ezHPC: Adopting a Program-wide, User-centered Design Approach to the ezHPC User Interface

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Abstract

The Engineer Research and Development Center Major Shared Resource Center (ERDC MSRC) has been tasked by the Department of Defense (DoD) High Performance Computing Modernization Program (HPCMP) to adopt a program-wide design for the development of the recently introduced ezHPC user interface. The purpose of ezHPC is to provide all HPCMP users intuitive, efficient access to high performance computing (HPC) resources needed in their regular course of work. At the core of user-centered design is an emphasis on fully understanding HPC users and their work environment, enabling support for user needs, not developer concerns, to drive the design process. Fulfilling this goal requires the use of a variety of methods from the field of usability engineering. For ezHPC, methods have included to date (1) inclusion of users as part of the design team, (2) a facilitated focus group session, (3) a usability walkthrough, (4) a usability evaluation, and (5) rapid prototyping.

In adherence to user-centered design, a user group (UG) was formed to serve as participants in the design of the ezHPC software. ezHPC UG members participated in a recent workshop for the purpose of assessing and improving the usability of the program-wide version of ezHPC.

Results are currently being used to guide the new design of the ezHPC interface using rapid prototyping. Prototypes are under development for regular reviews by the UG, followed by iterative refinement. This direct early involvement of users ensures more responsive, user-centered interfaces. Formal, large-scale usability evaluations are expected in the latter half of the software cycle.

1. Introduction

For ezHPC, usability methods have included to date (1) inclusion of users as part of the design team, (2) a facilitated focus group session, (3) a usability walkthrough, (4) a usability evaluation, and (5) rapid prototyping.

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2. Usability Workshop

A total of seven HPC users from a variety of backgrounds participated in the workshop. Though this number may seem small, studies have shown that, if properly composed, a group of this size is optimal for conducting a user-centered design (UCD) process[1]. Such a process diverges from conventional software development methods in that it focuses on eliciting user needs, rather than developer concerns, to drive the design. (Extensive usability testing occurs later in the development cycle and involves larger numbers of users, but this is both impractical and unnecessary in the design stage.) Hence, to support the user-centered design process, the workshop participants were carefully chosen to provide the broadest possible window into typical user

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needs. Out of the seven participants, four reported spending at least 50 percent or more of their time doing direct technical work; the other three participants provided user technical support to a large group of HPC users, each from different agencies with somewhat differing user cultures; e.g., some involved the use of more students than others. The latter point regarding differing user cultures is significant in obtaining the broadest representation of the user population.

2.1. Preworkshop Data

Prior to the workshop, each participant replied to a brief e-mail survey with the purpose of eliciting a broad view of the typical user workflow. These data were studied prior to the workshop and used to direct a focus group session held the first morning. A diagram depicting a high-level workflow, based on these data, is shown in Figure 1. An analysis of responses to the survey revealed three basic categories of work activities: (1) performing direct technical work, (2) communicating, and (3) monitoring. Specific activities and ranges for percentages of time were reported under each category. Note that some higher level activities, such as user support and supervising, encompass more than one of the fundamental categories. Thus, they are listed across the appropriate categories, e.g., user support, which requires both communicating and direct technical analysis.

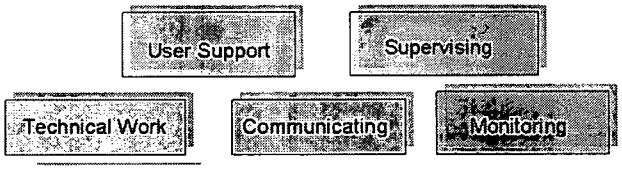

Figure 1. High-level workflow diagram

2.2. Workshop Focus Group Data

Focus groups, long used in marketing, have also proven useful in gathering usability requirements if properly facilitated and used in conjunction with other data-gathering techniques[2]. The workflow analysis shown in Figure 1 was used to initiate a focus group session held the first morning of the workshop. Participants engaged in discussion to further refine the understanding of the typical user work environment and, particularly, the most critical problems faced.

