NPS-MV-2009-001 8 April 2009

NAVAL POSTGRADUATE SCHOOL

Best Practices and Workflows for Producing Video-Based Classroom Content

Case Study: Producing X3D for Web Authors

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This report was prepared by the Naval Postgraduate School's (NPS) Modeling, Virtual Environments and Simulation (MOVES) Institute and funded by NPS Office of Continuous Learning.

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REPORT DOCUMENTATION PAGE	*Form Approved OMB No. 0704-0188*

1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** April 2009	**3. REPORT TYPE AND DATES COVERED** Technical Report

4. TITLE AND SUBTITLE: Best Practices and Workflows for Producing Video-Based Classroom Content Case Study: Producing X3D for Web Authors	**5. FUNDING NUMBERS**
6. AUTHORS Jeff Malnick, Don Brutzman, Jeffrey D. Weekley	
7. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Modeling, Virtual Environments and Simulation (MOVES) Institute 700 Dyer Rd., Wa-267 Monterey, CA 93943-5001	**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING/MONITORING AGENCY NAME AND ADDRESS Naval Postgraduate School Office of Continuous Learning	**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

11. SUPPLEMENTARY NOTES: The views expressed in this report are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION / AVAILABILITY STATEMENT Unclassified for public distribution	**12b. DISTRIBUTION CODE**

13. ABSTRACT

Introduction to Extensible Graphics (MV3204) and Advanced X3D Graphics (MV4205) are a pair of well-established courses with a custom textbook, examples, slide-sets, and the X3D-Edit authoring tool that includes embedded help and chat capabilities. This case study reports on lessons learned from producing 62 sessions totaling 37:35 hours of video instruction. Topics include how to create video sessions for each lesson, building a video website, and teaching to remote students while recording. Most importantly we show the feasibility of repeatability in recording video versions of course sessions with minimal post-production requirements, thus reducing video-production labor costs significantly. We also demonstrate the ability to use open-standard, NPS-produced open-source software to create a satisfactory course website instead of using closed commercial applications.

This report summarizes the entire course preparation process, ranging from necessary preparation of course materials to pre-production, classroom presentation production and post-production of video sessions. We also include detailed workflow charts, production checklists, conclusions, and recommendations for future work.

14. SUBJECT TERMS Video course production, Extensible 3D (X3D) Graphics, X3D Graphics for Web Authors, Best Practices, video production workflows	**15. NUMBER OF PAGES**: 66
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

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ABSTRACT

Introduction to Extensible 3D (X3D) Graphics (MV3204) and Advanced X3D Graphics (MV4205) are a pair of well-established courses with a custom textbook, an X3D example archive, annotated slide-sets, and the X3D-Edit authoring tool. This case study reports on lessons learned from producing 62 sessions totaling over 37 hours of video instruction. Topics include how to prepare and present video sessions for each lesson, recording and production techniques, building a video website, and teaching to remote students while recording. Most importantly we show the feasibility and repeatability of recording classroom video sessions with minimal post-production requirements, thus reducing video-production labor costs significantly. We also demonstrate the ability to use open-standard and open-source NPS-produced software to create a satisfactory course website.

This report summarizes the entire production process ranging from proper preparation of course materials to pre-production, classroom presentation, speaker recording, screen capture, digital production, and post-production of video sessions. Detailed workflow diagrams, production checklists, conclusions and recommendations for future work are also included.

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ACRONYMS AND ABBREVIATIONS

ACM	Association for Computing Machinery
A/V	Audiovisual or Audio / Video
API	Application Programmer Interface
CAD	Computer Aided Design
DIS	Distributed Interactive Simulation Protocol
DRM	Digital Rights Management
DTE	Direct-To-Edit hard drive disk
FCP	Final Cut Pro
HDV	High-Definition Video
HTTP	Hypertext Transport Protocol
IEEE	Institute of Electrical and Electronics Engineers
IMS	IP Multimedia Subsystem
IP	Internet Protocol
IPR	Intellectual Property Rights
MOU	Memorandum of Understanding
MOVES	Modeling, Virtual Environments and Simulation
NEW	Network Education Ware
NPS	Naval Postgraduate School
OCL	Office of Continuous Learning
OS	Operating System
P2P	Peer-to-Peer
QOS	Quality of Service

RSS	Rich Site Syndication XML format
SAI	Scene Access Interface, API for X3D
SAVAGE	Scenario Authoring and Visualization for Advance Graphical Environments models archive https://savage.nps.edu/savage
SDV	Standard Definition Video
SIGGRAPH	Special Interest Group for Computer Graphics http://www.siggraph.org
SIPRNET	Secret Internet Protocol Router Network
URL	Uniform Resource Locator
VGA	Video Graphics Array display hardware
VR	Virtual Reality
VRML97	Virtual Reality Modeling Language, ISO standard of 1997
Web3D	Web3D Consortium http:// web3d.org
WSA	Web Service Architecture
WWW	World Wide Web
W3C	World Wide Web Consortium http://w3.org
Xj3D	Extensible Java-based 3D Rendering Application Code base
XML	Extensible Markup Language
X3D	Extensible 3D Graphics
X3DE	X3D Earth
3D	Three Dimensional

ACKNOWLEDGEMENTS

The authors thank the NPS Office of Continuous Learning (OCL) for helping fund this project. Also, the authors would like to recognize the students of MV3204 and MV4205 for their support in this project.

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I. INTRODUCTION

1. SUMMARY

Introduction to Extensible Graphics is a well-established course with a custom textbook, examples, slides-sets, and an authoring tool that includes embedded chat capabilities. This report articulates how to create video sessions for each lesson, build a podcast site, teach to remote students while doing so, show feasibility of repeatable recording video versions of course sessions with less post-production requirements than usual, and demonstrate ability to use NPS-produced open-source software to create a satisfactory course website.

2. MOTIVATION AND GOALS

2.1 Motivation

The simple intention was to provide this visually complex material in a way that works for both in-resident students and students in remote locations or asynchronously. Because the X3D language and its application are open source technology, it is already accessible to many people. Therefore it makes sense to make the teaching of X3D accessible, as well.

These courses explain the fundamental principles of 3D graphics through an interactive display: providing interesting, high quality material for anyone to access. Video on the web has become synonymous with distance learning; yet 3D graphics remains an elusive media type for non-programmers. Combining the ease of watching video without having to necessarily install 3D graphics viewers with the X3D course extends the 3D world to the 2D of video. Describing these "lessons learned" in this report opens the door to further progress in other courses as well.

2.2 Goals

The course instructor had already designed and implemented the MV3205 and MV4205 courses as synchronous classroom-based offerings, yet needed to make only slight modifications for updated presentation as a video-based course. Redesigning the courses wasn't necessary since the presentations were easily recorded and ported to streaming media. The primary technical goal for this project was to streamline production and post-production so that each day's course-video publication might finish within 24 hours. While many automated tools exist for such work, none use High Definition (HD) video from multiple streams or high-quality screen captures as part of a production workflow.

Most published distance-learning videos consist of screen captures or single-source video, such as fixed camera or screen capture with sound. This work shows both speaker and interactive screen elements together in the finished video. The widescreen format of HD video is perfectly suited to this.

3. PROJECT OVERVIEW

The MV3204 and MV4205 course are media-rich classes designed to teach non-technical students the fundamentals of computer graphics. 3D graphics is a very visual medium although much can be learned from a traditional (2D) text, seeing is believing; or in this case, seeing is learning. High Definition Video (HDV) has a wider aspect ratio than Standard Definition Video (SDV), therefore is can accommodate both screen and speaker. Typically the display screens would include just slide sets, but in the case of X3D, the display also includes 3D graphics. They are dynamically represented within the video itself so that the student gets a sense of the subject more readily than static slides or texts can portray by themselves.

3.1 Course description

From the NPS Course Catalog: X3D for Web Authors (MV3204) is "an introduction to the principles of hardware and software used for computer-generated 3D graphics via the World Wide Web. The focus of the course is authoring interactive 3D scenes and a major design project. The course is intended for MOVES and Computer Science students working in visual simulation, or students in other majors interested in the basics of 3D modeling and rendering." The advanced course MV4205 continues with these topics and also covers additional advanced capabilities included in the X3D specification.

3.2 Course Materials

The course materials include a text book "X3D Extensible 3D Graphics for Web Authors" by Don Brutzman and Leonard Daly, with an accompanying website which has course slide sets, example scenes, an interactive software tool, and links to supporting documentation such as the X3D Specification. All materials are available online at http://x3dgraphics.com. The book may be purchased in hard copy or electronic copy. All other resources are free and published under open-source license.

Figure 1. X3D for Web Authors (http://x3dgraphics.com) is the textbook used for these courses

3.3 Teaching Objectives

Students need to be able to install, configure and run the basic tools needed for X3D Authoring: X3D-Edit and Xj3D browser (or similar). They need to be able to author simple scenes graduating to more complexity as the course continues. They need to grasp basic principles, vocabulary and techniques associated with 3D graphics in general (X3D in particular). All this has been demonstrably achieved with traditional students in classrooms. We expect that the same learning outcomes are achievable through this video-based course. We further expect that the production "lessons learned" can apply equally well to other courses, which may well be less demanding of multimedia resources and are likely easier to present.

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II. COURSE PREPARATION, PRESENTATION AND PRODUCTION

1. PREPARATION OF COURSE MATERIAL

Careful preparation is required to include video production in a DL course offering. Format is important. In this section, we discuss some of the considerations given to preparing to present the course as a video-based course, focusing on presentation style and technical considerations, production and post-production.

1.1 Slide Set Preparation

Slides must be clearly legible and font sizes sufficiently large so that they are rendered legibly in the final product. Serif fonts do not render well in video, as the detailed font aspects of each character must be recreated in video by pixel by pixel, see Figure 2 below. A sans-serif font (as shown in the first line of diagram) is preferable.

Figure 2. Pixel Representation of San Serif and Serif Fonts

Figure 2 shows that sans-serif fonts as raster graphics render much more cleanly, with less edge noise and they remain readable, even when highly compressed in video. Mathematical formulae are also troublesome and care should be paid to their rendering in the final video by using a larger font size. Within the constraints of screen size, larger sans-serif fonts are always rendered better when converted to video.

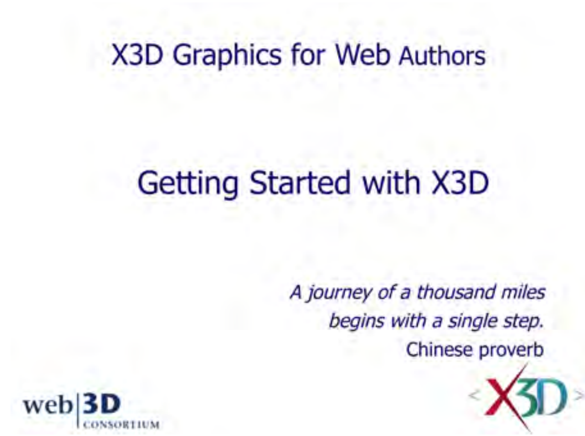

Figure 3. Recommended Slide Layout

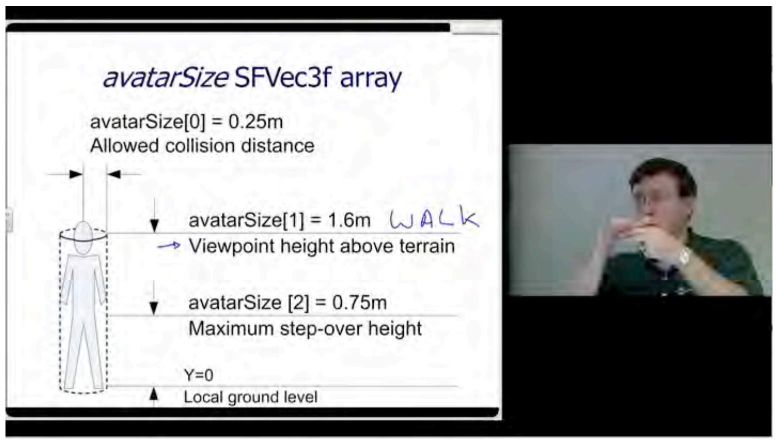

Figure 4. Recommended speaker and slide layout *without* chromakey transparency

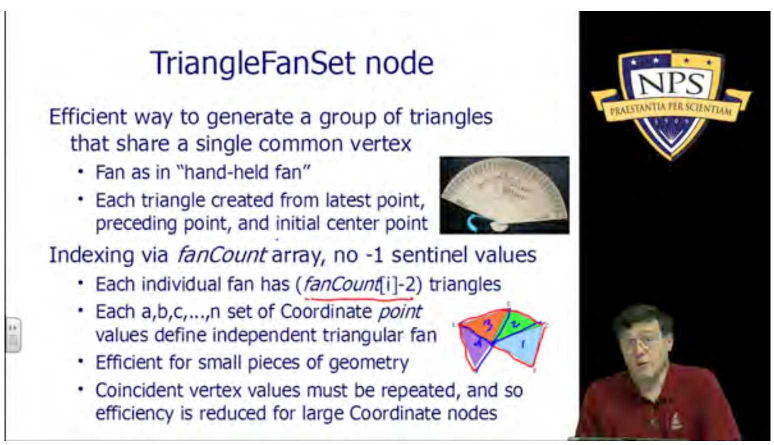

Figure 5. Recommended speaker and slide layout *with* chromakey transparency replacing speaker background

