STORYBOARD DEVELOPMENT FOR INTERACTIVE MULTIMEDIA TRAINING

Kay L. Orr, Ph.D.
Katharine C. Golas, Ph.D.
Southwest Research Institute
San Antonio, Texas

Katy Yao, Ph.D.
Consultant

ABSTRACT

Training applications using interactive multimedia capabilities are growing in number. The approach followed to produce these multimedia applications is essentially the same (analysis, design, development, implementation, and evaluation) regardless of the instructional delivery system.

Data from research studies, combined with development experience, provides insight into "what works best" for this particular delivery system, thus producing the most effective multimedia training in the most efficient manner. This paper addresses the procedures for storyboard development and provides specific guidelines for designing interactive multimedia courseware. Guidelines are presented for increasing interactivity, determining extent of learner control, determining most appropriate use of feedback, preparing visual elements (video, text, graphics and animation), audio elements, and programming. All of the guidelines are based on data from research studies. The research studies and literature which support the guidelines are specified by topic in the references.

ABOUT THE AUTHORS

Dr. Kay Orr is a research analyst in the Instructional Systems Section at Southwest Research Institute. She has worked on large-scale interactive multimedia projects, and she recently designed a workshop for effective preparation of storyboards for interactive courseware programs. She is an expert in the design and development of Digital Video Interactive programs. Her MS and PhD are in Instructional Technology from the University of Texas at Austin.

Dr. Katharine C. Golas is manager of the Instructional Systems Section at Southwest Research Institute. She began her career in ISD in 1977, by using the Interservice Procedures for Instructional Systems Development Model to develop print-based exportable job training packages. During the past 16 years, she has directed over 75 ISD projects, including twenty interactive videodisc projects and ten Digital Video Interactive (DVI)®* projects. She is currently directing research and development efforts using advanced multimedia training technologies. In 1992, she led a project team to redesign the Air Force ISD model and methodology. She has a PhD and MA in Instructional Systems from Florida State University.

Dr. Katy Yao is a consultant for Southwest Research Institute. She is an instructional development specialist and has served clients in the military, private industry, and education. She has managed and authored numerous training manuals and designed DVI®-based training systems. She recently designed a workshop for effective preparation of storyboards for interactive courseware programs. She holds MS and PhD degrees in Instructional Systems Technology from Indiana University.

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BACKGROUND

A storyboard is the documentation for interactive multimedia production which contains instructions for programming, an audio script, and a detailed description of the visual elements such as text, video, graphics, and animation. It is typically developed by instructional designers, with input from other development team members such as subject matter experts, videographers, programmers, and graphic artists. Storyboards are developed during the design phase of the instructional systems development process. The storyboard becomes the key design document that the entire production team uses as a base for developing the interactive program. The storyboard information is often reviewed and approved by the customer prior to the start of the development effort.

This paper provides specific guidelines for storyboard development and the rationale, based on research findings, for each guideline. The research studies and literature which support each guideline are presented by topic in the references. It is unlikely that in any one program, every guideline will be implemented. The guidelines are not meant to be applicable to all situations and environments. Their application depends on factors such as the hardware and software selected for ICW development and delivery, the learning skills and motivation of the target audience, the complexity and criticality of the instructional content, and, of course, available resources. The guidelines should be adjusted based on these factors.

BASIC ICW INSTRUCTIONAL STRATEGIES

Instructional strategies are the general instructional treatment given to lessons in an interactive multimedia course. When developing storyboards, the designer will be concerned with ensuring that:

- Interactivity is increased.
- Learner control is addressed.
- Feedback is appropriate for enhancing learning and transfer.

GUIDELINES FOR INTERACTIVITY

In any type of computer-based training, interactivity refers to the activities performed by both the learner and the computer. The quantity of interaction depends on a number of variables, including the type of input required by the learner, how the response is analyzed, and how the computer responds back to the learner. Research has shown that it is important to design as much meaningful interactivity as possible into an ICW program (Hannafin, 1989, Lucas, 1992, Thompson and Jorgensen, 1989, Schwier and Misanchuk, 1988). Borsook (1991) argues that in order for interactive instruction to be truly interactive, it should emulate interpersonal communication. Guidelines for increasing interactivity in ICW programs are presented below.

