North Canyon High School

Television Studio Restoration and Upgrade

A Proposal by Peter Torpey

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1 SUMMARY

In preparation for upcoming video production classes, North Canyon's television studio needs to be restored to working order. Existing systems need to be reassembled, tested, and serviced for proper operation. In order to meet the demands of practical education in video and broadcast production, as well as the skills and recommendations of the Arizona Department of Education, the television studio also requires a number of upgrades to equipment and facilities.

This proposal details the steps of a cost effective approach to restoring and upgrading North Canyon's video systems to meet these goals. The approach taken maximizes the use of existing equipment while integrated new components and technologies. The design is flexible in order to accommodate the needs of instruction and production of various types of programming. Equipment suggestions and estimated expenses are listed for each aspect of the restoration and upgrade.

2 INTRODUCTION

North Canyon High School is fortunate to have been constructed with superb facilities for the vocational and fine arts. Its television studio, located in Room 422 of the Industrial Arts Building, is no exception. Although, early in the school's design, the studio was relocated from a suite of rooms in the Auditorium complex to its present location and reduced in size and equipment, the then state-of-the-art technology has served the school and its students well.

Shortly after the school opened (as Paradise Valley High School), Leigh Bennett, the Video Production instructor at the time, was interviewed in a November 1991 issue of the Arizona Republic. In the article, Bennett explained the benefits of the new technology to students and suggested that the television studio would soon be providing instructional content throughout the school district. The program and facilities showed great potential for educating students in broadcasting and related technology as well as providing services to the school, district, and community.

In the years since Bennett retired, North Canyon has intermittently offered courses in video production. However, renewed student interest in the program has prompted the course to again be offered in Fall 2005, after an over three-year hiatus.

North Canyon's television studio has evolved little since its initial design in 1991. Then state-of-the-art equipment has grown outdated and the facility no longer meets the demands of education in video and broadcast television production. This proposal suggests modifications and upgrades that take in to account the existing infrastructure and specifics of North Canyon High School's current television production facility.

2.1 Objectives

This proposal seeks to satisfy numerous objectives in a cost-effective and timely manner. The most critical of these goals is to ready the school's television studio for upcoming Video Production classes in Fall 2005. This rapidly approaching deadline requires that the studio be returned to a functional state in a short period of time.

As part of this process, the equipment and facilities should be expanded upon and modernized in order to provide a learning experience that will provide students with marketable job skills and education that satisfies state recommended guidelines for technology education. At present, the television studio falls short of many of the competencies as outlined in the Arizona Department of Education's document: Competency and Indicator List for Radio / Television Broadcasting Technology[1]. These deficiencies are addressed by the measures outlined in this proposal (see **2.5 About this Document**).

[1] This proposal assumes that the educational program taught will be aligned with competencies for Option A: Electronic Journalism. North Canyon's studio space was intended for operations that address these goals. Competencies specific to Option B: Interactive Digital Media entail student creation of 2D and 3D animation, image editing, and other tasks best taught in a computer lab environment where each student has an individual

The proposed upgrades build on the television studio's existing infrastructure in the interest of time and expense. Necessary technologies are integrated into existing systems creating a flexible design that can continue to evolve as needs change in the future. The resulting system and configuration is designed to provide a suitable environment for teaching a real-world professional approach to video and broadcast production. Such a course will foster student collaboration and experience in various production roles yielding a marketable skill set.

The upgraded studio will make effective use of limited space. Additional resources can be shared in collaboration with related school departments and classes in journalism, photography, theater production, and the Media Center.

The suggested upgrades are also intended to create a facility capable of producing various types of programming and services yielding a high-quality product. Students will be able to produce a 'morning announcement' program as a live broadcast that will serve to inform students, faculty, and staff throughout the school of current events. Other production services can include the creation of promotional and instructional videos as well recordings of events, lectures, and performances for the school and community. Productions will be delivered in a variety of formats including DVD, VHS, and webcasts.

2.2 Inspiration

A rapidly increasing number of high schools throughout the nation are introducing or revitalizing courses in video production and broadcasting. To serve as a reference and inspiration, the links to the websites of two example programs are provided. Each demonstrates the possibilities for programming, delivery, quality, and educational opportunities that can be created at the high school level.

- North Canton City Schools, Channel 11
  www.northcanton.sparcc.org/~tv11/studio.htm
- Shawnee High School Television
  www.lr.k12.nj.us/site/shawnee/tv/

2.3 Digital versus Analog

In recent years, great importance has been placed on digital technology, particularly in the television broadcast and video production industries. Indeed, most television production facilities have upgraded to digital equipment for content creation and broadcast. The benefits include saving time and money on content creation, delivering superior quality to consumers as well as complying with anticipated FCC recommendations and standards.

In light of changes in these changes in the industry, it may seem appropriate to educate students using such state-of-the-art equipment in order to provide a marketable skill set. However, upgrading even a small studio like North Canyon's from analog to all-digital equipment would be a significant and potentially costly endeavor. From a pedagogical perspective and in the context of live production, such as a morning announcement program, little would be gained by moving to a digital format. A myriad of consumer and

workstation. North Canyon's television studio is not such a facility. However, in a practical curriculum aligned to Option A, students are also likely to acquire many of the Option B competencies during production.

professional digital standards make selecting and installing equipment a significant undertaking. The difference between digital and analog equipment in a live broadcast studio environment is primarily the signal format; a digital signal being of a higher quality. There is little difference in the way users operate most of the equipment, which is the primary consideration for instruction. One notable exception would be off-line non-linear editing (NLE) which relies on computer software manipulation of digital video. This type of editing would be a practical and essential skill for students to acquire in order to augment experience in live production.

Given that the expense of an all-digital upgrade far outweighs any benefits, this proposal takes a more economical approach by expanding on the existing analog infrastructure of North Canyon's television studio, rather than replacing it entirely. Where digital technology, such as NLE, would be appropriate, the proposed upgrade integrates the digital equipment with existing system. Future upgrade cycles may incorporate additional digital components. However, if a significant portion of the current equipment is found to be unserviceable and in need of replacement, a wide-scale digital upgrade may prove cost-effective or cost-equivalent while laying the groundwork for the future.

2.4 Cost and Acquisition

Estimated costs of equipment are listed in subsequent sections along with recommendations for equipment manufacturers and models. Shipping costs are not included. Additional minor capital expenditures such as cables, terminators, connectors, and mounting hardware are not listed. These costs will need to be determined upon additional review.

As an upgrade to capital infrastructure, the funding for the suggested purchases may be derived from the Capital Override Funds, under supervision of the Capital Override Oversight Committee (COOC). The cost of materials and labor for the installation of equipment may also fall under capital expenditures. Software may be acquired under district site license.

Purchasing may be favored through suppliers with which the PVUSD has a relationship, such as Troxell Communications (www.trox.com). However, for the purposes of estimating equipment costs in this document, the pricing of suggested equipment will be derived from B&H Photo-Video (www.bhphotovideo.com) catalogs, unless otherwise noted.

Other purchasing avenues may be investigated in order to minimize expenses. New and used professional video equipment can often be found on eBay (http://photography.ebay.com/) and other online retailers at a considerable discount. Additionally, many local television stations have recently undergone equipment upgrades and may be willing to donate remaining or unused equipment to the school.

Operating expenses, costs of consumables, and other non-capital expenditures are not listed. Such costs may include tapes, batteries, light bulbs, and maintenance. Funding for these may be derived in part by offering paid video production services to school clubs, departments, and the community. Additionally, during the 1997–1998 school year, advertising was sold in a manner similar to that of the school newspaper *Rattler Review*. Students of the Video Production class sold ten to fifteen second ads to local clients such as Paradise Valley Community College, Jamba Juice, and Great Skate. These spots would air during the morning announcement program, then titled *First Strike News*.

2.5 About this Document

The remainder of this proposal is comprised of two primary sections. Section **3 Restoration** outlines the steps necessary to restore North Canyon's television studio to working order. Section **4 Upgrades** details equipment and configuration changes necessary to fulfill unmet needs with the ultimate goal of creating a professional quality studio and production facility.

This proposal concludes with several appendices. **Schematic diagrams** are provided illustrating video and audio signal flows incorporating the suggested new equipment. A **plan view** of the television studio, control room, and audio room indicates space usage including a physical news set and personnel positions. **Renderings** of a sample news set and selected **diagrams** demonstrate possibilities for simple and inexpensive set construction.

Where appropriate, needs are referenced to items or sections of the Competency and Indicator List for Radio / Television Broadcasting Technology: Option A: Electronic Journalism (CIP No. 10.0200.10 and .20) published by the Arizona Department of Education in March 2004. The document and other related documents may be obtained from the AZTechPrep website: www.aztechprep.org.

2.6 About the Author

This proposal was authored by Peter Torpey, an alumnus of the International Baccalaureate Programme at North Canyon High School. Drawing on experiences with video production at Sunrise Middle School, Peter began working in the school's television studio under the supervision of Leona Drew during his freshman year at North Canyon. In subsequent years, Peter worked closely with Justine Weaver, Wendy Pleake, Kathy Jonas, and Dave Cornelius while taking independent study units in Video Production. During this time, Peter spent numerous hours in the school's television studio, studying production practices and technology, gaining an intimate knowledge of the equipment, and restoring the studio to a functional state. In conjunction with Student Government, he introduced morning video announcements in 1996. The following year, a Video Production class was reinstated. Peter continued to provide assistance in the production of morning announcements, video advertisements for upcoming school events, instructional videos (such as preparation for the Stanford 9 Test), promotional videos (including a video promoting the North Canyon's IB Programme), recording and integrating video into the school's theatrical productions, and other video projects.

