A Comparison of Affordance Concepts and Product Semantics

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Abstract: Recent years, Gibson's affordance concept has drawn many attentions in the field of human-computer interface and product design. However, the development of affordance concept in design practice is by far not yet matured, and the differentiation between affordance and symbolic meaning of designed artifacts is not clear. As a result, that wrongly exercising the techniques of "Product Semantics" while implementation of affordance concept is meant is often found in design field. Such confusion not only can hinder the development of ecological approach in design research, but also limit the potential application of affordance concept as well.

In this study, a literature survey was conducted to briefly review the development of affordance concept in design fields; and then a comparison was made to clarify advocacy as well as arguments proclaimed by these two popular concepts in product design, which were originally rooted from different theoretical background. At the end, directions for the application of affordance concept in product design or interface design were also pointed out.

Key words: *Affordance, Ecological Approach, Product Semantics, Products Design*

1. Introduction

The rapid mergence of computer, communication technology, and consumer goods underlies the evolution of design profession [3,16]. Product designer nowadays is expected not only to provide appealing forms to designated objects or concepts, but also to satisfy the operational and informational needs of users in the digital era through carefully planed human-product-interaction (HPI). Hence, proficiency in the interactions between users and products is becoming the key factor to successful design and development for usability-oriented products or services. Among the various theories of man-machine interaction, the concept of affordance introduced by psychologist J. J. Gibson [10] has received significant attention in the field of Human-Computer Interface (HCI) and product design [1,7,8,9,15,25]

Besides, due to the advance of microelectronic and material technology, designers' creativity no longer is constrained by the mechanics and physical material, thus, designers nowadays can free from the functional doctrine--Form Follows Function, to explore the possibility of shapes and satisfy user's needs beyond functionalism [3,5]. Hence, the concept of semiotics has caught the attention of some design communities, and the theory and practice of Product Semantics emerged in response to the need of finding a new theoretical foundation for design after the functionalism dominating era [30,32]. Products are seen as media to communicate with its users. Designers use the same design elements, such as: shape, color, size and texture, to encode the massage into

the form of products [2]. In this new design era, meaning of the product becomes the key. Hence, the slogan: "Design is making sense of things" or "Form Follows Meaning" is replacing the old doctrine [18,19]. In order to lay down a sound theoretical foundation for Product Semantics, Krippendorff proposed "an embedded set of four theories" to tackle psychological, socio-linguistic, techno-economic and ecological issues that designers might face, focusing on use, language, genesis, and ecology of mind [18]. In this framework, the concept of affordance was adopted by Krippendorff and some his followers as the supporting psychological theory [18,30]. The term affordance has received significant attention among advocators of Product Semantics since.

However, the term affordance used in today's design practice and theories have diverged from the concept originated by Gibson. Especially after the advent of screen-based products, many attempts of graphic and industrial designers focused on the symbolic meaning of artifacts, or so-called "perceived affordances", which have accelerated the misunderstanding of this notion [23,27-29]. In addition, the development of affordance concept in design practice is by far not yet matured, and the differentiation between affordance and symbolic meaning of designed artifacts is not clear [6]. As a result, that wrongly exercising the techniques of "Product Semantics" or metaphor while implementation of affordance concept is meant is often found in design field. Such confusion not only can hinder the development of ecological approach in design research, but also limit the potential application of affordance concept as well. Therefore, this study aims to clarify the concept of affordance by comparing affordances and meaning of designed artifacts from the view point of product design.

This paper is organized as follows: First, the purpose and the background of this study is introduced, then in section 2, a literature survey to briefly review the development of affordance concept in design fields is presented. In section 3, a comparison was made to clarify advocacy as well as arguments proclaimed by these two popular concepts, affordance and product semantics, in product design. Finally, directions for the application of affordance concept in product or interface design are pointed out in the section 4.

