A Procedural Model for Interactive Multimedia Development

James L. Mohler
Purdue University
West Lafayette, Indiana, USA

ABSTRACT

This paper discusses a model for the development of interactive multimedia. Through the use of five stages, it gives a methodical procedure to creating multimedia products. The uniqueness of the Multimedia Development Model is that it allows for total planning and increases communication within group settings; reducing and sometimes eliminating errors. Although rigorously adhering to any one model would be unrealistic, it chronologically presents the major points of concern when developing interactive multimedia.

INTRODUCTION

Multimedia is any combination of text, graphics, sound, animation, and video delivered and controlled by the computer (Vaughn, 1994). Interactive multimedia however shifts the controlling agent; giving control to the user rather than the computer. This shift of control allows for individually customized information flow (Park, 1994).

Multimedia is successful because it draws upon more than one of the five human senses; utilizing the two fundamental senses vital for information reception -- sight and sound. It also sparks human thought in the process due to motion and sound. Multimedia, although intriguing, does not require the user to be actively controlling what is being presented (Burger, 1993).

Interactive Multimedia

Planned interactions are known to have a very positive affect on learning. Learning theorists state that to reach an objective it must be practiced to help the learner cognitively incorporate it. The interaction, or "doing the objective," helps the learner reach the objective and recall the information, skill, or behavior that was practiced (Dick & Carey, 1992).

Objectives. Using the information gathered, the author can begin defining clear and precise objectives for the application. These objectives should not be confused with any objective associated with the content itself, although in certain instances there may be overlap between the content and product objectives. The objectives developed here strictly define the capabilities of the product, how the capability functions, and how to know if the capability was successful.

Design Phase

Once the appropriate variables have been analyzed, the multimedia group is more apt to develop a coherent metaphor and interface. Designing and developing these elements involves storyboarding the metaphor and designing the interface.

Metaphor. The metaphor of the multimedia project requires creativity and ingenuity. Based on the clear and documented direction yielded from the analysis phase, the multimedia group is ready to create the storyline of the presentation. This is done through a storyboard process. Storyboards include small "thumbnail" sketches of the media elements that occur on each screen of the presentation by manually sketching them as shown in Figure 3. The

Digital media is no different. Wolfgram (1994) states, "people only remember 15 percent of what they hear and 25 percent of what they see, but they remember 60 percent of what they interact with (p.12)." Multimedia, then, requires auditory and visual perception only. Interactive multimedia, alternatively, requires internal user processing and focuses on the needs of the user, thereby requiring the user to be actively thinking about the information being presented, making predetermined decisions, and presumably acquiring the information or skills being presented.

Lindstrom (1994) states, "that individuals retain 20 percent of what they hear, 40 percent of what they hear and see, and 75 percent of what they hear, see, and do (p. 26)." A 1987 study indicates that students using interactive programs learn and retain 25 percent more of the information presented and learn 50 percent faster than those who use traditional learning methods (Kolowski, 1987). A series of six studies conducted from 1990 to 1992 show that multimedia students have a 55 percent learning gain over students receiving traditional classroom teaching. They learn the material 60 percent faster, and their long-term (30-day) retention ranges from 25 to 50 percent higher (Adams, 1992).

By drawing upon multiple human senses and requiring human interaction, the learner acquires knowledge more efficiently. This makes interactive multimedia a powerful medium for education and training. It is also a very adaptive tool in marketing situations where a persuasive flair helps change an attitude or belief (Stephanae, 1994).

Efficiency and speed in the acquisition of knowledge are becoming a major concern as noted by Lindstrom (1994).

> The most striking paradox of the information age is this: the more information we produce, the less time we have to assimilate it. Even so, we are told to expect the volume of information to continue to multiply exponentially, theoretically without end. That presents a profound challenge to businesses and business people, who must find ways not only to distill information into knowledge but also to overcome the information repellents that people naturally exude as the data swarms increase. In an environment where an increasing volume of information vies for the attention of individuals and

storyboards can also contain information such as time lags, branching information, sound notes, transitional notes, and camera angle notes. The storyboards become a visual script for the multimedia product. The storyboards can be developed for the whole product or selected portions.

