PERSONALITY ASSESSMENT IN REGARD TO DESIGN STRATEGIES

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ABSTRACT. This paper discusses some preliminary results of several knowledge-acquisition and documentation-structuring techniques that were used to assess the working styles of architects. The focus of this assessment was on their strategic design behaviour. Hettema's Interactive Personality Model (Hettema 1979, 1989) was used to explain and interpret these results. The methods used to acquire the necessary data are protocol analysis, card sorting and interviews. The results suggest that at least three parameters can be used to explain and differentiate the strategic design behaviour of architects. These parameters are S (site-oriented), B (brief-oriented) and C (concept-oriented). A priority hierarchy of these parameters reveals six major distinguishable working styles. These results are captured in a new design model that can be used in data bank implementations.

1. Introduction

This introduction reviews recent developments in research on architectural design as well as the reasons why this research was conducted. Then the personality model is presented as a framework for understanding the implications of the data derived from the experiment. After a description of the experiment and its results, their implications for future research and software development are discussed.

![Diagram](Image)

Figure 1. A classic model of the general design process

1.1 CURRENT DESIGN MODELS

Many theories about design, architectural design in particular, describe the design process as a sequence of activities like analysis, synthesis and evaluation. Figure 1 shows a classic model of these three activities. There is a problem, however. Models of this kind are partly tautological. They do not lead to better insight in the complex design process, nor to fruitful development of a design-support system, unless they are extended and expanded with special features. On the basis of research, these models were augmented to generate more elaborate models like, for instance, the one designed by Archer (1969) shown in Figure 2.

Figure 2. A more elaborate design model by Archer

The problem with these more elaborate models is that they often describe the ideal design situation. That is, they show how the design process should take place (prescriptive models) instead of describing how it actually does take place (Van Bakel 1991).

1.2. Current Design Tools

Unfortunately, computer scientists use the models described above as a basis to set up an artificial process dispatch to support designers in their work. The problem is that when we talk about CAAD or Design Decision Support Systems (DDSS), the emphasis seems to lie on the role of the computer instead of the user (Durri 1984). Design programs used to be (and sometimes still are) developed without using the explicit and implicit knowledge of the designer. Fortunately, program developers have recognized these shortcomings, we now have some very useful design tools at our disposal. These are not merely number-oriented drawing tools. Using interview and observation techniques, the investigation revealed that these programs are very promising. Instead of just being used as a drawing tool, they can be applied as a design tool in the preliminary phase of the design process. A few examples of forms synthesized during the initial stage of a design process are shown in Figures 3 and 4.

These shapes were created in the sketch phase of the design process by running one of these programs on an Apple Macintosh computer. It took just a few minutes to create this conceptual image on the computer. Without a computer, it would take several hours to reproduce different representations of this visual image that can be rotated in space. Unfortunately, most modelling and rendering programs are developed with an emphasis on the description or representation of a design instead of the generation of a design. Also, to a lesser extent they are suitable to support sub-processes like calculating the costs, the requirements of energy, air-conditioning, etcetera.
But it is difficult or sometimes even impossible to use these programs in the design stage instead of the decision stage.

From the perspective of artificial intelligence, however, these developments are not surprising (Simon 1970a). At present, we are able to write complex algorithms to execute some specific problem-solving task. These algorithms usually pertain to generic tasks. A generic task is one that cannot be divided into sub-tasks (Chandrasekaran 1988). But we can ask ourselves whether architectural design is a problem-solving activity (Simon 1970a, 1970b; Newell and Simon 1972).

We can also ask whether we may conceive of design and DDSS as a fixed number of sequential generic tasks to be executed. In the development of expert systems, it became common practice to involve a knowledge technologist with a background in the cognitive sciences. His task is to use several Knowledge Acquisition and Documentation Structuring techniques to map the expertise without being restricted to implementation formalisms. KAIDS is such a method. It enables us to map domain-specific knowledge into a conceptual model without being restricted to implementation formalisms (Breuker et al. 1987). This conceptual model can, in turn, be used for the implementation of a design-supporting system (DSS). This is the main reason why we suggest shifting the focus of the attention. Instead of talking about a computer-aided design approach, we would like to emphasize a different approach, namely, a designer-aided computer point of view (Daru 1984).
Notice that we refer to the approach as design support and not decision support. We believe that decisions follow design and are a sub-domain of design, not vice versa. This relationship is schematically represented in Figure 5. Making a decision means that you have to choose an action or solution out of a set of options based on one or more criteria like cost, relation between rooms and buildings, amount of available space, etcetera. Some preliminary design activities will already have taken place before a designer has to make a choice between alternatives. Most existing tools are suitable for decision support but not for design support. This is probably because such tools are not attuned to how the designer works in general, or at a specific moment in the design process in particular. The most obvious way, then, to support design processes is to study the design process at a higher level of abstraction.

