

Being, Bringing and Bridging – Three Aspects of Sketching with Nature

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ABSTRACT

We articulate and reflect on the use of nature as a physical sketching material. We have closely documented explorations of various organic and non-organic materials found during excursions in a local forest and how we used them as resources in sketching. This serves as an exemplar case of how sketching in interaction design can be grounded in empirical explorations of nature. We discuss three examples of sketching based on explorations and experiences with elements and objects from a forest. Processes and characteristics of phenomena in nature such as falling leaves, melting and freezing of snow, and perennial growth allowed us to expand our design repertoire and sketching skills, especially as new forms of representations and interactions. Based on this we outline three aspects of how nature can be included in sketching processes: *being in nature*, *bringing nature to the lab*, and *bridging nature and interaction design*.

Author Keywords

Physical sketching; nature; research through design; design exemplar; design grounding; interaction design.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Sketching is a core activity within interaction design [8, 9, 24]. In the past, such practical aspects of interaction design were labeled “the black-art of CHI” [33] but have since then moved from being a mysterious art to a fairly well documented practice at the center of interaction design [10, 23, 35]. However, as interaction design as a discipline evolves, the practices that are associated with it also need to evolve. Here we turn to nature and the experiences it can provide to shed light on how they can be incorporated into

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sketching practices. Our aim has been to capture critical aspects about various interaction design challenges in a fashion that may contribute to a corpus of knowledge around sketching and interaction design practice.

While nature has a long history of inspiring work in arts and science, the corpus of documented design knowledge around the use of nature as a material for sketching is fairly limited. The work presented in this paper serves as an exemplar case of how sketching in interaction design can be grounded in empirical explorations of the dynamic character of nature, and being in nature. The work was conducted in the context of designing a mobile application for raising awareness about sustainability issues related to consumption of fruits and vegetables gleaned from various data sources that fed into the system. EcoFriends, the application itself is outside the scope of this paper but studies of it have been published elsewhere [26, 27, 29]. Here we instead focus on the design process and how we worked with nature during it.

The core of this work has been to articulate and reflect on our practical ways of sketching with elements of nature to provide a practice-oriented case. In the process we have closely documented our efforts of sketching with various organic and non-organic materials found during excursions in a local forest but also how the experience of being in the forest influenced the design. We reflect on three interrelated aspects of the design process. First, how experiences and explorations with elements and processes in the forest, were used to sketch interactions and representations. Second, we reflect on how our design research approach contributed with a particular way of seeing and meeting nature, thereby, turning it into a setting for design. Finally, we reflect on how this approach led to sketching becoming closely intertwined with our experiences and hands-on explorations using elements, such as wind and temperature, and objects, such as leaves and branches, gathered in nature.

The main contribution of our work is a detailed account of how a process of sketching was grounded in a specific material setting and how that renewed sketching practices. In particular, we show our practical ways of approaching the characteristics of phenomena in nature such as withering and falling of leaves, melting and freezing of snow and ice, and perennial growth. We conclude by discussing our experiences in the form of three high-level

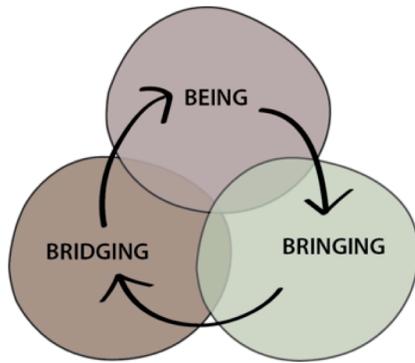


Figure 1. The aspects of being, bringing and bridging constitute an iterative process in design.

aspects of physical sketching in and with nature: *being in nature*, *bringing nature to the design lab*, and *bridging nature and interaction design* (see Figure 1). Together they outline a practical way of combining the dynamics of an inspirational setting (here nature) with a concrete design case.

With the experiential and aesthetic turn in HCI, sketching has become an increasingly important aspect of interaction design research and practice. An example of research that attempts to lay out the relation between sketching and common materials used in interaction design such as clay and play materials, Lego etc, is Tholander & Normark's [28] study of how the "talking back" of these materials relies on the social and situational circumstances of the design setting. However, while sketching using pen, paper, and other materials found design labs is fairly well studied [8, 24], sketching using other materials and processes is less investigated although some examples exist. Oulasvirta's [21] work on Body Storming focuses on bodily ways of engaging in sketching activities. Following this Márquez-Segura's [19] work on embodied sketching, emphasize that many qualities of design sketches are ephemeral and become temporarily manifest during the design process. To further expand our repertoires of sketching, new approaches and materials need to be explored and articulated in relation to how they support design. A step in this direction is Kosmack-Vaara's study of sourdough as a sketching material for exploring temporality in interaction design [14].

In design and architecture there is a long-standing tradition of turning to various external sources and situations for inspiration and grounding ideas. Nature and organic, living materials have been common sources for such inspiration. Examples where nature and organic processes are used as a ground for design include [4, 14] that taps into the richness of non-geometric forms, dynamic colours and textures found in nature such organic approaches to form-giving in relation to geometry are also discussed in [1]. Similarly, the "Animals Project" by the design group Front explored the possibilities of a non-humanly-mediated form-giving process [37], and the architecture of the famous Sidney

Opera house was strongly influenced by how geometric forms are generated and decay in nature [34]. In more ethnographically oriented strands of HCI, studies of practices conducted in nature such as gardening [11] or watching cherry trees blossom [2], draw out concepts and themes that can serve as starting points for design. Biomimicry or biomimetics [5] has gone a step further by building models and systems to solve complex problems based on solutions found in nature. Well-known examples of this include the Velcro tape that originates from the function of burs, air conditioning systems in office complexes modelled after the self-cooling mounds of termites [5], and the structure of mosquitos' needles that have inspired needles for painless injections in health care [39]. In intelligent user interface research nature has contributed to designs with a stronger sense of aliveness and agency [3]. While this body of work represents interesting solutions to problems in engineering and science. However, from an interaction design point of view there is also a need to articulate how sketching can be practically grounded in processes and elements of nature in a way that lends itself to novel interaction design processes.

