Applying the Spatial-Contiguity Effect to Software Manuals

Christopher Lam
Illinois Institute of Technology
lamchri@iit.edu

Abstract

Research on the design of user manuals has supported the multimedia principle, asserting the effectiveness of including screen captures along with text in procedural learning tasks. However, much of this research has yet to focus on several other major design principles presented in Mayer's Cognitive Theory of Multimedia Learning. This paper will provide designers and developers of user manuals a new perspective on the design process based on principles from instructional design, as described in Mayer's research. Mayer showed that students indeed learned more deeply when the design of multimedia documents adhered to these principles, regardless of medium. This study will discuss the ways in which user manuals adhere to one of Mayer's principles, the spatial-contiguity effect, and will provide recommendations about how user manuals can be improved by greater adherence to that principle.

Keywords: *user manuals, instructional design, document design.*

Introduction

User manuals are created to instruct users about how to properly utilize a piece of technology. Research surrounding the design of user manuals has been quite substantial, but has been limited in certain aspects pertaining to instructional design methods. Recent research has indicated the advantages of providing text and pictures in user manuals. Even though this research exists, there less work has focused on several other aspects of design in user manuals. For example, research has not clearly focused on aspects of design and development of user manuals such as tone, placement of images, and how much content should be included in a manual.

There is, however, an instructional design theory that addresses these issues in the design of multimedia instructional materials. A multimedia document can be defined as any document that contains a combination of text and images. Mayer's Cognitive Theory of Multimedia Learning (CTML) establishes several instructional design principles for multimedia documents, one of which will be further analyzed here.

This paper reports on an analysis of user manuals that looked specifically at the extent to which principles from Mayer's CTML were being applied. The goal of the study was to outline ways that the design of user manuals can be improved by discovering deficiencies in manuals based on principles set forth in the CTML. The current paper focuses on one principle in particular: the spatial-contiguity effect. This principle asserts the importance of keeping corresponding text and images in close proximity.

This paper begins with an overview of Mayer's CTML, followed by a brief review of the literature on user manuals. A description of the study, methodology, and the procedure used to evaluate the user manuals will follow the literature review. Some design recommendations will also be outlined. Finally, conclusions and implications for future research will be stated.

An Overview of Mayer's CTML

The CTML is based on three assumptions, from which Mayer's principles are derived. The three assumptions derived from cognitive science research include the dual channel assumption, the limited capacity assumption, and the active learning assumption. Paivio's research on the dual channel assumption concluded that humans have different processing systems for both verbal and visual information.[1] An example of this assumption is the way humans process

0-7803-9778-9/06/$20.00 ©IEEE.

animations, through the visual channel, and the ways humans process narrated text, through the auditory channel. The second assumption, the limited capacity assumption, was based on the idea that the amount of processing that takes place in either channel, visual or auditory, is quite limited.[2] Finally, the active learning assumption states that "meaningful learning occurs when learners engage in active cognitive processing including paying attention to relevant incoming words and pictures, mentally organizing them into coherent verbal pictorial representations, and mentally integrating verbal and pictorial representations with each other and with prior knowledge."[3, 129]

Mayer's CTML states that when instructional design methods adhere to these processes, they are more likely to promote deeper learning. It is from these three assumptions that eight principles of multimedia learning are derived: the multimedia principle, personalization effect, contiguity effect, coherence effect, modality principle, the redundancy principle, interactivity principle, and the signaling principle. However, only the spatial-contiguity principle will be further discussed in the course of this paper. This principle claims that students will learn more deeply when printed words are placed in a close proximity to corresponding images.[4]

In Mayer's (2003) study, he began to bridge the gap between instructional design principles and print documentation. His principles were already established for online media. However, in his 2003 study, Mayer discovered that his instructional design principles were indeed effective across two different media, book-based and computer-based.[3]

