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Yasuhiro Yamamoto, Shingo Takada, Mark Gross , and
Kumiyo Nakakoji

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design machine group
University of Washington
Seattle WA USA 98195-5720
<http://depts.washington.edu/dmachine>

Representational Talkback: An Approach to Support Writing as Design

Yasuhiro Yamamoto[†] Shingo Takada[†] Mark Gross[‡] Kumiyo Nakakoji^{†*}

[†] Graduate School of Information Science, Nara Institute of Science and Technology
8916-5 Takayama, Ikoma, Nara 630-0101 Japan
{yasuhi-y, michigan, kumiyo}@is.aist-nara.ac.jp

[‡] College of Architecture and Planning, University of Colorado
Boulder CO 80309-0314 USA
mdg@cs.colorado.edu

* Information and Human Activity Group, PRESTO,
Japan Science and Technology Corporation

Abstract

Designing documents, such as writing a technical paper, manual or WWW home pages, starts with a goal in mind but often does not simply proceed in a top-down problem solving style. The document design process consists of a cycle of interpretation, modification and understanding. It requires both generating parts (words, sentences, and paragraphs) and structuring them while exploring what to write. Our research aims at supporting this collage or trial-and-error style of writing as design, drawing on the concepts of reflection in action and hermeneutics. We propose “representational talkback”, which is feedback from intermediate situations that emerge during writing. We postulate that by providing writers with appropriate representations to amplify this talkback, we enhance their writing process. This paper presents a theoretical framework of our approach and reports a user study using a prototype system ART (Amplifying Representational Talkback) to understand what types of talkback are necessary during writing and possible representations for them.

1. Introduction: Writing as Design

While computer-mediated communication now widely incorporates multimedia, text-based information remains essential. As more and more people have an opportunity to author and publish information, it is important to reconsider writing skill in light of new

technologies.

Writing style has changed in recent years as computer tools have come to be widely used in place of pen and paper. Writing often does not proceed as a top-down process where one first identifies a stable structure, then gradually elaborates it from chapter to section to paragraph to sentence. It is now easier to produce a collection of disassociated notes and cut-and-paste them to produce a coherent story using a word processor. The process should rather be viewed as a process of *design* where the writer alternately identifies structure and generates content.

Our approach addresses this issue by viewing writing as a design task. Design theory tells us that we can take advantage of the power of representations during the writing process. Making a representation of a design situation allows the designer to reflect on an intermediate state, and helps the designer decide how to proceed. To effectively support this process, we must understand what types of design situations writers encounter and how they reflect on them. Obtaining feedback from the design situation in writing is less intuitive than in design domains that use physical or graphical media. The writer must perform more complex cognitive tasks: not just looking but reading. We aim to amplify the feedback of textual representations using multimedia representation technologies and so make writing easier.

Writing—designing a document—is a complex cognitive task. During a document design process writers often experience problems, for example, dissatis-

faction and deadlock. In the beginning writers often do not know: what to write; how to relate information chunks; and how to organize the chunks into a coherent document. As writing proceeds, writers sometimes get stuck. They wonder whether: the writing is consistent as a unit; and one part is in balance with the rest of the document. As the written part increases, writers need to explore: what position the current part has in the whole structure; what parts need to be modified and how; and what has and has not yet been written.

We view writing, or document construction, as a design process and therefore apply two design theory models: reflection-in-action and hermeneutics.

The reflection-in-action theory of Donald Schön [8] stresses that designers do not pre-plan what to do during a design task. Instead, the designer acts on a situation, reflects on what he/she has done, and decides how to proceed based on the feedback obtained from the consequences of the action. For example, until one actually starts writing sentences, one cannot pre-plan exactly what words to use. Only when the writer looks at what one has written, can one decide what to write next.

Hermeneutics is the discipline of understanding and interpreting texts, such as the Bible. In understanding text, the parts and the whole are mutually dependent. The parts must be read in the context of the whole; and the meaning of the whole consists in the meaning of the parts. For example, in comprehending a sentence, the meaning of each word is not determined until the context of the sentence is clear, and (conversely) the meaning of a sentence cannot be fully understood until the meaning of each word is fixed. Snodgrass and Coyne [9] view design as a hermeneutic process.

Based on these ideas, we propose *Representational Talkback* which is feedback from intermediate situations that emerge during design—in this case writing. By providing writers with appropriate representations to amplify this talkback, we can enhance their writing process. We call our approach the ART (Amplifying Representational Talkback) approach.

