KCSU: Going Digital
First Semester Report
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Abstract

The equipment in which Colorado State University’s student-run radio station, KCSU, relies on for its broadcasting is in great need of an upgrade. Most of the equipment used to run the station is terribly outdated, while the world of radio at large is rapidly moving to superior broadcasting technology. KCSU wants to upgrade much of their equipment in order to stand side-by-side with the rest of the industry.

As a senior design team within the department of Electrical and Computer Engineering at Colorado State University, we have reached the midway point in our collaboration with KCSU with the goal of laying out plans for the upgrade. This team has used a ‘divide and conquer’ approach to learning all about radio stations and selecting specific products to recommend to KCSU for purchase. That is, we distributed the tasks among team members, who then brought their results back to the team for group discussion and decision.

We have learned all about the inner workings of radio stations in general and the technology necessary for their operation. Using this knowledge, we have made an exhaustive recommendation of equipment for KCSU to purchase given budget and user constraints.
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Chapter I - Introduction

Colorado State University is the proud home to a student-run radio station that reaches over 250,000 people. Broadcasting at 10,000 watts, KCSU is one of the largest college radio stations in the country. One of the defining characteristics of KCSU is the huge variety of programming that the station produces. As a student-fee supported radio station, KCSU has a great deal of freedom in its programming. According to the station’s mission statement, “The music is selected to appeal to the 18-34 year-old audience interested in a daring, innovative, cutting-edge sound” (www.kcsufm.com). It is this radio station in which we have invested ourselves as design engineers.

Thousands of radio stations are now moving to higher-end, digitally-based systems as the core of their studios. This new technology is allowing these stations all over the world to provide listeners with clearer, more reliable sound; all while simplifying and optimizing the inner workings of the studios themselves. KCSU is certainly not one wanting to be left behind. Currently, the majority of KCSU’s in-studio equipment is horribly outdated. So in an effort to change this, the station’s Broadcast Operations Manager, Mario Caballero, requested that a team of electrical engineering students be formed to consult with KCSU with the goal of laying out plans to upgrade most of the equipment used in the studio. This is a report of this design team’s progress so far in collaborating with KCSU to accomplish this task.

The project is divided in two parts corresponding to the two semesters during which we will be engaged in it. During this, the first semester of the project, we have focused on the goal of selecting the proper equipment to purchase for the station’s upgrade.

This goal was reached by first setting ourselves to the task of learning as much as possible about the operation of radio stations in general and specifically KCSU. We immersed ourselves in radio news magazines and papers, perused hundreds of websites pertinent to the field and even shadowed a KCSU disc jockey, all in attempt to gain a deep understanding of the inner workings of this radio station. We did this because we understood, as a consulting design team, that we would only be able to effectively make decisions for the benefit of KCSU if we were expertly knowledgeable about the world of radio. Chapter III of this report provides more detail on our initial education of radio stations.

With our priority list in hand, it became our goal to actually go about selecting specific products to recommend for purchase by KCSU. The radio industry is flooded with products for every imaginable purpose. Due to the daunting nature of the task, we chose to split the project up into manageable sizes by assigning each member of the team one type of product at a time to research and then make a recommendation to the rest of the team as to which specific product to buy. Chapter II is a summary of each product chosen and our reasons for choosing it, specifically. This report is, therefore, a review of our steps during our first semester as a consulting design team for KCSU. Our mission is to aid KCSU in developing a plan for upgrading much of their equipment to current standards. Often, this means choosing devices that process signals digitally, rather than in the analog domain. We therefore declare that KCSU is “going digital”.

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Chapter II - How A Radio Station Works

At the beginning of our project, we were not completely sure how a radio station worked from the studio to the antenna onto our FM radio receivers. Mario Caballero gave us a lot of insight when he drew up a diagram (refer to appendix B) of all the interconnection components at the KCSU radio station. It was very helpful in showing how the components are connected together and how the radio signal is transmitted from beginning to end. There were many radio components that we were not aware of that existed in a radio station and how exactly each one functioned and connected with the other components. Even after extensive research on many of the radio components and knowledge of the interconnecting parts, we were still unclear as to how each component worked with the others. We were able to go on an educational trip to the radio antenna tower for KCSU and intimately see how the radio tower received and sent the radio signal. We were also privileged to visit another radio station, that already went digital, and gain a better understanding of how a radio station operates.

