









































#### 4.4 Hierachy of the AC(f)C(p)V

The A-C(f)-C(p)-V Associations Matrix can be shown in the form of a tree diagram, which is the HVM. However, it would be too complicated and the important linkage could not be shown if all the elements' associations were drawn into the HVM. To maintain the balance between detail and interpretability, the authors referred to Nielsen's (1993) five-point scale. Specifically, if the mean is more than 3.60, the score will be positive, meaning significantly associated. Figure 5 shows the links with a mean above 3.60. To make the discussion and reading easier, lines of different thickness show associations of different strength between the elements. In this case, for a score 3.60-3.80 the line is 0.75pt; for 3.81-4.00, 1.25pt; for 4.01-4.20, 1.75p; for 4.21-4.40, 2.25pt; for 4.41-4.60, 2.75pt, and for any score more than 4.61, 3.25pt. Graphs can help designers clarify their thinking and simplify communication with others.

In the HVM shown in Figure 5, 53 complete Means-End Chains can be seen. Each chain's intensity can be obtained by referring to Tables 2,3 and 4 and summing up the "From and To" values of every element in each chain. For example, for the chain A1→C(f)2→C(p)6→V3, the "From" value for A1 is 0 and its "To" value is 2.82. The "From" value for C(f)2 is 2.39 and its "To" value is 3.26. The "From" value for C(p)6 is 2.43 and its "To" value is 2.63. The "From" value for V3 is 3.99 and its "To" value is 0. Therefore, the strength of this chain is:

$$(0+2.82) + (2.39+3.26) + (2.43+2.63) + (3.99+0) = 17.52$$

Table 5 shows the top five chains with the highest intensity out of the total of 53. The most important chain is A8→C(f)3→C(p)2→V3, with an intensity of 20.43, which can be called a critical path. This demonstrates that the respondents regarded the "electronic map" attribute as important, and hoped that via this attribute they could get "information relevant to this journey", have "beautiful memories" and ultimately feel "happiness". To define the related goals, designers can simplify the HVM in Figure 5 if needed. Figure 6 shows that the top five chains should be taken into consideration first.

