Developing Enterprise Application Design Guidelines for Large and Multiple Displays

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Abstract
Enterprise use of large and multiple displays will soon dramatically increase due to increased availability, lower prices, and the potential for enhanced employee productivity and satisfaction. Current enterprise application design guidelines must be updated to capitalize on the additional screen real estate, while enhancing usability. This design exploration considers many of the factors and opportunities that must be included in a new design language for large and multiple displays.

Keywords
Software Design, Large Displays, Multiple Displays, Software Usability, Software Evaluation, Human-Computer Interaction.

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H.5.2. User Interfaces: Screen design, B.4.2. Input/Output Devices: Image display.

Enterprise Use of Large and Multiple Displays
The prevalence of large and multiple displays in large enterprise environments is dramatically increasing, due to lower cost and the potential for higher worker productivity. More pixels can usually be obtained at a lower cost with multiple smaller displays than with one

larger display [7]. Additional screen workspace allows open windows to be tiled with minimal obscuration. Larger windows can be opened without scrolling, additional information can be displayed within one's immediate field of view, and peripheral vision can be exploited. For desktop displays, these benefits should hold until displays reach approximately 48" wide and 24" high, when substantial head and body motion is required [5]. Usage of multiple displays is firmly entrenched in financial, IT, and design communities, and is spreading to domains such as Manufacturing and Supply Chain planning.

Introduction of the Windows Vista (formerly Longhorn) operating system, with its Avalon UI component, will strongly impact large enterprise software companies in several ways. Applications will change from pixel-based design to scaleable vector-based, because of Avalon's size scaling in units of 1/96th inch, rather than pixels [9]. This will enable applications to move beyond the current 92 pixels per inch (ppi) XGA standard, and become much sharper on higher-resolution displays [6]. Vista will also be optimized for wider aspect ratios than the current 4:3 standard, enabling more and wider windows on a display.

The promise of increased employee productivity is a strong motivator for large enterprise use of multiple displays. In office-type tasks, investigators have routinely found productivity improvements of 10%-25% when moving from current to widescreen displays [1, 2, 4, 8]. These, as well as additional ethnographic studies, have shown that large display benefits are due to improved work organization, less window obscuration, and less window switching. However, not all window features scale well to larger displays, indicating design opportunities.

Application Design Guidelines for Large Displays

Large software enterprise companies use guidelines and design patterns to unify thousands of applications developers. Specific guidelines for application designs on large and multiple displays should enable companies to capitalize on larger display space and enhance usability. The following discusses some of the issues that will need to be addressed by these guidelines.

Taking Advantage of More Screen Real Estate

Increasing use of larger and multiple displays will shift how user experiences are designed. Current design strategies focus on information needs for immediate tasks. With limited screen real estate, the user often must choose between a current task *or* access to navigation, search, related information, status or other ancillary information. With more available space, design can focus on *how* to make the wealth of information more comprehensible.

Currently design regions are within a window or application (such as the Windows MDI framework). Regions can be better spread out with large and multiple displays, than with single displays. Usable designs will also require improved strategies for distributing their information to other applications and browsers. In the same way that palettes can be torn off and moved outside an applications window, the user may want to pull out other parts of applications, like a charting tool which could automatically update when different data is selected.

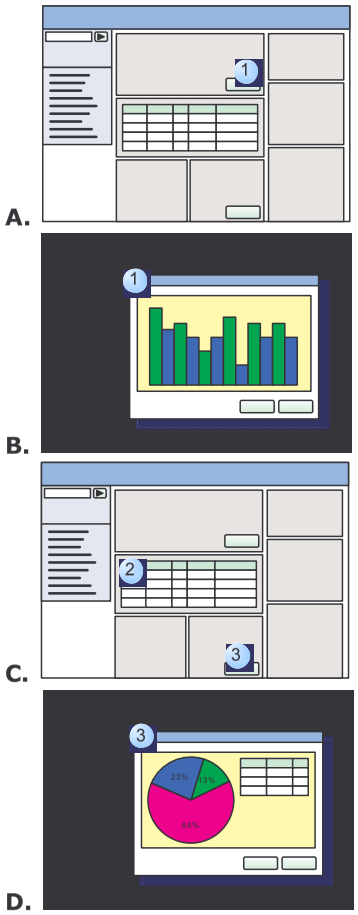

Figure 1. Current transactional application design. A. Click button to open window, B. View graph and close window, C. View table and click button to open another window, D. View graph and close window to continue.

Rules will be needed to define which window components will stretch, and which will remain static as windows are stretched across multiple displays. For example, stretching a table could add additional columns, but guidelines are needed to define the maximum number of data columns that could be reasonably and reliably comprehended. Sidebars could move as a window is stretched, but at what point is it too far removed to be usable?

Leaping Across the Bezel

There are design questions surrounding the types of experiences and interactions that can leap across the bezels of multiple displays. While algorithmic pixel correction (e.g., Mackinlay and Heer, 2004) can minimize perceptual discontinuities across a bezel, there are still questions involving the organization of work tasks across multiple displays. Palettes of graphics packages and development environments can be pushed to other displays to gain working space but it can be difficult to re-orient the task after crossing a bezel. On the other hand, unrelated utilities and experiences such as instant messaging, email, and sidebar utilities that the user wants to be able to monitor and act upon are suited for placing across disparate spaces.