Though the fundamental workflow did not significantly change, a focus emerged in a few key areas: (1) resource and allocation monitoring, (2) communicating with management, and (3) mentoring new employees. First, information that could be used to reduce turnaround time for getting jobs through queues emerged as a critical concern. Second, a need to convey resource allocation problems to nontechnical management was strongly voiced. Third, issues regarding training and mentoring new employees and students, many of whom may be non-native speakers, emerged as an area of some importance.

2.3. Usability Evaluation

In addition to the e-mail survey, a usability walkthrough was conducted by the design and development team prior to the workshop. The usability walkthrough is a technique for identifying potential usability problems in an interface[2]. It entails a team of usability specialists (and can include developers) who "walk through" a set of interactive exercises with an interface to identify potential problems, based on known usability heuristics and principles[3-5]. This technique has been reported to identify a significant percentage of usability problems in the design stage. Results are intended to be used as a guide, however, not a replacement for user testing. Hence, the results of the walkthrough were used in developing a set of tasks and an accompanying questionnaire for a usability evaluation performed by users at the workshop.

At the completion of the morning focus group session, participants engaged in a usability evaluation, in which they performed a variety of tasks using the current ezHPC interface and then evaluated its ease of use via a questionnaire. The tasks were designed to exercise all critical aspects of the system interface and to cover the broadest possible range of activities a user would perform in a typical day or week, again, based on results of the e-mail survey, other previous UG input, and the usability walkthrough results. In addition, emphasis was placed on writing the tasks in user (not programmer) language, and with maximum neutrality, i.e., instructing *what* task to perform, but not *how* to use the interface to perform the task. An example would be as follows: "Copy a file from your laptop to another HPC computer," versus "Go to the file management page, select the file you want to copy." The latter phrasing is better suited for testing to identify programming errors, not usability issues. The neutrality of the first task phrasing, however, is key to obtaining meaningful usability assessments[6].

After performing these tasks, participants responded to a usability questionnaire, which elicited two types of feedback: (1) Likert Scale ratings of system features[7], (e.g., 1–5, Strongly Agree to Strongly Disagree), and (2) freestyle comments. Each type of data, Likert scale ratings, and freestyle comments (as well as any other user input) must be considered to gain insight into how to improve the interface design. Highlights of results in job management, file management, script management, and Web design style are summarized. Since file

management issues emerged as one of the higher priority items, results for this feature are then presented in greater detail.

2.4. Usability Evaluation Results

In the area of ***job management***, results indicated users required better visual tools for job scheduling, clear history mechanisms for job queries, and unambiguous language for novice users regarding system events. In ***script management***, users needed more comprehensive, easier-to-use methods for finding existing scripts, and more user-centered methods for sharing scripts. In the area of ***file management***, users required more efficient methods for finding existing files, easier-to-use methods for copying files from host to host and from laptop to host. Finally regarding Web preferences, users preferred lighter, simpler interaction styles.

Again, the ***file management*** interface features sparked a significant share of the workshop discussion, not only in the questionnaire freestyle comments but throughout the first day's sessions. These features also stimulated some of the most highly split ratings (positive and negative), flagging it as a priority in the redesign. A screenshot of the interface for the file management interface evaluated is shown in Figure 2.

