SKIN: Designing Aesthetic Interactive Surfaces

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ABSTRACT
In this paper we propose SKIN as an interdisciplinary design approach for sophisticated interactive surfaces, with an emphasis on their meanings and aesthetic qualities. SKIN: Surface Kinetics Interface, aims at integrating concept-driven design process and exploratory critical engagement with forms and materials into current user-centered design approaches in HCI research. The procedures of developing three design concepts and prototyping one of them—an interactive lampshade—are described in detail to illustrate the proposed approach. The narrative of the design process is followed by a pilot study and designer reflection, suggesting the broader epistemological and methodological implications of this kind of approach.

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INTRODUCTION
As computing technology pervades everyday life, a new wave of Human-Computer Interaction has appeared, bringing challenges to current research paradigms in HCI [4, 18]. Recently many of the concerns of HCI research have changed to consider affective, experiential and cultural values of digital object beyond work or goal-oriented tasks. However, traditional HCI research is largely based on incremental scientific approaches, which struggles methodologically on issues such as the aesthetics of form and the subjective experiences and interpretations of digital artifacts—issues central to the problem space of tangible computing. Increasingly, the field is looking to design to help address these issues, and yet design is not yet fully integrated into HCI, nor the specific area of surfaces.

In the meantime, HCI research is increasingly concerned with everyday physical objects, while tangible computing has sought to borrow a research framework from different disciplines (e.g. HCI) to consider experiential aspects beyond technical implementation of novel interfaces [20]. However, a gap remains between user-centered perspectives in traditional HCI research and the need for understanding the aesthetics of experience with tangible digital objects. This gap is visible when one considers two trajectories in the field: the rise of polyvalent meaning and the somewhat related rise of sophisticated interactive surface technologies.

The Rise of Polyvalent Meaning
As digital technology is applied to everyday objects, interaction design is increasingly polyvalent in its aesthetics; that is, digital artifacts, instead of striving for closed meanings, are now striving for open meaning [34]. Visual qualities of objects now go beyond traditional notions that valorize transparency or efficiency of interaction. As the surfaces of objects increasingly involve active user construction of meaning through interaction, surface affordances and symbolic values are represented through visual qualities [3, 8, 23]. Moreover, a multitude of meanings are evoked from dynamic behaviors of interactive surfaces that respond to user interaction [10, 11, 17, 29]. In other words, in a significant conceptual shift, surfaces are no longer about mere decoration of a functional system, but can now embody aesthetic qualities of interaction, both in terms of experiential qualities and the construction of meaning—two areas where HCI needs to improve its approach.

The Rise of Sophisticated Interactive Surfaces
Advances in technology are enabling increasingly sophisticated interactive surfaces beyond buttons or displays on flat surfaces. New materials and sensors are often woven into object surfaces that both understand user inputs and display interactive behaviors [32]. Digital objects become dynamic and interactive by enabling rich user experience [29]. Studies on tangible/interactive surface and new materials have been increasing, but are typically focused on technical implementation [7, 22, 37] or based on incremental user research starting from user needs or ending up with user evaluation [24]. However, these surfaces are enmeshed in issues of aesthetics, experience, and engagement that go well beyond traditional approaches of user evaluation and transparency-oriented theories of user-centered design [27].
A Designerly Approach to Interactive Surfaces

The design process in traditional HCI starts from user research and problem definition, continues through prototyping, and is followed by evaluation and iteration [35]. Based as it is on modeling behavior, measuring ease of use, and predicting efficiency, this process is not optimized for investigating emerging concerns on experience and engagement with interactive objects.

Yet designers in the fields of product, industrial, fashion, architecture, urban planning and interior design have been engaging in aesthetics and experience for generations, while establishing design as a unique discipline that reflects their practice with materials and critical judgment [9, 33]. Traditional design methods and processes from those fields have established a discipline whose knowledge can be applied in HCI, though at this point they are unevenly applied. A design-based approach seems poised to address this key research problem in HCI [13, 39]. The issue that remains is how to integrate such an approach in HCI without compromising the benefits of the designerly approach nor what HCI already does very well.