Previous Research on User Manuals

Within the field of technical communication, research on user manuals provides a strong argument for applying instructional design principles, particularly the CTML, to print documentation such as user manuals. Ganier addresses document design principles for user manuals. Ganier outlines a model that describes the ways procedural instructions are processed.[5] The model includes five major steps: setting and holding a goal representation; integrating information from the document, the equipment and the user's prior knowledge; action planning and executing the action plan; activity monitoring and regulation; and integrating long term memory. Essentially, Ganier presents this model and points out the complicated nature of processing procedural instructions. He then uses the model to provide a basis for several design recommendations. One major suggestion is that instructions should be presented in a mixed format.[5] Further, he describes a study that compared instructions that contained text only versus pictures and text finding that "the results suggest that the cognitive load involved in the construction of a mental model (and an action plan) is lower in presentation formats that include pictures."[5, 21]

There has also been extensive research on screen captures in user manuals that seems to support aspects of Mayer's instructional design principles. Van der Meiji has conducted several studies comparing text-only manuals and manuals containing screen captures. In one such study, it was discovered that manuals that included images were more effective than those without.[6] Van der Meiji speculated that users gained confidence from the visual manuals because they were provided with immediate visual feedback, which in turn reduced cognitive load.

Because so much research regarding user manuals and procedural instructions has focused solely on issues regarding images and text, there is a clear gap in the literature where the current study may find a niche because much of this research has yet to discuss other instructional design principles. Although the research has discussed the multimedia principle, it has yet to specifically examine other instructional design principles including the spatial-contiguity effect.

Description of the Current Study

A study was conducted in which four of Mayer's instructional design principles were applied to software manuals. The purpose of this study was to examine the ways in which software manuals adhered to, or violated, the principles set out in Mayer's CTML. The findings presented in this paper focus on one of the four principles examined, the spatial-contiguity effect.

User manuals are essentially instructional material, used to assist users in learning new software or other technical device. Adherence to

the spatial-contiguity principle works to accomplish one of two major paths set forth to foster meaningful learning. Meaningful learning can be accomplished by either 1) reducing cognitive load or 2) increasing the learner's interest.[7] The spatial-contiguity principle addresses the former , while other principles not discussed in this paper address the latter.

The remainder of this paper outlines the methodology used for selecting the software manuals, as well as the process by which they were evaluated. Following the methodology, an analysis of the manuals is presented that outlines the findings of the evaluation, as well as a detailed analysis of the evaluation. Conclusions and recommendations are then provided based on the analysis. Finally, opportunities for future research are outlined.

Methodology

To study the application of Mayer's instructional design principles to user manuals, a thorough examination of user manuals was conducted. Four manuals were selected to be evaluated:

- Microsoft Digital Image Suite user manual- 2005
- Apple iPhoto user manual- 2006
- Blackboard Academic suite user manual- 2004
- Eudora Email 7.0 for windows user manual- 2005

To create a homogeneous sample, all of the manuals selected were software manuals, published in 2004 or later. Recent manuals were chosen to ensure the validity of the study because manuals have indeed evolved over the years. Moreover, manuals from the top software developers were chosen, especially Microsoft and Apple. These manuals were exact replications of the print manuals, and therefore, are not considered online manuals. The spatial-contiguity effect was kept in mind when examining the manuals. This effect states that deeper learning is promoted when printed words are placed in close proximity with corresponding images.[4] Manuals were considered in adherence with the spatial-contiguity effect when

- Corresponding text and images were located on the same page, especially in descriptive content
- Images that correspond to a specific step in procedural content were located either directly above, below, to the right, or to the left of corresponding text

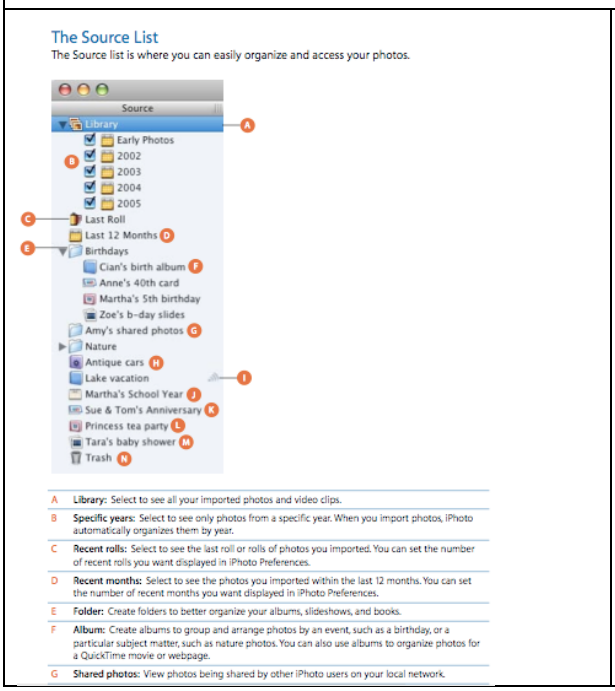
For the purposes of this study, descriptive content is any content that seeks to inform a user about specific features of a product, while procedural content is that which outlines a set of instructions for the user. Both types are present in most user manuals.