Creating A New Design Language

The current design language focuses on avoiding obscured content, switching, and information disclosure. Examples include dialogs obscuring the workspace, applications obscuring other applications, switching windows, tabs, applications, alt-tab, and different widgets for event alerting so the user can open an alert, dialog or window, to determine whether to disclose more information.

The new language should focus on *unpacking*, *simultaneity*, and *sharing*. Experiences, whether they are applications, utilities, or games can have their screens, dialogs and palettes unpacked from their tabs, dialogs, and other interface devices of real estate management. The unpacked applications can now spread over the available screen space. For example, a large window could show all formatting commands at once, so the user can see their individual states with minimal search. Figure 1 shows a transactional application with graphs buried in dialogs due to their space consumption. Figure 2 shows that information unpacked so that it is shown simultaneously. The design now supports the transaction and analysis tasks simultaneously.

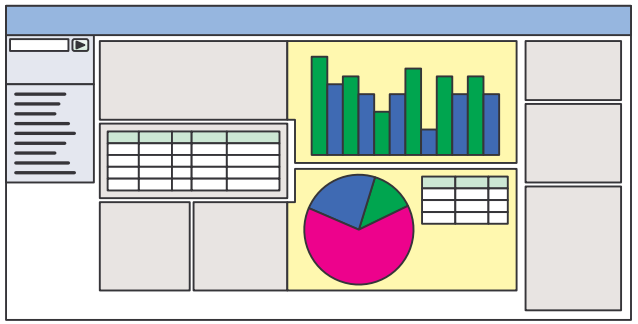

Figure 2. Same design from Figure 1 unpacked so user can view information simultaneously.

Unpacking applications is the first step to simultaneity, allowing users to access more tools at once. For example, instead of a tabbed or series of pages or dialogs, there could be one large space to simultaneously access all information on an object (or multiple objects).

Allowing more simultaneous screen objects will further emphasize issues of comparison, comprehension, and composition in design. More visual cues will be needed to draw inferences across the display(s). Sharing of the user's attention between primary and secondary applications will also need to be considered.

The increasing number of applications, widgets, toolbars, and sidebars in an interface will require more customizable methods for determining how space is populated. For example, the user could rank the importance of components, and the system could control their contrast or opacity. More important components could be larger and/or closer to the center. Color could be used to differentiate windows by importance or contexts.

Evaluating Design Usability

The new design language for large and multiple displays contains many elements that must be evaluated. Oracle's AdvancedUI group, within the Applications User Experience department, is now evaluating many of these features in its Visualization Lab. This 2-room, 1000 ft^2 usability lab houses three separate systems, each with a different display configuration: (1) A 17" XGA (1024x768) LCD display used in conjunction with an eye tracking system, (2) a 23" W-UXGA (1920x1200) LCD display, and (3) a Panoramtech 3-panel (3072x768) LCD system with minimal 11mm bezel separations. These systems enable the AdvancedUI team to conduct usability and performance studies using prototypes, then make appropriate design recommendations for further development. Researchers in the lab are currently investigating information visualization solutions and components on large and multiple displays.

References

[1] Colvin, J., Tobler, N., and Anderson, J.A. (2004), Productivity and Multi-Screen Computer Displays, Rocky Mountain Communication Review, 2(1): 31-53.

[2] Czerwinski, M., Smith, G., Regan, T., Meyers, B., Robertson, G., and Starkweather, G. (2003), Toward Characterizing the Productivity Benefits of Very Large Displays, Proc. INTERACT 2003, IOS Press, pp. 9-16.

[3] Mackinlay, J.D., and Heer, J. (2004), Wideband Displays: Mitigating Multiple Monitor Seams, CHI 2004 Proceedings, pp. 1521-1524.

[4] Pfeiffer Consulting (2005), The 30-inch Apple Cinema HD display Productivity Benchmark, URL: http://www.pfeifferreport.com/Cin_Disp30_Bench_Rep.pdf.

[5] Raskino, M. (2005), Bigger and Better Display Will Boost Productivity at Last, Gartner Research Report G00126172, April 1, 2005.

[6] Reynolds, M. (2005), Display Resolutions Set to Change, Gartner Research Report G00126431, March 8, 2005.

[7] Robertson, G., Czerwinski, M., Baudisch, P., Meters, B., Robbins, D., Smith, G., and Tan, D. (2005), The Large-Display User Experience, IEEE Computer Graphics and Applications, July/August 2005, IEEE CG&A special issue on large displays, 25(4), 44-51.

[8] Simmons, T. (2001), What's the Optimum Computer Display Size? Ergonomics in Design, Fall 2001, pp. 19-25.

[9] VedBrat, K., and Schechter, G. (2005), Advances in Display and Composition Architecture for Longhorn, Powerpoint Presentation, URL:download.microsoft.com/download/9/8/f/ 98f3fe47-dfc3-4e74-92a3-088782200fe7/TWPR05005_WinHEC05.ppt

[10] Zellweger, P.T., Bouvin, N.O., Jehøj, H., and Mackinlay, J.D. Fluid Annotations in an Open World. *Proc. Hypertext 2001*, ACM Press (2001), 9-1