IMPLEMENTATION AND EVALUATION OF A CLASSROOM MULTIMEDIA PRESENTATION SYSTEM

Lt Col James C. Mohan
Education and Technology Requirements, HQ AETC
Randolph AFB, TX

Abstract

Multimedia has charged onto the scene. Companies throughout the nation are putting a wide variety of subject matter onto CD ROM for use on home computers. Learners are beginning to expect fairly high levels of media sophistication in all aspects of learning whether individual CBT or in more exciting and visually stimulating classroom presentations. This paper discusses the evolution of a multimedia classroom upgrade for academic classes taught to Specialized Undergraduate Pilot Training (SUPT) students in the Air Education and Training Command.

The paper outlines the development of presentation requirements, constraints and product options. It also describes multimedia presentation development. The paper will also describe results obtained in both quantitative and qualitative reviews of the first fielded courseware.

Beginning in January 1995, a comparison was begun to measure the effectiveness of the newly installed multimedia presentation systems and the accompanying courseware. Quantitative evaluation included quizzes and end-of-course examinations administered to student pilots at 3 different SUPT bases. Quizzes were given to students taking a T-37 Systems Course. Quizzes were administered to the last class to use the older version of the courseware as well as the multimedia version. The same groups' final exams were also examined. The qualitative portion of the study included interviews with students and instructors involved with the multimedia version of the course. These interviews focused on issues such as the motivating aspects of the courseware and lesson aesthetics.

Quantitative analysis showed no statistically significant difference in student test-score performance. Qualitative analysis showed considerable satisfaction with the courseware's ability to show complex concepts, keep student attention and the presentation system's ease of use.

ABOUT THE AUTHOR

Lieutenant Colonel James C. Mohan is the Chief of Education and Technology Requirements, Air Education and Training Command, Randolph AFB, TX. He is the former commander of the 619th Training Support Squadron's Training Technology Flight. In that capacity he oversaw the acquisition and installation of multimedia presentation systems used in Specialized Undergraduate Pilot Training classrooms. Courseware developers under his command produce the multimedia courseware used in SUPT. Lt Col Mohan has flown the B-52G and has been a T-37 instructor pilot, flight commander and operations officer. He holds a doctorate in Adult and Vocational Education from Auburn University.

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MULTIMEDIA IN THE CLASSROOM

Multimedia has charged on to the scene with the advent of high powered, low-priced computers capable of handling the demands of these very data intensive operations. Companies throughout the United States are putting a wide variety of information onto CD ROM for home computers. Learners expect fairly high levels of media sophistication in all aspects of learning, whether individual CBT or in more exciting and visual stimulating classroom presentations. In the summer of 1994, the Training Technologies Flight of the 619th TRSS began an initiative to enhance the classroom presentations in Specialized Undergraduate Pilot Training (SUPT) and in the Introduction to Fighter Fundamentals (IFF).

Current Usage

Before continuing, a few definitions are required. First, multimedia. For our purposes multimedia is "the combination of sound, motion and still pictures, and text on one display device." (Whitaker, 1992) An electronic classroom is defined as a classroom equipped with electronic display devices capable of displaying computer-generated text, graphics, full-motion video and sound through an integrated, easy-to-use control system. Such a classroom may or may not have student accessible computers or response devices. The classroom system we envisioned can be described as either an electronic classroom or as a multimedia classroom. A review of the literature showed that in most cases, published studies have been directed at the K-12 level in which multimedia has been included as a part of classroom activities. It has not meant large scale integration of technology into the classroom such as digital display devices, electronic slides to support lectures or lessons, and the use of computers to develop or control presentations. That type of use has evolved mainly in the training or sales presentation areas of corporate America. Most articles uncovered in ERIC searches on the keywords of *electronic classroom* and *multimedia classroom* produced numerous hits. Almost all referred to studies of interactive video disk instruction or multimedia programs running on a PC for use one-on-one with the computer or in small groups.

