

Ease of Use/PC Quality Roundtable: Improving PC Ease of Use for the Business User and IT Professional

This white paper summarizes the results of the Ease of Use/PC Quality Roundtable's findings and recommendations in the commercial computing arena. Aimed at PC hardware and software designers, the white paper assumes a computer-savvy audience. Only one white paper in a series of papers that describe various areas of effort by the roundtable, it is a "living" document that will be updated periodically as the roundtable continues its research.

Ease of Use/PC Quality Roundtable: Improving PC Ease-of-Use for the Business User and IT Professional

A call to action to improve the PC experience
for the business user and IT professional by addressing
desktop and mobile usability issues

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Introduction: The Ease of Use/PC Quality Roundtable

When users experience difficulties with PC products that they can't resolve by themselves, they must call technical support or an Information Technology (IT) person for help. This causes the following problems:

- Increased technical support calls
- Increased product returns
- Increased cost of support to PC organizations
- Increased Total Cost of Ownership (TCO)
- A negative end-user impression of the PC industry

By addressing these problems, the commercial PC industry can reduce TCO, increase interoperability and reliability for commercial products, decrease customer service calls, and increase client satisfaction with IT-provided PC/networking solutions. In addition, as IT departments and infrastructure providers become more aware of the importance of these issues, ease-of-use will become part of the buying criteria and will drive change on the supply side faster than any other effort. Currently, the breakneck speed of innovation in the telecommunications industry is fragmenting the end-to-end experience. While innovation is important and shouldn't be impeded, it needs to be balanced by an awareness of and sensitivity to user needs.

The commercial-focused efforts of the Ease of Use/PC Quality Roundtable were started in December 2000 in response to requests from the trade press and from companies who had previously participated in the roundtable. Participants committed to improving the usability of business-environment PC products include:

- OEMs of desktop and mobile PCs
- Server OEMs
- IT-solutions providers

Note: Although the commercial-focused efforts originally started as a separate roundtable, the consumer and commercial groups have since merged into a single group.

Representatives from participating companies include customer support, quality engineers, human factors engineers, and IT professionals. Best-known-methods (BKM), perspectives, and processes honed during the consumer-focused effort enabled us to quickly energize the commercial effort, which focuses on the business PC world. Most of the data collected so far relates to desktop PCs and mobile PCs, while data collection for servers is underway.

The group collects and shares relative-importance data instead of exact numbers of calls. This approach protects the proprietary interests of participating companies. Intel collates the data, which typically is sent to Intel prior to the monthly meetings for blinding and summarization.

Participating companies provided summaries of top-ten issues from product returns, call-centers, usability testing, and customer feedback. Based on this information, we identified several areas where users and IT professionals are not currently satisfied with PC ease-of-use:

- Connectivity is too complicated and unreliable.
- Hardware quality and reliability is not sufficient.
- Installation and configuration of software is too complicated and problem-prone.
- Help and how-to questions (mostly about hardware update, installation, and configuration topics) are hard to resolve.

This white paper addresses each of these dissatisfaction areas, listing specific points of user dissatisfaction and their current causes. For each major issue, we hope to positively affect product design by describing the *desired user experience* and *desired IT experience* for each dissatisfaction area. A desired experience is the ideal experience provided by a given interaction with a PC system, from either the end-user or IT professional point of view. This should be grounded in reality, but approaching utopia. The key is that it not be weakened because it would be difficult to do, or even if we don't currently know how to achieve it.

Finally, for each area of dissatisfaction, we identify both *immediate* and *long-term opportunities* for improvements and provide *metrics* for tracking those improvements. An immediate opportunity is an action that narrows the gap between current solutions and the desired experience that can be implemented using existing tools and knowledge. A long-term opportunity is an action that narrows the gap between current solutions and the desired experience that can be implemented only through invention of currently unavailable technology, creation of new methods, or considerable time and effort. A metric is a well-defined measurement that allows the roundtable to track improvement within and between companies in an area monitored by the roundtable. For the purposes of this white paper, usability is defined as a complex attribute of product design that includes:

- Ease of learning
- Ease of recall
- Utility
- Efficiency and ease of use
 - Initial
 - Over time
- User satisfaction
 - Initial
 - Over time

Data Sources and Process

Our main source of information is call center data. Where available and relevant, we also use results of design-focused research, such as usability testing, and forward-looking data collection efforts, such as focus groups, requirements gathering efforts, and market research results.

The roundtable uses these data to support our analysis of key commercial computing usability issues and to motivate our descriptions of the desired user and IT experiences. We used the following process, already proven successful in the consumer desktop PC industry, to identify important areas for improving commercial computing ease-of-use:

1. Analyze call center data to identify important areas and causes of user dissatisfaction. These data are presented in aggregate to protect the proprietary interests of participant companies. This approach allows us to develop and share a truly industry-wide perspective.
2. Use the data to prioritize the most important issues. Prioritization is based on a combination of factors, such as the severity of a usability problem and the economic impact on PC producers or clients.
3. Identify and summarize the causes of issues that appear in the data. Some causes were pulled directly from call data. Other causes were identified through discussion and are based on experience.
4. Generate descriptions of the desired user experience and desired IT experience for each problem area.
5. Identify gaps in existing technology and business practices, and then define examples of opportunities that exist for industry product development teams to close these gaps. The roundtable does not attempt to define particular *solutions*, but only to identify specific problem areas and directions in which the industry might pursue near- and long-term solutions.

6. Identify *metrics* for measuring industry progress toward easier-to-use, more reliable commercial computing products.
7. Develop white papers, design tools, and other material that will improve the business computing environment.
8. Publish and evangelize deliverables to enterprise businesses, mid-sized business developers, and IT professionals.

The data and findings presented in this document provide an overview of existing problems, representing a snapshot of the current issues. The roundtable continues to track progress in the commercial PC industry against the problem areas we identify in this white paper. Participating companies share data on a regular basis and demonstrate where improvements are occurring, where ease of use remains constant, and where effort is needed because user satisfaction remains below acceptable levels. Where appropriate, additional white papers with more detailed data and causal analysis are likely to result from the roundtable’s efforts.

Summary of Our Findings

Figures 1 and 2 summarize much of the data we have collected so far for users of desktop and mobile PCs. Subsequent charts display more detailed data.