1. Provide opportunities for interaction at least every three or four screens or, alternatively, about one per minute. However, mandatory interaction with the computer should not be superficial. Without interaction, the program is just a fancy electronic page turner. However, if an action required is somewhat superficial, the student may be distracted by it and become annoyed. Students prefer not to have superficial interaction.

2. Chunk the content into small segments and build in questions (with feedback), periodic

reviews, and summaries for each segment. Chunking content into smaller units and providing opportunities for interaction (e.g., questions) within each information segment allows students to interact with the program more frequently. "Blending" instruction with practice reduces boredom and at the same time facilitates learning.

3. Ask as many questions as possible without interrupting the continuity of the instructional flow. Questions provide information for the system to evaluate student performance and branch them to an appropriate place in the instruction. Questions also sustain student attention by keeping them involved in the learning process.

4. Ask a question after, but not immediately following, the related content. Sometimes a gap between a question and its related content will facilitate learning by forcing the learner to mentally search for and review necessary information, rather than requiring them to immediately repeat what they were just taught. This searching and reviewing process can enhance retention.

5. Ask students a question that they can figure out the answer to from previously learned knowledge. A straightforward presentation of new content can be boring.

6. Ask students to apply what they have learned rather than memorize and repeat answers.

7. Use rhetorical questions during instruction to get students to think about the content or to stimulate their curiosity. Also use them as a natural transition between frames. A rhetorical question does not require students to overtly provide an answer. It invites students to *mentally* interact with the content. Used as a transition aid, it can direct students' attention to what is coming up next.

8. Consider designs where the learner is not presented with information in a linear format, but rather discovers information through active exploration in the program. With some tasks, such as problem solving, learning through discovery promotes understanding and remembering because new knowledge is linked substantively and nonarbitrarily to existing knowledge.

GUIDELINES FOR LEARNER CONTROL

Learner control refers to the degree to which learners are allowed to take charge of the instruction and their learning environment: what to learn and how to learn it. In many instances, learners can make appropriate decisions about the most effective way to proceed through a training program. Research suggests, however, that in some instances, learners do not choose the most effective route (Chung and Reigeluth, 1992). Careful consideration of learner control issues is important in ICW design. Guidelines for learner control of sequence and content for ICW programs are presented below.

1. Provide learner control of **sequence** when:

   a. Lengthy instructional sequences must be completed by the student in no specific order. Student motivation and interest will be maintained because students will be in control and not forced through a particular sequence which ultimately does not affect learning.

   b. Students are familiar with a topic and are able to make appropriate sequence choices. In this case, motivation is facilitated because students can choose information that is interesting and relevant to them.

   c. The training is for cognitive strategies or higher-order problem solving tasks. Sequence control in this instance will allow students to make selections that may facilitate flexible and novel thinking.

2. Do **not** provide sequence control to students in situations where the materials have a specific prerequisite order. Learning could be inhibited if the sequence is improperly chosen.

3. Provide learner control of **content** when:

   a. Students have significant previous knowledge of the content. Presentation of known materials is irrelevant and often uninteresting to students.

   b. Students have higher ability (that is, they are "sophisticated" learners). Sophisticat-

ed learners are often able to make content choices based on their particular needs.

c. There is a high probability that students will succeed in learning the content regardless of the chosen content. Students will perceive through feedback that success is under their personal control and is relatively independent of the chosen content.

d. Cognitive strategies and higher-order problem-solving (rather than facts) are being taught. Students may see the relevance of different content and will be able to use this information effectively in novel ways during the learning of cognitive strategies and higher-order problem solving.

e. The skills are not critical, the training is optional, and student motivation is high.