Outside the K-12 arena authors have explored the area of using the technology as presentation support aids. In the area of business education Klemin discusses several uses of multimedia. One he mentions is teacher presentation tools. He states: "Electronic presentations are replacing the chalkboard, allowing teachers to prepare vibrant presentations that enhance textual material with pictures, sound and graphics." (Klemin, 1993). At the university level, Kalmbach describes several uses for multimedia in the classroom. His descriptions include the use of simple operating controls and video projectors that allow students in all parts of the classroom a clear view of presentation aids and demonstrations (Kalmbach, 1994).

THE SUPT CLASSROOM

Previous Configuration

Classroom presentations make up a majority of the academic course work in SUPT. A T-37 student receives approximately 147 hours of classroom academic training and 42 hours of computer-assisted instruction (CAI). Once graduating from the T-37, he or she can expect 77 hours of classroom work in T-38 training and 18 hours of CAI. For the T-1A student, he or she can expect to see 82 hours of classroom academics and 101 hours of CAI. A cursory review of similar training programs shows a similar emphasis on classroom presentations for imparting knowledge- or comprehension-level information.

As of January 1995, the SUPT classroom had not changed appreciably in 30 years. Classrooms were equipped with overhead slide projectors, 35MM slide projectors and 16MM movie projectors. Most bases had video tape players and TVs available on carts. Classrooms also had blackboards. Some lessons were supported by large electro-mechanical system simulators and oversized wooden component mockups. The 619th TRSS, as the controlling agency for the curriculum, provided student workbooks, instructor guides and 35MM slides. Because of the limited ability to display video tapes to large groups, no video presentations accompanied the academic classroom presentations. Earlier 16MM films had succumbed to age and were not replaceable.

Possibilities

The rapid advance of presentation technologies presented a dizzying array of potential solutions to the problem statement: "What can we do to increase the effectiveness of our classroom presentations in light of new missions and deteriorating equipment and training aids." Several vendors provided demonstrations and product descriptions. Solutions ranged from fully integrated systems wired into the walls of the

classrooms to media cart solutions with TVs and VCRs. This initial review led to a solid understanding of capabilities and the foundation of a requirements statement.

Desired Capabilities

As requirements development began, several capabilities had been identified. First, all agreed on the need to project images to a sufficient size that students in the classroom could easily see even fairly intricate details clearly. Second, the system must be able to deal with full motion video in some way. Due to the changing nature of much of the curriculum, video tape was the preferred video source. Third, the development of presentation materials had to be within the production capability of the Training Technologies Flight of the 619th TRSS. Contractor support was not available and outside production support such as video mastering or slide development was undesirable.

Requirements Development

The general requirements discussed above formed the foundation of the research into the electronic classroom development. Interviews with academic instructors and personal experience of some flight members pointed to the need to provide quality visual aids to the student pilot. Those aids needed to be simple to construct and offer high visual impact. The point of the project was to take advantage of the motivating effect that multimedia has on the student through additional sensory stimulation that reinforces each student's preferred way of learning (Whitaker, 1992). Additionally, serious efforts needed to be made in the enhancement of visual displays in the current curriculum support materials; especially, full motion video.

Ease-of-use was also an important consideration. In SUPT, instructors frequently roam around the room while making their presentations. This requires the ability to interact with the presentation system by remote control. In addition, the instructor needed to have the ability to return to a specific slide or video sequence in the presentation without multiple clicks through the entire presentation. The system also had to closely approximate the current practices used by our instructor force. Ward Cates makes an important point when he states, "most teachers are unlikely to adopt innovations that require them to make radical changes in the way they presently teach." (Cates, 1992) That can be said for students and instructional managers as well.

Price is always a consideration in any purchasing situation. While early discussions assumed no limit on available funds, by the time alternatives had been assembled, price had to be factored in. One of the important issues that was considered was the total number of classrooms that need the upgrade compared with the total number of classrooms at our SUPT sites. Generally, classroom space is not an issue in SUPT. More often than not, classrooms sit empty for a good part of the day. Due the constraints of the flying schedule, SUPT students can be found in academics early in the morning and late in the afternoon, except for those students in the preflight phase. In some cases, classrooms are reserved for a particular class presentation due to the availability of oversized doors for training aids and the like. Seldom are all classrooms in use simultaneously. In an attempt to scope the purchase, each flying training wing was queried as to the number of simultaneously used classrooms. Those numbers were used to establish project scope.

