Applications of affordance and semantics in product design

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This paper aims to clarify the concept and elucidate the role of affordances in the interaction design for physical products by making a parallel comparison to product semantics. This study argues that the core of affordance concept in design lies not in expressing the design intent, but constructing the actions required in the user–product interaction. A framework consisting of three design dimensions: affordance, perceptual information, and symbol, is suggested to deal with different aspects in physical interaction design, in particular, the motor, perceptual, and cognitive factors with an illustrative example. In conclusion, implications for interaction design and future research are suggested.

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While providing new possibilities to designers, digital technology also poses new challenges to traditional design profession as well. Designers need to deal with new types of technology, application, design issues, as well as new methods (Bødker, 1991). These changes underlie the evolution of design industry. Besides the appealing and functional form, the embodied interactions between users and products also become one of the key factors for designing and/or evaluating a product. In order to understand how the physical attributes, composition, and shape can affect the user–product interaction, and how a product itself can convey necessary information through the interaction, designers turn to psychology for theories that respond to such questions. Among these theories, the concept of affordance provides an analogy explaining the link between users’ actions and material features of products. Since its introduction to the design community by Norman (1988), it has become a means to enhance the visibility and the usability of a product.

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Gibson (1966) coined the term affordance as part of his direct perception theory to denote the use-value of environmental objects taken with reference to
the intrinsic physical features of an organism. Underlying this concept, Gibson (1979) claimed “The object offers what it does because it is what it is”; hence, this term was created to stress the reciprocal relationships between environment and an organism rather than what an organism perceived about the environment.

However, the term affordance used in current design research and practice has diverged from Gibson’s original idea. Affordance, as many industrial designers understand, is about the visual cues that indicate required operations or intended functions of a product. Based on such understanding, designers often confuse affordance with sign, and employ icons and metaphors from product semantics to inscribe meanings into products while the exercise of affordance concept is meant. Such confusion not only hinders the theoretical development of interaction design but also limits the potential application of affordance concept in product design. Therefore, this study aimed to clarify the concept of affordance by comparing it with product semantics from the viewpoint of industrial design.

1 Background

In contrast to the information-processing theories about perception that presume meaning must be constructed inside the brain, Gibson’s theory of direct perception, also known as the ecological psychology, suggests that meaning is inherent in the organism—environment system, and it can be picked up directly by organisms without mental calculation (Bruce and Green, 1990). Essential to Gibson’s direct perception is the meaningful environment which an organism is situated in and interacts with. In order to describe it, the term affordance was coined to express the special property of the environment in relation to an organism (Gibson, 1966).

In an earlier version of the theory of affordances, Gibson (1977) clearly defined “the affordance of anything is a specific combination of the properties of its substance and its surfaces taken with reference to an animal.” For instance, if an object has a rigid, level, flat, and extended surface, and if it is about knee-high to the human observer, then it affords sitting-on. These five properties, rigidity, levelness, flatness, extendedness, and knee-height, are combined to yield a higher order property for the observer. If there is optical information of the five properties, and if the information is detected, then the affordance of sit-ability can be perceived. To explain the reason why affordances are more easily perceived than properties of the environment in isolation, Gibson (1977) stated further “the invariant combination of properties is “meaningful” whereas any single property is not.” According to these descriptions, the intrinsic meaning of an environmental object that Gibson has emphasized is limited to the actionable opportunities that the present environments can offer the observer.
As Jones (2003) points out, the definition for affordance gradually became less specific in Gibson’s later works. Instead of providing an explicit description, Gibson (1979) stated “The affordances of the environments are what it offers the animal, what it provides or furnishes, either for good or ill,” and affordances “have to be measured relative to the animal.” To Gibson, the term affordance is not the subjective values based on observer’s needs and experiences, but a fact in the organism—environment system that can affect the behavior of organisms. Just like the direct perception theory which is a radical departure from mainstream cognitive psychology, the concept of affordance diverges from the existing understanding of meaning with a new definition of what meanings are in the organism—environment system; thus it holds important position in the direct perception theory.

Gibson’s statements may be sufficient for an introduction to the concept, but may be not complete for its further application. Toward the development of a coherent theory of affordance, some refinements and formalizations have been made by other ecological psychologists. Among them, Turvey (1992) suggested that affordances were animal-relative properties of the environment that had significance to animal’s action. Based on this argument, he outlined a formalized description of affordances. Chemero (2003) argued that affordances were not properties of the environment, but relations between animals and features of environment. In both discourses, affordances cannot exist in the absence of animals or environment. A more general notion on this concern is adopted in this study that affordance is a three-way relationship among animal, environment, and action.