1.3. DESIGN CHARACTERISTICS

Before we continue, we should clarify a basic question: what are the characteristics of design processes? Many theorists describe design processes in terms of flexible, creative, undetermined, multidirectional, rough activities. Designers often use paper and pencil to create an outline using global and sometimes specific information about the type of building, the site, the brief, and so on. Therefore I think flexibility, multidirectionality, roughness, etcetera should also be features of a good design support tool for these preliminary design activities.

This may be an important reason why decision-making tools are not often used in the first phases of design. There is simply not enough specific information available at the time to decide upon. Even more plausibly, the designer may want to be free of these restrictions for a while. Before we can implement a useful design support tool, we need to know what is to be analyzed, synthesized, and evaluated. We have to know how this is done and in what order. In other words, we need to know more about the working style of the architect.

Style, in the context of this paper, has two aspects: a strategic and a tactical aspect. Strategy pertains to the general approach or plan a designer uses to come to a design. Tactics pertain to activities a designer executes in case his design strategy fails to be successful. We are not alone in assuming that the design processes of different designers can be distinguished from one another. Several other theoretical publications make the same assumption. Archea makes a distinction between designers who perform problem-solving activities in contrast with puzzle-making activities (Archea 1987). Perhaps a combination is possible, as suggested by Van Bakel (1991a, 1991b). Broadbent (1973) makes another interesting distinction between pragmatic, analogic, canonical, and iconic design activities. According to the definitions of these working strategies, it is very likely that the designer is going to use the available tools and information-processing...
systems in a different way for each strategy. As mentioned earlier, we are not alone in raising the possibility of distinguishing design processes. We are unique, however, in our approach. We use the Interactive Personality Model of Hettema, which in fact is a general model. It is used to predict and interpret human behaviour based on knowledge about specific situations (Hettema 1979, 1989). The relation of this model with respect to design is represented in Figure 6. To understand how the model can be used in this study, it will be introduced briefly in the next section.

Figure 6. Relation between different levels of behaviour

2. Interactive Personality Theory

The interactive personality theory of Hettema (1979, 1989) describes personality as "an active, intentional entity that has considerable impact on situations." Furthermore, it states that "persons and situations reciprocally affect each other, so that persons obtain feedback on their actions from the situations in which they act" (Hettema 1989, pp. 18-19). The theory uses a three-layer model to describe the personality system. This model consists of a cognitive-symbolic level, a control level and a sensorimotor-operational level. A schematic representation of this model is shown in Figure 7, where it is tailored to design processes in general and architectural design in particular.

Figure 7. A three-layer hierarchy of design actions
2.1. COGNITIVE–SYMBOLIC LEVEL

At the cognitive-symbolic level, a person can make use of situation concepts and transformation rules. People have a conception of the present situation (Sy1), a conception of the desired situation (Sy2), and, according to the theory, preferences for particular transformation rules in specific situations (Ry). These preferences are based on social learning and private experiences and are summarized in the strategic subsystem of personality. There is an interesting parallel with the personality model of Hettema (1989) and the ideas presented by Simon (1970a). The latter says that there are only a few 'intrinsic' characteristics of the inner environment of thinking man that limit the adaptation of his thought to the shape of the problem environment. All else in his thinking and problem-solving behaviour is artificial, that is, learned and thus subject to improvement.

Translated to the domain of architectural design, this means that an experienced architectural designer can use a more elaborated practical experience to enter the design situation. Accordingly, an experienced designer might have a much simpler strategy to execute a design task than a novice designer would have.