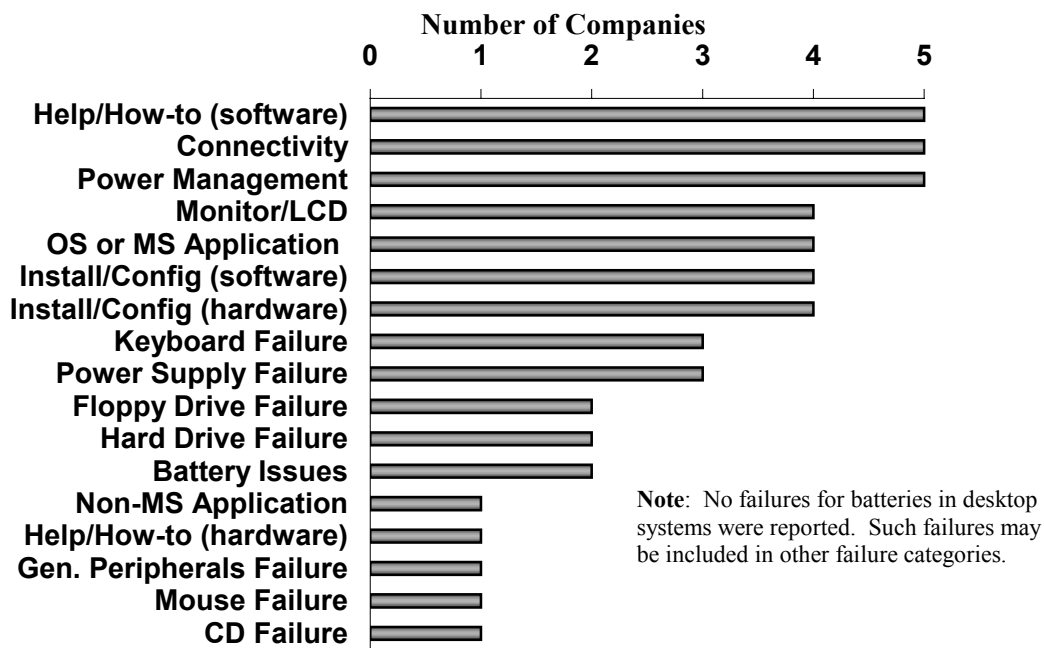


Figure 1. Summary of Desktop Problem Areas

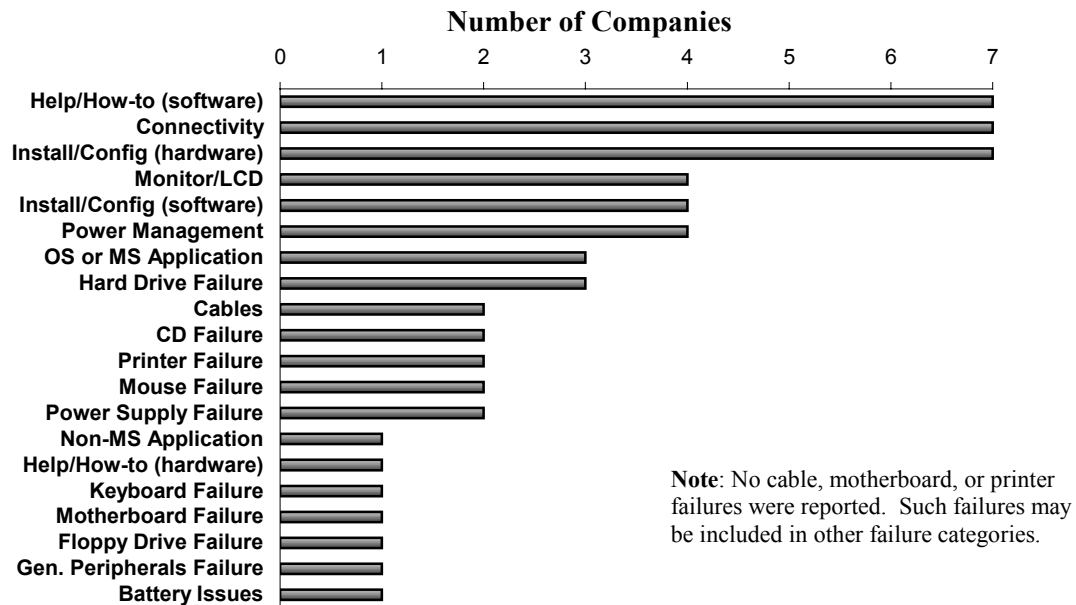


Figure 2. Summary of Mobile Problem Areas

Note: Desktop CD failures are included in the “Hardware Install/Configuration” total. Mobile operating system and Microsoft application issues are included in the “Software Issues” data.

As you can see, Figures 1 and 2 indicate that companies participating in the roundtable describe similar issues with both desktop and mobile PCs, with a substantial number of categories showing up in both top-five and top-ten lists for several companies.

Data Explanation: Keep the following points in mind as you read the rest of this paper:

- In general, the needs and concerns of users of desktop PCs apply to users of mobile PCs as well. However, users of mobile PCs have additional, unique concerns. Therefore, this paper uses a “Mobile Issues” section to emphasize mobile information where applicable.
- We used data gathered in the United States. Therefore, this white paper provides a U.S. perspective on multi-national IT operations and market needs. However, our conclusions may apply as well to other regions.
- While our data does not now show problems associated with wireless activity, we firmly believe that networking and wireless connectivity will become a significant source of problems as broadband access proliferates.

Connectivity

To be effective and efficient, business users need to reliably and quickly link to their networks, databases, intranets, and the Internet. This connectivity uses a wide range of technologies: standard modems and LANs, broadband solutions such as cable modems and DSL, various networking protocols, and numerous wireless options for transmitting and obtaining data.

Current Experience

Both desktop and mobile end-users are frustrated with connectivity. Connectivity hardware and software is complicated, difficult to install, and error-prone. Troubleshooting is difficult. The connection is easily

lost, forcing users to reconnect repeatedly. Additionally, plain old telephone service (POTS) features such as call-waiting and 3-way calling interfere with the connection.

Mobile Issues: For users of mobile PCs, connectivity problems are exacerbated because the hardware required for remote use is easily lost or broken. Nor is it apparent to users how to configure their modems or hardware to complete the dial-in. Difficulties associated with international dial tones are also specific to the mobile environment:

- Tones are not recognized by the modem.
- Users can't reconfigure modems.
- Users can't figure out how to dial out of hotels.
- No standard protocol exists for entering credit card data when connecting.
- No country-to-country standard exists for power and phone jacks.
- Users can't find the right number.
- Phone error messages are confusing.
- Users can't call for help because they are already on the phone.

Most Frequent Causes of Connectivity Problems

Figures 3 and 4 summarize the desktop and mobile connectivity issues.

