

The relation between interaction aesthetics and affordances

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Even though aesthetics and affordances are two important factors based on which designers provide effective ways of interaction through their artifacts, there is no study or theoretical model that relates these two aspects of design. We suggest a theoretical explanation that relates the underlying functionality of aesthetics, in particular, of interaction aesthetics and of affordances in the design process. Our claim is that interaction aesthetics are one among other factors that allow users to enhance the detection of action possibilities and consequently, the detection of affordances. Our aim is first to discuss the role of interaction aesthetics in the design process, and second to suggest an explanation for their role in the detection of affordances when users interact with artifacts.

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Aesthetics have long been considered in the design community as an undetermined research area where in most of the times it is approached by the abstract notion of beauty or by its correlation to usability issues (Norman, 2004). For years the role of aesthetics in design decisions has been challenged by usability concerning their importance in product's success (Hassenzahl & Monk, 2010; Norman, 2002; Overbeeke & Wensveen, 2004; Tractinsky, 1997; Tractinsky, Katz, & Ikar, 2000). Nowadays, aesthetic and emotional design gain their own place in design theory as they play a significant role in the development of our whole experience with products (Hartmann, Sutcliffe, & Angeli, 2007; Hassenzahl, 2004; Norman, 2003; Overbeeke & Wensveen, 2003). Thus, when designers are about to design a successful interaction, the decisions that are related to aesthetics appear to be of the most crucial in the design process.

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(considered as range of action possibilities), is proved to be a very useful cognitive tool linking perception with action (Albrechtsen, Andersen, Bodker, & Pejtersen, 2001; Norman, 1990). However, affordances are more than a cognitive element in the design process. The concept of affordance affect how designers think that action possibilities are perceived by users in their effort to choose the 'proper' functionality for their artifacts (Smets & Overbeeke, 1994). Both aesthetics and affordances are considered to be measures of product success, each one for the role it plays in the design process. Thus, designers always want to know how they could use these two ostensibly distinct theoretical elements in order to provide effective ways of interaction through their products.

However, there is no study or theoretical model that relates those two important aspects of design. Probably a reason for this is owed to the diversity of the current theoretical and experimental explanations concerning the meaning of aesthetics and its role in the design process. The notion of aesthetics is highly complex and the term 'aesthetic' is still very broad both in experimental studies and theoretical models.

Briefly, in most of the studies the 'aesthetic' is related to 'known' types of experiences or impressions that we usually have as we interact with products. Specifically, some researchers propose models of aesthetic usability relating aesthetics to beauty and goodness (see Tractinsky, 1997). Others propose models relating aesthetic impressions to qualities (e.g. adorable, cool, strong, tragic, etc.) that could characterize a product or other types of experiences such as, enjoyment, fun, trustfulness, attractiveness, etc. that are not limited to beauty and goodness (Hartmann et al., 2007; Park, Choi, & Kim, 2004; Sutcliffe, 2010). Such aesthetic impressions are not determined solely by haptic feelings but also by the intentions of the person that interacts with the artifact (e.g. visually, by touch).

From another point of view, there are authors that refer to aesthetics as a discipline of visual perception focusing mainly on the visual or physical properties (visual Gestalt) of an object. Accordingly, Sutcliffe, (2010) combines the aesthetics with some general principles that may lead to an aesthetic or appealing design result. From this view, aesthetics are related to qualities that appear in the physical form in which the content and services of the design are presented. Thus, aesthetics could be an important determinant of user satisfaction and system acceptability (Hartmann, 2006). In order to experience the aesthetic or/and beauty users need to follow their previous experiences to evaluate their surroundings by making cognitive interpretations and classifications in terms of style and content (Hassenzahl, 2008) like post, classic, and expressive aesthetics (Lavie & Tractinsky, 2004; Tractinsky et al., 2000). However, such approaches hardly lead to recommendations that can be safely generalized in

design methodologies like all those practical design methods, which are based on affordance theory (e.g. see [Maier & Fadel, 2009](#)).

Even though Norman has a long history on theoretical contributions in both aesthetics and affordances, he did not mention directly a type of processing that may link them in interaction process. However, in his book *The Design of Everyday Things* he claims that an aesthetically pleasing appearance is only a part of a successful product. The other part is understandability and usability, which are more important than attractiveness. His suggestion is that these two parts of design should go ‘hand in hand’ because focusing on aesthetics could blind the designer to the lack of usability ([Norman, 1990](#)). The question here is whether those two elements of design are so distinct to each other. Why should an aspect of the design process that is related to aesthetics be distinct from successful or unsuccessful ways of interaction? The fascination that a product may hold to users implies the development of such meanings that we ‘see and feel’ in a product that are equally accessible as the meanings that are related to action possibilities (affordances). Years later [Norman \(2003\)](#) enhances the ‘hand in hand’ argument by introducing the emotionally or aesthetically pleasurable side of design. As he argues, “the surprise is that we now have evidence that aesthetically pleasing objects enable you to work better” (p. 10). In these words we can see a latent relation between aesthetics and the anticipation regarding what an object affords. As we suggest below, what is proposed as ‘interaction aesthetics’ seems to play an important role in design by enhancing our ability to detect such action possibilities (affordances) that allow us to form anticipations of successful interactions.

