

The Modern Music Library



WPI



The Modern Music Library

An Interactive Qualifying Project Report
Submitted to the faculty of
WORCESTER POLYTECHNIC INSTITUTE
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in cooperation with WICN

by
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Abstract

The Modern Music Library IQP was completed in collaboration with WICN in order to assess the state of physical music library digitization and its practical implementations with a principal focus on the primary users of radio station libraries: DJs. In order to properly make recommendations to WICN, the investigator researched the processes of digitization, the workflows of DJs at WICN, and DJ software. Recommendations were made to WICN regarding digitization solutions along with specific software selections.

Acknowledgements

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Thank you to the WICN hosts for graciously allowing the investigator to observe their processes and to ask for their feedback.

Executive Summary

WICN (Worcester Intercollegiate College Network) is a Worcester radio station which plays ‘Jazz+’ music. This project was created with the intent to recommend digitization methods and post digitization software implementations and exists as a continuation of a previous IQP, “Updating and Modernizing WICN’s Music Library” (UMWML).

Project Focus and Objectives

The focus of this IQP is the digitization of a large music library and the development of practical applications for the DJs who utilize it. To accomplish this, three objectives were selected: (1) assess the current state of DJ’s workflows to address areas for improvement by discovering the inefficiencies in DJ’s workflows and determining what DJs could do with more information such as their habits or song metadata, (2) determine the optimal front-end interface to satisfy those needs by investigating the criteria which define the optimal software interface, and (3) develop a plan for the conversion and storage of large amounts of music of varying media formats by determining the process of converting music from physical to digital, the creation of a database and back-end, and how to synergize the database and the software.

Background

Radio has existed as a popular form of media for the past century, but in the digital age, radio stations must digitize to remain relevant. Radio station WICN has remained relevant through its commitment to the culture and arts of Worcester and the hosts who many listeners have grown fond of. Despite this, the large physical music library of WICN, consisting of five to ten thousand CDs and three to five thousand Vinyl records, requires digitization to remain functional and persistent. Though, when it comes to digitization, the pros and cons must be evaluated. The benefits of digitization include the preservation of resources and improved access of resources. The disadvantages of digitization include cost, time, and staff, as all three are required. Once the benefits and disadvantages have been considered, the process of digitization must be selected. There exist several options, including: manual CD ripping, automated manual CD ripping, and external CD ripping. Once the media has been digitized, it must be stored somewhere and somehow. For the how of storage, the question of which file format to choose arises. There exist lossy (i.e. MP3) and lossless (i.e. WAV) file formats. Lossless file formats are ideal for preserving the quality of music. The file format should support metadata, which holds the information relevant to songs, should that be desirable. After selecting a file format, the question of where it will be stored arises. The storage solution options include: hard drives, NAS (network attached storage), and cloud storage. The benefit of hard drives is that they are cheap, the benefit of NAS is that it is available over the local network, and the benefit of cloud is that it is available anywhere with an internet connection. Once the music is digitized and stored, the focus turns to

the disc jockey (DJ); the primary user of the library. DJs serve an important role as they are responsible for music selection and live commentary, which are the parts that listeners can observe. Therefore, it is important that DJs are given the optimal DJ software to aid them in their job. In terms of software, WICN would like specific features, including: remote access, spanish support, and Spinitron support.

Methodology

To investigate the questions laid out in the background (the objectives), two research methodologies were selected: participant observation and survey. Participant observation was selected due to the proximity and personal nature of that type of research, which would allow the investigator to gain an in depth understanding of the current state of DJ's workflows. An alternative research method considered was survey but it was found to be too impersonal and it could lack specific details which can only be gained through observation. Survey research was selected to investigate DJ software and interfaces as it allows for easy collection of responses to simple questions surrounding hosts' opinions on the interfaces shown. Alternative research methods considered were case study and focus group research. These methodologies were not selected due to scheduling conflicts due to the fact that the majority of WICN hosts are volunteers with jobs in addition to DJing and lack of time and funding.

Participant Observation and Survey

To accomplish the participant observation, three WICN hosts were selected by general manager David Ginsburg to ensure diverse and efficient results. Over the span of the week, the hosts were observed over two one-hour sessions (save for the last host who was observed once due to the wealth of information previously gained and lack of time) and consensually (Appendix A) recorded. Hosts were given a list of questions (Appendix B) at the start of each session which were answered throughout the course of the session.