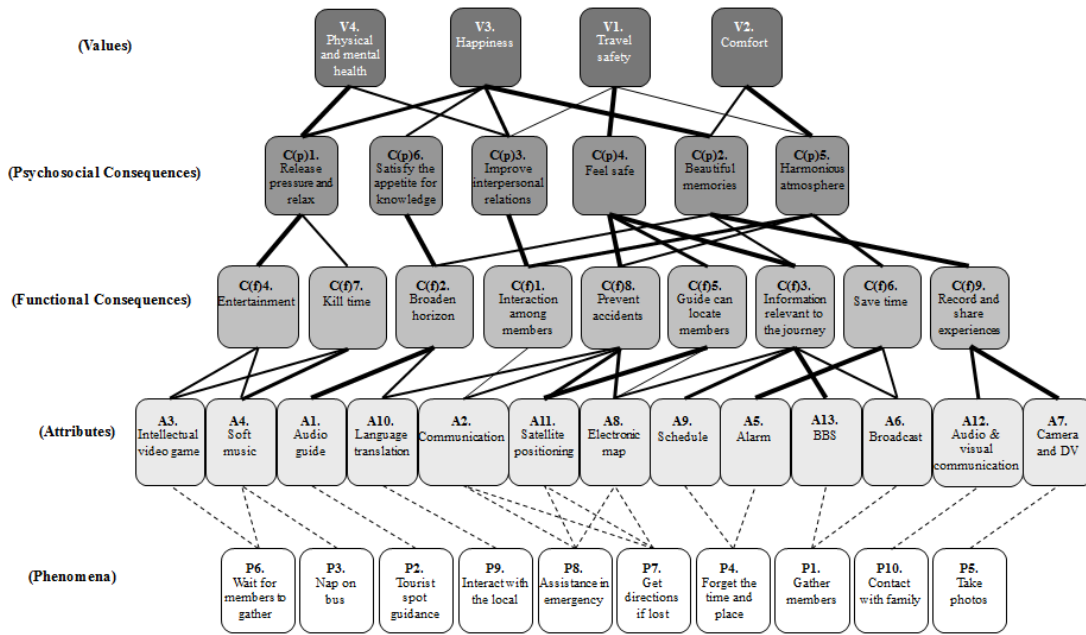


Figure 5. Hierarchical Value Map for electronic tour guide design

Chain	"From" and "To" values for elements	Strength
A8→C(f)3→C(p)2→V3	(0+3.16)+(2.81+3.09)+(3.49+3.89)+(3.99+0)	20.43
A2→C(f)1→C(p)3→V3	(0+3.21)+(2.93+3.57)+(2.80+3.92)+(3.99+0)	20.42
A13→C(f)3→C(p)2→V3	(0+2.98)+(2.81+3.09)+(3.49+3.89)+(3.99+0)	20.25
A2→C(f)1→C(p)5→V2	(0+3.21)+(2.93+3.57)+(3.45+3.79)+(3.21+0)	20.16
A2→C(f)1→C(p)5→V1	(0+3.21)+(2.93+3.57)+(3.45+3.79)+(3.19+0)	20.14

Table 5. Top five chains with the highest strength

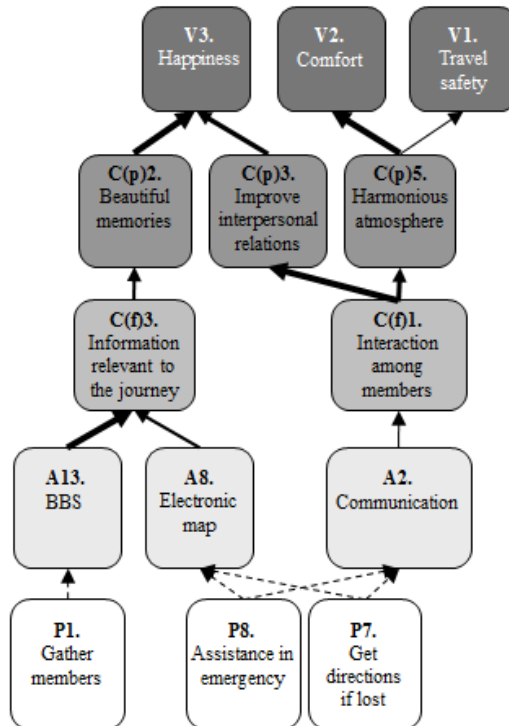


Figure 6. Streamlined Hierarchical Value Map

#### **4.5 Developing the prototype**

Consumers usually have rigid, pre-existing thoughts about the features of every product and service, and it is difficult to change this mentality. Because consumers lack knowledge and demand experiences from products in a new field, there is little help derived from them regarding suggestions for the attribute levels of innovative products. Most related studies focus on the features and functionalities of products or services and the instant satisfaction brought to consumers, but they neglect the emotional benefits behind the products or services. Consequently, they fail to fully understand consumers' intangible thoughts and feelings and the forces that drive them. Therefore, when designers conduct an innovative product design, more focus should be put on "consequences" and "values" levels.

After setting up the goals by means of a streamlined HVM (see Figure 6), Mind Mapping can be used to develop a prototype. When drawing Mind Maps, there are a few essential techniques (Gelb, 1998; Mento, Martinelli & Jones, 1999; Reed, 2005):

- Show the topic in words or pictures in the center of the paper, and then draw trunks
- On the branches extended from the trunk there should be a graph or a term
- All of the branches should form a structure of nodes with different thicknesses in the trunk and the branch
- When nothing comes to mind, a few blank lines can be added to the key terms to stimulate the user to fill them in later, if possible
- There are two ways to think: Brain Flow is thinking from one key term to another one, while Brain Bloom is thinking from one key term to many others
- Symbols, colors, or pictures can be placed onto key points to stimulate the brain to create other combinations
- The Basic Ordering Ideas principle should be used to categorize the items that appear. Mind Mapping uses thinking, selecting and understanding relevant information to help analyze decisions through the process of writing down key terms and drawing associations.

Undertaking effective Basic Ordering Ideas is a key step in drawing Mind Maps, allowing other ideas to be organized (Buzan, 2002). For instance, if “electronic map” or “audio guide” (at the attributes level) are written on the trunk right after the start of the “electronic tour guide design” brainstorming session, the subsequent items on the branches will be limited, thus ceasing the flow of the thought process. We can use Basic Ordering Ideas as the sources of associations. This method separates the association of key terms into a few categories or levels, letting the brain think in a natural way. Once the main ideas are expressed, the sub-ideas are easily presented. The elements at the “consequences” and “values” levels in Figure 6, i.e. information, memory, interpersonal relations, atmosphere, happiness, comfort and safety, are used as the bases for association with the trunk of the Mind Map, to extend possible products or services at the branch level, and then the functions or effects provided at the sub-branch level.