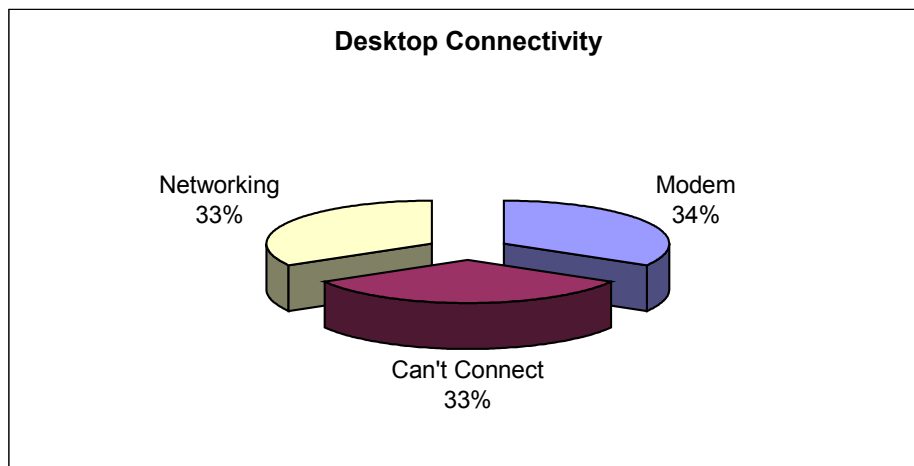


Figure 3. Desktop Connectivity Problems

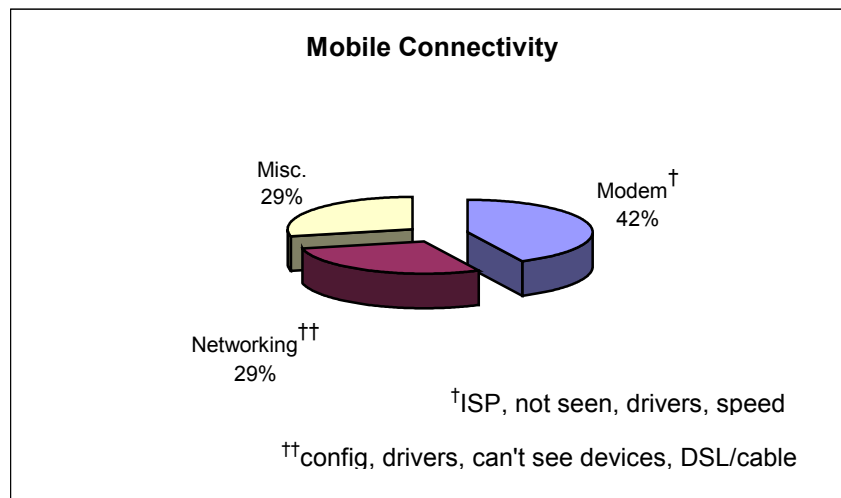


Figure 4. Mobile Connectivity Problems

Cable problems account for many calls and usability issues, including using the wrong cable (incompatible with hardware), not seating the cable connector properly, attempting to use a cable that is not long enough, forgetting a needed cable when traveling, and too many cables (spaghetti). In both Figures 3 and 4, cable issues are included in the “Can’t Connect” and “Networking” categories. In Figure 4, “Can’t Connect” issues are included in the “Modem” category.

Other connectivity issues involve problems with the infrastructure, such as users entering the wrong user ID or encountering password problems. In some cases, users don’t understand the policies for password structure. Also, policies for password structure differ from application to application. Finally, many users don’t know how to set a new password.

Mobile Issues: The problems that users of mobile PCs encounter have the following causes:

- Network Interface Card (NIC) issues:
 - Card is not seated properly.
 - Card is broken or has failed.
 - Card doesn’t work with the installed driver.
- Remote access and telecommuting:
 - Service is not available or data can’t be transported (due to problems with DSL, cable, or POTS features).
 - Problems exist with setup and configuration for dial-in software, modem, and so on.

Desired User Experience

Connecting is simple and secure. Users can connect anywhere, anytime, whether from desktop or mobile PCs. The infrastructure always provides acceptable (or better) transmission speed and quality. Dialing in to the network is as easy as double-clicking on a screen icon. Required hardware and cabling is easily obtained, easily connected, and durable. Configuration is invisible or clearly explained.

Desired IT Experience

Business users experience seamless, secure, transparent connectivity anywhere, anytime. Connectivity subsystems are integrated. Turnkey solutions exist for business environments and are easy to maintain

and service. Updates to phone directories can be completed seamlessly and quickly disseminated. Hardware is durable and cabling is available and easy to connect.

Examples of Immediate Opportunities for the Industry

- Develop “smart components,” such as NICs that signal users when the NIC is not seated properly, cables that indicate they are not fully connected, and devices that send messages to the operating system (OS) if they are plugged into the wrong ports. Users are then led through corrective measures.
- Develop a connectivity polling capability that allows the PC to detect the best connectivity method, automatically establish a connection, and maintain the connection.
- Develop automatic diagnostic routines that detect the following: when hardware is not connected, when components are missing, and when networking issues are inhibiting connectivity. These routines then lead users through corrective measures.
- Provide an overlap period during directory updates to allow all users to be notified and all users to switch to the new directory.
- Develop training that includes an overview of networks and instructions for dialing in remotely.
- Encourage IT training that teaches how to evaluate communications solutions for ease-of-use aspects.
- Provide clear dial-in instructions.
- Provide a tool that enables users to easily enter credit card data or alternate billing arrangements.

Examples of Long-Term Opportunities for the Industry

- Develop automatic connection-maintenance capabilities that re-establish connections and return the user to the point-of-loss.
- Develop a universal connectivity port.
- Develop a single, secure identifier for business users that ensures access to all necessary resources and allows easy maintenance of user profile information.
- Develop intelligent client-side connectivity diagnostics that isolate connectivity failures and initiate efficient solutions.
- Develop more rugged hardware that meets the usage requirements of the user environment.
- Form alliances with ISPs to provide simple, one-stop shopping for remote access setups.

Metrics

- Increased connectivity rates along with decreased drops and hangs for users of both desktop and mobile PCs.
- Decreased number of connectivity-related and dial-in support calls.
- Reduced problems and times for connectivity along with increased user satisfaction, as shown by usability testing.

Hardware Quality and Reliability

Current Experience

IT support personnel and users of desktop and mobile PCs experience similar problems with drives, monitors, keyboards, mice, and power supplies. These problems lead to loss of data, corrupted application configuration settings, and reduced productivity.

Most Frequent Causes of Hardware Problems

Figures 5 and 6 summarize the leading problems with hardware quality and failure.