To accomplish the survey, a list of several software options was amassed through research and five software options were selected. Only five options were selected to ensure the survey was not too long to encourage completion of the survey. Using screenshots of the software options (Appendix C) and the prepared list of questions (Appendix B), a survey was created. The survey was then sent to Mr. Ginsburg to be distributed to the WICN hosts.

Music Conversion and Storage Research

Separate from the DJ research was the research for music conversion and storage. To accomplish this Mr. Ginsburg was consulted to determine criteria for researching: cost, storage medium, and format. This criteria, in combination with the research completed in UMWML was considered when performing in depth online research.

Results

To understand the DJ's job, one must first know the tools that they use to do their job (Figure 2).

DJ Workflow

When observing the WICN hosts, the process of DJing became clear. The process can be split up into five categories: music selection, music playback, music logging, spot playback, and live commentary. The hosts observed added comments on the topic of digitization: they would like to be able to sort a digital library similarly to the hierarchy of CDs, by track time, and by genre. One host commented on the importance of song information being included in the software. Music selection is comprised of the time spent searching for and selecting songs. When selecting songs, some hosts prefer to plan out their music in advance while others do not. The hosts also noted complications with CDs, namely that they may be misplaced, disorganized, rearranged, or damaged. Once a host selects a song, they must queue it via CD player, Vinyl player, or computer. Several issues arise when attempting to queue songs. For example, when attempting to queue songs via the CD player, it is often difficult to know which CD is in which slot and which song is selected due to the minimal interface of the device (Figure 3). Once the host has queued a song, they can make the transition by manually crossfading songs with the mixer (Figure 4). Music logging currently exists as the largest hindrance for the hosts at WICN. The current system utilizes Spintron, which stores their playlist information. Each host has their own Spintron account and can access and view the radio station's entire playlist. Hosts noted the tedious nature of logging songs into Spintron and the complications which may arise as Spintron suggests songs they may be attempting to enter which takes further time from the DJs. The DJs noted they would like to spend less time logging to Spintron. Spot playback consists of the advertisements, prerecorded messages, and assorted audio clips which hosts may have to play during their session. WICN has a timetable set for hosts to play certain messages, such as an advertisement from a recurring sponsor. AudioVault is the current software used for the storage and playback of spots. Arguably the other most important category, along with music selection, live commentary consists of the time hosts spend speaking to the audience. Hosts consistently communicate the weather, the radio ID, and song information. They may also choose to interject commentary of other kinds as they see fit. Hosts collect the information they need about songs from the internet, liner notes, their own knowledge, etc. This process takes the longest for one host.

DJ Software Interface

Of the thirty one hosts at WICN, seventeen consented to take the survey, though they did not all complete it. Hosts were generally neutral or somewhat satisfied with the current DJ software used at WICN. Each software option was unknown to the majority of the respondents (Figure 5). In terms of overall ratings for each software option, SAM Broadcaster Pro received an average

rating of 6.08 with a standard deviation of 2.14, ProppFrexx ONAIR received a 5.80 mean rating with a standard deviation of 2.09, Mixx earned a 5.40 mean rating with a standard deviation of 1.91, RadioDJ earned a 5.40 average rating with a standard deviation of 2.62, and Virtual DJ received an average rating of 5.18 with a standard deviation of 2.25 (Figure 6). Several important criteria were gained from the fill-in answers in the survey, including: necessity of light theme and lack of complexity (simpler is better).

DJ Software and Digitization

Upon completion of the survey, thorough research of DJ software was completed. Many software options were considered but the list was ultimately narrowed down to twelve options. For each of these twelve options, thirteen criteria were considered (Appendix F). The comparison of each software may be seen in figures 7 and 8. In terms of digitization solutions, the investigator considered the options laid out in UMWML while also considering a new alternative, which is external digitization. External digitization consists of outsourcing the digitization to a different company and can be split into two categories: cloud digitization and physical digitization. Cloud digitization involves a company digitizing the CD library and housing the CDs and allowing the customer to stream the music from the cloud. Physical digitization involves a company ripping the CD library to the customer's preferred file format and then the company sends the CDs along with the digitized music files back to the customer.

