Spatial Positioning as a Representation that Helps us Think

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Our research focuses on the design of interactive systems that support early stages of creative design tasks. Externalization plays a critical role especially in the early stages of design. For instance, architects use sketches to explore possible design solutions as well as to frame design problems while going through a cycle of reflection-in-action. Subtle aspects of the sketch itself, for instance, the thickness of a line, may indicate how sure a designer feels about the part of the drawing and how much commitment the designer has made with to part. And this "talk-back" from the representation is often meaningful only to the designer him/herself.

We have studied interactive systems that serve as an externalization medium for users in the same way as paper and pencils for sketching does. Our approach is to make computer systems "invisible;" users must be able to feel that they are interacting with "*representations*" not with "*computers*" in using such systems.

We have used spatial positioning as an alternative to sketching for information domains where sketching does not work; for instance, technical writing, programming and exploratory data analysis. Spatial positioning of objects allows a designer to represent various aspects of a design task; by resizing an object, aligning objects, or putting an object in a certain position in terms of the whole space.

For the last five years, we have been studied the ART (Amplifying Representational-Talkback) systems, which use two-dimensional positioning of objects as a means for reflection in the early phases of a writing task [Yamamoto 2001]. The basic architecture of an ART system consists of three components:

1. *ElementEditor* in the middle with which a user creates, modifies, or segments an object as an element;
2. *ElementSpace* on the right where the user freely positions each element in a 2-D space; and

3. *DocumentViewer* on the left where the user views a synthesized overall content of the elements placed in ElementSpace.

Figure 1 illustrates the original ART-01 system, which supports a user in early stages of collage-style writing [Yamamoto et al. 1998]. With the system, the user positions segmented text as "elements" in a two-dimensional space (ElementSpace). An element is any unit that a writer may choose to think of as one, such as a phrase, a sentence, a paragraph, or a longer piece of text.

The essential part of the system is the use of the ElementSpace (the top-right window in Figure 1). Our previous case studies of ART-01 [Nakakoji et al. 2000] illustrate how two-dimensional positioning as an action helps designers be engaged in reflection-*in*-action, and how the resulting two-dimensional positioning of objects allows designers to perform reflection-*on*-action. We found that subjects used a variety of visual properties of two-dimensional positioning as a representation (Figure 2). Some put elements that need further attention in the bottom right corner of the ElementSpace. Some subjects made a set of completed elements be the same size and carefully aligned them. One user had two elements overlapping each other with a verbal protocol saying that she felt that they should be related to each other but could not describe how they are related (therefore they were overlapped and not aligned). Another user made some elements much larger than others so that it would "call for attention" later in the task. Subjects used different distances between two vertically positioned elements to represent different types of relations of the two elements. Some subjects placed two elements that were almost completely horizontally aligned but with a slight height difference so that they "looked" horizontally aligned but are not from the system's point of view.
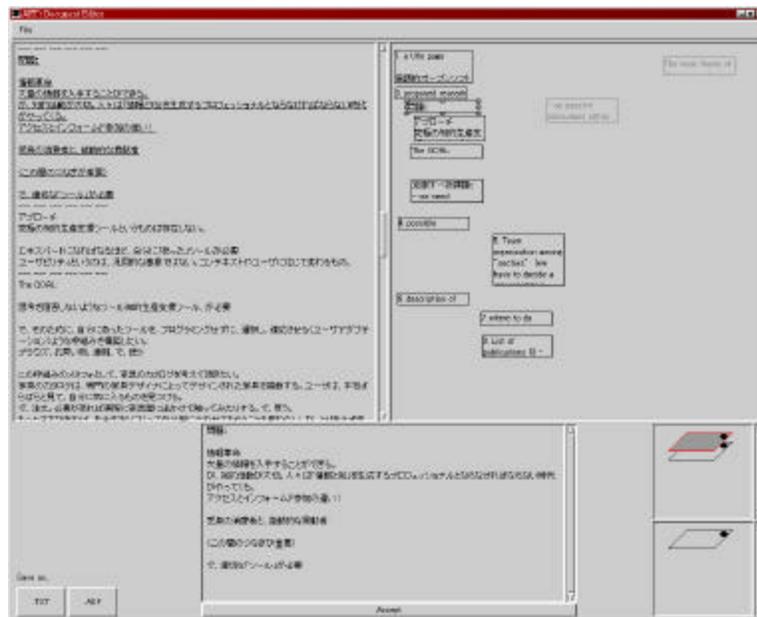

Figure 1: The ART-01 System

http://ccc.aist-nara.ac.jp/systems/art/

Figure 2: A Variety of Two-dimensional Positioning of Objects
Emerged During a Writing Task

Positioning objects in a two-dimensional space allows users to be engaged in reflection *in* and *on* action. During the process of positioning, continuously changing and emerging representations "talk back" to users allowing them to participate in reflection-*in*-action. Once objects are positioned, then users can read the two-dimensional spatial representation for understanding the current state and design rationale behind the design allowing them to perform the more detached reflection-*on*-action.