2.2. SENSORIMOTOR–OPERATIONAL LEVEL

The effect of the strategic system becomes manifest at the sensorimotor-operational level. That is, people observe the actual situation (Sx1), they execute specific actions (Rx), and they can observe the final situation (Sx2) when Sx1 is transformed. Behaviour specified by the strategic system may or may not be effective in transforming the environment as intended by the individual. Translated to the domain of architectural design, a plan of activities may not be practicable because of a shortage of time or because the techniques are not suitable for a solution.

2.3. CONTROL LEVEL

At the control level, processes have the capacity to alter the state of elements at the other two levels. At the sensorimotor-operational level, they can mould the environment to conform to cognitions. They do so by way of three possible state-transition mechanisms: exploration, substitution and persistence. An architect could look around to find support for his solution of the design problem (explore). He could execute a few other actions (substitute). Or he could try to convince his employer that his solution is the only possible in this case (persistence).

![Figure 8: Relation between six state-transition mechanisms](image-url)
At the cognitive-symbolic level, however, processes can replace cognitions to conform to the environment. They could do so by the use of three other state-transition mechanisms: reflection, uncoupling and redirection. An architect could alter his conception of the design problem (reflect). He could replace a few transformation rules and generate a modified plan (uncouple). Or he could decide to aim for a complete new solution (redirect).

The six state-transition mechanisms, represented schematically in Figure 8, belong to the tactical subsystem of personality and are used to maximize control. Tactics are also assumed to be largely innate mechanisms, acquired on the basis of heredity (Hettema 1989, pp. 170-171). However, in case the state-transition mechanisms fail to restore control, the disruption mechanisms - avoidance, extinction and distraction - are started to minimize non-control.

3. Experiment

3.1. Basic Model

As far as the conceptual design model is concerned, we are looking for a general model that, despite its generality, can be elaborated to include more detail without losing its readability. This model should enable us to distinguish variations in the design process due to individual preferences based on personality characteristics and experience. In other words, the initiation phase should not be predetermined by theoretical assumptions of how design should take place, in order to make it possible to distinguish design strategies. Furthermore the number of recursions and switches between phases must also be flexible to make it possible to distinguish design tactics. Finally, the model must be flexible, allowing the addition of new information (and control) to the design process and permitting recourse to automated processes. If we can find a model that meets these conditions, we can use the model to distinguish design styles. Thus, we would be able to support a designer on the basis of his personal preferences. The assumption was that a design style as a function of human behaviour is determined by personality characteristics. It is also determined by foreknowledge based on culture and social learning (Bandura 1977; Mischel 1977; Pervin 1984), as well as by the environmental influences under which activities take place. This should preferably lead to an integration of parameters in the model that correlate with these aspects. The model should thus consist of three processes: (i) an integration of a constantly changing environment; (ii) an interaction possibility between the environment and the individual; and (iii) the integration of variable as well as consistent parameters. IDEF0 diagrams enable us to meet these conditions (IDEF0 1981). If we describe the components discussed above in the top level of an IDEF0 scheme, the model looks like the one represented in Figure 9. The figure represents the top layer of the model.

![Figure 9: Top level of the design support model](image-url)
We must realize that the number of design solutions is not finite. This is partly because architectural design concerns an ill-structured problem (Simon 1970b). We believe that the difficulty goes even beyond this statement. We agree with Archea that architectural design is not only about problem-solving but also about puzzle-making (Archea 1987; Van Bakel 1991a, 1991b). The consequence is that we do not have a finite number of solutions, not even when the designer structures the design task and creates sub-tasks to be solved as suggested by Simon (1970a). This is only true for the design constraints that a designer imposes to himself. An important fact is that these constraints are very personal. The restructuring of the design task takes place by calling up certain constraints (Ry), sub-goals, and generators (Rx) from his long-term memory. These are factors not specified in the problem statement. The formulation of the task is therefore dynamic (Coyne et al. 1990). Ry and Rx are thus very important parameters in assessing the design styles of architects.