Recommendations

The recommendations have been split into three price tiers: low, mid, and high. Consistent throughout each tier is the FLAC format recommendation. It is also recommended that WICN expand their library via the internet if they wish to. In terms of storage, incorporating the digital library into their server would be ideal, but several large hard drives in their DJ booth computer is also viable. Creating back ups of their music is highly recommended regardless. For the low tier, digitization via manual CD ripping with hard drives (\$20-\$100) in conjunction with dBpoweramp (\$57) to be accompanied by RadioDJ (Free) is recommended. For the mid tier, digitization via automatic CD ripping with the Acronova Nimble (\$760) in conjunction with dBpoweramp (\$57) to be accompanied by RadioBOSS (\$239.95) is recommended. For the high tier, digitization via ReadyToPlay.com (\$1.30/CD) to be accompanied by ENCO DAD (price unavailable) is recommended.

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1. Introduction

The Modern Music Library IQP is as a continuation of a previous IQP, “Updating and Modernizing WICN’s Music Library” (UMWML), which was published in May 2017 by Albert Nanabeka, Jesse Kauffman, and Timothy Yungjae Vander Hart. In UMWML, the team discussed the processes and potential solutions for the digitization of the music library at WICN, a radio station based in Worcester, MA. They made recommendations for digitization hardware, database options, and software options. In this IQP, the digitization hardware and database options will be reevaluated by considering other potential solutions which may have been recently released. The primary focus will be the post digitization DJ experience, including DJ software, playlist creation, and general workflow, which will be thoroughly analyzed to determine areas for improvement and their solutions.

2. Background

This section establishes the foundation of the project. Prior to creating objectives or researching solutions, an understanding of radio, WICN, digitization, data, and disc jockeys must be gained. To conclude the background research, future research directions will be introduced.

a. Radio

For the past century, radio has existed as a popular form of media. Radio stations, private or public, serve as a data hub dedicated to serving the public. Whether it's listening to music, tuning into a baseball game, or hearing the daily news, people turn to the radio as a source for it all. As early as 1934, the United States government recognized radio stations' role in serving the public and enacted the 1934 communications act to enforce that radio stations made decisions that benefited the public by centralizing the communications administration to one federal agency (the Federal Communications Commission, FCC) and institutionalizing radio commission policies (Slotten, 2000, pp. 1920–1960). Yet the U.S. government has recently, starting around 1980, enacted policies to deregulate radio stations in order to prepare for the new technological world. The deregulation enabled an increased volume of informational programming due to changes such as less content control by the FCC and the abolishment of the Fairness Doctrine (Hazlett & Sosa, n.d.). Government intervention into radio stations reflects the nature of the radio station in society at different points in the timeline of radio history. In the year 2020, radio stations hold a special position as they attempt to compete with new online curated music services. Surrounded by the advent of the information of the digital age, with services such as Spotify and iTunes providing access to an almost infinite music catalog, television and streaming providing access to sports and other shows, and the internet giving access to a seemingly never ending wealth of information, most radio stations have shifted to digitization to remain an important part of society.

Therefore, radio stations' importance is derived from aspects separate from the digital age. One relevant aspect of radio's importance is the large consumer base it has already established. In 2018, "89% of Americans ages 12 or older listened to terrestrial radio in a given week" which is a slight decrease from 92% in 2009 (NW et al., n.d.). Taking advantage of the digital age, some radio stations have moved to the internet, either streaming simultaneously online and over the air or solely over the internet. This rise in digital radio listenership is visible as, "67% of Americans ages 12 and older had listened to online radio in the past month" which is a large increase from 20% in 2007 (NW et al., n.d.). WICN sees their share of listeners, attracting about 50,000 listeners each week according to Nielsen, though they currently have no support for communicating to the DJs specific listener stats for specific shows.

b. WICN

The primary focus of this project is a local Worcester radio station called WICN. The problem surrounds digitizing a sizable music library and the development of practical applications for the DJs who utilize it. The processes and ideas suggested later will hopefully be applicable to other radio stations and institutions in similar positions.

i. History of WICN

WICN (90.5 FM), which stands for ‘Worcester Intercollegiate College Network’, was founded in April, 1968. Based out of The College of the Holy Cross, the intercollegiate network started out as a joint partnership between their host school and Worcester Polytechnic Institute, providing curated classical music and has continued to provide curated programming since then.

