

REDUCING UNCERTAINTY IN THE DESIGN PROCESS: THE ROLE OF AESTHETICS

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ABSTRACT

Uncertainty in the design process is a common situation in which, designers and users are making decisions that are uncertain with respect to the (degree of) fulfillment of their goals. Therefore, design-participants (designers and users) need to develop ways that will handle and reduce their design-uncertainty in order to choose the best action before learning and prevent the possible failure of the interaction. Providing an explanation for the general role of aesthetics in an interaction, we suggest that aesthetics through their emotional dimension (aesthetic emotions) are implicitly associated with the design process by inducing the reduction of design-uncertainty. From our perspective aesthetics are about action. They are a fundamental aspect of design that enhances the communication between the design-participants by promoting the achievements of goals in the design process.

Keywords: aesthetics, aesthetic emotions, design-uncertainty, design process, emotions.

INTRODUCTION

Everyday life problems make us stand in front of many complex decisions, and that for the most of them we are not aware of their direct consequences. In fact we live and act only by knowing something about the future; while the problems of life and its manipulation arise from the fact that we know so little about them (Knight, 1964). Living in such uncertain environments we develop ways to minimize the risks of such decisions. As such, we use functions that aid us in

anticipating the implications of our future actions and in choosing the best alternative that will bring us one step closer to our goals, always with respect to the current conditions. Hence, we view the uncertainty as an aversive state that we are motivated to interact with in order to reduce it, most of the times by anticipating or learning (Bar-Anan, Wilson, & Gilbert, 2009; Bickhard, 2000; Osman, 2010). Generally, the best way to eliminate this uncertainty is to act-and-learn by your failure (Bickhard & Campbell, 1996), making the next same or similar interactive step much safer.

The interactive uncertainty is a common path that designers and users have to pass through in their road towards fulfilling their goals in the design process. From the designer's perspective, there is uncertainty with respect to deciding the ways to better offer/provide the ways of interaction with the environment, through the artifact, and according to his goals. From the user's point of view, there is uncertainty with respect to deciding which are the available ways of interaction with the artifact, according to his personal goals (Beheshti, 1993). Therefore, design-participants (designers and users) should develop ways that they allow them to choose the best action before learning and prevent the interactive failure.

In this direction, considering design as a cognitive process that supports anticipatory and purposeful (goal-directed) actions of the design-participants, our aim in this paper is to argue that aesthetic experience, through its emotional dimension, functions as an evaluative process that affects our anticipation for

stable interactions or in other words, for successful design decisions. What we propose is that aesthetics are a crucial aspect of interaction, and as such, they reduce the uncertainty of the design process.

THE UNCERTAINTY OF THE DESIGN PROCESS

DESIGN PROCESS AND MEANING-MAKING

Generally, in the evolution of human beings, design process is considered the central activity through which we attempt to change the existing situation into one that better serves our aims and goals. According to Banathy (1998), “design is a creative, decision-oriented, disciplined inquiry that aims to: formulate expectations, aspirations and requirements of the system to be designed; clarify ideas and images of alternative representations of the future system; devise criteria by which to evaluate those alternatives; select and describe or ‘model’ the most promising alternative; and prepare a plan for the development of the selected model” (p. 169). In this way, the term ‘design’ is usually referred to a goal-oriented process, in which the designer forms a web of representations concerning the design problem space (e.g. understanding needs) and the design solution space (e.g. solving problems and improving situations) (Bonnardel, 2000; Friedman, 2003). Almost all the theoretical approaches for the design process share a common aspect; the design process exhibits an interactive nature and it supports the meaning-based actions of the design-participants, thus design should primarily be considered as a process of cognitive construction (Arnellos, Spyrou, & Darzentas, 2007a, 2007b, 2010).

Accordingly, in our view, any analysis and modeling of the design process needs to shift from the perspective of *problem framing or/and solving*, to the perspective of *meaning-making*. 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 (i.e. designer and user) participating in the design process (figure 1).