3.2. What data?

Our main concern in this investigation is to identify the characteristics of the strategic design styles of architects. In other words, we concentrate on the strategic level of the personality model. We want to know which Ry’s are preferred by individual designers. What kind of research do we need to conduct in order to elaborate the model? It might be helpful to consider developments in the cognitive sciences. These sciences are in a pre-paradigmatic stage. Therefore, the best way to study design processes from that perspective is to observe them, for design consists of cognitive as well as sensory processes (Dekker 1985). These observations can, in turn, lead to a useful implementation-independent model to interpret design activities at a high level of abstraction. Hettema’s ModeMedia Matrix offers an opportunity in this direction.

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<th>Media</th>
<th>Measure</th>
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<td>Psycho-physiological measurement</td>
<td>II list detection</td>
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<td>V film stress studies</td>
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<td>Natural interview</td>
<td>VII interview</td>
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<td>VIII telemetry</td>
<td>IX natural observation</td>
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3.3. Subjects

The subjects were 11 male architects in the age range of 45-55 who responded to an announcement in a monthly journal for architects (B.N.A. 1990). The journal is distributed by the B.N.A., which is an abbreviation for Bond van Nederlandse Architecten (Union of Dutch Architects). The announcement asked for experienced architects who would be willing to take part in an investigation of design style.
3.4. Experimental Design

The focus of this paper lies on the strategic aspect of design styles. These are represented at the cognitive-symbolic level. Design strategy pertains to the plan a designer has when he is asked by a client to design a building. At this point, the only necessary information concerns the type of building to be designed. We can ask the architect what he would like to do to arrive at a solution. In making this plan of activities, there is no cause to change a preferred approach to finding a design solution. Therefore, cells I and VII of the Mode * Media Matrix will be used. Four techniques were used to acquire the necessary data. The first phase of knowledge acquisition took place at the private design studio of the architect. The other three took place in a laboratory situation.

3.4.1. Knowledge Acquisition 1. In the first phase, all subjects were visited at their own design studio. Notes were taken listing the furnishings of the room, such as books, drawing tables, drawing tools, computers, etcetera. During this visit a structured interview was also conducted, using a questionnaire as a guideline. The questionnaire included items like: "What do you do if you have difficulty finding the solution you are looking for?", "How much communication is there between you and your client?" and "What architectural style do you like very much and what style do you dislike very much?" These interviews were recorded on audiotape.

3.4.2. Knowledge Acquisition 2. In this session, the architect was asked to describe the activities he would preferably carry out if he were asked to design a day-care center. In other words, what is his plan to reach a solution? That was the only information provided about the hypothetical task at the beginning of the session. If the architect wanted additional information about a topic, this was given to him. So it was not really necessary for the subject to design the building if he did not like to design. The session took place in a laboratory situation specially designed for this research. Most of the necessary equipment that was available at a subject's own studio was also available here. Also materials concerning the design task were available, such as pictures of the scenery, a map, a brief, information about the client, municipal destination of the area, etcetera. When the subject asked for additional information, it was given to him. These protocols were recorded on audiotape.

3.4.3. Knowledge Acquisition 3. In the third session, a card-sorting technique was employed, using a Macintosh II computer with a 19-inch monochrome screen, Design/2.0 software to execute the task, and Screen-Recorder 2.0 to tape all the screen activities. The concepts displayed on the screen were derived from the structured interview of the first session, augmented with concepts from the NNI, which is the Dutch Standardization Institute. The subjects were asked to talk aloud and the protocols were recorded on audio tape. The task to be executed was formulated as follows:

In this task several concepts are displayed randomly at the bottom of the figure. There is also a matrix in which the concepts can be ordered. The matrix has two columns and several rows. The left column should contain concepts regarding all design tasks as they are executed in practice. The right column can contain concepts that are sometimes related to a design task. The top row contains concepts that are relevant at the beginning of the design task as executed in practice. The bottom row contains the concept pertaining to the end of a design task. It is your task to order these concepts in the matrix. You are free to remove, rename or add concepts at your discretion.
3.4.4 Knowledge Acquisition. In the last session, subjects were again asked to employ a card-sorting technique, using the same equipment as described for Session 3. The task, however, was different. The task to be executed was formulated as follows:

In this task you again see a number of concepts randomly displayed at the bottom of the screen. You are asked to split these concepts into two categories. Each of the categories has to be labelled. You can do this by using a concept included in the group or one that does not appear on the screen. Repeat this activity with each group until you have a maximum of two or three concepts in the resulting sub-group. As soon as you have only groups of two or three elements, you’ll have to regroup the members of these small groups using labels displaying why they belong together. You can use an existing concept as a label or you can add a new one. Repeat this activity until you are satisfied with the result.

