

**How are Windows Used?
Some Notes on Creating an Empirically-
Based Windowing Benchmark Task**

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ABSTRACT

Users of a windowing system were studied for the purpose of creating an empirically based windowing benchmark. Each filled out a paper questionnaire that sampled subjective opinions of windowing commands, and were observed for approximately 22 minutes while performing typical daily activities on the computer. Subjects were also asked to demonstrate a typical log-on procedure and were personally interviewed. Windowing command frequencies, and screen layout characteristics were collected and analyzed. The data revealed a relatively high use of a small number of commands that were primarily concerned with moving between windows. This study enabled the creation of a more accurate windowing benchmark task.

1. INTRODUCTION

Benchmarking has been used to compare computer speed and accuracy for more than 20 years (Lewis and Crews, 1985), but it has only recently been applied to the assessment of the human/computer interface. In this respect, benchmarking is simply the process of determining the performance of an appropriate sample of users on a standard set of tasks. Specifically, one is concerned with how well users perform the required tasks given a particular interface. The most notable application was that of Roberts (1979), and Roberts and Moran (1983) for their use of benchmarking to evaluate the performance and functionality of text editors. Borenstein (1985) provides a useful assessment of the Roberts and Moran methodology and gives some guidelines for suggested improvements. Benchmarks have also been successfully used to evaluate other aspects of the user interface. For example, Whiteside, Jones, Levy, and Wixon (1985) used a file manipulation task developed by Magers (1983) to evaluate performance on 7 different interfaces.

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To be an effective design aid, a benchmark must extrapolate well to the tasks that are being performed in the work setting. The more accurately a benchmark resembles the real world environment, the better its predictions of real world performance. This report describes the collection of windowing usage data that were used in the creation of an empirically-based windowing benchmark task. Due to space limitations, readers are referred to Gaylin (1985) for the actual benchmark tasks and a more detailed discussion of their creation and use.

2. METHOD

2.1 Subjects

Nine experienced computer users participated in the study. All subjects were Digital Equipment Corporation employees using a workstation with windowing capabilities. Four other subjects volunteered to participate but were rejected because they did not use the windowing capabilities of the system. One of the nine subjects stated that he was not a regular user of windows. Subjective ratings of the mean number of hours per day spent actively working on the computer was 5.6 hours (standard deviation = 1.7 hours) with a low of 3.0 and a high of 8.0 hours. Eight of the nine subjects stated that their primary duties centered around computer programming, the one exception being a technical writer involved with the construction of user manuals.

2.2 Equipment

The windowing workstation consisted of a large, high resolution, bit-mapped video display unit (VDU), a mouse, and keyboard. The major windowing capabilities of the system included:

- Creating windows
- Deleting windows
- Moving windows
- Attaching the keyboard to a window
- Popping windows to the front
- Pushing windows to the back
- Resizing windows
- Printing windows

2.3 Procedure

All subjects were videotaped in their own office at a prearranged time. Before starting, subjects were required to read and sign a statement of informed consent, and a photographic release form.

They were then given a questionnaire which asked them to rate a number of windowing commands on several parameters.

The video equipment was set up in back of the subject and to their left or right side to maintain a clear view of the VDU. Videotaping began upon the completion of the paper survey and lasted approximately 22.5 minutes (the length of one videotape). Subjects were asked to do typical daily work at the terminal and ignore the presence of the experimenter as best as possible. Videotaping was stopped during telephone calls or interruptions from other employees.

At the end of the observation period subjects were interviewed for approximately 10 - 15 minutes. Each was asked a similar set of questions regarding their use of windows. Subjects were also asked to demonstrate how they typically log-on to the computer and set up their screen. Total participation time for each subject was approximately one hour. Videotapes were later reviewed to determine the type and frequency of command use.

3. RESULTS

3.1 Observation Period Results

Windowing command frequencies were totaled across all subjects and are depicted in Figure 1. A total of 254 window related commands were observed across the 9 subjects. The most frequently used command was "cycling through the windows" which used a function key to attach the keyboard to a window, or bring a particular window to the forefront. Two other methods could have also been used to achieve these results. These were a "mouse activated pop" which required the user to place a mouse controlled "arrow" icon inside the border of the desired window and depress a mouse key, and a "menu activated pop" which was activated by selecting a menu icon located in the upper left corner of the desired window, and then selecting the option to pop the widow in front of other windows. When these three methods were summed they accounted for 59.5 percent of the total windowing commands used. Switching between split screen edit sessions (or edit buffers) was also logged because of its similarity to switching between windows and accounted for 3.5 percent of the commands used. When added to the above categories, the number of commands used to switch the active work area climbed to 63.0 percent. Thus most of the windowing commands involved switching between windows as opposed to the creation, deletion, or manipulation of window size and location on the VDU.

