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A Review on the Existing Visual Tools for Design Students

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Abstract

This paper explores possible solutions to overcome the problem of design students lacking the skills and knowledge of user testing and data analysis to inform design decision-making that can help them to create successful products. A preliminary investigation and review is reported of existing visual interactive software tools intended to support design students and lecturers. Some of these tools might meet the requirements for teaching sampling methods (selecting suitable people and products) as well as testing techniques including data collection, analysis, and interpretation to design students. A discussion of existing visual software tools is presented first, followed by a discussion of the relative merits and disadvantages of these, and a summary is presented at the end of the paper.

Keywords: Data Analysis, Design Students, Data Collection, Visual tools

1. Introduction

In developing product ideas, product designers or graphic designers tend to rely on their own intuition or experience. Although this may be useful for experienced designers, there are limits to how far the idea can be used to gather data, especially for novices who may lack the skills and experience to communicate effectively with consumers. In addition to that, creators of design curricula have tended to disregard courses that incorporate user preferences, views and needs that enable a design student to involve consumers in the product design process[1,2]. Furthermore, design students are taught to believe in their own intuition and creativity[3], which is fine, except that they also need to verify with their target audience that their ideas are acceptable. Consequently, designers often rely heavily on personal preferences, tending to understand the term "research" as the gathering of archival information instead of running user tests to inform design decisions[4].

Understanding consumers' needs in the early stages of the product development process are important[5]. Designers must be able to provide valid empirical evidence to convince clients to invest in new products. Hence the need for acquiring skills such as the application of statistical methods is important. Our early investigations suggested that design students might benefit from a visual and interactive method such as a visual software tool to assist them collecting and manipulating data[6]. This

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insight was based on responses given by the design lecturers during the interviews. Design students also claimed that they are visually literate and prefer visual to numeric information. Based on this feedback, existing visual tools that could potentially be suitable for design students to conduct systematic research were investigated, and reported in the following sections.

2. Methodology

Interactive tools that are potentially relevant for enabling a design student to collect and analyze data were identified and evaluated. The focus is on visual techniques for user input and system output. The interactive tools reviewed here were the only ones meeting the criteria as being suitable for design students, offering visual techniques for user input as well as for system output.

2.1 Visual Research Package

A Visual Research Package[7,8] is an exploratory tool that allows users to sort product images into three types of grouping activities: grouping freely, grouping by combining and grouping based on Semantic Differential (SD) scales[9]. While grouping freely allows participants to sort products however they like, grouping by combining requires participants to sort products into two or more groups: for example, "I like this product," versus "I don't like this product". In contrast, grouping based on SD scales enables participants to manoeuver stimuli or

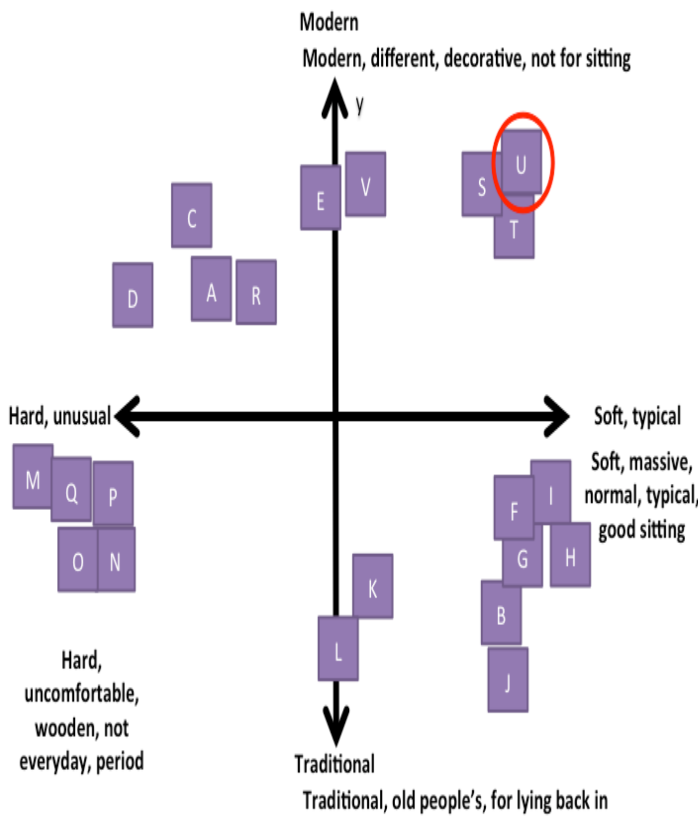

Figure 1. An example of a perceptual map generated by a Visual Research Package. Source: Redrawn from[7].

objects on a set of opposing adjectives; for example, Big - Small and Ugly-Pretty. This product is similar to the traditional card-sorting tasks that have been broadly applied in various fields such as psychology and design[10]. Card-sorting techniques usually consist of a set of cards with some descriptions or pictures prepared by a researcher. Participants then sort the cards into categories/groups, describe their sorting criteria as well as the names they use for each group/category[10]. Some advantages of the Visual Research Package are that the tool enables the user to choose several visual techniques for data collection and to view the results visually in a flexible manner. Users can click on the items in the results screen to access individual explanations for positioning a product in that particular location. However, this tool provides three different techniques for collecting data that could lead to confusion for design students who are unlikely to have had training in user testing. They might have problems deciding which technique to use.