WICN has gone through numerous changes throughout their history, such as the office of the station changing locations several times to better accommodate their needs. In 1980, WICN formalized their affiliation with NPR and in 2019, WICN holds the position as Worcester’s only NPR affiliate station. Despite the changes, WICN’s commitment to quality radio has not wavered as they have won several awards such as Spin Magazine’s choice for 1986 ‘Best Rock Station in the Country’ and the ‘Most Supportive of Local Music’ award which they won two years in a row starting in 2013 (*History of WICN – 90.5 WICN Public Radio*, n.d.).

In 1999, WICN became “New England’s Jazz & Folk Station” and currently continues to play ‘Jazz+’ music for New England. For WICN, Jazz+ means playing several genres with a primary focus on jazz. The other genres include bluegrass, soul, folk, blues, rock, folk-rock, classic country, alternative country, roots rock, new age, and cultural music. These various genres may be experienced via the various daily programs. Every program that WICN airs aims to “engage, inspire, inform and entertain” (*About Us – 90.5 WICN Public Radio*, n.d.) which is facilitated by the DJs who host the programs. The majority of the hosts at WICN are volunteers who share a passion for the arts and their work keeps WICN the radio station that it is. That passion contributes to the DJs’ role as gatekeepers into Jazz+, introducing listeners to new and interesting music, accompanied by relevant song facts and history. In coordination with their radio shows, WICN is able to broadcast to the world through their website and app to spread their music selection across the globe.

WICN believes that “Arts and culture contribute to a quality of life that keeps a community vibrant and economically alive [...] through the presentation of authentic, independent music [...] preserving America’s living art forms of Jazz and other music for generations to enjoy” (*History of WICN – 90.5 WICN Public Radio*, n.d.). WICN has several means to contribute to the arts, including their programs, local events, charismatic hosts, and audience. Programs like “Rhythms of the World”, which is hosted by Howard Caplan, have the ability to bring diverse cultures together and put their art on display and events such as Brown Bag Concerts offer free

performances to the general public,” with performers like Elan Trotman (*90.5 WICN Public Radio – Jazz+ for New England*, n.d.).

WICN is run by a board of directors consisting of 15 members, general manager David Ginsburg, director of client services Kate Travaline, 3 staff members, and their 32 program hosts. The team is always looking for new ways to support the audience and promote the arts as new programs and podcasts are developed. For example, WICN aims to record original content within their offices, such as in Studio 50 which is available for bands to record music, live performances, and special events.

ii. WICN’s Library

As New England’s Jazz+ radio station, WICN prides themselves on their diversity of music. Within their office in Worcester, WICN houses five to ten thousand compact discs (CDs) and three to five thousand records (Figure 1). The physical library is sorted according to genre; the main shelves hold the large collection of jazz music while side shelves hold other genres such as blues and bluegrass. Currently, the entire library exists only as physical media, meaning that none of it has been digitized yet.

When dealing with a physical library certain limitations are practically unavoidable. For example, in order to access the materials of a physical library, one must move to and be present at that physical library. DJs at WICN often must leave the DJ booth in order to access songs they would like to play. The DJs are also limited to the music which is available in the library, unless they supplement the library with music of their own. Additional limitations of physical libraries include the possibility of: damaged media, misplaced media, difficulty finding media, inability to simultaneously listen to media from multiple locations, inability to know when media was last used, and the library taking up too much space.



Figure 1. WICN's CD Library

c. Digitization

The possibility to digitally store and access music is a fairly recent development. Before the 20th century, music was only to be enjoyed live or by technology such as player pianos. That was until the late nineteenth century when music recording equipment was invented. Timothy Day writes that Josef Hoffman probably made by the pianist Josef Hoffman in 1887 in *A Century of Recorded Music: Listening to Musical History*. This was thanks to the innovations of Thomas Alva Edison “who had first succeeded in recording and reproducing sounds ten years earlier” and then presented Hoffman with a cylinder phonograph for recording. After the revolutionary invention and use of the cylinder phonograph started the wave of recording music, music recording technology continued to develop and improve. Recorded music has taken multiple forms since then, including LP, magnetic tape, stereo, audio cassette, compact disc, and digital recording and it continues to change and improve (Chanan, 1995).