Recently [Locher, Overbeeke, and Wensveen \(2010\)](#), implied a link between aesthetic experience and affordances in the information-processing theoretical framework they adopt. For them, the aesthetic experience is based on two encoding stages of processing, which in turn, are both based on two sense modalities: vision and haptics. These two modalities interact with each other in various ways in order for the design-participant to extract and encode information about the artifact. Therefore, and according to their claim, as the aesthetics of use emerge out of the dynamic interaction between a user and the artifact’s form and functionality, the artifact presents continually changing “action driven” affordances, which influence the interaction process. This means that affordances are not just about functional meanings and motor capabilities; they are also about emotional and cognitive processes that emerge through interaction ([Overbeeke & Wensveen, 2003](#)).

For us the ‘*aesthetic*’ is not limited to appearance, formal characteristics or to the vague notion of beauty. We consider the aesthetic experience as a complex cognitive phenomenon that constitutes several processes that emerge through interaction. Thus we use the term ‘interaction aesthetics’ instead of the very broad ‘aesthetics’ in order to give emphasis into the dynamic and interactive

character that aesthetics should have. Particularly, our argument is that ‘interaction aesthetics’ are emergent in our interactions with artifacts as basic emotional activities that could trigger branches of other processes (e.g. meaning-making, semiotic chains, complex emotions, anticipation, etc.) (Xenakis, Arnellos, & Darzentas, 2012) which in turn, and in a higher level of more complex processing could be considered and/or experimentally detected as satisfaction, attractiveness, feeling of control, fun, trustfulness, etc. Under this conception, interaction aesthetics could emerge only *in relation* to environmental conditions or events (e.g. objects of nature, designed artifacts, social events, etc.) and never on their own. Interaction aesthetics could provide us the possibility to abandon aesthetic traditions and prior theories, which were considered to be too speculative and unclear, and in return, to enable us in gradually opening the black box of aesthetic experience and trying to understand and explain how the phenomenon works. Following this perspective, we believe the possibilities of discovering new and different mechanisms of aesthetic experience in relation to other cognitive processes and phenomena are increased, while most of those mechanisms and interrelations seem to not be clearly detectable by merely observing the respective behavior (e.g. in experimental studies).

In this direction, our attempt here is to provide a new orientation concerning the underlying functionality that supports the detection of affordances. Our claim is that interaction aesthetics are one among other factors in the design process that recommends users to anticipate a successful (or not) interaction through the artifact, thus enhancing the detection of affordances. Specifically, our aim in this paper is first to discuss the role of interaction aesthetics in the design process, and second to suggest an explanation for the role they play in the perception of affordances when users interact with artifacts.

1 Interaction aesthetics and the design process

As it is specifically mentioned before, we consider the ‘aesthetic’ in a different sense than the one which is usually adopted; of mere application to the beautiful and ugly. Interaction aesthetics provide such a quality that could characterize natural situations as they occur through life (Dewey, 1929). Thus, interaction aesthetics and aesthetic experience should be understood in terms of the conditions of life and the respective activities of a human organism (Shusterman, 2001). Since life goes on not only in an environment but also in interaction with that environment, the aesthetic experience needs to be considered as a part of this interaction. In order to understand the role of the interaction aesthetics in design, we need to clarify all those aspects that characterize the notion of ‘design’ as a process that takes place as we live and act in an environment.

1.1 The design process

Almost all the theoretical approaches to the design process share a common aspect; the design process exhibits an interactive nature in order to support

meaning-based actions of the design-participants. Thus design should primarily be considered as a process of cognitive construction (Arnellos, Spyrou, & Darzentas, 2007, 2010). In a dynamic context of design, the process of meaning-making is *interactive* and *future-anticipatory*, and is explicitly related to the *construction and/or choice of appropriate functions for a specific interaction with the environment*. In other words, meaning-making is considered as the process of constructing *ways of interaction* with the environment. These ways of interaction are constructed as functions (the functional substratum) of each system (designer and user) participating in the process. In particular, the designer aims to communicate its meaning (range of possible ways of interacting with the environment) to the user, through the artifact. The designer offers/provides ways of interaction with the environment through the artifact, and according to his goals. In parallel, the user interacts with the artifact in order to understand those ways of interaction and in order to select and to use them according to his goals. User and designer are interacting through the artifact.

Therefore, the artifact is the *medium* of the design process. In other words, we consider design as an interactive and constructive (cognitive) process by which, each of the design-participants *select* among a number (range) of available ways of interaction. This problem of *action selection* and particularly, all those ways of interaction, which make us aware of the appropriateness of a function for a specific interaction with respect to our goals, are related to the construction of *design-representations* (Arnellos et al., 2007, 2010). Accordingly, design-representations are the *content* of the design process and they are directed towards the future, where successful outcomes of interactions are anticipated, always with respect to the goals of the design-participants. Therefore, and considering the interactive and future-anticipatory nature of the design process, we suggest that the awareness of the interactive alternatives is explicitly related to design-representations, which are constituted as *anticipation* of the design-participants.

Therefore, design-participants anticipate those design-representations; hence, design-representations become anticipations. In other words, design-representations, are emergent in anticipation of what further actions and interactions are indicated as possible in the particular environment through the artifact. A last issue that should be noted is that those anticipations have a positive or a negative value. This value is dynamically determined based on the *dynamic presuppositions* of the interaction (i.e. the conditions under which the interaction will succeed, that is, it will bring a design-participant closer to his goal). Those presuppositions are consisted of *the conditions of the environment*, of *the properties of the artifact*, and of *the design-participants' past experiences, overall cognitive capacities, and physical capabilities* (what is usually reduced to what we call 'target group' with respect to users).