In particular, the designer aims to communicate its

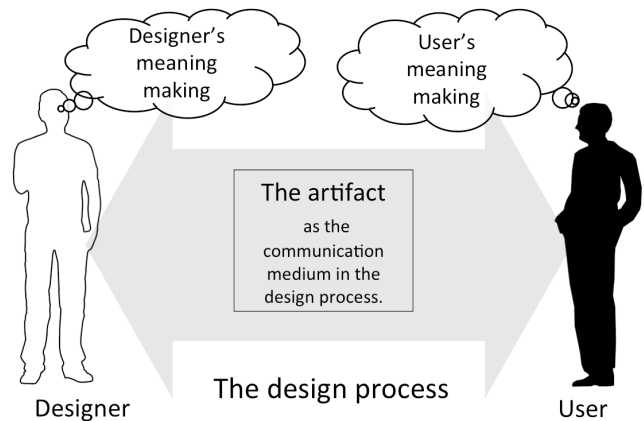


Figure 1 User and designer are interacting through the artifact, which is considered as the communication medium of the design process. Designer provides ways of interaction with the environment through the artifact and the user interacts with the artifact in order to understand those ways of interaction and to use them according to his own goals.

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 personal goals. In other words, users and designers are interacting through the artifacts. Therefore, the artifact is the *medium* of the design process.

DESIGN REPRESENTATIONS AS ANTICIPATION

We consider design as an interactive and constructive (cognitive) process by which, each of the design-participants *select* among a range of available ways of interaction (Arnellos, Spyrou, & Darzentas, 2007a), which are indicated by the environment (artifact) in connection to the design-participants' inner capabilities. The problem of *action selection* –all those ways of interaction, which make us aware for the appropriateness of a function or a combination of them for a specific interaction with respect to our goals–, is related to the construction of a *design representation*. Accordingly, design representations are the *content* of the design process (Arnellos, Spyrou, & Darzentas, 2007b; Arnellos, Spyrou, et al., 2010). It is important to note that those design representations 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, the 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. Moreover, those anticipations have a positive or a negative value, which is dynamically determined based on the *presuppositions* of 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). Therefore, presuppositions of interaction exhibit a dynamic nature that came from the properties of the design-participant and the environment he acts.

To summarize, design-participants try to communicate and to use their design representations, which provide a complex of ways of interaction with the environment, through the artifact. The artifact is the medium of the design process. The designer provides a range of actions with the artifact, and as such, he provides ways of interaction with the environment. Accordingly, the user selects from that range of actions with the artifact and, in this way, he selects his own ways of interaction with the environment. The provision and selection of actions, and consequently, the realization of the respective interactions, is related to the functional substratum (already existing or/and dynamically constructed and modified through interaction with the artifact) of the design-participants. The design representations are the content of the design process. Those representations are formed as anticipation, which has a value. This value is related

to the presuppositions (conditions) of each interaction, whose dynamic nature implies that the anticipation can also be false. Therefore, the deeper understanding of the functionality of such anticipation, how it is created and how it contributes to the design problem of action selection should be an essential component in any theory of design (Arnellos et al. 2007b, 2010; Zamenopoulos and Alexiou 2007).

THE VIRTUAL FALSIFICATION OF THE ANTICIPATION INTRODUCES DESIGN-UNCERTAINTY

Anticipation can be false in the sense that the respective representation that is formed by this anticipation could recommend the design-participant to choose an action that will be proved unsuccessful for his goals. This virtual falsification of the anticipation introduces uncertainty in the design process. As it is already mentioned, from the designer's perspective, there is uncertainty with respect to deciding the ways of interaction with the environment, through the artifact, and according to his goals. From the user's point of view, there is uncertainty with respect to deciding which of the available ways of interaction with the artifact would be the best according to his goals. Therefore, there is uncertainty in the design process, a situation that we call *design-uncertainty*.