4. Do **not** provide full learner control of content *when all topics in the instructional presentation* are required for successful completion of the program and there is a hierarchical order to the materials. If there is no hierarchical order to the lessons, let the students have control of the order but make sure they don't skip any relevant information.

5. Determine the amount of learner control based on your resource availability as well as these guidelines. Increased learner control over sequence and content generally requires more development work and more resources.

GUIDELINES FOR FEEDBACK

Feedback tells the learner about the accuracy of their response. Feedback can be used to address possible student misconceptions or lack of prerequisite knowledge. It can also be used to help students learn, enhance retention, and measure how much they have learned. Guidelines for feedback are presented below.

1. Keep feedback on the same screen with the question and student response. This reduces the memory load for the student.

2. Provide feedback immediately following a student response. Information about test results is important in the learning process. Delayed feedback can confuse students.

3. Provide feedback to verify the correctness and explain why. It may not be clear to students why their responses are correct or incorrect. Therefore, in addition to knowledge of results, feedback should provide specific information about a response.

4. For incorrect responses, give the student a hint and ask the student to try again. Without the hint, students may fail again and feel frustrated. The hint helps students recall relevant information to answer the question.

5. Tailor the feedback to each learner's response. Feedback should address the misconception a student may have by selecting a particular incorrect response.

6. Provide encouraging feedback. However, do not provide the type of feedback that may encourage a student to make an incorrect response on purpose just to see the feedback. Positive feedback can provide students with the motivation to learn. Cynical or negative feedback may discourage a student.

7. Add instructional feedback to simulation responses to explain why the simulated world reacted in a certain way or to provide a hint. In simulation, feedback is embedded in how the simulated world responds to a particular learner action. *In the test, feedback can be* phased out to facilitate transfer.

8. If possible, allow students to print out their test results. Students often like to maintain a hard copy record of their performance.

GUIDELINES FOR VISUAL ELEMENTS

Visual information in an ICW course serves to enhance the effectiveness of the training program. Visual elements include still frame and motion video, photographs, text, graphics, and animation. Guidelines for visual elements of an ICW program are presented below.

1. Do not jam a screen with too much information at any one point. Cluttered screens reduce learning efficiency and effectiveness (i.e., it takes more time to learn and more students often make more errors.)

2. When presenting a large amount of relevant information, display small chunks of information one at a time through:
   - Screen build-up
   - Window overlay
   - Icon buttons

3. Use windows to group or separate certain information from the rest of the display. This guideline helps to:
   - Draw students' attention to a particular set of data.
   - Reduce the density of display on the screen by superimposing one display on top of another.
   - Establish student expectancy that certain data will always appear in a certain format and location.

4. Use icon buttons for concrete concepts that can be represented pictorially in miniature. Icon buttons represent information that is available in a compact, easy-to-understand, pictorial format; and upon request of a student, disclose that information.

5. Consider presenting information graphically and spatially (e.g., in a diagram or a flowchart). Relationships among content or the overall program structure can be more easily visualized and remembered. A student's path through the program can be easily displayed and remembered.

6. Use the following techniques to keep students oriented:
   - Place certain information in constant locations.
   - Provide a consistent layout for the same types of screens.
   - Maintain the same perspective in a series of visuals. If a change of perspective is necessary, cue students to the change.
   - Use type sizes, colors, and shapes as cues.
   - Provide signposts which help a student know current and past locations, what lies ahead, and how to get there. Make signposts available for reference without requiring the student to move from the current location.
   - Provide a bird's-eye view, or long shot, before zooming into details, to establish a frame of reference for the student.

   Knowing where they are, how they got there, what they can do, where they can go and how they can get there gives students a sense of control. Making this information available allows students to concentrate on the program content rather than the navigation mechanism.

7. Use the following techniques to position information on a screen:
   - Present key information in prominent areas (e.g., away from the border).
   - Present information that changes from display to display (the body of the instruction) in the center of the screen.
   - Present recurrent information (e.g., menu bars) in constant locations.
   - Present navigation buttons near the borders of the screen.

