SESSION VI

USING COMPUTERS IN WRITING AND PUBLISHING

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Using a real-time replay of students' word processing to understand and promote better writing

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Research on the psychology of writing is difficult because the writing process is not as easy to study as is the written product. The software described in this paper, Real-Time Replay, provides access to the writing process by capturing all writer keystrokes and replaying them in real-time. Point of utterance revisions can be viewed at once by the writer, who can then provide an immediate, retrospective protocol of the process. In this paper, the main features of the replay software are described, along with an accompanying program for collecting descriptive statistics on written documents.

The writing process is inherently difficult to study, because it is not as accessible as the written product. However, the microcomputer can provide a unique way to reveal the writing process as it unfolds in time. This paper is about taking full advantage of the computer as an unobtrusive recorder of writer-machine interaction. By recording and then replaying a writer's keystrokes in real-time, both researcher and student can watch a recreation of the writing process exactly as it has occurred at the point of utterance. In capturing this record, the microcomputer can uniquely serve as both a research tool and an instructional aid.

Most educational and research applications of computer software in writing have emphasized such areas as computer-assisted writing instruction (e.g., *Writer's Helper Stage II*, by Wresch, 1988), style and grammar checking systems (e.g., *RightWriter*, 1988), and idea generators (e.g., *INVENT*; see Burns, 1984). The program introduced in this paper, called Real-Time Replay, provides a new research opportunity in the area of instructional computing and the psychology of writing.

Both Real-Time Replay and Keystats were programmed in the C language by Mike Emerson, who is a computer science graduate student at the University of Maine. Correspondence, including requests for information about acquiring either program, should be addressed to Sarah Ransdell, Department of Psychology, 301 Little Hall, University of Maine, Orono, ME 04469.

How Real-Time Replay Works

The idea for the Replay software actually came from several sources. Some commercial word processing packages such as *XyWrite III Plus* (1989) offer the option of keystroke capture through creation of a macro in the software's own programming language. The software package *EVENTLOG* (Hendersen, 1987) functions as a tool for recording real-time events and is intended primarily for researchers who score and record observational data. A program developed at the University of Minnesota (Sirc & Bridwell-Bowles, 1988) also captures keystrokes and works with MicroPro International's *WordStar* word processing program. Their program, called *Recording WordStar*, has primarily been used as an instructional aid and not as a research tool.

The replay program described here has the advantage of working with any software. Real-Time Replay simply captures characters in the PC's keyboard buffer before they are used by a software application. The program records both command keystrokes and ordinary characters and stores the time since the beginning of the session along with the character. The program takes advantage of the IBM PC and compatibles' built-in clock to record the timing of keystrokes.

The software is loaded into memory after one loads the operating system but before one loads an application; it stays resident unless the system is rebooted. A pop-up

menu with options to start, stop, print, replay, or erase the buffer is accessible by a control sequence.

Once Real-Time Replay is loaded, any word processing package that uses ASCII character sets can be loaded and used. The program stays hidden, and the user can switch applications, exit to DOS, or send files to a peripheral device without interruption. In the replay, the screen appears exactly as it did in the original recording session, with the same specific application prompts and screen characteristics.

Additional Descriptive Information Made Possible by Replay

An accompanying program called Keystats is used to collect descriptive statistics that are useful for analyzing writer-machine interaction. Keystats takes a Replay file and produces several mappings of the writing process. These options include: (1) the printing of all keystrokes made, including those that do not show up in the final product, such as revisions and control characters; (2) the printing of all keystrokes on a time-line, such that every line in the printout presents 16 sec of data and hash marks further delineate 1-sec writing periods; (3) the printing of key counts and percentages of all characters, including control characters and function keys; and (4) the sending of Keystats' output to a file rather than to a printer.

Keystats can be used to support information obtained from viewing a replay. Since it provides a permanent record of what characters were typed and how often, it can be used to determine, for example, the relative frequency with which writers use certain function keys, or what sequences writers use most often when they delete or add text, or simply reread a document. Keystats can also be used to note when writers are most likely to revise their work; that is, are most substantive changes occurring early in the process, or are they occurring only later, after a draft of the entire text has been created? Keystats complements Real-Time Replay in that it provides essentially the same information about the writing process, but at a glance, rather than as it unfolds in time.

Research Applications:

The Use of Retrospective Protocols

Writing research has seen recent increased interest among researchers in many disciplines. From the cognitive psychology tradition, the use of concurrent verbal protocol analysis has been pioneered by Hayes and Flowers (1983). This type of analysis involves asking writers to "say whatever comes into their minds" while writing. Although many who have embraced this approach have uncovered rich data about the processes of planning and revision, some others would argue that concurrent reports intrude and potentially change the nature of the composing process (Cooper & Holzman, 1983). Compelling arguments against using the less obtrusive retrospective report (Tomlinson, 1984) have precluded their use as a viable alternative to concurrent reports, since they are post hoc and prone to memory distortions.

The replay program suggested here offers an alternative to concurrent reports. It is completely unobtrusive, on the one hand; on the other, it permits the immediate viewing of the writer's work in real-time. Verbal reports based on such viewing are not impeded by memory loss and lack of stimulus input from the original writing process as much as traditional retrospective protocols are.

Other Ways of Using Real-Time Replay for Research

In addition to playing back the writing process for retrospective verbal protocols, Replay can also be used to analyze the impact of point-of-utterance revision processes. For example, it has been suggested that writers revise more when word processing than when handwriting (Lutz, 1987). It is important, however, to be able to determine whether such revisions actually change the content of what is being written or whether they merely change the surface structure of the text. Real-Time Replay can aid decisions about the types of revisions common during writing by providing direct observation of each revision and its effect on the meaning of the document.

Both Replay and Keystats have many possible applications that involve understanding the temporal aspects of the writing process. Past research, such as that by Gould (1980) and Matsushashi (1981, 1982), has relied on videotaping writers and then sampling tapes at various time intervals to measure such variables as pause duration and writing rate. Clearly this method is more cumbersome, although it should ultimately yield similar, though perhaps less precise, information.

Instructional Applications

In addition to the Replay program's potential for revealing the cognitive processes involved in writing, it may also provide insight for composition instructors and students. This insight may include such things as where writing blocks occur, where and when hesitations cause transition difficulties, and the extent of the use of deletions, substitutions, and insertions (Sirc & Bridwell-Bowles, 1988).

With Replay, writers can not only determine the fluency of their writing and the types of adjustments to the text they make most often, but also discover how they make use of the software. A real-time replay may be useful in conjunction with available courseware for writing instruction by providing a learning road-map. In other words, how does the student traverse the maze of functions available in a newly learned word processing package?

The perspicacious composition instructor can also use this information to understand how quickly students are mastering the more powerful functions within a word processor. For example, is the student deleting one character at a time to remove paragraphs of text? How often does the student move large portions of text within the document? Does the student need some typing instruction or practice? Questions asked about the writer-machine interaction can be driven by instructor and student as they watch and analyze the replay together.

Conclusions

Butler (1988) has stressed the importance of identifying and selecting courseware that can accomplish a particular task. If the task is to uncover how students write, then Real-Time Replay can provide valuable information about the processes involved.

Word processing has become a method of choice for many student writers. As more microcomputers are utilized in writing labs across the country, the importance of mapping the writing process in real-time will become increasingly auspicious, and in fact, accessible, through programs like Real-Time Replay.

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