A Design Research Approach

Methodologically, this work belongs to a category of research where design practice forms part of the knowledge production process. As such it embraces practice-based and creative design disciplines to contribute to knowledge production and development [25]. HCI has a tradition of falling back on applied behavioral science and user interaction studies for validation of design. Within that tradition design and sketching processes themselves have primarily played the role of creating *instruments* for studying use of technology, which in turn, has been seen as the actual knowledge contribution. In contrast to this, our work aligns with a practitioner approach to HCI [22, 36, 6], rather than the common user-study oriented forms of research and validation. Moreover, here sketching is not seen as a step in a linear process where sketches are gradually refined into functioning products, but rather as part of an improvisational and explorative way of engaging with ways of expressing the workings of a system.

A key element in *research-through-design* [36] is the focus on such practice-based dimensions of interaction design [18]. This perspective recognizes the knowledge that lies in design practice as such, in design and sketching processes, and in the resulting artefacts. A central assumption of this approach is that important design knowledge can be found in the design process itself, and that our ways of expressing that is limited in current research methods. A grounding in design research emphasizes conscious and articulated judgments, reflection and appraisal of design considerations [20, 24, 9] and take the role of user studies in more traditional HCI for validation of design knowledge. Thus, new ways of exploring how interaction design knowledge can be expressed and communicated is needed. Prominent examples of conceptualizing and expressing knowledge

from particular design cases is for instance made though, design exemplars, patterns, experiential qualities [17], annotated portfolios [7], strong concepts [12], and programs [22]. The work presented here provides design knowledge close to the practice itself, articulated in three aspects of sketching inspired by spending time in a forest and engaging with the materials found there. The concrete contribution of this work should therefore be understood in the articulation of a practical process of sketching and the experiences it is grounded in, rather than a novel use of nature as inspiration. Grounding is here achieved primarily by practical explorations, and also by relating to other documented design cases, and user encounters.

SKETCHING WITH ELEMENTS OF THE FOREST

First, let us explain what the sketching process was targeting. One of the main reasons for using the forest as a resource in our sketching process was that the ever-changing nature of the forest resembled the dynamic nature of interaction design. During each walk we brought an array of possible representational challenges in the back of our minds rather than a specific problem to solve, which formed our way of looking at and exploring objects and elements in the forest.

The forest walks took place in a typically Scandinavian forest with a rich population of pine and spruce, blueberry bushes, various kinds of mushrooms and moss, and smaller strains of oak, hazel, and birch. In Scandinavian countries forests play a central role in culture and everyday life. Through the Right of Public Access (an old customary law) all forestland, private as well as state and community owned, is accessible to the public for recreational activities including picking berries and mushrooms for own use. This is a mutual agreement meaning that nature is cared for by anyone using this right.

Our explorations were based on weekly walks along essentially the same route through the forest conducted during a whole year (see Figure 2). During walks we explored various elements, such as plants and places, trees, rocks, streams, flowers, moss, trails, and openings. Initially, we explored whatever caught our attention during a walk and took photographs and brought samples such as sticks, pine needles or fallen leaves back to the lab. Our approach was to not merely take properties of the forest and translate them into user interface representations, but rather to explore how our experiences of places, elements, and materials could be understood and incorporated into our sketching process. In the following sections, we have attempted to articulate and visualize the evolution of three interrelated sketches and how explorations in the forest became manifest in the design. In particular we pay attention to falling of leaves, melting and freezing of snow and ice, and growing and withering of perennial plants.

Throughout our walks, we reflected on various processes that we encountered in the forest, e.g. during an early snowfall we reflected on how the shape of a rock changed



Figure 2. The route of the weekly forest walks and example photos of the scenery.

when it was covered by a fresh layer of snow, we reflected on how hanging moss slowly grows on a fallen tree, and we observed how insects sped up the process of decay of a fallen stock. During early autumn leaves started falling to the ground and our focus shifted to how the wind affected their movement in the air. We observed the intricate patterns that leaves finally formed on the ground due to their variation in shape and colors, as well as their place in the overall mosaic. This was during a time of the year when objects and places changed significantly between each occasion, leading us to dig deeper into how we could use such changes in sketching forms and representations.

Sketching with Leaves. During walks in the autumn, we grew particularly interested in the intricate way in which leaves were falling to the ground and the unpredictable layers they created. We observed how the formation of layers was affected by the wind as well as other factors such as one of us passing by and disturbing the leaves. Through this process the leaves constantly rearranged themselves into intricate patterns that provided different visual impressions, due to variation in color and placement or made fresher leaves end up on top of the others partially obscuring underlying layers. (See Figure 3)

This led us to further explore the behavior of leaves. We began to more specifically reflect on how these particular



Figure 3. Left: Layering of leaves on the ground in the forest. Right: Just after a gust of wind has restructured the leaves.

observations and experiences could be used in sketching. We brought fresh, dry, and semi-decayed leaves back to the design lab. We explored and photo-documented their characteristics such as size and color but also attempted to feel the texture and weight of the leaves. We discovered how their shapes varied and felt the difference between dry and fresh leaves in our hands. We tried ways of dropping them from a height to explore how trajectories through the air were affected by the size, weight, and shape of leaves. We observed how the order in which they fell, combined with their trajectories, affected where and how they landed resulting in different patterns and layers on the ground (see Figure 4).



