Anthropomorphic Design:
Projecting Human Characteristics to Product

Jeong-gun Choi* Myungsuk Kim**

** Korea Advanced Institute of Science and Technology (KAIST)*
Daejeon, Republic of Korea, matrix@kaist.ac.kr
*** Korea Advanced Institute of Science and Technology (KAIST)*
Daejeon, Republic of Korea, mskim@kaist.ac.kr

Abstract: Recently, usage of anthropomorphic form has been a basic design strategy in the design of intelligent products. Proceeding from how anthropomorphism in various domains has taken effect on human perception, it is assumed that anthropomorphic form used in appearance and interaction design of products enriches the explanation of its function and creates familiarity with products. This study is aiming to build the basic knowledge of anthropomorphic design to inform both design studies and design practice. Towards this end, two fundamental questions need to be answered; how anthropomorphism influences the acceptance of design, and how the designers utilize anthropomorphism as a design strategy. In this study, to take up the first question, "how anthropomorphism influences the acceptance of design", identifying and describing people's cognitive responses to product appearance is preceded. The effects of anthropomorphized appearance and interaction on these physiological, emotional, and cognitive responses of users affect user performance or acceptance either positively or negatively. From many cases which we have found, misused anthropomorphic forms lead to user disappointment or negative impressions on the product. Therefore, in order to effectively use anthropomorphic forms, it is necessary to measure the similarity of an artifact to the human form, and then evaluate whether the usage of anthropomorphic design approach fits the artifact. Within anthropomorphic design approach, to design product appearance and interaction, it should find proper level of humanness which fits to its primary task and role to get positive effect from anthropomorphism.

Key words: Anthropomorphism, Metaphorical Design, Design Semantics.

1. Introduction

"There is an universal tendency among mankind to conceive all beings like themselves… We find human faces in the moon, armies in the clouds." – David Hume, The Natural History of Religion (1757).

Anthropomorphism has been noted for centuries throughout human thought, yet to many it remains inexplicable. By nature anthropomorphism cannot be eliminated; it occurs as one result of a perceptual strategy that is both involuntary and necessary. Though literature is one of the representative areas where anthropomorphism is employed, there are also arguments against it use in writing. Once philosophers revealed the intentions underlying its use, it became a less attractive rhetorical device. Numerous philosophers, natural scientists, and others have long criticized the practice of anthropomorphism. Despite this scrutiny, a thorough account of the causes of anthropomorphism has yet to be presented. Instead, two explanations - that it comforts us and that it explains the unfamiliar by the familiar – have, singly or together, been widely assumed (Robert W. Mitchell, Nicholas S. Thompson, & H. Lyn Miles, 1997). Other authentic arguments on purpose of anthropomorphic form is that it provides users with clues about the product's function, mode-of-use, and qualities, as well as a perception of what the product says about its owner or user, that is, the personal and social significance attached to the design. Giving an anthropomorphic form to the shape and motion of a product helps humans perceive it as an artifact that actually lives with them and shares the same space everyday. While many applications of anthropomorphism in the area of design are also motivated by these goals, it is neither a dominant design method nor a target of strong criticism.

This study starts with contrasting the benefits of anthropomorphism and the critical point of view on the misuse cases of anthropomorphic design approach. In many cases I found, misused anthropomorphic forms lead to user disappointment or negative impressions on the product. Anthropomorphized factors take a significant role in shaping user preference toward a product.

2. Anthropomorphic Design in Context

Anthropomorphism is defined in Webster's New Collegiate Dictionary (1977) as the "attribution of human characteristics to nonhuman things or events". In terms of design, anthropomorphism can be applied to the form of an artifact. Form is not limited to static features such as shape and color. Form can also be related to dynamic features such as movement. Therefore, it is necessary to find anthropomorphic forms for products, not only in terms of how they look, but from an entire set of experiences users acquire when they interact with products. To observe how the design of products delivers experiences to users, it is necessary to first generalize the qualities of form, and then study the underlying qualities of anthropomorphic forms in cognitive and social contexts of their use. This study begins by posing two areas where designers can apply anthropomorphic forms to industrial products, appearance and interaction.