Independently of how anticipation is valued, anticipation can be false. For instance, even though we have an anticipation that is positively valued, the selected action that is formed by this anticipation could be proved unsuccessful in the course of interaction. This virtual falsification of the anticipation introduces uncertainty in the design process. Under this conception, uncertainty in the design process, a situation that we call *design-uncertainty*, is considered a situation in which, design-participants are engaging in a design process by making decisions (i.e. provision and selection of actions with the artifact) that are uncertain with respect to the (degree of) fulfillment of their goals (Xenakis & Arnellos, submitted for publication). Therefore, design-participants need to develop ways that will handle and reduce their design-uncertainty. A very important process resulting in the reduction of uncertainty is learning (Bickhard & Campbell, 1996). Through learning designers could develop ways to anticipate the result of their decisions, by for example, structuring and following, design methodologies or specific methods (Cross, 2006). Additionally users learn to avoid all those interactions that will lead them to failure. However, design-participants do not always experience situations that are familiar or already known. This means that most of the design decisions need to be taken in uncertainty and design-participants have to act before learning. Aesthetics are considered as a crucial aspect in the design processes that contribute to the reduction of design-uncertainty.

1.2 The role of interaction aesthetics in the design process

Following an evolutionary perspective of aesthetics, we consider aesthetic experience as a phenomenon that is functionally related to bodily processes and particularly to emotional reactions (Hekkert, 2006; Xenakis, Arnellos, & Darzentas, 2012). In general, emotions are bound by our goals and the respective biological needs affecting at the same time our behavior (Brehm, Miron, & Miller, 2009; Nelissen, Dijkster, & de Vries, 2007). Although emotions may occasionally have direct effects in behavior, at a higher level of the conscious, emotions operate mainly and most efficiently by means of their influence on cognitive processes (Baumeister, Vohs, DeWall, & Zhang, 2007). They regulate our internal state in a way that we can be prepared for a specific interaction (Damasio, 2000). Emotional values of pleasure and pain provide us with information that is functionally useful for the evaluation of the current conditions according to our goals (Carver, 2001) and notify us with respect to moving towards the incentives and away from possible threats. Thus, the functional role of aesthetically-oriented emotional values is firstly to detect interactive opportunities or threats and secondly to signal other functions that control our decisions and behavior regulation processes. It is then important to have in mind that aesthetically-oriented emotional reactions emerge in relation to the anticipation of goal success or failure, and their intensity (i.e. the strength of the aesthetic value) proportionally influences our potential motivation to pursue that goal (Xenakis & Arnellos, submitted for publication; Xenakis et al., 2012). However, aesthetically-oriented emotions are elicited

not only in response to an actual goal achievement, but also in response to anticipated goal achievements, giving to aesthetic experience a future-oriented perspective (Desmet, 2007; Xenakis et al., 2012). This means that interaction aesthetics influence the anticipatory system of the design-participants, and as a consequence they affect their design-representations.

Accordingly, by *aesthetic pleasure*, we refer to emotional reactions with positive values, which are associated with a positively valued anticipation of the plans (provision and selection of actions with the artifact) of the design-participants, with respect to the fulfillment of their goals. In contrast, by *aesthetic pain*, we refer to those emotional reactions characterized by a negative value, which emerge when the designers and users are anticipating problems with their plans regarding the fulfillment of their goals.

Consequently, the aesthetically-oriented emotions influence design-participants towards creating, communicating and using those design-representations that will bring them closer to their goals. Hence, aesthetic experience functions as a recommendation mechanism, providing the design-participants with the ability to predict in a way the potential outcome of a selected action even before learning (Xenakis & Arnellos, submitted for publication; Xenakis et al., 2012). Particularly, through the aesthetic experience, the designer evaluates the interactive alternatives related to his anticipation (his own design-representations) in order to incorporate them in the artifact as indications of presuppositions of the interaction and to reduce the design-uncertainty. In parallel, the user through his personal aesthetic experience, reduces the design-uncertainty by assigning values to those indications of presuppositions of the interaction. These aesthetic values will be functionally available and useful to the user in order for him to form his own anticipation. The respective design-representation will aid him to select the proper actions that will lead him (safely) in a goal fulfillment (Figure 1). This makes the aesthetic experience a fundamental aspect in the design process, where its main role is to resolve the virtual falsification of the anticipated outcomes of a future design and thus to reduce the design-uncertainty.