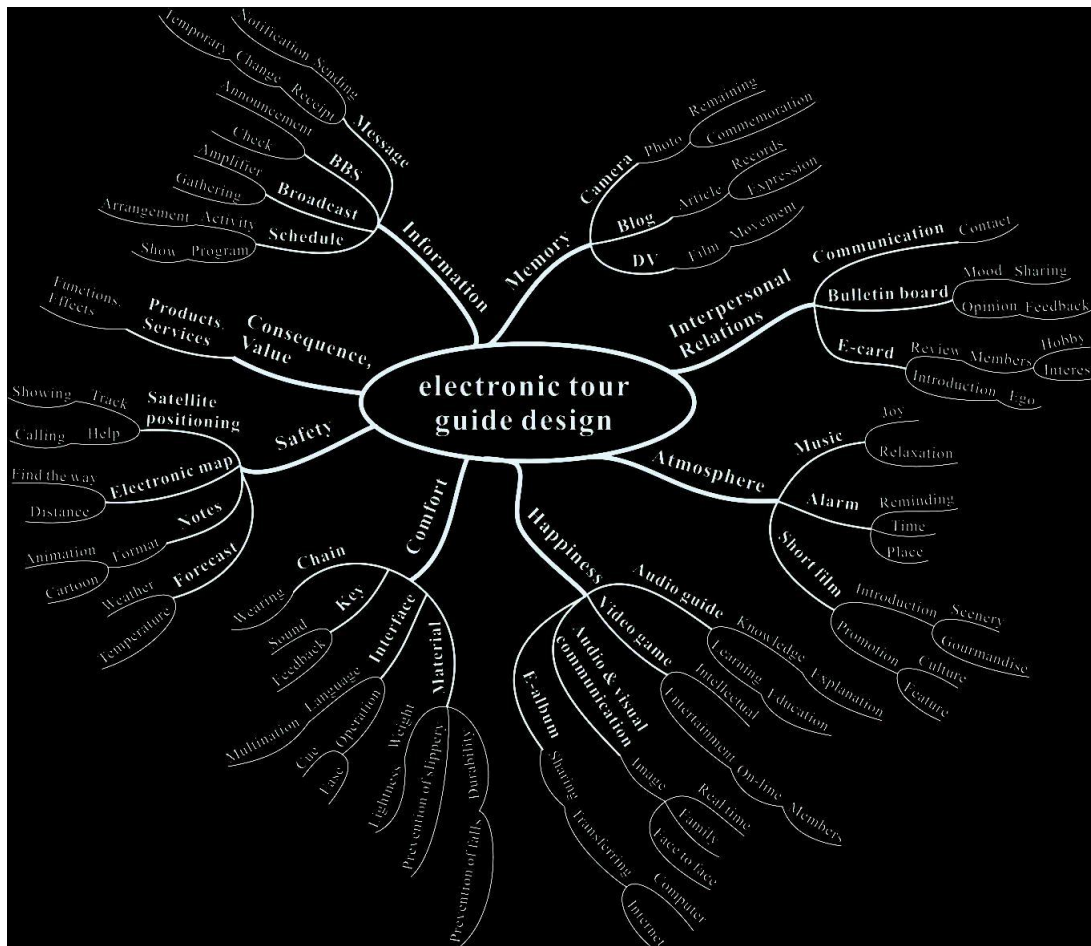


Figure 7. Mind Map for electronic tour guide design study

Designers then performed creative thinking according to their own experiences and knowledge, with the assistance of key term categorization in order to clarify the prototype of the electronic tour guide, and the results are shown in Figure 7.

Products or services that are extended from information, atmosphere and safety can be provided between the guide and the members to increase the depth and safety of the journey, while products and services that are extended from memory, interpersonal relations, happiness and comfort can help increase satisfaction with the journey and interpersonal interaction.