There are many elements involved in how a radio station functions. In regards to turning an outdated radio station into a digital radio station, our focus will be on how the components that make a radio station operate together. It begins at the audio console, where the DJ or automation system controls what goes into the audio console and what is sent out. The audio console is the heart of many input components, which includes microphones, telephones, automation software, CD players, a phone codec, and turntables. Once the audio console is set with the desired mix of the various outputs, the analog or digital signals are sent to the equipment rack. The signal is first sent through an emergency alert system which will cut off the signal if there is an emergency alert signal which can be triggered by various authorities. It is then passed to an audio cross point switch which determines if the signal should be sent to the main air room or to the production room. Next, the audio processor processes and cleans up the signal to protect from over modulation that would damage the studio to transmitter link (STL). Note that the STL is used only when the transmitter for the station is not located at the station. STL is a way to get the signal out to the transmitter. The STL transmitter’s hardware takes the signal and modulates it, to ~950 MHz in many cases, and then sends it to the STL antenna which sends the microwave signal to the receiving antenna at the large radio transmitter site. The STL antenna focuses the signal in one direction only, pointing it directly to the receiver. The STL receiver then picks up this signal and sends it to an audio processor which makes the signal stereo and determines the equalization which is specified by the user inputs of the audio processor. The signal is then passed to an FM exciter which amplifies the signal. Next, the FM transmitter modulates the signal to the appropriate frequency for listeners to dial in on their receivers. The FM transmitter takes this signal and sends it through the transmission line to the radio antenna. Different radio stations have different effective radiated power. KCSU’s antenna broadcasts at 10kW of effective radiated power. This effective radiated power makes KCSU’s radio signal available to all of Fort Collins and many surrounding areas. Residents who have a working FM radio receiver are able to hear all of KCSU’s great entertainment and sporting event coverage at 90.5MHz.
Chapter III - Initial Education

The implementation of the KCSU project for moving from analog to digital involves both an educational background and personal efforts of our group. This education can be explained by the allocation of resources such as web, vendors, catalogs etc., visiting radio stations and transmission sites, and the use of our educational background. As of personal efforts, we’re talking about the time and dedication we put into work.

On August 27, we had our first meeting with the KSCU Operations Manager, Mario Caballaro, to talk about the possible ways of implementing the KCSU project. From Mario’s input and needs, we gained an idea of how we were going to approach this work. We requested the block diagram of the current radio station (Appendix II). After that, we had a group meeting to discuss the related issues, how to start it, and what to do next. We decided to start doing some research on the internet about digital equipment for a radio station, to learn how they work, and how beneficial they can be for the radio station. Not only did we search on the internet, but we also extended research to catalog reading and calling vendors of different brands.

This work was reported weekly in our meetings and the personal work was shared among us. The need for that was to get an insight of all the components before we started thinking about the appropriate devices and the costs related. This was also a learning tool for all of us because we were able to exchange ideas and improve our work plan. Along with these works, we sometimes met with Mario to talk about the progress and clarify some needs.

All of this work could not be done without some schooling background. Going through some device specifications, we have to be able to understand some technical terms used such as voltage, current, power, decibels etc. Understanding these was very important to determine the difference between the analog and digital devices. An example was to determine the negative decibel number that an analog device takes versus digital to perform some functions.

In addition, we had consulted with an expert and also visited sites such as radio stations and a transmission site. On October 8th, we went to visit the KCSU transmission site. This trip was made by our senior design group, our advisor Dr. Rockey Luo, and Mario. On site we learned how the transmitter processes signals, how it is set up, and how much power it takes to process the signals.

On October 29th, we made a visit to KUNC in Greeley. There, we met with Larry Selzle, the broadcast engineer, who gave us a tour of the radio station and explained how it operates. Larry was able to answer all of our questions related to the conversion to a digital radio station. It was a very satisfactory visit because we learned man new things that we didn’t know. Some examples were the soundproofing of the production room and some thought on touch screens and that they are limited in functionality and therefore not recommended.

This educational background gave us insight on how we were going to implement this project. Moreover, time efforts and dedication were also key to come to the end of this project. The weekly searches and meetings exemplified our overall dedication to this work.
Chapter IV – Components

4.1 Audio Consoles

The heart of a radio studio is the audio console. This is where most manipulating and mixing between various devices occurs. An audio console is in a sense a glorified keyboard that is capable of managing various inputs and sending them out to the transmitter as one mix. A few of the different components that plug into the audio console include CD players, phone hybrids, microphones, automation equipment, and turntables. An audio console is the device that has multiple faders; this is how most people think of it.