8. To differentiate key information and attract or direct a student's attention, implement these cuing techniques:
   - Arrows, labels, narration
   - Separation of information into distinct objects
   - Windows
   - Colors, shapes
   - Highlighting, bordering, underlining
   - Mixed type sizes and fonts
   - Blinking

9. Use the following techniques for cuing information:
   - Reserve blinking for critical situations requiring immediate student attention or action.
   - Keep borders distinct from the object enclosed.
   - Highlight by either brightening the area of interest or dimming the background.
   - Limit highlighting to 10 percent of the display for effectiveness.
   - Avoid using too many cues at one time. Oversaturation of the techniques may reduce their effectiveness.

10. Use the following techniques for colors:
    - Limit the number of colors on each display. Too many colors on a display reduce effectiveness and aesthetic quality.
    - Use black on yellow, or black on white for text. Always use dark letters on a light background. Blue is an excellent back-

ground color. But don't use blue for text, edges, narrow lines, or small objects.
- Avoid distinctions based on the color cue only. When using colors, always use a second cue (e.g., label, shape, texture) for color-blind students.

GUIDELINES FOR MOTION VIDEO

Motion video is often a major element of ICW. A high level of detail is necessary in the storyboard to ensure that the video producer has sufficient information to get an accurate video shot. Guidelines for motion video are presented below.

1. Present all information in three-shot sequences (long, medium, and close-up) to establish visual orientation. Use close-up shots to grab the student's attention and imply that something is important. Use long shots to establish frames of reference. Try to avoid static shots when shooting motion video.

2. Use a zoom-in to focus a student's attention on a particular object while maintaining visual orientation. This provides a similar effect to a three-shot sequence.

3. When showing something new, focus on the subject long enough for the audience to register what is being shown. Once the audience has seen the subject in the shot, you don't have to focus on it as long the next time you show it.

4. Keep the main subject well lit and watch for possible background distractions. The eye focuses on lighted instead of dark areas and movement instead of static images.

5. Consider using the following motion video formats:
   - Facility/event walk-through (with an off-screen narrator)
   - Lecture (talking head)
   - Demonstration (show and tell) and modeling
   - Interview
   - Talk show format
   - Panel discussion
   - Dramatization
   - Simulation

6. Use "first-person" simulation to allow the student to perform actions as closely as possible to the actual situation (e.g., operating a piece of equipment or troubleshooting). Usually first-person simulation is the preferred method because it facilitates transfer from training to on-the-job performance.

7. Use "third-person" or directed simulation to allow the student to vicariously experience the situation by directing a "person" in the program to perform whatever actions the student wants to perform. A "third-person" simulation may be more appropriate when you want the students to explore the consequences of both right and wrong behaviors in a high-risk situation.

8. Use audio and video to reinforce each other. Never present two unrelated or clashing pieces of information at the same time with audio and video. Design a visual message appropriate to the content and make sure that each visual ties in directly to the accompanying audio. Presenting unrelated or clashing information or an inappropriate visual will often confuse the student.

9. Present a series of visuals before or at the end of instruction. Quick visual inserts presented *before* instruction stimulate recall of prerequisites, serve as an advance organizer, direct attention to key information, and heighten interest. Quick visual inserts presented *after* instruction remind the audience of the key information and enhance retention.

10. Show future events or consequences of unacceptable performance (e.g., disaster caused by human errors) prior to instruction. This guideline is useful to impress the audience with the serious outcomes associated with unacceptable performance and to motivate the audience to adopt acceptable behaviors or practices.

11. Repeat program content in either an identical format or a different perspective to draw attention to particular items, heighten interest, and enhance retention. Things that are repeated are often remembered better. The mere fact that something is repeated implies that it is important.

12. Use motion video rather than still frame if the content requires movement to clearly depict

the point. Use still frames if production resources are limited or there are storage limitations with hardware.