More specifically, 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. 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, as we already mentioned, is learning. Through learning the designer could develop ways to anticipate the result of his 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, most of the times, design participants do not experience situations that are familiar with 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. What we suggest in this paper is that aesthetics (aesthetic experiences or what we consider in the next section as aesthetically-oriented emotional reactions) is another aspect/process that reduces design-uncertainty before and/or during learning.

THE AESTHETIC EXPERIENCE IN THE DESIGN PROCESS

ON THE SCOPE OF AESTHETIC EXPERIENCE

The nature of aesthetic experience has a long history of discussions, which are mainly centered on concepts and aspects related to cognitive and emotional processes. Most of the authors in aesthetic philosophy suggest and argue in favor of the involvement of possible emotional reactions of pleasure and pain in aesthetic experience (Dewey, 1929, 1980; Cupchik, 1995; Santayana, 1955; Kant, 2000; Higgins, 2008). However, any attempt to clarify the nature of the aesthetics runs up against the problematic role of the aesthetic experience, which also comes from the puzzling and elusively vague nature of the underlying emotional activity. Generally, as Budd (2008) claims, in aesthetic philosophy there are different conceptions of the role of the aesthetics and no one seem to be the right one.

Nowadays, even though researchers from several fields combine our aesthetic experience or what we like or dislike with emotional responses (Ortony 1991; Zangwill 1998; Norman 2002; 2003; Denton et al. 2008), or define the emotional experience of pleasure or pain as a type of a process that mostly refers to our hedonic experiences (Frijda 2009; Berridge and Winkielman 2003), the scope of the aesthetics in our everyday life is still unspecified. Additionally, although it is a common conclusion in the design society that aesthetics emerge in our interaction with products, or that it is much more probable that we interact better with beautiful designs (Norman, 2003; Leder, Belke, Oeberst, & Augustin, 2004; Overbeeke & Wensveen, 2004; Hekkert & Leder, 2007; Locher, Overbeeke, & Wensveen, 2010), it is still vague why or when aesthetics are elicited in the interaction and consequently in the design process. Therefore, an

understanding of the link between aesthetic emotional responses and the design process is particularly important in order to clarify how aesthetics affect the decision making of the design-participants (Schwarz, 2000; Kumar & Garg, 2010).

Following an evolutionary perspective of aesthetics Hekkert (2006) claims that the notion of adaptation is behind our aesthetic preferences. Survival is the goal that pushes humans to solve adaptive problems. So, pleasure derives from those features that are advantageous to this adaptation. As he states, "beauty exists in the adaptations of the beholder" (p. 161). In the same evolutionary direction, Desmet (2007) argues that our emotions of pleasure or pain are elicited when in a specific interactive situation it is not sufficiently clear to us what we should choose as the next interactive step. Since we are motivated to make such a selection, emotions prepare and motivate us to "contend with the adaptational implications of the eliciting situation." (p. 385). In other words, pleasant emotional experiences pull us to situations that will be beneficial, whereas unpleasant will push us away from possibly harmful ones. Moreover, as Desmet claims, we have an emotional experience not only in response to an actual goal achievement, but also in response to a anticipated goal achievement, giving to emotional experience a future-oriented perspective.

Similarly, studies in neuroaesthetics have shown that what we perceive as aesthetically pleasurable is based on recognizable patterns linked to our survival mechanisms, providing to such experience functionality, by which it serves our capacity to manage uncertain interactions with the environment and gain from them in our future steps. Specifically, neurologists propose that the solution of the fundamental aesthetic problem (i.e. the origin and the role of aesthetics) lies in the deeper understanding of the connections between perception, the emotional neural structures, and the respective representational content of the objects that we interact with (Ramachandran & Hirstein, 1999; Barry, 2006; Jacobsen, Schubotz, Höfel, & Cramon, 2006). Hence, an important step towards explaining the role of aesthetics is to ground the functionality of aesthetic experience in emotional activity; what we call

aesthetic emotions (Brown, Gao, Tisdelle, Eickhoff, & Liotti, 2011; Xenakis, Arnellos, & Darzentas, 2012).