The current equipment is very old, nearly ten years. As part of ‘going digital’, this is a big piece to upgrade because even if all the equipment is digital but the audio console is analog, there is a loss of signal that occurs that could be avoided otherwise. The console used currently in both studios is the Airwave 12. It has been a very reliable board and will be upgraded because of its age and because it is analog. The upgrade of this equipment is one of the most important upgrades we are recommending and for that reason has received considerable thought and research.

We started out by narrowing down a list of audio console companies that we found in a Radioworld magazine. We decided on four companies to strongly consider: Wheatstone, Harris, Axia, and SAS. A few of the big guiding principles we followed were quality and strength of brand name, simplicity of the console, and ease of installation. It was important that the console not be too complicated as new DJ’s are added yearly and it is important to have a setup that offers valuable experience to persons that has little or no radio experience. We called and emailed several of these companies and pursued quotes on different system topologies offered. We decided to go with Wheatstone and the Esquared system topology. The Wheatstone boards are very simple to use and yet very powerful. The Evolution series boards are fully digital and able to accept both audio and digital inputs via the various modules that are connected to the board using a network switch.

4.2 - Audio Processors

An audio processor is a rack-mounted piece of equipment which takes an incoming signal and optimizes it according to the user’s specifications. Normal radio stations (KSCU included) have two audio processors between the DJ room and the antenna. The first of these in the chain has a very simple purpose: to perform automatic gain control and limiting in order to protect the STL line (microwave transmitter) from receiving a signal which might damage it. The automatic gain control also serves to make the quiet parts of the program louder and vice versa, thus regulating the overall volume of the signal.

The second processor lives out at the transmitter site near the Foothills campus, this processor serves as the final step in signal processing prior to broadcasting. This processor performs the final EQ, compression, and other DSP actions to make the signal sound as ‘good’ as possible before it is sent to the air. Of course, ‘good’ is a subjective concept to be determined by the user.
KCSU’s transmitter site processor is an Orban Optimod FM 8400 which we determined, along with the advice of Mario, was still new enough to not need replacement. Buying a new processor for the transmitter site would cost about $9,000, an expense that we felt would be wise to not pursue since the current transmitter site processor is not actually outdated. In essence KCSU would be paying a lot of money for a product that has hardly any advantage over the current one.

However, the current studio-side processor, an Orban Optimod 8200, is quite old and does need to be replaced. Our research led us to choose to replace this processor with an Omnia One processor. A phone conversation with a representative from Omnia revealed that the Omnia One is Omnia’s highest selling audio processor. It is popular for its small size, but still has lots of processing power. The other product we considered was the Orban Optimod 6300, which has comparable features for our purposes, but costs nearly twice as much.

4.3 - FM monitors

An FM monitor is used to allow the DJ and other station staff to keep track of the quality of the signal coming off the air. The unit will allow for the user to monitor the accuracy of the frequency modulation visually in real time as well as provide audio outputs to send to studio monitors for listening to the audible signal.

This is a rather small product field in that there is simply not very many companies that make products for this purpose, so selection was rather easy. The Inovonics Model 531 was selected for its small size, modern design and use of LED indicator lights, which are easier to read than quickly bouncing needles. This FM monitor unit has more features than we feel that KCSU needs (like the ability to easily monitor several competitor radio stations as well), but other products with fewer features were still similarly priced, or even higher.

4.4 - ISDN

Integrated Services Digital Network (ISDN) started with using the analog cable by dividing it to two windows to send two signals in the same time without interference between the signals for quality service. However, in the meantime we are using a special cable for ISDN for adding more specification and complexity for better convenient. In this way we are capable of sending back and forth more than two signals gives us higher time efficiency for exuding multiple task simultaneously. Also, keep in mind that we are using digital signal which has a higher efficiency in communication than analog signals. In the case here, we are minimizing the interference between the signals due to the sending of multiple signals at the same time but we can still detect digital signals with less probability errors than analog signals.