2 *Affordances and the design process*

It is a common conclusion from those who study the role of affordances in design that the term refers to action possibilities or opportunities that a user “directly” perceives in environmental conditions during his interaction (Auke, 2012; Gaver, 1996; Kannengiesser & Gero, 2011; Norman, 1999). These conditions denote not only artifacts but also events that exhibit those possibilities (Bingham, 2000). Particularly, following Gibson’s (1986) initial claim, the concept of affordance derives from theories of value and meaning, and its detection is strongly related to these two concepts. As Gibson claims, “the perceiving of an affordance is not a process of perceiving a value-free physical object to which meaning is somehow added in a way that no one has been able to agree upon;

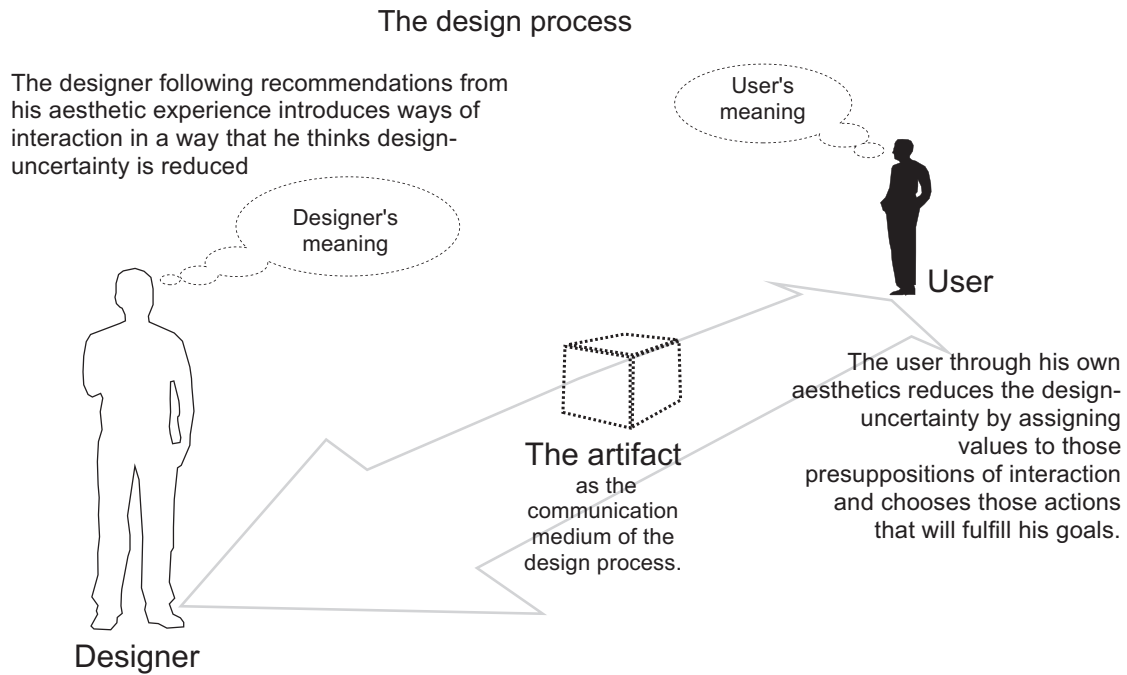


Figure 1 Interaction aesthetics, in a way, evaluate the interactive alternatives aiding the user to construct such meanings that will make clearer the way (action pattern) to goal achievement. On the other hand, designers provoke the aesthetic experience by enhancing their artifacts with such characteristics that will enable users to construct those meanings that will bring them closer to their goals

it is a process of perceiving a value-rich ecological object.” (p. 140). Affordances are not properties of the objective physical world. Their detection emerges as a consequence of interaction, and particularly of such mental and bodily processes that assign values to objects, whenever the existing conditions support their activation. In other words, affordances could be detected only when the artifact is somehow valued by appraising the information that is available with respect to those dynamic conditions (i.e. affordances are emerging during an interactive event). The conditions of interaction are dynamic since the context where the interaction takes place is always altered both internally (bodily and behavioral) and externally (environmental) with respect to the design-participant. These dynamically altered conditions give rise to different interpretations of what those artifacts may afford (Hirose, 2002; Kannengiesser & Gero, 2011) at the present time (the time of action) or in the future, where the designer should construct/offer those conditions in a way that the interaction will be successful. This conception gives to the way affordances come in our attention a dynamic nature that originates from the dynamic nature of the design process by which the design-participants can develop multiple ways of interaction through the same artifact.

Hence, even considering that the physical properties of an artifact stay invariant in the design process, the values and the meanings (design-representations) that a design-participant forms in every interaction with this artifact are dynamically

altered, constructing at the same time new action possibilities or new affordances. Therefore, the crucial question is not if the affordances pre-exist or not, if they are perceptible or hidden, but how are they 'perceived' or detected as action possibilities in the design process. On the same track, Norman (1990) calls these affordances as 'perceived affordances' and he claims that "they result from the mental interpretation of things, based on our past knowledge and experience applied to our perception of the things about us" (p. 219).

From our perspective regarding the design process, every artifact (environmental condition, or event) may afford a range of interpretations that have their origin in our goal-oriented behavior. Moving towards those goals, we select potential actions and make plans in order to accomplish a successful interaction with respect to the environmental conditions, our past experiences, and our mental and bodily capabilities. Since environmental conditions, or events afford a range of interpretation which, at least in human cognitive agents, are entrained by goal-oriented behavior, we cannot understand purpose and interpretation without the consideration of the socio-historical context in which the respective goal is formed and the respective affordances are interpreted (Noble, 1981). The artifact is a communication medium in the design process and its interpretation depends partly on our social conventions, whether such communication was intended or not (Norman, 2008). The artifact should support the emergent development of design-representations equally for designers and users. For instance, the design of a mailbox is based on the idea of *posting a letter*, which is formed from social conventions of the 'act of posting a letter'. A mailbox cannot support action without requiring users' memory, inference, and further interpretation. Metaphors in design are a familiar example of the implementation of social cognition in affordances (You & Chen, 2007). Such interpretation demands equally indirect perception in addition to the Gibsonian claim for direct perception, which rejects every engagement of memory and inference (Xenakis, Arnellos, Spyrou, & Darzentas, forthcoming).