This paper contributes to this agenda by outlining, exemplifying, and evaluating a designerly surface with a particular focus on interactive surfaces. Specifically, we offer SKIN: Surface Kinetics Interface, which is a designerly approach to creating richly interactive surfaces, particularly for tangible computing. The SKIN approach integrates both traditional design strategies and traditional HCI strategies. Our description both justifies this integration by exploring the epistemological commitments and methodological strengths of traditional design vs. HCI, and more importantly, we reveal in detail what this process entails. Rather than telling readers what to do via an abstract framework, we opt instead to make our process as transparent as possible, including un-pursued directions, unachieved intentions, and so on, in the hope of making SKIN genuinely visible and applicable.

SKIN: SURFACE KINETICS INTERFACE

Everyday objects of both design and nature have surfaces. As [26] writes, designers today manipulate surfaces to create skins that both reveal and conceal, skins that have depth, complexity, and their own behaviors and identities—“far from seeing surfaces as superficial, designers engage in them intellectually and materially.” In HCI, with the simultaneous rise of everyday (i.e., non-workplace) computing and sophisticated surface technologies, interface design focused on surfaces is in demand. Many studies have been carried out to apply tangible user interfaces [22], organic user interfaces [19], or shape-changing interfaces [38] to a variety of use scenarios [5, 6, 31]. Bringing these trajectories from design and HCI together, we offer SKIN to aid the investigation of the meanings and aesthetic qualities of these interactive surfaces.

SKIN: Rationale of an Alternative Process

SKIN refers to a design process for creating meanings and crafting aesthetic qualities using a particular understanding of surfaces, i.e., that form is not separate from function, that experiential aesthetic qualities are not incidental to interaction, etc. With SKIN, we propose an approach that complements traditional engineering and user-centered design (UCD) approaches in a couple key ways.

The UCD process, with its incremental scientific approach, has limitations in thinking beyond users and exploring creative design concepts with new materials or technologies [25]. Adopting top-down approaches for concept development from traditional design methodology, SKIN aims to expose and explore the potential design space of new technologies beyond satisfying current user needs. Accordingly, critical judgments made by trained designers constitute a different point of departure from user-centered design, with its “averaged” user needs.

In traditional design, conceptualization comes from designers’ engagement with form or materials of object, and their experienced knowledge on users and contexts of use. This approach is good at acquiring practical design skills and refining aesthetic qualities of final design object, but has not yet been systematically integrated into computing and HCI research. Therefore, we suggest that in aesthetic and tangible interaction design, we need to integrate more consideration of critical, playful, and exploratory engagement with physical design elements such as form, materials, interactivity, etc. The design process suggested by SKIN attempts to build knowledge upon the tangible design elements of interaction by focusing on the object instead of conceptual user experience.

That said, SKIN is not divorced from a user-centered design process. It continues to stress the importance of prototyping and evaluation and retains UCD’s strong commitment to engaging the user. It mainly complements this approach by amplifying the importance of the designer’s engagement with materials and practical exercise of design judgment, rather than ceding that authority to a scientific representation of user needs.

DEVELOPING DESIGN CONCEPTS

In this section, we describe three design concepts of SKIN by applying the design process briefly sketched above. The descriptions here are less theoretical and much more pragmatic than above, going into more detail about what the SKIN approach actually looks like in practice. We describe how essential design properties were iteratively developed and fit into each other, and ultimately how we could justify SKIN as a design process compared to typical user-centered design process. During this first phase, most of our concepts were explored as design thought experiments with little consideration for technical implementation.
Our Process: SKIN
We now specify our design principles used in our implementation of SKIN. The process begins with concept development and continues with sketching and prototyping. Two researchers, one with a background in Fine Arts and another in Interaction Design, explored design concepts through four sessions of weekly meetings for brainstorming and sharing individual survey of inspiring metaphors, visual images, relevant objects, and new material technologies. Finally, meaningful concepts were selected and specified based on the model of “rich interaction” [15]. The following paragraphs describe the details of each phase.

Exploring Concept with Metaphor from Living Creatures
Though controversial, metaphors used in current computing systems not only provide visual cues and icons, but also can help with constructing a mental model describing how the system would work on real-world experience [21, 35]. In designing SKIN, we considered living creatures including hedgehogs, starfish, and carnivorous plants as appropriate metaphors for objects with surface changing properties.