In more detail, ISDN works like a switched end-to-end that transmits voice, data, and video simultaneously. By using the duplex digital channel, one can use 128 to 512 kbps for high speed data applications for personal use which is refered to as Basic Rate Interface (BRI). On the other hand, you can use 23 channels to provide 1544kbps for business use which is refered to as Primary Rate Interface (PRI).
Since ISDN is used for the transmission of the digitization signal over a telephone network, it has a lot of applications and configurations. Here we are concerned about how ISDN has been used in broadcasting. First, the service is provided from a phone company and the ISDN machines are in the end-to-end digital network. ISDN is one way of interviewing outside of the studio as in sports events. The announcer at the offsite location has one end and the studio has the other end. The ISDN machine has an input which can be set in two modes, microphone or line mode. The ISDN device takes the input and codes it to send it through a phone line to the studio and from the studio to the offsite location. However, in the studio the interviewer can equalize the levels of the input. The signal can then be broadcasted to the radio. This way we get a fraction of a delay which is acceptable in broadcasting. Also, in the studio we can modify the signal if we connect the output of the ISDN to the audio console which is always the case.

Looking through the feature we gain from using ISDN makes it an important element for broadcasting and as a back up plan for a radio station. However, in our case, the ISDN we have in KCSU is four years old and is still current technology. Also, the ones in the market do not have significant features we need in addition to what we already have. We were directed by Mario that we would not update the ISDN so this is not included in the budget although we have learned about it and researched it.

4.5 - Microphones

In the wide world of audio, a quality microphone is a product that tends not to become outdated. For example, the industry standard vocal microphone for live rock and roll music is the Shure SM58. This microphone was first adopted by musicians in 1966 and has been the most popular vocal microphone in the world ever since. We approached this part of the project bearing this in mind.

Currently, KCSU uses one EV RE20 in each studio for the DJ to speak into and three EV RE27 microphones in each studio for potential interviewees. The RE20 is, arguably, a superior microphone to the RE27. Through the instruction of Mario, we’ve decided to buy a total of six RE20 microphones to replace the RE27s in both studios, thus making all the microphones in both studios RE20s.

4.6 - Phone Hybrid

The Telephone hybrid (sometimes called a Telephone Balance Unit) is a relatively simple electronic device used to connect a telephone line to the studio audio circuit. These are normally used in a radio station to connect callers into the air chain so that conversation may be broadcast.

In a communication system, the volume difference between a caller and receiver or a person trying to record a conversation was a concern that spurred the invention of the phone hybrid. It was first an analog phone hybrid, which has a built in capability to cancel out the volume
difference and provide a desired sound. This amount of reduction was measured in decibels (www.audiotheater.com).

The analog hybrid has some limitations because it cannot cancel out the entire sender’s audio. For this reason, engineers thought of a better way of solving this problem. Hence, the design of sophisticated Digital phone hybrid came to be that nearly cancels out the entire sender’s audio. KCSU, is currently using an analog hybrid, but due to this device limitation in its function, Mario Caballaro, KCSU manager is requesting to switch to a digital hybrid.

4.7 - RDS

Definition: RDS is a radio data system that displays song and audio information on an LCD screen to listeners. This message includes song title and artist information typically but may extend to whatever a DJ wishes. The RDS 730 is the model that we proposed to KCSU. It will easily interface through USB to one of the computers in the studio and allow KCSU to output data to equipped radios, an ability not currently available to the station.

4.8 - Software

The major pieces of software that are used are Adobe Audition, Broadcast Electronics Vault Express, Audacity, and RCS Linker and Selector. While most of the radio station can be operated without any computers, the benefit of these programs is largely for automation and also for editing and mixing sound clips and interviews. Let's take a look at what each piece of software does and then from there we will discuss the options and proposed updates we will make.

4.8.1 - Adobe Audition

Adobe Audition is a powerful audio manipulation software. It can be used for recording, mixing, editing, and mastering. This is the most used tools to edit audio at KCSU. About every option one would think of to do with audio clips can be done with this program. Multiple tracks can be used. Each track can be equalized. There are options to add in certain sound effects and digital musical instruments. A common occurrence is to record an interview and then use this program to edit the interview and add in a background track. KCSU also does small commercials to advertise certain events and businesses. This program would be used to create those commercials. The program can be used to batch process or to manipulate multiple files in the same way. It can also be used to slow down or speed up audio.