Figure 4. The physical properties and affordance of a leaf influence the layers and structures they create.

Furthermore we reflected on our experiences in the forest, and saw how external factors affected leaves, e.g. how they got stiff or crisp from frost on a cold autumn morning, how morning dew made them stick together, how they skipped along the ground in the wind, and continuously created and recreated layers on the ground. To us, they appeared as fragments governed by external forces when being thrown around on the ground. These experiences and explorations with leaves led us to explore how to make sketches using layers of objects, that displayed a similar kind of *structure* as leaves, while at the same time creating an impression of something that at first glance had been randomly *scattered* on the ground. To achieve this we experimented in the lab with samples of leaves dropped on a surface and observed the rich variation in the trajectories and the resulting layers. Only a few leaves were required to create a scattered impression (See Figure 5).

Next, we continued this form of physical sketching by deliberately placing leaves by hand in different patterns, exploring how their shapes affected each other, and how they came together to create an overall impression. This led us to reflect on exactly when the initially scattered expression began to take on a sense of order (See Figure 6). As it turned out, the irregular forms of each leaf seemed to contribute to a combined sense of both order and scatteredness. This duality seemed like a path for creating visual representations that combine structure and scatteredness that we found promising.

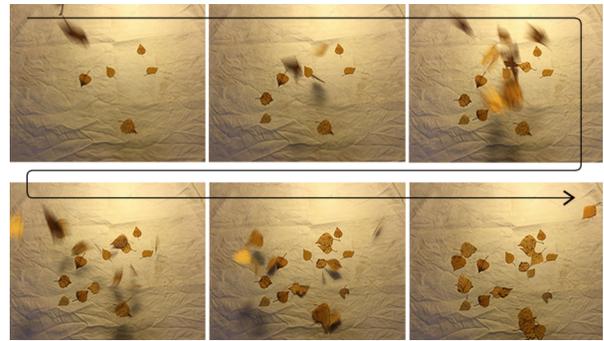


Figure 5. In the lab: Samples of leaves whirling down on to a surface. The sequence goes from top left to bottom right.



Figure 6. We made physical sketches with the leaves and imagined how of the leaves' could represent scattered data.

Representation and interaction: Next, we began exploring how the properties of leaves could be expressed in our own design, which focused on portraying fruits and vegetables. In early sketches, we played with how each leaf could render a photo of a specific fruit or vegetable, with a specific position and orientation conveying the sense that they had been dropped onto a surface - just like leaves. We also experimented with patterns similar to those of leaves to create a collage-like character in the interface (See Figure 7).

In reflecting over our design work, we decided to dig deeper into the continuous processes of change we had observed in falling leaves. We explored how leaves pile up and how this could be mirrored in our representations while capturing some of the experienced dynamics and unpredictability of how leaves behave.

These sketches resulted in a layered structure of objects (see Figure 8) that made it possible to make all objects visible in an overlapping fashion. All in all, our explorations of leaf layering in nature resulted in a sketch where each object could move up and down in a stack of layers (See Figure 8). Layering is a well-known and widely used metaphor for expressing inherent order in a structure. The aim of our exploration was to explore the way layering

Sketching with leaves



Sketching interface representations



Figure 7. Experiments with a scattered collage like structure.

is accomplished and how it renders an aesthetic value of dynamics to interaction. However, when making a prototype implementation of the sketch on a mobile phone for a large number of objects, we found that the scatteredness made it hard to comprehend the order of the layers. This led us to explore how to give a better sense of the relation between the objects. This is where we turned to another element in the forest – snow and ice.

Sketch with leaves



Interface sketch



Figure 8. Experimenting with letting the layer structures of the leaves being reflected in the representation.

Sketching with the Melting of Snow and Ice. As mentioned earlier on, we did not bring specific problems to solve on our forest walks, but with the on-going design process in the back of our heads, we started to explore the properties of snow and ice through that lens. During our walks in the winter season, the landscape was mostly covered in snow. This led us to reflect on how snow influences the overall experience of the forest. When the temperature dropped and the snow cover became stable, we were engaged in new playful actions relating to traces in the

snow, such as making angels, or following the traces of an animal that had crossed a trail (see Figure 9).



Figure 9: Traces of a snow angel and traces from a bird.

Our reflections of how snow affected our experiences of the forest led us to further explore how this could inspire us in designing dynamic layers. Frequently during our walks, the temperature had fluctuated around the freezing point. This let us to repeatedly experience the details of the rapid changes that snow can undergo. When engaging more closely with the various forms that snow took, we experienced the large number of factors that affected it. This included not only general factors such as temperature and humidity but also micro-level factors such as the specific location or interaction with surrounding elements. For example, we observed how snow was melting slower on the north side of a rock, or how a certain place was cooler or warmer which affected the cycle of melting and freezing in various ways.

We played with fresh snow in cold temperatures and low humidity to feel its lightweight character and how it spread like a powder from only a light breath (see Figure 10).