Analysis

A number of factors were included in program analysis beyond the factors discussed above. First was the development of a mindset that defines training technology as more than audio-visual devices. Robert Reiser states: "Today many professionals in the field think of instructional technology as a systems approach process." That is, "a systematic way of designing, carrying out and evaluating the total process of learning and teaching." (Gagné, 1987) Each solution was evaluated as to its total "system" utility with an emphasis on the technology, but not a seduction by it.

Government contracting can be a tangled web of procedures and requirements. After exploring options with contracting officials, a "turnkey system" was decided upon. The 619th was not interested in becoming a system integrator; especially due to the fact that the systems would be delivered to several bases throughout the southern United States.

An analysis of the courseware requirements identified several important requirements of the presentation system. First, courseware needed to be easily changed. While aircraft systems in SUPT aircraft are fairly stable, the environment in which the aircraft are flown changes frequently. Not only are maneuvers modified or added to the training syllabus, outside agencies such as the FAA can direct changes to airspace usage and other flying regulations that must be quickly and easily added to the course materials. This requirement led to the solution of digital text and graphics capabilities and the use of easily changed video to enhance the presentations by showing complex systems in operation.

While student and instructor concerns were important factors in the analysis, the fact that the 619th TRSS provides the presentations instructors use was never far from center stage. Any system not only had to be simple enough for an instructor to easily master, but

the development of the lessons had to fit within the talents of Training Technologies Flight members. Already a well equipped publishing center, the 619th TRSS had numerous computer-based tools to assist in the development of electronic presentations. As part of the AETC Interactive Courseware Flight concept, the Training Technologies flight was populated by computer scientists, behavioral psychologists, as well as a graphic artist. This effective blending of people and tools allowed fairly sophisticated solutions to be considered.

Related to this was the need for easy administration. Using 35MM slides, hundreds of slides had to be printed, assembled, numbered, collated, boxed, and shipped to the training wings. Under a digital multimedia system, presentations simply had to pass final quality control and be transferred onto diskettes. The result of this change was eight diskettes (primary and backup to each of 4 bases) taking the place of hundreds of slides.

Users were never far from the discussions. In keeping with the Quality Air Force principles, it was decided to offer users as much flexibility in system design as possible. While the core of the presentation system needed to be directed, peripherals and installation alternatives were to be offered as options as much as possible.

Throughout the analysis, numerous calls were made to other organizations to determine what other systems were being used at other levels of flying training. Conversations were held with and systems specifications were obtained from several active duty fighter training squadrons as well as the National Guard. Frank discussions with system buyers, developers and users concerning strengths and weakness provided significant inputs to our analysis.

Decisions

The result of the analysis was a decision to purchase a "turnkey" system that allowed the full integration of digital graphics, images, and video on one screen without the need for manual changes to the video source by the instructor. Additionally, the system had to accept graphics and images from multiple sources. The changeable nature of course video and the cost of mastering and reproducing interactive video disks eliminated them from the final solution. The fluid state of digital video and its high storage requirements resulted in the selection of video tape as the preferred video source. The video tape solution allowed for 619th TRSS-developed video segment filming and editing. The negative aspects of video tape included the inability of the presentation system to almost instantly access desired video segments as is the case with interactive video disks. This accessing delay was minimized by careful video segment ordering on the video cassette.

In the end, General Parametrics' *VideoShow HQ* was selected.

MULTIMEDIA PRESENTATION DEVELOPMENT

Effective Presentations

Effective multimedia presentations are simply more than adding multimedia capabilities to an existing lesson. In most cases the development of the multimedia presentation involves a complete rethinking of the unit or lesson under revision. When updating an existing lesson, the designer should realize that media had an impact on the current design. Adding media components will have a similar impact. In fact, the development of the new lessons should be considered an entirely new development effort. The complete lack of video in the previous course edition was an obvious and important factor. As Johnson states in the book *Electronic Learning,* the medium is only the vehicle for passing the information. It's not possible to study the media without including the programming (or message) being passed on it. (Johnson, 1987)

The first course chosen for conversion was the T-37 Systems Course. This course included 13.5 hours of classroom instruction interspersed with 9.5 hours of CAI. The development team consisted of an SME, designer, graphic artist, and videographer. Principles listed in the following discussion formed the basis of work.