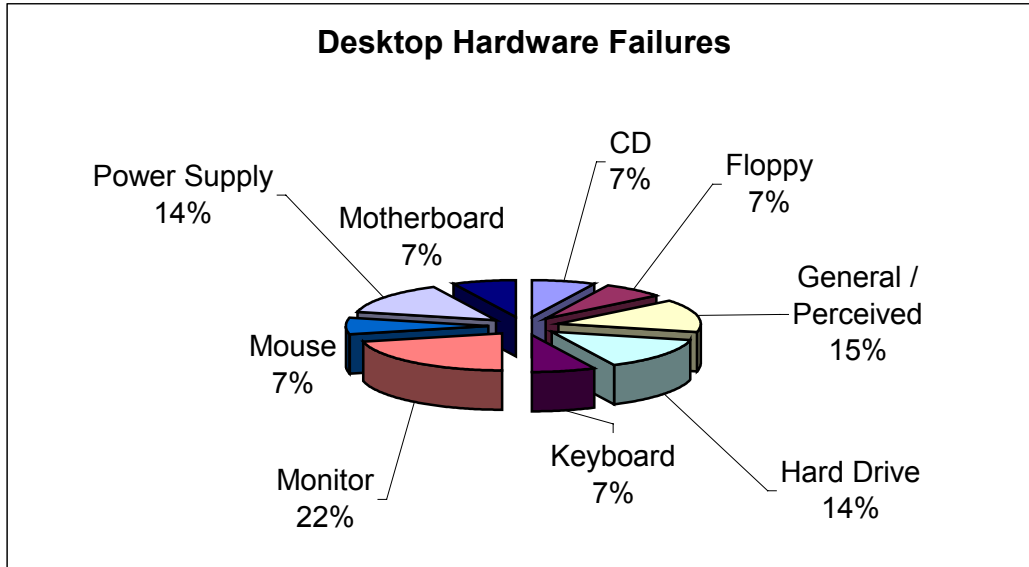


Figure 5. Desktop Hardware Failures

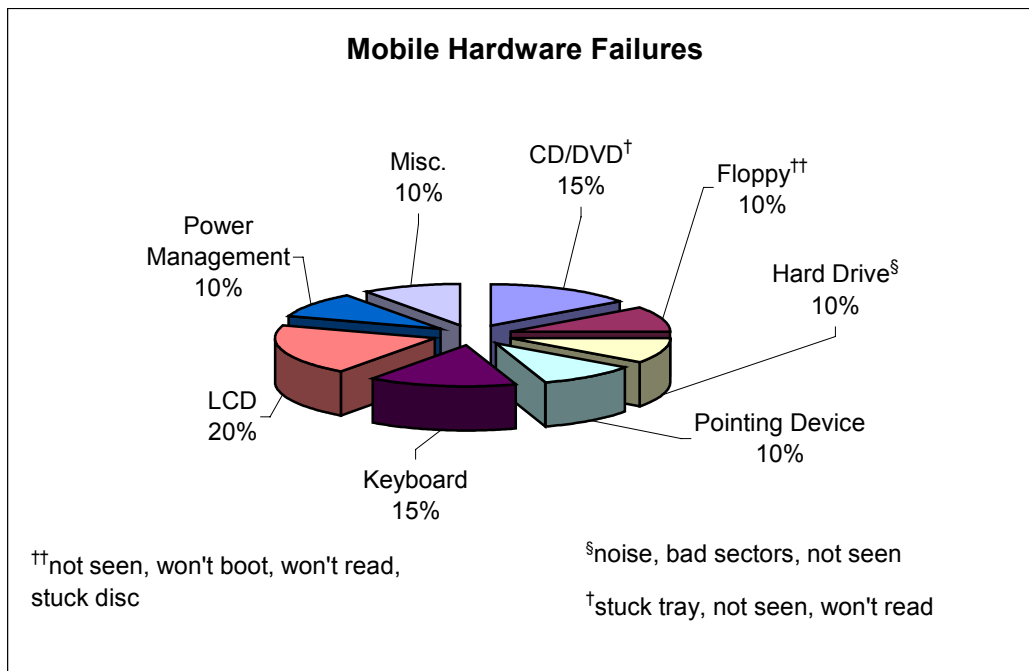


Figure 6. Mobile Hardware Failures

The impact of these issues on users varies, which affects the urgency for IT response. For example, hard drive failures are especially catastrophic to the user, because they result in loss of data, loss of

productivity, and mental stress. Our data indicates that hard drive failures often result in replacement of the drive, even when no defect is found (NDF). The symptoms that typically lead to hard drive replacement include noise during operation, operating system not “seeing” the drive, or an inability to save or access data.

We found that IT department and OEM hardware failure data were consistent, with a single exception: Although OEMs reported little data to indicate users have problems with keyboards and mice, IT departments consistently show keyboard and mouse problems in their top issues. One possible reason for this discrepancy is that people become fond of keyboards and mice, and resist upgrading them. Therefore, the devices suffer problems and failure as they age.

The following paragraphs examine problems with specific hardware components.

Hard Drives

Causes of hard drive failures are difficult to diagnose, and a substantial number of drives that are returned don't show the original problem when tested in the lab. In some cases, an error code that appears to predict imminent failure is prematurely displayed, and the unit is replaced. In other cases, the system no longer detects the hard drive because of changes made elsewhere. Other problems include the following:

- Users of mobile PCs attempting to exchange drives that are not compatible
- Drives showing bad sectors during scans
- Drives failing to allow normal boot processing

Monitors

Monitors are often “dead on arrival” (DOA) – they show no image at all when first installed. Causes include video cards becoming unseated or being inserted in the wrong port. When monitors do work, they may show faulty images (such as distorted picture, color defects, and interference patterns) at various points during their lifespan. In fact, monitors currently account for between 20% and 22% of hardware failures (see Figures 5 and 6).

Monitor problems are due in part to cost pressures and narrowing margins. As with many consumer electronics devices and businesses, the design tension between optimal design and cost (with “good-enough” design) plays an important role. In other cases, overheating can cause these symptoms. Electromagnetic frequency (EMF) interference can also cause distortion in the image, as can aging components and mismatches between the OS and the video card standard.

LCD monitors on mobile PCs also fail, with symptoms including blank screens, haloing, and other visual aberrations, such as backlights and dark lines on the screen. In general, we find that the durability of LCD monitors on mobile PCs does not meet the usage demands of the mobile environment.

Keyboards and Mice

Keyboards and mice often get dirty and break. Built-in pointing devices on mobile PCs can cause configuration conflicts or may fail to work properly. Finally, difficulties in connecting a keyboard or mouse show up as usability issues (the device is connected to the wrong port or ports are swapped).

Power Supplies and Power Management

Desktop power supply related issues are summarized in Figure 7.