For instance, hedgehogs and potato bugs show defensive behaviors by crouching bodies or erecting spines when approached by humans or other animals. There are numerous other examples of adaptive movement in nature, such as a flower opening its petals to absorb more light. Likewise, interactive object can be conceived of as an organic entity taking on different shapes or functional forms to respond to environmental changes or user actions. At the same time, this dynamic design metaphor provides a meaningful analogy in terms of animals’ subtle emotions or characters evoked from those behaviors. With the metaphor of living creatures as a core design direction of SKIN, we generated abstract design concepts through brainstorming and specified three of them through iterative visual and interaction sketches. They are independent of each other but related in terms of their metaphor and interactive behaviors.

Sketching Form, Interactivity, and Function
Once we had our initial concept in place—exploring surfaces using the metaphor of the hedgehog and similar creatures—we needed to develop this idea toward a useful interactive system. To do so, we applied the model of rich interaction suggested by Frens [15], which contains three major design elements—form, interactivity, and function [Figure 1]. These elements enable designers to develop the concept into an embodied object through iterative conceptualization. The developing concept is increasingly understood as an interactive artifact available to the meaning-making processes of the user.

Specifically, by form we considered physical design properties such as shape or materials, which have been mainly considered in traditional design discipline. A set of sketches was done to come up with surface structures to demonstrate design concepts, and different materials were tried out to implement working prototypes. By interactivity, the relationship between user and object is specified at the level of user action and perception and object input and output. Starting from form, we explored how certain forms can be used for intended interactivity or which form is required to realize certain interactivity. Lastly, function indicates purpose or context of use including how the sensory level of interactivity could evoke certain meanings or display purposeful information in practice.

Summarizing our process, we started from metaphors and came up with various surface structures and movements. Then, based on the framework of form, interactivity and function, we iteratively modified forms to support intended interactivity and searched for proper function from existing objects. We expect that this concept-driven design process complements current HCI design process by exploring design spaces for new user experience in a new (for HCI) way that is nonetheless rigorous, that is, based on a mature discipline, systematic, and theoretically justified.
Examples of Design Concept of SKIN

We now illustrate three design concepts that we have specified through the SKIN process described above. They are an inflatable cup, a tactile mouse, and an interactive lampshade [Figure 2].

**Inflatable Cup**

This concept applies SKIN to a cup by inflating its surface like bubbles when hot water is poured in. Inflated surface would look inappropriate to grasp as well as providing intuitive messages such as surprise or scalding temperature. This cup could prevent users from accidentally grasping or drinking a hot beverage—and do so in a way that is both sensually appealing and witty.

**Tactile Mouse**

This concept applies SKIN to the mouse by changing its surface textures according to the amount of time that user works with the mouse or the achievement of a given task. For example, if the user works with the mouse too long, the mouse would display spiky textures to raise awareness to the passage of time and/or the need for refreshment or break time—like a small pet bugging its owner. Alternatively, soft tactile feelings could be displayed if the user completes a task, which would provide a pleasurable tactile feeling that would be experienced as a form of encouragement. Diverse tactile properties of SKIN could introduce new ways of interacting with digital objects making user-object relationships more intimate.

**Interactive Lampshade**

SKIN can be applied to change shapes of an object by transforming the structures under its surface. This concept applies SKIN to a lampshade by changing its surface shapes according to the sound level in a public space. Specifically, the shape of lampshade can be transformed into either an open or closed form by changing the structures under its surface. Accordingly, the amount of light and effects of shadow can be controlled through surface shapes. The display of different light effects through SKIN could provide awareness of public atmosphere, for example, to influence people to behave appropriately in public spaces such as a library or office.

**MAKING THE LAMPSHADE**

In this section, we describe the details of modeling and prototyping the concept of interactive lampshade. The concept was selected out of three for further development considering its familiarity as an everyday object and its prototype implementation. Starting from a rough idea of opening and closing the lamp, we iteratively modified forms and structures for surface movement depending on available materials for prototype implementation. Once we had a prototype of the lamp, a pilot study was conducted to investigate how people would perceive the lampshade as an example of an aesthetic interactive surface and also to reveal the extent of any gap between design intention and user reaction. This gap serves not only as a key element of the feedback loop in user-centered design, but also as an opportunity for dialogue (e.g., in the participatory design tradition), as well as an opportunity for designer reflection, a critical activity in the designer’s ongoing cultivation of design sensibility.