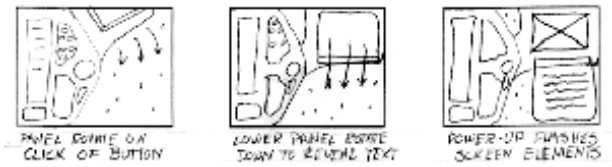

Figure 3. An example of a storyboard sketch.

The metaphor must remain coherent with the information discovered in the analysis. Coherency is important because the metaphor is the part of the presentation that gradually prepares the user for the confrontation with the interface. Individuals using any tool have a learning curve; the time required to learn to use the "new tool." If a metaphor is coherent, the user is prepared for the look and feel of the interface. Sometimes they are even prepared for how it functions. The familiarity with the interface before it is revealed depends upon the amount of realism with which the metaphor is developed and presented.

The metaphorical message being sent to the user must not only be coherent but also clear. Vagueness in the idea or storyline confuse the users and can consequently distract them (Marcus, 1995). Clarity is added by what is known as supporting elements. Supporting elements can include graphics, sounds, and video.

All of these elements contribute to attracting the user, drawing on his or her background and enticing them to pay attention. This is the power of the metaphor; to more easily attract and possibly entertain the user while disguising the real purpose of getting them comfortable with a new environment. Coherency and clarity in a metaphor help the user; performing the metaphor's main purpose -- introducing the interface.

Interface. The interface is the point of contact between the user and the computer. It is a point of interaction and must provide for feedback to and from both parties. The interface is developed through sketches that are first developed as primitive block shapes to represent interactive and non-interactive areas of the screen (see Figure 4). The block shapes are then refined to include panels of buttons, image or text areas, or "warm-and-fuzzy" areas. These sketches usually begin as thumbnails and are

> businesses with a finite capacity to absorb what is being offered, your message can be easily lost, misinterpreted, or ignored outright.
>
> Business communication must happen faster, it must be precisely targeted, and it must hit with the maximum impact. How well you execute those three requirements will determine, to a large extent, how you are measured by your customers and your competition (pp. 3-4).

Efficient ways of information acquisition must be utilized to make education, marketing, and training occur faster, more precisely, and with maximum impact; allowing organizations and individuals to remain successful.

Information Distribution

The goal of information distribution is for a message to be conveyed, comprehended, and either applied or acted upon (Lindstrom, 1994). This includes not only the communication process (information -- sender -- channel -- receiver), but also the retention and use of that information in various situations; signifying that a transfer of knowledge has successfully occurred (Gagne, 1974). Information presentation without cognitive incorporation, comprehension, or application is meaningless. This idea is explicitly conveyed in the following statements.

> Computers cannot be sincere. Nor can they be emphatic, enthusiastic, or empathetic. They can only collect, process, and store information. The power of information is not contained in the data, but in the ideas, the emotions, and the actions it triggers in the people who encounter it. Information is alive, evolving, and ever-changing (Lindstrom, 1994, pg. 5).

Information becomes powerful when it gains personal interpretation, comprehension, meaning, retention, and use; thereby becoming knowledge. It is the purpose of information distribution to personally transfer this meaning or message from one individual to another (Wolfgram, 1994). Without the transfer of the message, the informational data has no relevance. This is where traditional information distribution has lacked sufficiency -- transferring the real message behind the abstract letters and data; the internalization where consequently refined into "working drawings" drawn to screen scale. This means that the confines of the design layout is equal to the desired screen resolution and is measured in pixels as shown in Figure 5. Standard resolution for multimedia presentations is 640 pixels by 480 pixels by 256 colors (denoted as 640x480x256).

Figure 4. An interface planning sketch.