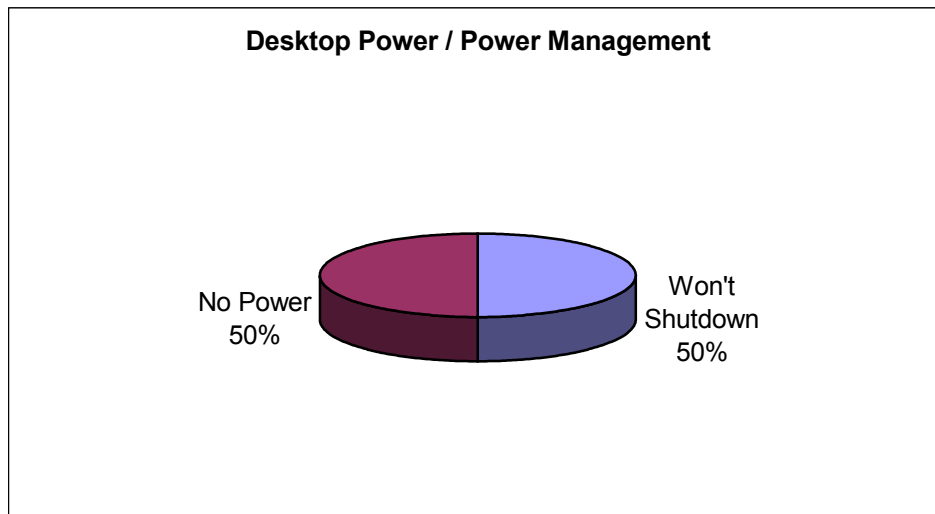


Figure 7. Desktop Power Management Problems

Two main issues are obvious: the system won't boot and the system won't power off. As with monitors, the cost/design-optimization tradeoff is clearly having an effect on power supplies. In addition to margin pressure, using fans with higher failure rates can increase power supply failure rates.

Although power management issues currently arise more often for users of mobile PCs than for users of desktop PCs, desktop power management may become an equally important issue as "always on" becomes more prevalent in the desktop environment.

Mobile Issues: Figure 8 summarizes the power supply and power management problems commonly experienced with mobile PCs:

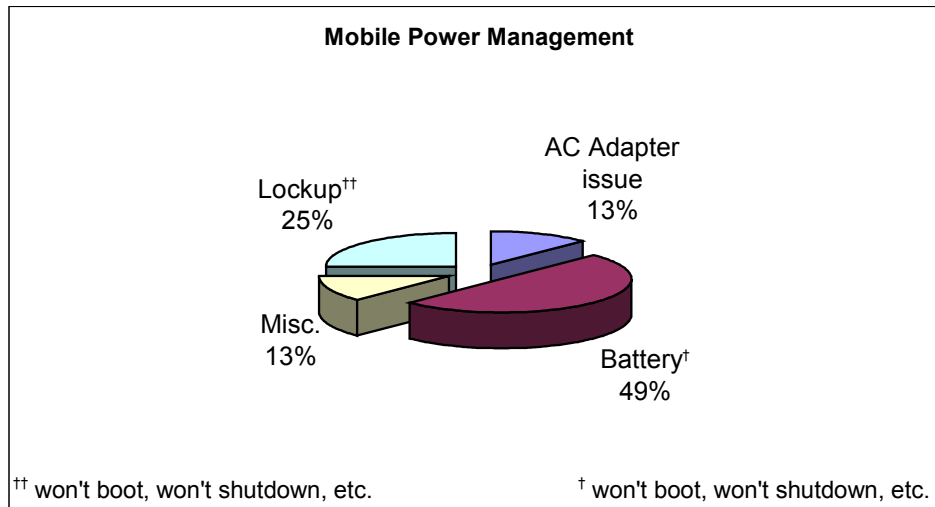


Figure 8. Mobile Power Management Problems

Users of mobile PCs experience some of the same power management problems as users of desktop PCs. They also encounter the following problems that occur exclusively in the mobile environment:

- The PC card is damaged or the dongle is lost.
- The pins are damaged.
- The connection jack or connector is damaged.
- The NIC card design allows damage to occur.
- Problems occur with docking stations and port replicators.
- Error messages and other performance issues are caused by forgetting to remove the NIC card when it is no longer needed.

Desired User Experience

Hardware components are designed to deliver quiet, efficient performance over the lifetime of the PC and are easy to replace if they do fail. Self-healing technology prevents data loss. Diagnostic routines quickly identify failed and near-failure components and provide guidance for replacing or fixing a component. Devices are designed to automatically optimize configuration settings. Users can easily find and change configuration settings.

Desired IT Experience

Hardware components are designed to deliver quiet, efficient performance over the lifetime of the PC and should be easy to replace if they do fail. Self-healing technology prevents data loss. Diagnostic routines quickly identify failed and near-failure components and proactively notify both users and IT personnel so appropriate actions can take place (such as replacing or fixing the component). Devices are designed to automatically optimize configuration settings. Users can easily find and change configuration settings.

Examples of Immediate Opportunities for the Industry

All Hardware

- Provide training to users on how to clean and maintain hardware.
- Establish a hardware “auto-monitoring” tool that warns users of imminent failure and indicates when equipment is not performing to specifications.
- Establish a bank of replacement hardware so that user downtime is minimized when component loss or breakdown occurs.
- Provide system specifications and compatibility information in an easy-to-find location.

Hard Drives

- Develop software that uses smart-drive data. Equally important, teach users how to take advantage of this feature.
- Develop automated user backup capabilities that integrate smart-drive data and IT monitoring and management suites.
- Develop efficient user performance settings and data storage that allow easy data migration and backup. (Migration is defined as loading a new computer with all the software from a previously used system.)
- Develop or implement diagnostic tools for hard drive failure.

Monitors

- Make monitor controls for display configuration easy to find and easy to use.
- Create design guidelines to help developers ensure that their applications always reset monitor settings that get changed by an application during run time.
- Provide a wizard that allows users to customize their monitor settings by matching the settings to the applications most commonly used on the PC (such as graphics or word processing).

Keyboards and Mice

- Print cleaning instructions on the bottom of the mouse and keyboard.
- Design mice and keyboards that are easily cleaned and reassembled by the average user.
- Sell keyboards and mice bundled with a small compressed air cleaner.

Power Supplies

- Investigate the benefits and drawbacks of redundant and hot-swap power supplies for desktop PCs.
- Investigate designs for more efficient, smaller, modular fans and power supplies. Also try to reduce the number of these components.
- Develop cooler component designs so less heat reduction is necessary.
- Provide training in power management.
- Develop a tool that lets users easily select the power management features they want.

Examples of Long-Term Opportunities for the Industry**All Hardware**

- Develop hardware monitoring software to identify and troubleshoot failed and near-failure hardware. This software should report the specifications for the hardware that needs to be replaced.
- Increase the ruggedness of mobile PCs so they can survive in real-world environments.

Hard Drives

- Develop a non-mechanical technology for storage.
- Develop a self-healing technology for storage.
- Refine hot-swap capabilities for desktop and mobile PCs.
- Develop or refine technology that reduces the risk of user data and configuration settings being lost or damaged.