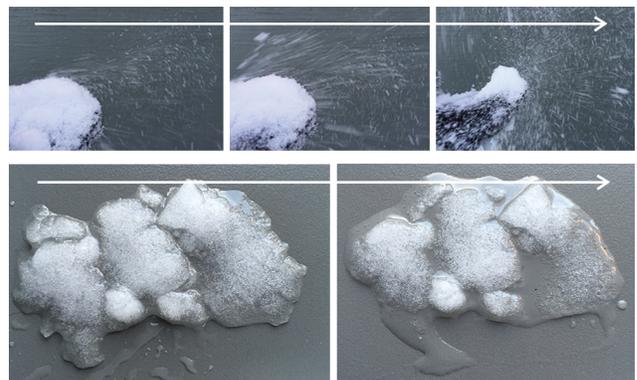


Figure 10: Experiments with snow. Top: Blowing on fresh, cold snow that distributes in the air. Bottom: Melting of snow becoming more transparent.

In some places there were warmer spots, like on top of a rock, which stores heat and makes snow melt quicker, and we saw how touching the snow affected the melting process by making the snow more compact. When the temperature dropped, we observed how the snow that had melted froze again, and layers of transparent ice were formed (see Figure 11, C). Conversely, when the temperature rose again, we could see small hole formations in the ice layer (see Figure 11 D). This allowed us to experience and document some of the reversible properties of snow and the many forms it can

take on. Through our continuous documentation we learnt how this is not a discrete on/off effect, but a fluent process moving between a fully opaque layer of snow, to a partially transparent thick cover of ice, to fully transparent crystal-clear ice, to perforated layers with melting water dripping to create small holes with the ground fully visibly underneath (see Figure 11, A-E). We were fascinated by how this was reversed when the temperature and humidity changed, causing the ice to dry and create crystals like snow, which sometimes covered the holes (C). Some stages of this process were sometimes skipped for example going from, semi-opaque directly to holes in the snow cover. All these processes changed the visibility of the underlying ground and gave us an impression of how snow actually worked as a dynamic filter.

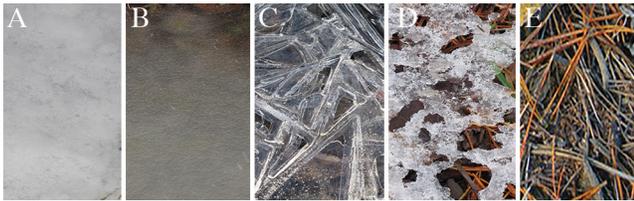


Figure 11. A: An opaque layer of snow, B: Melting into semi-transparent, C: Transparent ice, D: Peak holes in a thin ice layer, E: Totally ice free, clear.

The snow was harder to bring back into the lab as a sketching material, so most of the explorations took part outdoors. For instance, we sketched by slowly pouring water on the snow cover to see how this changed the appearance over time. We brought some samples of snow into the lab and let it melt on a table surface, where we watched the dynamic process of the snow going from fully opaque to partially transparent to transparent (see Figure 10). It became evident to us that the thickness and density of snow affected it to melt at a slower pace in some locations which affected the overall picture. These on-going variations in the appearance of snow and ice, acting as a dynamic filter, inspired us to see other possibilities on how to design the layering structure of objects while maintaining the sense of a partially unordered pattern created by falling leaves.

Representation and interaction: Next, we began exploring how to incorporate these properties into our design portraying fruits and vegetables. By drawing on the process of melting and freezing we decided to create sketches using various filter-like representations that resembled the snow and ice. (See Figure 12)

We continued sketching and tried to make the filter even more continuous by removing holes, and thereby also leaving the distinct layer structure that leaves had created intact. In these representations objects could range from almost opaque to fully transparent in a fluent manner over time (see Figure 13). Transparency and filter, are just like layering, commonly used solutions in interaction design representations, but they can be applied in many ways and

the point here is the explorative character and the aesthetics and dynamics of interaction it renders.

The dynamic filter created a sense of layering, where the filter affects each fruit and vegetable differently, just like the snow melts and freezes differently in different locations depending on factors intrinsic and extrinsic to the material. These filter-changes become visible over time (See Fig 14).

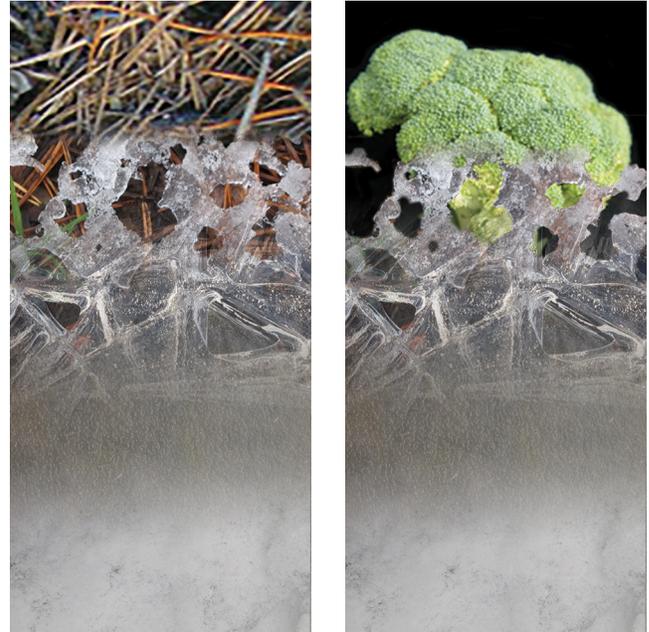


Figure 12. Left: Representing the process of visibility of snow and ice in a filter-like process. Right: adding the filter to a vegetable in the interface



Figure 13. How a certain object in the interface is affected by the dynamic filter.