Although expensive to produce, full-motion video can be used to represent reality and help the student achieve a high degree of transfer from training to on-the-job performance. Motion video can often add motivational value to training. For these reasons, motion video is often used to support affective domain objectives and simulations. However, it may be impractical or impossible to produce full-motion video. If this is the case, animation sequences and graphics may be substituted so that instructional effectiveness is not compromised.

GUIDELINES FOR GRAPHICS/ANIMATION

Graphics and animation sequences are often developed to enhance learning. Guidelines for graphics and animation design are presented below.

1. Use graphics or animation when:
   - A realistic presentation (i.e., video) may overwhelm the audience with too much detail.
   - Conditions or problems to be portrayed occur so infrequently that a video presentation is not practical.
   - Minute details are required. Video often has lower resolution than graphics.

2. Use graphics to reduce irrelevant details and highlight key information. Video may be used together with or following the graphic presentation.

3. Avoid biases or stereotypes in graphics or animation (gender, ethnic groups, etc.). Use of biases or stereotypes is insulting and distracting.

4. Use exaggeration and humor carefully to heighten student interest and to facilitate recall. People often remember exaggerated or humorous information better and can be motivated by it.

GUIDELINES FOR TEXT

Text is often used to present content or highlight certain information. Guidelines for designing text are presented below.

1. Limit the amount of text on screen. It is more difficult and takes longer to read text on a screen than in print. People read text on a computer screen at a rate 28 percent slower than reading from a book.

2. Position text appropriately. Regular text should be left-justified only. Center headings and titles. Don't hyphenate words at the end of a line.

3. Use the following format techniques:
   - Provide generous white space to separate blocks of information.
   - Use headings as content summarizers and navigation aids.
   - Convert sentences containing serial items to lists.
   - Organize complex information into tables to help learners integrate program content.
   - Reserve use of all upper case for emphasis and titles only.

4. Use the following attention-getting techniques:
   - Limit highlighting or boldface to 10 percent of the display.
   - Use italic type for titles or headings.
   - Use reverse video or blinking with extreme discretion. Never blink text to be read.
   - Use mixed type sizes or fonts to differentiate screen components.
   - Use no more than one attention-getting technique on a single screen. Remember that oversaturation will reduce the effectiveness of these techniques.

5. Verify the appropriateness of the colors used for text under simulated presentation conditions. The clarity of colors used for text will vary depending on such factors as lighting of the room where the ICW stations are and proximity of the student to the machine.

GUIDELINES FOR AUDIO

The audio part of a storyboard is used by the narrator during audio production. Guidelines for audio design are presented below.

1. Use audio for primary presentation of the program content when the message is short, simple, and requires immediate student response; or if the target audience has poor reading skills.

2. Don't allow audio to interfere with reading from the text and vice versa. To be most effective, audio and text should complement, not compete with, each other.

3. Don't put a lot of text on a single screen. Research data indicates that students find it easier to complete lessons which use audio extensively to present information. Students generally prefer not to have to read long text passages off a screen.

4. Don't let audio compete with video presentations. Audio should support rather than contradict or interfere with visuals. Long silences or competing audio and video may confuse students.

5. If audio is used, provide students with headphones. Students in a lab environment will not be distracted by the audio from other student stations if headphones are provided.

6. When scripting narration, consider using the following techniques:
   - Visualize the images that will be presented on the screen during the narration.
   - Use style and tone appropriate to students' language ability, subject matter knowledge, and vocabulary.
   - Write the script for the ear, not the eye. Read the script out loud to yourself and listen to how it sounds.
   - Keep the language simple, use the active voice, and be direct.
   - Use short sentences.
   - Watch out for acronyms, technical jargon, and unfamiliar terms. Define them if you have to use them.
   - Make the transitions from one concept to another clear.
   - Provide a corresponding visual for every piece of narration.
   - Avoid long pauses in visuals while waiting for extended narration to finish.
   - Select appropriate narrators.
   - Alternate male and female voices to provide variety and maintain audience attention.