Peter continued studying television, video, and film production and post-production while at the University of Arizona, where he graduated magna cum laude with a BA in Media Arts and a minor in Computer Sciences. Also, while at the UA, Peter worked as a Media Support Specialist at the Learning Technologies Center where he was responsible for production and post-production on numerous projects utilizing state-of-the-art digital equipment. Presently, Peter is a freelance visual effects artist, web designer, and developer of software to aid in visual effects and video production. More information may be found at www.petertorpey.com.

2.7 Acknowledgements

Peter Torpey would like to thank Justine Weaver for her interest and support in drafting this proposal.

3 RESTORATION

In the years since video production classes have been taught in North Canyon's studio, the facility had fallen into disrepair. The room has come to be used for general storage. Some equipment has been dismantled and found its way to other parts of the school or is missing. Prior to any upgrades, the television studio must be returned to a clean and functional state providing a learning environment that will satisfy much of **Competency 12.0**.

3.1 Maintenance

The television studio should be cleared of non-essential items and material that is being stored there. Thorough cleaning and maintenance of the facility should be performed.

Dust accumulation can be extremely harmful to sensitive video equipment. The effects of dust can range from minor errors in a video signal, as a result of the changed impedance of circuit boards, to complete failure of equipment due to shorts or improper airflow. Dust needs to be cleaned from all surfaces and carpeting vacuumed. Equipment and cables, including inside rack cabinets, should be carefully dusted. Solvents, cleaners, and electrostatic dusters cannot be used, as they will damage equipment.

3.2 Reassembly and Repair

In order to assess any equipment that is in need of repair or replacement, all of the studio components should be returned and connected in a functional manner. For an inventory of most of the equipment that should be on hand and the manner in which it needs to be connected, refer to Revision 5 of the schematic diagrams PAR–V–001, PAR–V–002, and PAR–A–001. Additional equipment not listed on the diagrams includes, wired and wireless microphones and receivers, cables, tripods, handheld cameras, light kits, additional monitors and VCRs, communications headsets and belt packs, among others. It will be easy to identify the major components of the studio that are missing and need to be replaced. Costs of repairs and replacements need to be assessed during this process.

Once the equipment configuration has been restored, each component should be tested thoroughly for defects, missing or bad cables, poor signals, and other indications of excessive wear that would prevent the item from functioning optimally. Camera lenses that have been left uncovered and have been improperly cleaned may need to be treated or replaced. Some equipment has been powered on continuously for several years thereby increasing the potential for damage. Video monitors may experience burn in or a general lightening of the phosphor emissions when left on. Small light bulbs in the switcher and tally lights will likely need to be replaced. Electrical components can also be damaged by surges or power failures that may have occurred while the unit was in a powered state.

Any equipment missing or damaged beyond repair will need to be replaced. The replacement must at least match the capabilities and features of the original component in order to be compatible with the current system and the upgrades in this proposal. Taking into consideration that this equipment is over 14 years old, many of the product lines have been discontinued. It may be necessary to purchase compatible models from used equipment resellers. For example, the recording VTR (JVC BR-S811U) is believed to be missing. This

deck communicates with the playback deck (JVC BR-S611U), time base corrector (JVC SAT-400U), and edit controller (JVC RM-G810U) through proprietary connections. Only a few models of recording decks were manufactured that support this configuration. Thus, short of replacing all of these components, a BR-S811U, now discontinued, is the only suitable replacement.

Some equipment, especially VTRs and cameras, will likely require the care of professional servicing in order to ensure proper functionality. Such devices should be maintained regularly. Other equipment, such as the video switcher and video monitors, will need to be recalibrated for the video system.

3.3 A/A Roll Editing Station

Not depicted in the Revision 5 schematic drawings is an S-VHS A/A roll editing station that was added to the television studio in 1997. This station consists of two Panasonic AG-1980 S-VHS decks linked by an AG-A96 edit controller. A small video or television monitor is connected to each deck. Output from the record deck may be tied to the studio video system through a genlocking time base corrector (see **4.4 Integration Necessities**). Additionally, the AG-1980 decks have RF inputs and timer recording so that they may be used to demodulate RF feeds.

3.4 New Resources

In recent years, North Canyon has been fortunate enough to receive technology upgrades and equipment for student and faculty use throughout the school. The Media Center has acquired new video projection units, computers, and carts featuring Mini-DV camcorders with analog output. These resources may be shared with video production classes. For example, the Mini-DV cameras would be invaluable to student electronic newsgathering (ENG) production (**Competency 14.0**). Students can use the cameras for recording newsworthy events for later integration in to morning announcement broadcasts and other productions. Equipped with RF modulators, these carts can also be used in the production of live remote feeds during a broadcast.

Photography and journalism classes have additional resources, such as digital still cameras, which may be of use to video production students. In field production, tripods are essential. While several tripods are available in the television studio, video production students may be able to share additional tripods, if needed, with other departments.

The television studio is also equipped with a portable light kit. This light kit is intended for field use, though it was typically used for in-studio lighting. To support students in ENG it may be desirable to acquire additional portable lighting kits.

3.5 RF Network

The RF Network provides a cable signal to every television throughout the school. The network's hub is the rack system in the Media Center which provides cable television, satellite, and tape feeds that may be viewed from any classroom.

In the past, during a live broadcast from the television studio, the program video signal was modulated to a sub-band RF channel in the studio's control room. A channel processor in

the Media Center rack remodulated the sub-band signal to a standard VHF channel for viewing.

A recent upgrade to the campus-wide RF distribution equipment and the Media Center's rack system removed the channel processor, making no provision for remodulation of a sub-band signal from the television studio. Thus, a new RF modulator tuned directly to an available VHF channel or new channel processor may be required. Under the new RF system, difficulty has been encountered attempting to broadcast from campus locations other than the Media Center. This may be the result of additional RF distribution amplifiers that were installed at the time of the upgrade, not taking in to account the need for remote RF signal sources. This issue will need to be addressed in order to produce live broadcasts.

3.6 Classroom

Since there is no classroom associated with the television studio, the studio floor must double as a classroom. For lectures, discussions, and production meetings, one or two tables may provide a writing surface for students. The tables should be collapsible so that they can be easily stowed when the room is needed for studio operations. A portable chalkboard or whiteboard may prove beneficial during lectures and production meetings. Ample student seating also needs to be provided. Folding or stackable chairs would allow for efficient storage, as well.

A standard consumer VCR can be kept on the cart with the studio video monitor for convenient presentation of videos to the class. The VCR can be connected to input B on the studio monitor. As an alternative to the studio monitor, a video projector may be used for larger display. The video projector may also serve a production function as discussed in section **4.8**.

4 UPGRADES

Several aspects of North Canyon's television studio require upgrades in order for the facility to meet state recommendations and provide a professional and comprehensive production environment in which to teach students practical real-world skills. The following suggested upgrades modify not only the studio's video and audio systems, but also include essential technologies for all aspects of production including sets and lighting.

The upgrades suggested in this section are intended to provide a cost-effective approach to satisfying production and instructional needs predicated on a functional existing setup as described in section **3 Restoration**. The following suggestions are to be considered minimal. Where appropriate, it is noted that more advanced equipment and upgrades would prove beneficial, improving capabilities and functionality beyond minimal requirements. If it is determined that a significant number of existing components need to be replaced, it may be prudent to apply the more advanced upgrades at this time, rather than replacing newly acquired equipment in the near future. Estimated costs for such advanced recommendations are not provided and will require further design modification and review.

In many cases, installation of the proposed upgrades is relatively straightforward requiring wiring and, in some cases, rack mounting. Electrical circuits in the studio, control, and audio rooms will need to be verified to meet the various new loads of computers, lighting, and other equipment. Additional circuits or outlets may need to be wired. Some of the drawers or cabinets in the control room may be fitted with standard 19" rack hardware for mounting certain components in a more attractive and practical manner.

Cost estimated provided are for major upgrade components. Costs for related necessities such as video and audio cable, connectors, video terminators, power cords, hardware, and tools are not enumerated. Such requirements will need to be evaluated once other materials and equipment are approved and, in many cases, rely on physical measurements, which would need to be made onsite.

4.1 Computers

Since the television studio's initial design in 1991, computers have become an essential technology that must be integrated into North Canyon's production facility. Many of the pre-production and production tasks as described in **Competencies 17.A** and **18.A** are best accomplished using a computer. To this end, four general-purpose computer stations are proposed. Any reasonably equipped mid-range computer can easily meet these requirements and ship with necessary hardware and software. It is recommended that the computers be PC compatible systems as they are easier and cheaper to upgrade, with respect to both hardware and software, as needs change. In order to conserve limited counter workspace 17" LCD panel monitors should be considered over bulky CRTs.

As these computer stations will be used by students to plan productions, develop and research news stories, and write scripts, a word processing program, such as Microsoft Word is essential. A laser printer should be provided so that hardcopies of documents and scripts can be created as needed. Scheduling software may be desired for planning student production assignments and easily allocating time and resources. Software tailored to the needs television and video pre-production, news management, and script writing may be

useful, though they are often complex in scope and should not be considered absolutely necessary.