In terms of data analysis, this tool allows users to view the results on a 2D map, which is also known as a perceptual map. Perceptual maps or mapping provides an idea about how consumers perceive brands, specific to relevant dimensions with visual in a graphical form[11]. The perceptual map as a method of data visualization, is widely used in the domain of marketing to study relationships between visual product attributes, product design and positioning, brand switching, as well as customer value and satisfaction[1,12]. However, perceptual maps in the marketing world generated by complex statistics such as Multi-Dimensional Scaling (MDS) are usually neither colorful nor visually attractive, which is probably not suitable for a design student who prefers information that is aesthetically pleasing, as was identified in our preliminary investigations[6]. It might also be too complex for them to understand and interpret the map. Figure 1 shows an example of a perceptual map on SD scales of 'Hard, unusual –Soft, typical' and 'Modern – Traditional' generated by the Visual Research Package. In the Figure, products denoted by the letters C, A, R, and D are somewhat harder and unusual but also more modern than those denoted by H, I, F, G, B and J; the product that should be judged to be most modern, soft and typical is U as circled in red. The disadvantage of this tool is that no further statistical analysis is provided.

2.2 Computer Aided Kansei Engineering (CAKE)

CAKE, developed by[13], is an Extensible Markup Language (XML) technology survey tool based on attribute rating tasks of SD scales. CAKE was inspired by the Japanese term, 'Kansei' that can be defined as an individual's subjective impression from a certain artifact, environment or situation, using all five senses; sight, hearing, feeling, smell, and taste[14]. This web-based online survey platform allows users to design survey questions by creating forms for participants' demographic information and by inserting stimuli and semantic terms involved in the study. During the rating task, participants rate each stimulus on sets of adjectives; for example, on the Ugly- Pretty semantic scale. CAKE then automatically sorts the products according to the scales at the bottom of the screen.

Similar to the Visual Research Package tool, CAKE generates perceptual maps as the visual output. CAKE can also generate MDS perceptual maps comprising multiple adjectives. However, to obtain these visual outputs, data must be exported to statistical software, SPSS for analysis. Analysed data are then transferred back to CAKE and presented visually in a perceptual map. Conducting analyses in SPSS requires some knowledge of statistics, which is likely to be difficult for design students who are not taught statistics in their training. In addition, the MDS map can be very complex to interpret and to infer consumers' perception of products correctly. Hence, this tool was considered unsuitable for design students.

2.3 Web-Based 2D Analytical Tool

The Web-based 2-Dimensional (2D) analysis tool[15,16] allows participants to position images of products with a Drag-and-Drop tool on a 2D map using SD scales, inspired by the 2D image scale often used in design enterprises for studying market segmentation and user preferences[17]. A 2D map comprises X and Y coordinates (x, y) positioned in four quadrants as illustrated in Figure 2. For example, imagine that a collection of Products (PA, PB, PC, PD, PE) were positioned on the map according to adjectives (Boring-Interesting, Ugly-Pretty) as perceived by five consumers.

As indicated in Figure 2, the tool allows participants to drag-and-drop product images indicated on the left side of screen (Section A) onto the 2D map (Section C) at the point they perceive the product to 'belong' in terms of the adjectives shown at the ends of the dimensions until all products have been placed somewhere on the 2D map. Section (B) is an Animation Control whereby participants can play with a 3D view of the product image in (A) for a more complete view before positioning it in section (C). The 2D map space along with the drag-and-drop technique comprises visual and interactive criteria deemed suitable for a design student: neither of them involves numbers and they are easy to handle and understand. In addition, the 2D map as a platform for input data can efficiently reduce human error in data entry, quickly and easily, as opposed to users manually entering the textual data. For these reasons, the techniques of 2D map and drag-and-drop were considered suitable for the design students. At its best, the tool generates results visually using Multivariate Analysis of Variance (MANOVA) a

