

Multimedia Help: A Literature Survey and a Preliminary Experimental Design

by

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1. Introduction

Multimedia has become widely accepted as an effective interface for exploratory education. Despite this fact, little is known about this new form of interface – in which context is it appropriate and which media should be used for presenting what kinds of information. Designing a multimedia interface is currently based on programmer's intuitions and, increasingly, design skills of graphic artists and educators whose experiences are on designing presentations on media. Multimedia applied to a help interface is a dynamic form of communication capable of brining as many medium as appropriate into use. However, lack of understanding of the tie between efficacy in learning in a multiple-media help environment and effectiveness in user's operational performance implies a need of studies to understand this relationship. What we want in a long run from these studies is a model which would help predict the relationship between how users learn from different and integrated media and translate the information learned into activities required to operate in interface environments.

Sun has a strong interest in supporting multimedia help in order to ease the learning process of the increasingly more sophisticated OPEN LOOK environment; the target audience are non-technical users. The objective of this Collaborative Research (CR) between GaTech and SunSoft Inc. is to investigate through conducting an experiment effectiveness of various mappings from help information to media. The investigation will explore, singly and in combination, use of media such as text, static graphics, video, speech audio, and context-sensitive animation, in the context of on-line help. Expected results are experimental data analysis, discrete recommendations for integration of multimedia to Sun on-line help support, and the software architecture for a multimedia help prototype to be developed for the experiment.

In pursuing this CR, previous research and studies in related areas including psychology, human factors, and education have been surveyed. What we looked for in the survey are leads for building an information categorization which can suggest a systematic break down of help contents, and evidences which support or discourage uses of certain presentation forms in various contexts; presentation media and types of information are part of the context we specifically looked

for. The result of the survey provides a structured view of help interfaces, a feel for how much studies related to multimedia have been done, the current standing of human information processing relevant to multimedia, how different researchers approached media-related problems in their studies, and what our next steps should be towards multimedia help studies. The result of the survey is summarized in the following section.

2. Summary of Literature Survey

2.1 Help Research and Taxonomy

2.1.1 General Background on Help

Our first step is to understand the structure of help and distinctive features which can categorize help information in order to understand the purposes which different kinds of help information serve. There have been a few efforts which characterize features associated to help. Borenstein (1985) categorized the access and presentation aspects of help; access is differentiated by whether the system or the user initiates help, and user-initiated help is further differentiated by the means (keyword access, menu, spoken words, etc.) by which access is generated. Presentation is differentiated by the method used to present help (scrolling text, window, speech, pictures, etc.) and by the information source for the presentations (on-line manual text or representations). Borenstein's taxonomy is by far the most extensive help categorization among help research prior to this CR.

Borenstein used a user perspective as a ground to characterize help. In this section, we will compile a taxonomy of help interfaces in the same fashion using Borenstein's taxonomy as a start. We will then fill in each category with more subcategories as well as extend the taxonomy to include media and presentation styles. Specifically, how the user perceives interfaces of help systems in our taxonomy consists of how to access help and the presentation of help presented as responses to help requests; the latter includes the content substance, the media in which it is presented, and how the presentation adapts to various contexts.

Table 1 summarizes help features combining this user view of help interfaces and Borenstein's taxonomy. Two aspects of help access are summarized: who initiates help, and how to access help when the user is the initiator. Three categories of help presentation are summarized – the nature of help content, the medium and presentation style of help, and the level of help's adaptiveness to its environment. The following subsections discuss these features in more detail.