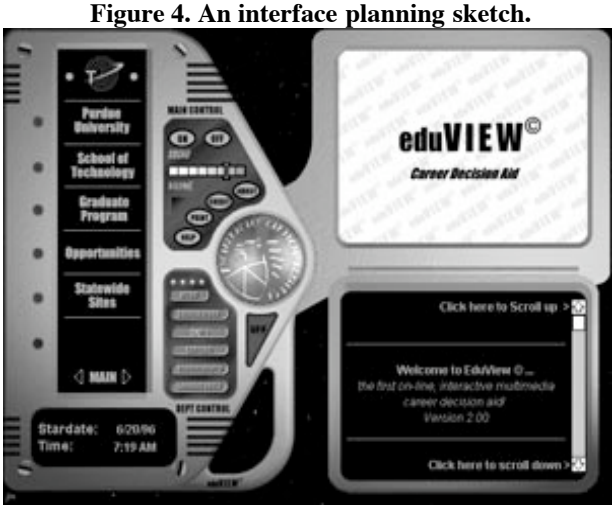

Figure 5. A refined interface drawing.

Resolution plays an important part in the development the media elements of the final interface. By drawing the interface at an appropriate but accurate scale, guesswork is eliminated. Many of these sketches can be drawn manually or digitally, but the final concept drawing is usually digital. The interface is the visual embodiment of the ideas and functions decided upon during analysis and is graphically shown through a final conceptual drawing.

Human Computer Interface (HCI) design is a rapidly evolving field. This field focuses on the characteristics of good interface design which include clustering of common buttons, instantaneous feedback (such as a click sound when the user picks on a button), clear iconic representations, readable

information becomes knowledge and is alive and useful within the individual.

Traditional Media

The sole limiting factor of paper-based materials is that they provide a calloused and distant means of user interaction with the information being presented. They also give a shallow and somewhat blurred view of intended meaning since they utilize only one human sense through obscure characters and motionless graphics. This type of media, also known as "monomedia" (Lindstrom, 1994), has small aesthetic value due to the static nature of the printed page. It presents a monotonous world to humans who are multimedia communicators -- desiring motion and sound. Low knowledge transfer via the printed page can also be attributed to the lack of user interaction with the information. These two factors create a mild barrier in the process of cognitive processing and encoding. In essence, the medium becomes an inhibitor of the message it is trying to convey; vaguely describing, at best, the intended meaning.

When it is used, interactive media enhances and reinforces the message. Animated graphics, auditory data, and videography incorporated into interactive multimedia utilizes a wider range of human senses, easily sparks deeper processing, and helps paint a clearer picture of intended meaning. This makes the information easier to decode, interpret, comprehend, and encode into the cognitive schemata. It also increases interest and motivation making the learning process more enjoyable (Stansberry, 1993).

A METHOD

A review of literature leads to many project-specific items that must be addressed when creating multimedia products, but few give a structured, step-by-step method that is replicable. The multimedia development process includes five major stages that are applicable for most developmental needs. The process can be implemented, to varying degrees, for short- or long-term projects.

The Multimedia Development Model, shown in Figure 1, is the embodiment of those five areas. The model is a typical progression in a real-world project. Uniquely, all the later stages draw upon the documented information from the analysis phase; allowing for total planning before implementation.

on a button), clear iconic representations, readable text segments, use of color, and pleasing graphics. All of these features contribute to a user-friendly environment as shown in Figure 6. The most important point, however, is that the user consistently be in control. At no point should the computer do something the user does not expect. Users that are unfamiliar with an environment become uncomfortable when they feel out of control, thus undermining the information transfer process. To overcome fear, intimidation, and loss of interest the interface should incorporate many of the good HCI design features.

Figure 6. An example user interface.

Production Phase

The production phase is where development of the "soft" product begins. This phase includes prototyping, testing the prototype, revision, and finalizing the application.

Prototyping. The prototyping phase is the first attempt at making the final product. Throughout the analysis phase, the group is actually preparing a plan of attack for the project. The prototype is the introductory implementation of that plan. It provides a means of creating a sample of the final product; giving the client the opportunity to accept the existing interface, metaphor, and interactive programming. It does this by providing a means to test media integration, programming, and content flow. Often things do not work out as planned. The prototype gives an opportunity to test what is believed to be true as it relates to the project.

Testing. Once the prototype is completed, it is distributed for testing. The criteria for this test are based upon the objectives, while the parameters for the test are based on the content. and audience.