According to many theorists, emotions of pleasure or pain are considered as a monitoring mechanism or as a feedback system that regulates the effectiveness of a potential or chosen interaction. Under this conception, such emotions are there to notify us with respect to moving towards the incentives and away from possible threats. In addition, through the respective feedback system, emotions compare and rate signals, which correspond to the progress that we make against our prior emotional states (Schwarz, 2000; Nelissen, Dijker, & de Vries, 2007; Brehm, Miron, & Miller, 2009).

Hence, the scope of aesthetic emotions (pleasure or pain) is firstly to detect interactive opportunities and threats, i.e. the possibility of a successful interaction or not, and secondly to signal other cognitive or biological functions, which control our actions and plans. As such, aesthetic emotions are related to our goals by means of their influence in our representations, since they function as an input into our decision and behavior regulation processes (Baumeister, Vohs, DeWall, & Zhang, 2007; Damasio, 2000; Xenakis et al., 2012).

Our perspective adopts this view of aesthetic experience as a process which is functionally related to emotional activity, and which elicits basic emotional values such as pleasure and pain. As it is argued in Xenakis et al. (2012), these basic aesthetic emotions are considered to be the result of the appraisal of events with respect to their implications for well-being or for the satisfaction of our goals, motives and concerns. Through those values, as Xenakis et al. (2012) claim, we generate complex, dynamically flexible action patterns, which are related to our representations, in order to learn and cope with specific environmental conditions. Considering that the appraisal process is a function, which detects opportunities and threats in a given interaction then, according to the model they suggest, the outcome of the appraisal process (emotional states of pleasure or pain) *can also been seen as a function that strengthens or weakens the anticipation for the respective dynamic presuppositions*. At the same

time, this function implicitly informs us about the current internal or external conditions supporting our representational content.

Summarizing, such basic aesthetic emotional values emerge as a feedback system in the interaction process, when goal fulfillment is anticipated or not (Panksepp, 1992) and their intensity (i.e. the strength of the aesthetic value) proportionally influences our representations and our potential motivation to pursue our goal.

This conception of aesthetics is not limited in our sensory perception. As Oscar Wilde (2006) very effectively has said, "*no object is so beautiful that, under certain conditions, it will not look ugly*", (p.107) and those conditions are not always related to our senses or the physical characteristics of the object (Xenakis et al., 2012). What we aesthetically think or feel about something could change even though our senses perceive it as unchanged. Therefore, aesthetic experience is a highly complex phenomenon grounded in bio-cognitive processes, whose emotionally-related activity is fundamental for the development of our whole interactive experience (Wilson & Gilbert, 2008).

Accordingly, our claim is that the scope of aesthetics in design process is highly related to the functionality of these aesthetic values and to the way they influence the anticipatory system of the design-participants. More specifically, in the following section, we provide a functional explanation of the way an aesthetic experience is generated through the emotional values of pleasure and pain, and resolves (and in a way reduces) the design-uncertainty by providing at the same time values to the anticipation of the design-participants.

AESTHETICS REDUCE DESIGN-UNCERTAINTY

So, the question is what aesthetic pleasure or pain stands for in the design process, and what then, an aesthetic experience provides to the communication between the design-participants?

Following the above-mentioned conception of aesthetics, when we talk about 'aesthetic pleasure' we refer to a range of basic emotional outcomes of an

appraisal that are positively valued, that is, that 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, when we talk about 'aesthetic pain', we refer to those emotional outcomes, which are characterized by a negative value, which emerge when designer and user are anticipating problems with their plans regarding the fulfillment of their goals. Consequently, these basic aesthetic values of pleasure and pain influence design-participants towards creating, communicating and using those design representations that will bring them closer to their goals.