Help Interface (User View)	Help Access	INITIATOR: System-initiated/User-initiated
		ACCESS METHOD: Keyword-based/Natural-language-based/ Graphical/Gestural/Spoken
	Help Presentation	CONTENT: Label/Descriptive/Spatial/ Functional Relation/Procedure/ Pre-condition/Post-condition/Temporal/ Covariance/Reference/Error Message/Prompt/ WHY Explanations/Trouble Shooting
		MEDIUM: Textual/Static-Graphical/Animated/ Speech Audio/Non-speech Audio/ Video/Multimedia
		ADAPTIVENESS: Static/Context-sensitive/ History-sensitive/User-sensitive

Table 1 Help Interface Characteristics

Who Initiates Help : Passive vs. Active Help

System-initiated help monitors user activities and intervenes when the user makes mistakes (Kearsley, 1988) or diverges from known goals. Borenstein, as mentioned earlier, differentiated whether was invoked by the user or by the system. Kearsley (1988) and Balzert & Lutze (1987) also taxonomized system-initiated and user-initiated help access. This kind of help is also referred to as *active*¹ help (Fischer, Lemke, and Schwab, 1985; Matthews and Bismas, 1985; Hecking, 1987).

System-initiated help is always alert and obviously requires extensive knowledge of expected user behaviors and goals in the particular application domain it supports in order to be active. **User-initiated** help, on the other hand, does not monitor the user and hence requires less information storage. It requires the user to make explicit requests to access help information. In contrast to the term active help, user-initiated help is also called *passive* help (Fischer, Lemke, and Schwab, 1985; Hecking, 1987). Traditional help systems are passive. Multimedia help to be studied in this CR is also assumed to be passive.

¹ Italics are used to list other terms which are similar or related to the categories in the taxonomy.

Access Method : Forms of Help Request

In traditional textual interfaces, explicit help requests are most likely *textual* questions. These questions may be formed using a set of limited *keywords* known to help subsystems or *natural language* may be used such as in the Unix Consultant (UC) system (Wilensky, Arens and Chin, 1984; Chin, 1986). With interfaces advancing and the use of multiple media becoming common, explicit textual requests may use or be combined with other media such as *graphical*, *gestural*, or *spoken* forms, to better convey the intention of user requests. It is potentially more natural when the forms used to access help are consistent with the interface styles being used. Graphical help access ranges from minimally graphic, such as selecting a help topic from a menu as normally supported in the Macintosh interface (Apple, 1988), to highly graphical such as pointing at graphical objects on the screen to form help questions. VSTAT's help (Stevens and Miller, 1987) is an example of the latter where the user can combine textual questions with pointing at objects on the screen.

Though the help request aspect is not the focus of this CR, mentioning it here completes the picture of help interfaces. It also serves as a pointer to what a help designer should be thinking about in designing a help interface.

Content : What Help Delivers

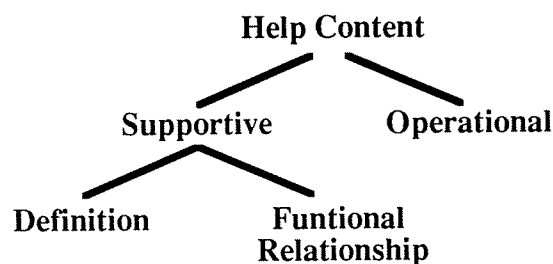
Terminologies used to label the kinds of help information content are the most confusing. Following are some examples.

Breuker (1987) identified two kinds of knowledge important for a user to acquire skills: support and operational knowledge. *Support knowledge* gives context-independent meaning which justifies the operations used; the operations are chosen by the user based on her *operational knowledge* which is used for solving task-related problems. Barnard, Wilson, & Maclean (1987) mentioned the need for *procedural knowledge* to support user translation of cognitive tasks—understandings of what a computer application program can do for her—into actions. These actions are actions to be performed in a computer interface and the parameters required to complete these actions. Gwei & Foxley (1990), following an educator, Ennis (1969), prescribed a good help system as being equipped by *interpretive* (what) and *descriptive*¹(how) explanations. Carroll & Aaronson (1988) conducted a study to understand the importance of separating conceptual *how-it-*

¹The term *descriptive* used by Gwei and Foxley is rather confusing in the context of other research. They used the term to mean descriptions of procedures rather than descriptions of objects or concepts.

works and procedural *how-to-do-it* help in user learning to perform tasks. This "how-it-works" information is similar to the *device model* proposed by Kieras & Bovair (1984) as being essential in learning *how-to-operate* unfamiliar equipment. Gong & Elkerton (1990) made explicit that *conceptual assistance* is especially useful when the application of previously learned procedures is required in new situations.