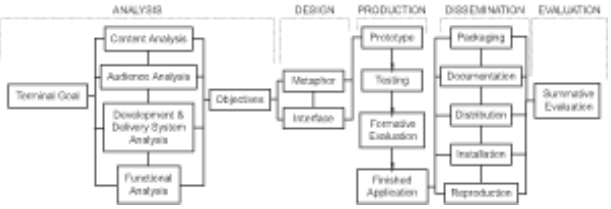

Figure 1. The multimedia development model.

The Analysis Phase

The analysis phase of any multimedia project can be the most time intensive portion. Of the time spent working on a project, 20 to 30 percent includes developing ideas, verifying those ideas, and deciding how to implement them. By stringently analyzing a proposed project, the user reduces or eliminates rework.

Terminal Goal. To begin any major multimedia endeavor requires a clear definition of the main goal of the project. Sometimes a simple clarification made to an existing "fuzzy" goal is sufficient, while at other times the developer must create and define a goal. During this stage, a goal may be as simple as "explaining the purchasing process in the ACME Steel Company" or as complex as "describe the fundamentals of descriptive geometry" This goal, although stated in general terms, must imply the intended terminal outcome as a result of the product.

Content Analysis. The content in itself may already exist by way of a content design model or it may need to be created. At this point, the author must ask an important question. Can the content be effectively presented on the computer faster, cheaper, easier, or better than other methods? Several sources suggest that multimedia is the cure-all for information distribution, but as some believe, not all content lends itself to multimedia development (Shelton, 1993). Multimedia, although a powerful medium, has limitations. The content needs to be analyzed to determine optimum compatibility with multimedia or traditional medium.

During the latter part of the content analysis, media integration is an important element to consider. If the content already exists, from where are images, sounds, and text coming? If it is new material, from where will the media elements come? Who will obtain or create them? Are copyrights secured for their use? Do licensing or release statements need to be issued to use the media elements? How will they be digitally incorporated (i.e., file format utilization)? Answering some of these questions may have to wait until analysis of the development and delivery systems, but legal consequences can result without proper copyright

delivery system, and functionality. This testing should occur under the circumstances in which delivery will take place. If the intended platform is a 486 DX2, test it on a 486 DX2. If the application is to be used on a network, test it on a network. If the audience is business professionals, employ professionals to test it. The parameters reflect the intended circumstances for use.

Formative Evaluation. The formative evaluation is made after testing of the prototype has occurred. It requires the author to review the testing data, accept or refute the resulting prototype and, consequently, continue or abandon the work. This gives an opportunity to discuss problems or revisions that need to be made and where misinformation occurred within the multimedia design process. When a well documented analysis phase has been performed, only minor modifications are usually necessary. The formative evaluation gives an opportunity for discussion about revising, deleting, or adding to the application and where those changes are necessary. It may be necessary to conduct another test and evaluation procedure if significant revision seem necessary.

Finished Application. Using the programming shell of the approved prototype, finished media elements are incorporated, programming is completed, and the application is finalized. After the application is finished, it may need to be translated into a usable and protected format for distribution using software specific utilities.

Dissemination

Once the application is finished the author must physically prepare it for distribution; packaging, installation programs, documentation, reproduction, and distribution must now be executed. Assuming decisions were made during delivery analysis, some areas may already be completed or at least carefully thought through with a number of individuals involved with the project. It is possible that much of this work can be done concurrently with other tasks.

Packaging. Packaging for the finished multimedia product is determined by the media. There can be several options depending upon which medium is chosen. Diskette media require the creation and design of labels while CD-ROM requires design of the imprinted CD label and the jacket. Each medium has its own packaging requirements and choice

acquisitions, not to mention extreme difficulties in integrating certain file formats and media elements into a multimedia venture.

Audience analysis. Background, skills, knowledge base, and age all contribute to the way information is presented and whether it is received. Also important is the number of audience members: Is it a large audience or a single user? Does the audience include students, business professionals, specialized individuals, or an audience with a general background? The answers to these questions alter information presentation style and absolutely determine metaphor and interface development. If the audience is composed of students, something attention-getting may be required. Younger students are used to modern television programming such as MTV and the like; to gain their attention requires more than a slide show approach. Alternatively, older students or conservative business professionals can be offended by this approach. By analyzing the audience and documenting their requirements and interests, the developer ensures a more successful multimedia project.