From the viewpoint of a semantic approach, "experience", the objective for measurement, stands for complex, contextualized "meaning" under considerably various circumstances. Objects are always seen in a context (of other things, situations, and users, including the observing self) (Ulrich Neisser, 1976). Objects such as products that perform multi-function tasks generate more complex meaning in accordance with contextual changes. What a thing or product represents (the totality of its meaning) to someone corresponds to not only actual contexts but also to its imaginable contexts. The context into which people place the object they see is cognitively constructed, whether recognized, anticipated, or wholly imaginary. A future domestic service robot is expected to have a great diversity of uses; a 'service robot' will not typically have a single prominent use. Vacuuming, carrying a newspaper, turning off the television, and chatting with the user examples of functions that are imaginable to ordinary people. In contrast with the case of a robot that can perform only a single task among those, people refer to different robots from their own experiences with robots and assume the robot can perform multiple tasks, and they accordingly respond to the robot with imaginable contexts. Therefore, observing variable meanings for variable contexts is practically impossible. We therefore argue that it needs to simply observe meanings that can be objectified largely according to the designer's efforts. In other words, we need to control the context of the

product's use. Accordingly, we narrowed "meaning" to "form" as research's objective to measure, thereby circumventing the problem of dealing with uncontrollable contexts.
Klaus Krippendorff (1984) outlined four essentially different contexts in which objects may take on meaning in different ways.

- Operational context, in which people are seen as interacting with artifacts in use
- Sociolinguistic context, in which people are seen as communicating with each other about particular artifacts, their uses and users, and thereby co-constructing realities of which objects become constitutive parts
- Context of genesis, in which designers, producers, distributors, users, and others are seen as participating in creating and consuming artifacts and as differentially contributing to the technical organization of culture and material entropy.
- Ecological context, in which populations of artifacts are seen as interacting with one another and contributing to the autopoiesis (self-production) of technology and culture

Among Klaus's four types of contexts, form is explored only in an operational context in this study. Efforts of designers to control the humanness level of products by applying anthropomorphism initially affect meaning in an operational context. Other meanings that diverge from the initial meaning then follow in other contexts. If we attempt to study respondents' reactions in other contexts(e.g. a sociolinguistic context), observations will have to be carried out for a considerably long period of time. Also, when respondents are more familiar with the given objects, they will perceive the object wholly differently. Thus, it is apparent that we cannot purely observe people's reaction toward an object in terms of its design itself if we conduct long term observations.

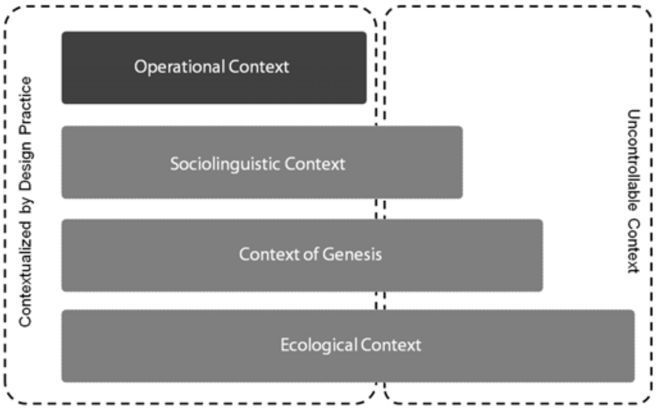

Figure. 1 Uncontrollability of Context

3. Classification of Anthropomorphizable Domain

Carl DiSalvo, Francine Gemperl, & Jodi Forlizzi (2005) addressed the question of classifying anthropomorphic form from the designer's point of view. DiSalvo et al. classified anthropomorphic form into four groups, structural anthropomorphic form, gestural anthropomorphic form, anthropomorphic form of character, and aware anthropomorphic form. The distinctions between the four groups were derived from examining evidence of anthropomorphic form in designed artifacts. However, rather than classification of anthropomorphic form, we focus on classifying the domain to which anthropomorphism is applied, because we deal with anthropomorphic forms as the targets of observation and evaluation in this study.