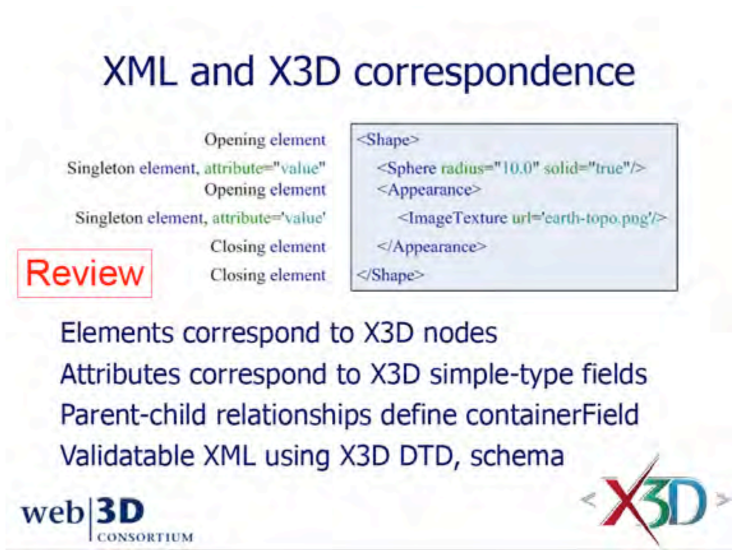

Figure 6. A regular slide from the X3D slide set

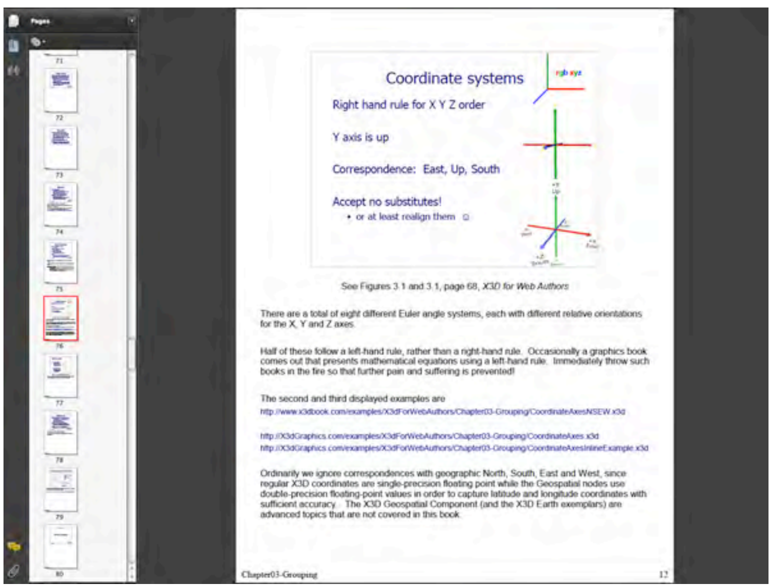

Figure 7. Dual view in .pdf viewer for X3D slide set showing both slide and accompanying notes

1.2 Speaker Preparation for Video Presentation

Instructors must also be aware of the peculiar limitations of video itself. They may be required to be stationary, rather than walking back and forth in front of a whiteboard. If chromakey is to be used (see Figure 5), they may also be asked to refrain from wearing certain clothing types or colors. Solid, muted colors are often best. Professor Brutzman chose solid colors with no patterns, except a small SIGGRAPH logo that was appropriate for the topic at hand. Also, the instructor must also know the boundaries of the camera framing in order to keep any arm gestures from going out of frame during post processing. Figure 6 shows Prof. Brutzman's actual camera frame. If he gestures outside of this frame his hands will not show up in the final video.

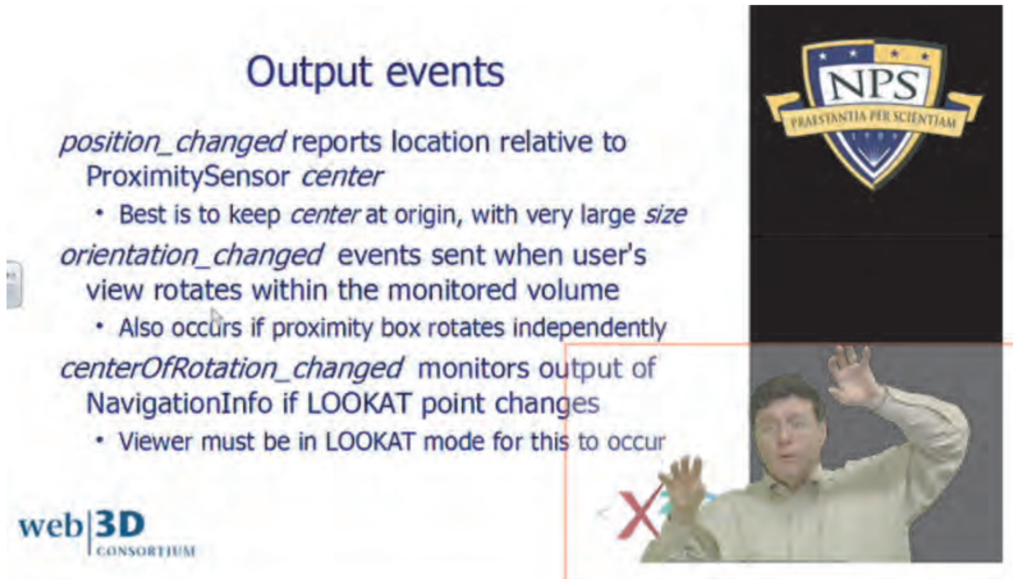

Figure 8. Example of actual camera frame, and a gesture that fits

1.3 Class Format and Scheduling

In MV3204 and MV4205, 10 minutes at the beginning and 10 minutes at the end of class are set aside for questions. The students in this course did not have individual microphones, so it was not possible to properly capture their questions on camera. Multiple microphone setups require constant operator intervention using a mix board. This restrictive format enabled Prof. Brutzman to present the material for the camera but also with the advantage of having an audience. Deliberately moving questions outside of the presentation greatly reduced post-processing costs (perhaps by a factor of 2) by eliminating the need for multiple scene edits.

Certain key phrases (such as "welcome back" or "see you next time") at the beginning and end of each session are also helpful they cue the video editor and the students (or possibly any automated systems of the future) that the formal part of the lecture has begun or ended. They also provided continuity across each segment.

It is advantageous to have a dedicated space for the recording where equipment can be stored permanently or install fixed equipment. See future work at the end of this report for more on permanent installation. At the very least, we recommend that a locking cabinet be installed in the classroom where audio-visual gear can be stored when not in use.

It is necessary for the recording technician to arrive at least 20 minutes before each class to setup any equipment, check its functionality, calibrate display devices, adjust focus and white balance the camera, etc. See section 2.2 for details. While breakdown of the gear is faster, depending on the software involved, uploading of the screen capture from the instructor laptop to the server can take some time. It is therefore helpful if no class were scheduled before or after recording when setting up in a regular classroom. Alternatively, 30-minute video sessions permit proper setup, teardown and potential trouble-shooting within a one-hour period.

1.4 File Naming Strategies

Large video databases are complex and can easily become disorganized. The key to a reliable production workflow is to have all video data backed up and correctly named in accordance to a predetermined naming convention. For the courses MV3204 and MV4205, file-naming convention was changed during transition to the advanced course, MV4205. Initially the naming convention "MV3204.DayMonthYear.Clip0N.mov" was given to each individual clip for each days filming. However, later experience provided that "CourseNumber.YearMonthDateClip0N.mov" was more easily organized by day of lecture, having the day of the month come last in the date sequence.

This simple conversion of naming convention for project clips made the video workflow easier and provided the editors on the project a higher level of organization. Each individual original clip file name is given the day of the lecture in the post-production process. After recording is finished the Direct-To-Edit (DTE) drive is attached via firewire to the computer. The DTE drive copies the video from the camera and in doing so automatically gives the clip its own naming convention, which unfortunately is not very useful. Because the current DTE drive is a FAT32 hard disk device, it will not make files larger than 1.86GB. That file size translates to approximately 9 minutes of video in the JVC HDV codec.

If the course is 50 minutes long the DTE creates 6 files, 5 of which are 1.86GB and another that is a partially filled FAT32 segment that is approximately 800MB. These six clips represent that day's entire lecture. It is best to rename files by hand to avoid any mishaps that an automated naming script may incur. The rename process is streamlined by highlighting the first clip in the series, then right clicking and choosing "rename." Next, the appropriate predetermined naming convention is applied. In this case it is ClassNumber.DayMonthYearClip0N.mov. Since this is the first clip N is 1. Before renaming is complete the entire clip name is highlighted except the clip number, ClassNumber.DayMonthYearClip0X.mov, the highlighted section is copied to the computers clipboard, and the clip is finished being renamed. The next step and the step that is repeated for the following clips in the series is to select the next clip down, enter rename mode, and paste the clipboard contents into the clip name and add the number it is in the series to the N section, in the second instance it is 2. This step is repeated for all clips in the series. For quality assurance, all clips are organized by file date before the renaming process begins to ensure they are modified in proper chronological order.

2. VIDEO PRODUCTION PROCESS

For a detailed graphical workflow of the video post-production process see APPENDIX D

2.1 Pre-Planning

A. Equipment

One can spend almost limitless amounts of money on video and audio equipment. The list below represents the currently evaluated best-of-breed at maximum value:

- Camera: JVC GY-HD110, High Definition Video Camera
- External Hard Drive: JVC DR-HD100, Direct To Edit (DTE) 100GB Video Storage Hard Drive
- Microphone: Shure SM89 Shotgun Condenser, Shure Wireless Lavaliere, and Techtronic's Boundary Microphone
- Interactive Display: Smart Technologies ID370 Sympodium
- Post-Processing Computer: Apple Mac Pro Workstation
- Video Server: Apple XServe RAID
- Cluster Computing Assets: Apple Mac Mini plus server and Mac Pro processing assets

While the options for audio-visual equipment are myriad and sometimes confusing, often this technology is constrained more by budget than anything else. Strategically approaching the technical problems inherent in this endeavor is key. Equipment should be interoperable, scalable, and of sufficient quality to meet the high expectations of the target audience. The task of making the equipment interoperable is paramount and difficult. The following sections detail the approach used in this project, though it is by no means the only approach.

B. Pre-Planning the Shoot

Pre-planning is not limited to finding the date and time of the course. There are many important planning elements of the shoot that need to be looked at beforehand in order to make sure that the scene is properly lit, that audio is not interfered with by electrical, hallway, or building noises, and also de-conflicting other possible interruptions.

MV3204 and MV4205 were filmed with different backgrounds behind the speaker. MV3204 was filmed in the classroom with the white wall as the background. MV4205 was filmed in a conference room with a green screen background. For MV3204 a side-by-side layout was chosen because of the white background, while a chromakey transparency background (the slides were imposed as the keyed video) was used for MV4205. Chromakey compositing is computationally more expensive than picture-in-picture and thus requires more post-processing time to render. While no formal benchmarks were performed, chromakey compositing seemed to require an approximate fifty percent longer rate to render. Aesthetically, chromakey is much superior and preferred by viewers.

C. White Balance and Light Sources

In dry runs, a camera is positioned and someone stands in as the professor to help setup. Factors such as color temperature, white balance, and light sources are important. Color temperature is a characteristic of the visible light. Florescent lights tend to be cool while incandescent lights tend to be warm.

Lamps with a lower color temperature (3500K or less) have a warm or red-yellow/orangish-white appearance. The light is saturated in red and orange wavelengths, bringing out warmer object colors such as red and orange more richly. Lamps with a mid-range color temperature (3500K to 4000K) have a neutral or white appearance. The light is more balanced in its color wavelengths. Lamps with a higher color temperature (4000K or higher) have a cool or bluish-white appearance. Summer sunlight has a very cool appearance at about 5500K. The light is saturated in green and blue wavelengths, bringing out cooler object colors such as green and blue more richly as shown in Figure 9.

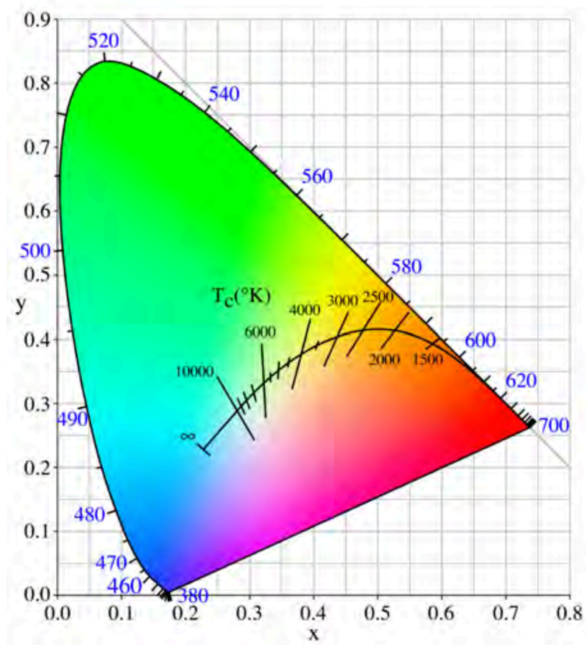

Figure 9. Color temperature (in Kelvin), you can see the color that temperature will be at a certain degree of Kelvin. Notice that "cooler" light more blue while "hotter" light is more red.

White balance is the process that removes unrealistic colorcasts in video. White balance is particularly challenging in front of a large green screen, projector, or other high contrast lighting environment. In this case we used no additional lighting. Better lighting it recommended for future projects.

If the light in the room is challenging, careful speaker position and camera adjustment can go a long way to mitigate the poor conditions. The camera is kept in "full-auto" mode, which prevents the color balance from being disturbed when lights are dimmed for slide presentation or other special media viewings such as video or 3D graphic display playback.

D. Audio Check

In preliminary testing of the video environment, various microphones are evaluated. If the presenter walks around, then using a wireless lavaliere microphone provides him freedom to move from the podium. If the instructor stays behind the podium, then using a boom or shotgun microphone is adequate. In that case finding an appropriate spot to place the shotgun or boundary microphone is the next step. Setting up as close as possible to the presenter is the best solution, while also ensuring that any microphones and accompanying stands remain positioned out of camera frame.