With a goal to *'post a letter'*, design-participants form design-representations, which are based on a future anticipation that the medium of the design process (e.g. the mailbox) will support or afford a successful posting. This anticipation emerges only when the *dynamic presuppositions* of interaction denote that the conditions under which the interaction will succeed, exist; the letter will be properly placed inside the mailbox in order to be collected by the postman. Posting a letter is supported only in certain conditions where, for instance, the box has a slot where letters can get in and the user has the capacity to detect and reach the slot. However, these presuppositions can be wrong. For example, i) the perceived 'slot' in this box is only a black marked line and no letter could get in ii) the mailbox has the appropriate design and the environmental conditions are the appropriate ones too, but the user cannot detect the slot, iii) although the mailbox has the proper design and the user have all the capacities to reach the slot, the user is confused on how a letter could be posted, and so

on. This means that all those *dynamic presuppositions* of interaction are not merely properties of the artifact but instead, they emerge as the design-participant decides to interact with it according to his goal.

In particular, what we suggest here is that the affordances in the design process are about future action possibilities, or rather, future interactive potentialities through which the design-participant anticipates that he will result to goal fulfillment. Following Bickhard and Richie (1983) we call the content of design-representations regarding these interactive potentialities *interactive affordances*. More specifically, *interactive affordances are all those interactive potentialities that the dynamic presuppositions afford for a further action*. In order for the design-participant to detect them, those dynamic presuppositions of interaction (at least a part of them) that will convince him to anticipate a successful interaction must be fulfilled. However, as we already mentioned those dynamic presuppositions can be false denoting a false design-representation, a false interactive potentiality that we call *false interactive affordance*. In other words, *the interactive affordances emerge when all those internal and external conditions to the design-participant that indicate the appropriateness of a potential action, exist*. This claim focuses on the dynamic presuppositions of interaction that support the interactive potentialities and not merely to an environment that either is a neutral manifold of action possibilities or invite a user to do certain actions. The artifact can prompt a user to certain actions only when the user is and acts within conditions that support that invitation (Withagen, de Poel, Araújo, & Pepping, 2012). The design-participant has such mechanisms that appraise all those conditions for their *appropriateness* and he may then set himself in the service of such invitation. Aesthetic experience as we will argue in the next section is such an evaluative/recommendatory process.

Despite Norman's argument concerning the interpretation of perceived affordances and their relation to past knowledge and experience, there are courses of interaction where the design-participant should form a design-representation in which there is no actual or similar experience to recollect. When there is not available information that will possibly support the design-participant in confirming the appropriateness of an action, the process of action selection is getting more complex and uncertain. As we already argued in Section 1.2, in cases of design-uncertainty interaction aesthetics is one factor among others that aid the design-participant to reduce such uncertainty and finally form positively or negatively-valued anticipation of interaction. Consequently, as we argue in the next section, interaction aesthetics is a crucial aspect that affects the process by which we detect interactive affordances.

2.1 Aesthetic experience enhances our ability to detect the interactive affordances

As mentioned before, the role of interaction aesthetics in design process is considered as one of assigning values (of pleasure and pain) to interactive

situations in order for the design-participant to resolve the virtual falsification of the anticipated outcomes of the design process (Xenakis & Arnellos, submitted for publication). An aesthetic experience through the aesthetic emotional values influence the anticipatory system of the design-participants, and consequently it affects the formation of the respective design-representations regarding their goals. Particularly, aesthetically-oriented emotions with positive values function as a recommendation mechanism to the design-participant suggesting that the current conditions afford future interactive potentialities and a successful course of action.

These conditions are about the environment in connection to internal states of the design-participant (e.g. bodily and psychological states). Both internal and external conditions are responsible for the formation of the dynamic presuppositions of interaction. What we argue, in particular, is that aesthetically-oriented emotions appraise all those conditions and indicate to design-participants the existence (or not) of the dynamic presuppositions of interaction. This means that our aesthetic experience affects only our anticipation for interaction and thus our interactive potentialities with artifacts. This means that aesthetic experience does not form design-representations but it only influences them by recommending values for their content. Interaction aesthetics will not inform the design-participant for the specific type of action that could probably result to goal success, in contrast to interactive affordances that share the same content with design-representations; the appropriateness of a specific potential action (Figure 2).

Interaction aesthetics, in a way, *support the process of selecting the best action* by assigning values to those conditions that indicate the appropriateness of interaction. Specifically, the aesthetically-oriented emotions signal the design-participant that the dynamic presuppositions of interaction afford a further interactive step. In other words, aesthetics enhance our ability to detect interactive potentialities in order to form the respective design-representation. What we suggest is that, *aesthetic experience enhances our ability to detect interactive affordances*. However, both aesthetically-oriented emotions and interactive affordances are about projections of future interactive outcomes, which are anticipated to result in goal success. Since the anticipation could fail, both aesthetically-oriented emotions and interactive affordances could also fail when the outcome of the selected action is not the one anticipated.