Despite the different terminologies used by these researchers, they agree on roughly two types of help information – that about how to perform tasks (**operational**), and that being supportive knowledge to understand purposes of these tasks (**supportive** or *conceptual*). There seem to be slightly different but complimentary opinions in the supportive information. The terms *supportive* knowledge and *conceptual* assistance are rather broad, and within their scope they include both *interpretive* and *how-it-works* explanations – interpretive information provides **definitions** of components and how-it-works information provides concepts about **functional relationships** of components in a system. So far, the breakdown of help information is as follow:

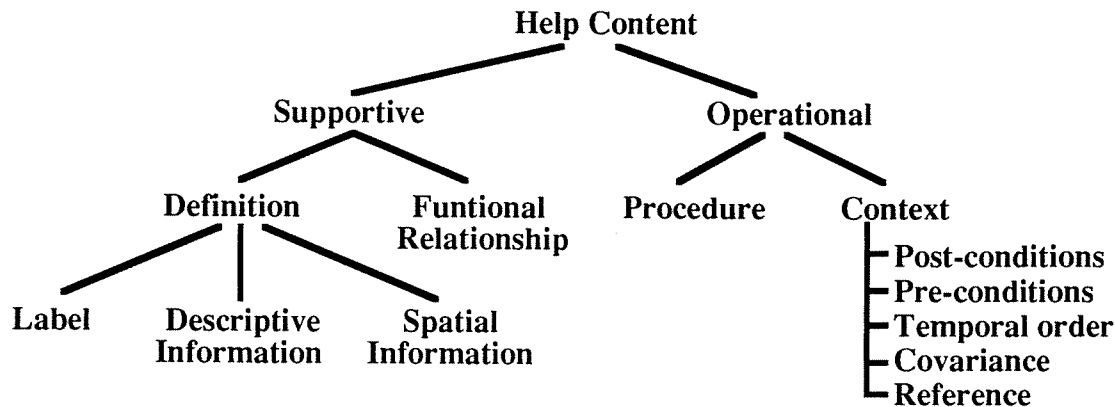


Bieger & Glock (1985) compiled a taxonomy of types of information needed for procedural picture-text instructions. In their taxonomy, they combined information categories identified from their observational study of an assembly task with pictorial information categories by Mandler and Johnson (1976), semantic case roles by Fillmore (1968), and predicate relationships by Grimes (1975). Some of relevant categories identified were: **inventory**²—information which specifies objects or concepts such as names; **descriptive**—figurative details of objects or concepts; **spatial**—location, orientation, and composition of objects; **operational**—procedures of what to do with objects; *contextual*—information which provides organizations of other information that may precede or follow, such as task **pre-** and **post-conditions**; **temporal**—time courses of series of actions or events; **covariant**—relationship between two or more pieces of information; and, **emphatic**³—pointers to other information. The information categories by Bieger & Glock is rather comprehensive and useful for categorizing help contents.

² is termed **Label** in the tree and in Table 1. We try to simplify these terminologies to fit on-line help better. This category is one example.

³ is termed **Reference** in the tree and in Table 1. The title reference is more indicative of what the help information categorized by Bieger and Glock is for.

The first 3 categories identified by Bieger and Glock – inventory, descriptive, location – serve well as breakdown categories of definition. Their contextual category serves well as a breakdown of information concerning operations other than the procedural information itself. We layout the breakdown of operational information as procedural and contextual, the latter contains categories taken from Bieger & Glock. The current breakdown is as follow:



The CONTENT: cell of Table 1 summarizes these categories of information. We only included the categories at the bottom of the tree above in the cell. There are also other types of help not covered by these researchers such as error messages, prompts, explanations for WHY questions, and trouble shooting help; they are also included in the table. Information in these categories are harder to subcategorize since their contents can be very application- and situation-dependent.