A switch or router/switch is required creating a local network enabling collaboration and file sharing among computers. Internet access is also recommended for journalistic research, access to resources available on the Internet, and collaboration with other departments. Announcements and news items may be received from the main office or others via e-mail or secure web delivery system for incorporation into morning announcement programming. E-mail access would also prove effective in communication with advertising clients and in coordinating services and resources. As included with most available systems, computers will need to be equipped with 10/100 Mb network interface cards.

As described in section **4.3 Teleprompters**, one of the general-purpose stations may be used to drive teleprompters. At least one station should have image manipulation software such as Adobe Photoshop for preparing graphics and titles for use in documents and video productions. A scanner, digital camera, and related software may be convenient, though infrequent use may be done elsewhere on campus where such technologies are already in place. Another computer station, located in the audio room, will allow students to learn digital audio techniques. This computer will require a sufficient audio card, the inputs and outputs of which will be tied into the studio's audio system. Basic audio editing and manipulation software will be required along with CD burning capabilities.

Suggested General-Purpose Computer Equipment

Item	Unit Price	Qty.	Price
Computer, Monitor, Office Suite	$ 1,100.00	4	$4,400.00
Additional Software[2]	$ 1,000.00	1	$1,000.00
Printer	$ 200.00	1	$ 200.00
6-Port Switch, Router / Switch	$ 100.00	1	$100.00
Audio Headphones	$30.00	2	$60.00
		Total:	$5,760.00

Table 4.1

4.2 Digital Editing Station

It is essential that students learn industry-standard digital non-linear editing (NLE) skills and technology as indicated in **Competency 15.0**. In addition to the general-purpose computers listed in section **4.1**, at least one NLE station is necessary. This proposal describes the integration of a single digital station in to the studio's video system. If funds provide, some of the general-purpose stations may be replaced with a system that meets the NLE specification and serve dual in a dual capacity. While multiple NLE stations will allow students to produce and edit projects, additional equipment will be necessary to integrate more than one NLE in to the studio's video system.

Again, a PC compatible system is recommended, as it will be easier and less expensive to upgrade software and hardware than proprietary solutions in the future. Comparable software is available on both Macintosh and Windows platforms, so platform choice need not be a concern for this reason.

[2] Software such as Adobe Photoshop and Microsoft Office/Word may be available under District site license.

The NLE computer must be sufficiently powerful to handle digital video and audio streams. The minimum PC system requirements are:

- 2.6 GHz Pentium 4 Processor
- 768 MB System RAM
- 128 MB 8× AGP Graphics Card with OpenGL Support
- Microsoft DirectX-Compatible Sound Card
- 30GB System Hard Drive (IDE or SATA)
- 120GB 7200rpm UDMA 66 Data/Video Drive (IDE, SATA)
- OHCI-compatible IEEE 1394 interface (FireWire)
- 10/100 Mb Ethernet NIC
- CD/DVD R/W Drive and Software

The system should run Microsoft Windows XP Professional operating system for compatibility with video editing applications such as Adobe Premiere Pro 1.5. Premiere Pro is an industry-standard video editing application for the Windows PC and is comparable to Apple's Final Cut Pro. The video editing application will be the most important application software for this system. It may be purchased at academic pricing as a stand-alone or with Adobe's Digital Video Collection, a software bundle featuring additional advanced applications which are useful but nor required. Adobe Photoshop should also be installed on this system.

As video editing and animation programs consume considerable screen real estate, a two-monitor configuration is recommended. Two monitors may be connected to dual-head graphics adapter or to individual AGP and PCI graphics adapters. As for the general-purpose computer stations, 17" LCD flat-panel monitors are recommended to conserve counter workspace.

A Mini-DV deck connected to the computer via FireWire (IEEE 1394) would allow digital video recorded from Mini-DV cameras to be captured into the computer (see **3.4 New Resources**). Final edits can then be recorded back to Mini-DV tape, VHS, or burned to DVD for distribution, archive, or student demo reels (**Competency 2.2**).

The non-linear editing system may also be integrated with the studio video system using a bi-directional DV media converter. The media converter will link the DV signal over FireWire to the analog systems enabling recording and playback to and from analog sources such as studio cameras and VTRs. Additionally, the NLE station can play back pre-editing sequences and motion graphics packages during live broadcasts.

Suggested Non-Linear Editing Station Equipment

Item	Manufacturer	Model	Unit Price	Qty.	Price
NLE Computer			$ 2,800.00	1	$2,800.00
Editing Software			$ 1,000.00	1	$1,000.00
Monitors			$ 1,400.00	1	$1,400.00
Mini-DV Deck			$ 500.00	1	$500.00
DV Media Converter		Pro-SDI	$ 2,479	1	$2,479.00
Audio Headphones			$30.00	1	$30.00
				Total:	$8,209.00

Table 4.2

4.3 Teleprompters

Teleprompters are essential for on-air talent to present a professional appearance. They allow talent to read easily the show's copy while maintaining eye contact with the camera. Such eye contact is essential for audience attention and to understand what is being said. As teleprompters are ubiquitous in journalistic broadcasting, students should learn to use them. This addition is also necessary to satisfy **Competencies 11.10** and **19.4a**.

For North Canyon's studio, a teleprompter should be added to each studio camera. The prompters will need to be sufficiently lightweight so that the may be attached to the existing camera mounts and tripods without needing to replace this hardware. Consequently, LCD units approximately 10" to 12" in size are recommended. While less expensive, heavier units would require replacing the tripods with models that can sustain the additional weight of the prompter and counterweights. Adapters may be required to fit the prompter housing to the camera lens.

One of the general purpose computers described above may provide the source for the prompters. Specialized teleprompter software or a standard text editor configured to display large white text over black may be used to display the show's script. A professional handheld speed controller or mouse allows the prompter operator to scroll through the text as it is being read.

Prompter units should accept a composite video signal, as this is easier to distribute and cable than a VGA signal. A scan converter is required to convert the computer's VGA signal to composite video for delivery to the camera prompters. The scan converter or each prompter unit will need to have a function that reverses the video image for proper display on the beam splitter. As indicated by the schematics in appendix **A1**, the scan converter output may also be sent to equipment in the control room racks for display to the director during a production.

Suggested Teleprompter Equipment

Item	Manufacturer	Model	Unit Price	Qty.	Price
Teleprompter	Mirror Image	LC-1550	$ 4,595.00	2	$9,190.00
Scan Converter[3]	AVerKey	AVK3 PlusE[4]	$ 149.99	1	$ 149.99
				Total:	$9,339.99

Table 4.3

4.4 Integration Necessities

Several components are required in order to integrate any new sources into the existing video system. All video signals in the system must be properly synchronized by genlocking the source to a reference signal. While some equipment accepts a genlock reference signal, equipment that does not must first send their signal to a time base corrector (TBC) or frame synchronizer.

In most cases, the synchronized signal is sent to multiple devices. This is accomplished by a video distribution amplifier (VDA). A VDA is also needed to distribute a black burst signal

[3] Some computer video cards may come already equipped with a built-in scan converter with composite output.
[4] Pricing from AVerMedia (www.aver.com)

for genlocking the new sources. Currently, the studio is equipped with a Grass Valley Group 8500 tray containing six VDA cards. While the tray has a capacity of eight cards and two power supplies, which would be sufficient for the proposed upgrades, the appropriate cards may no longer be manufactured. Individual or dual VDAs may be purchased instead.

New sources outlined in this proposal include the NLE digital video converter and the A/A roll editing station. Both of these sources will require video signal synchronization and DAs.

Similarly, audio distribution amplifiers (ADAs) are necessary to send audio signals to multiple components. For stereo audio sources, an ADA is required for both the left and right channels. Following the current setup, audio sources typically only feed a single device (the audio mixer via patching). It is therefore unlikely that additional ADAs will be needed.

Video sources that generate both a key and fill signal for use by the effects keyer and downstream keyer (DSK) of the DV-7 switcher require that the fill signal be delayed by 90ns. If graphics from the NLE are intended for use with the DSK a single video signal containing superblack values may provide both key and fill. Similar to the connection of the system's character generator, a video delay box of approximately 70ns prior to the VDA (or a delaying VDA) for the fill signal must be added.

Most all connections in the studio are made through a patch bay. As the existing audio and video patch bays are nearly full, new patch bays will be needed. There are three options for the new patchbays that should be roughly equivalent in price. A single rack unit (RU) single row patch bay can be added for audio and one for video. The disadvantage of this approach is that patches cannot typically be normalled[5] in a 1RU bay. Two 1RU or 2RU double row bays may be added to allow for normalled patches. A third option is a 2RU patch bay with both audio and video jacks.

Patch bays may be purchased assembled or as individual components for custom configurations. For consistency with the existing patch bays, the video bay requires standard ¼" video jacks in the front and BNC jacks in the rear, normal terminated at 75Ω. The audio patch bay requires ¼" TRS Longframe jacks in the front and punch blocks in the rear. New patch bays should be mounted in Rack 1 near the existing bays so that patches may be made between bays. Additional patch cables of the respective types should also be purchased.