**Searching for Forms**

The form of the object is conceptually related to organic life forms, given its dynamic metaphor and interactive behaviors. The skin of a hedgehog and potato bug, for instance, often responds to sudden movements by changing from soft...
and smooth to rough and spiked [Figure 3]. In other words, not only does the overall shape change, but its texture does as well. The shape change is protective in the sense of offering a physical barrier to harm; the texture change is protective in the sense of offering an intuitive yet nonetheless semantic warning to potential predators.

A second design point related to the form of the light is the functional change that it undergoes to alter the amount of light emitted. Flower petals change their form and shape while blooming and adapting to the lighting conditions in the environment. The original lamp shape conceals the light, but the outer shade changes the lamp’s shape by opening outward and allowing more amount of light to be emitted from the center. This process is also conceptually similar to the way animals change their shape when they perceive movement or loud sound.

With an overall shape that can turn inside out in response to the user’s voice, the exterior decorative patterns are composed of natural, organic shapes, while the interior is an abstraction of a face. The abstract facial form is meant to provoke emotional undertones while adding an element of personification to the lampshade. This also allows one to see animate characteristics embedded in the object. The lamp, for instance, reveals grotesque or aggressive faces in the presence of loud voices. Details of the exterior patterns were simulated using 3D modeling software [Figure 4].

Searching for Materials
We have searched for proper materials to seamlessly turn the lampshade inside out. We originally attempted to control the surface change by utilizing SMA (Shape Memory Alloy). We did however, experience considerable difficulty controlling the motion in a fluid and consistent manner as well as adapting the structure to respond to human voices since SMAs were originally designed to respond to immediate temperature changes. We found that dividing the whole lampshade into six units and inserting motors to rotate each unit inward or outward is far more functional and produces the desired outcome [Figure 5].

The user’s voice triggers the motors controlling the lampshade meaning that the user sees the surface changing in real-time. The microphone picks up the ambient sound and controls the range of rotation, which is directly determined by the sound level. The sound was processed using Pure Data [30] and motors were controlled using Arduino [1].

The structure of rotating double-sided surface units is applied to demonstrate the concept of SKIN, as an alternative solution. Although the surfaces are actually static, made of gypsum powder from rapid prototyping with 3D color printer, they effectively simulated the aesthetic qualities that we intended. Prototyping rich interactive surfaces clearly must differ from traditional low fidelity prototypes of the past, since aesthetic qualities are an essential part of, rather than a superficial decoration to, the interaction; we return to this point later.

Pilot Study and Preliminary User Response
We conducted a pilot study of the lamp prototype with four graduate students from HCI and two PhD students from Cognitive Science in two separate sessions. The main objective of this study was to demonstrate the prototype to some users and to explore meaningful questions to discuss regarding to the development of SKIN as an approach, not so much to evaluate our prototype as an early instantiation of a “real” or commercial product, as in traditional HCI research. Participants were invited to the studio where the lamp was installed, and each session took about 40 minutes.

At first, the coordinator introduced the study and started a casual conversation without explaining how the lamp actually works, since exploring the function from its forms and interactions was also part of this study. After 5 minutes of conversation, participants were asked 1) whether they had recognized any changes from the lamp, 2) what they thought the lamp reacted to, 3) whether those changes from the lamp had influenced their behaviors, and 4) for what they thought the lamp could be used. The following is a summary of responses for each question:

• All the participants quickly got the idea of how the lamp works—responding to voice or ambient sound.

• Participants also pointed out that the lamp did not accurately detect orientations of the sound, that is, whether sound comes from over here vs. over there. This issue seemed much more important to our participants than we expected, and yet surely their interpretation is closer to the hedgehog metaphor than our own was.

• Some participants mentioned that the glare of the light bulb was annoying, making it hard to keep their eyes open, particularly when the shade was opening. They indicated that this definitely influenced them to speak softly or less often.

• In contrast, others mentioned that the changes from the light triggered them speak more: “I wanted to play with it more, make different sounds, change my voice, sing, or whatever I could do to make it move differently.”

• All agreed that the light attracted their attention as a delicate art piece different from usual objects, suggesting that the aesthetic dimension was central to the interaction.

Personal interpretations of its meaning or function varied. Interestingly, the responses were slightly different according to participants’ backgrounds, as shown in the next two bullets.