The invention of the phonograph preceded the “dawn of [the] information revolution” in the twentieth century leading to the information society of today (Maurya, 2012). As music recording technology developed within the information revolution, it became more accessible and practical and the levels of accessibility have increased to the point where music can be stored

digitally. “Once information is transformed into digital form, it can be copied and distributed at near-zero margin costs” (Waldfoegel, 2017). Near-zero margin costs relate to the reduced cost of bringing new works to the market as music can be published digitally on the internet without factors such as a major labels, studios, or publishing houses and the fact that digital music can be instantly transferred over the internet at reduced costs, meaning costs associated with physical music media are virtually eliminated.

i. Benefits

In addition to reduced costs, organizations have numerous reasons to opt into the current wave of digitization. For WICN digitization serves as a way to preserve and access the library which already exists within their studio. As society shifts towards a more encompassing digital sphere, many institutions find themselves in a situation where they must find a solution for the digitization of their library. Already in 2001, The Institute of Museum and Library Services (IMLS) found that one third of academic libraries and a quarter of public libraries were involved in the digitization of library resources (Quan Liu, 2004). Before any institution can begin to digitize though, they must first consider the benefits and reasons to digitize, though the reasons’ importance can only be determined by the opinion of the institution. For example, a library may consider the most important benefits to be preservation of resources, improvement in efficiency of library searching, and improved access to resources (Fabunmi et al., 2009).

ii. Disadvantages

Once the benefits of digitization are evaluated, potential issues must also be considered. Maple and Henderson consider the major complications to revolve around three critical and comprehensive categories: infrastructure, collections, and staffine. Within each category persists the questions of funding (2011). For many institutions looking to digitize, the infrastructure to create, store, and support a digital library is non-existent along with the staff required to establish and maintain it. The obstacle posed by collections is primarily that of copyright and ensuring no copyright is infringed when digitizing and using the shared digital library. Another major complication may arise that depends on factors such as the size of the library and the resources available to the institution that wishes to digitize, namely time. In order to address these problems, any institution must analyze their own situation. In the case of WICN, there does not exist a digitization infrastructure currently, its collection is relatively large but not overwhelmingly so, and they are composed of a mix of volunteer and non-volunteer staff.

iii. Process

Once the positives and negatives of digitization have been considered, if an institution wishes to digitize then it must consider the process of how it will be accomplished. There exist several solutions, each with different monetary and time costs. At the low-tier is the possibly most time

consuming option of manually digitizing music using cd drives and a vinyl recorder if necessary. Next is the mid-tier option which is to employ hardware which is specifically made for digitizing large music libraries. UMWML evaluated several options to fulfill this purpose: the Primera Disk Publisher Bravo 4200, the Acronova DupliQ, and the Acronova Nimble USB Plus (Nanabeka et al., 2017). The last option, the high-tier, is external digitization. An example of external digitization is the company Murfie which will digitize large CD libraries for a price; their 2x platinum plan costs \$149 a year, gives the first 200 albums for free, but costs \$0.15 per album after (*Murfie Music*, n.d.). In addition to the yearly cost, Murfie only offers the digitized library for streaming. For the first two options, ripping software must be chosen in order to be able to use and interpret the data that is being ripped by the hardware. Two viable options to suit this need were considered: dBpoweramp and Exact Audio Copy (Nanabeka et al., 2017). Once the software has been selected, a database solution must be selected which will store the newly digitized library. The topic of storage will be discussed in the next section.

Due to the lack of ripping hardware, ripping software, and a database, each of these things must be independently evaluated in the case of WICN to ensure that each specific need is sufficiently satisfied.

d. Data

The digitization of a sizable music library may result in large amounts of data which need to be stored. Storage is the preservation of data in some physical form. Music storage exists in many formats such as the aforementioned, LP, magnetic tape, stereo, audio cassette, compact disc, and digital recording. The compact disc and the vinyl record have been used for decades in recent history as the primary method of music storage. Digitization allowed the preservation of music to improve to the point where lossless audio, which will be discussed in the following section, can be compactly stored on storage drives. This has enabled the possibility of shrinking physical music libraries to a fraction of their physical size by storing thousands of songs on just a few drives. There are several formats of drive storage, the two most common taking the form of hard drives and solid state drives. The average user's PC (personal computer) will likely contain some combination of these two drives.