First, the course arrangement was formed with an information processing model in mind. As described by Johnson, the information processing model

> "postulates that learning is comprised of a number of processes between the point where the learner is stimulated by something that is to be learned and the point when a response is produced that indicates learning has occurred. Among the processes are attention to the stimulus, selective perception of characteristics of the stimulus, retention in short term memory, retrieval of information, response generation, performance and feedback regarding performance." (Johnson, 1987)

Important to the designer is that "most learning is the result of an interplay between processes internal to the individual and events external to the individual. When events are assembled in ways designed to enhance internal processes in an individual, the events are called instruction." (Johnson, 1987) The design also included realization that when instructors related "media" materials to the learning objectives, learning

was enhanced. This is perhaps best related to Ausubel's "advanced organizer" concept. (Heinick, 1989)

Next, displays were designed with many of the concepts put forth by Malcom Fleming. Fleming lists seven aspects of instructional displays that enhance learning. They are

1. Attention is highly selective.
2. Attention is drawn to what is novel.
3. Attention is drawn to moderate complexity.
4. Lean displays focus attention
5. Learning cues can direct attention (arrows, circles)
6. Learner expectations strongly influence attention
7. Moderate uncertainty may induce careful attention

(Gagné, 1987)

Displays also made use of several others of Fleming's suggestions. He states that what occurs in the first and last displays of learning program can have a critical effect. He goes on to list several ideas that relate to that general statement. They are

1. The items a learner encounters first and last are better remembered.
2. Abstract introductions that subsume the lesson's information form an advanced organizer that help learning.
3. Introductory materials such as objective statements can facilitate learning.
4. Concluding interactions such as summaries and post-lesson questioning techniques can enhance learning.

(Gagné, 1987)

As mentioned above, changing the media in an existing course often requires significant modification to the design of the lessons. One of the biggest hurdles the developers faced was overcoming the tendency to simply duplicate the previous lessons in a digital format. After several experiments and design reviews, developers developed an excellent appreciation of the impact obtainable by the various tools at their disposal. Most important was the use of video.

Video provides a number of important advantages. Primarily, it allows high fidelity representation of actual systems operations. With creative editing and appropriate narration, complex procedures can be displayed in seconds rather than requiring minutes of verbal explanations. An excellent example of this was the use of video in describing the operation of the T-37 landing gear system. Internal gear actions and sequencing indications were taped in the simulator. External views of extending and retracting landing gear were taped in a hangar using an aircraft on jacks undergoing system checks. Prior to this, a student's first exterior view of landing gear operation was during the formation phase near the end of T-37 training. Video segments were either used as an introduction to a more detail discussion of system operation or as a culmination of a detailed discussion to tie concepts together.

Tools

Two sets of tools are used to develop the multimedia presentations. The first set are those tools purchased with the presentation system and marketed by the hardware vendor. These tools include video capture software and hardware, graphic presentation conversion software, and presentation development hardware.

The video capture hardware and software combination allows developers to capture any image currently on video tape. The file produced by this software is a standard targa (.tga) file. These files are easily manipulated by several commercial products. The big advantage to this capture process, however is the high degree of compression available once the image has been enhanced or altered to the desired degree. The graphic presentation conversion software allows existing presentations such as Microsoft *Powerpoint* slides to be converted to the presentation system's format.

The presentation system software is a Windows-based product similar to *Powerpoint*. Text is directly entered onto the screen. Video windows are simply drawn onto the screen with dialog boxes used to enter video control and timing codes. If connected to the presentation system, previews are instantly available on an NTSC (TV) monitor or other projection device.

The second set of tools used in courseware development consist of those usually associated with PC graphics development. Graphic manipulations of captured video images are accomplished with photo-imaging software. An example of this use is changing the needle on an airspeed indicator photo to reflect various airspeed limitations. A popular graphics package was used to add learning cues such as arrows and circles to other captured images, as well as in the development of original artwork.

Not related to PC imaging are video production tools. For this project, a video camera, light table, and basic analog video editing decks were obtained. This equipment is used to assemble the lesson video tapes. These tapes consist of several video segments edited butt to butt. No professional level editing is done. In those cases where special effects or other high-level video support is required, visual information personnel are enlisted.