Development and Delivery System Analysis. An important aspect of designing interactive multimedia is the development and the delivery system. Most individuals are knowledgeable about the hardware and software they have to create the project (i.e., the development system). It is mentioned only for those who may be unaware of its importance, but in project settings composed of several individuals -- which is usually the case -- this analysis provides an opportunity to discuss the various hardware and software capabilities available to all individuals. Departmentalized companies are often oblivious to the resources available in other departments and are often surprised by collaborative capabilities. By first discussing departmental resources, all individuals involved in a project become aware of the various avenues of creation. It also allows an opportunity for discussion about the most efficient means of creating various portions of a project as well as who has what skills.

Alternatively, the delivery system, with all its subtle complexities, is often overlooked. The capability, mainly of hardware, is of prime importance. With the plethora of hardware systems, options, and platforms available, the individual needs to analyze the setting in which the project will be run. Concerns such as display systems; computer specific information such as CPU speed, amount of RAM, distribution media (i.e., floppy depends upon budget.

Installation. For distributing most products, file compression is required. When this is the case, it is desirable to have a commercial installation tool copy the files from the distribution media to the user's hardware. This insures that all necessary items are placed in the proper location. There are numerous programs available to create customized installation programs for the non-programmer.

Documentation. All software should include some type of documentation, even if it is simply how to install it. This can be digital documentation, usually found on the first disk, as well as hardcopy information distributed with the project. The amount of documentation needed to adequately get the user up and running will depend on the complexity of the multimedia piece. The failure of many software products is the lack of good documentation.

Reproduction. Once a master set of media has been created for a product, replication can begin. Most reproduction houses are capable of reproducing media cheaper than can be done in-house and, just as with printed media, cost is inversely proportional to number of copies. Time also enters this equation, generally increasing prices for quick turn-around. When planning the reproduction, the author needs to clarify, as well as justify what size print run is cost-effective, yet feasible.

Distribution. A concern that is usually not discussed until the end of the project is where the product will be shipped when completed. The author's responsibility does not end until the product is safely in the client specified destination. Sometimes the client may handle reproduction and dissemination, thus the author is relieved of this responsibility.

Evaluation

The final evaluation phase, also called the summative evaluation, is done by the author to determine the final effectiveness of the multimedia application by comparing it to all of the objectives developed during the analysis phase. Often the client and the author will do this independently; other times they will work together to perform it.

This evaluation can be performed in a variety of ways. By testing the final application with a sample group the interested individuals can determine the

disk, magneto-optical, SyQuest, or CD-ROM); as well as control devices such as a mouse, keyboard, radio- or laser-transmitted input hardware need addressed. All of these variables affect the type and amount of digital media used within a multimedia piece.

By defining the limiting parameters for a delivery system, an effective multimedia presentation can be created. The developer can do this by being apprised to limitations and remaining within capable creative and liberate means. When reviewing both the development and delivery systems, note that the product is only as strong as its weakest development or delivery system link. For example, a 486 SX with 64 MB of RAM is not any more effective for a multimedia presentation with included video than a 486 SX with 8 MB of RAM. The weakest link principle applies. The slow speed of the SX databus counteracts any effect the extra RAM would have on displayed video. The capability of the computer to hold information in main memory is available, but the internal road for information flow from drive to display is much too slow. Included video, although capable of being loaded into memory, will still play very slowly and sporadically.

When dealing with clients, who have expectations and deadlines, analysis of the development and delivery systems keep the developer from (a) proposing what they cannot create with available resources, and (b) creating what cannot be effectively used during delivery. These are two of the biggest failures due to poor planning.

In addition to analyzing the two systems, the delivery environment must be analyzed as well. By analyzing the delivery environment the individual can plan for display screen sizes, amount of surface noise or other distractions, as well as requirements for effectively using the multimedia tool. Time of day can also have a direct bearing on the effectiveness of the presentation.

