

THE ACCESSIBILITY OF MULTIFUNCTION PRINTERS

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The Accessibility of Multifunction Printers (MFP): An Updated Usability Study of

Accessible MFPs and a Survey of MFP Users with Vision Loss

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Structured Abstract

Introduction

This article investigates the use of multifunction printers (MFPs) by individuals with vision loss, and explores current accessibility solutions to determine the extent of accessibility and usability for those who are visually impaired with suggestions for improvement.

Methods

A usability study conducted in early 2014 recruited ten volunteers with varied levels of vision loss and user experience. Each performed four tasks on the Lexmark, Canon, and Ricoh MFP accessibility solutions.

An online survey conducted between October 2011 and April 2012, used a volunteer sample recruited through advertising and distribution through private organizations. The sample consisted of 26 individuals who were blind and 34 who had low vision; all participants had experience using MFPs. The sample included 58% women, 83% white, 78% college graduates. Median age range was 45 to 54 years old.

Results

Usability study respondents had a high success rate performing tasks, averaging a rating of 4.5 out of 5, and scores increased over the four tasks. Participants preferred the Lexmark machine due to its familiar QWERTY keyboard interface.

Most survey respondents (80%) use an MFP at home for personal use; 67% use MFPs in the workplace. Fifty-eight percent used assistive technology with their MFPs. The most important MFP function was printing, followed by scanning and copying. Faxing was least important. Those with low vision were more likely to use the MFP's copy function than those who were blind ($p < .002$). To improve accessibility, respondents suggest higher contrast, larger characters, speech output, and tactile controls.

Discussion

People with vision loss use MFPs at work and home. Current accessibility solutions for MFPs work well for individuals with vision loss, but there is much room for improvement. Manufacturers should be urged to implement suggestions from research participants to increase the accessibility of their products.

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INTRODUCTION

Among the most-widely used pieces of office equipment, Multifunction Printers (MFP) assist workers in common everyday tasks including copying, faxing, scanning, and printing. The ability to use an MFP is essential for most office jobs today, as well as for being personally productive in a variety of fields. Before the advent of MFPs, basic copiers and printers were used, many of which had simpler tactile interfaces allowing easier use by those with vision loss. Most MFPs now have embedded touch-screen visual displays, making their use much more difficult for people who are blind or visually impaired.

Section 508 of the Rehabilitation Act Amendments of 1998 requires that the U.S. government purchase only electronic and information technology that is accessible to people who have disabilities; this includes office equipment products. Further, the Twenty-First Century Communications and Video Accessibility Act (CVAA) has expanded these requirements to include access to advanced communications services and equipment, including those devices involved with email communications, a feature included in many MFPs. In addition to these federal requirements, many state governments also require their electronic and information technology to be accessible to people with disabilities. MFPs will need to be accessible in order to be marketable to federal and state government offices and workers.

The use of accessible technology has been shown to improve the lives of people with vision loss by increasing employment opportunities and advancement (Kelly, 2011, Kelly & Wolffe, 2012, McDonnall & Crudden, 2009), improving academic skills (Cooper & Nichols, 2007, Zhou et al, 2012) and leading to better psychosocial outcomes (DuBosque, 2014, Emerson & Bishop, 2012, Smedema & McKenzie, 2010).

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According to the 2012 National Health Interview Survey (American Foundation for the Blind, 2014), there are 20.6 million adults with vision loss. Data from the 2012 American Community Survey (ACS) show that 38% of working age individuals with a visual disability are employed compared to 72% of the general population and only 25% work full time compared to 53% (Cornell University, 2014). Employment for many people with vision loss depends on the ability to use common office equipment, and the inaccessibility of these devices may contribute to the high rate of unemployment. Thus it is essential that MFPs and other common office equipment be accessible.

Burton & Huffman (2006a) surveyed business leaders about the importance of employees being able to use ten types of office equipment. Large furniture-sized multipurpose copy machines received the highest rating in importance, followed in second place by desktop printers, scanners, and faxes. In 2006, Burton & Huffman (2006b) found major accessibility barriers in the representative MFP machines they tested. Eghtesadi et al (2002) examined popular copiers and found that most machines did not include accessibility features.

A recent study (McDonnall, O'Mally, & Crudden, 2014) found that most employers were unaware of how people with vision loss could perform typical job tasks. In particular, less than one-quarter were aware of how people with visual impairments could access general office equipment.