2 Affordance in design

In the context of industrial design, affordance can be pinned down to a much narrower but more complicated subject. It is defined as a three-way relationship among users, objects, and actions. Thus affordances are regarded as the potentiality of products that can support user action without requiring users’ memory, inference, and further interpretation. This very concept is attractive to many designers, not only because it provides a simplified and externalized framework to explain how the material features in a product can directly affect a user’s action; but more importantly, this concept helps designers to shift their focus from users’ mind to their action, which suggests new possibilities for design research and practice.

Long before the design community became aware of the concept of affordance, Gibson (1976, in Gibson, 1982) had claimed that designers often modify properties and surface layouts of objects to obtain needed affordances but without a satisfactory theory. He implied that the theory of affordance could provide a new theoretical basis for design. In his view, products are not ‘a patchwork of forms’ to users, but the possibilities of actions. Through interacting with the products, users can activate a sequence of possible actions to achieve their
goals in the end. Thus, designers should pay attention to the meaningful interactions between products and the users instead of the abstract form or graphics.

Ironically, the affordance concept popularized within the user-centered design community was introduced through Donald Norman’s book *The Psychology of Everyday Things* instead of Gibson’s works. According to Norman (1988), “the term affordance refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used.” He further stated “Affordances provide strong clues to the operation of things.” As a cognitive scientist, Norman’s viewpoint on perception is in conflict with Gibson’s direct perception. Norman believes that affordances result from users’ mental interpretation of things and themselves, which are based on their previous knowledge and experience (Norman, 1988). Following Norman’s interpretation, the information implying a usage of objects is regarded as an affordance. No matter the actual affordance exists or not. Affordances, as described by Gibson, is the action possibility of objects with reference to the physical condition of the user, while in Norman’s interpretation, it is the perceived information with reference to the mental and perceptual capabilities of the user.

Norman’s version of affordance has been widely accepted by the design community without noticing the deviation. In his more recent article, Norman (1999) attempted to clarify the misuse of the term affordance in design practice and literature, and used the term ‘perceived affordance’ to differentiate his version of affordance from Gibson’s. Unfortunately, as McGrenere and Ho (2000) pointed out that his clarification might diminish further misuse in the future, but it still did not clearly separate the affordance itself from the information signifying it. Hence, Torenvliet (2003) urged researchers and designers to reclaim the original meaning of affordance in design.

### 3 Affordance in product semantics

Other than those user-centered design colleagues, the concept of affordance was often commented in the literatures of product semantics circle as well. Product semantics was originally defined as the “study of the symbolic qualities of man-made forms in the context of their use, and application of this knowledge to industrial design” (Krippendorff and Butter, 1984). Krippendorff (1989) later refined the definition to address “the cognitive and social contexts of their use,” and described the concern for the symbolic qualities in design as a paradigm shift from ‘design for function’ to ‘design for meaning’. This angle was often accompanied with the presumption that product is a communication vehicle that enables reconstruction of intended meanings. Accordingly, designers used the well-established design elements, such as shape, color, texture, to embody the intended message as form. From here, users respond to
the physical form to make sense of the product, thus create their own interpretations (Giard, 1990).

In a theoretical groundwork proposed by Krippendorff (1989), affordance was one of the ‘semantic dimensions’ describing operational meanings of objects. As part of the psychological base for product semantics, the term affordance was appropriated to denote “all possible behaviors (form) that confirmed what a user expected the object to do (meaning).” An artifact and its affordances referred to “cognitive models or constructions that user identified as things of a particular kind, not to what they ‘objectively’ were.” In addition, Krippendorff (1990) claimed “Product semantics aims at the design of thing whose affordances cover at least the range of meanings users have in mind.” The concern was placed on the relationship between users’ cognitive models and perceivable features in product, which focused on high-level cognitive processing in mind but not perceptual–motor level interactions. Some cases deviated from Gibson’s idea even further, in which the term was commonly interpreted as a symbolic representation of operational instructions or functions in product semantics, for instances, ‘ecological semiotics’ (Krampen, 1989) and ‘object’s self-sign’ (Bush, 1990). In order to correctly present a product’s affordances for intended semantic interpretation, such as function, operation and qualities of the product, designers were suggested to start with users’ cognitive models, then provide perceivable characters and features which corresponded to readily available cognitive models namely metaphors and signs (Krippendorff, 1989). Hence, the information signifying the existence or the purpose of an affordance was so indispensable that it was often mistaken for affordance itself. The design focus of this conception in product semantics was not physically manipulating what a product could offer its users, but was controlling how users perceived a product.