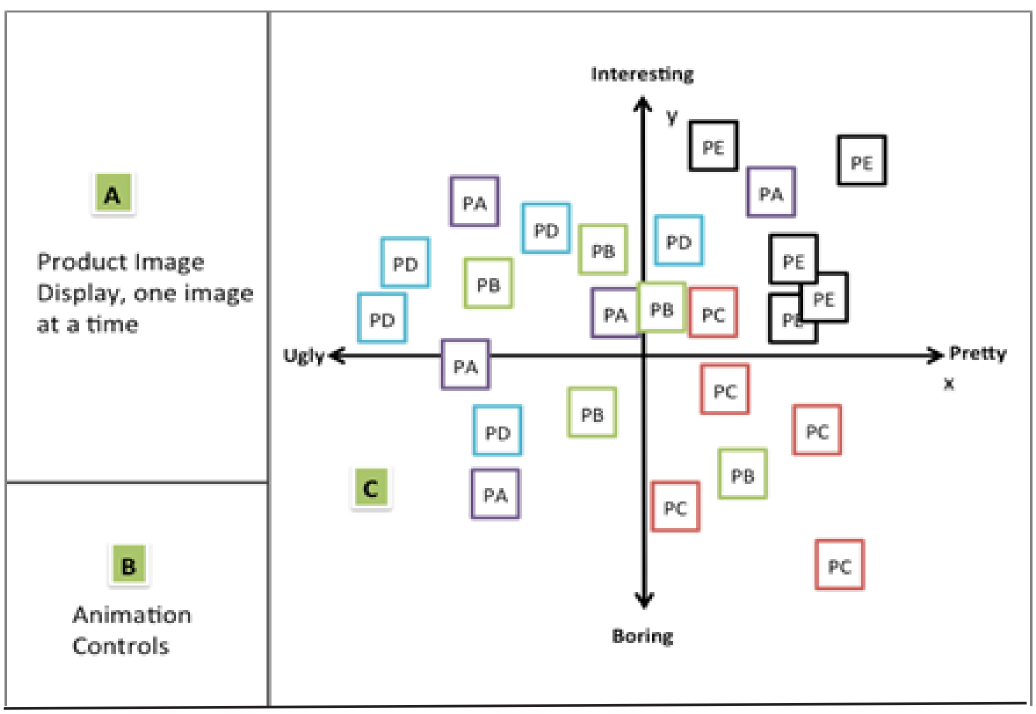

Figure 2. An interface screen of Web-based 2D Analytical Tool with the positions of five product images obtained from five participants. Source: Redrawn from[15].

statistical analysis function, and, the tool extends its capability with the integration of a Morphological Analysis to further analyze the product forms. These include colors, textures, shapes and structures that can serve as references for future development of new products. Another advantage of using a Web-Based 2D Analytical Tool is that users can filter the visual results according to either 1. the position of all products, for example, all ten products placed by all participants, or 2. The positions of only one product placed by all participants. This tool enables users to see how consumers perceived the product(s) according to the adjectives shown on the two orthogonal scales. This tool is unique because it involves a 2D map for both data entry and output. That is, users are able to enter data in the form of product images and obtain the output visually on a 2D map. The input data vary with activities such as sorting images into groups, combining, or rating products on a semantic differential scales, attribute ratings or a similarity type of judgment. Nevertheless, the analysis part provided by this tool is complex. Thus, the Web-based Analytical Tool is not considered ideal for design students.

2.4 Focus-on-Stimulus, Focus-on-Attributes, Drag and Drop

Author in[18] developed three computer programs that also employ attribute-rating tasks for measuring multiple visual stimuli with multiple scales. In their study, the performance of the three programs was compared with the manual Paper-and-Pencil approach. The three programs used methods that differed from the others. The first program used a separate evaluation rating-method known as Focus-on-Stimulus. The others used two joint evaluation-rating methods called Focus-on-Attributes and Drag-and-Drop. For Focus-on-Stimulus, each stimulus is separately rated on a number of scales. In the Focus-on-Attributes, a few stimuli are rated in comparison with each other on a specific scale. Drag-and-Drop on the other hand, requires participants to drag and drop stimuli to the chosen location on a Semantic Differential scale. All stimuli appear simultaneously in Drag-and-Drop. These three methods allow participants to perform re-adjustments even after all stimuli have been rated.

While all three programs can be used automatically to gather and enter data into computers, none can produce visual output directly. Chuang et al. employed Multi-Dimensional Scaling to generate a perceptual map. Although this function can be performed using SPSS software tool, the whole process can be problematic for design students. Therefore, this tool would seem to be not ideal for the present purposes.