Medium : Presentation Forms of Help

Possibilities for help presentation have followed advances in user interfaces. The traditional text-oriented interface for decades has dictated text as the dominant presentation form of help. With the advent of graphical interfaces, presentation of help was no longer restricted to textual format. Static pictures have been used in help (X, 1988; OPENLOOK, 1990) to relate explanations of concepts with what the user sees in graphical interfaces. However, static pictures do not achieve the full-fledged visualization, which other presentation forms could achieve, of the overall dynamic procedures involved in advanced interfaces.

As higher-performance computers and higher-resolution screens become common, static graphics can be easily displayed in a window and aesthetic animated media are no longer an impossible luxury. Displaying pre-recorded video materials is becoming common. Graphical animated help suggesting what needs to be done directly on the screen has emerged. As a matter of fact, a few attempts to use graphical animation in help marked early innovations in the animated help direction

and predated the use of video on a computer display. Cullingford, Krueger, Selfridge, & Bienkowski (1982) used pre-stored animated demonstrations to support context-sensitive textual help explanations in their CAD HELP system. Neiman (1982) extended CAD HELP to include a generation of graphical animation from the scriptal knowledge originally used for textual explanations. Feiner (1985), though did not use animation, used static graphical illustrations indicating movements in his automated explanation system, APEX, to suggest steps of operations. In the author's earlier prototype and also in her thesis, simple two-dimensional context-sensitive animation of input devices were used to illustrate interactive procedures in an application context (Sukaviriya, 1988; Sukaviriya, 1991). Other media, such as speech audio, are conceivably becoming suitable in various situations.

Table 1 summarizes six different forms which can be used to present help information –*text, static graphics, animation, speech audio, non-speech audio, video, and multimedia*.. To accommodate the growing interactive multimedia technology, the multimedia category implies the use of an integration of the preceding media.

Adaptiveness : Static vs. Sensitive Help

Kearsley (1988) and Balzert & Lutze (1987) categorized help which presented pre-stored information without modifications as static help, and help which varied its content according to runtime context and/or individual user preferences as dynamic help. Kearsley explicitly considered systems which, though only presenting pre-stored information, provide somewhat intelligent help access mechanisms to present different pieces of help text based on recent history of user actions as dynamic help.

Generating **static** help at runtime is a matter of accessing and presenting the information as stored. Typical commercial help systems such as Unix™ man pages, Microsoft Word help (Microsoft, 1989) and OPEN LOOK spot help (OPENLOOK, 1990), though advertised as being "context-sensitive," present help from pre-stored materials therefore are categorized as static help in this taxonomy.

Dynamic help, by contrast, is generated at runtime, either from a more structured help information, or processable representations or data structures. Dynamic help can be made appropriate to user needs by using various contextual factors to vary explanations, either by selectively retrieving appropriate information tokens or selecting different generation strategies. Generating help on the fly at runtime hence allows for incorporating sensitivity to help content, hence is sometimes called *sensitive* help.

Dynamic help or sensitive help can be further sub-categorized depending on the factors it is sensitive to. Some categories are suggested in Table 1. For example, help is *context-sensitive* if its content varies depending on the current runtime context such as program state, screen state and data state. Example context-sensitive help systems are described in (Sukaviriya, 1991; Feiner & McKneown, 1990). Context-sensitive help also includes currently existing entities in its explanations; this also includes trivial sensitivity such as in the *File 'xxx' not found* message where 'xxx' is always replaced by the name of the file in question. Context-sensitive help in (Sukaviriya, 1991) lengthened help presentations whenever the current context is not appropriate to include additional presentation which helped set up the required "help stage"⁴.

Another example is history-sensitive where help contents vary according to user history, for example, the most recent commands used, certain keyword options used, interaction techniques frequently chosen, input devices used, how the user gets to the current state, and so forth. An example of this type of help system is reported in (Senay, 1987). Senay's help system provided help based on the user's history of frequency of command usage. Another category of sensitive help is when help varies the explanations for each individual user based on how knowledgeable she is, her preferences, her accumulated efficiency with different system tools and resources, etc. Such help is termed *user-sensitive* in Table 1. Help systems in this category are reported in (Travellyan and Browne, 1987; and Chin, 1986). History-sensitive and user-sensitive help are grouped under the one category of *adaptive* help in (Lutze, 1987; Balzert and Lutze, 1987).