4 Comparison of affordance concept and product semantics

At the first glance, the idea of affordance seems similar to product semantics. They both presume that users do not perceive pure geometrical or physical properties in things, but meanings. And both concepts provide a means to relate form to meaning for industrial designers. However, the underlying assumptions of perception in these two concepts are contradictory; hence ‘meanings’ of products discussed in them are not at the same level. Unfortunately, the distinction between affordance and semantic interpretation of products is vague in industrial design owing to the ambiguity in design literatures. In this section, we will draw attention to the fundamental differences of these two concepts: the theoretical root, the associated issues and the actualizing methods.

Firstly, the concept of affordance was originated form Gibson’s direct perception, while product semantics was a design theory influenced by the cognitive
conventions. According to Gibson, perception is a direct consequence of reality without any form of information processing. Thus the meaning discussed in the concept of affordance is not users’ judgment or evaluation of products’ perceived qualities, but the action capabilities based on objective conditions of users and products at present. On the contrary, the cognitive psychology underlying product semantics claims that meaning is cognitively constructed in the user’s mind based on the information perceived by the senses. Thus, users’ interpretation of a product is predominantly influenced by their personal experiences, socio-cultural background, and needs.

Secondly, the design issues that these two concepts concern are different. Affordance is the intrinsically behavioral relation between users and objects. Its existence is independent of users’ awareness and demand because it is the reason for the potential action (Reed, 1996). In this view, affordances in product design are not meant to convey information for communication purpose, but are the groundwork for the necessary behavior in achieving a product’s function. Thus among seemingly infinite affordances, which will catch the user’s attention most? Why is an action executed but not the others? Questions like these might be important to designers, but they are not within the scope of the theory of affordance. On the other hand, to product semantics, as suggested by the term ‘semantics’, meaning is the key. The outward appearance of a product appears as signs capable of arousing user’s cognitive response to the product, such as aesthetic preference, functional interpretation, and symbolic association (Crilly et al., 2004). The semantic perspective on product design focuses on the communication and social issues in design.

Thirdly, the methods to actualize these two concepts in product design are different. The reciprocal nature of affordance is reflected in product design as ‘physical constraints’ (Norman, 1999) to facilitate or prevent certain user behaviors, thus ergonomics and anthropometric data are often adopted to modify product features for the expected utility. While affordance concept placing emphasis on the utility structure in products, the semantic approach to product design emphasizes assisting users in correctly interpreting products. Most of the semantic approaches consist of three common steps, namely, determining an intended character for the product, selecting relevant attributes, and exploring visual expressions of these attributes (Butter, 1990). In the process, designers heavily rely on metaphors or icons to transform meaning into the form of products, for instance, borrowing an existing symbol or shape from other object or event for the purpose of relating products to the intended characters.

To clearly state the subtle dissimilarities between product semantics and affordance theories, a checkup list, as shown in Table 1, highlights the main differences between the two. Opposing to focusing on the cognitive interpretation of design by product semantics, the concept of affordance inclines to seeking
the utility of compatible features between users and products. Thus the concept of affordance challenges designers to avoid the reliance on symbols and cultural conventions in design. Instead, it encourages them to utilize possible intuitive actions that can serve as function in the process of user–product interaction.

### 5 Action and information in physical products

The efforts and contributions made by various interpretations of affordances are valuable. However, to clarify its original meaning and refine current understanding of the relations between users and products are even beneficial. The original notion of affordance proposed by Gibson was about action, not information. Action and awareness are two instruments users cope with the encounters with the physical world. The aspects of the physical features in products that organize these regulations are entitled affordances. Thus, affordances are resources that a product offers its users of a certain type. They do not cause action but simply make it possible (Reed, 1996). Gaver (1991) clearly stated “Affordances per se are independent of perception,” and “Affordances exist whether or not they are perceived, but it is because they are inherently about important properties that they need to be perceived.” In order to better understand the concept of affordance, Gaver (1991) suggested designers should separate affordances from perceptual information about them; thus, he provided a framework to distinguish four possible situations: perceptible affordance, false affordance, correct rejections, and hidden affordance (see Figure 1). Most of the commonly cited examples of affordances refer to perceptible affordances, in which perceptual information is available for an existent affordance. Affordances in other three situations are misleading or neglected. In order to effectively utilize affordances, making affordances perceptible is a common approach in interface design.