In light of the background presented above, we break down the anthropomorphizable domain into two areas, 'appearance' and 'interaction'. The design of interaction between human and product is considered to fall within the realm of the industrial designer's responsibilities. When developing an intelligent product such as a robotic product that has perceptive, cognitive, and action ability, the appearance of a product must be designed with consideration of its interaction style, and vice versa, because most interactions when a product is processing perception, cognition, and action are expressed through physical features of the product, i.e., "features of appearance"

3-1. Usage of Anthropomorphism: Appearance

There is a long history of designers imitating human form. Artifacts that have anthropomorphic form can be found everywhere in our daily lives. The usage of anthropomorphic form in design was manifested mostly in the appearance of artifacts in the past. This history goes back thousands of years to ritual vessels (Carl DiSalvo, et al, 2005). At that time, the makers of these artifacts attempted to use human form straightforwardly. The shapes of vessels have a strong association with the human body. This bald expression of human shape makes an explicit statement about the purpose of anthropomorphism at that time. Although the use of human appearance for vessels was required for religious reasons, anthropomorphism was not always intentionally employed. Form in appearance may be recognized as an anthropomorphized form not only when it is originally designed as such but also when it is merely interpreted in this way.

Humanlike forms can be found in contemporary design as well. The front of an automobile can be thought of as resembling a human face. People commonly compare headlamps or tail lamps of an automobile with human eyes. The image of the automobile evokes the characteristics of humans. Since eyes are one of the most significant visual features among all facial features with respect to forming facial expressions, automobile designers pay deliberate attention to the design of headlamps and tail lamps, which are interrelated with the overall characteristics of an automobile. People may associate the shape of lights with friendly or angry eyes of a human face. This association has a major impact on the impression the viewer has of the appearance of automobiles. BMW GINA light visionary model concept (Figure. 2) wears a fabric "skin" comprised of a wire-mesh inner stabilizing layer and a water- and temperature-resistant outer layer. This concept is not just symbolizing human features but directly borrowing them. The headlamps are hidden until the driver turns them on, only instead of popping up like '80s Pontiac Firebird, the skin smoothly opens to reveal lights as human opens eyes.

Figure. 2 BMW's GINA Light Visionary Model Concept

Observing anthropomorphic form in products requires not only interpretation of the designer's intention but also people's cognitive response to the products. When reviewing the work of Crozier(1994), Cupchik(1999), Lewalski(1988), Baxter(1995) and Norman(2004), a strong precedent emerges for using the following three categories to describe cognitive response to product appearance: aesthetic impression, semantic interpretation, and symbolic association(Nathan Crilly, James Moultrie & P. John Clarkson, 2004). Aesthetic impression is defined as the sensation that results from the perception of attractiveness (or unattractiveness) in products. Semantic interpretation is defined as what a product is seen to say about its function, mode-of-use, and qualities. Symbolic association is defined as the perception of what a product says about its owner or user: the personal and social significance attached to the design. These three cognitive responses can be found in every artifact. However, the influence of each response on the whole cognitive response may differ according to the attributes of an artifact. Also, the influence of anthropomorphism on each response may differ according to the attributes of an artifact. In the case of a ritual vessel, anthropomorphic form serves as a linchpin connecting symbolic association. The humanlike body shape of the vessel recalls its implications for sacrificial rituals.

Anthropomorphic form in products has increasingly been used for functional purposes rather than symbolic and religious purposes. The appearance of an object can create an affordance that provides the user with perceivable possibilities for actions. James. J. Gibson (1979) claimed, "The object offers what it does because it is what it is". Hence, this term can be interpreted as meaning that appearance is one of the most significant elements of an artifact in terms of explaining its functions and capabilities. Designers need to understand visual cues that indicate required operations or intended functions of a product. As functions of a product become more complex, designers increasingly rely on affordances to encourage a semantic interpretation.