Ambient noise is another major factor to eliminate during preliminary class planning. Air conditioners, building construction, and airplanes are all of significant concern. To minimize the impact these noises can have on the final recording, using equipment that adequately attenuates the background noises is essential. Often the shotgun microphone is good for this problem as long as the noise source did not manifest itself from behind the presenter.

E. Layout and Editing Protocol

A predetermined layout for the project was made beforehand. On the following page are two examples from the X3D For Web Authors video archive. Figure 7 on the following page is from MV3204, that is the side-by-side images, and Figure 8 is from MV4205, showing a composited image. Using the side-by-side approach worked well, but experimentation with composited video by using a green screen in the advanced course proved superior. Advanced software and sufficient computing horsepower is needed to support rapid turnaround using the compositing approach.

Figure 10. Side-by-Side Compositing: 1 hour of video takes 3 hours to render (3:1)

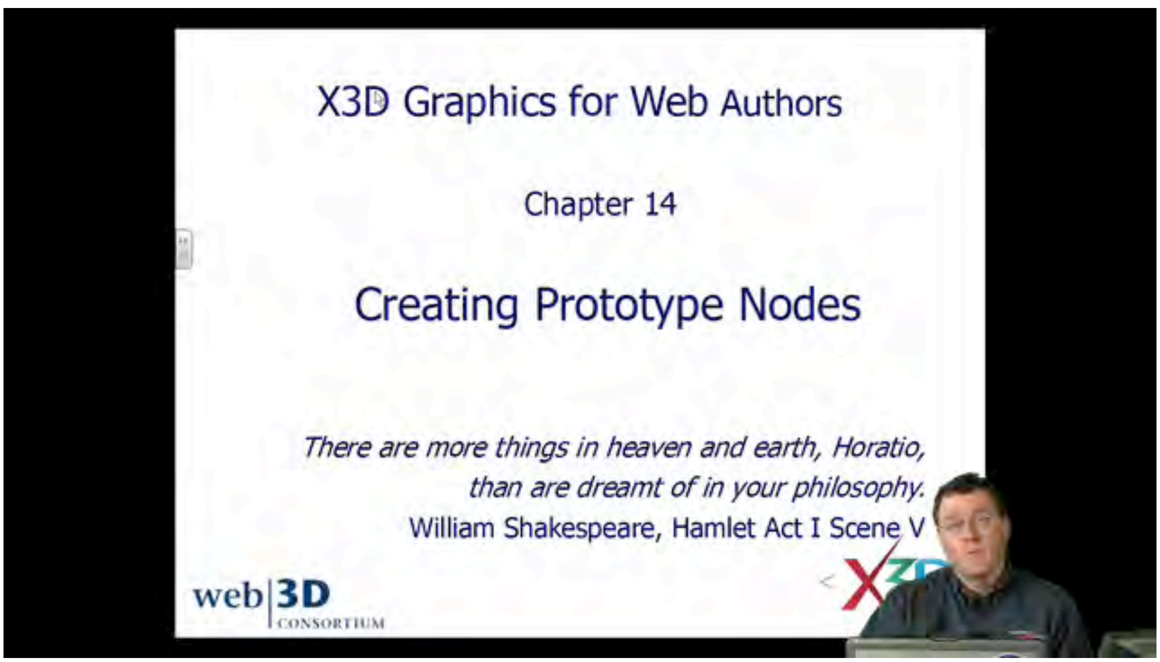

Figure 11. Chromakey Compositing: 1 hour of video takes upwards of 15 hours to render (15:1)

2.2 Pre-Production

A. Setup Interactive Display

The Smart Board Sympodium Interactive Pen Display is the hub of the presenter's media chain. A touch-screen device, it overlays any drawings or annotations that the presenter may add. This device was central to the project. Feed back from students has shown that it helps keep the material more interesting over longer periods. Having this device in the distance-learning project adds an element of superior quality to the final product and provides an educational boost for the distance-learning student.

Figure 12. Smart Board Sympodium Touch-Screen Display – model ID370 Cable Connections

The accompanying Smart Board screen capture software is used to capture all of the lectures for MV3204 and MV4205. This program outputs either a Windows Media Player file, which has a .WMV file extension, or a "muxed" AVI video that is more scalable and readily available for editing in Final Cut Pro. The AVI setting was used in this project as that was more easily integrated into the QuickTime-based workflow. Rolling tape on camera and Direct-to-Edit (DTE) hard drive begins before the class presentation starts. The video/audio/desktop sync takes place by "clapping" the clapper as shown in Figure 18. It is always vital to synchronize these two video streams as this saves hours of effort and possible major mistakes in post-production.

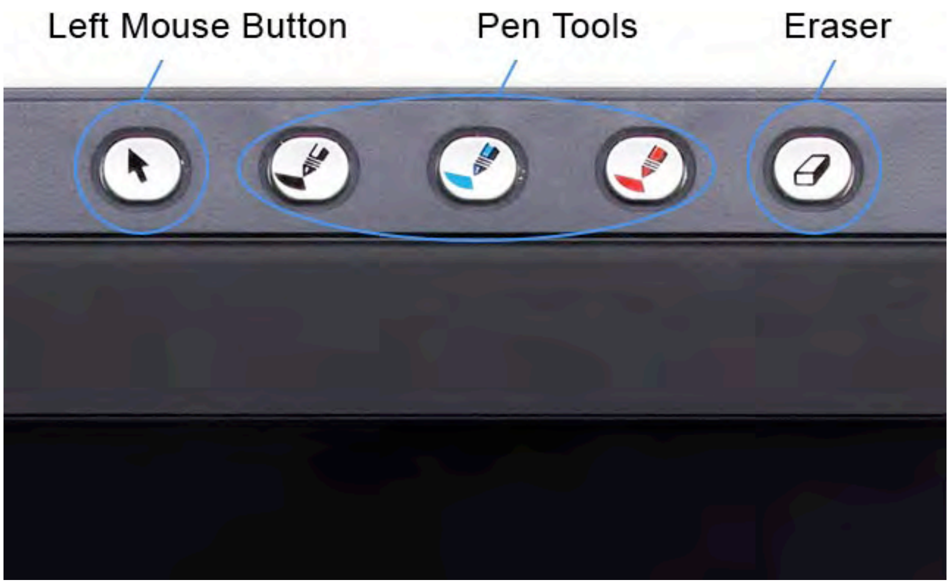

Figure 13. Smart Board Sympodium Touch-Screen Operation Buttons, choose any to articulate media on the screen, used often to toggle between pen colors, eraser, and pointer

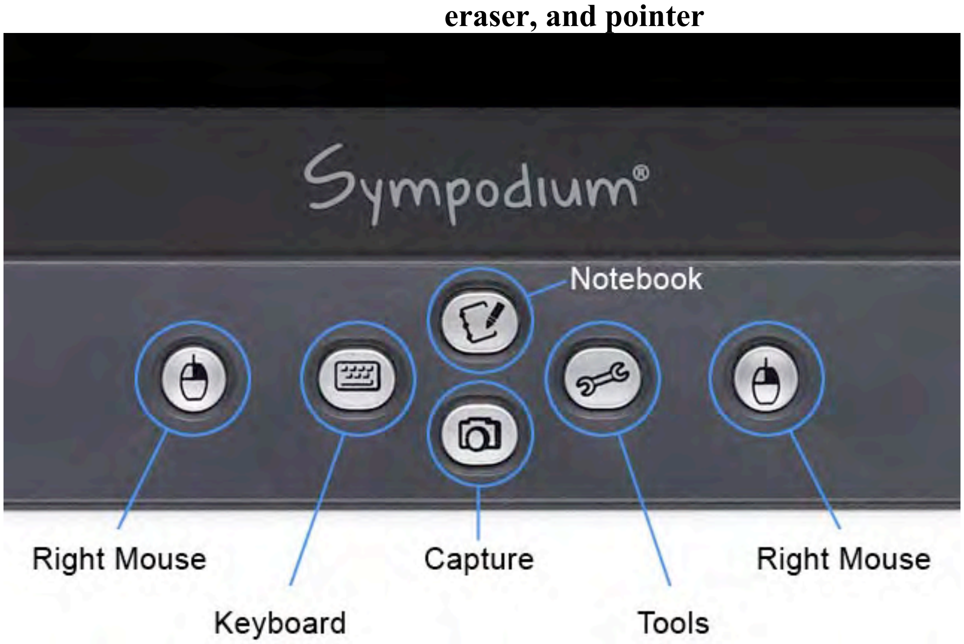

Figure 14. Smart Board Sympodium Touch-Screen Tools on-board Buttons; these are seldom used in production

B. Backup Tapes

Tapes are cumbersome and bulky compared to their digital representation. However in cases of disk failure or lost media, tapes are an essential and consistent source for backup. Tapes for this course are kept in boxes, organized by date. Because there are as many as two tapes per class, and five classes per week, for ten weeks, several boxes of recorded tapes were filled. Access to the tapes was not necessary unless a failure occurred digitally such as a crashed hard drive or corrupted media. Tapes and boxes need to be labeled as part of session production. Always start a new tape for each session, in order to eliminate the possibility of overwriting prior content. The camera operator should also set the "write protect" tab on each tape when complete.

C. Camera Setup

The camera setup is kept as simple as possible. The JVC HD110 is fixed to a simple aluminum tripod in the pre-designated place chosen during the pre-production phase. Hooking it up to the DTE disk and audio drop was all that had to be done before class began. To a novice cameraperson this may take up to 20 minutes to complete, but in regular practice it should only take 10. The following figure shows the necessary equipment connections. Testing that recording is successful is critically important to avoid failed recordings and lost class time.

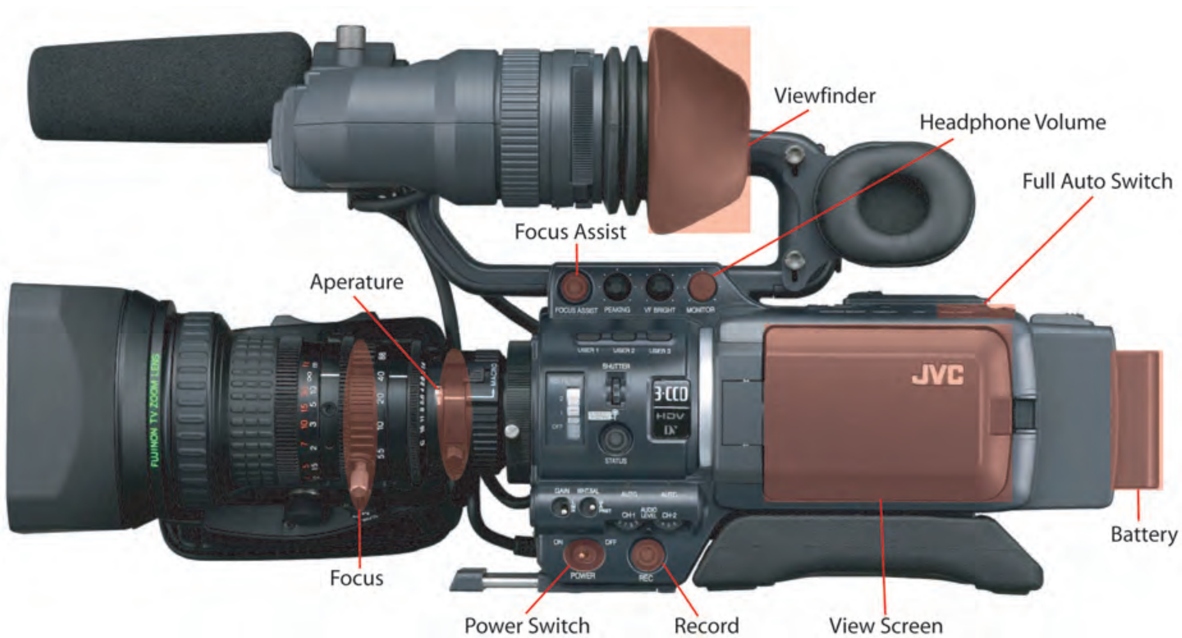

Figure 15. JVC HD110 Left Side Common Control Surfaces

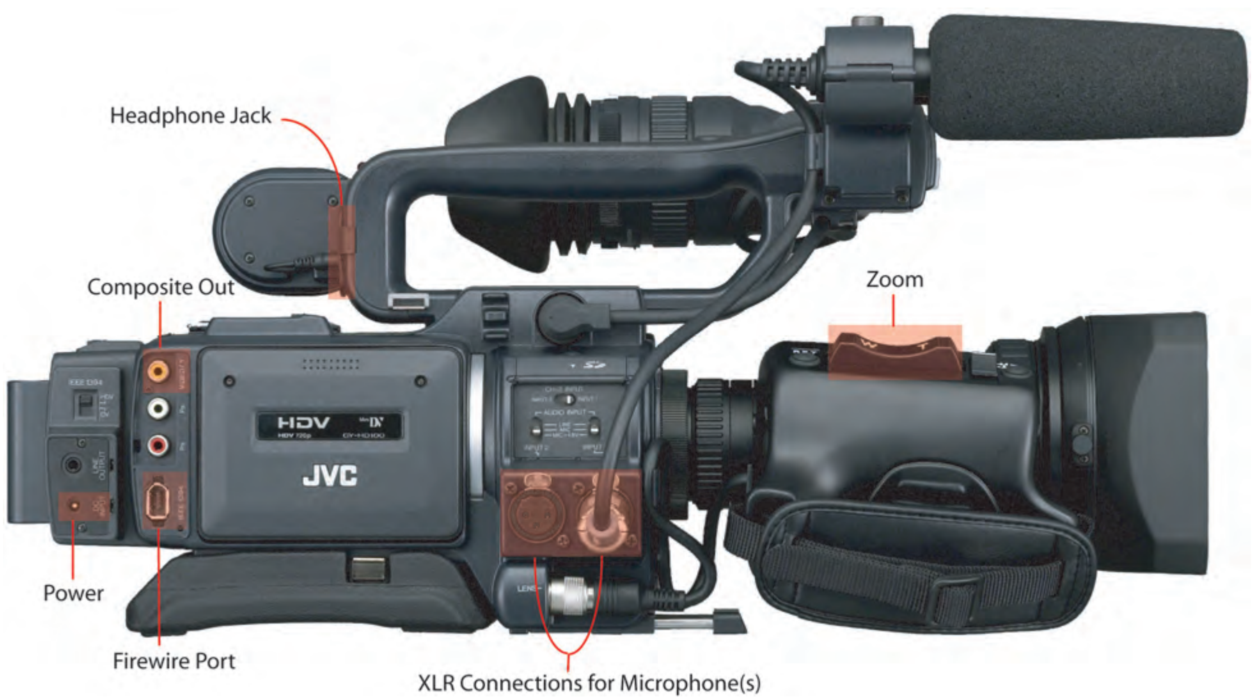

Figure 16. JVC HD110 Right Side Common Control Surfaces

JVC offers many different cameras, however professional quality video requires professional quality equipment. The JVC HD110 is currently top of the line in price per performance. This camera (sometimes called a "prosumer" device) has the typical features of other professional grade equipment such as on board dual XLR connections, full manual or full auto mode, High Definition (HD) 720 Progressive Scan (720p) capability or Standard Definition (SD), and a 16:9 aspect ration Fujinon lens.