Huffman, Uslan, Burton, & Eghtesadi (2009) evaluated the accessibility and usability of two MFP access solutions for people with vision loss: Canon's Voice Guidance Kit, an embedded system within the MFP, and Xerox's Copier Assistant, a dedicated computer connected to the MFP. Eight participants who were blind or had low vision tested these two systems and, overall, were successful performing most of the required tasks. The embedded

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access solution was preferred over the separate computer option. Participants gave detailed suggestions for improving each of the access solutions.

The present study included two phases. The first was a follow-up on the 2009 evaluation by Huffman, Uslan, Burton, & Eghtesadi (2009), this time examining the accessibility and usability of three current MFP accessibility solutions from Canon, Ricoh and Lexmark. Access technology has changed rapidly. At the time of the 2009 study, there were no MFP access solutions that used a web interface. This follow-up study was critical in order that this new paradigm could be evaluated for accessibility. In addition, since the Canon solution had been significantly changed, it too was included in this study. The second phase of this study was a web-based survey of current users of MFP systems who are visually impaired in order to learn how MFPs are being used, to gather information on accessibility problems being encountered, and to learn the relative importance of specific MFP features.

USABILITY STUDY METHODOLOGY

In order to achieve the goal of full accessibility, manufacturers of MFPs need to take a Universal Design approach. According to Steinfeld & Maisel (2012), Universal Design involves improving our environment, products, and systems to meet the goal of full inclusion.

Universal Design focuses on creating products that are able to be used by the widest audience possible, assuring that products are simple to use, and include perceptible information regardless of how they are used (Story, Mueller, & Mace, 1998).

For people who are visually impaired to operate a multifunction printer independently, the following basic characteristics are required:

1. Non-visual access to the information and tasks available on control screen(s).
2. Optimized visual characteristics of embedded small touch-screen liquid crystal displays.

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3. Large-print, high-contrast control buttons that are tactilely and visually distinguishable from their surroundings.

4. Accessible operating manuals.

For MFPs, the most challenging of these requirements are the first two, ensuring access to the visual characteristics conveyed by embedded touch screens.

Apparatus

The current usability study re-examined the Canon access solution that was studied in the 2009 study. In addition, access solutions for Ricoh and Lexmark were evaluated. Xerox's Copier Assistant, which was evaluated in 2009, has not been updated to work with newer operating systems, so was not re-evaluated in this study. See Table 1 for a list of the capabilities of the three MFPs evaluated in this study. Evaluations for all three access solutions were performed with Non Visual Desktop Access (NVDA) paired with Firefox, and JAWS paired with Internet Explorer.

Ricoh, Lexmark, and Canon use different methods for providing accessibility to their multifunction printers. Both Ricoh and Lexmark use browser-based systems for providing access to their respective document centers. Ricoh's Access Module has a web app that uses nonstandard controls while the Lexmark Accessibility Solution uses a web interface with standard HTML controls; both are accessible from devices with web browsing capability. Canon uses a Text-To-Speech system called Canon Voice Guidance that is built directly into the document center and is controlled with the hardware keypad.

Unlike the other multifunction printers in this study, Canon uses a built-in Text-To-Speech solution to provide access to its document centers. The Voice Operation Kit allows users

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to utilize the tactile keypad to navigate menus and initiate jobs with speech feedback. Users can change the Text-To-Speech voice used, adjust the volume, and adjust the speed of the voice.

Participants

Ten volunteers with vision loss participated in this evaluation. Participants were contacted by a local blindness agency in West Virginia requesting their participation. Volunteers included seven males and three females with ages ranging from 22 to 71 years old. Eight were visually impaired since birth, and two became visually impaired before the age of 20. Five were able to access print using magnification, the others were not print users; for the purpose of this report those who use their vision to read will be referred to as having low vision, while those who do not use their vision to read will be referred to as blind. All but one participant had experience using copiers, although experience for several was minimal.

Usability Test Procedures

Test administrators provided a description of the overall testing process to participants including a brief description of each machine and its accessibility solution, including a description of the layout of the keys and their functions. Participants were allowed to tactually and visually examine the controls and ask questions. Test administrators demonstrated the use of the interface, allowing users to view and listen to the entire process. The order of machine testing was randomized for each participant.

Participants were asked to attempt to complete the following four tasks for each of the accessibility solutions:

- Make three copies of a three-page document, and collate the output.
- Make a double-sided copy of a two-page document.
- Scan a two-page document and save the image to a computer.

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- Scan a two-page document and e-mail the image to a recipient.