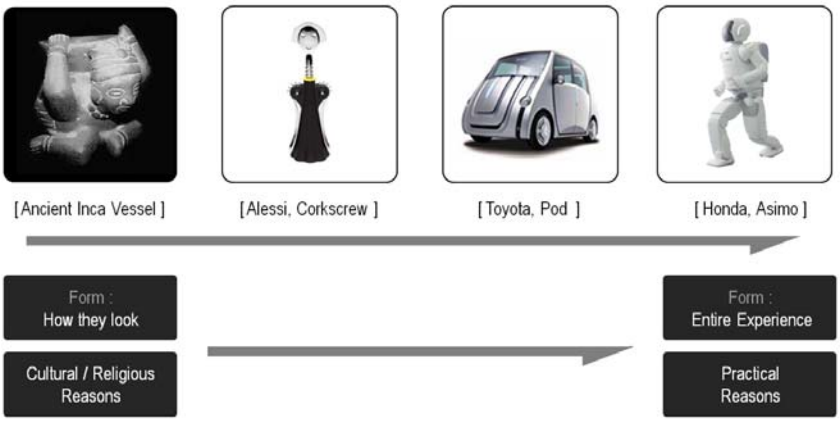

Figure. 3 Paradigm Shift of Anthropomorphic Design

3-2. Usage of Anthropomorphism: Interaction

As product designers assumed responsibility largely for covering ugly engineered mechanisms with pleasing forms in the past, anthropomorphic design meant only for appearance of product. However, anthropomorphism has also been effectively used in the design of interactions between humans and products. Anthropomorphism in interaction can be delivered through a multimodal interface. Appearance can be delivered only through visual languages, but interaction can be manifested through auditory, tactile, and other languages. For example, sounds made when a car door is opened and shut can be associated with different human characteristics. A low-pitched sound supports the assignment of a dignified and noble human character to a car. Although the car door sound is not a human voice, it is interpreted as a human feature in this case. Concern for gender differences and the adaptation of a human emotion model in the development of human-robot interactions are other examples of the usage of anthropomorphic form in interaction design.

4. Application of Anthropomorphic Form

4-1. Anthropomorphic Form as Metaphor

In language, metaphors probably are the most powerful tropes for creating new realities. They are the tools for poets, inventors, and politicians. For designers, visual metaphors are important in making new technology comprehensible. In the context of use, metaphors enable the recognition of artifacts in terms of the dimensions and features of other and more familiar artifacts. Therefore, to make new users understand what to do with new products on new technology, designers have used metaphor for creating a container for a particular set of affordances.

In product design, affordances originate from different types of metaphorical sources, for example, an existing product, a plant, an animal, or a human. Several research teams have been developing new types of industrial products with new, improved functional qualities using biological and bionic analogies. Biological forms, coloring, structures, constructions, functionality, and general aesthetic appearances found in the natural world (botanical as well as zoological organisms or parts of them) serve as models for promising applications in creating useful designs.

As an example, engineers, designers, and biologists at Mercedes-Benz worked together to develop the Mercedes-Benz bionic car (2005). Its template was a sea dweller from tropical latitudes: Ostracion Cubicus – more commonly known as the boxfish. Despite its unusual-looking shape, the fish is extremely aerodynamic and can therefore move using a minimal amount of energy. It is also able to withstand high pressures and, thanks to an outer skin consisting of hexagonal bone plates, can survive unscathed following collisions with corals or other sea dwellers. These characteristics are also ideal for a car designed to achieve the best possible levels of energy efficiency and passenger safety. This is known as “biomimetic design”. Biomimetic design enhances a product’s technical performances as well as facilitating semantic interpretation.

For intelligent products, various types of metaphors have been used for their design. This started with organisms such as insects or animals that can be imitated relatively easily. As developed technologies began trying to imitate complex human features, anthropomorphism emerged as an important issue in both product engineering and design.

On the other hand, metaphor can be a flawed means of communication. Lakoff and Johnson [x] write that metaphor not only emphasizes similarities between two things, but also hides non-similarities.

