A Cost Structure Analysis of Manual and Computer-supported Sensemaking Behavior

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Abstract

We have studied the effects of different kinds of analytic tools on the behavior of people doing rapid large-volume data assessment, analysis and organization. The studies reported here contrast the micro-structure details of automated clustering techniques, the use of standard timeline and cluster visualization methods in comparison to desktop paper sorting and piling. This analysis shows that the lack of expressiveness and responsiveness in current interface designs dramatically limits human performance, suggesting ways in which the next generation of analytic tools must evolve in order to be useful for large volume / complex analysis tasks.

1. Introduction

Sensemaking for analysis tasks can be seen as the process of creating a representation of a large volume of information that allows the analyst to perceive structure, form and content within a given corpus. This kind of task—large corpus understanding—is a fairly typical analysis task in a number of intelligence and business settings. We are especially interested in what people do when faced with sensemaking tasks that use large document collections: such tasks seem to be central to many kinds of intelligence analysis tasks in both governmental and business domains.

When people need to rapidly make sense of a large document collection they usually begin by skimming the documents and organizing the collection into temporary groups (clusters). In this study we contrast the time and effort subjects put into sensemaking of document collections for both manual manipulations of physical documents and when using online clustering tools.

A common assumption is that almost any kind of automated assistance will improve human performance. We began this series of studies with this naïve assumption as well [Slaney]. We expected visualization tools and automatic clustering to help, but they didn't in every case. Why?

## 2 Uses of Paper- & e-Clusters

In a new study we observed how subjects performed a less structured task: reading, organizing, and preparing a presentation about a collection of documents. We wanted to understand the differences between the paper and the electronic presentations. We videotaped 10 subjects performing a task and measured their sensemaking costs.

We studied subjects using paper and two different electronic systems: eClassifier [Spangler, 2002] and SSIGS [Qu, 2003]. eClassifier is a commercial product that automatically clusters documents based on their semantic contents and then displays the organized documents in a set of flat clusters. SSIGS is a similar research tool that was designed to support the sensemaking task by providing a framework for organizing searches and their results. In all cases subjects saw 100 newswire articles from the city Baku.

The interaction techniques were quite different between the paper and the eClassifier or SSIGS. Figures 1 and 2 captures some of these differences: documents could be moved easily and rapidly into piles, document summaries could be browsed much more quickly with the tooltip rollover technique. Using the video of subject behavior we created during each test, we analyzed the actions of our subjects, measuring how long different activities took, and how often they were performed.

Most striking is how much easier some activities are than others, and how this changed people's behavior. In the paper case, opening a document (picking it up from a pile of paper) is easier than with either electronic tool. This low cost / high ease of use is likely the reason that subjects read more articles on paper than they do electronically. Subjects read more when they can access more of a document more quickly.

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[1] Currently at the University of Michigan
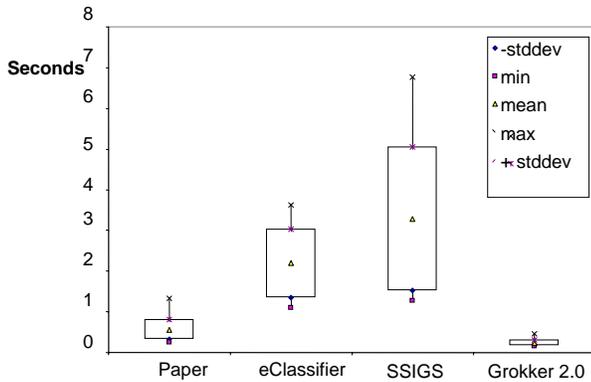
Skim Count:		136	218	197	
Read Count:	125	29	32	41	

Figure 1. Time to read a new document in the paper setting, and to open a new document in electronic systems.

After selecting a document, electronic tools display the full document to the user. The counts below the graph show the number of documents that are skimmed (by looking at the title summary in eClassifier and SSIGS, or the tooltip in Grokker), and the number of documents where the full article is displayed.
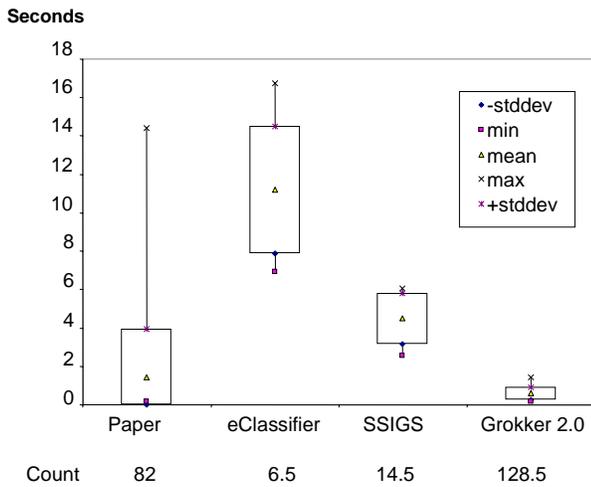
Count	82	6.5	14.5	128.5

Figure 2. Time to move a new document and (on line below) the number of times a document was moved into a cluster in each of the four different studies.

3 Redesign of Grokker

In response to our subjects difficulties in the original studies, we re-designed the original application (Grokker1) to reduce the cost of operations in which paper was faster and simpler.

Grokker2 has four major changes to facilitate direct manipulation of the documents compared to the original tool: (1) Small iconic buttons have been replaced with larger buttons that contain the first few words from the article's title to give a sense for the document's content. (2) Users can quickly drag an icon anywhere on the screen: either to remove a document from consideration, or quickly sorting a document into a new pile. (3) Users can add text to the display to label the piles or organize their work. Finally, (4) we improved the formatting of the tooltip article display to make it easier for subjects to grasp the article's content at a glance.

As shown in the figures, the changes in behavior were dramatic. Subjects moved significantly many more documents with Grokker2 than they did even with paper. More interestingly, even though the time to access the full document was as fast as paper, if not faster, subjects were content to use the short summaries that were provided on average 197 times and only read the full article 41 times. The tooltip summaries were judged to be more useful by subjects since they were often content to read the just summaries, even though bringing up the full document was faster than paper.

3.   Conclusions

It became strikingly clear that the cost structure of paper documents and pile use has several key points: the time cost of directly accessing the contents of a document, the time cost of creating an informal (but highly useful) cluster, and the time cost of assessing an existing cluster. Small changes in the time properties of these actions can cause dramatic effects in the ability of a user to see, manage and understand the corpus.

As Gray [2004] has shown, even milliseconds matter when it comes to making tradeoffs between choosing to look for information available on the desktop or to access an internal memory. When faced with many thousands of milliseconds difference in the interface designs of our tools, we find huge differences in the number of documents seen and understood by the subjects.

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