Figure 3 illustrates the ART-03 system (a.k.a. Time-ART), which is another application that also serves as design media for early stages of exploratory empirical video analysis tasks [Yamamoto et al. 2001]. Using ART-03, a user can position text chunks, images, cropped video segments, or sound segments freely in the space and resize those positioned objects as they like. The system provides a video/sound editor with which designers can easily crop an interesting segment and put the segment in a 2D space. ART-03 also provides multiple views; one view allows designers to classify objects into groups using different *depth*, and another view allows designers to understand which part of a movie/sound is cropped. Each object can be annotated with text and the system automatically produces a document by compiling objects and their associated annotations. The representations provided by ART-03 has been found useful to support early stages of a design task by neither requiring any unnecessary commitments nor obstructing designer's thinking processes, allowing a designer to interact with representations.

The name "ART" comes from an acronym of *Amplifying Representational Talkback*. *Representational Talkback* [Nakakoji et al. 1998] is a concept we have developed based on Schoen's design theory [1983], and is defined as: "perceptual feedback to the human designer from the externalized design artifact." Representational talkback is an intermediate situation that emerges during a design task. We focus on visual, perceptual representation rather than textual or cognitive representation that are symbolic and verbally expressible. Perceptual external representations
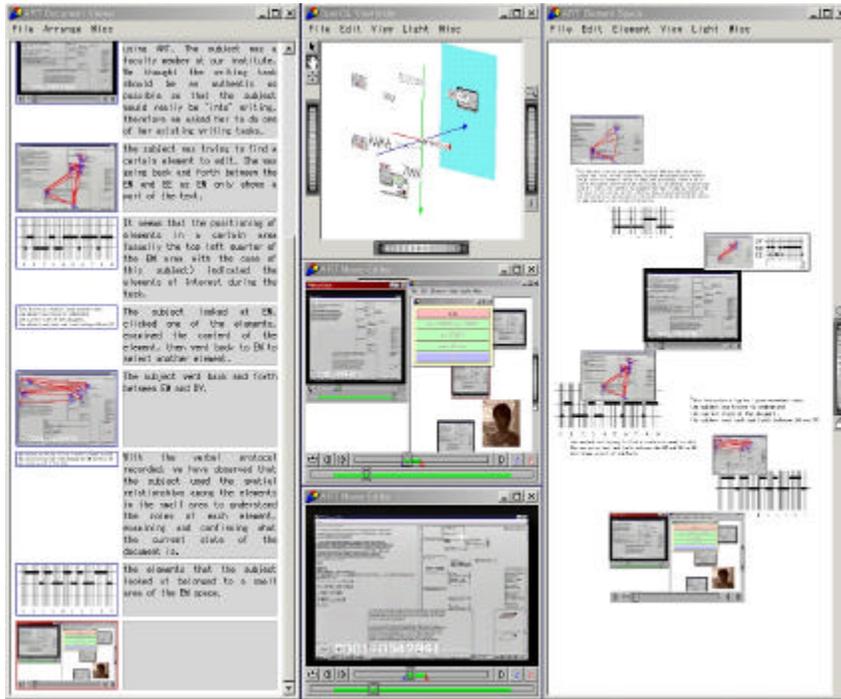
Figure 3: ART-03 for Exploratory Empirical Video Analysis Tasks

http://ccc.aist-nara.ac.jp/systems/Time-ART/

"provide information that can be directly perceived and used without being interpreted and formulated explicitly" [Zhang 1997], and external pictures (representations) can give people access to knowledge and skills that are unavailable from internal representations [Reisberg 1987].

We use spatial positioning as a medium for a user's externalization that helps him/her think. Different from many existing spatial hypertext systems, users of our ART systems are not necessarily interested in the structure emerging in the 2D spaces. They use those emerging structures only as externalizations useful in their intermediate thinking processes and not as final design artifacts. The users' goal is not to obtain the structure in the space. In ART systems, final artifact is represented in DocumentViewer, not in ElementSpace. Spatial positioning is a representation that serves for problems, not for solutions.

Currently we are expanding our ART approach to other domains with increasing emphases on multimedia. There has been little research on how intuitively one can represent a segmented movie or sound in a space. We will pursue these design challenges through our prototyping effort.

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