2.1.2 Conclusions

The taxonomy built gives a concrete picture of on-line help. For the purpose of this CR, we will concentrate on experimenting with mappings from help contents to various media. The taxonomy places both help contents and media in the context of which aspects of help this CR is addressing.

Robinson (1987) concluded that whether information should be presented textually, verbally, or graphically depended on the kind of tasks users had to perform or responses they had to give back to the system. In the next section, we will look into some human information processing work which attempted to predict human performance based on compatibility between information and human responses.

⁴ Lutze (1987) referred to this kind of context-sensitivity as *projective*, which refers specifically to providing explanations of how to achieve the user's desired goals from the current state.

2.2 Background on Human Information Processing

As summarized in (Baecker and Buxton, 1987), human operates based on limited cognitive resources and competition for these resources for one task is likely to degrade performance on another concurrent task. Wickens, Sandry and Vidulich (1983) have shown that different sensory modalities utilized different resources, and their related research further suggested insights into understanding the resource competition based on compatibility between input modalities, central information processing, and responses.

Studies on compatibility between stimuli and responses dated back to 1953 by Fitts and Seeger (1953), and later by Fitts, Peterson, and Wolpe (1963). Their experiments showed a superiority in performance when there was a spatial compatibility between stimuli (S) and expected responses (R). Keele (1986) summarized that the reaction time, in addition to S-R compatibility, also depended on the number of stimuli per response and the number of response choices per stimulus. A number of researchers as cited by Gopher and Donchin (1986) later attempted to predict response time as a function of the central processing which occurred after perceiving a stimulus and before issuing a response.

"An important . . . view of human as a processor with an upper limit on information transfer [from stimulus to response] was the developing recognition that different tasks impose different demands on this processor and therefore *load* it to different extents. . . if [channel] capacity is measurable, and if different tasks consume different amounts of capacity, then some tasks consume less than full capacity and must leave a residual of spare capacity, a hypothetical quantity that might be measurable." (Gopher and Donchin, 1986)

The view stimulated attempts to model the processing capacity; one of the models is based on the energy metaphor (Kahneman⁵, 1973), which states that task performance degrades as a result of a shortage supply of "processing resources." Kahneman proposed a single-resource model in which processing resources resided in the same pool and an additional task would, regardless, drain more resources from the same pool; the model was contradicted by later experiments (Navon and Gopher, 1979; Ogden, Levine and Eisner, 1979; Wickens, 1980; Wickens, Sandry and Vidulich, 1983) which exhibited that performance on some tasks interfered with one type of task, but not with another.

Wickens, Sandry & Vidulich (1983) proposed that highest performance would be exhibited when there is compatibility between input stimulus modality (S), central processing (C) (or code of

⁵This reference is missing.

internal representation as referred to by Robinson & Eberts, 1987), and output response (R). Table 2 shows two input modalities and their compatible central processing and responses.

Input Modality	Central Processing	Output Response
Visual	Spatial	Manual
Auditory	Verbal	Speech

Table 2 Predicted S-C-R Compatibility by Wickens, Sandry, and Vidulich (1983)

They performed experiments on single task performance on both verbal (memory search) and spatial (tracking) tasks, and the results of the experiments confirmed their prediction. Subjects performed poorest when both input modalities and output responses were incompatible with the type of central processing required. Their experiments, which were designed so the results would be beneficial to a cockpit environment where a primary task was spatial, showed that 1) competition by a second task for either visual encoding or manual responses disrupted performance; 2) competition was greater among tasks with low S-C-R compatibility and time-sharing efficiency increased when compatibility increased; and, 3) increases in workload showed greater degradation in performance when compatibility was low. The effect of S-C-R compatibility on performance was confirmed by another set of experiments by the same group as reported in (Wickens, Vidulich, and Sandry-Garza, 1984).