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**Table 1 Differences between product semantics and affordance theories**

<table>
<thead>
<tr>
<th></th>
<th>Product semantics</th>
<th>Affordance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assumption of perception</strong></td>
<td>Mediated perception (information processing needed)</td>
<td>Direct perception</td>
</tr>
<tr>
<td><strong>Meanings of product</strong></td>
<td>User’s cognitive interpretation of the product</td>
<td>Action possibilities based on objective conditions</td>
</tr>
<tr>
<td><strong>Content of interaction</strong></td>
<td>Information: Perceivable qualities in product with reference to cognitive models</td>
<td>Physical action: Physical features in product with reference to user’s capability</td>
</tr>
<tr>
<td><strong>The purpose of design</strong></td>
<td>Providing information to express the usage, the function, and other symbolic qualities of the product</td>
<td>Providing the utility structure to facilitate or prevent certain user behaviors</td>
</tr>
<tr>
<td><strong>Methods of actualization</strong></td>
<td>Following a convention understood by the user to apply icon, symbol, or metaphor in product design</td>
<td>Adopting ergonomic and anthropometrical data to modify product for the expected utility</td>
</tr>
<tr>
<td><strong>The role of a designer</strong></td>
<td>Through the design of product appearance and interface to assist users understand the product</td>
<td>Through manipulating physical properties of the product to regulate the user’s behavior</td>
</tr>
</tbody>
</table>

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However, providing consistent perceptual information about an existent affordance is different from providing information to ensure proper use of a product by a mediating representation, or a symbol, in short. The former approach is to make the attributes relevant to the action available for perception. Such type of information does not need to be interpreted to follow. As for the latter approach, when a symbol is used to highlight an existent affordance, or provide information beyond the action itself, users need to refer to available cognitive models or conventions to understand the message from designers. This situation contrasts with that in which information for affordance can be directly perceived without cognitive interpretation.

Hence, it is beneficial to extend Gaver’s framework (Figure 1) to a three-dimensional structure to cover affordances, the perceptual information about them, and symbols for actions related information. As shown in Figure 2, the third axis describing the existence of symbol is added to the plane formed by ‘affordance’ and ‘perceptual information’ axes. Distinguishing among affordance, its perceptual information and symbol allows one to consider affordance as a design factor in its own right and to better understand the merits of different design approaches. Therefore, any embodied interaction can be analyzed in terms of combinations of these three factors in interaction design.

6 An illustrative example

This section is intended to illustrate the difference of affordance concept and product semantics through a case study, employing the framework proposed in Section 5. Throughout the design process, various factors have to be taken into consideration to fulfill specified goals. A mass amount of design knowledge is required before reaching the final solution. As a result, it is quite difficult to pinpoint specific theories or methods involved in a design process. However, possible actions supported by physical features of a product and symbols cognized via shared conventions, the respective treatments of
affordance concept and product semantics in design, can be easily differentiated from each other. Thus, an everyday appliance (a stereo cassette recorder) offering diverse interactions via its physical controllers, makes an excellent choice for illustrative purpose. Five types of controllers (including: sliding switches, rotary knobs, push buttons, cassette compartment doors, and display windows) seen on the control panel of a stereo cassette recorder (Figure 3) were analyzed to show what were intended by designers, and how they were implemented through affordances, perceptual information for affordances and symbols to reveal the distinction between product semantics and affordance in design.

6.1 Sliding switches
The three switches marked as ‘A’ in Figure 3 allow users to press and slide up and down to set different function modes, including audio source, stereo/mono, and dubbing speed. The appearances of the three switches are identical, but each functions differently. By providing an adequate amount of height above the panel surface, and suitable traction matching the size and the muscle strength of users’ fingers and physically constrained sliding direction, the designer utilizes the affordances of ‘Pressability’ and ‘Slidability’ to allow users...
to slide the switch up and down. In addition to making the intended action possible, perceptual information for the relevant product features is available for users to pick up. Thus two critical actions for proper use of this type of controller, press and slide, are self-evident. However, the perceptual information for the affordances only makes users aware of the possible actions. It does not provide information about the consequences of these actions. To help users understand the intended function of each switch, additional information for the outcome of users’ actions is needed. In this case, text labels are imprinted on the control panel to visually represent the intended function of each switch and the expected outcomes of operating these switches.