Monitors

- Create Application Programming Interfaces (APIs) that enable the OS to take advantage of and control monitor settings. That is, design interoperability between hardware and the OS for monitor configuration.
- Ease the diagnosis and cure of incorrectly seated components by developing helpful, explicit error messages.
- Improve retention methods for card slot design.

- Reduce the number of video modes and subsequent user confusion over settings.
- Identify categories of monitor performance and reliability (i.e., lowest cost versus most robust performance) and identify how these features impact the IT TCO model. Then, advertise and position monitors so that cost versus quality is better delineated and user expectations are properly set.
- Automatically detect and inform the user of the video source being used. This way, on systems with both an add-on video and integrated video, the user can use either connection and still get feedback from the computer.

Keyboards and Mice

- Investigate making current technologies less expensive. Continued price reductions are likely as vendors realize economies of scale, efficient manufacturing, and so on.
- Investigate alternative I/O mechanisms that have fewer moving parts or use other modalities, such as infrared or touchpads.

Power Supplies

- Develop power supplies that alert users and IT (via the network) before failure occurs.
- Develop mobile PCs that use less battery power.
- Improve batteries so they have a longer useful life.

Metrics

All Hardware

- Decreased downtime due to hardware failure.
- Decreased “debug time” due to incompatible system hardware.
- Reduced number of calls related to hardware failures.

Hard Drives

- Decreased downtime for hard drive repair.
- Reduced downtime due to hard drive issues.
- Reduced calls due to hard drive issues.
- Reduced numbers of NDF instances.
- Decreased time spent migrating and lower cost per migration.

Monitors

- Reduced number of monitor-related calls.
- Drop tests show improved card retention.
- Reduced errors and increased user satisfaction associated with monitor configuration tasks (as shown by usability testing).

Keyboards and Mice

- Reduced failure and return rates.
- Reduced TCO costs related to replacement or stock of these items.

Power Supplies

- Reduced number of power supply-related calls.
- Decreased mean time for repair or replacement.
- Equipment meets the industry average cost per watt per *MTBF hour* (Mean Time between Failure hour). MTBF is an industry-standard measurement of the average out-of-box experience related to product reliability.
- Reduced or eliminated downtime due to exhausted batteries.

Software Installation and Configuration

Current Experience

Installing software on client machines is too difficult and complex for many users; it is non-trivial for IT professionals as well. This sometimes results in software applications or devices not working properly after installation. The current environment, BIOS, and drivers already installed all affect whether a given software installation is successful.

Most Frequent Causes of Software Problems

Anything that requires software to be installed on a client system can lead to problems during installation and configuration. Figures 9 and 10 summarize the leading categories of software installation or configuration issues for users of desktop and mobile PCs.

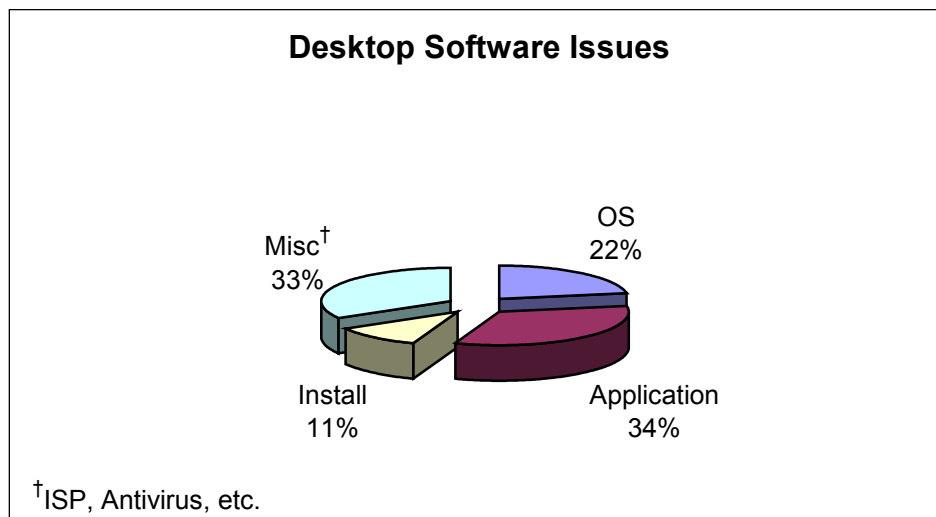


Figure 9. Desktop Software Problems

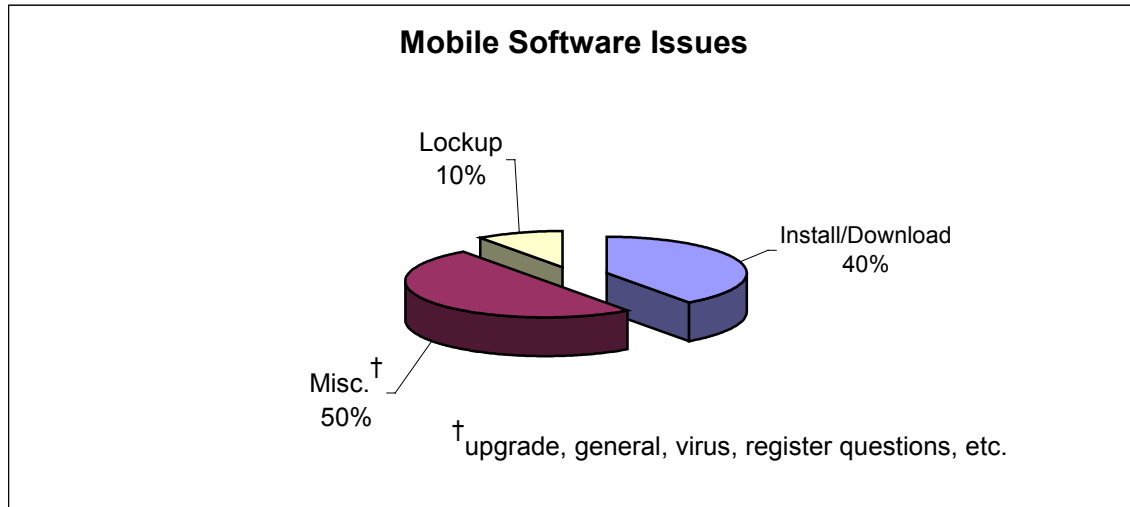


Figure 10. Mobile Software Problems

The following list provides more detail about these major sources of software installation problems in a business environment:

- **Incomplete installations, mistaken wizard entries, or other problems during the installation process:**
 - In the device manager, the user selects or installs the incorrect driver or settings.
 - Driver installation and configuration problems create dynamically linked library (DLL) conflicts about which the user knows nothing (often called “DLL Hell”).
 - The user initiates an application update or upgrade from the Web or other source. This can create tracking and uninstall problems.
 - If the user cancels in the middle of an installation routine or makes a setting change that initiates an installation, the driver may not install completely and some files may be broken or incomplete.
 - Software upgrades don’t always delete previous revisions.
- **Issues resulting from operating system re-installations or upgrades:** During an OS upgrade, hardware installation, or software installation, a new incorrect driver is installed. Often, the Software Fault Protection (SFP) prevents the correct driver from installing.
- **Re-installations required due to device or application failures:**
 - Drive failure occurs.
 - Video, peripheral, or card failures occur.
 - Device and card naming conventions differ between the OS and vendor documentation (the device or application can make registry changes that locks the OS from shutting down).
 - The application installs and overwrites the driver without checking for a more recent version.
- **Installations required to bring all users up to the same version of an application.**
- **Problems caused by virus and other security software and features:**
 - Antivirus changes and antivirus interaction with the application installation routines cause problems.
 - User loses personal control of the configuration (IT does it).
 - Corporate-driven software drains or strains available user task resources such as available agents, hard disk space, RAM, and CPU processing power.
 - Users must remember multiple passwords, IDs, and protocols. Often, passwords must be synchronized.