Robinson & Eberts (1987) conducted a related experiment supporting the S-C-R compatibility theory. While the primary task used in their experiments was a flight simulation like video game, which was similar in nature to that of Wickens et al, the secondary task used a more complicated stimuli of a hierarchical sequence of emergency warning messages. Because of the hierarchical nature of the messages, they could experiment with the presentation rate of this stimulus on performance. By using the hierarchical sequencing stimuli, the results revealed that subjects had difficulties maintaining context when stimuli were presented auditorily, but not so when stimuli were presented visually. They accounted some redundancy of information embedded in the nature of pictorial displays for this outcome. Subjects with visual stimuli also performed better after training while subjects with auditory stimuli did not; they accounted the compatibility of the spatial nature of pictorial displays to the manual responses for this, and speculated that subjects could develop more complete spatial representations of the aircraft systems through training with visual stimuli. Moreover, since the secondary task obviously required visual encoding and was

incompatible with auditory input and speech output, auditory/speech subjects had more difficulties when presentation rate was increased in their dual-task experiment.

Attempts by human information processing researchers have been initiated by the need to predict how long it would take a person to perform a task. Research brought into attention in this report focused on low level stimulus-response tasks. Their research findings are still insufficient to help design the experiment for this CR, which attempts to study performance for far more complicated tasks. However, there is a same tone which we feel would reflect the prediction of task performance at a more complicated scale. That is, help information as inputs presented with a high compatibility with the tasks to be performed should yield higher task performance. It is worth noted here that, for the purpose of on-line help studies, task performance time is perhaps not as critical as success in completing tasks and whether help is efficiently useful. With these facts in mind, we feel that the findings in human information processing research may prove to be useful in doing the analysis of this CR's experimental results.

2.3 Background on Comparative Studies of Media

Multimedia presentation started much earlier than multimedia computer interfaces from the days of school teaching and the search for more effective communication media which would enhance student learning in classroom environments (Wells, Mondfrans, Postlethwait & Butler, 1973; Gorman, 1973; Borg & Schuller, 1979; Rankowski & Galey, 1979). Though we feel that their experimental methodology was often questionable, these educators deserved to be mentioned as pioneers in trying to understand the use of multimedia in classroom environments. Later researchers associated with psychology and human factors (Strang, 1973; Booher, 1975; Stern, 1984; Baggett, 1984; Palmiter & Elkerton, 1991) have used more concrete performance measures, which resulted in more reliable outcomes.

Strang (1973) performed an experiment to compare pictorial-only self-instructions for an automobile repair procedure with pictorial-verbal instructions. His results showed that subjects receiving pictorial-verbal instructions could performed with far less additional help from human instructors than those receiving only pictorial instructions, though they spent more time learning the materials. Those receiving pictures with both printed and oral instructions performed the best with the least additional help. The results of Strang's experiment are encouraging, but they were not specific at how verbal instructions were written to enhance the pictorial instructions. Neither did they collect information of the additional help the subjects requested; such information would be useful to figure out discrepancies of the pictorial-verbal media combination.

Booher (1975) mentioned that the difficulty in performing comparative studies among media lied in the difficulty in preparing information for comparison which is the same in content but which can be presented in different formats. He also cited Hartman (1961) that the relationship of information in one medium to that in another was important since information presented in different media may be related, unrelated, redundant, or contradictory. He conducted an experiment to compare relative comprehensibility of pictorial and written instructions, emphasizing on comparing multiple media with one medium, redundancy of information between media, and type of information in each medium. His instruction domain was operations on radio equipment. The results from his experiment showed that multiple media (pictorial and printed) was superior to printed only format in speed, but showed no difference over pictorial-only format. Multiple media was superior in subjects' accuracy than pictorial alone, but not over printed media alone. In overall, addition of pictorial information had a great effect on performance speed, but little on accuracy. He found redundant information between media having little effect on performance, and that pictorial form was good for presenting static objects than printed form and printed form was better for presenting information about action responses.

Stern (1984) studied written text, graphics, combined text and graphics, and digitized voice messages as a means to communicate procedural instructions (of how to withdraw cash from an automatic teller machine) and error messages. His experiment revealed that both text and combined text & graphics were superior to graphics alone, and voice supplement (used only for error messages) for text did not improve the performance. Two drawbacks in this experiment were: 1) some subjects had pre-experience using ATM, hence were possibly already familiar with the procedure; and 2) the tasks chosen for the experiment could not be communicated effectively through graphics alone, especially the error message. Use of graphics in this experiment would be regardlessly inferior to other media such as text which can explain errors not graphical presentable better by its nature.