One at a time, each task was described and participants were given as much time as they needed to complete the task before going on to the next task. Participants were told that they could ask questions or use the system's help feature whenever they desired to do so. Test administrators took detailed notes along the way, and all sessions were videotaped. Test administrators assigned a success rating to each task performed, on a scale from 1 to 5, as follows:

Rating 1 Not successful at the task

Rating 2 Successful after the test administrator's involvement and assistance

Rating 3 Successful after hesitation and asking several questions

Rating 4 Successful after asking a few questions

Rating 5 Successful after asking minimal questions or completing the task independently

USABILITY STUDY RESULTS

The average performance rating for participants over the four tasks was 4.8 out of 5 for the Lexmark, 4.5 for the Canon, and 4.2 for the Ricoh, indicating a high success rate for tasks on all the MFP accessibility solutions. The average ratings for each task by machine were over 4.0 (successful after asking a few questions) except for Task 1 on the Ricoh (3.6). Out of the 120 individual machine-task combinations (10 participants, 3 machines, 4 tasks each), only ten yielded scores lower than 4.0, and the majority of these lower scores were for the same participant. Looking at all the machines together, the overall success rate increased over the four tasks (Task 1, 4.1; Task 2, 4.6; Task 3, 4.6, Task 4, 4.8) despite the fact that the tasks were ordered from less complex to more, indicating a learning effect.

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Ricoh's app requires the screen reader to switch from using the HTML web interface to using arrow keys to navigate. Due to its non-standard interface the web app does not work well with all screen readers and browsers. The best combination is the Firefox web browser in conjunction with the Non Visual Desktop Access (NVDA) screen reader.

Lexmark's web interface uses standard HTML controls that allow it to be used on all devices with a web browser. Standard links, edit fields, and buttons are used in a simple and unadorned HTML web interface facilitating quick load times and a better experience for users of mobile devices. Multiple jobs can be submitted and launched with unique codes that are generated; the user need not return to the accessible interface to begin another job if they have many to complete in a row. Because Lexmark follows good accessibility practices in their HTML web interface, a specific browser and screen reader combination is not needed for best results.

Participants overwhelmingly selected the Lexmark machine as their preferred access solution – eight participants selected Lexmark, one selected both Lexmark and Canon, and one selected Canon. Whether the participants had low vision or were blind did not affect their machine preference.

Lexmark was generally chosen due to its familiar, intuitive HTML web interface. With the Canon solution, users could not independently set up a sequence of often-used tasks and set them as “favorites”; they would require assistance from a sighted person. Once created, they would be able to use those favorites independently.

In contrast to the results of the 2009 MFP evaluation (Huffman, Uslan, Burton, & Eghtesadi, 2009) which found that participants who were blind performed better at the assigned

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tasks than those with low vision, the current study found no difference. On average, the five blind participants scored 4.5 across all the tasks, and the five with low vision averaged 4.6.

SURVEY METHODOLOGY

Participants

This survey included responses from 26 MFP users who are blind (for this study, those who don't use their vision to read) and 34 who have low vision (those who primarily use their vision to read). The sample consisted of 58% women and 42% men, whose median age range was 45 to 54 years old. The vast majority of the sample was white (83%) with 17% non-white or of mixed race. Seventy-eight percent were college graduates, and half of these graduates had also attended graduate school. Most were employed either full time (57%) or part time (8%). Their median income range was \$40,000 to \$60,000. Nineteen percent had a household income of \$20,000 or less, and 8% earned more than \$100,000 per year. The majority of respondents were visually impaired from birth (63%), with a total of 80% being visually impaired before age 18. Eighty-two percent of respondents had received some formal training to accommodate their vision loss, and were most likely to have had training or services provided at school (42%).

Survey Procedure

Respondents were recruited through an announcement in AccessWorld, as well as distribution through a number of organizations serving people who are blind or have low vision. Individuals were invited to visit a web page where they could participate in the survey using the website Survey Monkey (www.SurveyMonkey.com). Participants responded to mostly multiple-choice questions, although there were also several open-ended questions.

SURVEY RESULTS

Use of MFPs

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The majority of respondents (67%) reported that they have used an MFP at their workplace. A total of 77% have used an MFP either at their workplace or at home for work purposes. However, the largest number of respondents (80%) used MFPs at home for personal use. The most common brand of MFPs used by participants was Hewlett-Packard, followed by Canon.

The most important function of the MFP for participants was printing, followed by scanning, then copying (see Table 2.) All three of these functions were selected by a majority of respondents as being very or somewhat important to their specific needs. Faxing was the least important function, but still almost half thought it was very or somewhat important. Printing and copying were used more than once a week by the majority of respondents, and faxing was used by only a quarter of the participants more than once a week. Surprisingly, scanning, which was the second most important function reported by participants, was used at least once a week by only 49%. A full 39% of respondents used the print function six or more times a week, followed by the copy function, used more than six times a week by 18% of the sample; few used the scan and fax functions as often. A majority of participants (58%) used assistive technology to make their MFPs usable.