As previously explained, aesthetically-oriented emotions could make us aware for those interactive potentialities, even before learning. This means that interactive affordances need not count on past experience and knowledge of the design-participant in order to be perceived, as Norman demands. We have the ability to assign ways of interaction through objects even though we know nothing about them. Objects or events in the course of interaction

Meaning-making in the design process

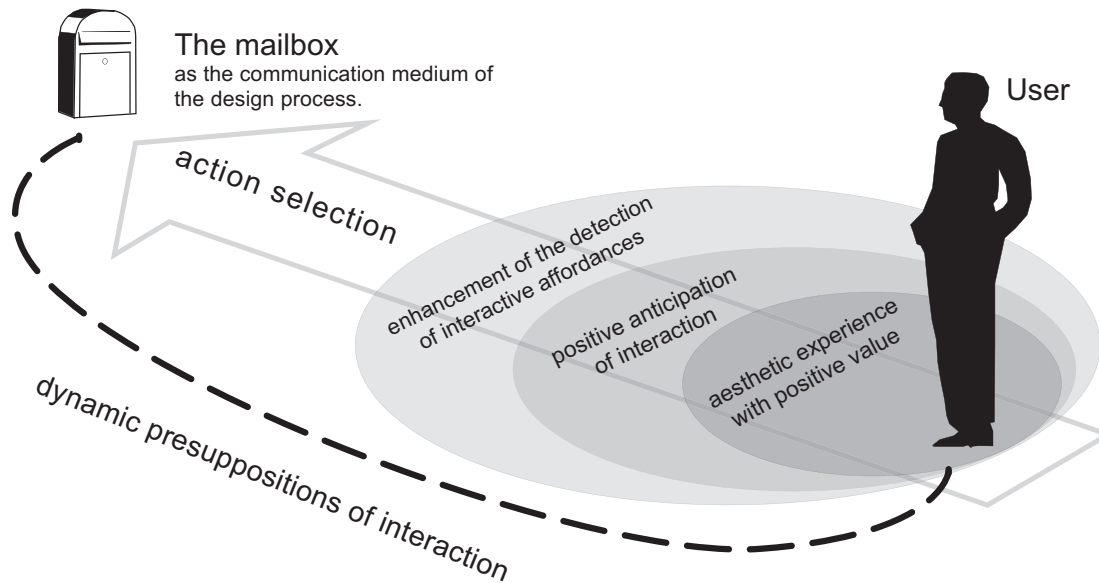


Figure 2 The user trusting his aesthetic experience (recommendations) reduces his design-uncertainty by assigning aesthetic values to the current presuppositions of interaction thus enhancing the ability to detect the interactive affordances. Overall this will result in appropriate (according to his goals) ways of interaction with the artifact

have such meaning only if the dynamic presuppositions of interaction are indicating the achievement of a goal.

One more crucial aspect regarding the relation between interaction aesthetics and interactive affordances is that they both belong to the content of the design, and simultaneously are interpreted in the design process from two perspectives: the designer's and the user's perspective, making design a process of mediated communication (Arnellos et al., 2007; Arnellos et al., 2010; Crilly, Good, Matravers, & Clarkson, 2008; Xenakis & Arnellos, submitted for publication). In particular, the designer aims to communicate his meanings (ways of interaction) to the user through the artifact. Therefore, every modification in the form of the artifact is another added value (positive or negative) in this communication, which may modify (expand, reduce or even alter) the range of those ways of interaction. This means that besides the aesthetically-oriented emotional reaction that the designer evokes in users through a specific modification, he also enhances the detection of new interactive affordances. Those new interactive affordances are new interactive potentialities, and thus they can trigger the emergence of new design-representations.

For instance, when the designer is about to decide how the 'slot' may appear in his concepts of a mailbox, he triggers his aesthetically-oriented emotions that evaluate the designed presuppositions of interaction. Considering the elicited aesthetic

values the designer incorporates those interactive potentialities (interactive affordances) in the 'slot' that can easily be detected by the chosen target group in order to reduce their design-uncertainty or the possibility of an interactive failure (false interactive affordances, false design-representations). In turn, a user trusting his aesthetic experience (recommendations) reduces his personal design-uncertainty by assigning aesthetic values to the current presuppositions of interaction thus enhancing the ability to detect the interactive affordances (Figure 2). If the 'slot' is supported by positive aesthetic values with respect to an anticipated goal fulfillment, then the mailbox may afford the 'act of posting a letter'. In other words, when those interactive affordances that the user detects are similar to those that the designer designs the product may attain 'its goal'.

Summarizing, in the dynamic context of the design process interactive affordances are more than static aspects that are determined in the physical world. They are all those interactive potentialities for a further action that can be afforded based on the dynamic presuppositions present at the interaction. Which means that their detection depends on other dynamic processes that constitute our experience with the environment. Our claim is that aesthetically-oriented emotions, which are the content of aesthetic experience, provide us the ability to assign values to those dynamic presuppositions of interaction enhancing the detection of interactive affordances.

Therefore, designers should have in mind that when they 'design functions based on affordances' (see e.g. Hsiao, Hsu, & Lee, 2012; Maier, Fadel, & Battisto, 2009; Nathan, 2010; Norman, 1999; Smets & Overbeeke, 1994) they build a range of interactive potentialities in their artifacts that triggers the aesthetic experience of their users. As users form their design-representations several aesthetically-related emotional reactions assign values to the already designed interactive potentialities that the artifact indicates, thus affecting the whole aesthetic experience with it. If then the user, affected by his aesthetic experience, detects a range of interactive affordances that are similar to those designed by the designer the product may attain "its goal". In this way, interaction aesthetics and interactive affordances are functionally related in the design process.