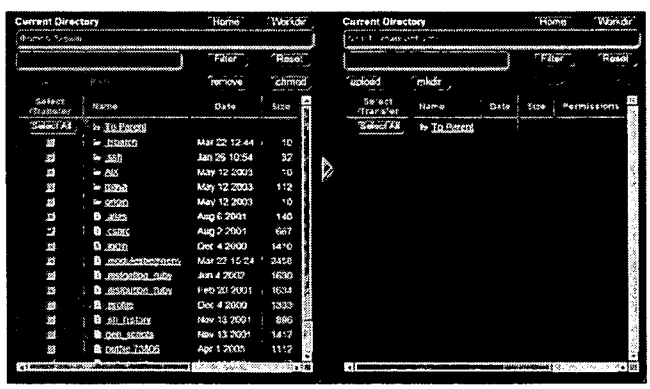

Figure 2. File management screen

To reiterate, this interface was designed by a skilled, experienced programming team, though untrained in usability. Based on their best understanding about users' experience with software tools and interfaces, they made many seemingly logical choices in the interface paradigm and features. For example, the dual-pane paradigm draws on a common graphical interface for file transfer[8]. However, the original intent of this paradigm was primarily to support the transfer operation on a file, and not the many other operations a user may wish to apply to files, e.g., editing, listing, changing permissions, and searching. As an interface paradigm, it does not come without cost: by splitting the screen in half horizontally, it reduces the display area for the file listing, requiring users to scroll right to view important information about a file. It also forces a left-right sequencing that is not intuitive for all operations, such as changing permissions or deleting a file. Further, the interface used the classic terminology for file transfers "upload/download", mixing a "vertical" logical view (up/ down) with a left-right interaction orientation.

Second, a "filter" option provided in the file selection window presents another example where the developers reasonably relied on another interface feature with which their experienced UNIX users would be familiar, the UNIX filter command line function. However, this does not translate easily to the graphical, Web-based paradigm for several reasons. Experienced UNIX users, knowledgeable of the many ways a filter can be applied, might be unsure which was offered, while inexperienced users would likely be unfamiliar with the term or technique. These issues did not render this feature inherently bad or good; they simply underlined the necessity of determining the critical underlying need for all users and designing an approach to fit that need. These potential problems had been identified in the usability walkthrough; the evaluation yielded further insight.

Listing and Viewing. The most positive Likert ratings pertained to ease of obtaining a file listing (5 Agree, 1 Neutral, and 1 Disagree to "It was easy to obtain a file listng."). Despite the overall positive ratings, several user comments related to this feature, particularly file filtering, were negative and important to note for the redesign. Excerpted comments include

- "When filtering file listing, I had no idea how the filtering was done: whether the filter was applied to the file name, the full path, ownership, etc." (User #1)
- "I found the filtering mechanism confusing." (User #4)
- "Our new users are not familiar with filtering." (User #7)

Copying and Transferring. The most split Likert scale ratings, as well as some of the most negative freestyle comments, pertained to file transfers and copies. A near equal split occurred on user's ratings of the ease of copying files from one host to another (three agree/strongly agree, and two disagree), as shown in Figure 3. An exactly equal split of user ratings occurred for the question on ease of transfers from laptops to hosts (three participants agreed, three disagreed), as shown in Figure 4.

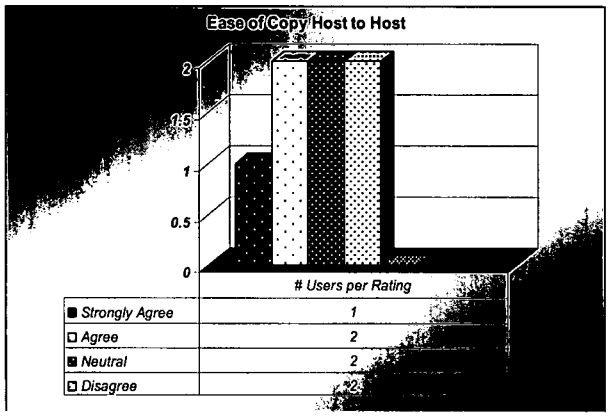

Figure 3. Results for ease of copy from host to host

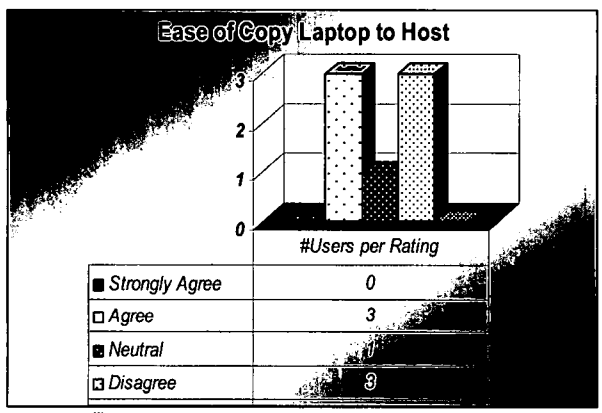

Figure 4. Results for ease of copy from laptop to host

Split ratings often indicate problem areas, but require more analysis of user comments than more consistent ratings. Difficulties encountered included, first, understanding of how to actually perform the transfer or copy, and second, knowing whether the transfer had occurred. Excerpted comments include