2. Literature review

2.1 The Original Concept from Gibson

The term *affordance* was coined by Gibson as a part of the theory of direct perception, also known as the Ecological Approach, to refer to the actionable properties between the environment and the organism that lives in the environment [10]. According to the paradigms of cognitive psychology, human behaviors, such as thinking, acting and perceiving, are guided by mental schemata or cognitive model, which are mainly based on their previous experience and knowledge [13]. In contrast, Gibson's theory of direct perception stresses that attributes of an object could provide effective perceptual information about the object itself. In short, "The object offers what it does because it is what it is" [10]. Essential to this theory is "the reciprocal relationship between animal and environment" [6], and the notion of affordance was developed to express the property of the environment in relation to the organism that lives within. In *"The Ecological Approach to Visual Perception"*, Gibson described affordances as follows:

> *"…the affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill."* (p.127)
>
> *"An affordance points both ways, to the environment and to the observer."* (p.129)
>
> *"…the affordance, being invariant, is always there to be perceived. An affordance is*

> *not bestowed upon an object by a need of an observer and his act of perceiving it. ... It says only that the information to specify the utilities of the environment is accompanied by information to specify the observer himself. "* (p. 139)

Thus, affordance could be defined as the perceivable potentiality of the human-scaled object that supports the intended action without requiring memory, inference, or interpretation. This concept is attractive, not only because it simplifies the complexity and representational issues for designing artifacts [24], but the shift of focus from what's inside human being's mind onto the "ecological physics" of artifacts is helpful in understanding how people use them to fulfill the intended purpose, and suggesting new possibilities in design [8].

2.2 Affordance in Design from Cognitive Engineering Perspective

There are mainly two design communities initiating the introduction of affordance from psychology to design. Most notably, it was made by the pioneer of Cognitive engineering, Donald Norman, in his influential work "The Psychology of Everyday Things". Affordances are appropriated from the intrinsic and objective relation between environments and organism within to the "perceived and actual properties of a thing, primarily those fundamental properties that determine just how the thing could possibly be used."[25] Since then, affordance became a design factor of an object to hint users how it should be used. Unfortunately, this concept was often adopted by the design community without complete understanding [25]. Additionally, in Norman's definition, the distinction between affordance itself and the information to reveal the affordance is blurred. The ambiguity in Norman's interpretation and use of affordances has sprouted varying uses of this concept [1,13,20]. In his more recent articles, Norman attempted to clarify the misuse of the term affordance in design practice and HCI literature [27,28], but the confusion still remains [21].

2.3 Affordance in Design from Semiotics Perspective

The other design group, product semantics, also noticed the potential of affordance in industrial design. Product semantics is "a study of the symbolic qualities of man-made forms in the cognitive and social contexts of their use and application of the knowledge gained to object of industrial design." [19] Design is more "making sense of things" than "form-giving".

Krippendorff suggests this "symbolic qualities" or "meaning" of man-made forms may grow from different contexts, such as: operational context, sociolinguistic context, context of genesis, and ecological context. In his framework of product semantics, Krippendorff used the term *affordance* as one of the semantic dimensions to describe the operational meaning of objects [19]. The concept has caught on quickly in this design community, and evolved to become "the perception of meaning by combining the function and meaning of a product." [30], "the ecological semiotics" [17], or "object's self-sign" [4]. In product semantics, affordance is defined as the "functional representations of external objects", and therefore, some internal encoding of symbols is usually involved in the affordance-building design process.

3. A Comparison of Affordance and Product Semantics

3.1 Overview

At first glance, the concepts of affordance in ecological psychology and product semantics are similar, because they both are discussing the interaction and communication between the environment (or objects) and animals (or

users). After close examination of the research focus, the theoretical root, and the methods to implement these two concepts, the distinction is clear.

First, the content of the interaction focus between objects and users is different. For ecological psychology, affordances reveal the "achievable actions" between objects and users, and the actions for both sides are reciprocal. From one of Gibson's unpublished manuscripts, Gibson divided the man-made environments (artifacts) into three distinct categories: modification for utility, modification for symbolic meaning, and modification for aesthetics. It clearly states that only the modification for utility in the first category effects affordance, while the modification for displaying information and aesthetics doesn't [12]. In product semantics, the meaning of products is the key issue, no matter what the messages encoded by designers and perceived by users are the same or not. In addition, the semantic issues discussed include all of the three categories, even beyond.