Finally, we want to make clear that affordances are an important design tool but it is not the only available that aids designers to introduce effective functions in their products, i.e. functions that could lead users to a rich and successful interaction. Our aim in this paper was to provide such an explanation that take advantage of the dynamic nature of interaction aesthetics and the respective processes that constitute the aesthetic experience, and to propose a possible relation on how we detect affordances through interaction. We believe this explanation will enhance our understanding of the potential usage for interaction aesthetics and affordances in design decisions, and would provide a new orientation on how affordances and interactive aesthetics are both affect the perception of artifacts and product in design.

3 Conclusions

In the design process every artifact, environmental condition, or event may afford a range of interactive potentialities that have their origin in goal-oriented behavior. We make plans, we assign meanings to objects and events, and finally we select potential actions that fulfill our goals. This process of action selection presupposes that the design-participant uses a range of functions that enable him to distinguish those conditions that support action possibilities. In other words, the design-participant exhibits a functionality that supports him in being aware of the dynamic presupposition of interaction and in detecting the interactive affordances. Our claim is that the content of interactive affordances is not to be found merely on the environmental conditions that presuppose a range of action, but to all those mental and bodily capabilities in relation to environmental conditions that support or afford a specific action.

Interaction aesthetics through their emotional character function as a recommendation mechanism in the design process that in a way evaluates, even before learning, all those internal and external conditions that are anticipated to support a successful interaction. Through the aesthetic experience the design-participants evaluate the interactive potentialities in order to form the appropriate design-representation. Designers incorporate interactive potentialities to artifacts as interactive affordances that confirm the dynamic presuppositions of interaction and reduce the design-uncertainty. Users, through their personal aesthetic experience, reduce the design-uncertainty by assigning values to those interactive potentialities, thus enhancing their ability to detect the interactive affordances. Overall, interaction aesthetics aid the design-participant to enhance the process by which the interactive affordances are detected.

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References

- Albrechtsen, H., Andersen, H. H. K., Bodker, S., & Pejtersen, A. M. (2001). *Affordances in activity theory and cognitive systems engineering*. Risø National Laboratory. Risø-R-1287(EN), 1–38.
- Arnellos, A., Spyrou, T., & Darzentas, J. (2007). Cybernetic embodiment and the role of autonomy in the design process. *Kybernetes*, 36(9/10), 1207–1224.
- Arnellos, A., Spyrou, T., & Darzentas, J. (2010). Naturalising the design process: autonomy and interaction as the core features. In M. Milkowski, & K. Talmont-Kaminski (Eds.), *Beyond description: naturalism and normativity, Texts in Philosophy, Vol. 13* (pp. 265–288). London, England: College Publications.
- Auke, J. K., P. (2012). Characterising affordances: the descriptions-of-affordances-model. *Design Studies*, 33(2), 113–125.

- Baumeister, R. F., Vohs, K. D., Nathan DeWall, C., & Zhang, L. (2007). How emotion shapes behavior: feedback, anticipation, and reflection, rather than direct causation. *Personality and Social Psychology Review*, *11*(2), 167–203.
- Bickhard, M. H., & Campbell, R. L. (1996). Topologies of learning and development. *New Ideas in Psychology*, *14*(2), 111–156.
- Bickhard, M. H., & Richie, D. M. (1983). *On the nature of representation: A case study of James Gibson's theory of perception*. Praeger Pub.
- Bingham, G. P. (2000). Events (like objects) are things, can have affordance properties, and can be perceived. *Ecological Psychology*, *12*(1), 29–36.
- Brehm, J. W., Miron, A. M., & Miller, K. (2009). Affect as a motivational state. *Cognition & Emotion*, *23*(6), 1069–1089.
- Carver, C. S. (2001). Affect and the functional bases of behavior: on the dimensional structure of affective experience. *Personality and Social Psychology Review*, *5*(4), 345–356.
- Crilly, N., Good, D., Matravers, D., & Clarkson, P. J. (2008). Design as communication: exploring the validity and utility of relating intention to interpretation. *Design Studies*, *29*(5), 425–457.
- Cross, N. (2006). *Designerly ways of knowing*. Germany: Springer.
- Damasio, A. (2000). *The feeling of what happens: Body and emotion in the making of consciousness* (1st ed.). Harvest Books.
- Desmet, P. M. A. (2007). Product emotion. In H. N. J. Schifferstein, & P. Hekkert (Eds.), *Product experience* (pp. 379–397). USA: Elsevier.
- Dewey, J. (1929). *Experience and nature*. London, England: George Allen & Unwin, LTD.
- Gaver, W. W. (1996). Situating action II: affordances for interaction: the social is material for design. *Ecological Psychology*, *8*(2), 111–129.
- Gibson, J. J. (1986). *The ecological approach to visual perception* (1st ed.). USA: Psychology Press by Taylor & Francis Group, LLC.
- Hartmann, J. (2006). *Assessing the attractiveness of interactive systems. CHI '06 extended abstracts on Human factors in computing systems*. Montréal, Québec, Canada: ACM. (pp. 1755–1758).
- Hartmann, J., Sutcliffe, A., & Angeli, A. D. (2007). Investigating attractiveness in web user interfaces. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 387–396). San Jose, California, USA: ACM.
- Hsiao, S.-W., Hsu, C.-F., & Lee, Y.-T. (2012). An online affordance evaluation model for product design. *Design Studies*, *33*(2), 126–159.
- Hassenzahl, M. (2004). The interplay of beauty, goodness, and usability in interactive products. *Human-Computer Interaction*, *19*(4), 319–349.
- Hassenzahl, M. (2008). Aesthetics in interactive products: correlates and consequences of beauty. In H. N. J. Schifferstein, & P. Hekkert (Eds.), *Product experience* (pp. 287–302). San Diego: Elsevier Science.
- Hassenzahl, M., & Monk, A. (2010). The inference of perceived usability from beauty. *Human-Computer Interaction*, *25*(3), 235–260.
- Hekkert, P. (2006). Design aesthetics: principles of pleasure in design. *Psychology Science*, *48*(2), 157–172.
- Hirose, N. (2002). An ecological approach to embodiment and cognition. *Cognitive Systems Research*, *3*(3), 289–299.
- Kannengiesser, U., & Gero, J. S. (2011). A process framework of affordances in design. *Design Issues*, *28*(1), 50–62.
- Lavie, T., & Tractinsky, N. (2004). Assessing dimensions of perceived visual aesthetics of web sites. *International Journal of Human-Computer Studies*, *60*(3), 269–298.
- Locher, P., Overbeeke, K., & Wensveen, S. (2010). Aesthetic interaction: a framework. *Design Issues*, *26*(2), 70–79.