Bieger & Glock (1985) suggested a comprehensive taxonomy for information needed to furnish effective procedural instructions. They performed an experiment in the same vein as that of Stern (1984) but were more elaborative on the kind of information presented to subjects. They mentioned their concern on relevancy of presentation media (text and/or graphics) to the kind of information. Unfortunately, the experimental results they reported only concluded that subjects with provision of all three categories of information – operational, spatial, and contextual – completed tasks in lesser time and superior accuracy. They, however, did not experiment with different presentation forms for these kinds of information.

Baggett (1984) studied the role of contiguity in forming associations between the visual and spoken material in a dual-media presentation. The particular context used was assembly kits, and only subject's ability to associate names with visual objects were tested. Her results revealed that audio in synchronization with or following within 7 seconds after images worked best both in the immediate tests and the retention tests 7 days after. She also speculated that linguistic materials represented concrete concepts and automatically created visual images when presented alone. Presenting audio before video would pre-create an image and make it difficult for subjects to associate concepts with images which followed. The results confirmed her hypothesis that images were associated with concepts if they were within temporal contiguity (0-7 seconds), or, in other words, the verbal information rehearses the images. This experiment was on labeling object names and was somewhat a memory test. The experimental results showed no indication whether how effective performing tasks would be if instruction materials were presented in the same fashion.

The latest comparative study between media was performed by Palmiter & Elkerton (1991). Palmiter & Elkerton compared the effectiveness of procedural instructions for HyperCard authoring tasks delivered as animated demonstrations, written text, and a combination of the demonstration and a spoken version of the written text. Their subjects were presented instruction materials before performing tasks. Data on speed and accuracy in performing tasks were captured, both right after the training and 7 days after for retention analysis. Their results revealed that subjects trained with animated demonstration only, and those trained with animated demonstration and text performed more accurately and faster right after the training, but slower and less accurate than the text-only group 7 days after. Their experiment, which showed that animated demonstrations resulted in faster performance, confirmed a graphical medium as having a high utility for speed performance similar to Booher's experiment (Booher, 1984) on static graphical instructions. However, the fact that animated demonstration also yielded better accuracy contradicted with Booher's results; this may attribute to the fact that animation can demonstrate exact procedures without the unavoidable discontinuity in static graphics when used to portray dynamic procedures embedded in graphical interfaces. It might as well be that these two experiments were based on two totally different task domains. Palmiter & Elkerton's experiment however was based on HyperCard™ tasks thus was more related to graphical interface applications.

The superiority in accuracy and speed in animated demonstrations was on tasks identical to that in the training session. Palmiter & Elkerton's results, however, showed that animated demonstrations did not transfer well to similar tasks. The animated demonstration group of subjects had difficulties when presented with similar but different tasks, while text-only subjects

required almost no extra time. This aspect reassured that animated demonstration should not be used singly. Though the demonstration-spoken text group did not perform well in this similar situation, we can speculate a few reasons here. Firstly, it may attribute to the fact that spoken text somehow compete for the same processing resource required to understand the animated demonstration. Using Wickens' theory of S-C-R compatibility, both demonstration and spoken text require the same spatial processing with reference to the HyperCard's graphical interface. Spoken text is both incompatible with the type of processing and competes for the same processing resource required by the demonstration, therefore causes subjects to ignore the spoken text in order to concentrate on the demonstration. (This also implies that when presenting simultaneously, visual presentation naturally wins in drawing user attention in a graphical interface. Whether this is also true in a text-based interface is inconclusive.) Secondly, Palmiter & Elkerton applied the result of Baggett's experiment (Baggett, 1984) in their experiment and played the animation simultaneously with the spoken text. Baggett's experiment was focused on the ability of subjects to associate names with assembly kits and the narrated voice in her experiment mainly labeled what was being seen in the film. Unlike Baggett's experiment, viewing an animated demonstration of procedures in a graphical interface involves more conceptual processing than just name labeling, and presenting spoken text simultaneously or within a close time may be ineffective in this situation.