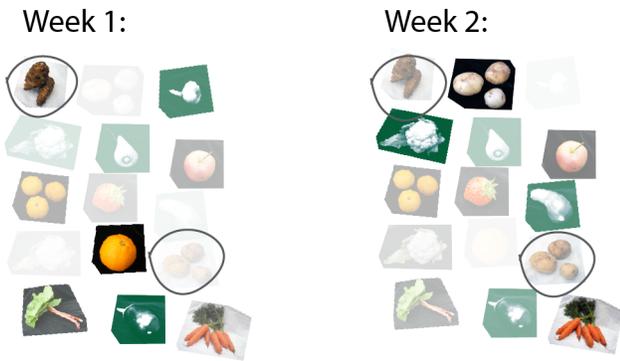


Figure 14. Interface sketches: In “week 1” the filter over the artichoke is fully transparent, while in “week 2” it is more opaque. In “week 1” the filter over potatoes is almost opaque, while in “week 2” visibility has increased.

Now we were faced with finding ways of portraying the variations of the filter as it changed over time. A common conceptual metaphor for time is the cyclic model such as a watch face [38]. We decided to apply this to our representation, by placing each object on a circular surface, where you move back and forth in time by scrolling the background as if turning a wheel. However, when making a prototype implementation of this sketch on a mobile phone for a large number of objects, we found that when scrolling in time it was difficult to get an overview of the differences that the filter expressed. This would make objects disappear from the screen, thereby not allowing for comparisons (see Figure 15). At this point we once again turned to our experiences in the forest, the growing and withering of perennial plants.



Figure 15. A circular time metaphor, where all objects are distributed evenly and stuck on the surface.

Sketching with Perennials: Growing and Withering. Since our weekly forest walks lasted for a whole year, we experienced several seasonal shifts in the forest. From early spring when the forest wakes up and starts to germinate, to

summer and blooming, to autumn when plants wither away, and finally winter when plants decay and are hidden under snow. Our experiences of these seasonal changes led us to explore elements that reoccur year after another. When looking back at our documentation, we were especially interested in the growth process of perennial plants, and how each unique plant is affected by temporary changes such as the local weather and temperature. In particular, we explored an *Anemone hepatica*, since this was common along our excursion path (see Figure 16).



Figure 16. Seasonal changes in an *Anemone hepatica* in the forest from spring to winter.

We documented changes in colour, form, volume, size, and saturation of liquid in the plant for each flower in photos. We noticed how they recurred in the same places, and how volume and size followed a similar pattern between seasons (see Figure 17), but varied depending on local factors.

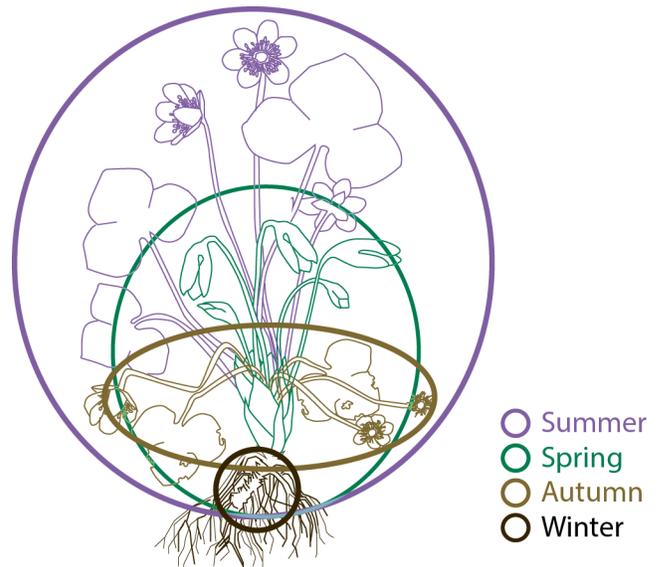


Figure 17. Illustration of shifts between growth stages over a year in a perennial plant (here *Anemone hepatica*), captured in volume and size.

Representation and interaction: Inspired by the recurring position of perennials, we decided to mirror the sense of objects having a fixed *position* on the screen. This allowed us to separate the scrolling of time from the actual objects (see Figure 18, left).

Now, time changes as the circular background of our representation is turned, while each fruit and vegetable remain in the same spot. Like the growing and withering of perennials, objects in our representation changes in size and volume when the user scrolls back and forth in time (See Figure 18, right). Scrolling gives an impression of an alive surface with objects moving in depth combined with the filter changing transparency to give a sense of ever-changing scenery. (See Figure 18).

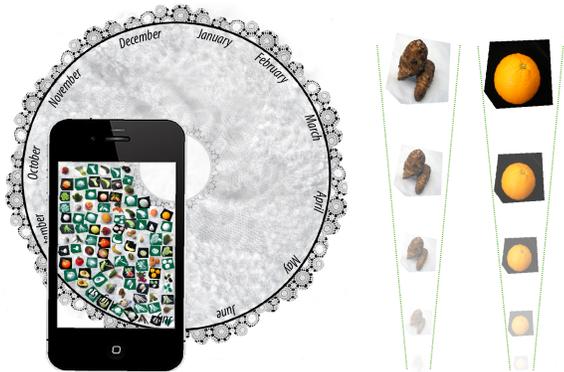


Figure 18. Left: Each fruit and vegetable with a fixed position. Right: Size reflecting a perennial character.