Respondents were given a list of techniques they would prefer to use to make MFP controls and displays more useable. Blind participants responded to a list of non-visual techniques, and those with low vision were given a list of visual techniques.

For controls, participants with low vision were most likely to prefer larger characters on labeling, followed by high contrast between background and labeling, and high contrast between background and controls. Almost all those who were blind chose speech output software, followed closely by tactile controls; braille dots or bumps were chosen by almost two-thirds of

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the participants (see Table 3.) Although respondents with low vision were not directly asked about speech output for displays, five individuals in this group wrote in that they wanted this. Similarly, this group was not asked about tactile identification, but two individuals wrote in this preference on their survey. Presumably, if speech output and tactile marking had been asked about specifically in the survey that people with low vision responded to, a larger number of individuals would have chosen these options. Other preferences that were reported included a tilting screen, the ability to control directly from a smartphone, use of different colors for function buttons, and the inclusion of a cancel button for each function.

For displays, respondents who had low vision were most likely to choose high contrast and larger characters, followed by low glare and built-in screen magnification; less than half preferred a brighter screen (see Table 4.) Almost all respondents who were blind chose speech output software; less than half indicated they would prefer a braille display. Additional techniques mentioned by participants included larger display screens, being able to change settings using a smart phone or the web, and being able to change the background and foreground colors. As with control preferences, those with low vision were not asked about speech output, yet four individuals indicated on the survey that they wanted this; it seems likely that if it had been given as an option a large percentage of respondents would have chosen it. Future surveys on the topic of MFPs should include non-visual technique choices even for people with some vision.

Statistical analyses (ANOVA and CHI-square) were conducted comparing the low vision group to the blind group on all responses to the questions in this survey. Note that almost all questions were identical for respondents who were blind and for those with low vision; survey items addressing access techniques were parallel though not identical. There was only one

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statistically significant difference between these groups – those with low vision were significantly more likely to use the MFP's copy function with higher frequency than were those who are blind ($p < .002$). Importance of the copy function, however, did not turn out to be significantly different for these groups.

DISCUSSION

The survey of MFP users gathered information on how people with vision loss are using the devices, how important the functions are to them, and what their preferences are for accessibility of the devices. The usability test studied the use of three existing access solutions by participants who are blind or visually impaired.

Despite having little time to familiarize themselves with the products, participants' performance ratings were quite high for all the MFP accessibility solutions, indicating that the solutions are not difficult to learn. Of the three accessibility solutions tested, Lexmark was the most popular. It included a simple well-designed interface that Internet users are familiar with, and included the largest number of accessible features, allowing users to quickly understand how to accomplish assigned tasks. For the Canon access solution, which was next in popularity, a big drawback was that users had to set up certain functions before they could use them independently of sighted help. Ricoh was the least favorite of the three solutions. Its interface was less intuitive and violated some of the standards of the Web Content Accessibility Guidelines (W3C, 2014).

The Canon access solution had the advantage of being integrated into the MFP itself, allowing users to walk up to the machine and use it without preparation. Ricoh and Lexmark relied on separate devices to interact with the MFP. Input devices that are separate from the MFP introduce additional security concerns (Naraine, 2013).

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Although the Lexmark accessibility solution received the highest success ratings, and Ricoh the lowest, average scores were rather high for all, indicating that all the systems can be learned without a lot of difficulty. A clear learning effect was demonstrated by participants over the four tasks they were asked to perform. Although the tasks were ordered by difficulty, success ratings increased over the four tasks. This finding is encouraging and suggests that users will quickly learn these systems and become better as they use them.

Suggestions from users to improve the access solutions they tested included making the text larger, reducing glare, increasing contrast, and providing voice output. These suggestions mirrored the findings of the user survey regarding preferences. In the user survey, respondents with low vision preferred larger characters on controls and displays, high contrast between background and controls and between background and labeling, low glare on displays, and screen magnification. Those who were blind preferred speech output for controls and displays, and tactilely distinguishable controls. Most did not indicate that they wanted a braille display. See Sidebar 1 for a list of recommended improvements for each of the three MFPs tested in the usability study.

It's important to note that survey respondents who use their vision to read indicated that they would like to have non-visual techniques available to them. Specifically, respondents mentioned wanting to have speech output and tactile markers available to them. Having multiple methods to obtain information increases the accessibility of a product. Surveys addressing accessibility that are aimed at people who have low vision must be sure to include non-visual techniques as well as visual ones.