Analysis of Selected Manuals

Each page of the manual was scanned, keeping in mind the spatial-contiguity effect. If a positive or negative example was observed, a screen capture of that example was taken. This article will present these instances.

As described in the methodology, a section of a user manual was considered in violation of the spatial-contiguity effect if both words and corresponding images were not located on the same page. This effect was most often violated in the descriptive sections of the manual; however, there were some instances in which manuals that were examined violated the spatial-contiguity effect for procedural materials as well. The spatial-contiguity effect asserts that users will learn more deeply when printed words are placed in a close proximity to corresponding images.[4] It is clear that the multimedia principle has been corroborated with research that addresses the importance of including screen captures in software manuals. It is also clear that many companies, for example Microsoft and Apple, indeed do include screen captures and other images in the software manuals that they produce. However, the multimedia principle is not the only issue that should be addressed when designing user manuals. The spatial contiguity effect addresses the interplay between images and text, stressing the importance of placing relevant pictures and text in close proximity to each other. Figure 1 shows a violation of the spatial-contiguity effect in a descriptive section of the Apple iPhoto software manual.

Figure 1- Violation of spatial-contiguity effect (two separate pages of the manual)



The Source List

The Source list is where you can easily organize and access your photos.

Source

Library
Early Photos
2002
2003
2004
2005
Last Roll
Last 12 Months
Birthdays
Cian's birth album
Anne's 40th card
Martha's 5th birthday
Zoe's b-day slides
Amy's shared photos
Nature
Antique cars
Lake vacation
Martha's School Year
Sue & Tom's Anniversary
Princess tea party
Tara's baby shower
Trash

A **Library:** Select to see all your imported photos and video clips.

B **Specific years:** Select to see only photos from a specific year. When you import photos, iPhoto automatically organizes them by year.

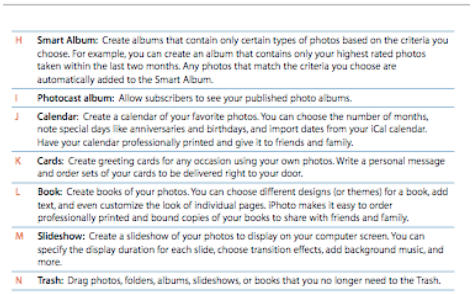
C **Recent rolls:** Select to see the last roll or rolls of photos you imported. You can set the number of recent rolls you want displayed in iPhoto Preferences.

D **Recent months:** Select to see the photos you imported within the last 12 months. You can set the number of recent months you want displayed in iPhoto Preferences.

E **Folder:** Create folders to better organize your albums, slideshows, and books.

F **Album:** Create albums to group and arrange photos by an event, such as a birthday, or a particular subject matter, such as nature photos. You can also use albums to organize photos for a QuickTime movie or webpage.

G **Shared photos:** View photos being shared by other iPhoto users on your local network.



H **Smart Album:** Create albums that contain only certain types of photos based on the criteria you choose. For example, you can create an album that contains only your highest rated photos taken within the last two months. Any photos that match the criteria you choose are automatically added to the Smart Album.

I **Photocast album:** Allow subscribers to see your published photo albums.

J **Calendar:** Create a calendar of your favorite photos. You can choose the number of months, note special days like anniversaries and birthdays, and import dates from your iCal calendar. Have your calendar professionally printed and give it to friends and family.

K **Cards:** Create greeting cards for any occasion using your own photos. Write a personal message and order sets of your cards to be delivered right to your door.

L **Book:** Create books of your photos. You can choose different designs (or themes) for a book, add text, and even customize the look of individual pages. iPhoto makes it easy to order professionally printed and bound copies of your books to share with friends and family.