D. Frame Camera

When setting up the camera, the presenter is framed with the shoulders and head in the upper two thirds of the frame. Focusing the presenter properly may take practice, since the lens used might not support auto focus and is quite difficult to manually focus due to camera sensitivity. The camera operator needs to ensure the presenter is within the safe zones. The safe zones are the 16:9 borders that the camera superimposes on the viewfinder. This frame represents the borders of the recorded image. If the presenter is outside of this frame area, then he or she will be cut out of the picture when viewed on a television.

Though the television safe area is not applicable to web-viewable video, it is still good practice to frame the presenter in this way since future renderings of the video may be viewed on a television display. The focus assist especially is helpful in focusing the camera. Camera frame is checked once more before the shoot begins to ensure that the camera remains pointed correctly and the presenter has not moved outside the safe zone.

E. Setup DTE

The Direct To Edit hard drive (DTE) is a "black box" video recording device. It does not require use of the camera record button, since it is self-contained and records from the DV firewire port on the side of the camera.

Figure 17. Focus Enhancements Direct-To-Edit (DTE) Hard Drive

Note that a failure point in this process is the hard drive space on the DTE. It is necessary to always unload recordings and re-format the disk each day in order to make habit of having a clean disk each time filming takes place. This simple task ensured the disk had the necessary space for that days work.

F. Microphone Setup

Below are three common microphone set-ups for the shoot. This project used a lavaliere and boom-type (i.e., shotgun) microphone. The Lavaliere works well in single person shoots where the speaker moves frequently, and the shotgun or boom microphone is superior in circumstances where audience and speaker are both involved.

Figure 18. Microphones used for this project, from left to right, top to bottom: Lavaliere microphone for lapels; the Shure SM89 Shotgun is the main microphone for project production; and the Shure boundary microphone.

Figure 17 shows a boundary microphone, which was used intermittently when other microphones were malfunctioning or were not available. This microphone has wide spatial coverage, and thus picks up a lot of extra noise. This microphone is great for capturing audio from students when placed in the classroom properly. However using it as the main microphone for the speaker is not very useful since the resulting audio is muddy from excess background noise.

Instructions follow for setting up each of these devices is on the following page.

Lavaliere Microphone

- Make sure the microphone transmitter has plenty of battery life, replacing every 1-2 days
- Affix the microphone to a non-distracting spot on the presenters collar, running the wire underneath the shirt or coat and placing the microphone transmitter in a comfortable pocket where it will not get sat up on or damaged.
- Turn on the microphone receiver at the camera and ensure that all XLR connections from the receiver to camera have been made correctly by checking audio levels
- Do a sound check and listen with headphones for the microphone rubbing on clothing, drop out in the levels, or other minor adjustments that are needed before beginning

Boom Microphone

- Set the microphone and stand next to the podium
- Start raising the microphone by extending the main pillar with the twist adjustment at the neck of the stand
- Then raise the microphone even higher with the boom adjustment (where the microphone connects to the stand). This should raise it about 10ft high off the floor
- Adjust the microphone so it is almost 90 degrees facing down but still above the speaker's head, and out of the camera frame (it should be right out of the top of the camera frame)
- Plug the XLR cable (the microphone cable) into the channel 1 XLR input on the camera

Boundary Microphone

- Take the microphone out of the case
- Place it next to or near the presenters computer
- Run the cabling from the microphone underneath any tables and use gaff tape to attach the cable to the ground
- Plug the cable into the camera's XLR input
- Boundary microphones have a tendency to be a bit noisy from table bumps so try to isolate them acoustically

G. Sound Check and Fine Tune Camera Frame

Sound checks are done before and during the presentation for quality assurance. During the initial sound check listening for pops, room noise, line noise, or clothing from the presenter rubbing on the microphone (if using a lavaliere) is key. Audio is more important than video in some cases: if the speaker video is inferior, simply dubbing in original high-quality audio over the screen capture of the slides might avoid the need for doing a re-shoot.

After the sound check is complete, the camera frame is checked once more to make sure that the presenter is not outside the safe zones and remains properly in focus. High-definition cameras are quite sensitive and minor speaker movements away from or towards the camera can cause the image to become out of focus. A second check by another person of the frame and image quality before the shoot for quality assurance is often helpful.

H. Load Speaker Presentation Material

The presenter or on-duty video technician is responsible for opening up all applications for use in the presentation before the shoot. This is especially important if the speaker is on a computer that is not his own or is unfamiliar. In the latter case pre-installation of the screen capture tools onto the machine is necessary. This usually involves preparation since the Smart Board software package used for screen capture requires downloading. A software license may also be needed.

2.3 Presentation

A. Presentation Slides

As stated earlier, slides must be structured and formatted with the video workflow in mind. Slides are vital to the final video product and necessary steps must be followed in order to maintain quality assurance. Slide layout is a critical consideration. Typeface for slide text should be sufficiently large and should not use Serif fonts. The use of these fonts obscures text in the render process as the intra-frame compression in h.264 and other codices has a hard time handling the winged edges of these font types.

B. Presenter Guidelines

The presenter should be prepared for instruction in a video-based classroom. Preparation includes detailed knowledge of the video-based classroom workflow, the limitations of the video editing process, and a good grasp of the material at hand. Hand gestures are best when slow and deliberate. The instructor should be prepared to follow a strict filming schedule in order to make the video workflow more simple. This schedule is prepared in the pre-production process with the inclusion of all parties that may be present for the pre-production, production, and post-production process. In this way everyone is informed of the necessary schedules, keeping lines of communication open and flowing.

C. Classroom Students

Classroom students are encouraged to stick to the production guideline, however their feedback and critique of that guideline remains quite important. The reason for having video-based classrooms is to increase the amount of learning and resources for the students. However, they need to be briefed beforehand on what to expect during the course of a video-based lecture. They need to know when it is and is not appropriate to participate in discussion, and to be aware of the filming. No eating or drinking should take place in a video-based classroom production since this can make more noise than is acceptable. People opening up soda cans and eating chips on the audio track does not allow the production of high quality content.

D. Distance Learning Students

Students participating from a remote distance-learning classroom, via telecom, or via other means are encouraged to mute their microphones during the production part of the course. This step keeps any remote noise or feedback from their microphones off the audio track, and also eliminates other line noises that may occur during the filming process. Similar to the in-classroom students, distance-learning students need to be briefed beforehand on appropriate video-based classroom etiquette. Thus everyone who is participating in the course needs to be informed of the process and how they are involved in order to properly support the video-production workflow.

2.4 Video Production Process

A. Start Recording

A Direct To Edit (DTE) hard drive and tape based capture is used during the record phase. To streamline the workflow a DTE alone can be used, bypassing the tape capture step, while still using tape as backup. The DTE works great perhaps 99% of the time, however it did crash once during the course of our project. It also ran out of batteries and space on a few occasions, thus the tapes are important to have as a replacement. However, using the tape backup requires stopping every hour as they only have 63 minutes of record time capacity available on them. Ordinarily this interruption is not a problem since the few classes longer than an hour can have intermediate breaks planned beforehand.

When recording begins, ensure the time code on the DTE and camera are counting. This guarantees that the tape in the camera is recording and that the DTE has a connection to the camera and is getting information off the fire wire port. If the DTE time code is not counting, then either the fire wire cable is plugged into the computer port instead of the DV port, or else another problem exists (such as lack of space on the hard drive). The class presentation needs to be stopped, the problem fixed, and then class presentation can resume.

B. Start Screen Capture and Mark for Synchronization

Starting the instructor screen capture and simultaneously clapping the clapper is the method for marking a sync point for post-production. The mark for sync is a frame that is captured on the video camera that makes obvious the point at which the screen capture began.

Doing this with a clapper is a simple way to sync two video feeds, namely the one from the video camera and the one from the computer. This way the screen capture is in sync with the presenter. Count down aloud from three, and then on zero the presenter hits the record button on his computer as the clapper is clapped.

Figure 19. Clapping the Clapper: Provides a video marker for starting the desktop recording stream.

This step takes only seconds and saves hours in post-production. If a sync point is not made on either stream in some way, with a clapper or a hand signal, synchronization may actually be incorrect later. With the sync frame available, matching is simple and easy.

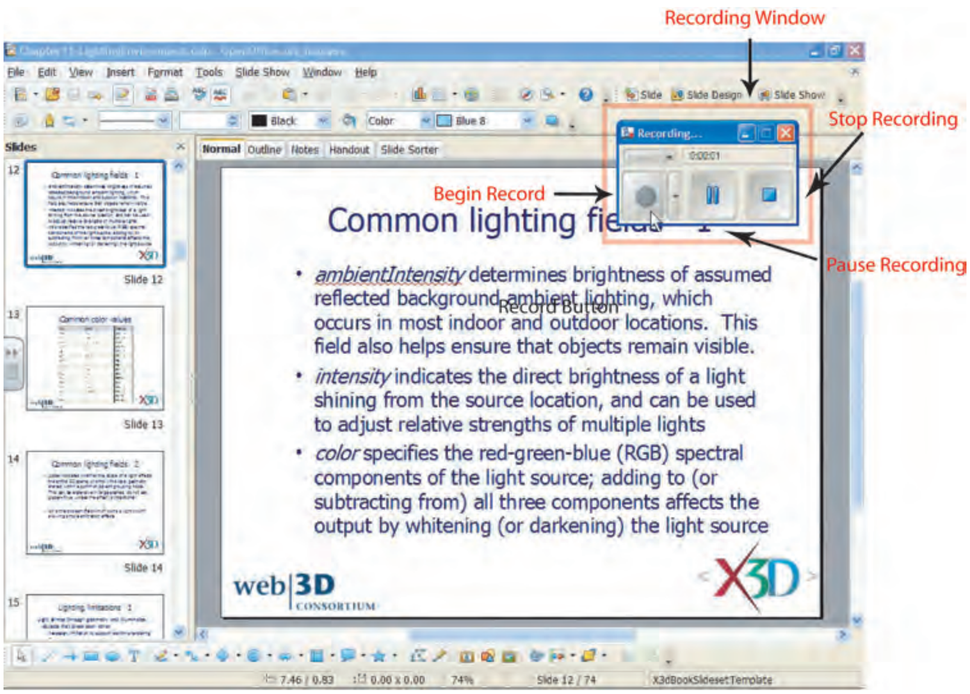

Figure 20. Screen Capture Tool Operation

Choose the record button in the screen capture window to begin recording desktop video. This command is processes as the clapper is clapped to maintain sync with the instructor video stream.

C. Cue Speaker to Begin

Following the clapper synchronization, fine checks are re-performed. When audio, frame, lighting and time code generation is checked again, it is time to cue the presenter to present.

D. Take Production Notes

During the production there are times that the speaker either needs to stop or is otherwise interrupted during the presentation. The camera operator needs to keep records in advance that a certain interruption requires an edit in post-production. Taking detailed notes about what happened during a particular class can greatly expedite the post-production process. A handwritten notebook is often helpful. Electronic notes for any particular class are best saved in the file directory of the media that they describe. During the edit phase when the media is imported the editor can see the notes in the directory and does not have to second-guess if there were pre-determined edits to be made. Purchasing or producing simple software that facilitates the recording of production notes is an important task for future work.

E. Stop Camera Recording

High Definition (HD) Digital Video (DV) Tapes have a time limit of 63 minutes. There are no options for recording at a slower tape feed, as in Standard Definition or VHS. However, direct-to-edit systems, such as camera-integrated hard drives or external camera hard drives have no such limitation. Write files size is limited, but recording time is only limited by the size of the drive. Therefore, it is not as critical to stop the recorder precisely when the presentation is done. Nevertheless, in order to keep organized and reduce files sizes on the server, the DTE is stopped fairly soon after the presentation was done. Again, key words from the instructor, such as, “That concludes our lesson today…” help in determining when the DTE can be stopped. If in doubt, wait. Presenters need to remember that they must treat the camera as if it were a person, since this helps to keep the end of a session clear and understandable.

F. Stop Screen Capture

Screen captures are similarly unconstrained, but should also be ended as soon as practical after the presentation is finished. To avoid confusion, a single person should be designated to stop both the camera and the desktop screen capture. This avoids stopping the screen capture before the camera has stopped. Both should continue uninterrupted, even if the presenter wishes to ignore a false start and start over. It is much easier to edit one continuous video (or two) in a pair of files, than to try to match multiple similar recorded takes in different files.

G. Rename and Save Screen Capture

The screen capture software automatically assigns a basic file name to the screen capture upon saving it. Rename each file according to the predetermined file naming convention. Map the dropbox directory on the server and then save the files to the correct folder. A copy of each screen capture is also kept on the capture computer, just to ensure that if something happened during the network transfer process that a backup file remains.