- Many passwords are case-sensitive, so the CAPS LOCK and NUM LOCK keys cause problems.
- Users don't understand that when the connection is lost, they don't have access to shared resources.
- **User customizations not retained:**
 - The base build is not compatible with minor hardware revisions (for example, BIOS/2nd generation video).
 - An individual department's software customizations and applications are lost when refreshes or upgrades are implemented.
- **License control issues:**
 - Too many licenses exist for different software packages.
 - Too many users or copies of an application exist for the current number of licenses.
 - When old software is replaced by new software, licenses get out of sync with installed versions.
- **Migration issues:**
 - After a hard drive recovery, if the drive is not functional, all the data and settings from the original drive needs to be transferred to the replacement drive.
 - User-specific data, pointers to data, hardware drivers, software customizations, and applications are lost.
 - Data identification, data transfer, and user-specific configuration tasks are poorly understood.
 - Migration tools are inefficient and frequently unsuccessful.
- **Training issues:** People are not trained to use the OS or application properly.

Mobile Issues: For users of mobile PCs, upgrading or installing the OS is plagued by the following three additional problems:

- Successful upgrades require that all previous media be used. Mobile systems are often configured using a server at work; when changes are made at another location or when the user logs in remotely, the OS looks for the original media and will work only if the mobile system is linked to the same server from which the installation was done. Usually this requires IT to step in, because the user rarely knows which is the correct server.
- Many times installers provide only a shell, then rely on the balance of the installation to be taken from the Web, which is slow and frustrating.
- Periodic automatic updates of anti-virus applications over a modem can lock up a user's machine for long periods. Users can't stop the process or choose when the process occurs.

Desired User Experience

The installation of operating system, application, and device software and drivers is quick and easy, whether the installation is for the first time, part of an upgrade, or part of a migration. Correct versions of drivers are always available. Reboots, decisions, and user inputs are minimized. When user input is required, instructions are non-technical, procedural, and easy to understand. The user is notified when installation is complete and successful.

Desired IT Experience

IT staff never have to get involved with user-initiated installations. IT-initiated new installations, upgrades, and migrations are automatic, unattended, and trouble-free. If issues do arise, they are addressed through self-healing. For those that aren't self-healed, IT professionals have recourse to diagnostic applications that quickly isolate and correct the problems.

Examples of Immediate Opportunities for the Industry

- Create design guidelines for installation developers that capture key elements of a user-centric install experience (for example, unattended, good feedback, and so on).
- Ensure early, iterative end-user involvement in the design of software installations and applications. Thoroughly document users' needs (for example, applications, drivers, and so on).
- Develop and perform a needs analysis for benefits and drawbacks of different methods of providing drivers (centralized versus decentralized).
- Create an installation process that proceeds smoothly, whether software or hardware is installed first.
- Ensure that applications automatically default to the correct settings.
- Develop "key-wording" guidelines for error messages to ensure that users have a clear understanding of the PC system state.
- Establish a software and system-level interoperability plug fest.
- Thoroughly test all upgrades to identify problems.
- Notify users when performing upgrades that may create DLL conflicts.
- Provide file management training to users.
- Provide a tool for password maintenance.
- Develop a migration wizard that allows easy identification of needed components (such as files, applications, settings, and preferences) and a trouble-free migration.
- Develop formal backup policies.

Examples of Long-Term Opportunities for the Industry

- Develop software diagnostics (analogous to hardware diagnostics).
- Develop device specifications so that devices contain the correct driver (for example, in firmware) and provide it to the client PC.
- Develop new technologies that address "DLL Hell." Possibilities include applications or OS capabilities that track driver versions and maintain copies as needed by the system for proper functioning.
- Develop self-healing technologies to minimize the impact that installation and interoperability issues have on end-users.
- Improve software upgrades to make them more seamless.
- Create industry commitment to use standard, generic "reference" drivers so all major categories of devices recognize and work with the generic driver. Optimal performance could be achieved with proprietary drivers.
- Develop standard techniques that allow applications to install without supervision. Allow users to choose between unattended or supervised installations.
- Develop efficient tools for data migration.
- Develop a new technology that automatically identifies needed data, migrates it, and validates that the data is correct.
- Develop a new technology that automatically backs up the current system's critical information so that it is always available for migration.

Metrics

- Reduced number of calls related to software installation and configuration.
- Reduced number of observed software installation and configuration problems during usability tests.
- Reduced number of touch-labor calls.
- Increased industry acceptance of design guidelines.
- Observed increase in downloads of white papers and requests for design guidelines related to ease-of-use topics.
- Reduced time and calls relating to upgrades.

- Reduced number of calls for lost files and applications.
- Decreased migration time and cost.
- Reduced number of migration follow-up calls.

Help and How-To Questions

Current Experience

Users find it difficult to select and configure hardware and software add-on products that best augment (or are compatible with) their current PC. When these actions are required, users often can't find answers to questions that naturally arise about compatibility, specifications, best solutions, and so on. In such cases, users tend to call vendors to get their questions answered.

Most Frequent Causes of Information Problems

According to our data, users of desktop PCs have questions that center almost exclusively around hardware installation and configuration issues (as opposed to hardware failures or other errors). Questions relate to memory and resource management; system features and available resources; where to find files, drivers, and directories; how to install and configure new hardware; and error states. Users of mobile PCs also had these types of questions. Figures 11 and 12 summarize the breakdown of these questions.