Currently KCSU has a license for version 2.0. We are proposing an upgrade to version 3.0. This would provide the newest features as well as the latest software support and patches to ensure reliability and maximize productivity.
4.8.2 - Broadcast Electonics Vault Express

This is the automation software that is used. While KCSU does not do as much automation as most radio stations, it still takes advantage of this tool to be able to arrange a playlist of songs and audio clips. Automation software is used to configure exactly how a radio show will go and is able to be executed automatically at a later time. This is especially convenient to be able to have a radio broadcast throughout the night while the DJ can be out of the studio. This software takes a text file and from there goes to the database of audio and constructs a playlist as dictated by the DJ.

After a discussion with a representative from Broadcast Electronics we determined that we do not have the newest version but the company will provide free updates. As all of the equipment updates take place the update to the newest version of Vault Express will also take place.

4.8.3 – Audacity

This is a piece of free software that is similar to Adobe Audition but with fewer features. It can be used to manipulate audio and add together tracks and make equalization adjustments. The newest version of the software will be installed.

4.8.4 - RCS Linker and Selector

Selector is a music scheduling program. It can be used to rip songs, or convert them into a format that allows them to be stored on a hard drive rather than on a CD. This is beneficial because a database can be created to store all of the music and is used with the automation software. It would not be possible to do the automation without this ability, to rip songs onto a hard drive. Selector is used to quickly browse the database of audio. It is also very powerful in that it helps in orchestrating song order based on the length of different audio clips and songs.

Linker is a scheduler. It is used for scheduling non-music files such as jingles, promos, and public service announcements. It works along with Selector.

The radio station will continue to use this software. We will recommend that the newest updates of the software be installed upon installation of the new hardware.

4.9 - STL

Some radio stations that have an antenna in place physically do not have to transmit the signal to an offsite location. The signal can be send through a cable to the antenna. However, for the radio stations that have their antenna far away from the studio they need to transmit their signal to the antenna which is typically located at a better location. One way to send the signal is using studio to transmitter link (STL) system. This system takes the signal as either analog or digital and equalizes it and sends it to a relatively small antenna that shoots a microwave signal straight to the antenna. It can transmit the signal from few miles to hundreds of miles.
In the case we have at KCSU the STL transmitter is used to shoot the signal straight to the antenna at Horsetooth Mountain. KCSU is using the Harris STL transmitter that takes the signal and samples it at frequency 44.1 KHz and transmits it with a frequency of 950MHz to the antenna. Also, we have another STL receiver at the antenna site that demodulates the signal to be processed to send it through the main antenna.

After talking to Mario and considering the research that we did in the STL transmitter we found that the STL receiver is still fairly new and the ones in the market for the transmitter and the receiver do not have many features that we need in our radio station. Also, due to the higher cost for it we agreed with Mario to not buy a new one. (some information provided from nicomusa.com)

4.10 - Studio Monitors

The world of studio monitors is a difficult one to wade through due to the massive number of different products available. Currently, KCSU uses a pair of JBL 4410a speakers (8-ohms, 10 inch woofer, 100 watts max output) mounted in each studio powered by an EV7100 amplifier. The amplifier provides these speakers with 75 watts per channel.

In choosing a replacement for these we first decided to go with a self-powered set of monitors, thus eliminating the need for an external amplifier. Another advantage of self-powered monitors is that the amplifier is engineered to the exact specifications of the speaker it will be driving. That is, the amplifier and speaker are perfectly matched together. Ideally, we would also like to choose monitors with a woofer at least 8 inches in diameter to aid in reproducing low frequencies.

Those above constraints help to narrow the field of products significantly. After this narrowing, we selected products based on popularity ratings from other users, and company reputation.

Our primary selection is the Yamaha HS80M, biamplified for a total of 120 watts per speaker, each with an 8 inch woofer. They also have room control EQ switches on the rear panel. These are sold for $350 each for a total of $1400 for four (two per studio).

Our backup choice if the budget becomes tight is the M-Audio Studiophile BX8a, also biamplified for a total of 130 watts per speaker, and also with an 8 inch woofer. These are sold for $500 per pair for a total of $1000.

Chapter V - Future Expansions

As the project goes for next semester, one of the future plans is redesign the broadcast rooms to use the area more effectively. Also, that would include purchasing new furniture or modifying the one we have in the studio. Also wiring is one of the tasks we have for next semester. The wiring we have in KCSU new is done in the old fashion way, through the walls and behind the tables. We will try to lay the wires in nice, neat way so it looks more professional and easy to
maintain. Moreover, after we decided what we are going to have to upgrade, next semester we are going to find how these equipment works together. It may need extra devices to change the frequency or to block some frequency, for example, due to the component input requirement but it does not do it by itself. Also, it can be just software that interfaces between two devices or between the device and the user.