M **Slideshow:** Create a slideshow of your photos to display on your computer screen. You can specify the display duration for each slide, choose transition effects, add background music, and more.

N **Trash:** Drag photos, folders, albums, slideshows, or books that you no longer need to the Trash.

The spatial-contiguity is being violated in this example because the textual description of the graphic spills over to the following page. This is detrimental to the user for several reasons. First, the screen capture and the text are dependent upon each other. That is, the screen capture itself does not tell the user anything about the software, nor does the text. Although the text does give the user a short definition of each item, without the screen capture to complement the text, the user will not likely retain such information. This leads to another major problem that the user will come across: switching back and forth between pages to refer back to the screen capture. This process is not merely an annoyance, but also can become a detrimental to learning.[4] The natural flow of reading becomes interrupted and can cause problems in retention. Furthermore, the user loses the context that the corresponding image provides when the text that spills over onto the following page is not accompanied by the original image.

There are several ways that document designers can combat this problem. One major problem occurs with the amount of space that is available on a page. Often times it is difficult to fit all of the corresponding text and images on a single page. One way keep pictures and words in close proximity is to repeat the image on the second page, so that it can be referred to on the following page as well. This provides the user with the proper visual context for the textual descriptions. This might not be the best solution to the problem, however. Document designers might argue that repeating the same image is not only redundant, but may even confuse users. Further, it can potentially cost more on the production side, forcing the publisher to use more pages and high resolution images. Therefore, another way to solve the problem would be to more effectively utilize space in the document, so that all of the pertinent information could fit on one page. An example of this approach is shown in Figure 2.

Figure 2- Adhering to the spatial-contiguity effect by effectively utilizing space

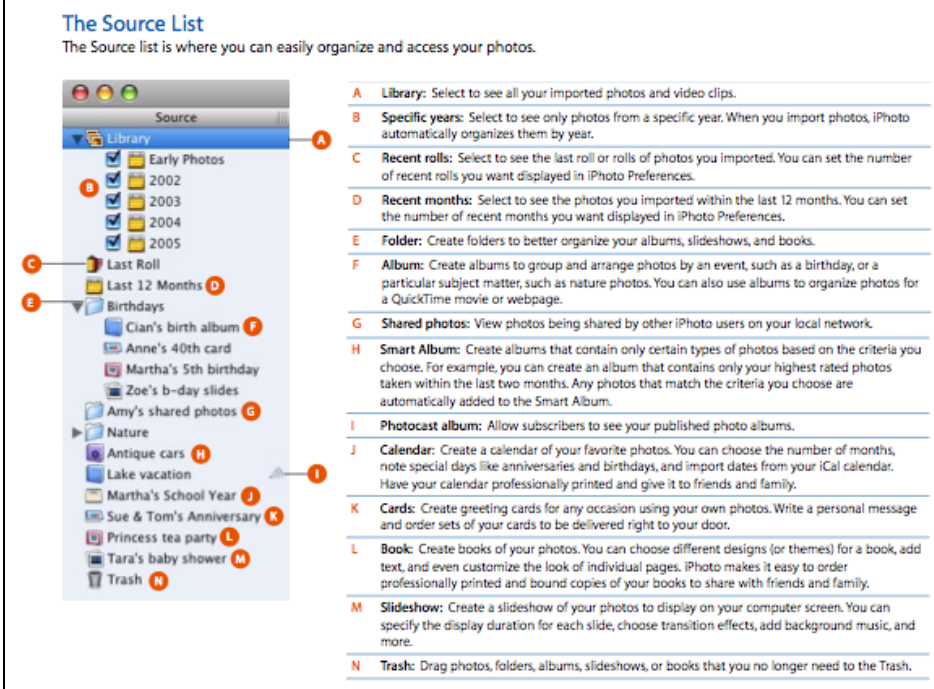


Figure 2 effectively displays all of the necessary content in a single page. It can be argued that it is quite difficult to fit 14 item descriptions and a screen capture into one page, but this example shows that it can be accomplished with a conscientious use of space. A user would be able to utilize the example in Figure 2, rather than the one in Figure 1, because the last seven item descriptions are located on the same page as the reference screen capture. By incorporating the strategy outlined, the contents are displayed more effectively and efficiently.