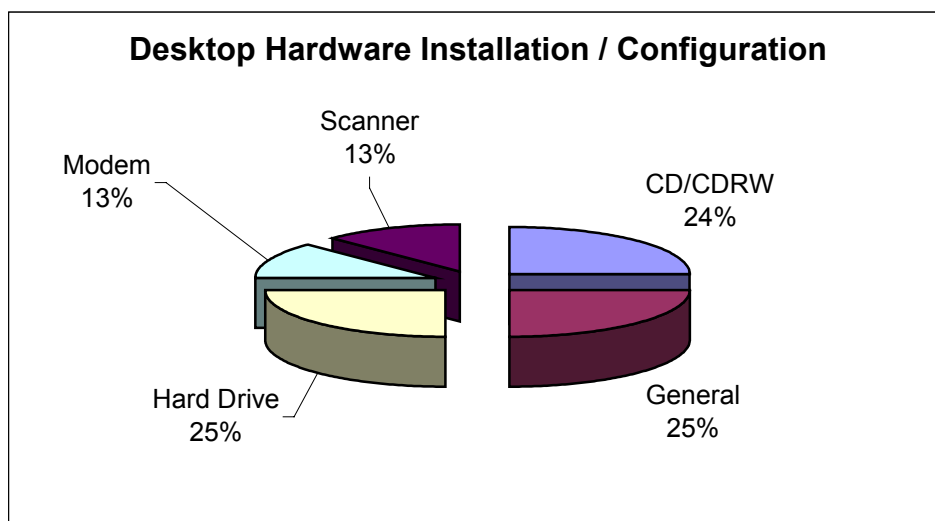


Figure 11. Desktop Help and How-To Issues (Hardware Configuration and Installation)

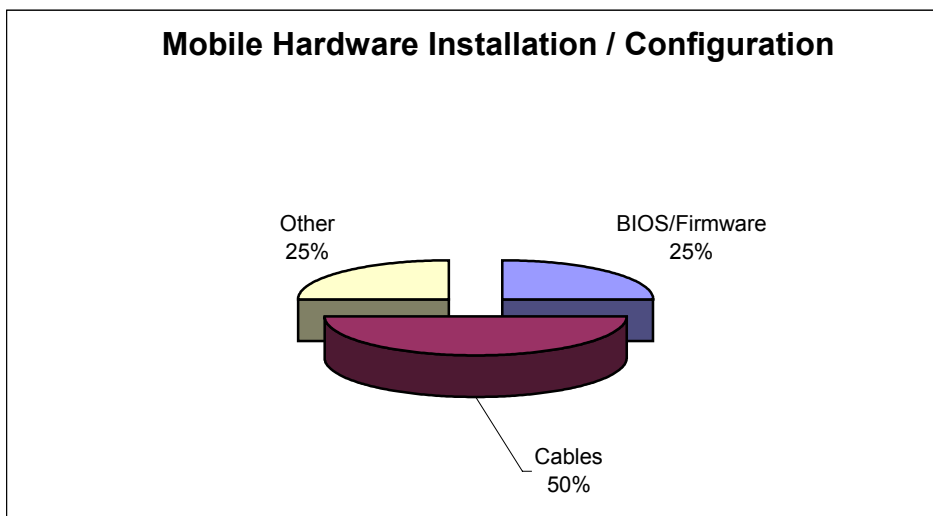


Figure 12. Mobile Help and How-To Issues (Hardware Configuration and Installation)

Unlike users of desktop PCs, however, users of mobile PCs had questions about areas other than hardware configuration and installation, as shown in Figure 13.

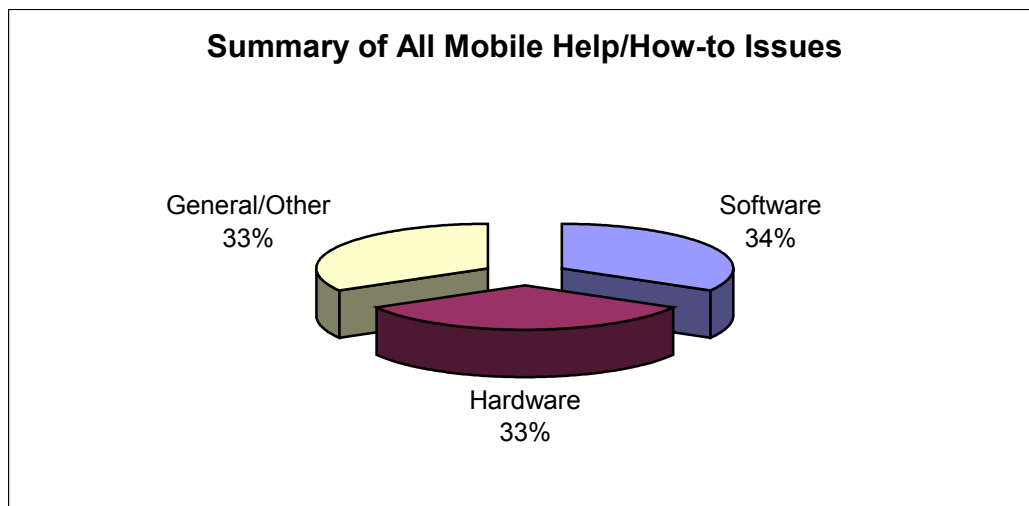


Figure 13. Summary of All Mobile Help and How-To Issues

Desired User Experience

Users have access to clear, easy-to-understand information about their current system and options for extending or upgrading hardware. This information meets a wide range of goals. For example, a user can get an assessment of which hard drives are compatible with the current system and which options are best for differing needs or goals in an upgrade.

Desired IT Experience

PC systems provide complete, easy-to-understand information about their configuration. Web sites or other sources provide business users with complete information about what specific products ought to be

selected for an upgrade, given different goals or needs. All options are IT-approved and unlikely to cause problems.

Examples of Immediate Opportunities for the Industry

- Notify users when new upgrades and updates are available.
- Automatically display upgrade messages when a hardware component has reached a certain threshold value.
- Provide some kind of “litmus test” to ensure that the upgrade has been completed successfully.

Examples of Long-Term Opportunities for the Industry

- Provide quick access to hardware components by making them easily and intuitively removable and installable.
- Develop an online listing of existing hardware and software with the following attributes:
 - Links to updates and compatibility options
 - Links to information on how to install and configure the hardware

Metrics

- Reduced number of calls associated with hardware installation and configuration questions.
- Decreased time spent performing hardware installation and configuration, as shown by usability tests.

Call to Action

The Ease of Use/PC Quality Roundtable recommends that companies in the PC and IT industries integrate the near-term opportunities described in this paper into their upcoming products and service plans. Longer-term actions may require new technologies or cross-industry effort (for example, standards). Some long-term actions may be most effective when taken by companies in collaboration, others that confer competitive advantages will be pursued privately. As industry leaders, we will encourage these developments internal to our companies and in existing or new standards bodies. We encourage others in the industry to do the same.

As commercial computing ease-of-use and quality improves, the industry will benefit and users’ perception of ease-of-use will improve. The roundtable will monitor improvements and will continue to analyze and report emerging commercial ease-of-use issues.