3.5. RESULTS

There are two types of results. The first type consists of the protocols recorded during each session. The second consists of the material produced by the subjects, either on paper or on the computer screen. The results will be discussed in the order of the sessions.

3.5.1. Results Session 1. Some architects described the architectural design process as a spiral like the one discussed by Zeisel (1981). According to the description they gave, the design process is like a spiral starting very wide and gradually narrowing down as it reaches the design solution. Ten out of the 11 subjects mentioned that communication is a very important activity that takes place during the general design process (Column 2 of Table 2). And four of them even mentioned the importance of communicating with the client while creating the concept or image of the design (Column 3 of Table 2). Communication with the proper authorities and other people involved influences the design process. This involves gathering extra information, discussing propositions, but also negotiating about elements described in the brief. Many subjects also gain some extra information by reading magazines or books about the topic, and some even plan a vacation to get new impressions for a particular design task.

3.5.2. Results Session 2. In the analysis of the protocols recorded during this session, it appeared that subjects had different ideas about which elements play an important role in the design process. The number of elements and activities differed. One interesting fact was that all subjects mentioned three particular elements they considered important in every design task. These are the brief, the situation, and the imaginary solution or concept (Column 4 of Table 2).

The situation concept refers to the location, urban plan, site, etcetera. The distinction between the brief and the situation regards the flexibility of their elements. The brief can be changed more easily than the situation. Whereas you can easily change the number of rooms in the brief, it is more difficult to change the existing surrounding buildings on the site. Of course, according to the subjects, there are exceptions.

The brief is described as containing the conditions that the solution should address, such as the volume, the height, the number of rooms, the organization that is going to use the building, etcetera. Some of the subjects even make a distinction between qualitative and quantitative aspects of the brief. The quantitative aspects are the ones mentioned above. Qualitative aspects concern how the building should look or what it should represent. Typically, some of the architects who make this distinction also mention that this aspect is explored by communicating with the client.

The other subjects who do not make this explicit distinction claim to find these qualitative aspects in the situation and the brief.
The imaginary solution or concept is in fact a visual image that the subject has upon receiving the task or after gaining some extra information. It is not necessarily a complete solution but includes what the building should look like and/or self-imposed constraints. In this session, subjects had to describe a plan of activities after receiving the globally formulated design task. An interesting fact was that the order in which these elements were discussed differed among the subjects. Also the importance of the concepts as described by the subjects differed. Another even more interesting fact is that all possible 3\times6 sequences appeared. This is schematically represented in Figure 10.

Each bar shows the priority of the concepts according to the subjects. The wider part in the bar corresponds to the aspect that was given the highest priority. The smallest part of the bar corresponds to the aspect that was given the lowest priority. This priority was estimated by the sequence in which the aspect was discussed, the amount of time spent on it, and by direct questions. Some of the architects explicitly mentioned that this preference of activities cannot always be carried out in practice, for instance because of time pressure. The distribution of these 11 architects across the six styles is 2,2,3,1,2,1, as shown in Figure 11.

3.5.3. Results Session 3. Some remarkable differences between architects are displayed in Table 2. As shown, the three aspects of design discussed under the results of the previous session appear again in the Table (Column 5 of Table 2). However, the order in which they appear differs
for three subjects with respect to the results of the previous session. This new frequency, as
obtained by this technique, is displayed in Figure 12. According to Figure 12, style 2 (situation,
imaginary solution, brief) and 4 (imaginary solutions, situation, brief) don occur in practice for
this population. Some architects emphasize finances as an important determinant of design,
whereas others do (Column 6 of Table 2). The use of alternative designs, variants and models is
also variable (Columns 7, 8, 9 of Table 2).

![Figure 12. Style distribution of knowledge acquisition 3](image)

3.5.4. Results Session 4. Every structure obtained by the subjects differed from those of the other
subjects. Summarizing these results, we can say that architects have different ideas about the
relations between actions and concepts.