Figure. 4 Ever-one (KITECH, 2006) & Robokin-M01 (Sejong Robotics, 2006)

Ever-one/two of Korea Institute of Industrial Technology (KITECH) and Robokin-M01/F01 of Sejong Robotics (figure. 4) are highly analogous to living models in appearance. The major application of these types of robots is communication with humans, which is accomplished using a certain level of facial expressions and speeches. However, the perceivable humanness of the robots' intelligence cannot yet satisfy its uncommon similarity of appearance. In this case, highly humanlike appearance hides non-similarities between metaphor source, human and robot. Before these robots can be implemented to serve humans as intelligent products in the home or office, designers should consider the problem of discordance between anthropomorphized level appearance and interaction ability. Such discrepancy can lead to user disappointment or negative impressions.

4-2. Usage of Anthropomorphism: Relationship between Appearance and Interaction

One of the early Japanese roboticists, Masahiro Mori (1970), proposed that as robots become more humanlike, they become, to a degree, more familiar. However, as with a human corpse, they risk becoming eerie when they appear too human, especially when they are discovered to be mechanical through touch or by other means. If design concerns are not carefully managed for robots, anthropomorphic forms used in the design of their appearance can have a detrimental influence on human perception and preference.

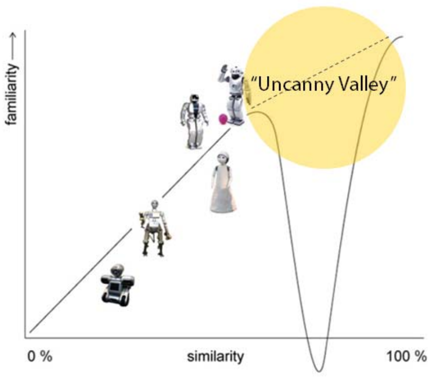

Figure. 5 Masahiro Mori's 'Uncanny Valley'

The term 'Uncanny Valley' refers to a graph of emotional reaction against the similarity of a robot to human appearance and movement (Figure. 4). The term was coined by Mori, although it is often wrongly associated with his later work "The Buddha in the Robot" (1982). As a machine acquires greater similarity to humans, it becomes more emotionally appealing to the observer. However, when it becomes disconcertingly close to a human there is a very strong drop in believability and comfort, before finally achieving full humanity and eliciting positive reactions once more; this is the Uncanny Valley. However, if robots (or any anthropomorphized products) have an amount of humanness in their appearance equivalent to an amount of humanness in interaction ability (intelligence), this drop, i.e., the "uncanny valley", can be avoided.

5. Evaluation of Anthropomorphic Design

When people are asked to verbally report on nonhuman things, they often employ adjectives that describe human characteristics. This helps explain the strong relationship between verbal cues from their expressions and perception to the anthropomorphized objects. Meaning of anthropomorphic form can be represented by verbal interpretations of products by informants. Regardless of whether the object is originally designed in an anthropomorphized form or it is only perceived as such, human characteristics are attributed to it. Accordingly, verbal reporting on anthropomorphic form is applicable evidence to evaluate anthropomorphism. When developing criteria to measure the usage of anthropomorphic form, it is necessary to collect verbal adjectives that directly illustrate the human features related to the form. The criteria known as the Big Five as well as those denoted by the acronym MBTI are useful tools for this.

These adjectives and criteria must be reorganized in accordance with the purpose of anthropomorphism. Then, after measuring the humanness of a product in terms of both appearance and interaction using appropriate criteria, it was necessary to check whether one value parallels the other. Synthetically, we propose that there are basically three steps to evaluate the usage of anthropomorphic form: designing measurement criteria, measuring humanness in both appearance and interaction, and evaluating the degree of symmetry in the two values.