Suggested Equipment for Integration

Item	Manufacturer	Model	Unit Price	Qty.	Price
Dual TBC/Frame Sync	Hotronics	AP-41SP[6]	$ 1204.95	1	$1,204.95
1×6 Video DA[7]	Laird Telemedia	LTM-VDA6	$ 189.95	3	$ 569.85
70ns Video Delay	Allen-Avionics	VAR-256	$ 279.95	1	$279.95
Audio Patch Bay[8]	ADC		$ 500.00	1	$ 500.00
Video Patch Bay[8]	ADC		$ 500.00	1	$ 500.00
				Total:	$3,054.75

Table 4.4

[5] A 'normalled' patch is one that allows typical connections to be made without a patch cable.
[6] For a small increase in price, a Hotronics AP-41SD TBC provides SDI output for future conversion of the studio to digital signals.
[7] If possible, GVG 8500 series cards should be used fill the existing tray for two of the three required VDAs.
[8] Estimate from Mr. Patchbay (http://home.flash.net/~motodata/patchbays/right.html)

4.5 Additional Improvements

The upgrades discussed in this section are not required to create a sufficiently capable production environment for the purposes of a high school television studio. Rather, these are suggestions for more advanced production technology that may be added if available funds allow. Otherwise, they may be considered in future upgrades. Replacing items such as the primary switcher, as described here, would likely require a significant redesign of video flows beyond what is illustrated in Revision 6 of the schematics in appendix **A1**.

The existing EchoLab DV-7 switcher, the heart of the video system, allows for only six sources and has a single mix/effects bus (M/E) and downstream keyer (DSK). While these limited capabilities are adequate, as more video sources are added to the television studio, accessing them will become cumbersome at best. As the studio grows and more functionality is demanded, the system will soon outgrow its switcher.

Competency 12.7 suggests that students have experience operating a special effects generator such as a digital video effects unit (DVE). While DVEs are common in professional broadcast production environments, they are not essential components. A DVE can be a stand-alone unit that would serve as an additional source to the main switcher. However, increasingly DVE functionality is being built in to switcher systems.

Modern switchers, such as those available from EchoLab and Grass Valley, employ digital processing, but still accept many common analog signal formats. A digital switcher with composite video input would be compatible with all existing equipment. Some inputs could be upgraded to component video to allow for higher quality signals from some of the existing equipment that already supports component output, such as the studio cameras and VTR 1. Modern switchers, in many cases, no longer require synchronized analog sources, thereby eliminating the need for TBCs or frame synchronizers and delay lines as are required by the existing system. Most digital switchers accept serial digital interface (SDI) connections as well which would provide superior connectivity and quality to digital equipment such as the proposed non-linear editing station and any future upgrades to digital cameras, decks, computers, or other sources.

An upgrade to a larger digital switcher would likely include a DVE while providing additional inputs for sources such as computers, cameras, VTRs, and feeds. A switcher with two or more M/Es would allow for more professional and complex graphics compositions, such as a double box, and keys than the current system. Multiple DSKs and built-in still stores would also facilitate corner bugs, lower thirds, and graphic branding.

Presently, tally lines are wired from the DV-7 switcher to the camera remote control units (RCUs) to illuminate the tally light at the front of each respective camera viewfinder. The Ikegami PM9-5A monitors for the cameras and VTRs in the control room rack also have tally lights. However, these lights have not been wired. Doing so is a simple matter of bringing out the appropriate leads on the DV-7 D-Sub 9 pin tally connector to the necessary connector on the PM9-5A units to complete the short-to-ground connection. In the case of the cameras, a DPST relay may be required to trigger the tally of both the RCU and monitor.

4.6 Production Aids

A few minor items are necessary to facilitate production a studio operations. A simple peg or post board may be mounted on one of the walls in the audio room would provide a convenient place to store coiled cables. This would assist in teaching students proper cord and cable wrapping and storage practices to ensure longevity of the items.

In a typical production environment, the show director and producer are often seated on a slightly elevated platform at a desk overlooking the technical director and control room equipment. Such a desk or table would be useful for North Canyon's control room providing a writing surface for the producer and director during a broadcast. Due to the limited space between the rack console and the opposing wall (and audio room door), a narrow table of only a foot or so in depth would need to be purchased or constructed.

In order to properly time live broadcasts, clock or count up/down timer with second accuracy should be centrally mounted in the control room rack. In view of the director and producer, the clock would ensure that broadcasts start promptly and all stories are completed in the allotted time.

4.7 Lighting

As with any visual medium, proper lighting is essential to creating a pleasing image. Television studios typically have a light grid suspended from the ceiling. A light grid consists of a lattice of pipes from which lighting instruments are hung. The light grid may also feature cable trunks along the pipes with 'tails' from which the instruments receive power.

Unlike some television studios in the school district, North Canyon's studio does not have a light grid or professional lighting instruments. In the past, standard fluorescent ceiling lights have provided insufficient illumination. A few lights from a small light kit intended for mobile production have been used to augment the studio's built in lighting.

In order to provide required lighting and to comply with **Competencies 13.0**, a light grid and professional lighting instruments should be installed. Light grids may be constructed from 1½" light pipes and hardware or may be purchased as more elaborate kits that provide rail systems. The studio has a 12-foot suspended acoustic ceiling. Thus, the light grid should descend one foot below that height to allow room for instruments while providing sufficient clearance for people, equipment, and set pieces below. The light grid should be firmly suspended from structural members in the plenum in a similar manner to the existing curtain track. It will be necessary to consult the fire and building codes to ensure structural and electrical safety and to be certain that heat generated by lights will not pose a fire hazard or inadvertently trigger the ceiling sprinkler system.

Studio lighting controls can range from simple circuit breaker switches, where each lighting instrument is wired to an individual circuit, to complex computer-automated systems. **Competency 13.3** requires students to have familiarity operating a light board. For the purposes of North Canyon's studio, a small cost-effective self-contained light board with built in dimmers should be sufficient. The light board suggested in **Table 4.5** includes dimmers for six channels. To power the board, it will be necessary to ensure that two dedicated 1000W wall circuits are available.

As specified in **Competency 13.2**, a variety of lighting instruments are used in television studios including Fresnels, scoops, and cyc or set lights. A sufficient assortment should be available to allow lighting for various set and chroma key configurations. Given the low height of the lighting grid and the small space, tungsten lights in the 300W to 500W range should provide ample illumination for video production and allow several instruments to be wired to a single dimmer channel without exceeding a maximum 1000W load. Lighting instruments should be fitted with U-Ground (Edison) connectors or Twist-Lock connectors. Twist-Lock connectors enable instruments to be readily shared with the North Canyon's auditorium theaters. However, the suggested light board features U-Ground jacks. The different types of connectors can be used together with inexpensive adapters or specially made cabling.

Other lighting requirements include grounded 12AWG cabling to supply power to the light board and from the light board to instruments on the light grid. Clamps, drop poles, and safety cables will also be required to secure instruments to the grid. Gels, color frames, gobos, and diffusion material can be shared with the drama department.

Suggested Lighting Equipment

Item	Manufacturer	Model	Unit Price	Qty.	Price
Console / Dimmers	Dove Systems	SM1-DUG[9]	$ 567.00	1	$ 567.00
Grid Pipes, Hardware[10]			$ 2,400.00	1	$2,400.00
500W Fresnel	Altman	4.5″ Fresnel	$ 274.95	4	$1,099.80
300W Scoop	Altman	14″ Scoop	$ 159.95	4	$ 639.80
500W Cyc/Set Light	Arri	Mini Cyc	$ 279.95	3	$ 839.85
				Total:	$5,546.45

Table 4.5

The above suggestions are a bare minimum to meet the state competencies and basic requirements of production. It is intended to supplement the existing fluorescent lighting currently installed. In an actual studio environment, all illumination would be provided by lighting instruments from a grid. Additional larger instruments requiring greater power would be necessary. The current suspended acoustic ceiling and fluorescent fixtures may be removed and replaced entirely by acoustic baffling (to reduce noise from mechanical, HVAC, and plumbing equipment in the plenum) and a light grid. Circuits capable of supporting several thousand watt loads would be made available to lighting instruments on the grid. These circuits may be derived in part from the circuits for existing lighting. A more elaborate dimming and switching solution may also be required.

4.8 Physical Set

A physical news set for morning announcements and similar programming will greatly contribute to a professional look of North Canyon's video productions. In past years, a computer generated rendering of a news set was chroma keyed with on air talent. Such virtual sets require that only one camera may be used from locked-down position. This approach does not allow for students to learn the proper operation of cameras in a typical studio environment. A physical set would provide students with the opportunity to learn

[9] Priced from SLD Lighting and Sound (www.sldlighting.com)
[10] Price estimated. Actual materials and cost will need to be determined.

proper camera framing and technique, lighting for sets, direction, and performance (**Competencies 11.0**, **13.0**, **18.A**, and **19.A**).