H. Breakdown Equipment

The last part of the production workflow is the breaking down of the equipment. If there is another class in the space directly after the video class, then breakdown needs to be accomplished in10 minutes or less. Considering the time it takes to rename the screen capture file and post it to the server, there isn't a lot of time for equipment breakdown. This is especially true if the class presentation runs long.

A productions checklist for all the above-presented procedures is located in Appendix A of this report.

3. POST-PRODUCTION

3.1 Inventory Footage on Shared Storage

There are many vital steps in the video archive process. Possibly the most important is having a file name protocol and directory structure that is organized and well maintained. In fact, this may be the most important step in the video post-production process. To save the most time in the long run is to keep with a standard file name structure such as **ClassNumber.DateClip0X.mov**. In the real world an example looks something like this, **MV4205.2008December01Clip01.mov**.

Finding a file name protocol and sticking with it is vital to successful file organization on the server. The DTE firmware has an automated file name protocol that doesn't explain much about the data on the clip other than the date and time. It is usually jumble of numbers followed by the latter. Immediate action after a shoot is to sit down, hook the DTE up to the computer, and carefully re-name all the files.

Because our current DTE is a FAT32 storage device it will not make files larger than 1.86GB, which is roughly 9 minutes of HDV 720P video at 30FPS. Classes are about 30 minutes or more, and so on average 4-5 or more clips need to be renamed afterwards. Using an automated file naming application such as an Apple Script to rename the files proved to be cumbersome and caused more problems than solutions. It is more useful and more reliable to go through each file and rename by hand, as follows:

- Highlight the first clip in the series, then click again or right click and choose "rename"
- Enter in the naming convention, i.e., **ClassNumber.YearMonthDayClip0X.mov**, for example **MV4205.2008December12Clip03.mov**
- Before finishing highlight the entire clip except the clip number **ClassNumber.YearMonthDayClip0X.mov**
- Now choose Command 'C', meaning copy highlighted text

- Now go onto the next clip in the series, and replace the DTE name with the one you copied from the prior clip and you get **ClassNumber.YearMonthDayClip0**, now simply add the ‘2’ for clip 2 and you get **ClassNumber.YearMonthDayClip02** close the file rename window (the .mov is added automatically as the file is recognized as a QuickTime file)
- Repeat for the rest of the clips in the series. Check the results.
- If you are unsure if the series is in proper order choose to resort the window by file date and it will find the time stamp in the file system and organize the series in temporal order properly.

3.2 Post to Shared Storage

Once a file name protocol was established it is time to move the data from the DTE to the archive storage area. The storage area is on a shared server that is dedicated to video work on the intranet, i.e., it is not exposed outside the NPS firewall. Video takes up a lot of space and establishing a dedicated server with capacity for all the archive video material is important. All the media is saved to this server, including the raw capture video and the final product. Having this archive organized as a consistent data store is essential when an inconsistency is found in a video later on that needs to be re-edited, or when someone needs the same film reproduced in a differently rendered format.

The server directory organization for each course is the same. There are three tiers to the directory for each class. The first is the class name usually designated by “CourseNumber” or in this case “MV3204” and “MV4205.” The second tier a folder named “ClassNumber.Date” or “MV3204.2009Jun08.” The third tier is the raw video that sits within each individual class date folder and is named “ClassNumber.DateClip0n.mov” or, as shown above, “MV3204.2008Jun09Clip01.mov.

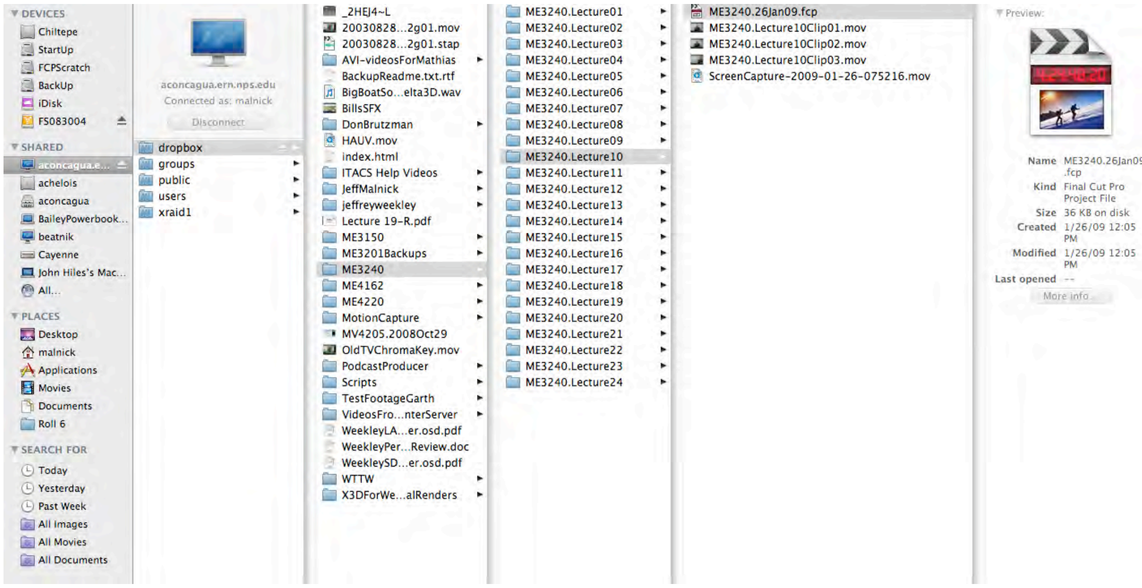

Figure 21. Server Directory Organization

In recording each of the X3D For Web Authors courses, a total of 1 terabyte of data was produced for all the raw video, screen captures, transcodes, and Final Cut Project files. See Appendix C on the raw data for both courses including folder sizes for each element such as Final Cut Projects, Raw video, rendered video, and total hours for each.

3.3 Open New Final Cut Pro Project

Final Cut Studio is a very technical video-editing suite; it makes a world of difference in production quality and speed when the editor becomes familiar with both this suite and its tools (or at a minimum the basics of non-linear editing). Final Cut Studio is currently superior to all other non-linear editing platforms in price and features. A one-seat license of Final Cut Studio combines several applications including Soundtrack Pro for audio editing, and Motion for motion graphics. These advanced programs can add a significant professionalism to a final product. All the tools in the Final Cut Studio suite were used in production of this course, from basic motion graphics, to editing and sweetening audio for final videos, were used in developing this project.

The first thing to do with a Final Cut project is to SAVE IT! Always save the project file to the same directory as the clips it represents. FCP Projects are simply XML files that tell the Core OS on a Mac how to edit the media assets it accesses. Putting this file in the same directory as its media assets not only helps organize the files but also saves plenty of frustrations with OS permissions errors in the rendering process later on.

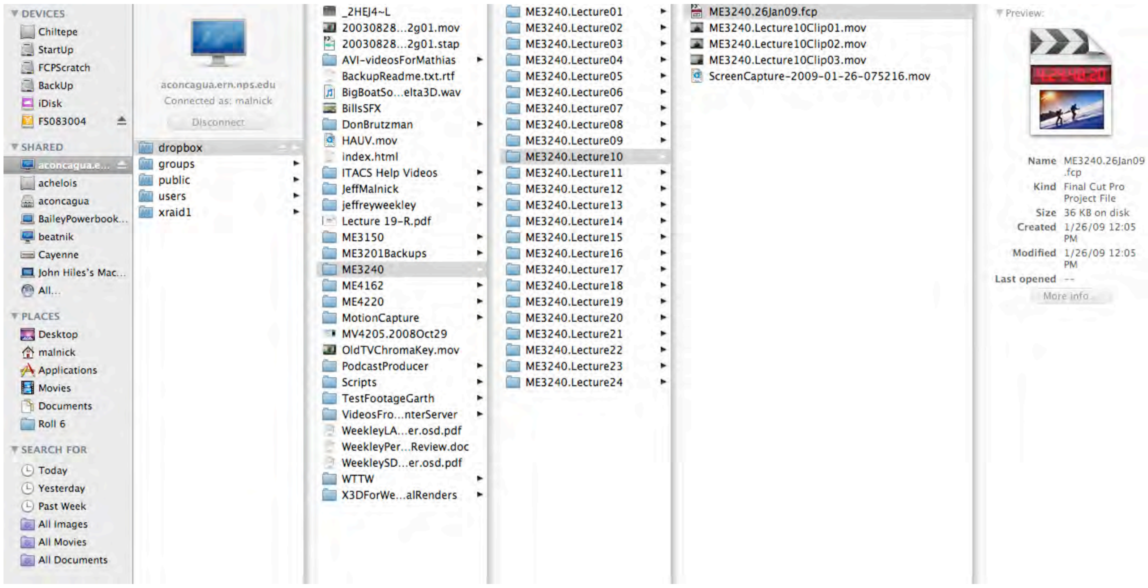

Figure 22. Example of Saving FCP Project with media assets.

A. Import Media to Project

After saving the project file the media assets are imported to the Final Cut project. Because the server directories are organized by name it is easy to quickly find the media for the project. Organization and attention to detail is stressed throughout this process because of the multitude of media assets amassed. This discipline streamlined the workflow and was important in achieving the one-day turn around on videos, as set in the objectives for this project.

3.4 Edit Project

Each video is viewed once through in its entirety. At the beginning and end of each video a fade-in and fade-out is placed in the first and last 15 frames. Final Cut allows users to save a “favorite” setting for any of its numerous editing tools. In MV3205 and MV4205 production a fade-in, fade-out favorite was made that had this 15-frame per second pattern. In MV4205 a favorite setting was made for the chromakey filter. This filter needs to be tweaked for each video as minor changes in lighting occur. However, having the favorite saved once enabled a more streamlined editing workflow for each individual session.

Motion favorites are also developed. Motion is a key word in Apple speak that refers to motion graphics, from basic to advanced. Apple’s motion graphics editing suite, Motion, is part of the core API for Final Cut Pro, and embedded within the Final Cut Pro framework are motion templates that allow users to generate basic motion graphics within FCP without having to open the Motion application. For ease of video editing, motion favorites were created for the introductory sequence in MV3204 and MV4205 when the speaker frame moves from full screen and is scaled to 30% while moving to the right side. In MV4205 this was somewhat more complicated because of the chromakey filter, but we still maintained the same 70% scale and move the speaker image to the right, though lower in this case.

Motion progression for the introduction of the video is thus consistent throughout the project, in Figure 20 this progression is seen in detail. As the speaker finishes introducing coursework for the day, he is scaled 30% and moved to the lower right as the slide set is faded in. This motion favorite takes about 15 minutes to develop and can be used over and over again after that via drag and drop in the FCP timeline.

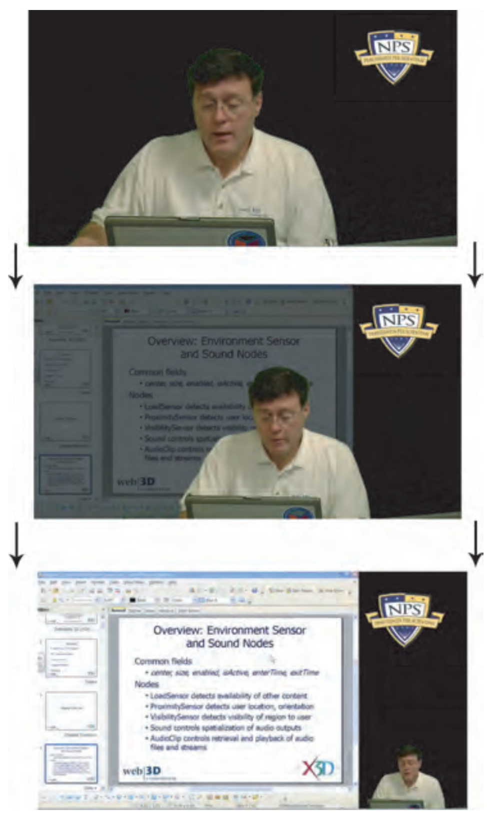

Figure 23. Intro motion progression: The speaker is scaled and moved out of the way while the slide is set to fade-in.

Once the initial motion favorites are added to the FCP sequence edits are made to the clips. FCP uses non-destructive editing. This means that FCP makes an XML file that is used as an instruction set during the rendering process to create a new file from the original media assets. This leaves all original media intact for future use. At the end of the editing process the instructor is re-scaled to 100% and moved to full screen for the final key words, "until next time…" then a fade-out to black. This approach helps the student get a stronger sense of the instructor's personality and feel more engaged in the session.

A. Save Project in Project Folder

Save the project often throughout the editing process. Final Cut Pro does have an auto saving function, but do not rely on this as these are separate XML files from the actual Final Cut project used - only use the auto-save backups in case of power outage or system failure. The final cut project should be saved in the same directory of the media it represents with a consistent file name as the other final cut projects in order to avoid confusion when working on several courses at the same time or for indexing purpose.

3.5 Rendering

Video rendering is a technically complex process. There are many different software codec's and the necessary parameter variables such as frame rate, data rate, aspect ratio, and frame size can seem endless. After extensive experimentation, settings for 640x360 (16:9 aspect ratio), at 15 frames per second, with a maximum data rate of 800 kilobytes per second (Kbps) was found to be the current best approach. Practically however, the tools throttled down the data rate to 671 kbps to allow for transport data (XML metadata associated with the video plus stereo audio). Integral in this experimentation was the use of the Compressor software tool. It allowed us to preview, save, and apply settings known to work well across multiple projects.