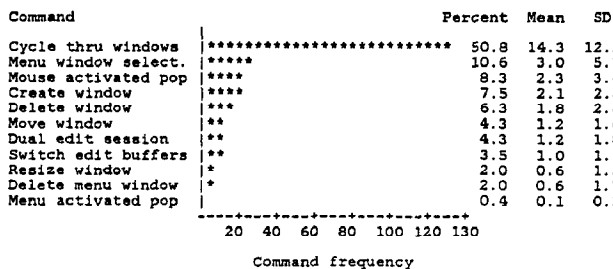


Figure 1. Observed window command frequencies

Figure 1 also shows the mean and standard deviation for commands used in the 22.5 minute period. In all but one instance the standard deviations exceeded the means, indicating a large amount of variation of command use between subjects.

In addition to window commands, data were collected on the amount and type of windows used and is shown in Figure 2. ALL WINDOWS refers to any type of window used, with the exclusion of menu windows. The other categories are a subset of this category. GENERAL PURPOSE windows were regular windows that were used for a variety of purposes. INFORMATIONAL windows were any that were used for status information such as the current directory or file being edited. A CLOCK WINDOW was fairly popular among users and usually contained a small (4 cm. x 4 cm.) clock with an analog display. An INACTIVE WINDOW was any general purpose window that was either reduced to the size of an icon or saved on the screen for use if necessary, but was not being actively used.

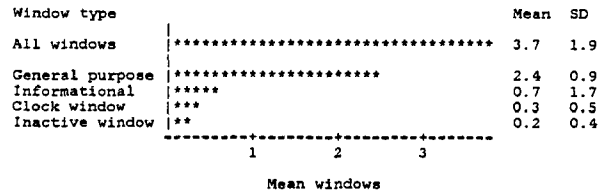


Figure 2. Mean number of windows used in the 22.5 minute observation period

All frequency counts, which were the basis for these means, were a measure of the maximum number of windows present at one time during the 22.5 minute observation period. In actuality then, these values will be somewhat inflated because not all persons maintained the maximum number of windows on the VDU for their entire observation period. However, most of the subjects maintained relatively stable amounts of windows throughout the observation period.

From the data it can be seen that there was a mean of 3.7 windows maintained on each VDU, with 2.4 being GENERAL PURPOSE windows. Standard deviations for all categories are again high, indicating a large amount of variation of the number of windows used between subjects. The CLOCK WINDOW category is the result of three persons using one clock window each and the INACTIVE WINDOW category results from two persons, each having one inactive window. The INFORMATIONAL window category resulted from one person using five, and a second person using one informational window.

Subjective responses (collected in the paper survey) pertaining to the average, as well as the minimum and maximum number of windows typically used while working on the computer are shown in Figure 3. In general, subjects rated using an average of a little less than 3 windows, with a mean maximum of

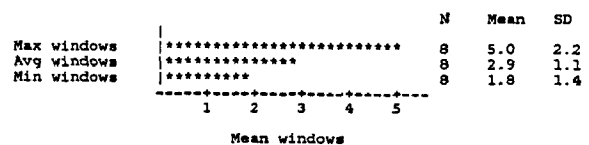


Figure 3. Subjective assessment of the amounts of windows used

5, and a mean minimum of 1.8 windows.

3.2 Observed Log-on Commands

Observation of log-on procedures revealed the command frequencies shown in Figure 4. The log-on period was defined as that required by users to initially access the computer accounts available to them, and setup their terminal in a typical work configuration. The most frequently used command continued to be "cycle through windows." However, some other commands had much higher percentages of use than in the 22.5 minute observation period. Mean setup time was 122.6 seconds (SD = 121.7 seconds). In general, subjects indicated that their initial screen setup remained unchanged throughout most of the day.