The change over time is illustrated by the two curves in Figure 19. The curves represent the changes in size and transparency, while the objects stays at a fixed point on the screen. When the background wheel is turned, the orange and tomato, grows and shrinks as if moving up and down through layers. In the left part of figure 19, representing October, the tomato is highly visible, while the orange is less so. To the right, representing September, the orange is more visible, while the tomato has shrunk in size compared

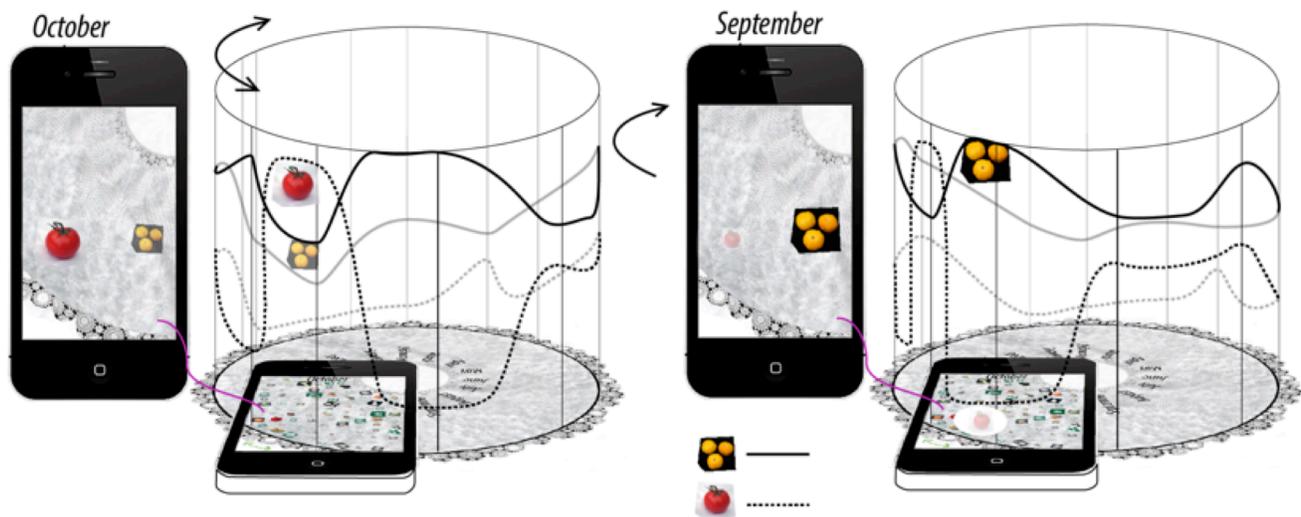


Figure 19. Changes in transparency and size over time exemplified by the two curves, the curve that the orange follows and the curve of the tomato.

to October.

These three relational sketching examples illustrate both how we made use of findings from the forest to meet our design challenges, and how our experiences worked as a catalyst in the creative form-giving process rendering aesthetics to the interaction.

DISCUSSION

A fundamental challenge in interaction design is to find ways of dealing with the inherently dynamic character of interaction, and especially to align it with emerging novel technologies. As researchers in interaction design, we are dealing with a moving target, as the properties and settings of our design efforts constantly evolve, and challenge us to find ways of shaping the “dynamic gestalt” [17] of particular interactions. We have explored how practical engagement with nature can be incorporated into sketching practices as a way to attend to the dynamic and aesthetic characteristics of interaction design. The core of our work regarded exploring and articulating ways of sketching based on experiences in a local forest. One should note that these experiences concern aspects of nature that many people might consider mundane and have similar experiences of. The point we are making is about attending to what such experiences reveal to us, and thereby, serve as an alternative way of integrating nature and its elements as resources in a design research practice.

A main theme in this work was concerned with detailed articulations and documentations of the design process. Based on this we have outlined three aspects of sketching based on experiences in nature (see Figure 20):

- *Being in nature* by experiencing, discovering and, exploring.
- *Bringing nature to the design lab* by experimenting, manipulating, and understanding
- *Bridging nature and interaction design* by designing, transferring and applying.



Figure 20. The aspects of being, bringing and bridging do not have a linear structure, but is an iterative process where activities are sometimes interleaved.

Being in Nature

The first aspect of sketching in nature revolves around how *being in nature* throughout a design process can capture a broad range of inputs to the design. Being in nature can be as simple as taking a walk in a local forest in order to open up one's thinking. It is also about actively attending to elements of nature from the point of view of a specific design problem in various ways. For instance observing how moss grows in a layered structure on a rock, or to touch and feel elements, objects, surfaces and spaces in nature - for instance, by making angels in the snow - in order to identify specific characteristics. Throughout our own research process, explorations in the forest gave us insights into the rich variety of forms, shapes and structures that elements of nature can take and the many ways they can be brought into design. As we hope to have illustrated, such ways of being in the forest, provides an engagement that is different from what would appear in a traditional lab setting, thereby, resulting in design alternatives that otherwise would not be found. Being in nature provided us with a range of experiences with potential for influencing a design process. Examples of this include inspiration for a specific form language, ideas for new qualities of interaction, or concrete solutions to a design problem. Such explorations provide a particular design-oriented lens for being in nature that both expand one's sketching repertoire and reasoning about a design case.

As discussed above, grounding interaction design work in nature can mean many different things. One key aspect regards how one's concrete embodied presence in nature with an orientation towards sensing and playing with familiar elements of the forest frames design in a particular way. The mere fact of mindfully taking design challenges into the forest, creates a certain reflective lens that highlights the experience and often playful and spontaneous actions in the forest. Walking, looking, and being in the forest becomes a deliberative way of thinking about

interaction and representation in the context of a particular design challenge. It allows breaking free from conventions and routine practices in order to explore the unexpected both in the design process and the resulting design. While this might seem unsystematic, we argue that this way of approaching design carries potential for opening up and expanding the creative aspects of how we conduct design research and practice.