- "I do not like the upload and download buttons. They are confusing. I think the local client should be selectable in the left or right window..." (User #3)
- "Problems transferring large files from PC to HPC. Need better upload/download management. Can't tell when file is transferred, would like visual feedback..." (User #7)

Finally, two questions in the usability questionnaire pertained to user preferences and habits regarding file management. Responses showed overall (six out of seven participants) that finding files and copying files were both the most frequent and most critical file management tasks they performed on a daily basis. Freestyle comments on this feature, along with post-assessment verbal discussion, indicated that what users needed most critically was an ability to find files through searching the file system, rather than applying filters to specific listings or file system locations. Though they rated the latter as desirable, they viewed a general search capability as a higher priority fundamental need.

3. Prototyping

Prototyping is a critical phase in user-centered design and involves iteratively generating interface designs and refining them based on user feedback[9]. Unlike the functional aspects of software, user interface features demand this level of interaction with users to achieve correct results. The team began prototyping the new interface design once feedback was given on the prioritized usability results. A mixture of horizontal (overall system organization) and vertical (specific feature) prototyping is being used[10]. Highlights of prototyping results to date are given in the following subsections.

3.1. File Management

The home page and file management pages were mocked up for user review. Only the file management screen mockups are shown in Figures 5 and 6, since they show critical refinements to the home page, e.g., a lighter interaction style and streamlined menu. Key features of the file management redesign include (1) a single-pane approach with full horizontal file listing as the default, (2) a redesigned set of file operations, newly named and placed in one location across the top of the single pane, (3) a file search capability, and (4) a redesigned copy interaction.

The single-pane approach allows a user to view a full detailed file listing by default and reduces scrolling and other readability issues in the original interaction. The operations supported on a file, as well as their names, were also redesigned. For example, the "upload/download" and "transfer" terminology was discarded in favor of a simple "copy" operation that could be applied to any file, regardless of its location.

Some names for file operations were retained, however, such as "chmod" for changing file permissions. This term, understood by experienced UNIX users, was an example where their needs and those of novice Unix users required a balance. For new users, however, once learned, this terminology is unlikely to change. Also, training support will be included through such means as documentation, tool tips, and a dialog interaction labeled "Change File Permissions" that will occur when the button is pressed.

Second, in response to the need expressed by users for the ability to search the file system, a new operation, "Find Files", was added. This allows users to perform a

search of the file system, based on keywords they provide.

Finally, the interaction for the copy operation was redesigned to use a dialog, prompting users for source and destination files and locations. A progress meter displayed on the bottom of the screen indicates the status of the copy operation. This bar can be minimized or dismissed.

User reaction to the mockups has been positive overall with some mixed reviews on the copy operation. Several users expressed the desire to provide persistent access to the destination screen in the interaction. Methods for providing this while retaining the single-pane default view are under consideration by the design team.

