Function in Design Presentations

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Introduction

The problem we address is that of automatically generating the presentation of some given information about a designed object [Roth et al 1994]. In particular, we are interested in the presentation of information about computer networks. We assume that a presentation will be instantiated as a display on a given device.

When generating a presentation, the needs of the user (of the information), general human-computer interaction (HCI) principles, and the capabilities of the device will determine which displays will be appropriate and which of these will the best possible choice.

As an example let us consider the problem of presenting the down-time cost of all the computers in a network. If the user to whom this information is to be presented (for instance a network manager) is interested in identifying the computers with the highest downtime costs, the display should have a form which makes this identification easy. For this purpose a histogram or a sorted list of downtime costs would be good candidates. On the other hand, if the user (for instance a service person) is interested in locating the computers with high downtime costs, it would be more appropriate to present the values using a graph or a map.

It is generally accepted that a histogram is a better way to present numeric information that needs to be compared than a list of values. However, if the device for which the display will be generated only allows alphanumeric output, the histogram alternative has to be discarded.

These, and other similar principles, give a way to rank the alternative presentations mentioned above. From these it should be clear that generating an appropriate presentation may be a complex task that requires the use of different kinds of knowledge from various sources.

Presentation as Design

Based on the example in the previous section we can see some similarity between a presentation problem and design problems. Let us explore this similarity in more detail.

We have already seen that the user's needs (e.g., what the presentation is going to be used for) determine the appropriate display alternatives, exactly as design requirements determine the solutions to a design problem. Just as such designs are restricted by various constraints (e.g., material constraints), the graphical elements and graphical properties of the device restrict the set of displays that can be generated.

Further, a presentation is intended to be used for some given purpose. This use assigns a certain role to the presentation. Hence, the corresponding display will fulfill a certain *function* when used [Chandrasekaran 1994] [Chittaro et al 1994]. For instance, in our previous example, the display will have to relate some values to each other, corresponding to the user's goal to compare these values.

Depending on the amount and structure of the underlying information, and the goal of the user, the function of a display may be simple (such as "to relate" in our example) or complex. In the latter case no single display element may be suitable to provide the required functionality, and so the *function has to be decomposed into subfunctions* – possibly in a recursive manner.

For instance, if the function of the presentation is to describe a given network, this could be decomposed into showing the topology of the network and relating its performance characteristics to average performance values of similar networks. Obviously the decomposition itself will also depend on the needs of the user.

The same function may be provided by different displays. Depending on the required functionality and the graphical properties of the device, some of these displays me be more appropriate than others (e.g., for relating two numeric values using a graphical display graphics, such as bar charts or pie charts, are more appropriate than text). Based on the functional description, a high level, conceptual description of the display can be chosen. We call such a description *style* description.

Displays can be *constructed by combining smaller displays*. For instance, displays can be grouped together, linked, placed in different relative positions, and so on. This is similar to configuration as step of a design process. The "smaller displays" themselves must be chosen. They must provide the required functionality. Finally, in order to be generated, displays must have their *parameters* (e.g., colors, sizes, distances) *set properly*, exactly as parameter values must be set in parametric design.

The above considerations allow us to view presentation problems as design problems and, as a consequence, to model the presentation process as a design process [Brown 1992].

According to our model, the presentation process consists of four phases corresponding to the phases of design: *function selection and functional decomposition* (corresponding to functional design), *style selection* (corresponding to conceptual design), *display configuration* (corresponding to configuration design) and *parameter selection* (corresponding to parametric design).

1. **Function selection and functional decomposition.** In this phase, the user's needs are mapped into the function(s) the display has to provide. If the resulting function is complex it may be recursively decomposed into subfunctions. The result of this phase is a functional model of the

display to be generated. The process uses different kinds of knowledge such as user goals, user preferences, general and domain specific HCI principles and so on [Chappel & Wilson 1993] [Wehrend & Lewis 1990].

2. **Style selection** is the phase in which functional descriptions are mapped into a high- level style descriptions of the display. For instance, this phase decides whether text or graphics will be used for the presentation. It is important to notice that there are some essentially configuration-type display elements (such as tables) that may be treated as styles as a result of preferences or domain-specific practice. Style selection is also a knowledge-intensive process making use of similar types of knowledge as the previous phase.