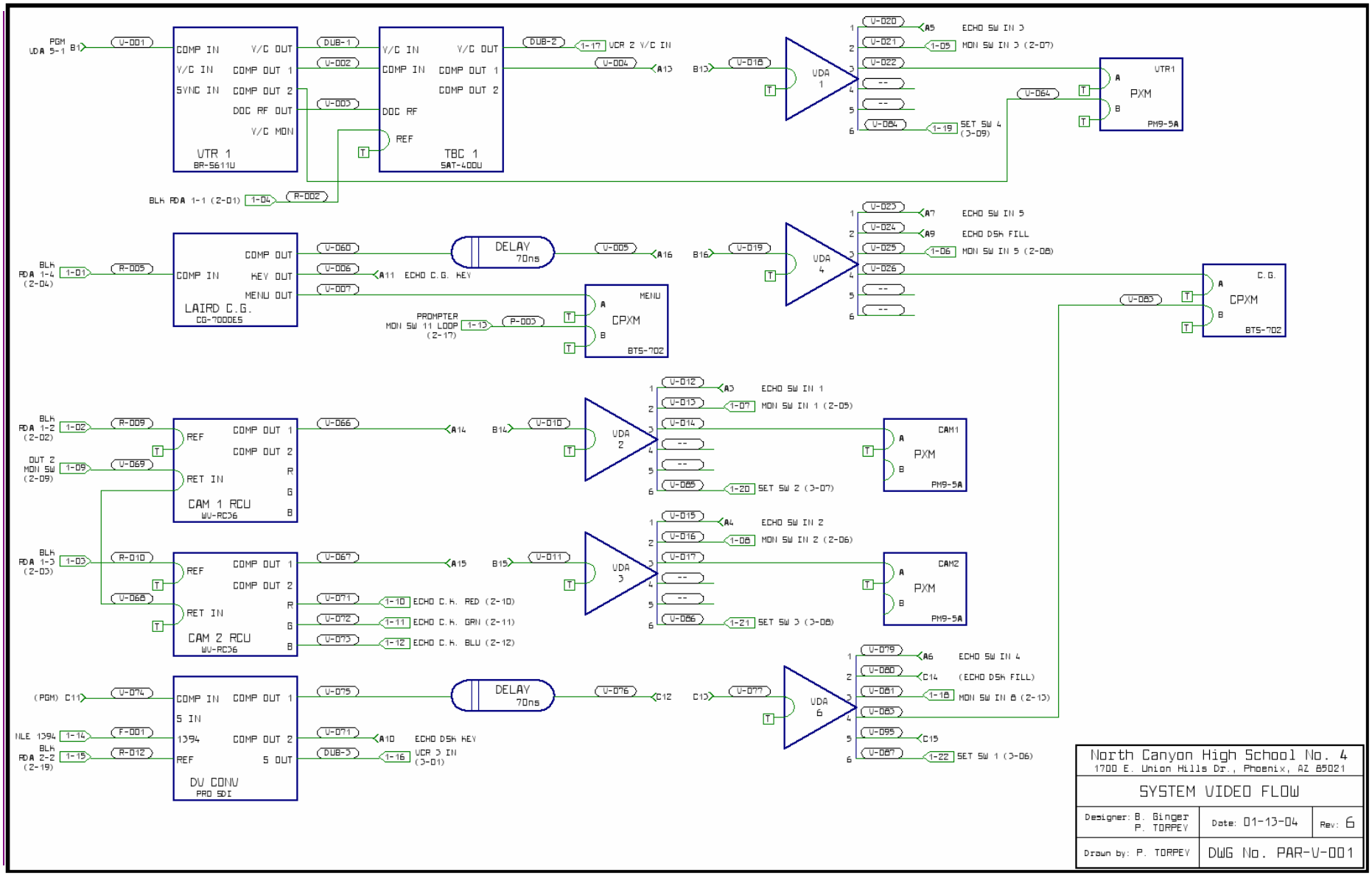
Using standard studio construction techniques, a simple and inexpensive yet professional-looking set can be built. A modular design allows the set to be assembled, disassembled, and reconfigured for the purposes of the production and other uses of the studio floor. A series of 4' × 8' flats form the basis of the set. Flats can be supported by stage jacks and sandbags. Also, flats should be joined with C-clamps for easy setup and striking. Other set pieces should include a news desk of sufficient size for at least two on-air talent and riser platform of approximately 4"to 6". Talent at the news desk should be seated on adjustable height stools or low-back armless office chairs. The set design should allow sufficient floor room for cameras, equipment, and personnel. A possible set design is illustrated in appendices **A2** and **A3**. Set construction can be accomplished as cooperative projects with students or faculty in North Canyon's woodworking lab or theater scene shop.

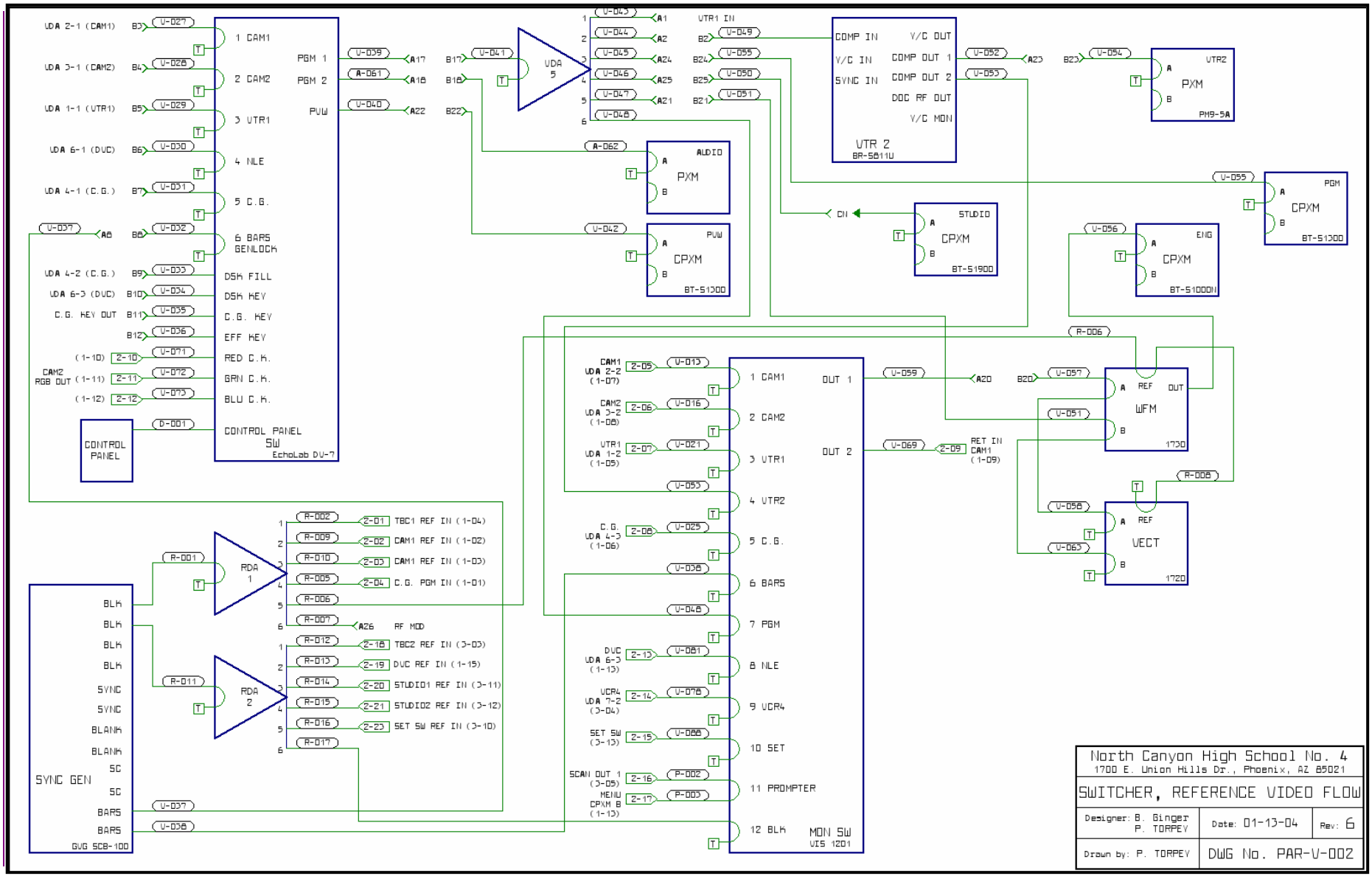
To add to the visual appeal of the set, on-set graphics may be displayed on video monitors or through a video projection unit (VPU). The schematic drawing PAR–V–003 Revision 6 in appendix **A1** indicates how video signals can be routed through a small switcher (such as the JVC KM1200 not currently in use) for display on-set. Video sources and monitors that will appear on-camera need to be synchronized to the system via RDA 2. VPUs typically are based on LCD display technology and, consequently, are not likely to require synchronization. A VPU should be selected that has sufficient brightness to read on-camera under set lighting conditions. Functions for color adjustment and projection geometry, such as keystoning, are necessary.