Evaluation

As described in the Air Force ISD model, evaluation is a continuing process in the development of the classroom presentations. In the formative evaluation category, not only were Subject Matter Experts (SMEs) constantly available for critique and assessment, squadron supervisors were frequently called on to offer inputs during the development process. Video quality control was especially tight. Examples of video critiques included such things as torn flight gloves, flight caps protruding from flight suit pockets, and mispositioned switches in videos filmed in the simulator.

Summative reviews were planned as a two fold process; quantitative and qualitative. Quantitative evaluation consisted of two statistical measures. The first was a measure of presentation effectiveness using a quiz given to students who took the course using the previous 35MM version of the classroom lecture. The same quiz was given to students receiving the multimedia version of the material. A second measure was obtained by measuring the same classes' performance on the end-of-course examinations.

Qualitative evaluation consisted of telephone interviews with both students and instructors. Since 35MM courseware is still the predominate form of classroom instruction, both students and instructors have had close, first-hand, experience with both presentation techniques. Those interviews focused on the aesthetic and motivating characteristics of the multimedia courseware. Additionally, specific critiques were solicited on display techniques and formats.

RESULTS

Quantitative

The quantitative evaluation included students in two different Specialized Undergraduate Pilot Training (SUPT) classes at three different bases. The first group of students received the instruction using the previous version on the courseware; that is, student workbooks, lecture supported with 35MM slides, and Computer-Assisted Instruction (CAI). The second group received instruction using student workbooks, lecture supported with the multimedia classroom presentation system, and the same CAI. Since there had been no changes in the aircraft's systems, changes to the student workbook were not significant. Lesson outlines varied to take advantage of the opportunities afforded by the presentation system.

The first group consisted of 58 students. The second group consisted of 65 students. Several of the classes studied had international students assigned to them. While they took the quizzes and tests, their scores were not included in the analysis.

Lesson Quiz. The quiz used in this analysis was a ten-question quiz covering material presented in the class hour devoted to the hydraulic system. This hour was selected because of its structural similarity to the 35MM version and varied use of all aspects of the multimedia system; that is, captured video, graphics, and full motion video. The quiz was designed to measure those items stored in short term memory immediately following the presentation.

The statistical test applied to the data was a Student's t test of two samples assuming unequal variance. The computed means of the two samples showed the mean score of the students taking the multimedia version of the quiz was slightly lower than those taking the previous version. However, the scores obtained by the multimedia students were more tightly grouped and generated a lower total variance. Because of the possibility that the multimedia courseware could actually have a negative effect on training, two-tailed t-tests were performed. That is, the test was structured to assess the possibility of degradation as well as improvement. When applied, the t-test showed no statistically significant difference between the two groups. The following table displays the results of the analysis. In the tables, column 1 refers to students receiving the 35MM courseware and column 2 refers to students receiving the multimedia courseware.

t-Test: Two-Sample Assuming Unequal Variances

	35MM	*Multi-Media*
Mean	69.65517	66.30769
Variance	301.6334	192.4038
Observations	58	65
Hypothesized Mean Difference	0	
df	109	
t Stat	1.171807	
P(T<=t) two-tail	0.24383	
t Critical two-tail	1.981966	

Keep in mind that while the scores were reported on a one hundred point scale, With ten questions without partial credit, the difference in the mean scores was actually 6.96 versus 6.63, or .33 questions.

Final Examination. The final examination given to the students was a 34 question test covering all aspects of the aircraft's systems and system operation. SUPT tests are based on the training objectives of the course

that are described for both students and instructors. Objectives ask that students be able to do or know specific things, the instructors teach them those things and the tests measure those things. As a result, exam scores are very high. Perfect scores are not unusual. Scores below 85% are considered failing and are unusual.