The spatial-contiguity was violated more often in descriptive sections of manuals, as shown in Figure 1. This is quite logical because the descriptive sections of manuals, much like the example from Figure 1, often display a large amount of description. The sheer quantity of items that need to be described is often times so large that it is difficult to fit everything onto one

page. Even though the descriptive sections of manuals violated the spatial-contiguity effect most often, there were instances in which the effect was violated in procedural sections of software manuals. Although the effect was found to be violated often in procedural sections, it is important to investigate because procedural type material may be more vital to the completion of a specific task. The user can often explore the software to familiarize themselves with the content in the descriptive sections of a manual, but they will not be able to perform certain tasks through a trial and error approach. For example, a beginning user of Microsoft Word may not know how to record a new macro. Because this procedure is complicated, and not often used in every day word processing, the procedural instructions would be vital for a beginner to complete the task. An example of procedural instructions violating the spatial-contiguity effect can be seen in Figure 3, again taken from the Apple iPhoto software manual.

Figure 3- Spatial-contiguity effect violated in a procedural section

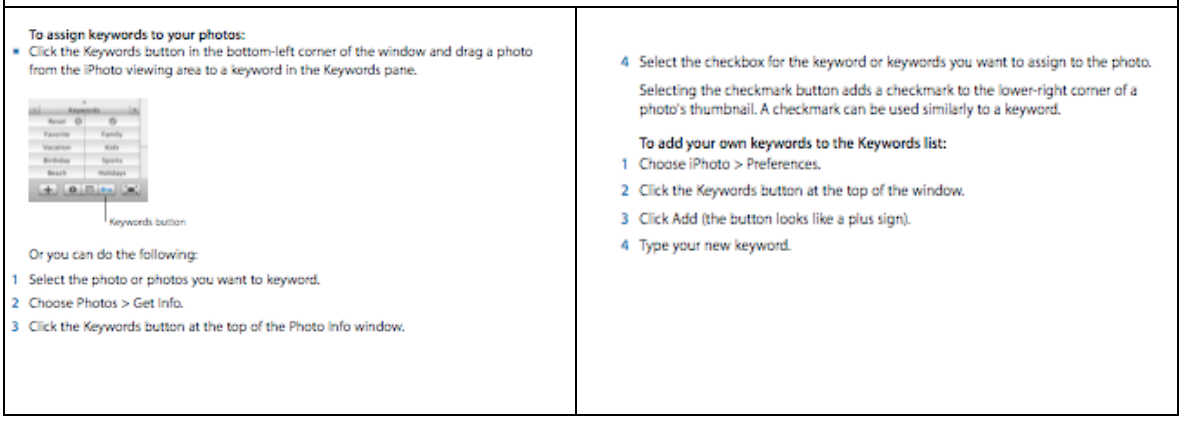


Figure 3 shows several problems that occur from separating text from corresponding images. In this case, the final step of the procedure is located on the following page where the screen capture is placed. This can potentially be a major problem if the final step is a vital one in completion of a specific task. In this case, step 4 brings the task to completion, asking the user to "select the checkbox for the keyword or keywords" they should assign to the photo. Not only is this a vital last step for completion of the task, but it also describes an action that relies on the screen capture. The user does may not know where the "checkbox for the keyword or keywords" is located.

Another major problem with separating text and corresponding images is what appears after the final step of the procedure. In this case, a new set of instructions is displayed. This could be potentially confusing to the user, because unrelated procedures are located on the same page, in close proximity. Further, research has indicated that users of manuals often use them reference material. This means that they do not read them in sequential order, like a book, but rather flip to the page where they feel they need to find an answer to a problem they are having. This has implications for the spatial-contiguity effect. If a user flips to the second page in Figure 3, the first thing that they see is step 4 from a procedure that has absolutely no context. This isn't to say that the user cannot simply turn back the page to find the context in which the step belongs to, but it makes it inconvenient and difficult for the reader. Although it may be difficult to keep separate procedures on different pages, being sure to place text and corresponding images on the same page would be an effective solution to avoid the problems discussed.

Figure 4 shows the same procedural information as the previous example in adherence to the spatial-contiguity principle.