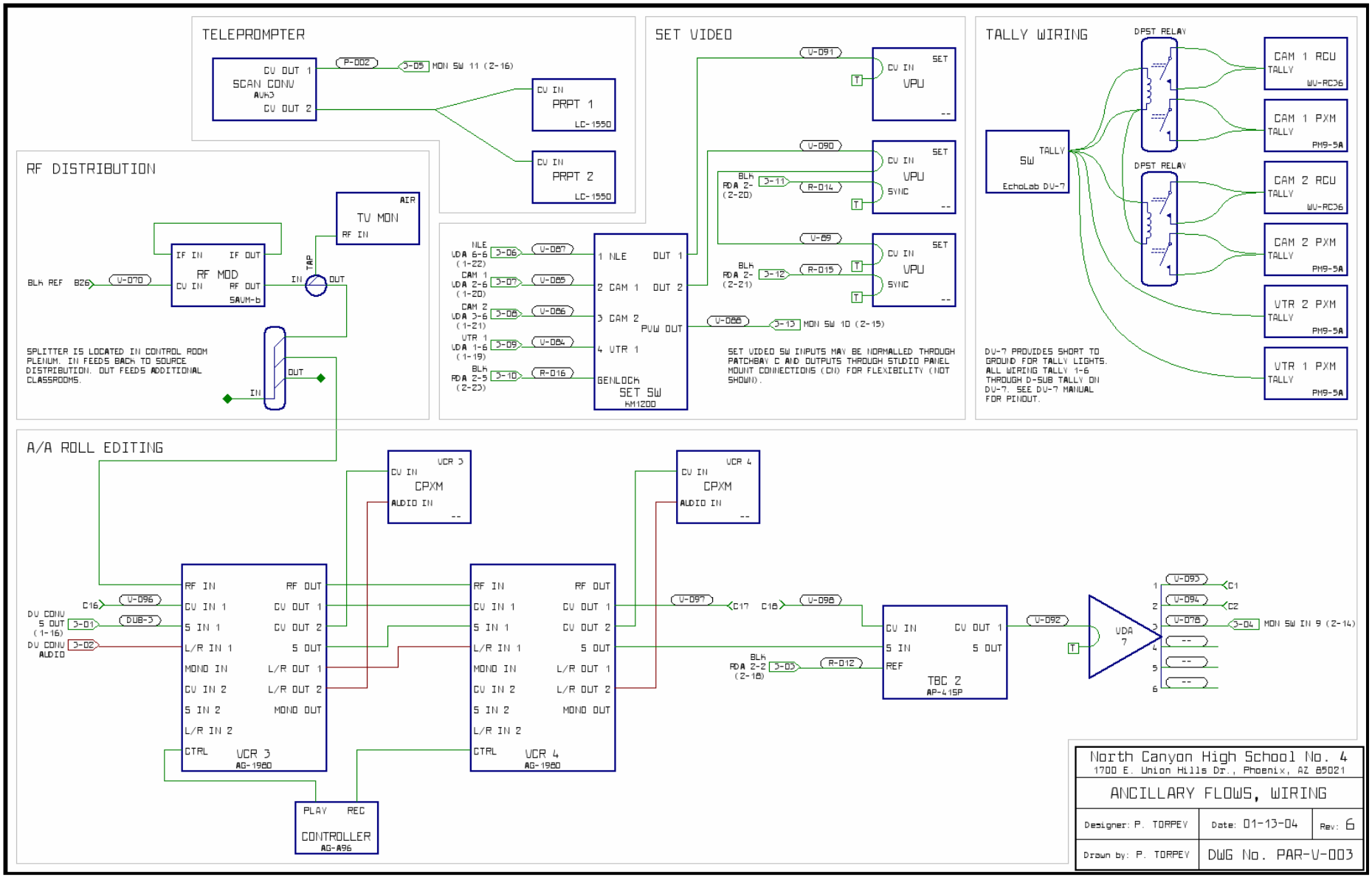
A1 UPGRADED SYSTEMS SCHEMATICS

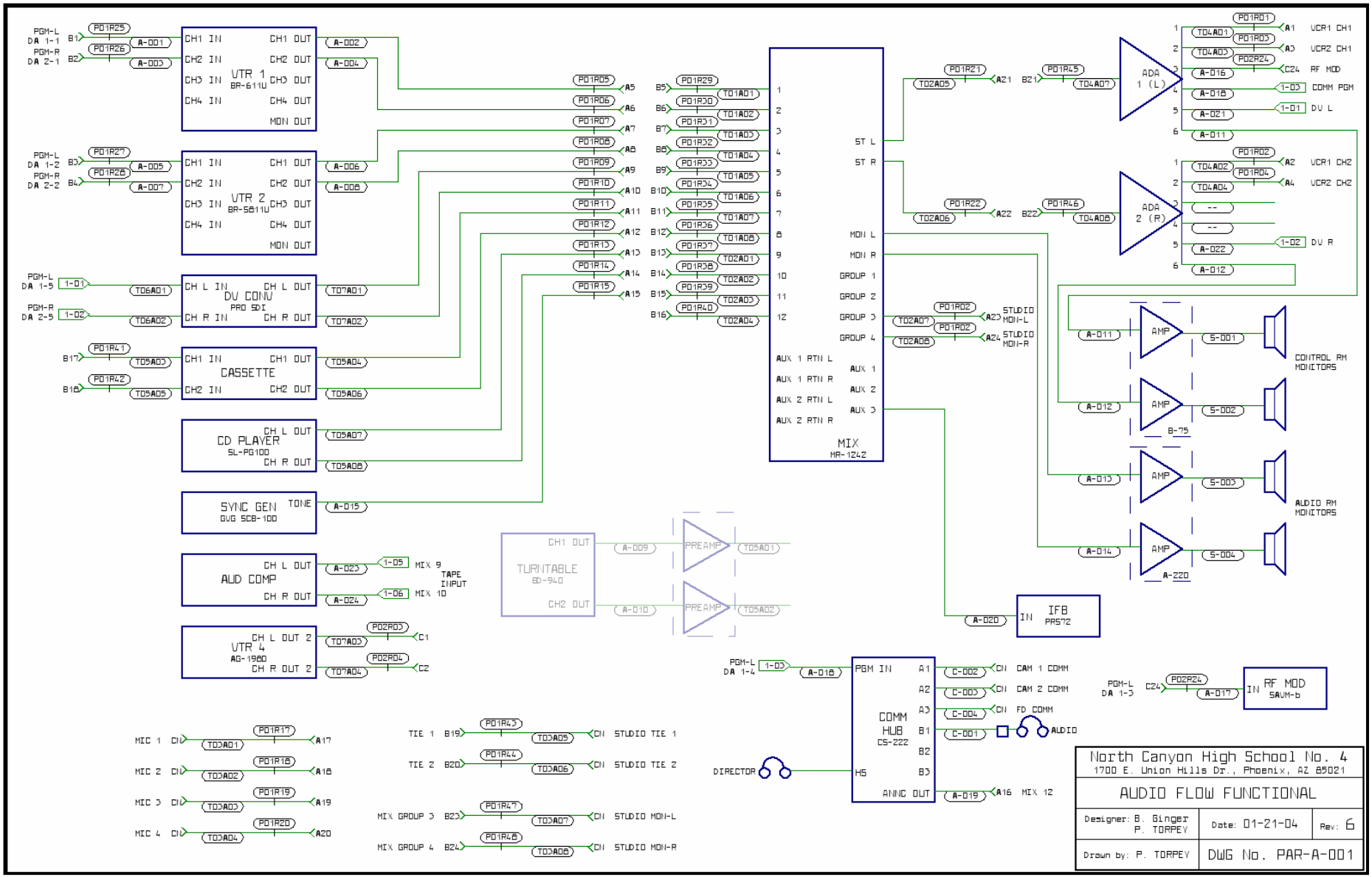
The following schematic drawings illustrate the connections of most studio equipment including the upgrades suggested in this proposal. These drawings constitute Revision 6 of the studio's design. They are based upon Revision 5, which represents the state of North Canyon's television studio as of 1998.

- **Drawing No. PAR–V–001**
  System Video Flow: Cameras, C.G., VTR 1, Digital Converter
- **Drawing No. PAR–V–002**
  Switcher, Reference Video Flow: Switchers, Reference, Monitors
- **Drawing No. PAR–V–003**
  Ancillary Flows: Teleprompters, A/A Roll Editing Station, On-Set Video, RF
- **Drawing No. PAR–A–001**
  Audio Flow Functional: Audio Devices, Mixer, Communications, Monitors