As with the quiz score, a two-tailed t-test was performed on the scores obtained from the same two classes used in the quiz measurements. Again, as with the quizzes, no significant changes were indicated in the two-tailed test. The results are summarized in the following table.

t-Test: Two-Sample Assuming Unequal Variances		
	35MM	*Multi-Media*
Mean	33.5088	33.19047619
Variance	0.7901	0.963133641
Observations	57	63
Hypothesized Mean Difference	0	
df	118	
t Stat	1.86431	
P(T<=t) two-tail	0.06476	
t Critical two-tail	1.98027	

Analysis

The results of the initial set of test scores were encouraging. Use of the new courseware did not have a negative affect on the already very high performance of SUPT students. This, while gaining development, distribution and administrative savings due to the relative ease with which the courseware could be managed compared to the previous media.

Developers had some small concern that the newness of the presentation system might distract the students from the information due to the use of animations, slide transition and video in windows; all new for the SUPT student. Inexperience with the courseware was also a concern. Instructors had presented the previous version of the courseware several times. The tested groups were participating in classes where the courseware was being presented for the first time with live students. An analysis of test scores for subsequent classes should assist in limiting the effect of inexperience with the courseware and the presentation system itself. In this case, the newness of the courseware and the inexperience with the presentation system did not significantly detract from the overall course effectiveness. This reflects favorably on the impact of the multimedia screen presentations and the presentation system's ease-of-use.

Outside the area of student performance, there were measurable improvements in the area of courseware administration and maintenance. Using 35MM slides, after computer generated slides and photos passed their final quality control, up to 2 weeks could elapse before multiple slides sets were printed, collated, numbered, packed and mailed to the units. Once there, the slides would have to inserted into slide trays before they could be used. With the digital media, once the quality control check was passed, disks can be copied in a few minutes and dropped into the mail. Changes require only that the files be recopied onto disks and mailed. Disks having the previous version of the courseware can be returned for reuse.

Qualitative

Interviews were conducted with each of the instructors teaching the multimedia version of the T-37 Systems Course, as well as several of the students. In all cases both the instructors and the students deemed the multimedia version of the courseware effective and aesthetically pleasing.

Instructors felt that the courseware was surprisingly easy to teach. In the previous version, slides generally contained either words, graphics or photos, not combinations. Instructors commented that the slide construction that included key points as well as a supporting photo, graphic, or video segment made preparation for the class easier. Because most of the main points in the instructor guide were now "bullet statements" on the screen, instructors noticed the need to reference the instructor guide decreased substantially. This allowed instructors to move freely around the room without finding themselves on the opposite side of the room as their notes, uncertain about the next point.

Instructors also felt the system itself was easy to master with only a small amount of practice. In those cases where mobile systems were used, instructors found setup was easy and did not require undue preparation time. On the negative side, it was noted that some fine detail was lost due to the relatively low cost projectors that were purchased. This was noticed mainly on things such as numbers on selection wheels on the transponder and radio frequency knobs.

Instructors also believed that the graphics intensive slides with computer slide "builds" and embedded graphics held student attention better than the 35MM slide courseware. Several commented on the use of the video segments as effective way to convey complex subjects in less time than before.

Students who were interviewed had experienced both the multimedia courseware and the 35MM courseware. At the time, the T-37 Systems Course was the only multimedia course fielded. They expressed favorable opinions about the delivery media. They felt that the

use of video greatly helped getting complex issues across. Video segments such as the canopy lowering segment clearly showed what was somewhat confusing when described only in words and still pictures. Students appreciated the effect of video overviews and summaries using different words than those used by their classroom instructor.

From a motivational stand point, students felt that the courseware was more interesting and visually pleasing and therefore easier to pay attention to. It must be said, however, that SUPT student pilots are generally very highly motivated, especially early in the training program.

CONCLUSIONS

All persons involved with the multimedia classroom project were pleased with the results. Developers felt they were able to improve the quality of the classroom presentations students received. Instructors felt that the presentations were easier to deliver and more effective. Students liked the high-impact graphic displays of complex information. System administrators liked the simplified logistics and the ease and speed at which changes could be fielded. By all qualitative measures, the program was a success.

Quantitatively, the data also show the same success. Student performance, already at a very high level, did not decline. Also worth examining is the effect of this being the first time the instructors had taught the material to a live class. Follow-up testing of subsequent classes' test scores should aid in determining whether actual improvements in student performance will occur when instructors reach full familiarity with the courseware. Administratively, real time savings were noted. Reduced handling and more efficient handling of courseware changes proved advantageous.

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