7. To make it easier for the narrator or professional talent to record or read the ICW audio, use the following techniques:
   - Number all pages in the upper right-hand corner.
   - Use a legible type size.
   - Specify how acronyms should be read.
   - Spell out all numbers.
   - Spell difficult words and names phonetically.
   - Separate each letter in an abbreviation with a hyphen (e.g., I-C-W).
   - Describe nonverbal cues in parentheses.
   - Indicate pauses by the word "PAUSE" in parentheses.
   - Indicate emphases in parentheses if inflection is not obvious.
   - Double or triple space between lines.

8. Stick to the message. Tell the students only what is relevant.

9. Keep the audio script short and simple. If the message is too long, break it into chunks separated by instructional activities (e.g., quizzes, reviews, hands-on exercises). Students may get bored if they receive information passively from the program for an extended period of time.

10. Use sound effects as cues. Once the link between a sound effect and a specific event is established, the sound effect can serve as an efficient navigation aid, such as the following:
    - Use a beep or an "oh-oh" to clue students that they've done something incorrectly on the screen (e.g., wrong entry). Provide headphones to the students so classmates won't know when mistakes are being made.
    - Use tunes associated with certain events in the program (e.g., introduce a quiz with a short music sequence).

11. Keep production limits in mind (i.e., budget, time, and technical capabilities of production staff and equipment). Allow time for audio rework, which could happen as the development effort proceeds. You obviously want to avoid reaching a point in the development effort where you have run out of funds and "aren't quite finished" with the program.

GUIDELINES FOR PROGRAMMING

The actual programming or authoring of an ICW program typically occurs during the development phase. However, consideration needs to be given to a number of programming issues during

storyboard design. It is wise to establish programming standards before beginning to storyboard the content. Standards save time; they eliminate the need for reinvention and modification. Standards also promote clarity and consistency. Although a certain degree of flexibility is necessary and changes may occur along the way, standards establish consistency throughout the entire ICW program. Follow these program standards, unless you can offer a convincing argument as to why the standards are not applicable to your design.

Consider Programming Standards or Conventions for:

Screen Type

- Course/lesson/subject title screen
- Introduction/overview screen
- Instructional screen
- Inserted question and feedback screen
- Review screen
- Summary screen
- Practice/exercise screen
- Test screen
- Help screen

Screen Layout

- Amount of text
- Text placement
- Headings
- Margins
- Text font and size
- Captions
- Color (text, background, emphasis, borders)
- Attention-getting cues
- Paragraph indentation
- Buttons (what - navigation/help/content; format - icon/text)
- Menus (structure, labels)
- Windows

Questions and Feedback

- Presentation of questions (text, audio, graphics, or combination)
- Type of student responses required (pointing, selecting, or text entry)
- Number of tries allowed
- Hints
- Type of feedback for each try (knowledge of result, explanation, remediation)
- Presentation of feedback (text, audio, graphics, or combination)

Presentation Sequence in Each Segment

- Title screen
- Opening (motivational video segment)
- List of objectives
- Main body of instruction with inserted questions and periodic reviews
- Summary
- Exercise, practice, and test

Miscellaneous

- Naming conventions for video segments and files
- Transition
- Sign-on procedures
- Cursor placement on each new screen
- Voice (e.g., referring to students as "you" and the program as "I" or a third person)
- Movement instruction (given via audio channel or buttons on the screen)

SUMMARY

The guidelines presented in this paper are based on over ten years of research regarding the design and development of interactive multimedia courseware. Because the research findings are at times contradictory, it is important that the guidelines and approaches that you select be based on the particular circumstances of your training application and users. For example, factors such as the learning skills and motivation of the target audience, the complexity of the instructional content, and the hardware and software selected for ICW development and delivery will greatly affect the courseware design. These guidelines are not meant to be applicable to all learning situations and training environments. The guidelines should be selected and adjusted based on specific program requirements and resources.

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