As it is already mentioned in the beginning of this paper, those representations are formed as anticipation of ways of action with the artifact, and consequently, of ways of interaction with the environment. Furthermore, that anticipation has a value related to the conditions (dynamic presuppositions) under which the respective ways of interaction will succeed or not. As previously explained, it is the dynamic nature of the conditions in

their design-uncertainty that positive and negative emotions with aesthetic values are elicited. Specifically, when a positive aesthetic value is elicited the respective anticipation for the resolution of a particular design-uncertainty is positively valued. In that case, an aesthetic experience functions as a recommendation based on which, the respective interaction could result, if selected and if successful, in the elimination of the design-uncertainty. Correspondingly, when a negative aesthetic value (pain) is elicited the anticipation for the resolution of the design-uncertainty is negatively valued. Now, the outcome of aesthetic experience recommends the avoidance of the interaction, thus again, reducing design-uncertainty.

At this point, we must have in mind that aesthetic values could differ from the pleasure or pain that we feel in our senses. Someone could ascribe a positive aesthetic value in a painful (sensual) experience that recommends a goal fulfillment. This painful experience (with positive aesthetic value) could strengthen our anticipation for goals success. This means that pain (acquiring in this context a positive

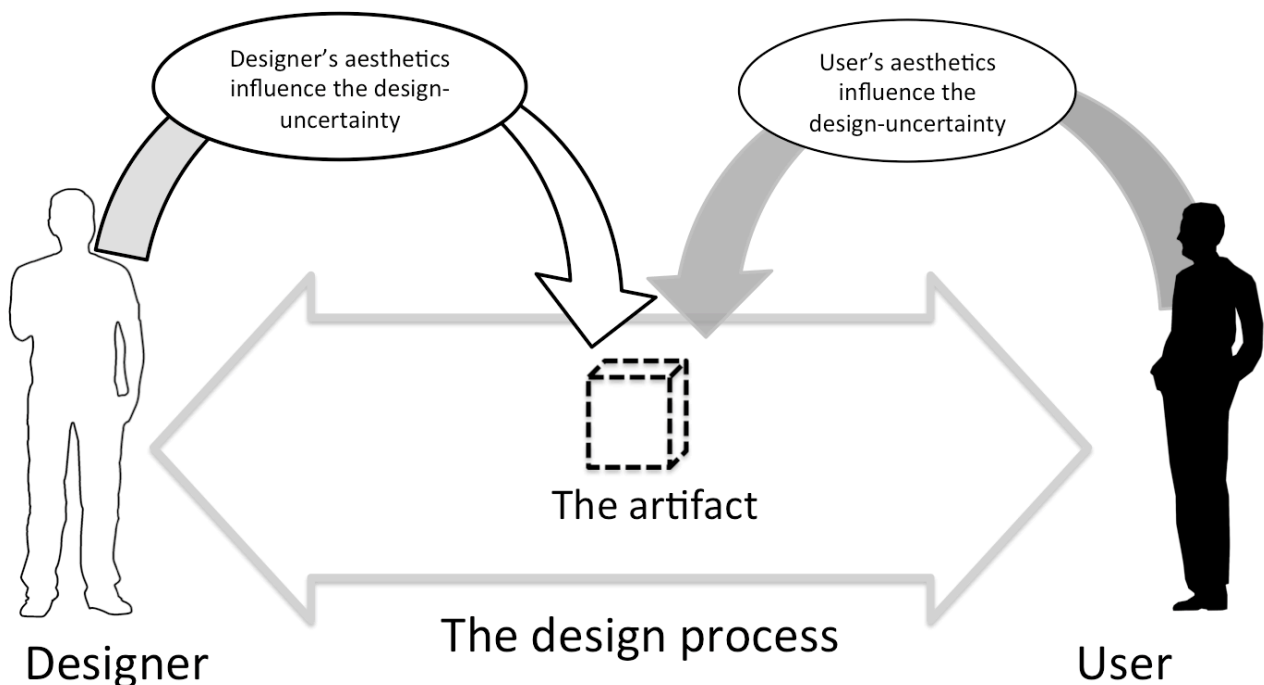


Figure 2. Aesthetics, in a way, evaluate the interactive alternatives aiding the user to construct such meanings that will make clearer the way (action pattern) to goal achievement. On the other hand, designers provoke the aesthetic experience by enhancing their artifacts with such characteristics that will enable users to construct those meanings that will bring them closer to their goals