6.2 Rotary knobs
The two rotary knobs marked as ‘B’ in Figure 3 on the upper-left of the control panel are the volume and balance controls. Users can control the audio output volume or adjust the stereo balance by simply turning the knobs. Both knobs provide users the affordances of ‘Finger Gripability’ and ‘Turnability’ to make the turning action intrinsically possible. However, like the above mentioned sliding switches, the appearance and the required operations for these knobs are the same, but the assigned functions are different. The perceptual information for affordances of ‘Finger Gripability’ and ‘Turnability’ can directly inform users the actions available, but not the functions of the knobs or the consequences of their actions. Hence, text labels representing the upcoming results of turning the knobs in different directions are added to spare users the trouble of trial-and-error, and to reduce unnecessary mental load for learning and memorizing the corresponding functions.

6.3 Push buttons
The cassettes play/record controls are marked as ‘C’ in Figure 3 at the bottom of the control panel. While the function mode is set to ‘tape-playing’, users can press these buttons to control the recording and playback functions. The flat surface of each button leaves no room for users to grip, but it provides adequate space for users to touch and press by fingers. Through the affordance of ‘Pressability’, this design makes pressing buttons a possible behavior for users. However, like the earlier examples, the perceptual information of ‘Pressability’ can only direct users to note these buttons are pressable, it does not provide sufficient information for the diverse results of the same action upon each of them. In this case, a text label is marked above each button to signify its intended functions. In addition, standardized symbols, common in many recording/playback devices, for ‘play’, ‘stop’, ‘fast forward’, ‘rewind’, and etc. are employed to enhance the communication of product functions.

6.4 Doors
For users to insert or eject a cassette, the door of a cassette compartment provides two basic operational functions — open and close. Users need to
press the ‘eject’ button to trigger the underneath click-lock mechanism to release the door and cause the door to open. The type of push button controller has been discussed in Section 6.3, thus the focus of this section is on the controller for closing doors. To close the door, users need to push directly the door until a ‘click’ sound is heard. The door itself is a push plate. In addition to providing enough space for users to push, the rigidity and the size of the door also help to produce sufficient leverage to against the resistance from spring hinge beneath the door. However, the affordance of ‘Pushability’ allowing users to push the door shut without aiming for any particular spot also exists on the surface of almost every substantial object, except that most of the time they are not utilized by designers. These seemingly countless unintentional affordances could be ‘side effects’ shaped by needed product features, or something just emerged during product embodiment which never caught designers’ attention. In order to distinguish the intended ‘push’ action from the non-useful ones, and to make the affordance of ‘Pushability’ more visible, a row of five concave dots are placed on the outer corner of the door, marked as ‘D’ in Figure 3, to provide a visual cue for users. However, this dotted sign is more symbolic or decorative than functional. Users can push anywhere on the door to make it closed effectively when it is opened. But pushing the dotted area does not have any impact on it when the door is closed.

6.5 Windows
The transparent window on the cassette compartment door, marked as ‘E’ in Figure 3, is for users to monitor the tape during the recording or playback process. The window is part of the cassette compartment’s door. Some innate affordances, such as ‘Pushability’ described in Section 6.4, still exist for users. In addition, the transparent quality and the adequate size of the window further offer users the affordance to ‘see-through’, which is crucial to the monitoring function. The see-through affordance is self-evident. When users lay eyes on the window, the action ‘see-through’ is automatically executed. To help users monitor the state of the cassette tape, three vertical lines functioning as a ruler is added on the window to help estimate the remaining time of a tape. A triangle arrow pointing to the right is printed on the right of window to signify the rolling direction of the tape.

6.6 Summary
From the above analyses, in a process of user—product interaction, product semantics and affordance theory can both contribute to a better design from different aspects. To summarize, Table 2 highlights the differences of how these five controls can achieve intended functions through semantic approach and affordance approach. The intended function of each control is listed, as well as how it is implemented in terms of action (affordance) and message (symbol).
In terms of the affordance theory, the existence of the complementary physical relation between human users and products is the reason for the possible actions in product handling. In many cases, even when users cannot figure out what a product or a control is for, the existent affordances can still lead users to potential actions intuitively. Some of the actions will help users to complete their tasks, some will not. Some are intended by designers, some are not. That is why a product can be used in many different ways, even beyond designers’ expectation. The problem often found in this example was that affordances just pointed out the possible actions, but no consequences informed. To reduce the unnecessary trial-and-error, designers can either remove the undesired affordances to prevent certain...
behaviors from occurring; or provide visible and comprehensible information for users to predict the consequences of their actions beforehand. The latter approach is considered methods of product semantics.

