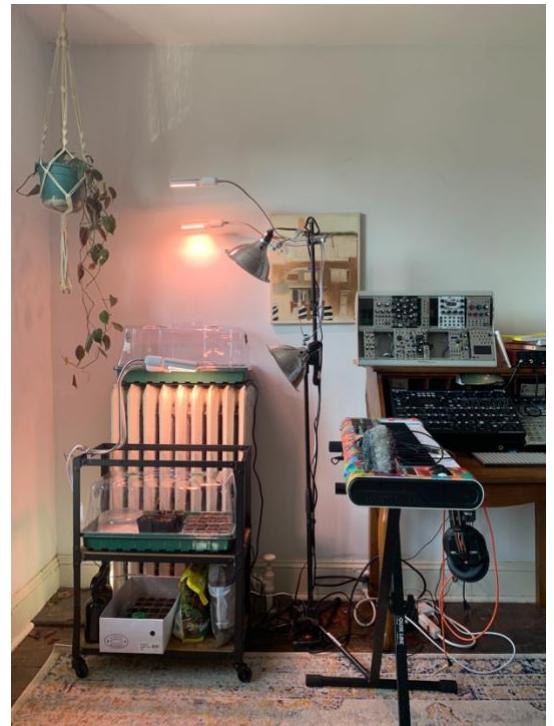
Design, Research, Reflection



The design of Flora came out of extensive material exploration. From the cultivation of the mimosa pudica, to the fabrication of the enclosures, the design is rooted in existing and accessible technological and scientific paradigms. Flora is, in one sense, only speculative in that a fully-functioning scale prototype hasn't been made, though each independent element has been successfully prototyped. This is partly due to losing access to resources and facilities in the wake of the pandemic, which has led to an inspiring shift towards envisioning design possibilities in digital spaces that are not yet possible through contemporary digital fabrication techniques. It is also speculative in the paradigm that it imagines. It is hard to believe a system like this could exist in the field of consumer products that leverage semi-autonomous watering systems to make caring for plants as simple as possible. Flora is designed to counter this idea that simplicity and efficiency are the highest aims when it comes to representing the needs and interests of non-humans, which may depend in part, on a human caretaker for survival. It is also meant to prompt further imagining into how this paradigm may be exacerbated in the future when digital sensing technologies can observe the needs of non-humans with even more granularity. Flora represents a speculative paradigm of interaction utilizing the morphologies of plants uniquely suited to interface with digital systems so that we may further blur the imaginary line separating nature and technology.

Mimosas







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