In order to understand what types of talkback are necessary and possible representations for them, we have conducted a user study using a prototype system. The following section begins with a brief overview of writing process theories and discusses implications for computer support. Section 3 proposes the key concept of Representational Talkback. We focus on what types of meta-comments people use as they construct documents; we refer to these meta-comments as the design situation's talkback. Section 4 reports on a pilot study of people's writing styles using a prototype called the ART (Amplifying Representational Talkback) system.

Section 5 makes concluding remarks.

2. A Writing Process

Cognitive tools, which help people to perform cognitive tasks, also affect how people think [7]. A system supporting document construction therefore requires the consideration of human thinking processes in writing. Studies of writing process have been conducted mainly in psychology, where various models are proposed [3].

2.1. Related Work on Writing Process

Kintsch and van Dijk [4] suggest that a writing process consists of production, where writers create information, and transformation, where writers change the order of information chunks, describe the structure, replace words and change viewpoints. They point out that information they call *meta-comments* which do not directly relate to the document content but which do pertain to the state of the document and its structure, play an important role during writing. Hayes and Flower [2] suggest that a writing process consists of planning, translating and reviewing. The planning process has sub-activities: planning, generating and revising. These sub-activities take place iteratively on various levels of granularity (words, sentences and paragraphs). Neuwirth et al. [5] suggests that four processes constitute a writing process: knowledge acquisition; exploration of possible viewpoints; identification of structures; and selection and location of the content.

Based on these theories, Hunter and Begoray [3] suggest that writing cannot be characterized as a single model but rather one with complex inter-related sub-processes. They propose four tasks: generation, organization, composition, and revision. Generation means coming up with new ideas; organization means deciding about structure; composition means producing sentences out of the structure; and revision means modifying the document.

2.2. Toward Computer Support

The writing process models outlined above suggest that two tasks alternate repetitively—the expressive task of writing and the reflective task of considering what to write. Current computer tools for writing support one or the other but not both. A word processor, for example, enables a user to actually type a document. But it does not support the user in producing ideas. An idea processor, on the other hand, helps a

user to organize concepts but it does not support the production of a document. Yet the above models suggest that these two activities are inseparable. It is thus important to support both activities in the same framework so that writers can move smoothly back and forth without cognitive disruption.

Document construction consists of a cycle of understanding what to write, externalizing it, and interpreting its result or effect. Most existing tools for document construction give priority to externalization and place little emphasis on understanding and interpretation. For example, when using a tool that provides an outline mode to support interpretation, users can easily lose their train of thought when they change from one mode to another. The tools make it difficult to shift from externalization to interpretation.

During writing, writers read to reflect on what they have written so far. In the beginning, though, they devote more effort and attention to actually producing text, and less to reading. Toward the end, they spend more time reading what they have written and only a little time writing. Finally, when they complete the writing task, only reading takes place.

A study by Noda et al. [6] shows that people gain a better understanding when they are allowed to place document chunks in a two-dimensional space. They found that when subjects read a newspaper article with intentionally jumbled paragraphs, they typically used spatial information to make sense of the content. Subjects who were allowed to use visual cues scored better in a post-experiment quiz about the content of the document than subjects who were not allowed to organize sentences spatially on a screen but were only allowed to read the article from the top to bottom. Thus people can use spatial cues as a meta-comment to help understand the content of text.

Conventionally, typesetters use visual cues to increase the readability of a document. For example, a large bold font indicates a document title. Indentation stresses the beginning of a paragraph, or distinguishes quotations from the text. These visual cues, however, are mainly for readers. Why not support the writing process by providing writing-process-specific visual cues?

3. Representational Talkback

3.1. Definition

To provide users with a view of the interdependence of the whole and the parts of document, we propose the concept of *Representational Talkback*. Representational Talkback, based on Schön's design theory [8], is

defined as:

Feedback to the human designer from the externalized design artifact.

Reflection on an artifact is based on this feedback and leads the designer to the next action (what to externalize next). For example, after making a conceptual sketch of a floor plan, an architect may see certain problems or opportunities; this in turn suggests a next round of drawing.

With respect to the domain of writing, the following two points should be considered. First, while Representational Talkback in a design domain with inherently spatial information (e.g., architectural design) can be obtained by visual inspection of the design artifact (the drawing), a written document requires the additional cognitive effort of reading to obtain Representational Talkback. For example, in Figure 1 (a) which indicates a furniture arrangement, it is clear that the door will collide with a piece of furniture. By contrast, the sentences in Figure 1 (c), which do not connect logically, are not obviously absurd until people read them and understand their content.