Product semantics can be applied in the design process to help users make sense of the product. More specifically, designers can convey high-level meanings through holistic appearance of a product, and depict the functions of different parts of the product through visual cues. The role of these symbols is to make users note the affordances significant to product functions and the overall purpose of the product. In order to make intended messages understandable, designers rely on the knowledge and experiences shared among users to construct symbols as part of the product. For instance, labels and signs used in this example make users aware of the available operations and their purpose.

7 Conclusions and suggestions
From the viewpoint of interaction design, an affordance can be seen as an emerging action capability based on the physical properties of a product and its users. Once the objective conditions of a product and its users are eligible for an affordance, this actionable relation comes into view independent of users’ awareness and needs. The concept of affordance is useful in interaction design because it directly relates user’s behavior to the externalized features in design. Furthermore, it helps designers shift focus from the high-level cognitive processing to the perceptual–motor level interaction, an issue that has been commonly neglected. This action-oriented concept could open the door for designers to explore innovative interactions beyond convention.

While being applied to product design, affordance concept is often confused with the semantic interpretation of products. Thus, the starting point of this study is to clarify the concept of affordance and product semantics, and to elucidate the different roles of affordances and symbols in interaction design. We argue that affordance is about action but not communication, and suggest the core of affordance concept in design lies not in communicating the design intention for designers, but providing the requisite structure to await the emergence of functional affordances for target users.

While the concept of affordance encourages designers to utilize embodied interactions as product functions, underlying affordances can exist regardless of perception or correct interpretation by the user. In order to utilize affordances without sacrificing the usability and functionality of products, making functional affordances visible and comprehensive is a common approach in interaction design. However, the elaborated work to specify an affordance or convey the purpose of this intended affordance should not be confused with the affordance itself. To illustrate and recognize the contributions of the two theories discussed in the study, we expand Gaver’s framework of separating affordances.
from their perceptual information into a three-dimensional framework for analyzing interactions in product design. The proposed framework consists of three dimensions: affordance, perceptual information and symbol to express different aspects while building a physical interaction in design, namely, making the interaction possible, perceptible and meaningful. The underlying advantage of the framework is that it helps designers distinguish different design aspects regarding product usage, so the designers can thus focus on each specific goal aimed at achieving particular requirements.

As demonstrated by the five types of controllers in the example (Figure 3), the diverse interactions required for product functions can be seen as the results of different combinations of affordances, perceptual information and symbols in the design process. The example presented here are for illustrative purpose to demonstrate how the framework can be used as a tool for analyzing user—product interactions for real products, and to explain how design intents can be embodied through different design approaches.

As the framework does clarify different approaches in actualizing certain user behavior, it also brings out a number of issues pointing to future research directions.

Firstly, insight into the nature of design intent might be gained via the framework. It would be beneficial to understand how designers incorporate different product features into an intended interaction? How does the design intent affect the selection of these product features? Can these product features be categorized into affordance, perceptual information and symbols? Is such categorization appropriate? Thus the framework developed so far can be evaluated.

Secondly, the effectiveness of the three factors proposed in the framework was not addressed. As the scale in the proposed framework is binary; thus the three factors can only be either existent or not existent. However, an existent affordance difficult to be carried out cannot contribute to a better physical interaction. The same goes for the other two factors. In order to better utilize the three factors to evaluate and improve user—product interaction, it would be valuable to extend the scales from binary to continuous.

Thirdly, possible interference or enhancement among affordances, perceptual information and symbols in interaction design was not discussed in this paper. In the proposed framework, these three factors were presented as perpendicular axes in space, which implies they are independent design aspects. The underlying assumption is that designers can focus on each individual goal aimed at achieving specific requirements, thus users’ reactions to each factor are analyzed separately. However, using the framework as a tool to analyze user’s reactions to product appearance might be problematic. Further in depth
experiments or case studies are required to investigate user’s response to product appearance. This would result in a user side of framework for understanding how users react to design. In addition, the deviation between design intent and user behavior can be examined.

The affordance plays a significant role in the user–product interaction, despite of lacking succinct methods for its implementation. This concept provides a link for designers to direct connect material features to user’s behavior. It allows designers to focus on the perceptual–motor level interaction, and examine the possible utility of the interactions. This study is a preliminary attempt to discover what this concept can be used in product design.

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