PGM
VDA 5-1 B1
V-001
COMP IN
Y/C IN
SYNC IN
Y/C OUT
COMP OUT 1
COMP OUT 2
DOC RF OUT
Y/C MON
VTR 1
BR-S611U
DUB-1
V-002
V-003
Y/C IN
COMP IN
DOC RF
REF
Y/C OUT
COMP OUT 1
COMP OUT 2
TBC 1
SAT-400U
DUB-2
1-17
VCR 2 Y/C IN
V-004
A13
B13
V-018
VDA 1
V-020
V-021
V-022
V-064
V-084
A5
ECHO SW IN 3
1-05
MON SW IN 3 (2-07)
1-19
SET SW 4 (3-09)
VTR1
PXM
PM9-5A
BLK RDA 1-1 (2-01)
1-04
R-002
BLK RDA 1-4 (2-04)
1-01
R-005
COMP IN
COMP OUT
KEY OUT
MENU OUT
LAIRD C.G.
CG-7000ES
V-060
V-006
V-007
DELAY 70ns
V-005
A16
A11
ECHO C.G. KEY
PROMPTER MON SW 11 LOOP (2-17)
1-13
P-003
MENU
CPXM
BTS-702
B16
V-019
VDA 4
V-023
V-024
V-025
V-026
A7
ECHO SW IN 5
A9
ECHO DSK FILL
1-06
MON SW IN 5 (2-08)
V-085
C.G.
CPXM
BTS-702
BLK RDA 1-2 (2-02)
1-02
R-009
DUT 2 MON SW (2-09)
1-09
V-069
REF
RET IN
COMP OUT 1
COMP OUT 2
R
G
B
CAM 1 RCU
WV-RC36
V-066
A14
B14
V-010
VDA 2
V-012
V-013
V-014
V-085
A3
ECHO SW IN 1
1-07
MON SW IN 1 (2-05)
1-20
SET SW 2 (3-07)
CAM1
PXM
PM9-5A
BLK RDA 1-3 (2-03)
1-03
R-010
V-068
REF
RET IN
COMP OUT 1
COMP OUT 2
R
G
B
CAM 2 RCU
WV-RC36
V-067
V-071
V-072
V-073
A15
B15
V-011
VDA 3
V-015
V-016
V-017
V-086
A4
ECHO SW IN 2
1-08
MON SW IN 2 (2-06)
1-21
SET SW 3 (3-08)
1-10
ECHO C.K. RED (2-10)
1-11
ECHO C.K. GRN (2-11)
1-12
ECHO C.K. BLU (2-12)
CAM2
PXM
PM9-5A
(PGM) C11
V-074
NLE 1394
1-14
F-001
BLK RDA 2-2 (2-19)
1-15
R-012
COMP IN
5 IN
1394
REF
COMP OUT 1
COMP OUT 2
5 OUT
DV CONV
PRO 5DI
V-075
V-077
A10
ECHO DSK KEY
DUB-3
1-16
VCR 3 IN (3-01)
DELAY 70ns
V-076
C12
C13
V-077
VDA 6
V-079
V-080
V-081
V-083
V-095
V-087
A6
ECHO SW IN 4
C14
(ECHO DSK FILL)
1-18
MON SW IN 6 (2-13)
C15
1-22
SET SW 1 (3-06)
North Canyon High School No. 4
1700 E. Union Hills Dr., Phoenix, AZ 85021
SYSTEM VIDEO FLOW
Designer: B. Ginger
P. TORPEY
Date: 01-13-04
Rev: 6
Drawn by: P. TORPEY
DWG No. PAR-V-001

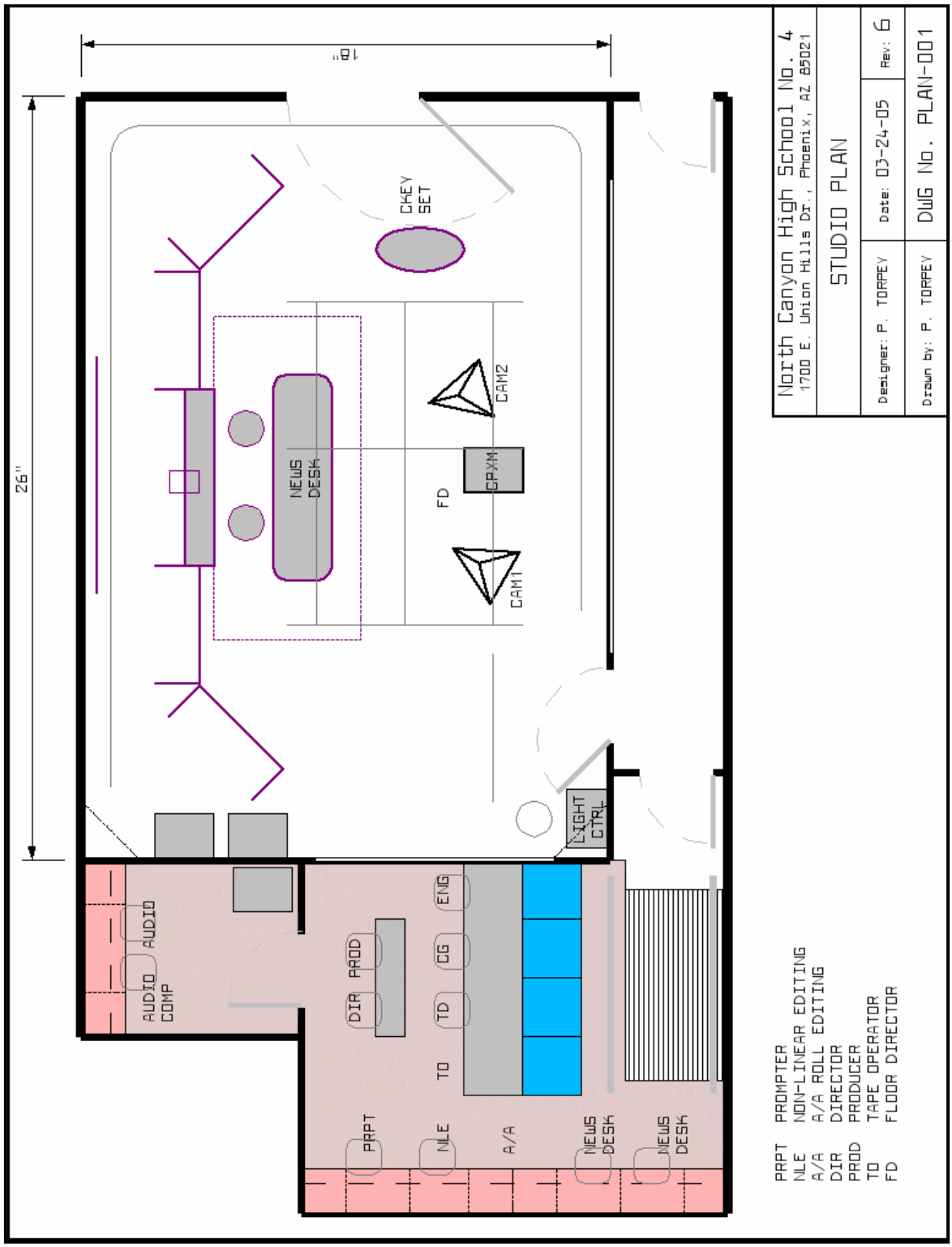

1 CAM1
2 CAM2
3 VTR1
4 NLE
5 C.G.
6 BARS GENLOCK
DSK FILL
DSK KEY
C.G. KEY
EFF KEY
RED C.K.
GRN C.K.
BLU C.K.
CONTROL PANEL SW
EchoLab DV-7
PGM 1
PGM 2
PVW
CONTROL PANEL
VDA 5
VDA 2-1 (CAM1)
VDA 3-1 (CAM2)
VDA 1-1 (VTR1)
VDA 6-1 (DVC)
VDA 4-1 (C.G.)
VDA 4-2 (C.G.)
VDA 6-3 (DVC)
C.G. KEY OUT
CAM2 RGB OUT (1-11)
(1-10)
(1-12)
VTR1 IN
COMP IN
Y/C IN
SYNC IN
Y/C OUT
COMP OUT 1
COMP OUT 2
DOC RF OUT
Y/C MON
VTR 2
BR-5811U
VTR2
PXM
PM9-5A
ALDIO
PXM
PVW
CPXM
BT-51300
STUDIO
CPXM
BT-51900
PGM
CPXM
BT-51300
ENG
CPXM
BT-51000N
WFM
1730
VECT
1720
REF
OUT
RET IN CAM1 (1-09)
RDA 1
RDA 2
TBC1 REF IN (1-04)
CAM1 REF IN (1-02)
CAM1 REF IN (1-03)
C.G. PGM IN (1-01)
RF MOD
TBC2 REF IN (3-03)
DVC REF IN (1-15)
STUDIO1 REF IN (3-11)
STUDIO2 REF IN (3-12)
SET SW REF IN (3-10)
SYNC GEN
BLK
SYNC
BLANK
SC
BARS
GVG SCB-100
CAM1 VDA 2-2 (1-07)
CAM2 VDA 3-2 (1-08)
VTR1 VDA 1-2 (1-05)
C.G. VDA 4-3 (1-06)
DVC VDA 6-3 (1-13)
VCR4 VDA 7-2 (3-04)
SET SW (3-13)
SCAN OUT 1 (3-05)
MENU CPXM B (1-13)
1 CAM1
2 CAM2
3 VTR1
4 VTR2
5 C.G.
6 BARS
7 PGM
8 NLE
9 VCR4
10 SET
11 PROMPTER
12 BLK
OUT 1
OUT 2
MON SW
VIS 1201
North Canyon High School No. 4
1700 E. Union Hills Dr., Phoenix, AZ 85021
SWITCHER, REFERENCE VIDEO FLOW
Designer: B. Ginger P. TORPEY
Date: 01-13-04
Rev: 6
Drawn by: P. TORPEY
DWG No. PAR-V-002