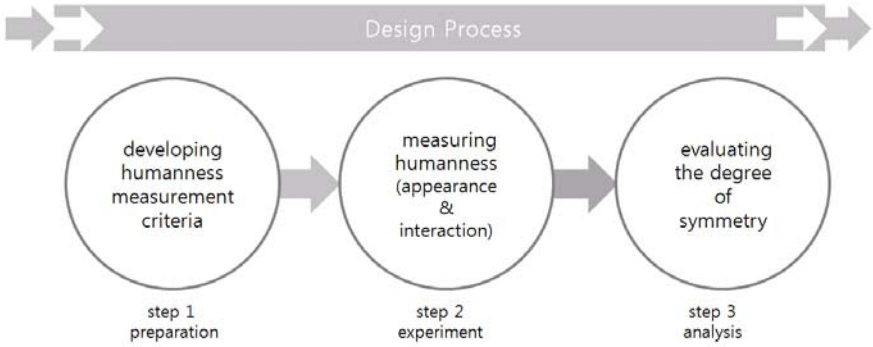

Figure. 6 Evaluation steps of the usage of anthropomorphic form in design process

5-1. Exemplification of Evaluation: Measuring Humanness

Experiments of measuring humanness were only for incorporating our proposed evaluation steps in concrete level. It was an initial trial for conducting each step in the evaluation. Aim of experiments was not finding a new design solution from data we obtained, but elucidating the relationship between humanness of product and participants' preference for the product.

Measuring product's appearance: The pictures of existing robots were made into cards, and these were used in the robot image evaluation experiment for children. The names of the robot and other explanations were excluded (Figure. 7 is showing the rear side with robot name and specifications), as it was felt that children may be influenced by other information in addition to the appearance of the robots. Participants performed the image mapping with 43 pictures of existing robots, and sorted the robots according to its human ness, similarity of an artifact to the human form. Taking 24 children that were fourth grade students in Daejeon, Korea were selected as participants.

Figure. 7 Robot Card for Evaluation

Measuring product's interaction: Measuring humanness of product's interaction abilities requires different criteria for different role and performance of products. Therefore, we developed criteria for evaluating a teaching assistant robot's humanness in interaction between the robot and children as a sample case. The criteria were composed of verbal adjectives representing a teacher's typical characteristics and well-known qualities. The qualities of teaching-assistant robots can be established by reconstructing the qualities of human teachers, who perform a similar role to that of the teaching-assistant robots. The qualities of teachers are usually the concern of the field of pedagogy. 113 people comprised of teachers and student teachers participated in this questionnaire (web-based). With the data of this questionnaire, the qualities were grouped by factor analysis, for the case of teachers and teaching-assistant robots. As a result of the factor analysis, primary 24 qualities grouped into 6 factors, and these 6 factors (Table 1) were used for evaluation criteria.

Table 1. Humanness measurement criteria for teaching assistant robot's interaction

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
	Tenderness · Kindness	**Leadership**	**Knowledgeability**	**Flexibility**	**Reliability · Patience**	**Sincerity · Impartiality**
	Tenderness Kindness	Leadership	Accuracy Agility	Flexibility	Reliability	Sincerity Impartiality
Role images	Clemency Dignity Sense of duty Paragon Educational affection	Competency	Knowledgeability		Patience	

For measuring humanness in robot's interaction, we used a five-lane board (scored 1 to 5), so the closer the robot was to a similar image for the given criteria(role image factors), the more often the card was placed to the right end, that being the higher scoring end. Same participants with measurement of appearance performed the image mapping with movie clips of 6 representative robot's (out of 43 robots) interaction with users.

5-2. Harmony of Appearance and Interaction

To utilize anthropomorphic form for product appearance and interaction, it needs to find proper level of humanness which fits to its primary task and role. We are not able to demonstrate specifically what level is proper for a teaching assistant robot from the limited result of our experiments. However, we figured out that humanness in interaction ability of teaching assistant robot is fixed at a certain level for its given role and task, and the suitable level need to be answered in design stage (humanness measuring step). Only then, we can find appropriate humanness level of appearance according to its humanness level in interaction.