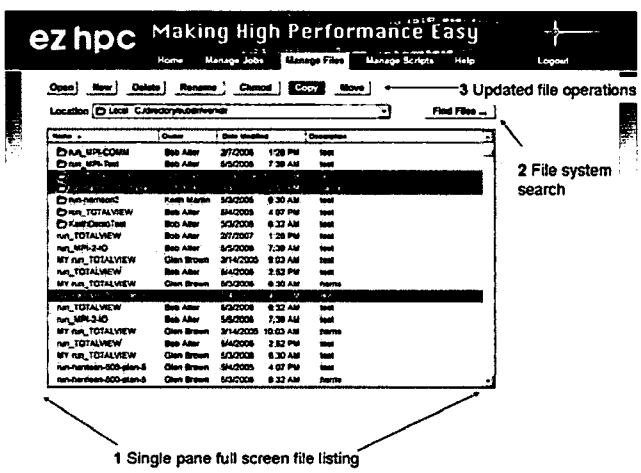

Figure 7. File management mockup

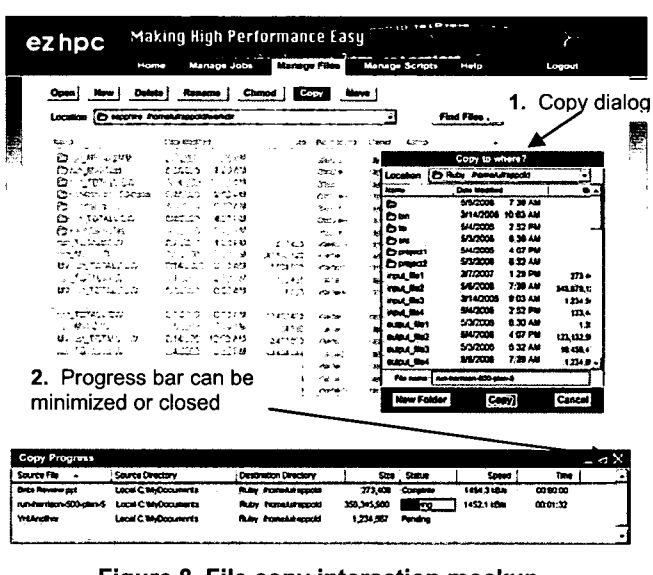

Figure 8. File copy interaction mockup

4. Conclusions

This paper has presented ongoing results of applying a user-centered design process to a program-wide version of the ezHPC user interface. This process has applied several well-tested usability techniques, most notably the formation and input of a user advisory group in activities including a focus group session, a usability evaluation, and rapid prototyping.

Currently, the prototypes are incrementally evolving in response to feedback from the user group to a final system; summative usability and error testing is scheduled in the latter half of the project life cycle.

Acknowledgments

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References

1. Norman, D.A., and S.W. Draper, *User Centered System Design: New Perspectives on Human Computer Interaction*, Hillsdale, NJ, Erlbaum, 1986.

2. Rosenbaum, S., G. Cockton, C. Kara, M. Muller, and T. Rauch, "Focus Froups in HCI: Wealth of Information or Waste of Resources?" In *Proceedings of CHI 2002*, pp. 702–703, 2002.

3. Nielsen, J., and R.L. Mack, *Usability Inspection Method,* New York, John Wiley & Sons, 1994.

4. Bias, R.G., "The Pluralistic Usability Walkthrough-coordinated Empathies." In J. Nielsen and R.L. Mack (eds.), *Usability Inspection Methods*, New York,John Wiley& Sons, 1994.

5. Spencer, R., "The Streamlined Cognitive Walkthrough Method: Working Around Social Constraints Encountered in a Software Development Company." In *Proceedings of CHI 2000*, pp. 25–259, 2000.

6. Hartson, H.R. and D. Hix, "Toward Empirically Derived Methodologies and Tools for Human-Computer Interface Development." *International Journal of Man-Machine Studies*, 31, pp. 477–494, 1989.

7. Oppenheim, A.N., *Questionnaire Design, Interviewing and Attitude Measurement*, London, Pinter Publishers, 1992.

8. winftp, http://www.wftpserver.com/wftp.htm.

9. Preece, J., Y. Rogers, and H. Sharp, *Interaction Design: Beyond Human-Computer Interaction*, New York, NY:, John Wiley & Sons, 2002.

10. McCurdy, M., C. Conners, G. Pyrzak, B. Kanefsky, and A. Vera, "Breaking the Fidelity Barrier: An Examination of Current Prototypes and n Example of Mixed-fidelity Success." In *Proceedings of CHI 2006*, pp. 1233–1242, 2006.