- Maier, J. R. A., & Fadel, G. M. (2009). Affordance-based design methods for innovative design, redesign and reverse engineering. *Research in Engineering Design*, 20(4), 225–239.
- Maier, J. R. A., Fadel, G. M., & Battisto, D. G. (2009). An affordance-based approach to architectural theory, design, and practice. *Design Studies*, 30(4), 393–414.
- Nelissen, R. M. A., Dijker, A. J. M., & de Vries, N. K. (2007). Emotions and goals: assessing relations between values and emotions. *Cognition & Emotion*, 21(4), 902–911.
- Nathan, C. (2010). The roles that artefacts play: technical, social and aesthetic functions. *Design Studies*, 31(4), 311–344.
- Noble, W. G. (1981). Gibsonian theory and the pragmatist perspective. *Journal for the Theory of Social Behaviour*, 11(1), 65–85.
- Norman, D. (1990). *The design of everyday things*. New York, United States: Doubleday Business.
- Norman, D. (1999). Affordance, conventions, and design. *interactions*, 6(3), 38–43.
- Norman, D. (2002). Emotion & design: attractive things work better. *interactions*, 9(4), 36–42.
- Norman, D. (2003). *Emotional design: Why we love (or hate) everyday things* (1st ed.). New York: Basic Books.
- Norman, D. (2004). Introduction to this special section on beauty, goodness, and usability. *Human-Computer Interaction*, 19(4), 311–318.
- Norman, D. (2008). Signifiers, not affordances. *Interactions*, 15(6), 18–19.
- Overbeeke, K. C. J., & Wensveen, S. (2003). From perception to experience, from affordances to irresistibles. In *Proceedings of the 2003 international conference on designing pleasurable products and interfaces* (pp. 92–97). Pittsburgh, PA, USA: ACM.
- Overbeeke, K., & Wensveen, S. (2004). Beauty in use. *Human-Computer Interaction*, 19(4), 367–369.
- Park, S., Choi, D., & Kim, J. (2004). Critical factors for the aesthetic fidelity of web pages: empirical studies with professional web designers and users. *Interacting with Computers*, 16(2), 351–376.
- Shusterman, R. (2001). Pragmatism Dewey. In D. Lopes, & B. Gaut (Eds.), *The Routledge companion to aesthetics* (pp. 97–106). New York, United States: Routledge.
- Sutcliffe, A. (2010). *Designing for user engagement: Aesthetic and attractive user interfaces. Synthesis lectures on human-centered informatics*. San Rafael, CA, United States: Morgan & Claypool Publishers.
- Smets, G., & Overbeeke, K. (1994). Industrial design engineering and the theory of direct perception. *Design Studies*, 15(2), 175–184.
- Tractinsky, N. (1997). Aesthetics and apparent usability: empirically assessing cultural and methodological issues. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 115–122). Atlanta, Georgia, United States: ACM.
- Tractinsky, N., Katz, A. S., & Ikar, D. (2000). What is beautiful is usable. *Interacting with Computers*, 13(2), 127–145.
- Withagen, R., de Poel, H. J., Araújo, D., & Pepping, G.-J. (2012). Affordances can invite behavior: reconsidering the relationship between affordances and agency. *New Ideas in Psychology*, 30(2), 250–258.
- Xenakis, I., & Arnellos, A. The role of aesthetics in the design process. *Design Issues*, submitted for publication.
- Xenakis, I., Arnellos, A., & Darzentas, J. (2012). The functional role of emotions in aesthetic judgment. *New Ideas in Psychology*, 30(2), 212–226.

- Xenakis, I., Arnellos, A., Spyrou, T., & Darzentas, J. Aesthetic judgement: an interactive semiotic framework. *Cybernetics and Human Knowing*, forthcoming.
- You, H., & Chen, K. (2007). Applications of affordance and semantics in product design. *Design Studies*, 28(1), 23–38.