TELEPROMPTER
CV OUT 1
SCAN CONV
AVH3
CV OUT 2
P-002
J-05
MON SW 11 (2-16)
CV IN
PRPT 1
LC-1550
CV IN
PRPT 2
LC-1550
SET VIDEO
V-091
CV IN
SET
VPU
--
V-090
BLK
RDA 2-
(2-20)
J-11
R-014
SYNC
V-89
RDA 2-
(2-21)
J-12
R-015
V-088
J-13
MON SW 10 (2-15)
NLE
VDA 6-6
(1-22)
J-06
V-087
CAM 1
VDA 2-6
(1-20)
J-07
V-085
CAM 2
VDA 3-6
(1-21)
J-08
V-086
VTR 1
VDA 1-6
(1-19)
J-09
V-084
BLK
RDA 2-5
(2-23)
J-10
R-016
1 NLE
2 CAM 1
3 CAM 2
4 VTR 1
GENLOCK
OUT 1
OUT 2
PVW OUT
SET SW
KM1200
SET VIDEO SW INPUTS MAY BE NORMALLED THROUGH PATCHBAY C AND OUTPUTS THROUGH STUDIO PANEL MOUNT CONNECTIONS (CN) FOR FLEXIBILITY (NOT SHOWN).
TALLY WIRING
DPST RELAY
DPST RELAY
SW
TALLY
EchoLab DV-7
CAM 1 RCU
CAM 1 PXM
CAM 2 RCU
CAM 2 PXM
VTR 2 PXM
VTR 1 PXM
TALLY
WV-RC36
PM9-5A
DV-7 PROVIDES SHORT TO GROUND FOR TALLY LIGHTS. ALL WIRING TALLY 1-6 THROUGH D-SUB TALLY ON DV-7. SEE DV-7 MANUAL FOR PINOUT.
RF DISTRIBUTION
AIR
TV MON
RF IN
IF IN
IF OUT
RF MOD
CV IN
RF OUT
SAVM-b
BLK REF
B26
V-070
TAP
IN
OUT
SPLITTER IS LOCATED IN CONTROL ROOM PLENUM. IN FEEDS BACK TO SOURCE DISTRIBUTION. OUT FEEDS ADDITIONAL CLASSROOMS.
OUT
IN
A/A ROLL EDITING
VCR 3
CV IN
CPXM
AUDIO IN
--
VCR 4
CV IN
CPXM
AUDIO IN
--
C16
V-096
DV CONV
S OUT
(1-16)
J-01
DUB-3
DV CONV
AUDIO
J-02
RF IN
CV IN 1
S IN 1
L/R IN 1
MONO IN
CV IN 2
S IN 2
L/R IN 2
CTRL
RF OUT
CV OUT 1
CV OUT 2
S OUT
L/R OUT 1
L/R OUT 2
MONO OUT
VCR 3
AG-1980
VCR 4
AG-1980
V-097
C17
C18
V-098
BLK
RDA 2-2
(2-18)
J-03
R-012
CV IN
S IN
REF
CV OUT 1
S OUT
TBC 2
AP-415P
V-092
T
VDA
7
V-093
V-094
V-078
J-04
MON SW IN 9 (2-14)
C1
C2
PLAY
REC
CONTROLLER
AG-A96
North Canyon High School No. 4
1700 E. Union Hills Dr., Phoenix, AZ 85021
ANCILLARY FLOWS, WIRING
Designer: P. TORPEY
Date: 01-13-04
Rev: 6
Drawn by: P. TORPEY
DWG No. PAR-V-003


VTR 1
BR-5811U
VTR 2
BR-5811U
DV CONV
PRO 5DI
CASSETTE
CD PLAYER
SL-PG100
SYNC GEN
GVG SCB-100
AUD COMP
VTR 4
AG-1980
MIX
MR-1242
ADA
1 (L)
ADA
2 (R)
AMP
IFB
PR572
RF MOD
SAVM-b
TURNTABLE
BD-940
PREAMP
COMM
HUB
CS-222
North Canyon High School No. 4
1700 E. Union Hills Dr., Phoenix, AZ 85021
AUDIO FLOW FUNCTIONAL
Designer: B. Ginger
P. TORPEY
Date: 01-21-04
Rev: 6
Drawn by: P. TORPEY
DWG No. PAR-A-001

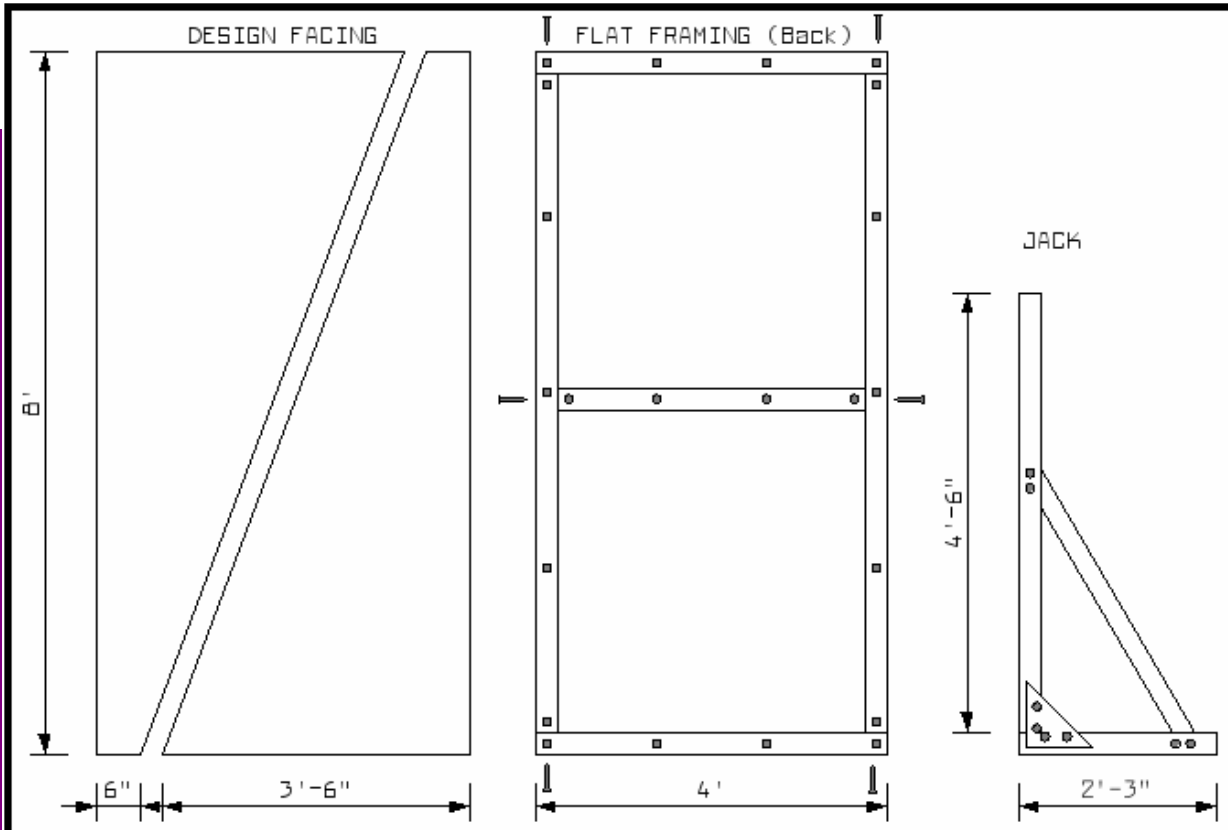
A2 SAMPLE STUDIO USAGE PLAN

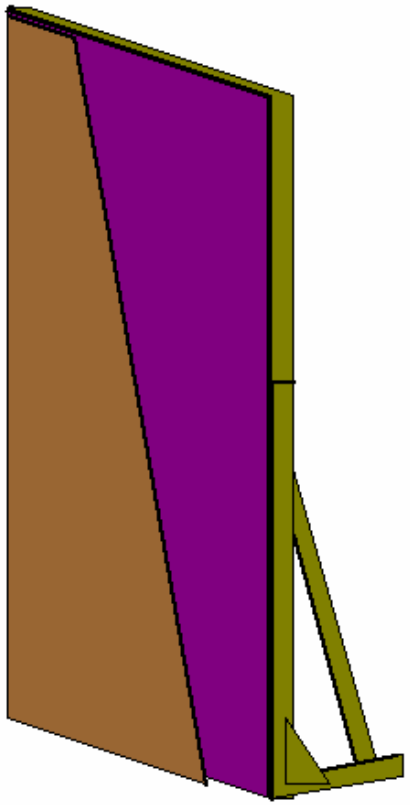
The following plan diagram indicates the physical location of some equipment and production positions including a suggested set configuration.



A3 SAMPLE STUDIO SET AND CONSTRUCTION

Three renderings are presented below that depict a simple hypothetical news set for North Canyon's studio. The set shown matches the configuration presented in **A2** and as outlined in **4.8 Physical Set**. The image of the school behind the news desk may be Duratrans or a projected graphic. A diagram detailing construction of a 'Hollywood flat' for use in the set follows.





FLATS:

Facing:
¼" 4'x8' Luan 1 + ½ ea.

All Framing:
1"x3" or 1"x4" B or C select
Rails:
4' 2 ea.
Stiles:
7'-10½" 2 ea.
Toggle:
3'-10½" 1 ea.

Screws:
Flat-Head Wood Screws
No. 8 1½" 34 ea.

DESIGN FACING may be adhered with wood glue and additional screws.

JACKS (2 per Flat):

Struts:
1"x3" or 1"x4" B or C select

Cornerblock:
9"x9" ¼" Plywood scrap

Screws:
FHWS No. 8. ¾" 8 ea.

FLATS are joined with each other and with JACKS using two 6" C-clamps.

JACKS should be sandbagged when in use.

North Canyon High School No. 4
1700 E. Union Hills Dr., Phoenix, AZ 85021

FLAT CONSTRUCTION

Designer: P. TORPEY	Date: 03-24-05	Rev: 6
Drawn by: P. TORPEY	DWG No. SETD-001	