Second, as Figure 1 (b) shows, in a drawing one can use graphical means to represent a meta-comment, for example by sketching one element more crudely than other more precisely drawn elements. In writing, on the other hand, you cannot represent the level of completeness or the level of commitment explicitly without actually typing in a comment to the effect that the document is not yet complete. But adding these comments disturbs the smooth writing process and distracts the writer.

3.2. Talkback types

The meta-comments of representational talkback refer to observations about the structure and organization, not the content of the document. We can identify two different types of observations: subjective observations that the writer makes about the document, and objective observations that the writing support tool can make. For example, the former include meta-comments about the goals of parts of the document ("explain history of cognitive science"), missing sections ("add section on computational models here"), or indications about sureness or level of commitment ("not sure we should include this..." or "rough draft. tighten."). The latter include information about the document that may be useful to the writer, but is not immediately obvious by inspection. For example, objective meta-comments include the lengths of existing sections, the author (in the case of multiple collaborating authors), or the change history of a section.

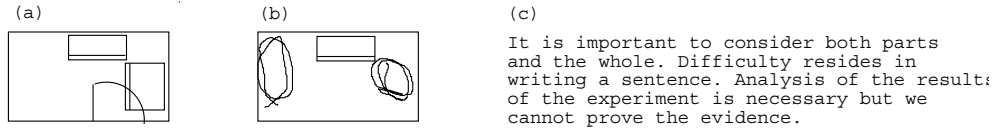


Figure 1. Representational Talkback: (a) the drawing reveals a problem; (b) the sketchy drawing reveals a lower level of sureness; and (c) in writing, more effort is needed to see the problem.

A good example of representational talkback of objective observations is the scrollbar in a Windows system (see Figure 2). The size of a scrollbar handle indicates the location of the displayed portion of a document with respect to the whole document. At the same time, the size of the “handle” indicates the ratio of the size of the displayed area to that of the whole document. A small handle indicates that the document is large. The Macintosh window system, on the other hand, lacks this representational talkback. The size of the handle remains the same regardless of the document size. When the window displays the top portion of the document, for example, the handle appears the same whether the document is just a little larger than the window size, or twenty times bigger.

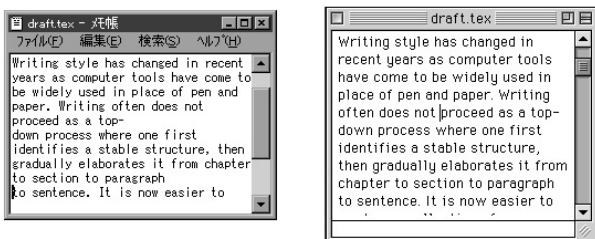


Figure 2. Representational Talkback: The Windows scrollbar handle (left) indicates the size of the document; the Macintosh version (right) does not.

A variety of media choices are available for displaying representational talkback. These include position on the page (or screen) of chunks of text both vertically and horizontally, as well as typeface, color, transparency, and other familiar typographic devices. To make effective use of the ART approach, users of a document construction system must adopt conventions for mapping meta-comment meanings to representational media. For example, the writer might decide to indicate missing sections of text by leaving blank space

in the document; to indicate level of hierarchy by indenting text; and to indicate level of commitment by the color of the text.

4. Writing with The ART System: A User Study

To design a system to support writing as design based on the above ideas, we need a better understanding of what types of meta-comments emerge, what types of feedback are needed during writing, and what representations might serve as Representational Talkback for such meta-comments. To study this, we have built the ART (Amplifying Representational Talkback) system (see Figure 3) as a test-bed to observe people’s writing processes and explore the potential of computer systems to support representational talkback.

This section first gives a brief description of ART, followed by a report on a user study we conducted with three subjects using ART.

4.1. The ART System

ART is a document design assistant developed in Smalltalk (VisualWorks 2.5J), that supports document construction as a design task [10]. The goal of ART is to explore how amplifying Representational Talkback of the document might support writers. ART aims to enable users to map the feedback they need onto available multimedia representations. For example, if users wish to indicate a level of completeness for each paragraph, they can map that information to color or horizontal position. As we built ART to study people’s writing processes, the current implementation is based on minimalist design principles [1]; by providing minimal functionality ART aims to avoid disturbing users’ thinking.