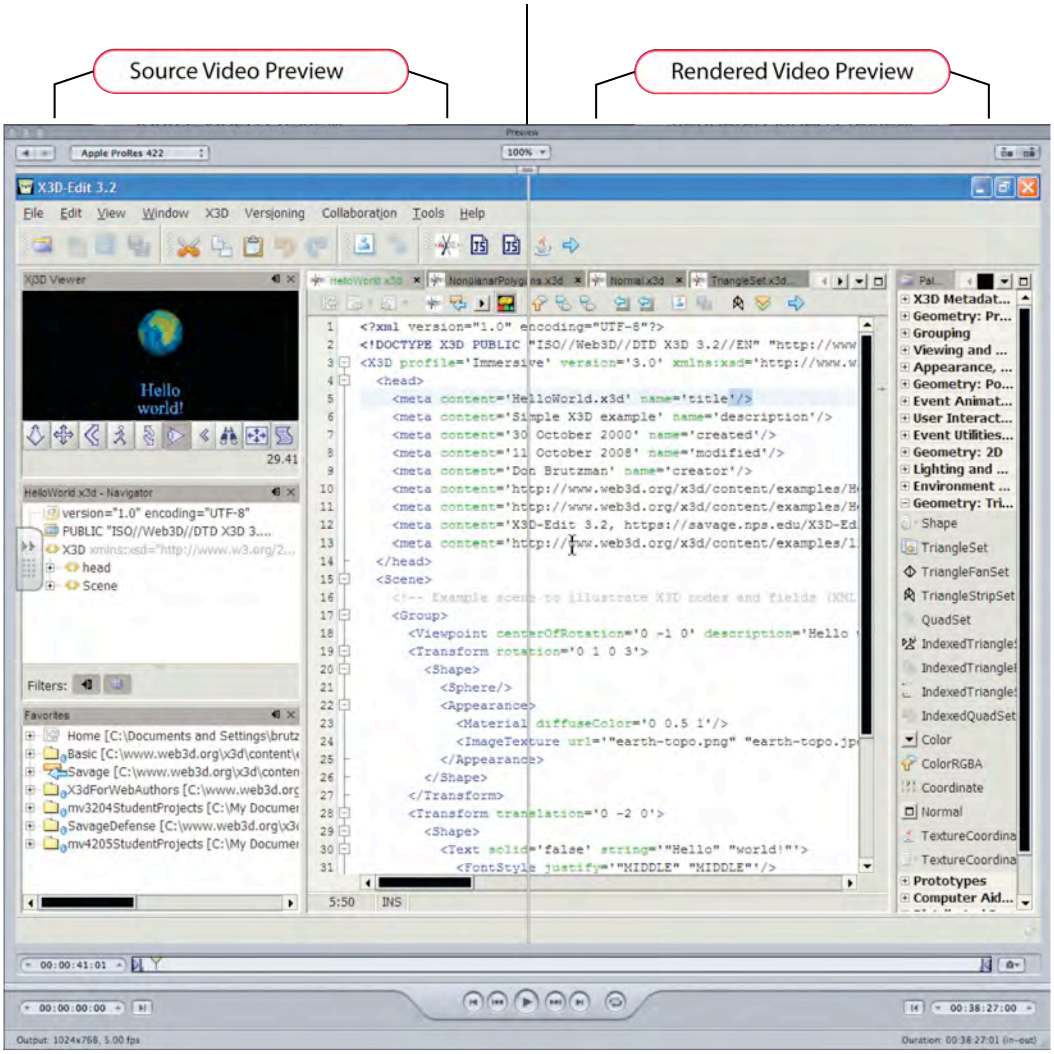

Figure 24. Compressor Video Render Preview

Many different problems that may exist in a final video rendering can be seen using the preview window of Compressor, the preferred transcoding software. Most important, from a visual perspective, was typeface quality in slides and tools. Experimental results showed that it was possible to halve the original frame rate while keeping the data rate high so that the typed text was preserved with the least amount of aliasing, while still maintaining a high-enough frame rate for the speaker to appear smoothly rendered. This enabled successful streaming of high-quality video over heterogeneous networks with a minimum of rendering artifacts. The largest video files were arbitrarily selected for further evaluation. Files larger than 400MB were used to optimize streaming, files size and frame rate. Smaller files were also evaluated for the same settings, but files smaller than 100MB were left as is.

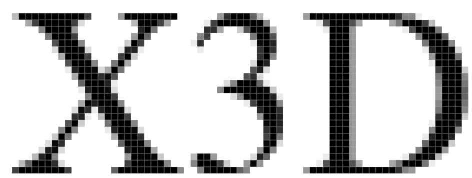

Figure 25. Example of Serif Font showing satisfactory quality at reduced frame-rate

Careful choice of video codec helped most with this optimization. Modern codec's such as H.264 generally work well, but they must be balanced against streaming data rates, quality of service, frame size, and target display devices. For instance, the codec is practically irrelevant when trying to show a low-quality 320x240 (QVGA) render on a high-quality 1280x768 (UXGA) display device. Therefore, keeping in mind that many compression algorithms are lossy, it is always better to start with larger files, higher bit rates, and larger renders for testing. Philosophically we prefer Open Source software, but often these video codec's are not portable. Thus we choose codec's that can be viewed across multiple operating system platforms with players that are free to use.

Reviewing the render result after the video render has completed is also important. First review the final render at the beginning and end for the initial fade-in/out transition, and then check relevant motion graphics for transcode or render errors. Then sample at random multiple frames and sequences in between. This gives a quick but thorough look at the video to make sure there were no compression problems such as lost video in the final product. Sound levels also need to be checked. Once visual and audio review is complete, post the rendered video file first to the master archive on shared storage for backup and then on the web server for distribution.

Once the video is posted to the web page, the final task is to ensure it streams correctly. Various problems with server maintenance can cause a video to not stream, meaning that full download of a file is necessary rather than beginning to play while the download proceeds. This last step ensured the final product was viewable to the rest of the web community. This project used a public web server that was separate from the server where our master file archive was kept. This kept the master archive secure and was less difficult to maintain.

III. LESSONS LEARNED

Some technological aspects of this project are not new. However the dynamic nature of video technology demands constant attention when new technologies come into play, and often reinforces what is already known. This section summarizes numerous lessons learned (and relearned).

1. BE PREPARED

Daily setup demands that whomever is responsible for production needs to arrive early. This is critical because there is an extensive amount of technology involved in such a project: computers, cameras, external hard drives, network environments, touch screens, and audio hardware. The list of problems that may occur on any day is large, thus each day’s production requires vigilant attention to detail. Computers crash and cameras break; external hard drives can fail, and can run out of space or batteries; network environments can go down; touch screens go out of sync when not properly calibrated, or can fail on the hardware side. Wireless audio systems have a number of possible faults that include but are not limited too batteries running out on the transmitter or receiver, coaxial cable improperly shielded causing line noise, improper positioning, or hardware malfunctioning. The operator needs to add extra time for unexpected problems.

The computer to be used for presentation needs to be up and running when the presenter arrives. Slides are to be loaded and demonstration applications also need to be up and running, as does the screen capture software. Having to work into class time to take care of technology distracts the attention of a class, and is a non-starter for successful learning. The primary mission of the project is to engage students while making the learning environment better and more flexible. Having to stop or run into class time to take care of problems is not appropriate, especially if those problems can be taken care of in the pre-production phase.

The instructor needs to set appropriate expectations for learning in a video-based classroom environment at the beginning of the course. Students need to be aware that there are no questions asked during the main part of the lecture, and that questions can be written down or reported on the chat channel and saved for the end of class. Ten minutes before and ten minutes after each presentation was the rule of thumb for questions and answers for this project. Students are informed and prepared to deal with this learning constraint, however in the bigger picture they are able to easily access the video of that days lecture and review day's the lessons, which reinforces their educational experience in a positive way.

2. FORMAT IS EVERYTHING

Formats and settings for all recording aspects are developed and agreed upon during the pre-production phase. Proper lighting, camera frame, instruction posture, gestures, digital format such as the final video and webpage, and the video delivery method are important. These specific elements represent the core of the video-based classroom. In order to be successful at developing good video content, special attention needs to be paid to the following areas.

A. Light Format

Most classrooms present a challenge for proper lighting. Often the in-room lights are not well suited for video production, and the option of bringing additional lights in can distract from the learning experience. This project relied on in-room lights for its production, because the professional-quality cameras used were able adapt well to the lighting successfully. However, in the advanced MV4205 course when chromakey was introduced, some glitches in the green screen filter occurred. These glitches were due to the absence of proper backlighting on the green screen. A surface that is lit in a linear fashion is key. In this way no single color is differently lit, and thus the green screen can be successfully keyed out with a singular luminosity. The absence of proper backlighting produces a color gradient where uniform luminosity was being looked for by the Final Cut filter.

B. Camera Frame

Camera frame is the way in which the frame around the video is positioned. It includes the centering of the presenter and any other objects in the picture. For this project the presenter was the only object in the frame and we used a two-thirds rule, that is, two-thirds of the frame is taken up with the presenter's head in the upper third and his head and shoulders below. This frame method was discussed at length during the pre-production phase and agreed upon by the instructor, editor, and producer of the project. This agreement between all parties allowed the instructor to avoid going outside the frame with hand gestures, and also added continuity to the series of videos.

C. Instruction Posture and Gestures

The posture of the instructor is back straight and not slouching. Video tends to magnify gestures, tics, habitual speech patterns, pauses, emotion, and other human characteristics. Physical gestures need to be gradual and deliberate for best effectiveness. It is important to be aware of all these considerations in order to make professional grade videos. Simply putting someone in front of a camera and expecting to get good results is not the plan of action. Attention to detail on behalf of the cameraperson to provide feedback, remind and coach the presenter is key. Posture directly affects the frame of the camera; if the presenter slouches then the format for frame is changed and the video becomes inconsistent with the frame of the other videos in the series. Attention to details and consistent practice avoids these problems, and increases the overall value of the product.

D. Spoken Gestures

Spoken gestures are consistent phrases that the instructor or presenter uses to begin and end a lecture. These gestures are developed in pre-production. They create continuity between a series of videos and simultaneously aid in the editing process. Like camera frame, prepared verbal phrases such as, "Welcome back…" and, "That is all" at the beginning and end of each day's material give each video structure. They also signal to the students when it is appropriate and inappropriate to begin or end asking questions. In the editing process they help the editor find the beginning and end of a lecture, saving time by allowing him to easily scrub through the video for one spot, which avoids listening to any superfluous material and speeds workflow productivity.

E. Digital Format

The term Digital Format refers to the format of the media generated digitally. Here, this term is used loosely to include the final video product and the web page the final product is viewed on. However, it can include other digital media representations, though not used during the production of MV3204 or MV4205.

a. Final Video

The final video is the end product for each lecture. The format for this should be determined during the pre-production phase. This format includes all the elements of the video including rendering specifications, color space, filtering, and Final Cut favorites such as fade-in/out and motion specifications for any motion graphics. This is very technical and often a challenge to determine on one pass; during the production cycle of this project the final layout format for these specific elements was not determined until the advanced course was produced.

Rendering specification is as follows: aspect ratio at 16:9; size is 640x360; data rate is 800kbps at 15Fps. This final rendering specification was the result of experience in MV3204. Data rate needs to be low enough to stream smoothly while high enough to maintain video integrity.

Color space is a dynamic model of contrast and RGB representation in a frame or sequence of frames (video). The color space for each video is made to be similar to each other in order to maintain continuity. Color space is changed of left on its own after determining its RGB makeup and contrast ratio with video scopes. Sometimes a video may need to be rendered with a 3-way color corrector due to camera white balance being off, and other times not. This simply depends on the specific nature of that given video.

Final Cut favorites for a specific fade-in/out pattern are developed in pre-production. In this project a 15 frame fade-in/out favorite was created to maintain continuity. A favorite motion movement for the presenter was also made to scale smaller and move out of the way of the slides in the intro, then scale up and move to center for the ending lecture gesture. These favorites provide continuity and also streamline the production workflow.

b. Web Page

Web page development is a dynamic process. During the production cycle of this course the web page went through several iterations. Appendix F shows the final web page product. The web page is the format for delivery of the video. It is important to include metadata that may be of interest to students regarding each video segment. Another possible addition might be postage-stamp image for each segment, though for this version we decided against adding them in order to reduce page size when printed. Several metrics are included for this web page such as a synopsis of what each video is about, the length of the video, and the organization is based on the book so that students can easily cross-check book information with real-time video examples. This resource is priceless and so maintenance needs to be diligent and on going.

3. CASCADING EFFECTS OF FALLING BEHIND

Due to the work-intensive nature of the video production process, it is vital that the production team does not get behind on work. In November 2008, the primary video editor of this project underwent surgery while classes and recording continued. Completing and clearing the backlog took until after the teaching quarter ended because the editing and rendering pipeline process effectively takes 24 hours per video segment. These processes take up a lot of time, and if one employee is absent then another employee must step in to take over immediately. Simply filming the classes and transferring the files to the shared storage is not enough. For example, consider a one-week absence of the key video producer. In this case classes are five days per week for one hour per day recording.

After one week, a backlog of 5 hours of footage is created. Because the video must be viewed in its entirety at least once in the editing process it takes at least one hour (1:1) to three hours (3:1) to edit the video, and with the composite layout rendered on a Dual dual-core (4 processors on two cores) 3.2 gigahertz Mac Pro, it is a ratio of 15:1 (estimate) hours of rendering per hour of video. Already 5 - 15 man-hours and 75 hours of rendering time are behind schedule (almost two weeks of rendering time for HDV video). Furthermore, production is significantly slowed when the material is unfamiliar to the editor. It is thus imperative to edit the video as quickly as possible. An additional consideration is that the Final Cut Pro suite is locked during render time, which means that the only way to clear a backlog is to have multiple machines with their own FCP license.