## **5 Discussion and limitations**

When developing a new system that is both large and complex, analysts and developers tend to collect a huge amount of general consumer data, thinking that in this way consumer demand can be known. However, such data can only reveal superficial information and has various other limits, ultimately indicating only the starting points of those factors that are most important. Therefore, when doing surveys of consumers, more attention should be paid to the nature of their needs. Many techniques have emerged to elicit these, but these mostly deal with decisions with regard to the product's functions and interface features. Understanding consumers' cognitive structures and related factors and drawing out the concept of a product's prototype based on these has received relatively little attention. This study thus combined Participant Observation, Means-End Chain and Mind Mapping to obtain pertinent information on consumers and develop the prototype of an electronic tour guide system. The contribution of this study has been to demonstrate that using EDM to elicit consumers' needs and develop prototypes of products is an effective approach. Another contribution is that the authors have altered the attribute-consequence-value model to a phenomenon-attribute-functional consequence-psychosocial consequences-value one, which can help researchers better understand consumers' behavioral intentions when using certain products.

EDM offers an electronic tour guide with a number of product or service functions that are more meaningful in terms of information, memories, interpersonal relations, atmosphere, happiness, comfort and safety. The electronic tour guide makes the GPT safer as well as more convenient and enjoyable. In addition, this system integrates relevant information and functions that can save on manpower, time and social costs. However we cannot evaluate the amount of cost savings involved. This study attached great importance to applying Participant Observations to exploring phenomena and using the Means-End Chain to understand respondents' cognitive orientations, as well as using Mind Mapping to develop a product prototype. Also, clearly defining each step and the process of information transmission can help solve conventional problems, such as undefined

tasks and the difficulty in linking each step, which are common in empathic design operations.

Although EDM can effectively improve the development of an electronic tour guide, there are some limits to this study. First, each respondent has a different level of involvement in GPT, which may affect their five-point scale evaluations. The best testees would be people who had just come back from a GPT or often join one. Second, the authors considered only the connections between neighboring elements, like AC(f), C(f)C(p) and C(p)V. Increasing C(f)C(f), C(p)C(p) and VV may reduce the limits, but the extra Associations Matrix would sharply increase the burden for the respondents and the benefits could be questionable. Third, to help each reader understand the meaning of each branch, the Mind Map in this case was expressed in key terms. When using Mind Maps to present the prototype, individuals or groups could use sketches to communicate their design ideas.

## **6 Conclusions**

In the past, in order to deal with most customer demands,, businesses only needed to manufacture products in large quantities and maintain sufficient inventory to ensure there was no shortage of supply. However, for today's businesses, higher flexibility is needed in both design and production processes in order to cope with dynamic market reactions. The EDM built up in this study has several advantages when dealing with this situation: First, it is based on careful observations: Human behaviors have to be followed consistently and observed precisely to acquire consumer phenomena which are closely related to the topic. Second, EDM is different from information gathered by a Means-End Chain. It requires that the respondents express the associations among elements at each level. In addition, EDM is different from survey questionnaires which use statistical techniques to explore these associations, as it collects the associations directly indicated by consumers. Third, streamlined HVM focuses on the cognitive structure of the consumer market, making the key links more obvious and thus useful for designers who are setting goals and making decisions. Fourth, Mind Mapping can effectively sort the unorganized thoughts that appear in the process of creative thinking, and create new, comprehensive associations to raise the innovative value of the prototype. Lastly, through EDM, the cognitive communication between designers and consumers can be improved, and the precision and creativity of problem-solving can be raised so that consumers' needs can be more perfectly met. To sum up, the consumer demands that are considered in the design process should be based more on what has actually been observed, rather than on designers'



imagination. The A-C(f)-C(p)-V connection network behind each phenomenon can be clearly identified step by step through the elicitation of phenomena cards and laddering interviews. The HVM, after being organized, focuses on the cognitive structure of the consumers, and it can be used in group brainstorming. A streamlined HVM can be applied to set up design goals, facilitate the progress of radiant thinking in mind mapping, and further create prototypes.

In the case study of the design of an "electronic tour guide", the authors found that the EDM was easy to handle and very useful, and this may lead to widespread future use of this model. Moreover, applying the EDM practitioners and researchers gain the following advantages. (i) Each step of EDM can be executed easily and is closely connected to the next step, and this can shorten the design time. (ii) They can accomplish classification of consumer demands and understand the relationships between each demand effectively. (iii) They can set up the design goals based on the statistics, and proceed to develop product prototypes. The methods of EDM emphasize visualizing information, and its future studies target different products or different consumers, the senses of touch, smell, hearing or taste may also be taken into consideration and used to more precisely predict and explain consumer needs. To summarize, EDM is composed of a series of systematic methods to uncover consumer demands, then transform the gathered data into design information to develop a product or service, in this case an electronic tour guide. Based on the information collected, designers can precisely identify and forecast consumers' underlying demands.

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