i. File Formats

To be able to store music on a computer, it must have a file format. MP3, a very common audio file format, is a lossy file format most commonly used for storing music. Lossy files use algorithms to remove unnecessary parts of media in order to reduce the size of the file in storage. Meanwhile lossless files maintain the original media completely, though several algorithms have been developed to reduce the size of lossless files without sacrificing any quality. When it comes to storing music for radio playback, lossless files are ideal, due to the fact that no audio quality is lost. A major drawback to lossless audio files is their size, which plays an important role in

storage solution decision. For an organization like WICN, the primary decision is whether lossy files are acceptable. MP3, MPC, OGG, AAC, are several viable options for lossy file formats and some popular lossless file formats are, WAV, FLAC, ALAC, APE. When choosing within a grouping, choosing a specific format may be accomplished by comparing the particular strengths and weaknesses of each format, such as typical file size, sound quality, and metadata support. For example, FLAC is a compressed format while WAV is not so it usually results in smaller file sizes.

ii. Metadata

Some file formats enable the addition of metadata, which is “data that provides information about other data” (*Definition of METADATA*, n.d.). Metadata can take several forms; descriptive, structural, and administrative, but at its core it is used for resource discovery, resources being the information about the file (Melvin, n.d.). For music, metadata exists as a part of a song’s file and can be accessed by software to retrieve relevant information. Typically information such as song title, artist, and genre may be contained within the metadata. Metadata is used in order to replace the information typically provided on the packaging of CDs and Vinyl records. Whereas one may just read the album title, artist, and track names off of the back side of a CD case, a computer needs to read the metadata of a song’s file in order to provide the user with all that information. WICN is interested in using metadata to contain: album titles, artist names, the year recorded, record labels, song titles, song lengths, notations for explicit language in the lyrics, and musicians performing on the albums.

iii. Internal Database

For organizations such as WICN with a sizable music library, the storage solutions must scale accordingly. There are three main large scale storage types for organizations: hard drives, NAS (network attached storage), and cloud. Hard drives involve taking the hard drives that were previously mentioned and scaling them by adding many more drives. NAS storage tends to exist within the same building it is used in, networking the storage over the local network. It works by putting together several hard drives and networking them with software so they may be accessed over the internet. Cloud storage relies on large databases, typically located somewhere away from the user, which are accessed through the internet. It has gained significant traction and popularity in recent history for its reliability and ease of use. A method for organizations who do not wish to create their own cloud storage is to pay for a service offered by another organization with a large scale database that offers cloud storage solutions. A comparison of the three options can be referenced in Table 1.

	Speed	Cost	Reliability	Security/	Ownership
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				Accessibility	
Hard Drives	Limited by drives chosen	\$50-\$200 per drive	Depends on the drive	Normally more accessible due to proximity, can be lost in disaster	Complete ownership
NAS	Limited by drives chosen and local network connection	\$200-\$2000 Depends on number of drives and the drive enclosure	High Depends on the setup and drives	Typically more accessible due to proximity, can be lost in disaster	Complete ownership
Cloud	Limited by Internet	Depends. Often high if paying external company ~\$200+/year	High (depends on the company)	Accessible in case of disaster	Depends on contract

Table 1. Music Storage Options Comparison

iv. External Music Sources

In addition to an internal music database there exists supplementary external music sources. These sources contain large databases which are commonly available online and are accessible by WICN. External databases of music provide huge areas for potential growth as they can fill in gaps in smaller libraries. Services such as Spotify, iTunes, SoundCloud, and BandCamp provide huge libraries instantly accessible via the internet. In addition to these sources of music exist large databases which contain metadata for music, such as MusicBrainz. There have even been games created, such as the one created by Michael I. Mandel and Daniel P.W. Ellis called MajorMiner, which make metadata collecting an enjoyable game (2008). These databases of metadata exist to be accessed and to supplement a digitized music library. The supplementation of metadata may be dependent on the digitization method as with some software, the input of metadata may be manual which could require considerable time to create.

v. WICN's Database

WICN currently does not possess the infrastructure required to store the data which will result from digitization. WICN possesses several PCs running Windows which are used by the team but otherwise there exists no hard drive framework, NAS, or cloud storage solution ready. External databases are already partially being used by a few of the hosts who bring their laptops to plug in to use iTunes, though no native support for external libraries is being utilized in the current software situation. Due to the fact that none of the library has been digitized yet, there also are no files or metadata yet.

e. Disc Jockeys

The primary users of radio station databases, DJs (disc jockeys), serve as an important 'face', or voice for radio stations. Over the decades, their role has changed to suit the time, yet the primary role throughout the lifespan of the DJ has been to deliver music to the masses. B Lee Cooper considers how DJ's are "music gatekeepers, community leaders, cultural icons, and zany personalities" (2007), yet these roles were not present at the dawn of the radio and had to develop over time.