Production workers for this project had two machines to edit video and render on. The machine that had more processing power, i.e., more CPU's, was used to render, and the less powerful machine was used to edit. Workflow is often delayed because it took a very long time to render video. On various occasions a "transcode" of a screen capture was made in order to match the timeline in Final Cut Pro. For various reasons the screen capture might not match up with the time line speed but a transcode recording made of this video was able to match the time line settings in FCP in order to make it match up in speed. This process took about one extra hour because a cluster of computers was used to render these videos. One might ask why all Final Cut projects are not rendered via the cluster. That answer is simple in that a FCP licensee is needed on each individual machine, which would have been prohibitively expensive. In order to transcode only QuickTime Pro and Compressor are needed on each machine.

The lesson with lost time on the job was a hard-earned one. Had the primary video editor not been sick, the goal of being on time with course video throughout the entire project would have been reached. However, it was also learned that having a composited layout was very inefficient in the rendering process. In future work this approach is not recommended for a one-day turn around basis unless significant computing power is available for rendering. Instead, stick to a less processor-intensive layout that is much easier for CPU's to render. A 15:1 render ratio for composited video is not adequate for completing one-day turn around, as had been the previous quarter.

4. ORGANIZATION

Organization in the pre-production, production, and post-production process is vital. This project did not start out with the best organization technique; rather, the process was established and improved as the project proceeded. In the beginning the before-mentioned procedures for server and file organization did not exist. Instead, many files with similar metadata in their file names but in different formats were lackadaisically placed on shared storage. This caused great distress when final renders came out improperly or the need to re-connect media to an older project came about. Also, there was no standard operating procedure for where to save screen captures. Some third-tier directories with the video assets had these files and other times the screen capture was saved in an entirely different third tier folder named “ScreenCapture.”

The only successful way to find a file sometimes was to use Spotlight, the Apple meta-directory search tool. This is NOT recommended and is no way to organize data. On a few occasions classes needed to be re-shot entirely because files went missing on shared storage, only to be found later down the road on another computer. This project’s main lesson learned is good directory and file organization goes a long way; create these structures beforehand and stick to project SOP’s.

5. OTHER SCREEN CAPTURE OPTIONS

This project used the Smart Board screen capture software that is downloaded in the Smart Tools package. This decision was made because the machine to be used during the course was a PC running a Windows operating system. In the experience of the producers of the project, the best PC based open-source software for this job would be the Smart Tools screen capture tool. However, if the use of an Apple OS is the choice of the presentation computer then other more viable options are available. One such option is the Apple Utility Podcast Producer.

Podcast Producer accesses our shared server, and automatically and easily produces a screen capture video, a video from the laptops web camera, or an audio file. This program has streamlined the workflow this is an Apple based operation. Using Podcast Producer enables the production of QuickTime files of the screen capture and takes out two steps from the PC based screen capture workflow.

The first step it removes is the transcode process. The Smart Board screen capture tool can produce either a Windows Media Player file or an AVI. The AVI was more easily integrated into the transcode workflow. The screen capture needed to be in QuickTime format, as two or more different media formats in one timeline in Final Cut Pro is not allowed. This is the reason for transcode of the AVI to QuickTime before beginning a new FCP project. *Podcast Producer* eliminates the transcode process because it generates a QuickTime format to begin with. This reduces workflow by around an hour depending on how the transcode is done.

The second process it eliminates is uploading the screen capture to shared storage. Podcast Producer is a server side application that automatically generates a folder that it sends the podcast too upon completion of the recording. The only caveat here is the need to ensure the computer doing the podcast is connected without interruption to the local network during the recording process. On more than one occasion the podcast failed because of network error, but otherwise it worked 98% of the time.

6. OTHER VIDEO REOCORDING OPTIONS – HARDWIRED SOLUTIONS

The avenues for taping the instructor or presenter are many. In this project we used a JVC HD110 which is a HDV video camera. This camera is the workhorse of the production process. In doing this project the realization of other possible ways to record class that would make simpler the mission of class recording came about. One way is by outfitting a classroom with permanent recording equipment in the back of the room and at the podium.

The idea here is that one would have a room equipped with one to three cameras, tables or chairs in the lecture hall with individual microphones, and a podium with either a smart board or Wacom tablet built in. In this scenario the recording process might be as simple as entering the room, and depending on the cameras, either begin recording to tape plus to a HDD or just to a HDD. Flip the switch to a mixer for the microphones, and begin the recorder on the smart board or Wacom tablet for the presenter, it’s that simple.

The benefits of this set-up would be a taking out the hassle of setting up and taking down equipment. This step takes an additional 90 minutes of preparation depending on how much equipment had to be set-up. In this project time was budgeted before class to prepare the equipment to be moved to the shooting destination (i.e., a classroom on campus), the time it takes to make as many trips as are needed to travel with the equipment to that destination, and the time it takes to set-up. Then record the course. Then the time it takes to breakdown and follow necessary SOP's for post-production.

The time it takes to set-up and breakdown is often excluded from the actual time it takes to record the class; the pre-production/post-production process is the usual suspect. However, in the experience of the authors it was found that there is a very large amount of time that is taken up just traveling to and from the destination with equipment. This is real time and real man-hours of work. Often this time doubles the amount of time a given recording may take. Thus, the idea of having a classroom(s) already outfitted with this equipment would greatly help workflow efficiency and cost by reducing man work hours for production.

IV. CONCLUSIONS AND RECOMMENDATIONS

1. CONCLUSIONS

Sustained one work-day turnaround for video production of course sessions is feasible. Proper prior preparation and staffing support is essential. One-day turnaround is also a necessary goal to avoid backlog delays and post-production problems. The high definition format for combining slide-set presentations, software demonstrations, speaker audio, and speaker video is an excellent approach for synchronizing and packaging course materials.

Production and post-production remains labor intensive. Future software support may reduce labor requirements further. Extensive attention to detail is necessary to properly produce high-quality course content.

All in all, many good lessons were learned in the conduct of this project. We have shown that, with proper preparation and support, one work-day turnaround of classroom video production for web delivery is feasible. The creation of workflow guidelines, processes and procedural checklists makes this approach repeatable and economically viable.

An excellent pair of courses are now available online for distance learning, covering technically advanced topics in interactive 3D graphics in an accessible way.

Further layout preparation and hardware support for proper classroom recording of video and audio is needed. For courses with only a few students studio presentation and recording is a preferable alternative to classroom presentation and recording.

2. RECOMMENDATIONS FOR FUTURE WORK

2.1 Podcast Producer

Podcast Producer is a Apple utility in the Core Mac OS. This program can capture a screen, audio, video, or file and upload automatically to a designated server running the proper server-side Podcast Producer software. This program greatly reduces costs and stress associated with production by automating the upload process, indexing videos, and encoding in a Final Cut friendly codec h.264.

2.2 Hardwired Classroom

Having a hardwired classroom with video support permanently installed increases productivity and lowers costs by reducing classroom associated setup such as running audio, setting up the Smart Board, properly lighting the subject, and setting up the video camera. Having a classroom for these purposes, a duel classroom and studio combination also increases video quality.

2.3 Maintain Log Book

Maintaining a logbook during classroom presentations so that notes and suggestions are not lost is highly recommended. A web-based approach is preferable so that other producers on the project can also maintain the log, decreasing communication breakdowns and allowing multiple authors to edit the video in post-production. Logbooks might also streamline workflow by pre-determining edit points so the video does not have to be watched in whole to find areas of correction.

2.4 Web-Based Software Support

Future projects need to develop or purchase a web-based software support for course production to facilitate workflow, catalog results, and auto-generate web pages for content delivery. Having this ability can lower production costs and streamline production workflow.

2.5 Curriculum Support and Distance Learning

As preparation for future versions of this recurring course further work needs to evaluate

- Inserting bookmarks/markers/tags in the video to support direct indexing by students.
- Feasibility of chat-channel interaction for asynchronous feedback and shared example evaluation.
- Construction of a video-friendly classroom for future course production.

- Suitability of Blue-Ray technology for bundling and high-quality remote delivery of diverse cross-linked multimedia course material, including slides/video/3D/HTML/tools.

Students at NPS and elsewhere have expressed interest in attending a DL version of the course. Creation of an offline version that includes video lectures might make it further available to Navy students at sea or on remote deployment.

Currently 7-10 students take the course every 6 months from various departments. This is an excellent introductory course that might be used to attract further students to NPS. Feedback from students next quarter will be used to determine whether a broader student base might be attracted.

This distributed course directly serves the MOVES curriculum. It has also served thesis students doing cross-disciplinary work in the CS, IS, ME and METOC curricula. It is suitable as an elective to any NPS student interested in 3D visualization as part of their thesis.

2.6 Institutional Video Production

Need to check the estimated levels of operator effort in up coming course productions to verify whether these values (based on current best practices) indeed provide a good personnel-budget planning tool.

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APPENDIX A

PRESENTATION RECORDING CHECKLIST

1. Smart Board Set-Up

- ◊ Place the Smart Board on the **right hand side** of the podium
- ◊ Plug the **laptop projector cable** from the podium into the VGA port on the Smart Board
- ◊ Plug the USB cable from the Smart Board into Don's laptop (any port is fine)
- ◊ Plug the VGA cable from the Smart Board into Don's VGA laptop port
- ◊ Power on Smart Board (Don't forget to **plug it in!!**)

2. Camera Set-Up

- ◊ Place the camera and tripod next to the second row of tables from the front of the room, next to the moveable wall.
- ◊ Plug in the JVC power cable under the desk (Large power supply with battery charging ports on top; plug into camera.
- ◊ Raise camera monopod (the vertical adjustment underneath the camera mount) about ¾ of the way up (roughly eye level with Don)

3. DTE Set-Up

The Direct To Edit hard drive (DTE) is the black box with a screen that records all the video. This devices does not require you to use the camera record button, all you simply need to do is hit the record button on the DTE.

- ◊ Plug the firewire cable from the camera into the firewire port on the DTE labeled **DV**
- ◊ Power on the DTE (hold down the **ON** for a few seconds)

4. Audio Set-Up

- ◊ Set the boom microphone and stand next to the podium on the movable wall side
- ◊ Start raising the microphone by extending the main pillar with the twist adjustment at the neck of the stand
- ◊ Then raise the microphone even higher with the boom adjustment (where the microphone connects to the stand): This should raise it about 10ft high
- ◊ Adjust the microphone so it is almost 90 degrees facing down but still above Don's head, and out of the camera frame (it should be right out of the top of the camera frame)
- ◊ Plug the XLR cable (the microphone cable) into the channel 1 XLR input on the camera

5. Camera Aim + Smart Board Capture Process

- ◊ Start recording on the DTE by pressing the record button **TWICE** (red button in the upper left hand on the DTE below the On button and above the rewind button): You'll know it is recording when the time code on the DTE screen begins counting up – you must **START THE DTE BEFORE ANYTHING ELSE** (i.e., the DTE needs to begin recording before you synchronize the screen capture, see the following steps)

- ◊ Aim the camera at Don to frame him, see below example photo of what the frame should look like (see figure A)
- ◊ Take the clapper and write in the correct date ("Sept XX 2008)
- ◊ Tell instructor you are ready to begin and synchronize the screen capture and video by clapping the clapper while instructor simultaneously clicks the record button on the screen capture software

6. Backup Tape

- ◊ Label with date, course number, speaker, and session title
- ◊ Label box with date and course number
- ◊ Do not reuse or double-up on tapes unless the manufacturer says you may do so. Some tapes can be re-written, others not

7. Shutdown Procedure

- ◊ Stop backup tape
- ◊ Set write-protect on tape
- ◊ Save screen capture file
- ◊ Transfer screen capture to shared storage
- ◊ Transfer DTE recording to shared storage
- ◊ Transfer electronic notes/update shared storage notes
- ◊ Ensure all directories and files are named correctly and organized properly

APPENDIX B

VIDEO-EDITING CHECKLIST

1. Capture and Export
   - Add an extra video track for your screen capture, then align and match the video appropriately
   - If using FCP, go to the motion tab and select the desired size and spacing for the video and screen capture, this is also known as framing.
   - Trim your video and add a fade at the intro and end.
   - Export: There are many choices here, for this project we exported in h.264, 50% of source size (640x360), at 15Fps, and capped the data at 800kbps with the streaming bit set.
2. Quality Assurance
   - Once the export is finished open the file and check the beginning, middle, and end for discrepancies in the compression or transcode process.
   - Also make sure to check your edit points, where you cut and where there are cross fades, as those areas tend to be more sensitive to the compression process.
   - Check audio.
3. Render Video