The ART system handles a part of a document, or a document chunk, as an *element*. An element is any unit that writers choose to think of as one; an element may be a phrase, a sentence, a paragraph, or a longer piece of text.

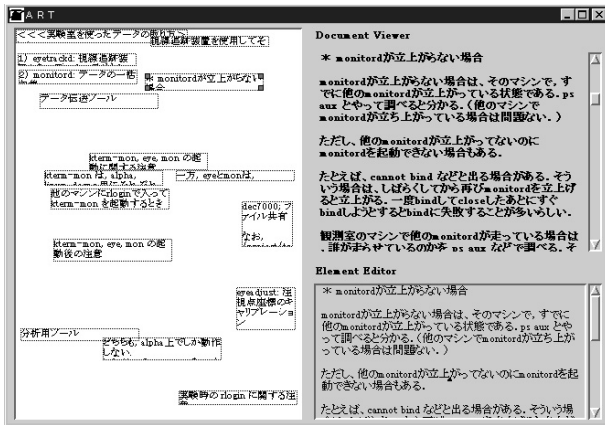


Figure 3. The ART System — left: ElementsMap; top right: DocumentViewer; bottom right: ElementEditor.

The ART system consists of the following three components:

1. ElementsMap ... This component graphically displays elements that comprise the document. The entire content of an element is not displayed, only the first two percent of the element's text. An element's vertical position in the ElementsMap corresponds to its position in the document sequence. Users can freely change the order of elements in the whole document by changing the vertical relationship of elements in ElementsMap. Users can also merge multiple elements into one. The size of the element box corresponds to the size of the actual element (unless a user resizes the box) and thus this also provides a meta-comment about the element size.
2. ElementEditor ... This component is a text editor for the contents of the currently focused element. Providing editing functions such as cut, copy, paste, the ElementEditor makes it possible to divide one element into two using the "spin off" command. Changes made here are automatically reflected in the ElementsMap and the DocumentViewer.
3. DocumentViewer ... This component displays the whole document allowing users to look at details of other elements. It displays the actual content of the document by sequentially scanning the elements displayed in the ElementsMap from top to bottom. When users select an element in the

ElementsMap, the corresponding element is highlighted in the DocumentViewer.

These components provide respectively: an overview of the whole in terms of the structure of parts, details of a part, and the context of the part with details of neighbourhood elements.

4.2. Overview of A User Study

The user study consisted of three subjects modifying a document that concerned the usage of instruments in a laboratory located at our institution. The document was a collection of notes with no coherent structure. The subjects were each instructed to refine the document in turn.

The subjects were researchers at a university information sciences department. They had spent several hours using ART prior to the study so they were familiar with its functionality. They had not seen the target document before the study.

The first subject took the document and restructured it using ART. The entire document was initially given as one element. The subject restructured the document by splitting the document into smaller elements and changing the order of the elements to make the story flow better, but was not allowed to make any changes to the text.

The second and third subjects took the document produced by the first subject and refined it using ART with actual text editing with two slightly different initial conditions. The second subject received the exact document produced by the first subject, including the split-up elements and a two-dimensional visual representation of the elements in the ElementsMap. The third subject, on the other hand, received the document as only one element. Thus, the second subject was given spatial information in the ElementsMap produced by the first subject, while the third subject was not.

The subjects were instructed to spend about an hour on their tasks until they felt that they had finished their task. The first, second and third subject spent sixty, seventy, and sixty-five minutes, respectively on their tasks. We collected two types of data: (1) 8mm video recording of the computer screen and the subject's verbalized thoughts; and (2) post-task interview.

4.3. Meta-Comments and Uses of Representational Talkback

This section describes meta-comments that emerged during the document design task and the ways that the subjects used the representational media available in

ART. All three subjects made heavy use of elements in ElementsMap. The first and third subjects started by segmenting the document into elements and gradually restructured them. In contrast, the second subject who was given the already structured elements in ElementsMap made by the first subject, gradually merged elements as he refined the document.

Interestingly, not all the subjects used the positional information of elements in ElementsMap in the same manner, and their usage changed during the task sessions. During the first ten or fifteen minutes the first and third subjects mainly segmented the document into elements. They positioned elements almost randomly as they defined a chunk of the document and “split it out” as a new element. As the task proceeded, the first subject started left-aligning elements at the same level of granularity (titles, chapters and sections). The third subject, on the other hand, never aligned elements but only maintained the vertical relationship.

In what follows, we summarize “meta-comments” we observed from the subjects’ behavior and their protocol and how they mapped the meta-comments to representational information in ElementsMap.