So far our situation as we can see that we came with two plans. Most likely due to the budget constrains, KCSU will go with the lower budget. In the future, the expectation for KCSU is fulfill the needs for the modern FM radio station. In the mean budget, we left what we are not going to change now to be in the future plans. These plans include the big components that still fairly new and the small components that do not affect much in the meantime. Big components include changing the antenna place because now it consumes 10K Watts for transmitting the signal. We may need to change its position to be higher in Horsetooth Mountain to reduce the power consumption to nearly 1.5K Watts. Also, considering the development in building in Fort Collins we may not have the direct path for the signal from Lorry Student Center to the current antenna which is going to make it hard for the signal to reach to antenna. We need to look more for the cost and the appropriate place for the new antenna. Also, the signal processor is expensive and fairly new component that we may consider to change after few years. STL transmitting system, changing the desktop to Mac desktop are some of the components left for KCSU future plans to consider for change.

Chapter VI – Conclusion

The goal of this semester was to have two proposals for Mario about the proper equipment to purchase for the radio station in order for it to go digital. Finding the right equipment was the challenging part. We decided to divide the project into portions and collaborate on each one of our findings.

As the project started we weren’t sure of where to begin our research. We gathered some radio magazines to read and shared them with each other and discussed our findings. We learned how current technology and future technology was playing their part in today’s current radio stations across the world. We used this information to get an insight on how much we would want to change KCSU. After meeting with Mario a couple of times, Mario discussed with us what he wanted to do with the radio station and what he was expecting from us. After the radio equipment was distributed to each team member to research, we were all still a little confused about how a radio station actually operated. We had a couple of opportunities to visit the radio antenna tower and another local radio station KUNC, to visually see what was going on. The trip to KUNC helped us a lot in our understanding of how a radio station goes digital because KUNC had recently switched to digital and was already broadcasting in High Definition (HD).

After getting a solid foundation on how a radio station works, we decided on the crucial radio equipment that we had to replace and which ones would still be able to operate digitally without being replaced. After researching even further into the radio equipment, we started to select multiple manufacturers and models to compare. We had to decide which brands and models were going to best fit the needs of a student run radio station. Many factors came into play, as we had a certain budget to keep in mind. A large amount of time was spent in deciding the
brands and models because we could only discuss a few of the components at a time. After many group discussions, we were able to come up with two well thought out equipment proposals for Mario. He has yet to decide on the one that will best fit his needs, but we are positive that both of our proposals are what he is looking for.

Appendix A – Abbreviations
CD – Compact Disc
DSP – Digital Signal Processing
DJ – Disc Jockey
EQ - Equalization
FM – Frequency Modulated
HD – High Definition
ISDN – Integrated Services Digital Network
KBPS – Kilobytes Per Second
KCSU – The ‘K’ is an FCC standard denoting that the station is west of the Mississippi River and ‘CSU’ stands for Colorado State University
KHz - Kilohertz
KUNC – Definition of K defined in above KCSU entry. UNC means University of Northern Colorado.
LCD – Liquid Crystal Display
LED – Light Emitting Diode
MHz – Megahertz
RDS – Radio Data System
STL – Studio to Transmitter Link
Appendix B – Budget

Proposed Plans for KCSU

Budget from the department of Electrical and Computer Engineering:
We did not use any of our allotted $250 for the semester. We have no prototypes or expenses that would elicit any purchases.
Appendix C – Flow Chart

[Diagram showing connections and components like Mic processors, Airwave 12 audio console, VaultXpress automation PC, DJ pc with Adobe Audition, Denon CD player 1, Denon CD player 2, Denon CD player 3, Comrex Vector Phone codec, Talkback, Turntable 1, Turntable 2, BTS intercom mic, Connecting punch blocks under the desk, and Connecting punch blocks in the wall next to the equipment rack.]

KCSU Control Room Drawing #1 Sept 2008
KCSJ Transmitter

In from STL antenna on tower microwave 950 MHz from studio at LSC

Harris CD Link STL receiver

Orban Optimod 8400 Audio Processor

Harris FM Exciter
Harris 5kW FM Transmitter

Transmission line

4 bay antenna to create 10kW Effective Radiated Power

FM radio receivers tuned to 90.5