Functional Analysis. The functional analysis is a continuation of the general goal. It seeks to define all of the functional capabilities within the final multimedia project including the major goal if it is an implied output or feature. For example, the functional analysis for a project whose general goal is "allowing the user to search through a database of images and text to gain information" would include display output as part of the functional analysis. It would also define other important features that the application would perform. This can include capabilities such as printing, external application use, other outputs such as text or graphic digital files, CNC output, stereovision output, or any

program's effectiveness. An alternative method, to simply test functionality, requires the creation of a checklist derived from the objectives. An entire array of tests can be created to evaluate any aspect of the product that is desired.

CONCLUSION

The Multimedia Development Model, although not applicable to all situations, will alleviate miscommunication between group members, and between clients and authors, thus reducing errors. In all situations, regardless of the duration of a multimedia project, the four primary analysis elements are vitally important. This author cannot conceive of a situation in which content, audience, development and delivery, and functions would not affect what is developed and how the product is developed. Products that are successful are a result of planning in all these areas.

REFERENCE LIST

- Adams, G. L. (1992, March). Why interactive? Multimedia and Videodisc Monitor, 10, 20-24.
- Burger, J. (1993). The Desktop Multimedia Bible. New York: McGraw-Hill.
- Dick, W. & Carey, L. (1990). The Systematic Design of Instruction. US: Harper Collins Publishers.
- Gagne, R. M. (1974). Essentials of Learning for Instruction. Hinsdale, IL: Dryden Press.
- Kolowski, N. (1987, February). Development of interactive instution materials. Instructional Delivery Systems, 1, pp. 8.
- Lindstrom, R.L. (1994). The Business Week Guide to Multimedia Presentations: Create Dynamic Presentations That Inspire. New York: McGraw-Hill.
- Marcus, A. (1995, February). Making multimedia usable: User interface design. New Media, 5, pp. 98-100.
- Park, W.T. (1994, May). Creating virtual worlds: New tools for movies. New Media, 4, pp. 53-54.
- Shelton, S.M. (1993). Multimedia. Technical Communication: Journal of the Society for Technical Communication, 40, pp. 694-704.
- Stansberry, D. (1993, February). Taking the plunge. New Media, 3, pp. 30-36.
- Stephanae, S. (1994, April). Interactive advertising. New Media, 4, pp. 43-52.

other type of relevant features.

The functional analysis includes a verbal description of output features. It always includes a descriptive flowchart that shows all of the linear and non-linear paths in the product as well as external links and functions; it is a visual representation of the verbal description. Figure 2 displays an example of a functional analysis flowchart. This flowchart visually shows all of the levels of interactivity and what options the user has at any instant in the application. It also gives the user a roadmap or skeleton for the creation of programming during the production stage. It shows the natural breaks that occur in the information; allowing for modularization if so desired.

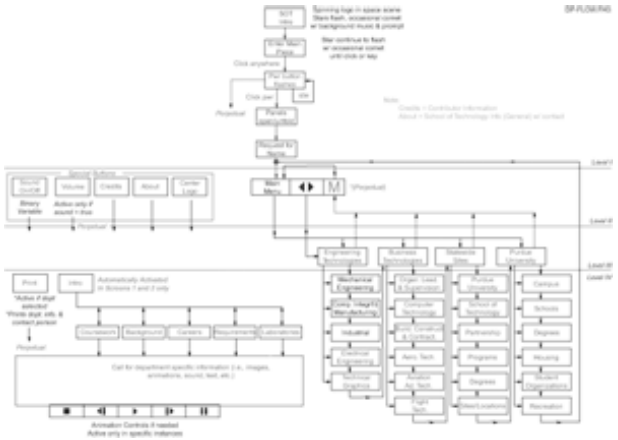

Figure 2. An example of a functional analysis flowchart.

Vaughn, T. (1993). Multimedia: Making it Work. New York : McGraw-Hill.

- Wolfgram, D.E. (1994). Creating Multimedia Presentations. Indianapolis: Que.

Contact the author at:

1419 Knoy Hall
West Lafayette, IN 47907
765.494.9089