Figure 4- Procedural material adhering to spatial-contiguity effect

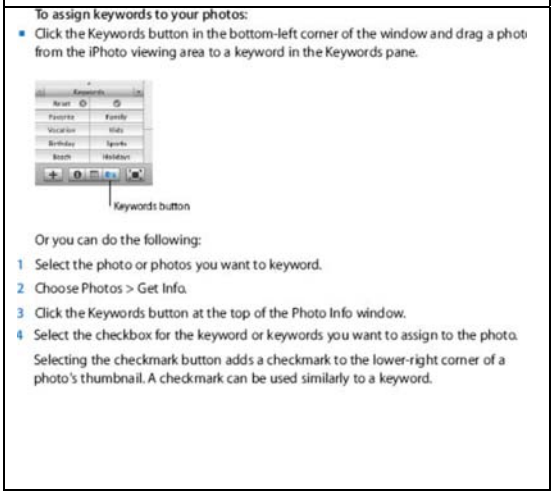


Figure 4 shows a positive example of the spatial-contiguity principle. It keeps the entire text of the procedure and the screen capture all on one page. This not only makes it easier for the user to learn that specific procedural information, but it also clearly separates the material from any subsequent set of instructions, making the information more clear and easier to use.

Conclusions

This evaluation of user manuals, in light of Mayer's CTML, accomplishes several things. First, it brings to light the areas in which user manuals can be improved. By examining manuals from two major corporations, certain findings can be generalized to smaller companies. The spatial-contiguity effect was a common problem throughout the manual analysis. More specifically, the violations occurred most commonly in descriptive sections of the manuals. For example, violations occurred in areas where there was a large screen capture depicting several icons used throughout the software (see Figure 1). The icons were visually shown and then textually described. In these instances, a large quantity of images and corresponding descriptive text was necessary, making it difficult to fit onto one page.

Two major recommendations were given to improve upon this problem: 1) Better utilize the any white space within a page to fit the all of the text and corresponding images onto one page; or 2) Repeat the image on the subsequent page to accommodate the text that spills over.

It can be concluded that even the higher quality manuals, those produced by Apple and Microsoft, violated the spatial-contiguity principle. Document designers and other producers of such manuals should be aware of this violation when designing manuals. By consciously being aware of this when creating manuals, the end product can possibly become much more useful to users.

Implications for Future Research

This study has several implications for future research. Future studies can be conducted examining several other principles derived from Mayer's CTML. Usability tests can be conducted on two sets of user manuals: those that adhere and those that violate Mayer's principles. The success rates of each group of manuals can be compared to determine the implications that the instructional design principles have on user manuals. Stronger recommendations for the design of user manuals can be suggested from these subsequent studies.

References

[1] A. Paivo, "Mental representations: A dual coding approach," Oxford: University Press, 1986.

[2] P. Chandler and J. Sweller, "Cognitive load theory and the format of instruction," *Cognition and Instruction*, vol. 8, pp. 293-332, 1991.

[3] R.E. Mayer, "The promise of multimedia learning: Using the same instructional design methods across different media," *Learning and Instruction*, vol.13, pp. 125-139, 2003.

[4] R.E. Mayer, "Research-based principles for the design of instructional messages," *Document Design*, Vol.1, pp. 7-20, 1999b.

[5] F. Ganier, "Factors affecting the processing of procedural instructions: Implications for document design," *IEEE Transactions on Professional Communication*, vol. 7, pp. 15-26, 2004.

[6] M. Gellevij and H. Van der Meiji, "Empirical proof for presenting screen captures in software documentation," *Technical Communication*, vol. 51, pp. 224-238, 2004.

[7] R.E. Mayer, S. Fennell, L. Farmer, and J. Campbell, "A personalization effect in multimedia learning: Students learn better when words are in conversational style rather than formal style," *Journal of Educational Psychology*, vol. 96, pp. 389-395, 2004.

About the Author

Christopher Lam is a PhD candidate in the Technical Communication program at the Illinois Institute of Technology. He has designed and developed instructional design materials for professional organizations. His current research interests are in the area of instructional design and usability.

0-7803-9778-9/06/$20.00 ©IEEE.