The most significant message which our evaluation framework delivers is making designers aware of accordance of humanness level in appearance and interaction in their designing stage. From the exemplification we conducted, we could verify the assumption that humanness of appearance and interaction should be in accordance.

During the execution of the case study, a few more implications for designing evaluation criteria were found. Measuring the absolute value of the humanness of the anthropomorphic form used in products may not be possible. Participants always required comparative samples when they rated the humanness of products. Participants understood the term 'humanlike' as 'natural' or 'realistic', because they assumed that robots were inevitably human-based. When showing movie clips to allow participants to see how robots interact with users, blocking the part of the robot that was not related to the present interaction proved to be a critical issue. The results of the experiment strongly supported the hypothesis that disparity between the humanness of product appearance and interaction promotes a negative influence on preference toward robots.

6. Conclusion

Human features had not been easily accessible sources of metaphorical design. Later, high-technology has driven anthropomorphic design since intelligent products which replace human labor and intelligence were invented. Anthropomorphism in designing those intelligent products is not yet imperative, while it in literature is. Employing humanlike forms or interactions is not always an appropriate choice for them. Even for humanoid type robots, perfectly mimicked form or interaction is not the best answer to attract and satisfy users. Every technology passes through an immature phase in which human models are used as metaphors for design. The newest intelligent product such as robot may not be an exceptional case. Designers need to be careful to use anthropomorphic form which raises the problem that users misconceive product's actual quality.

The aim of this study has been to profile the doctrine of anthropomorphism in design, and to explore and suggest ways in which design researchers can achieve added insights in their efforts to comprehend anthropomorphism in the practical design field and in the research arena itself. Through the further research, we will not attempt to develop an "anthropomorphic design" to inform other designers of how they should do better design, but rather we provide one another starting point for criticizing and reflecting on seemingly 'natural' ways of designing .

7. References

[1] Baxter, M. (1995). *Product design: a practical guide to systematic methods of new product development.* London: Chapman & Hall

[2] Crilly, N., Moultrie, J., & Clarkson, P. J. (2004). Seeing things: consumer response to the visual domain in product design. Design Studies, 25(6), pp. 547-577

[3] Crozier, W. R. (1994). *Manufactured pleasures: psychological response to design*. Manchester: Manchester University Press

[4] Cupchik, G. C. (1999). Emotion and industrial design: reconciling meanings and feelings. First International Conference on Design & Emotion Delft, The Netherlands, pp. 75–82

[5] DiSalvo, C., Gemperle, F., & Forlizzi, J.(2005), Imitating the Human Form: Four Kinds of Anthropomorphic Form. Cognitive and Social Design of Assistive Robots, Carnegie Mellon University from http://anthropomorphism.org

[6] Gibson J.J. (1977). *The Theory of Affordances. In: Shaw R.E., Bransford J., (Eds.), Perceiving, Acting and Knowing: Toward an Ecological Psychology.* Hillsday NJ.: Lawrence Erlbaum Associates.

[7] Krippendorff, K. (1984). An Epistemological Foundation for Communication. Journal of Communication 34(3), pp. 21-36.

[8] George, L. and Johnson, M.(1980) *Metaphors We Live By.* Chicago: University of Chicago Press.

[9] Lewalski, Z. M. (1988). *Product esthetics: an interpretation for designers*. Carson City, NV: Design & Development Engineering Press.

[10] Mitchell, R. W., Thompson, N. S., & Miles, H. L. (1997). *Anthropomorphism, Anecdotes, and Animals*. New York: State University of New York Press

[11] Mumford, L. (1963), *Technics & Civilization*. Harvest Books

[12] Neisser, U. (1976). *Cognition and Reality.* San Francisco: Freeman

[13] Norman, D. A. (2004*). Emotional design: why we love (or hate) everyday things.* New York: Basic Books.

[14] Reeves, B. & Nass, C.(1996), *The Media Equation*. California: CSLI Publications

[15] Young, R., Pezzutti. D., Pill, S., & Sharp, R. (2005). Design and semantics of form and movement. The language of motion in industrial design, DeSForM Programme