Bringing Nature to the Design Lab

The second aspect of sketching in nature that we have engaged with concerns bringing elements and objects of nature back to the design lab in order to explore and experiment with properties of these materials. This allowed us to attend to aspects of nature in more detail, for instance the shapes and colours of leaves or how snow melts over a surface. The lab allows us to control and manipulate materials in a systematic manner, and relate them to the technologies we are designing. Our engagement with the dynamic characteristics of snow and ice, i.e. how it melts and freezes, the various ways leaves moved in air and how the perennials grew, are all examples of experiments we conducted. Through this we were able to express transformation and change in our interface in unconventional but concrete manners.

In addition, the explorations of the various forms, structures and layers of falling leaves could most straightforwardly have been used to transfer the visual qualities to our specific design problems. However, a core assumption of our design approach was that design inspiration and ideas are not simply out there to be discovered and used, rather, they arise through particular experiences in on-going design processes. To go beyond the mere transfer of surface properties into design, we argue that experiences and explorations of the forest must be tightly aligned with the specifics of a design situation. In some cases this might result in straightforward design solutions, while other cases become more conceptual and indirect. Hands-on manipulations allowed us to explore not merely inherent properties of objects themselves, but also, emergent aspects such as how snow can be moulded and used and take on new meanings depending on the context. For instance, it can be used as a "weapon" in a snowball fight or a surface for playful expression in making snow angels. In addition these different uses can change the physical properties of snow such as density. Careful attention to the material enabled us to focus on details of our forest explorations and how they could contribute to our sketches through text, photographs, visual depictions, and other expressions.

Bridging Nature and Interaction Design

The third aspect of sketching in nature concerns bridging explorations, experiences, phenomena and properties of nature with interaction design. This revolves around giving shape to an interactive artifact based on explorations and experiences from being in nature and bringing nature to the lab.

Bridging can be achieved at many different levels ranging from the minute to the whole. By concretely aligning, mapping, transferring, and translating physical and experiential qualities novel design representations and interactions can be created. Such sketching provided a highly design specific way of understanding transformational characteristics of nature that stands in contrast to more general attempts to identify the workings of nature and mimic that in design [5]. By specifically attending to experiences in the forest, we were able to develop novel ways of sketching and put this in relation to interaction and representation. As transformation - or change - is at the core of all interaction design these forms of bridging activities harmonize with designing for the dynamics of interaction.

Furthermore, this provided a more fundamental viewpoint of what can be learnt from nature by deeper engagements and reflections of being in nature and bringing materials from the forest. This includes how the forest appeared to us at a particular moment, such as how leaves fall on a rainy day, the shape of a rock after a snowfall, as well as how phenomena emerge and are experienced over time, such as the slow growing and withering of plants. In the case of perennials we focused on the characteristics of place, size, saturation, and volume. While in one sense this is a one-to-one mapping between nature and our sketches, it also involved a conceptualisation of aspects of nature that are not accessible through one-off observation.

Reflections on Design Research

The design research strand of HCI still struggles with how to formulate what interaction design knowledge actually is. Thus, as a field we need to continuously engage with how to identify key parts of our design processes and develop ways to express them. We hope to have shown how sketching in nature can be understood as a form of design knowledge that goes beyond the everyday practices of designers. Thereby, our work complements other approaches, such as ethnographically grounding design in studies of nature [2]. Most importantly though, the articulated design exemplars of our work show potential to serve as generative resources [12, 17, 18] for other designers to broaden their design repertoires. These exemplars are a contribution to the conversation of how to communicate the often black-boxed aspects of interaction design knowledge [33]. This kind of work is merely one way of communicating the steps of going from grounding and inspiration of design, to concrete design. Our approach may serve a number of purposes such as grounding, documenting, communicating and validating research and in turn open up the often hidden processes in design research to make it accessible for discussion and critique.

Thus, this points to the value of considering deeper engagements and reflections with subjective experiences of an inspirational setting in creating concrete design concepts. We would like to emphasize that what we have presented is

a particular form of articulation focusing on photographs, graphic depictions and text of how nature can be used in sketching and in creating a novel design solution. In our work we have focused on the visual and tangible qualities of nature, other qualities such as sound and smell are of course equally important aspects that could have been considered. Our aim of this has been to capture critical aspects of our reasoning about various interaction design challenges in a fashion that contributes to a corpus of knowledge around sketching and interaction design practice. The purpose of engaging with the inherently transformational character of nature in design research is not only about how it concretely can inform our design or that it could be immediately transferred to other design settings or applications. Rather, the value lies within how such reflections and articulations serve as a way of debating what design research is about and how our challenges can be addressed in practice.

REFERENCES

1. Cheryl Akner-Koler. 2007. *Form & formlessness: questioning aesthetic abstractions through art projects, cross-disciplinary studies and product design education*. Axl Books.
2. Fredrik Aspling, Jinyi Wang, and Oskar Juhlin. 2016. Plant-Computer Interaction, Beauty and Dissemination In *proc of ACI'16*, Milton Keynes U.K.
3. Melanie Baljko & Nell Tenhaaf. 2008. The aesthetics of emergence: Co-constructed interactions. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 15(3), 11.
4. Philip Ball. 2011. *Shapes: nature's patterns: a tapestry in three parts* (Vol. 1). Oxford University Press.
5. Janine M. Benyus. 1998. *Biomimicry: Innovation Inspired by Nature*. HarperCollins Publisher Inc.
6. Thomas Binder & Johan Redström. 2006. Exemplary design research. In K. Friedman, T. Love, E. Cortes-Real, & C. Rust (Eds.), *Proceedings of Design Research Society International Conference—Wonderground* (Paper No.0152). Lisbon, Portugal: Centro Editorial do IADE.
7. John Bowers. 2012. The logic of annotated portfolios: communicating the value of 'research through design'. In *Proceedings of the Designing Interactive Systems Conference* (pp. 68-77). ACM.
8. Bill Buxton. 2007. Sketching user experiences: getting the design right and the right design. Morgan Kaufmann.
9. Nigel Cross. 2011. *Design thinking: Understanding how designers think and work*. Berg.
10. Elisa Giaccardi and Elvin Karana. 2015. Foundations of materials experience: An approach for HCI." *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. ACM.