• Participants from HCI mostly interpreted the lamp as an intimate or fun-related object: “Maybe I can personalize my interaction with the lamp, for example by making it react only to my voice or specific rhythms”; “I could play certain tones of music to make certain shapes of the lampshade”; “Maybe it can direct conversation by spotlighting one who talks a lot, then moving the spotlight to others if one person speaks too much”; “It can be used for mood-light for story telling, like when parents read a
book to children in the night”; “It could be used for disco ball to give awareness of party time,” etc.

**Participants from cognitive science suggested that the lamp could complement sensory perception by transforming auditory input to visual display:** “The object could support users to be aware of their environmental conditions, for example, when deaf person watches for a baby”; “It could be used for therapy. The louder or more aggressive people get, the more the ‘petals (indicating the units of the lampshade)’ turn to show the aggressive faces —like a kind of bio-feedback piece of equipment”; “It could be used as a night light. When someone moves and makes some noise, the light opens up! Very cool,” etc.

Our sample sizes are, of course, too small to suggest anything substantive about HCI versus cognitive science participants; however, this difference at least suggests that the users’ construction of this artifact’s meaning is very much dependent on their own perspectives and orientations.

Beyond specific answers for given questions, participants discussed some critical issues regarding interactive surfaces, such as the ambiguity and ambience of interaction with SKIN, or the recognition of its shape-changes:

- **Due to its dynamic interactive behaviors, the lamp is hard to ignore and attracts attention from all. This may be good for intimate relationships between user and object (such as talking more to play with it or to discover new shapes of the lamp made by sound), but may distract real experience among people.**

- **If the user is not informed of the specific interactivity or function of the lamp, its form or interactive behaviors might be ambiguous. The gap between form and function might be either an interesting space to explore for some users, or simply an annoying light effect for others.**

- **At first, participants just recognized whether the shape of lamp was either open or closed: “the ‘closed’ lamp is very delicate looking, while the ‘open’ lamp is much more aggressive.” However, as they interacted with the lamp longer, they could recognize the details of the surface patterns and speculate diverse meanings: “the inside of the surface looks like a face or a totem pole. It reminds of people sitting around a camp fire”; “The faces on inside are definitely aggressive looking, but it is fun to see all of the shapes, spirals, colors, so it kind of provokes me to make noise. It is fun to make it move.”**

Users immediately distinguished the inside and outside portions of the piece showing that they grasped the animal metaphor. Nonetheless, each user reacted somewhat differently to the ‘reversible skin’ revealed during rotation. This implies that the ambiguity, with proper abstraction and materialization of SKIN, provides motivation as well as room for individuals to actively explore hidden meanings of interaction beyond understanding its transparency.

**User-Artist Dialogue: Intentions and Interpretations**

As suggested earlier in the paper, and as is commonly experienced in HCI as well, a gap formed between artist intention and expectations and user response. We used this as an opportunity for reflection.

The artist had came up with the final surface patterns since she found that complex organic shapes rather than simple shapes was a more effective way of maintaining the user’s attention, because delicate shapes encouraged the user to engage the object more thoroughly and gradually discover the metaphor. When the modules begin rotating at about 45 degrees, the surface patterns of insect legs begin appearing on the side of the object [Figure 4]. Once the modules turn 120 degrees, side views of the face patterns begin to appear, and once rotation reaches 180 degrees, entire faces emerge. During the pilot study, it was observed that each stage of interaction allows participants to perceive different facets of the object from unique points of view. Participants thoroughly enjoyed making different levels of noise and observing how the piece responded to their noise level. The interactive aspect of the lamp fostered both imagination and direct participation. The continuous changes of the organic shapes make the user’s experience more ecological compared to discrete information display from usual digital devices; people are invited to participate in a continuous and dynamic interactive environment. This metaphoric aspect of SKIN makes the most use of our innate perception toward environment and other living creatures.

In terms of function, although the initial intention of the lampshade was to provide awareness of social etiquette in public space, participants could come up with diverse ideas of what the lamp could be used for, from personal to social and from therapeutic to hedonic purposes. We considered the depth of surface detail allowed users to make diverse meanings and interpretations from the lampshade. In this study, abstract forms or indirect information from the object created a gap between designer’s intention and user’s interpretation, in the sense that the metaphors are ambiguously construed. That is, some might see the faces as threatening while others see them as interesting or exotic. What is noticeable in this study is that the semantic indeterminacy could make the experience with the lamp richer rather than frustrating by providing room for discovering hidden meanings in the surface. This indeterminacy could lead to personalization or appropriation of the lamp, and to any other unexpected functions.