which the selected interaction will take place that introduces design-uncertainty. Hence, it is when design-participants attempt to resolve and reduce

aesthetic value) could also signal our anticipatory system that there are the appropriate conditions for a successful interaction, thus forming a positive

aesthetic experience. However, there are other cognitive aspects (e.g. past experiences, other related meanings) that also affect our anticipatory system in the formation of the final design representation. This means that the aesthetic experience only partly affect the design representation and not entirely.

In general, based on the account sketched above, aesthetic emotional values are elicited in the design process and particularly, in *action selection*. Therefore, we suggest that an *aesthetic experience resulting in the values of pleasure and pain, functions as a recommendation mechanism, providing the design-participants with the ability to resolve the design-uncertainty regarding the success or failure of an anticipated interaction*. Hence, *the feeling of anticipation for a successful resolution or not of a design-uncertainty is suggested as a model of minimal aesthetic experience* (figure 2).

Through aesthetic experience the designer evaluates the interactive alternatives in order to form the proper design representation and to incorporate them in the artifact as indications or affordances that confirm the presuppositions of interaction and reduce the design-uncertainty. In parallel, the user through his personal aesthetic experience reduces the design-uncertainty by assigning values to those affordances that support or not the presuppositions of interaction that are indicated to him. These aesthetic values will be functionally useful to the user in order to form his design representation. Finally, this design representation aid him to select the proper actions that will lead him (safely) in a goal fulfillment

Aesthetics provide the design-participants with a recommendation of a future interactive outcome regarding an action they are about to provide or/and select on an artifact. As such, aesthetics, among other things, provide values to the design representations affecting the whole design process. Hence, every time a design-participant is in front of an uncertain situation and has to decide which action is the best with respect to his goals, aesthetics are there to aid him in making such selection by reducing design-uncertainty. This means that a design-uncertainty could be reduced by both positive and negative aesthetic experiences. A negative experience, for instance, may

reduce the design-uncertainty by protecting the user from a harmful interaction making clear that the best action is to seek for safer or better alternatives, always according to his goal. However, even though an aesthetic experience reduces the design-uncertainty, this does not imply that the design-participant will choose the proper action for his goal. This is because aesthetic experiences and the respective anticipation have always the possibility of failure in the design process.

CONCLUSIONS

Since the anticipation of goal success is related to the ways of interaction that design-participants chose independently, it follows that aesthetics are not properties of the artifact but they *belong* to the content of design, that is, they are part of the design representations. Therefore, aesthetic experience and its values are emerging in the design process and in particular, in the interaction of each design-participant with the artifact. In general, aesthetics are constructed in the design-participant's cognitive and emotional realm, and they are not pertaining to the artifact but to the whole interaction with the environment. Overall, we suggest that aesthetic experience serves our well-being, since it functions as a feedback system in order to prevent the interactive error. This feedback system, by affecting the values of future anticipation, is directly engaged in the formation of our design representations. Hence, aesthetic experience is implicitly associated with the design process. Aesthetics are about action by promoting the achievements of goals in the design process.

Finally, regarding the question of what an aesthetic experience serves in the respective communication between design-participants, we argue that 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. So, designers should try to *provoke* the aesthetic experience by enhancing their artifacts with such characteristics that will enable users to construct easily those meanings that will bring them closer to their goals. Therefore, our claim is that aesthetics enhance the communication between the design-participants by reducing design-uncertainty. Accordingly, every modification in a

product that aims at the reduction of the design-uncertainty has always implications to our aesthetic experiences with products.

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