Second, Gibson's affordance is part of the direct perception theory. The word *affordance* is derived from the phenomenal character *Aufforderungscharakter* in Gestalt Psychology [10] to explain why actionable properties (value) of thing seem to be perceived immediately and directly. The theory of affordance follows the tenet of ecological approach of perception: perception and action is inseparable, and the information of how objects and users interact can be directly perceived, or pick up. Most importantly, an affordance of things is often valid for all the users with same physical scale and condition, despite the different needs or contexts. Product semantics is a design theory, which merges semiotics with information theory and cognitive psychology. The designer is seen as the sender of messages in the form of a product and the user as the receiver of those messages. The encoding and decoding process is influenced by the designers and users' experience, socio-cultural background, intentions and contexts. [6,19]

Third, the methods to implement the concept of affordance and product semantics are fundamentally different, despite of the common misconception in current design practice. In the implementation of affordance in design, the reciprocal nature of affordance is reflected in the relationship between human abilities, body dimensions and the design of the environment, hence, methods of ergonomics and anthropometric data are often used [6]. Since affordances exist whether they are perceived or not, for good or ill, reexamining the action possibility of uses and artifacts can open up new interaction or usage of existing technology and material beyond cultural convention [33]. However, the few so-called affordance-based designs fail to come up a systematic approach to apply affordance in design. The need of affordance-based design method is waiting to fulfill. On the other hand, the methods to apply semiotics in product design seem diverse [30-32]. But, in general, these product semantics approaches usually convey meaning through the use of metaphor (or simile), for instance, borrowing an existing symbol or shape from another field to relate the product to that field.

In short, the distinction of these two concepts is clear. They stem from different theoretical background; thus, the focus of the research issue, and the methods adopted in design practice is different. Unfortunately, the development of affordance concept in design practice is by far not yet matured, due to designers' mistaking "cultural convention" or "symbolic meaning" for affordance [23,27,28], and the current understanding of this concept is insufficient for its application in design. As a result, "at the concrete level of designing artifacts it is quite difficult to point out the differences between product semantics and affordances." [6]

3.2 A Close Checkup

To clearly state the subtle difference of these two design theories, a checkup table shown below highlights the

main differences between product semantics and affordance theory.

Table 1. Main differences between product semantics and affordance theory

	Product Semantics	**Affordance Theory**
Theory background	Semiotics, Information theory, and Cognitive psychology	Ecological approach (to perception)
Channel	Mediated information (information processing needed)	Direct perception
Content of Interaction	Meanings of different levels	Actionable properties
Relation to Users and Contexts	Users' awareness, needs, context and cultural background dependence	Invariant relation between users and environments based on their intrinsic properties; independent of users' awareness, needs, cultural background and contexts
Methods of implementation	Metaphor, Simile, Irony…etc. Association, Convention	Ergonomic and anthropometrical data
The role of designer	As the sender of the message; no control over user's interpretation An important role to initiate the communication	As the creator of the artifact; through manipulating physical property of artifacts to alter affordances Affordance naturally exists with/without designers

3.3 Clarifications and Discussions

The two theories based on different theoretical background and assumption can be distinguished clearly from the description and the comparison table above. However, due to the ill-defined nature of design problems, the deductive process from design specification to product form remains black-boxed. Traditionally, a designer bases on his/her experience, knowledge and personal preference to embody the final product; hence, no matter the design originally based on product semantics, or affordance theory, in the end the outcomes of the design process seem indistinctive. The message encoding process in product semantics, though some guidelines or suggested steps are provided in applying metaphor or simile, still depends mainly on designer's competence, experience, and aesthetic preference to shape the final product, like traditional design practice does; therefore, the alleged "meaning-centered" product semantics is becoming more a style than a new design theory.