The exact origin of the DJ is unknown, though it is believed that DJs have been in existence since as early as 1926 (Fong-Torres, 2001). Yet this form of the DJ was still not the common form that one may recognize in 2019. It wasn't until 1932 when Al Jarvis, who is credited with creating the role of the DJ with personality, started the first ever 'Make Believe Ballroom'. In an unprecedented move, Jarvis began presenting music on radio like an emcee presenting live acts at a concert, curating a music showcase for listeners. Soon after Jarvis came an acquaintance of his, named Martin Block, in 1935. Martin Block brought the 'Make Believe Ballroom' to New York and popularized the role of DJs as a personality. The 'Make Believe Ballroom' that started the wave of DJs didn't last long though, as new DJs with other zany personalities began to join the scene, expanding the DJ's roles to include those described by B Lee Cooper (2007). According to one author, it was Block that inspired Walter Witchell to coin the term 'disc jockey', "Yet Bill Randle, one of the deans of the profession, has traced the term to the late Jack Kapp a record executive who called DJs 'record jockeys' in 1940-possibly because their job often included controlling the sound volume, or "riding the gain," on their records", either way, it was the birth of the DJ (Fong-Torres, 2001).

As the role of the DJ developed, famous DJs began to take their place on the world stage, including: Alan Freed, Bill Randle, Dick Clark, and Wolfman Jack (Cooper, 2007). These DJs and others continued to evolve the role of the DJ, becoming cultural icons and introducing many to new music, such as previously neglected music from the black community (Fong-Torres, 2001). In contemporary society, the role of the DJ varies greatly, depending on the station and genre, yet the essence of the DJ as pioneered by those who came before, remains the same.

At WICN, DJs exist to fulfill this same role. They introduce listeners to new music across the many genres which encompass Jazz+ and serve as gatekeepers, informing the public and helping listeners discover genres. Through their passion for music and the radio station, the DJs at WICN are able to cultivate the arts and culture and inspire listeners. They are able to do so through their song selection, which offers a diverse selection of jazz and other genres, and through their hosts' personalities. Many listeners turn to WICN hosts for their commentary and insight regarding topics surrounding the music they play, current events, etc.

i. Workflow

The process by which hosts at WICN create playlists begins with the selection of the songs, which may be chosen from WICN's library or their own, prior to the show. While some DJs take advantage of modern software such as iTunes, which allows them to stream music digitally in exchange for a rights fee, other DJs continue to play music from physical media formats; namely CDs and Vinyl records. For example, Pamela Hines is a host who plays primarily Vinyl records on Saturdays. Then the hosts will decide on the song order, considering factors such as song length, announcement breaks, and commercial breaks. When using physical media, additional information about the music can be obtained a number of ways: having previous knowledge, doing research, or reading the liner notes. The DJs at WICN use these resources available to them to air music while also providing thoughtful relevant information. Though, with easier access to song information, DJs could be better equipped to provide useful commentary about more songs. Finally, the hosts will then enter the song info into Spinitron as the song is playing or after the show has concluded.

ii. Software

Contemporary DJs typically operate on computers and as such, require software to enable them to do their job. There exist many options when it comes to DJ software, including: Dalet, AudioVault Flex, Sam Broadcaster Pro, PlayoutONE, Virtual DJ, and MediaMonkey (Nanabeka et al., 2017). Currently WICN is using AudioVault flex along with Spinitron as its music solution with Audacity as its recording solution. Spinitron is accessed via the internet and is used to generate playlists, which are used for business (royalties) and record (playlist history) reasons, while AudioVault is used for handling broadcasting and spots and is not accessible via the internet.

The common elements which persist in all the available software are the User Interface (UI) and User Experience (UX). UI involves how the actual interface, which the user sees, is displayed and organized. Features such as customizability vary across programs, for example, some programs have a customizable interface, like AudioVault, while others do not, like MediaMonkey. How the UI is laid out and how the software is written will affect the UX as users attempt to navigate and utilize it. These factors must be considered when selecting DJ

software as the UI must be understandable by the DJs who use it and the UX must be accessible and enjoyable enough to promote further and continued use of the software. In terms of accessibility, many factors may be considered, such as language or accommodations for people with disabilities.