- chunking information as a unit: All of the subjects segmented the document into elements even though they were not explicitly told to do so. For example, the third subject scanned the document for a keyword (e.g., “monitor”), and observed that the last couple of paragraphs “*are very different from the other parts.*” He then split out the paragraphs as one element and placed it at the bottom of the Element Map. Then, he browsed up the document again scanning for another keyword and identified another chunk. He repeated this process several times until he reached the top. As noted above, he basically placed each element randomly in the ElementsMap maintaining only the ordering relationship; he did not care whether they were aligned to the left or right, or aligned at all.
- annotating the content of an element: The second subject encountered several questionable statements in the original document, and he wanted to annotate them. He produced new elements as “commentary elements.” As a convention he put a commentary element to the right of the original text. When he wanted to comment on only a part of the content of an element, he wrote the comment directly within the element.
- representing unsureness: The subjects used a variety of ways to represent *I am not sure yet about this*. The first subject put elements that she was

not sure about at the bottom right corner of the ElementsMap. She also distinguished those unsure elements from completed elements by left-aligning completed elements. The second subject used a similar strategy, as he resized completed elements to the same size, while he widened elements that he wanted to revisit.

- representing relationships among elements: All the subjects placed an element close to another element if they thought they were related to each other. In some cases subjects overlapped two elements if they thought they were related but were unsure exactly how. When the subjects were sure how two elements related logically, they never overlapped those elements but placed them one next to the other.
- representing logical relationship: The first subject wanted to represent that *these two are alternatives* and placed the two elements horizontally, top-aligned. Interestingly, she also aligned three elements the same way to represent *these are three things you need to do*. She assigned different logical meanings to the same configuration of elements.
- understanding the current progress: The subject used a variety of visual information to understand their progress in their tasks: the size of the element they were working with, how many elements were scattered or organized in ElementsMap, and the number of elements in ElementsMap.
- understanding the current context: The subject often got lost. “*Where was I?*”, “*oops, where does this come from*”, “*the chunk I was dealing with had disappeared*” in the transcripts corresponds to when the subjects had obviously lost their current context. With ART, the subjects were unable to maintain the context when manipulating different elements.
- hiding completed parts: The first and third subject wanted to hide the elements that they felt they completed because “*I am done with these and I do not want to see them anymore.*” We were not sure if they wanted to collapse elements because the window size of the ElementsMap was too small. In the post study interview, however, both subjects stated that they needed the collapsing or hiding functionality regardless of the size of the ElementsMap. They just wanted to “hide” information irrelevant to the current task at hand. The ART system could not support users in representing this meta-comment.

- representing comments on the relationships among elements: All the subjects often reflected on what they constructed in ElementsMap as the structure of documents started emerging. For example, when the first subject placed an element in ElementsMap, he often traced existing elements in the structure with a mouse, and expressed relations among the elements: “okay, so this is about ‘monitord,’ and then this is about ‘eyetrackd’ ...” or “these are alternatives, ... right.” They wanted to comment on the structure, or relationships among elements, or how sure they were about the structure. One subject wanted to have (a functionality) *something like an on-line footnote*. The current version of ART did not allow users to represent this information.

In summary, the subjects used the structure of elements in the ElementsMap while editing the contents of an element, suggesting that they depended on both the content information and structure information, following the hermeneutic circle. The simple two-dimensional space of ElementsMap allowed the subjects to represent quite a few types of meta-comments. There was no coherent mapping between the kind of meta-comments and representational types, not only among the subjects but even within a subject. The subjects were good at associating and interpreting multiple meanings to a single configuration (e.g., horizontal top alignment) in different contexts.

Based on the study, we identified that the current functionality of ART does not support users in (1) understanding the current context, (2) hiding completed parts, and (3) representing comments on the relationships among elements. To cope with the problems, we are now redesigning ART to incorporate:

- a history mechanism to allow users to return to a previous context,
- a tracing paper mechanism which would allow users to group some elements and copy them to another layer of tracing paper to control the visibility of each element. This would also allow users to make changes to a document in an exploratory manner.
- an annotation mechanism to allow users to make explicit the structure of elements in the ElementsMap.

5. Conclusion

Widespread use of computer tools such as word processors has given rise to new, collage-like, writing

styles. To match the thinking process in this new writing style, the ART approach supports an integrated writing process including not only downstream externalization of text but also upstream understanding and interpretation. ART supports the writing process by amplifying Representational Talkback, casting document construction as design.

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