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4. Discussion

Looking at the results of the different techniques, we can say that interaction and communication
are two fundamental aspects of the architectural design process. All the architects mention the
importance of communication with the proper authorities and the client to gain the necessary and
relevant knowledge to reach a design solution. To some architects this interaction with the client
is even desirable to get more insight in the qualitative aspects of the brief. This means that some
of the architects hold discussions with their clients about what the design should look like. The
implications for the design-supporting system to be developed are that it should allow communication at different levels with the client and the proper authorities.

Architects mention that in practice design is exposed to changes at different levels. Changes can take place at the qualitative level by changing the imaginary solution, using another detailing because of financial problems, etc., and changes can also take place at the quantitative level, for instance by fundamental changes in the brief concerning the size and height of the building, the number of rooms, etc. The design-support system should enable us to implement these changes easily and as soon as possible at the different levels involved with these changes.

If we compare the results of Figure 11 and Figure 12, there seems to be a contradiction in the data obtained (see Figure 13). They are, in fact, not contradictory because of the formulation of the tasks being executed. In the second session, subjects were asked to describe a plan of activities they would prefer to execute during a design task, while in the third session they were asked to describe the activities as they take place in design practice. This was confirmed by asking these three subjects to explain the differences between the results. This was done by first explaining the assumption that all design tasks consist of at least three elements: namely, situation, brief, and imaginary solution. They were then asked to rank these with respect to preferable importance. The results were in accordance with those of Session 2.

![Figure 13. Non-linear correlation between strategy and tactics](image)

Then they were asked whether this could always be achieved in practice, and to rank these elements with respect to design practice. This time the results were in accordance with those of Session 3. Interpreting these results with respect to the Interactive Personality Model of Hettema, this means that indeed there is a distinction between design strategies and design tactics. The line in Figure 13, which displays the variance between design strategy and design practice, is fortunately not straight. This means that architects can indeed have a design plan that is practice needs to be adjusted because of particular frictions that occur.

Also, on the basis of the elements distinguished by the IPM and the elements retrieved by these experiments, we can say that the model might be useful in distinguishing strategic design styles. If we refine the basic IDEF0 scheme of Figure 9 by using these results and the IPM, the next layer looks like the one shown in Figure 14. The model enables the user to follow his design strategy by providing flexibility in the initiation phase and by allowing different recursions. The only restriction is that each phase should be encountered at least once in order to come to a design solution. Depending on the tactical mechanisms (that need to be assessed in future research) preferred by the user, a strategy shift can take place. Furthermore, a critical analysis of design tools (Dara 1992) can help us in suggesting a specific tool for a specific situation. For instance, if a designer prefers to begin with the imaginary solution, the system might suggest the use of a tool such as Architron. If this does not lead to a satisfying conceptualization, the system might suggest the use of a different tool, depending on the design strategy and design tactic of the user.
To test the usefulness of this model, future research is aimed at the development of an SRS personality questionnaire and the assessment of psycho-physiological measurements. The SRS questionnaire will be used to assess a design strategy in a guided and easy way. SRS is an abbreviation for Situation-presented, Response, and Situation-transformed. This questionnaire should be specifically developed for the domain of architectural design. A description of the construction of such a questionnaire can be found in Hettema (1989). At present, we are working on a prototype. The use of this questionnaire, if it is balanced concerning the representation of domain-specific situations, can probably lead to a first fruitful attempt to create a useful design-supporting system. In case the design-support model enables us to distinguish design strategies and design tactics, it is very likely that the system based on this model can make a suggestion about which tool to use in a specific problem situation based on personal preferences of the designer, which have been assessed before implementation. The advantage of using SRS questionnaires is that we are not restricted to the use of fictitious design tasks, executed in a laboratory (Teyken 1988; Hartel 1990). The psycho-physiological measurements will be used to assess the design tactics. This knowledge, and the use made of the model in previous design tasks, can be assembled in a hypertext stack. This stack should keep track of tactical manipulations and strategy shifts due to experience. As can be seen, a lot of work still needs to be done. But we can conclude that the approach discussed here can lead to a practical and useful design-supporting system based on personal preferences correlated with design styles.

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