11. Elizabeth Goodman and Daniela Rosner. 2011. "From garments to gardens: negotiating material relationships online and 'by hand'." *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM.
12. Kristina Höök and Jonas Löwgren. 2012. Strong concepts: Intermediate-level knowledge in interaction design research." *ACM Transactions on Computer-Human Interaction (TOCHI)* 19.3 (2012): 23.
13. Parsa Kamenhkhosh. 2010. Design Naturally, unpublished Master Thesis
14. Elsa Kosmack Vaara. (2017) Exploring the Aesthetics of Felt Time Unpublished thesis manuscript, Doctoral Thesis No.6 2017, KTH, Royal Institute of Technology
15. Klaus Krippendorff. 2005. *The Semantic Turn: A New Foundation for Design*. crc Press.
16. Stacey Kuznetsov, Kittur Aniket, and Eric Paulos. 2015. Biological Citizen Publics: Personal Genetics as a Site of Public Engagement with Science. *Proceedings of the 2015 ACM SIGCHI Conference on Creativity and Cognition*. ACM.
17. Jonas Löwgren. 2009. Toward an articulation of interaction esthetics. *New Review of Hypermedia and Multimedia*, 15(2), 129-146.
18. Jonas Löwgren. 2013. Annotated portfolios and other forms of intermediate-level knowledge. *Interactions*, 20(1), 30-34.
19. Elena Márquez Segura, Laia Turmo Vidal, Asreen Rostami, and Annika Waern. 2016, May. Embodied sketching. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (pp. 6014-6027). ACM.
20. Harold G. Nelson & Erik Stolterman. 20003. The design way: Intentional change in an unpredictable world: Foundations and fundamentals of design competence. *Educational Technology*, 2003.
21. Antti Oulasvirta, Kurvinen, E., & Kanjaunen, T. (2003). Understanding Contexts by Being There: Case Studies in Bodystorming . *Personal Ubiquitous Computing*, 7, 125-134.
22. Johan Redström. 2011. Some notes on program/experiment dialectics. *Proceedings of the 4th Nordic Conference on Design Research* (pp. 129-136). Helsinki, Finland: Aalto University School of Art and Design.
23. Erica Robles & Mikael Wiberg. 2010. Texturing the material turn in interaction design. In *Proceedings of the fourth international conference on Tangible, embedded, and embodied interaction* (pp. 137-144). ACM.
24. Donald A. Schön.1983. *The reflective practitioner: How professionals think in action*. Vol. 5126. Basic books.
25. Erik Stolterman. 2008. The nature of design practice and implications for interaction design research. *International Journal of Design*, 2(1), 55-65.
26. Jakob Tholander, Anna Ståhl, Mattias Jacobsson, Lisen Schultz, Sara Borgström, Maria Normark and Elsa Kosmack Vaara. 2012. "But I don't trust my friends: ecofriends-an application for reflective grocery shopping." *Proceedings of the 14th international conference on Human-computer interaction with mobile devices and services*. ACM.
27. Jakob Tholander & Carolina Johansson. 2010. Design qualities for whole body interaction: learning from golf, skateboarding and BodyBugging. In *Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries* (pp. 493-502). ACM.
28. Jakob Tholander, Maria Normark, and Chiara Rossitto. 2012. "Understanding agency in interaction design materials." *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM.
29. Jakob Tholander and Mattias Jacobsson. 2013. "Ecofriends: designing for critical reflection using social voices." *Interactions* 20.1: 58-62.
30. Vasiliki Tsaknaki, Ylva Fernaeus, and Mischa Schaub. 2014. Leather as a material for crafting interactive and physical artifacts. *Proceedings of the 2014 conference on Designing interactive systems*. ACM.
31. Elsa K. Vaara, Anna Ståhl, Sara Borgström and Jakob Tholander. 2012 "Ecofriends, reflection with technology.". In *Proceedings of CHI'12*, May 5–10, 2012, Austin, Texas, USA.
32. Anna Vallgård and Johan Redström. 2007. Computational composites. *Proceedings of the SIGCHI conference on Human factors in computing systems*. ACM.
33. Tracee Vetting Wolf, Jennifer A. Rode, Jeremy Sussman and Wendy A. Kellogg.2 2006, April. Dispelling design as the black art of CHI. In *Proceedings of the SIGCHI conference on Human Factors in computing systems* (pp. 521-530). ACM.
34. Richard Weston. 2000. Influence without anxiety: Jørn Utzon, Silkeborg Museum and Le Corbusier. *Architectural Research Quarterly*, 4(02), 106-122.
35. Mikael Wiberg. 2014. "Methodology for materiality: interaction design research through a material lens." *Personal and Ubiquitous Computing* 18.3: 625-636.
36. John Zimmerman, Jodie Forlizzi, & Shelley Evenson. 2007. Research through design as a method for interaction design research in HCI. In *Proceedings of*

the SIGCHI conference on Human factors in computing systems. (CHI'07). 493-502.

37. www.frontdesign.se/category.php?id=66&product=171
Last visited 2017-04-06
38. Eviatar Zerubavel. 1985. *Hidden rhythms: Schedules and calendars in social life*. Univ of California Press.
39. <http://biomimicry.org/biomimicry-examples/#.VpfbzsArJo4>. Last visited 2017-04-07