The theory of affordance, as many design researchers and HCI specialists suggest, can be extended to the man-made environment. But in Gibson's works, no direct hint is provided for design community to gain benefits from this concept, besides employing proper human scale to elicit the intended function or interaction [12]. Therefore, the methods that can truly reveal the nature of both design theories are still waiting to be discovered or developed.

4. Conclusions and Suggestions

In discussing what a good design is, semantics is an indispensable issue. Many attempts and elaboration have been done to provide a systematic approach to manipulate the meaning or value through design process. Product semantics is one of the design theory and approach, which "makes use of the conceptual framework of the

difficult science of semantics, which studies meanings as expressed in language, in order to create a more inclusive, meaning-centered design theory and aesthetic." [22] In discussing the interactions between users and products beyond what we have know, then, affordance theory can provide a framework to construct the relationship between users, products and the potential interaction, no matter if the interaction is useful, useless or harmful. According to the directed perception theory of Gibson's, when the objective relation of a user and a product is eligible for a given affordance, the interactive behavior elicited from that affordance is possible, independent of the needs, the intention, and the contexts. This relation is intrinsic, open, invariant, and beyond our cultural constraint, therefore it could open the door to some unexplored territory for interaction design. These two design theories rooted from different backgrounds contributing to better design from different aspects, however, the development of affordance concept in design practice is still in its infancy, and the differentiation between affordance and symbolic meaning of designed artifacts is not clear. As a result, that employing techniques of product semantics or cognitive approach while implementation of affordance concept is meant is often found in design practice. This confusion not only hinders the development of ecological approach in design research, but also limits the potential application of affordance concept as well.

This study aims to clarify the misunderstanding and misuse of affordance concept in product design, especially confusing affordance concept with product semantics. Returning to Gibson's original definition, and examining the difference between affordance and symbolic meaning would help us to shed light on the divergence of the concepts, and point out the possible direction for the application of affordance concept in product design.

References

1. Albrechtsen H, et al. Affordances in Activity Theory and Cognitive Systems Engineering, Technical Report Risø-R-1287(EN), Risø National Laboratory, Roskilde (2001).
2. Aldersey-Williams, H. et al. Cranbrook design : the new discourse, New York : Rizzoli (1990).
3. Burdek BE. Geschichte, Theorie und Praxis der Produktgestaltung (Chinese edition), Taipei: Asia-Pacific Press (1996).
4. Bush DJ. Body Icons and Product Semantics, in Semantic Visions in Design : proceedings from the Symposium on Design Research and Semiotics, Susann Vihma (Ed.) 17-18 May 1989 at the University of Industrial Arts Helsinki UIAH (1990).
5. Chen WY, Design Literacy: Toward A New Discourse , Taipei: Asia-Pacific Press (1997).
6. Djajadiningrat JP. Chapter 3. Gibson' s Theory of Affordances: A Framework for Design, in Cubby: What You See Is Where You Act--Interlacing the display and manipulation spaces. Doctoral dissertation. Delft University of Technology, Netherlands (1998).
7. Flach J, et al. (ed). Global Perspectives on The Ecology of Human-machine Systems, Hillsdale, N.J.: L. Erlbaum Associates(1995).
8. Gaver W. Technology Affordances. Proceedings of CHI'91, New Orleans, April 28 - May 2, 1991. ACM, New York, P79 – 84 (1991).
9. Gaver W. Affordances for Interaction: The Social Is Material for Design. Ecological Psychology 8(2), P111-129 (1996).
10. Gibson J. The Ecological Approach to Visual Perception, Boston: Houghton Mifflin Company (1979).
11. Gibson J. A Study in the Psychology of Decorative Art, unpublished manuscripts, Cornell University (1979).