2.5 Hierarchical Sorting Method and Divide-and-Conquer Method

Author in[19] further developed their methods evaluating a larger number of stimuli using multiple scales and attribute-rating tasks called the Hierarchical Sorting Method and Divide-and-Conquer Method. The former method is based on a Paper-and-Pencil approach while Divide-and-Conquer are based on sorting algorithms for computing. In Hierarchical Sorting, participants were asked to sort a large number of stimuli in a hierarchical manner whereby they first sort the stimuli into a number of groups such as 'rational, neutral and emotional', then re-sort these groups into more smaller groups and sub-groups. By contrast, the Divide-and-Conquer Method uses computer algorithms to first sort a large number of stimuli randomly and then to present these groups to participants to continue refining stimuli into smaller groups and sub-groups. The differences between these two programs are that the Hierarchical Sorting Method requires participants to sort the raw stimuli while in the Divide-and-Conquer Method, a computer automatically divides the large number of stimuli randomly into three subgroups, to be sorted later by participants. In other words, participants sort fewer stimuli than in the other methods.

Both methods have some advantages: Divide-and-Conquer are faster to complete, and Hierarchical Sorting is preferred by participants because they can focus on the details of the stimuli after they have grouped them by similarity at the initial stage, even though the process is more time-consuming. These two programs, while providing efficient platforms for design students to obtain data, again require an additional knowledge of statistics not just to run MDS but also to interpret the output. Similarly, this tool used MDS for data analysis to generate perceptual maps, so is unsuitable for a design student.

3. Discussion

Taken together, the investigations found various software tools catering to both input and output, and relying on more or less complex inferential statistical analyses. Visual data collection techniques have been used to gather feedback from consumers using a variety of tasks ranging from sorting tasks to attribute rating tasks and 2D maps with image positioning capabilities. It is important to note the differences between these techniques with relevant examples. In sorting tasks, participants are given a collection of stimuli, for example watches, to be assigned into groups according to certain criteria that the researcher selects. These may include opposing adjectives such as "like" versus "dislike", or choices such as "I would choose" versus "I would not choose". In attribute-rating tasks, participants are provided with a collection of product stimuli, for example, telephones, and asked to rate each based on attributes such as, "traditional - modern", "big - small", or "simple - complex". A 2D map is very similar to the attribute-rating tasks in the sense that it involves attributes or pairs of adjectives as guidance for the judges to evaluate products, but a 2D map technique employs image-positioning tasks in a 2D space. As discussed earlier, a 2D map with image-positioning task or drag-and-drop can be considered further as having visual and interactive criteria, allowing a design student to see products projected on a 2D space clearly and visually.

The tools reviewed in this paper rely entirely on the designers' own experience, knowledge, and intuition to decide which attributes or adjectives to use in a study intending to further their understanding of consumers' perceptions of products. As noted elsewhere[8], product images that have been pre-assigned to certain adjective-pairs can lead to a limited range of possible solutions. Author in[8] suggested that designers should allow participants more freedom to evaluate or rate products based on their own judgments rather than on the designers' preferences. This argument would appear to support Hsu, Chuang, and Chang's findings in the sense that designers and consumers are likely to perceive the same products differently[20]. In addition, consumers' understanding and interpretations of adjectives may also differ from that of designers. Hence, it would be worthwhile to ask consumers to suggest relevant attributes for product evaluation rather than relying wholly on the designers' points-of-view. None of the existing tools reviewed here address this issue, suggesting a new tool must be developed, enabling a design student to gather attributes from the consumers' points-of-view.

Apart from offering consumers an opportunity to articulate their perceptions of products presented visually via interactive displays, however, with respect to statistical analyses, excluding the Visual Research Package that did not mention any analysis method, none of these tools took into account designers' expertise in descriptive and inferential statistics in generating results. Most of the existing tools require some types of complex inferential statistical analysis that can be problematic for a design student. In addition, none of the tools help designers to understand issues and biases associated with sampling. For example, assigning participants into groups to be able to compare results between different demographics, and having an equal number of participants per group could possibly help designers to understand the basic concept of data sampling for user testing. These suggest that the new tool to be designed must offer simple rather than complex statistics, considering the limited knowledge of statistical analyses among design students and at the same time allowing them to understand the basic concepts of statistics, at least for a start. The elements of data sampling, user testing and its implications should also be incorporated into the new tool. All visual software tools explored also use Perceptual Maps as the visual output, suggesting its widespread use is not just in the design field but also in marketing and so deserving further exploration in order to be incorporated in the new tool.

4. Conclusion

This paper reviewed the existing visual software tools that might be suitable for a design student to collect and analyse data to inform design decisions. The study concluded that the existing tools reviewed in this research did not specifically address the lack of systematic data collection and analyses knowledge and skills among design students, suggesting the need to design a new tool. The study found several techniques that might be meaningful to design students and deserve further explorations, such as a 2D map for collecting data, simple and quick statistical techniques for analyzing, and Perceptual Mapping as the means for presenting the visual output. It is hoped that the tools reviewed and techniques found and summarized here would be of benefit to the software developers, in developing more effective and efficient tools to conduct systematic research and ultimately to inform design-related decisions.

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