Lastly, the lamp proactively detects the ambient sound level and displays it through fine surface patterns attracting users’ attention regardless of their need. This means that interaction could not only start from human intention but also from object behaviors. Many participants already mentioned about their concerns about how the lamp might be annoying as well as how they are nonetheless intrigued by the lamp’s aesthetic qualities as well. This mixed response suggests that the relationship between annoyance and aes-
thetic pleasure may not be linear—i.e., that as annoyance goes down, it becomes more aesthetic, and vice-versa—but rather that annoyance may be a part of the aesthetic, and that different users will experience this relationship differently. As digital objects become smarter and more autonomous, the balance between intimacy and intimidation needs to be critically considered.

DISCUSSION
We took a different perspective from that of prevalent HCI research by suggesting the concept of SKIN both in terms of design process (e.g., working from concepts and metaphor, uninformed by users at first) and values of its experience (especially regarding the surface form as an integral part of the interaction). Both of these characteristics are complementary to a traditional user-centered design approach and merit further attention from the HCI and tangible interaction design communities. In this section we reflect on how this approach reconfigures several key concepts and elements in HCI research.

The Surface is Not the Surface
To explore meanings and aesthetic qualities of interactive surface, in this study, we have focused on physical design properties of surface instead of on practical functions. By going through surface-oriented design process of SKIN, we found that the surface in tangible computing is no mere superficial design feature sitting on top of the “real interaction.” Rather, it can be essential to the generation of different meanings and experiences. Form does not necessarily follow from function, and we need to reconsider this relationship, especially in tangible and embodied interaction, a point rendered quite obvious not just to researchers but to the general population by such devices as the Wii and the iPhone.

Prototyping Surfaces
But this increasingly obvious point has deeper implications. For example, it complicates notions of high- vs. low-fidelity prototyping, which are operational, methodologically charged concepts in HCI research. Since subtle differences in aesthetic qualities play a significant role in user experience (personal interpretation of meanings evoked from interactive surfaces), user responses to low-fidelity prototype lacking in delicate look and feel are of dubious value. We therefore must also become methodologically rigorous in factoring in aesthetics and experience into our prototypes, and SKIN’s emphasis on materials, forms, and metaphors is a contribution in that direction.

Evaluating Prototypes of Surfaces
Changes in the forms and goals of prototyping also necessarily change our notions of how to evaluate and what we are evaluating in iterative interaction design. Regarding the subtleties of aesthetic qualities, evaluation is complicated by the need to evaluate too many variables as a whole object. In other words, it would be meaningless to measure and control for individual design variables such as form, color, texture, historical/cultural reference, and so on separately, because these variables are perceived, experienced, and interpreted holistically. At the same time, this holistic approach to aesthetic experience with interactive objects underscores the need for theoretically sound strategies to craft the delicate aesthetic qualities of our design concepts during development.

CONCLUSION
Both the theory and practice of working with sophisticated, aesthetic interactive surfaces needs much more work. We identify two new directions for future research.

Toward Material-Based Interaction
Related to the issues of our evolving research and design process, the physical implementation of our prototypes is a major challenge, since most concepts of SKIN deal with materials not yet existing. For this study, we started our design concept of dynamic and seamless surface changes; however, due to technical limitations, we demonstrated the concept by rotating static surfaces. This turned out to be sufficient to demonstrate the concept both technically and aesthetically, and yet it is hard to know what exactly was lost as a result of this compromise. The challenge remains to come up with rigorous ways to realize effective surface structures with different visual and tactile feelings.

Toward Dynamic Human-Object Relationship
Since interpretation of meanings and perception of aesthetic qualities are very subjective, the focus of research needs to move from objective evaluation of interactive surface by averaged users to exploration of the various meanings constructed by users as they unfold over time. This form of user research integrates the critical judgment and design sensibility of the designer with the perceptions, needs, and expertise of the users. Accordingly, the interactive object with SKIN needs to be conceptualized differently from previous static or task-oriented object [28, 36]. Considering that dynamic interactive behaviors of tangible and embodied objects may change the relationships between user and object in surprising ways, we will explore new perspectives to investigate more influential, affective and intimate human-object relationship through different design case studies on interactive surfaces.

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