APPENDIX C

X3D FOR WEB AUTHORS VIDEO DATA STORAGE

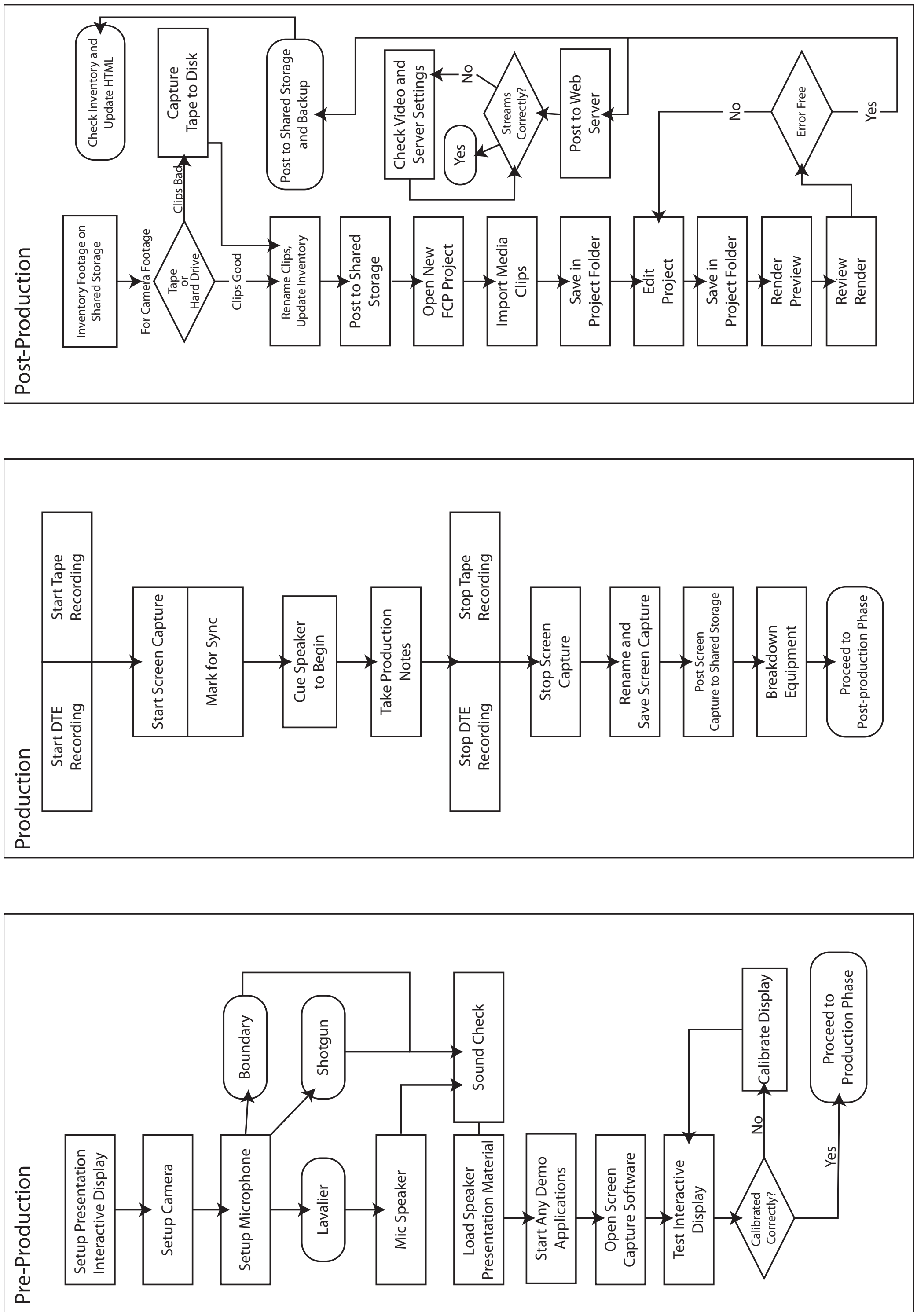
X3D For Web Authors
Archive Data Sheet

Overall Archive Data: Statistical Data for Each Aspect of the Production Process

	MV3204 Raw	MV4205 Raw	Screen Captures	Transcoded SC	Final Renders	Final Cut Projects	**Total**
Size (GB)	525.42	321.55	5.19	55.7	32.03	0.084	**939.974**
# of Files	46	27	63	72	82	73	**363**
Hours of Video	26.271	16.078			40	n/a	**82.349**

APPENDIX D

PRODUCTION PROCESS FLOWCHART



APPENDIX F

APPROXIMATE WORK TIME FOR SINGLE CLASS

Primary Shooter	Novice	Expert
Pre-Production / Classroom setup	20 Minutes	10 Minutes
Production / Class Presentation	35 Minutes	35 Minutes
Classroom Teardown	15 Minutes	10 Minutes
Post-Production	3 Hours	2 Hours
Troubleshooting	45 Minutes	45 Minutes
Average Estimate For Hours Worked Per Single Class	**5 Hours/day**	**4 Hours/day**

<u>Sustainable Rates</u>

Novice: One 4-5 hour course per week
Expert: Two 4 hour courses per week

The rates above represent a typical 4 hour per week course. Given our experience these values represent an approximate value of man-hours per course per week. As the table above conveys, man-hours worked per week are dependant on experience in the various aspects of video recording. APPENDIX F conveys the overall production time budget and offers another valuable guideline when planning your budget for course production.

APPENDIX G

OVERALL PRODUCTION BUDGET

Shooter Type	Novice (Days of Labor)	Expert (Days of Labor)
Equipment Purchase And Testing	2	2
Video Server Setup	2	2
Website Setup	2	2
Preparation, Meetings, And Rehearsal	2	1
Novice Training And Supervision	3	3
Novice Software Training	5	0
Budget for course load Of 40 classes at 4 hours/week	25	20
5% Re-shoot Rate	3	1
Estimated Total Man-Days Of Labor	**44 Days of Labor**	**31 Days of Labor**

APPENDIX H

WEB PAGE INDEX, COURSE VIDEOS: X3D FOR WEB AUTHOR

Course Videos: X3D for Web Authors

These video lessons support the textbook X3D: Extensible 3D Graphics for Web Authors, which shows how to build and animate models using X3D.

Primary supporting materials for the book and these video lessons include the X3D-Edit authoring tool, example scenes, and chapter slidesets. Supplementary learning materials include X3D Resources, X3D Tooltips, and X3D Scene Authoring Hints.

These videos were produced during the presentation of two MOVES Institute courses: *Introduction to X3D Graphics* (MV3204) and *Advanced X3D Graphics* (MV4205). The course presenter is book coauthor Don Brutzman.

Examples	**Chapter Sessions**	**Session Descriptions**	**Time**	**.pdf**
0	Getting Started	Goals and motivation, installing X3D-Edit authoring tool and example scenes, course introduction	46:50	slides
1	Technical Overview 1A	Introduction, historical background, Web3D Consortium, importance of standardization, X3D Specifications and International Organization of Standards (ISO), intellectual property rights (IPR) and open-source software, interoperability considerations	47:47	slides
	Technical Overview 1B	Browsers and players, models versus programming, scene graphs, behaviors and events, profiles and components, document metadata, fields	35:10	
	Technical Overview 1C	Importance of consistency, strong data typing, accessType, XML design patterns for X3D, compressed binary encoding, standards liaison organizations	25:35	
	Technical Overview 1D	X3D-Edit authoring tool development, functional testing, bug tracking, version control, Netbeans, help system	17:17	
2	Geometry Primitives 2A	Shape and geometry nodes, common geometry fields	30:17	slides
	Geometry Primitives 2B	Box and Cylinder nodes, X3D Tooltips	35:21	
	Geometry Primitives 2C	HelloWorld example, Cone Cylinder and Sphere nodes	34:44	
		Text node for flat 2D strings, launching an		

	Geometry Primitives 2D	X3D scene into one or more external players, multiple-field MFString arrays, handling special characters using XML character entities	46:31	
	Geometry Primitives 2E	FontStyle node for vertical and horizontal alignment of text, open-source licenses	17:38	
3	Grouping 3A	Grouping node concepts, XML encoding	12:04	slides
	Grouping 3B	Inline node and url field: creating an ordered list of equivalent url references	42:02	
	Grouping 3C	X3D resources and additional references, Inline node, url fields, level of detail (LOD) node	46:28	
	Grouping 3D	Switch node, review grouping node concepts, 3D grid resources	27:30	
4	Viewing Navigation 4A	Viewing, navigation, bindable nodes and binding operations example	11:30	slides
	Viewing Navigation 4B	Viewpoint node, viewing and navigation	32:20	
	Viewing Navigation 4C	NavigationInfo and Anchor nodes, uniform resource locator (url)	39:33	
	Viewing Navigation 4D	Billboard node keeps children facing user view, Collision node reports collision between polygonal geometry and user view	46:55	
	Viewing Navigation 4E	ViewFrustum prototype example: visualizing range of camera visibility in an X3D world	9:22	
5	Appearance 5A	Appearance node for associating material and textures with geometry, inside a parent Shape node	21:45	slides
	Appearance 5B	Material and TwoSidedMaterial nodes, Universal Media materials library	43:20	
	Appearance 5C	Textures and ImageTexture node, texture coordinates, image copying and flipping to produce a continuously repeating texture, file formats	42:31	
	Appearance 5D	MovieTexture and PixelTexture nodes, LineProperties and FillProperties nodes	32:42	
	Appearance 5E	PixelTexture node, SFImage data type, PixelTexture image-import tool	44:52	
	Appearance 5F	More on PixelTexture node, hexadecimal representations, MovieTexture node animating on top of geometry	39:25	
	Appearance 5G	TextureTransform, TextureCoordinate and TextureCoordinateGenerator nodes, Pellucid materials-visualization tool	22:33	
	Geometry 6A	Points lines and polygons: triangles, single-sided and double-sided polygons, right-	20:22	

	Geometry 6A	hand rule. Common fields: counter-clockwise (ccw) and colorPerVertex.	29:22	
6	Geometry 6B	Points lines and polygons, continued. Other common fields: convex (versus concave), creaseAngle, and various index fields. Color, ColorRGBA, Coordinate and CoordinateDouble nodes.	39:41	slides
	Geometry 6C	Pointset, IndexedLineSet and LineSet nodes	40:25	
	Geometry 6D	IndexedLineSet continued, LineProperties node	5:24	
	Geometry 6E	IndexedFaceSet and ElevationGrid nodes	43:39	
	Geometry 6F	Extrusion nodes (plus a Play-Doh Fun Factory!)	39:14	
	Event Animation 7A	Event animation, behaviors and ROUTEs, data types, overview of 10-step process	40:20	
	Event Animation 7B	Animation 10-step process, ROUTE editor, interpolation, Time sensor, scalar interpolator, interpolation nodes	34:01	
7	Event Animation 7C	TimeSensor and ScalarInterpolator nodes, double linear interpolation principles	40:16	slides
	Event Animation 7D	ColorInterpolator, OrientationInterpolator, PositionInterpolator and PositionInterpolator2D, NormalInterpolator and CoordinateInterpolator2D nodes	1:06:37	
	User Interactivity 8A	User interactivity, pointing devices, selecting and dragging, common fields	50:53	
	User Interactivity 8B	TouchSensor node and pointing-device selection	27:03	
8	User Interactivity 8C	Creating a morphable model using CoordinateInterpolator, PlaneSensor node, CylinderSensor node, ArbitraryAxisCylinderSensor prototype, SphereSensor node, KeySensor and StringSensor nodes, plus advanced prototypes TimeDelaySensor, TimeSensorEaseInEaseOut and DoubleClickTouchSensor	1:33:48	slides
	Event Utilities, Scripting 9A	Event Utility nodes: comparing continuous interpolators to discrete sequencers and triggers, declarative versus imperative programming styles	34:48	
	Event Utilities, Scripting 9B	Event Utility nodes: BooleanFilter, BooleanSequencer, BooleanToggle, triggering event-animation chains with BooleanTrigger, then IntegerSequencer, IntegerTrigger and TimeTrigger nodes	1:06:23	
9	Event Utilities, Scripting 9C	Script node, scripting concepts, event model	21:14	slides

	Event Utilities, Scripting 9C	and execution model	21:14	
	Event Utilities, Scripting 9D	Event cascades, field connections for script code, SimpleScriptStateEvents example	1:18:09	
	Event Utilities, Scripting 9E	Scripting advanced examples: ScriptSimpleStateEvents, ScriptEvents, ScriptComplexStateEvents, directOutput and mustEvaluate fields, initialization and shutdown, comparison of direct field control and ROUTEd event control	45:19	
10	Geometry2D 10A	Geometry2D nodes: concepts, Arc2D, ArcClose2D, Circle2D, Disk2D	32:27	slides
	Geometry2D 10B	Geometry2D nodes: Polyline2D, Polypoint2D, Rectangle2D, TriangleSet2D	31:59	
11	Lighting, Environment 11A	Lighting concepts, common lighting fields	40:48	slides
	Lighting, Environment 11B	DirectionalLight node, NavigationInfo headlight, and PointLight nodes.	41:40	
	Lighting, Environment 11C	Spotlight node. Environment concepts, Background, TextureBackground and Fog nodes.	1:43:39	
12	Environment Sensor, Sound 12A	Environment Sensor concepts and LoadSensor	35:55	slides
	Environment Sensor, Sound 12B	ProximitySensor and VisibilitySensor nodes	23:31	
	Environment Sensor, Sound 12C	LoadSensor node, constructing a Heads Up Display (HUD) prototype	16:15	
	Environment Sensor, Sound 12D	Sound concepts, Sound node, AudioClip node	29:31	
13	Triangles, Quadrilaterals 13A	Triangles and Quadrilaterals: common and distinguishing geometry concepts	32:51	slides
	Triangles, Quadrilaterals 13B	Normal (perpendicular) vectors, Normal node, TriangleSet node for ordered definition of points into polygons, and morphing TriangleSet example	43:44	
	Triangles, Quadrilaterals 13C	Ordered polygonal nodes: TriangleFanSet, TriangleStripSet, and QuadSet	33:27	
	Triangles, Quadrilaterals 13D	Indexed polygonal nodes: IndexedTriangleSet, IndexedTriangleStripSet, IndexedTriangleFanSet and IndexedQuadSet	46:13	
	Prototypes 14A	Prototype concepts, X3D language extensibility, declarations versus instances, strong typing, syntax contrast XML (.x3d(and ClassicVRML (.x3dv)	36:51	
	Prototypes 14B	X3D Player support and Schematron validation; Prototype declarations (ProtoDeclare), ProtoInterface, ProtoBody	40:36	

		and field declarations		
14	Prototypes 14C	IS/connect links between ProtoInterface field definitions and ProtoBody contained node declarations	27:33	slides
	Prototypes 14D	Using IS/connect to expose an embedded Script node; External prototype declarations (ExternProtoDeclare) and field signatures	32:08	
	Prototypes 14E	Prototype instance (ProtoInstance) copies and fieldValue re-initialization. Advanced example: *ViewFrustum* prototype demonstrating a complete combination of best practices with prototypes and scripts.	59:20	
Totals	**62**	**That's all for now. Good luck with X3D!**	**37:35:06**	**1200+**

Video production credits: Jeff Malnick and Jeff Weekley, NPS. Labor support provided by the Office of Continuous Learning (OCL).

Videos are rendered and viewable using Quicktime.

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Revised 18 February 2009.

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