12. Gibson J. The Theory of Affordance and the Design of Environment. In E. Reed and R. Jones, (Eds.) Reasons for Realism: Selected Essays of James J. Gibson. Hillsdale, NJ: Erlbaum, p.413-416 (1982).
13. Hammer N. Releveant Cognitive Models for Design Products, in Semantic Visions in Design: Proceedings from the Symposium on Design Research and Semiotics, Susann Vihma (Ed.), May 17-18 1989 at University of Industrial Arts Helsinki UIAH. Helsinki: Publications of the University of Industrial Arts UIAH A7, 1990, p.94-99(1990)
14. Hartson HR. Cognitive, Physical, and Perceptual Affordances in Interaction Design, (in press, Behaviour and Information Technology) (2003).
15. Kirlik R, Miller A, Jagacinski RJ. Supervisory control in a dynamic and uncertain environment ii: A process model of skilled human environment interaction. IEEE Transactions on Systems, Man, and Cybernetics, 23:929–952, 1993(1993).
16. Koelsch F.The Information Revoluiton, (Chinese edition), Taipei: Yuan-Liou Publishing (1996).
17. Krampen M. Semiotics in Architecture and Industrial/Product Design, The Idea of Design: A Design Issues, V. Margolin & R. Buchanan (Ed.), MIT Press, pp. 89-103(1995).
18. Krippendorff K. Product Semantics: A Triangulation and Four design Theories, in Product Semantics '89 : proceedings from the Products Semantics '89 Conference, Vakeva, S.(Ed),16-19 May 1989 at the University of Industrial Arts Helsinki UIAH. Pp.a1-a23(1990)
19. Krippendorff K. On the Essential Contexts of Artifacts or on the Propositoin that "Design Is Making Sense (of Things)", in The Idea of Design: A Design Issues, V. Margolin & R. Buchanan (Ed.), MIT Press, pp. 156-184 (1995).
20. Maier J, Fadel G. Affordance: The Fundamental Concept in Engineering Design, ASME DETC/DTM, Pittsburgh, PA, Paper No. DETC2001/DTM-21200(2001).
21. McGrenere J, Ho W, Affordances: Clarifying and evolving a concept. Proceedings of Graphics Interface 2000 (2000).
22. Michl J. "[Book reviews of] Väkevä, Seppo, ed. Product Semantics '89 Helsinki 1990; Vihma, Susann, ed. Semantic Visions in Design. Helsinki 1990", Scandinavian Journal of Design History 2 (1992): 123-7. (1992)
23. Mitchell CT. Affordances for Information Technology, New Thinking in Design: Conversations on Theory and Practice. New York: Van Nostrand Reinhold.94-97(1996).
24. Murphy RR. Case Studied of Applying Gibson's Ecological Approach to Mobile Robots, IEEE Transactions on systems, man, and cybernetics-part a: system and humans. Vol. 29, No. 1, January 1999, p 105-111(1999).
25. Norman D A. The Psychology of Everyday Thing, New York: Basic Books Inc (1988).
26. Norman D A. The Invisible Computer: why good products can fail, the personal computer is so complex, and information appliances are the solution. Cambridge, Massachusetts: The MIT Press (1998).
27. Norman D A. Affordance and Design, http://www.jnd.org/dn.mss/Affordances-and-design.html (last visited:4/29/2002) (1999)
28. Norman D A.. Affordance, Conventions, and Design, Interactions, May-June, 1999, 38-42 (1999).
29. Preece J, et al. Interaction Design: beyond human-computer interaction, New York, NY : J. Wiley & Sons, p25-26. (2002)
30. Vakeva S (Ed). Product Semantics '89 : proceedings from the Products Semantics '89 Conference, 16-19 May 1989 at the University of Industrial Arts Helsinki UIAH (1990).

31. Vihma S (Ed). Semantic Visions in Design: proceedings from the Symposium on Design Research and Semiotics, 17-18 May 1989 at the University of Industrial Arts Helsinki UIAH (1990)
32. Vihma S. Products as Representations: a semiotic and aesthetic study of design products, Helsinki :University of Industrial Arts Helsinki UIAH (1995).
33. You H, You M, Chen K. Affordances in Objects: A Primary Study on the Formal Description of Affordance for Product, Bulletin of 5th Asian Design Conference: International Symposium on Design Science, 2001, Seoul, Oct. 11~13, 2001(2001).