3. **Display configuration.** Once the elements have been selected from which the presentation will be constructed they have to be composed in such a manner that the result produces the required functionality. The display configuration phase builds spatial relationships between the different display elements. Relationships include nearness, relative position (above, below, same page), grouping, and so on.

4. **Parameter selection.** In the final phase of the presentation process the values of the parameters are set. This is where colors, sizes, and distances are chosen. The output of this phase is a complete description of the display to be generated.

The Function of Display Elements in a Presentation

The goal of our research is to study presentation as a design problem. A particularly interesting part of this is the study of function and functional design in the context of the presentation process. In the following we present some of the most interesting problems in this context.

1. **Static functions**

   Displays and display elements used in presentation have static functions. Most of the work on representing and reasoning about function refers to so called *dynamic functions*, that is, functions resulting from the use of the behavior of the object modeled. However it has been recognized that there are several situations when a designed object provides its function without behaving, that is without exhibiting any kind of state change, flow or other dynamic phenomena. A typical example of this is the (main) function of a chair, which is to support some weight.

   Although for this kind of example a behavioral account can be given (e.g., based on balance of forces, claiming that the behavior is *to maintain* a certain state, or *to prevent* the object from moving to some state – such as to prevent the chair from collapsing), this approach is neither plausible from a cognitive point of view, nor is the complexity of this kind of modeling reasonable.

   We think that the functions of displays and display elements in presentation are particularly good examples of static functions primarily because they seems to be inherently static, that is no behavioral account can be given for the functions they provide. These *functions are directly related to the structure, shape and different graphical attributes* (such as color, size, distance) *of the display elements*. This means that for modeling displays, some structure-function (SF), rather than a structure-behavior-function (SBF) model will be appropriate. Such a model should allow for representing function, structure, and relations between them, such that reasoning within the structural or functional models, and between the two of them (e.g., mapping function to structure) can be easily performed.

2. **Function sharing**

   Another interesting problem related to the function of displays, and display elements, in the design of presentations is that of function sharing. In the "device world", function sharing is a desirable phenomenon allowing for the use of a component in different roles, taking advantage of several of its possible functions. The function of a display or display element is generally to convey information. A display or display element may have several meanings or interpretations (e.g., an arrow may point to something, but it also may show a direction). In general, it is not good practice to use displays or display elements that may fulfill several functions. This may lead the user to miss some of the information intended to be conveyed, or it may generate ambiguity in the interpretation of the presentation.

   Multiple meanings and ambiguity are very important issues to be considered in the design of presentations. Dealing with them may require the use of a lot of knowledge from various sources.

3. **Classification of presentation functions**

   In our research we identified several functions that different displays may provide. For instance a figure may *illustrate* a text, a text may *explain* a picture, a histogram may *relate* some quantities to each other, a color or shape may *highlight* another display element, a frame may *group* several display elements, and so on. It would be interesting to identify further such functions and to try to classify them. It would also be useful if such a classification would reveal some *generic static functions* that could be used in modeling the function of static objects in other domains.

4. **Special kinds of functions**

   The design of presentations also constitutes a good example for studying some special kinds of static functions such as "esthetic" functions. This kind of function is special, due to the way they are evaluated and "reasoned" about. The basis for such evaluations and reasoning are usually not physical principles or rules, but rather psychological, social, or emotional phenomena.

5. **Emerging functions in presentation**

   Presentation design may also provide a good example for the study of some emerging functions. This is still a rather intuitive idea and is based on the observation that the overall look of a presentation may convey some information that is not necessarily a combination of the pieces of information conveyed by the display elements of which it is constructed. For instance, a presentation may suggest an overall balance, regularity or order, even without the need for the individual display elements that compose it to have functions of their own. This observation may show a bridge towards (intelligent) data visualization.

Conclusions

In this paper we showed that information displays can be viewed as a design problem, and how, based on this, the presentation process can be modeled as a design process. Functional design is an important part of the design of presentations. Interesting problems are raised in the domain of representing and reasoning about the functions of designed objects, especially static functions. We have listed a set of interesting research topics raised by our approach to presentation. Further research will concentrate on these topics.

As a result of our research we developed a system which included a module for intelligent presentation of service and management information about a computer network [Brown et al 1995]. This module was designed based on the four phase model of presentation described in this paper.

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