3. Experimental Design

Not all different types of help information can be displayed in all media. Descriptive information of a non-visual object would be difficult to convey in graphics, for example. The underlying application also plays a role in determining the information contents of help thus how they should be presented. For example, descriptive information of a dialogue box in an interface builder software would be conveyed easily using partial graphics in the explanation, while descriptive information of a database record may not necessarily need graphics. The same kind of help information specifically designed for different interface styles may carry interface-specific characteristics which is more appropriately presented in some media for one style and some other media for another style. For example, because of its spatial-oriented characteristics, a graphical interface often necessitates object locations as part of help explanations; presenting information about locations by pointing directly to an object would be more straightforward in a graphical interface. Continuous interactions with various objects in a graphical interface also imply that a continuous medium may be more effective to convey the continuous aspect of task operations in the interface. The key idea here is: help information contents should be determined in the context of the application and the interface style help is supporting. We must keep this relationship

between help information and the interface style of an application in mind while designing help presentations.

Simultaneous use of media also depends on which medium can effectively complement another medium. In user interfaces, we are assumed dealing with only two input channels: visual, and auditory. Text, static graphics, animation, and video use the visual channel; spoken text and non-speech sounds use the auditory channel. Applying Wickens' S-C-R compatibility theory, competition of the same input channel will degrade performance, especially when S-C-R compatibility is low. A basic rule of thumb is to always combine as medium in one channel with another medium in the other channel so not to overload one same input channel. We hypothesize that using two media which compete for the same channel would take longer for users to process help. Whether their task performance would be affected cannot be concluded from this assumption alone.

With this rule of thumb, only certain combinations of media are worth exploring. To narrow the scope of this CR's experiment, non-speech audio will not be investigated. We are approaching the experimental design from the point of view of making a transition from traditional textual help to utilize more graphical media in presenting help information. Textual information will be taken straight out from a technical document produced professionally at Sun by technical writers. With this assumption, we are interested in replacing and/or making textual information more efficient by bringing other media to present alternative forms of information as appropriate. We will not investigate integrating text and speech-audio, but rather use them as alternatives of each other for delivering verbal instructions.

Help information presented only as text will be used as a base for comparison. From our experience with animated help, and from previous studies, static graphics, animation, and video (with no verbal information) have shown to be ineffective when used alone, and are therefore eliminated from being experimented singly. This leaves as with coupling speech-audio with static graphics, video, and animation.

Given that users are allowed to spend as much time as they wish to process help, we do not have to strictly design the experiment strictly following the rule of thumb mentioned previously. Complementing text and graphics, though they compete for the same visual channel, can be practical. The fact that users can look back and forth between text and graphics (as opposed to looking at graphics and hearing verbal instructions) may encourage a different learning strategy which may result in a different performance level. In addition, a window environment allows displayed text and graphics to retain in a work environment while the actual work context remains

visible. This will allow users to compare help information with their work context and associate the information with their current tasks or problems. We hypothesize that this kind of help will yield different performance data from such help as context-sensitive help which actually displays animated in the current context hence bridges the gap between mapping help information to the actual work context.

4. Experiment

After a discussion at Sun in September, we narrowed down the experiment to 3 major categories of information: definition, procedure, and trouble shooting, and 5 between-subject groups. The 5 groups will receive instructions in text only, text & static graphics, speech audio & static graphics, speech audio & video, and speech audio & context-sensitive animation. Our hypothesis is that each instruction mode is an improvement of the preceding modes and task performance for each group should improve over the previous groups. We also hypothesize that context-sensitive animation will show better performance for trouble shooting help information where the actual context is used to show how to correct the problems at hand. Each subject will be presented with 5 different sets of help information in each category, and will be ask to perform tasks identical or similar to the one just presented. For help on definitions, questions will be asked following the instructions. We hypothesize that when tasks get more complicated, performance of groups with "better" mode of instructions will perform better.

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