Command	Percent	Mean	SD
Cycle thru windows	32.4	4.3	7.4
Menu selection	18.1	2.4	1.6
Move window	17.1	2.3	1.8
Create window	17.1	2.3	1.6
Resize window	12.4	1.6	1.9
Delete window	2.9	0.4	1.1

Mean logon commands

Figure 4. Mean observed log-on command frequencies

3.3 Paper Survey Results

Subjects were asked to rate 17 window-related commands on the basis of six major categories: 1) Frequency of use, 2) Usefulness, 3) Friendliness, 4) Complexity, 5) Naturalness, and 6) Importance. A seven point bipolar scale was used with -3 being the worst rating and +3 the best rating, zero was neutral. The purpose of the paper survey was to obtain data on commands that might be too infrequently used to be sampled in 22.5 minute observation period. In this regard the most pertinent rating categories for the creation of a benchmark were frequency of use, importance, and usefulness. The paper survey results for these categories are shown in Figures 5 - 7 respectively. The ratings for the other three categories can be found in Gaylin (1985). The commands that people were asked to rate are located on the far left of each graph. N refers to the number of persons who responded to that command definition. Caution should be exercised when evaluating some of the ratings because they may be based on a small number of respondents (for example, SET SCREEN DEFAULTS).

Subjects were asked to rate a command even if it was functional only for a specific application within a window. This enabled the capture of commands used in dual edit sessions that were felt to be similar to windowing features currently available in other products. For example, moving text from one edit window to another. If a command was not currently available on the system, subjects were asked to rate how important and useful they thought that command might be.

To determine whether the frequency of use of a command had been influenced by its relative ease or difficulty of use, the three rating scales consisting of friendliness, complexity, and naturalness were analyzed. That is, were some commands infrequently used because they were too unfriendly or complex? Or were they rarely used because they were useless or unimportant? If the former was true then

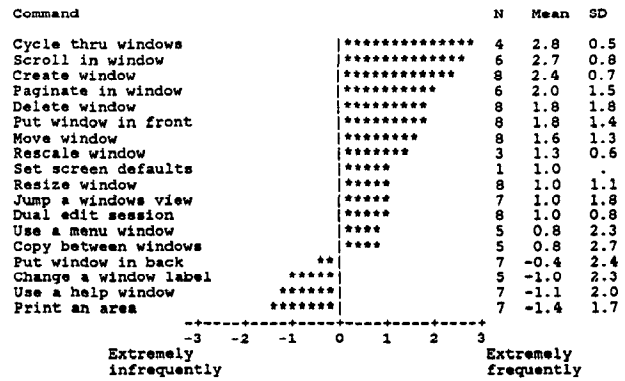


Figure 5. Frequency ratings

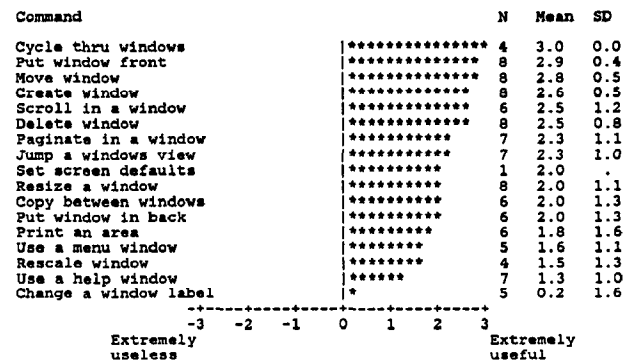


Figure 6. Usefulness ratings

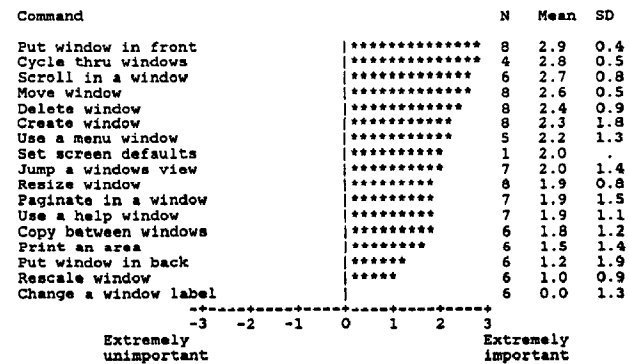


Figure 7. Importance ratings

the command might be used more frequently if it was better designed. If the command was rated as being easy to use (friendly, natural, simple) and was still unused then it was probably not important.

To this end, Pearson Product Moment correlations were calculated between all rating categories in the paper survey, and between rating categories and observed command frequencies (see Table 1). Low positive correlations were found between the ease of use categories and both the observed and rated frequency of use of a command. This indicates that poor ease of use probably had little effect on either the observed or rated frequencies of command use. In addition, observed and rated frequency of use was much more highly related to the "usefulness" and "importance" categories.

dows, scrolling, or paginating the view of a window, that are currently available on other systems. Future research in this area should be directed at sampling the types of work and commands used on these other systems to validate or modify the current benchmark.

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