The user survey results demonstrate that printing, scanning, and copying are the most important functions of an MFP for people with vision loss. Those with low vision were

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significantly more likely to use the copy function than those who were blind. While faxing was clearly less important to respondents, it was still considered an important feature by almost half the respondents.

Based on the findings of the usability study and the user survey, the following recommendations are proposed for developers of MFP access solutions:

- Developing a solution integrated with the MFP device is preferable to using a separate device.
- Use of a U.S. standard QWERTY keyboard interface is preferred, as most users will already have experience with the interface and will find tasks easier and quicker to learn.
- Labels, controls, on-screen text need to be larger and have high contrast
- Speech should be available for all tasks
- Best to have multiple methods to perform a function (speech plus touch plus text, etc)

In general, the American Foundation for the Blind recommends that in order to optimize the design of visual displays, manufacturers should use large fonts when possible, declutter the interface and limit the amount of text and icons located on a single screen, offer a white on black color scheme that eliminates grayscales completely, ensure that screen elements are spaced appropriately, and use a low glare display that can be tilted.

It is interesting to note that survey respondents were most likely to use Hewlett-Packard MFPs than any other, despite HP's lack of an accessibility solution, followed by Canon MFPs. These findings align with the general global market for MFPs: Hewlett-Packard has the largest

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market share worldwide (41%) for hardcopy peripherals, followed by Canon (20%) (International Data Corporation, 2013).

IMPLICATIONS FOR PRACTITIONERS

Those working in the rehabilitation field need to be familiar with the access solutions for multifunction printers evaluated in this report, so they can make suggestions to potential employers about how their clients might be accommodated. Rehabilitation workers should encourage their clients to become familiar with accessible solutions, as these are commonly used in the workplace. Knowledge of how these MFPs work should be beneficial in seeking employment.

Teachers of visually impaired children and young adults should be aware of accessible solutions for MFPs, and make sure their students aware of them. Many students will need to be familiar with MFPs in order to increase their future job prospects. If a school can afford to purchase an accessible solution, students with visual impairments would be able to use these independently for their schoolwork when printing, copying, or scanning are required.

CONCLUSION

The user survey found that somewhat more people with vision loss use MFPs for personal use than for employment purposes. Those who use individual MFPs from home will benefit from the availability of accessible solutions in order to independently work from home or engage in social activities or individual interests that require MFPs.

Printing, scanning, copying, and faxing continue to be critical tasks that workers are expected to handle in a modern office. In order for office workplaces to continue to be as accessible as possible to people with vision loss, the development or improvement of accessible, useable multifunction printers are essential. In addition to its importance for 508 compliance, the

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availability of accessible MFPs will ensure that those with vision loss will continue to be able to perform the same tasks as their sighted colleagues in the workplace.

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Table 1.

Capabilities of the Three Evaluated MFPs

	Canon	Lexmark	Ricoh
Basic Copy	Yes	Yes	Yes
Advanced Copy	Partial	Yes	Partial
Scan	Yes*	Yes	Yes
Fax	Yes*	Yes	Yes
Tactile Keys	Yes	Yes, with optional sticker overlay that was not available at time of testing	Yes
Tilting Display	Yes	Yes, but not available at time of testing	No
Reverse Contrast Option	Yes	No	No
Access at Machine	Yes	No	No
Access from Computer or Smartphone	No	Yes	Yes

* Destination must be preconfigured by system administrator

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Table 2.

Importance and Usage of MFP Functions (N varies from 44 to 60)

Function	Percent having Function	Percent Indicating that Function is Very or Somewhat Important	Percent Indicating that Function is used more than once per week	Percent Indicating that Function is used six times a week or more
Copy	100%	65%	58%	18%
Scan	97%	67%	49%	9%
Print	92%	85%	85%	39%
Fax	75%	43%	25%	7%

Table 3.

Preferred Techniques for making MFP Controls More Usable

Visual Techniques (asked only of those w/low vision)	Percent (N=34)
Larger letters and numbers on labeling	85%
High contrast between background and labeling	76%
High contrast between background and controls	71%
Non-Visual Techniques (asked only of those who are blind)	Percent (N=26)
Speech output software	92%
Tactile controls	88%
Braille dots/bumps for identification	62%

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Table 4.

Preferred Techniques for making MFP Displays More Usable

Visual Techniques (asked only of those w/low vision)	Percent (N=34)
High contrast bet background and words and numbers on screen	79%
Larger letters and numbers on display	76%
Low glare on display	65%
Built in screen magnifier	65%
Brighter screen	41%
Non-Visual Techniques (asked only of those who are blind)	Percent (N=26)
Speech output software	92%
Support for braille display	46%