For WICN, several factors must be considered when evaluating software solutions. They specifically want software that is remotely accessible and compatible with AudioVault or can be a single master system to replace the current system. The program must also have multi-lingual support, specifically it must support Spanish and English. Therefore these things will be taken into consideration alongside ensuring that the software is accessible to the diverse group of DJs at WICN while also being.

f. Research Direction

WICN as a radio station continues to provide broadcasting to support the arts and culture within their local community and abroad and requires digitization of their music library to continue doing so efficiently. As their catalog grows and the staff changes, the task of knowing and utilizing the library grows more difficult. Moreover, exploring the relationship between the radio DJ and their tools, the software and hardware, introduces questions relating to the possibility of improvement of their work processes and the ideal combination of technology to do so. The questions introduced include: what is the current state of DJ's workflows, what could DJ's do with more information, what is the optimal software interface for DJs, and what is the best method of physical media conversion and storage?

3. Methodology

To determine the best procedure to digitize a large music library and explore the relationship between radio DJs and their tools, the following research objectives were determined: (1) assess the current state of DJ's workflows to address areas for improvement by discovering the inefficiencies in DJ's workflows and determining what DJs could do with more information such as their habits or song metadata, (2) determine the optimal front-end interface to satisfy those needs by investigating the criteria which define the optimal software interface, and (3) develop a plan for the conversion and storage of large amounts of music of varying media formats by determining the process of converting music from physical to digital, the creation of a database and back-end, and how to synergize the database and the software. To investigate these objectives, participant observation and interviewing and surveying methods were employed.

a. DJ Workflow

A fundamental understanding of DJ's workflows is required to assess the current state of DJ's workflows to address areas for improvement by discovering the inefficiencies in DJ's workflows and determining what DJs could do with information such as their habits or song metadata. Participant observation was selected as the preferred research method to enable this understanding. The proximity and personal nature of participant observation research allowed the investigator to observe the unfiltered processes central to the first objective. Alternative research methodologies were considered, such as survey research. Survey research was not selected due to the limited breadth and depth of information which can be collected from a questionnaire and their impersonal nature. Information such as how DJs physically operate and tasks which DJs may carry out subconsciously are unlikely to be well represented in a survey.

Prior to practicing the participant observation research, the investigator communicated with WICN's general manager, David Ginsburg, to select the hosts which would participate in the study. Three consenting hosts were selected to be observed over the course of a week across a total of five sessions. Despite the relatively small sample size, the hosts were selected to ensure optimal cooperation and efficient discovery of processes while maintaining diverse practices. The number of sessions was selected to compensate for any potential complications such as shyness and sessions were determined to be about one hour long to allow for an in depth understanding of each host's processes. At the commencement of each observation session with a new host, hosts were given a consent form (Appendix A) and a list of interview questions (Appendix B). After hosts signed the consent form, the investigator video recorded the DJ setup and the host's interactions with it. During observation sessions, handwritten notes were taken by the investigator to accompany the video recording. When taking notes, the following information was focused on: time management (song times, advertisement time slots, etc.), songs selected, notable DJing actions, and general comments and questions. In addition to observation notes, interview question response notes were taken. During long break periods, primarily provided by

long songs, hosts answered various questions asked by the investigator, starting with the provided interview questions and followed by additional questions which arose from observation.

b. DJ Software and Interface

An understanding of what good DJ software necessitates is required to determine the optimal front-end interface to improve performance by investigating the criteria which define the optimal software interface and how software can improve DJ's workflows. This is especially true for the hosts who use the software. Surveying was selected as the preferred research method to enable this understanding. Several alternative research methods were considered, including focus group research and case study research. Focus group research was not selected due to the difficult nature of scheduling and coordinating enough DJs to meet at one time since most hosts at WICN are volunteers who work jobs in addition to being a DJ. Case study research was not selected because it involves a long-term funded study and does not lend itself to group feedback. Group feedback, meaning receiving feedback in a group setting where members of the group may influence each other's opinions. Therefore, survey research was selected due to its ability to efficiently receive mass group feedback without time restrictions. Survey research also tends to be better for simpler questions which do not require participants to influence each other in a group environment, such as an individual person's opinion on an interface's aesthetics.

Prior to creating and dispersing the survey, research on DJ software was performed. Researching software options consisted of independent online investigation of available DJ software options by considering the criteria selected in UMWMP in addition to the software options that were previously examined. Once a sizable list representing the population of available DJ software was collected, five software options were selected to be utilized in the survey. The DJ software selected was: SAM Broadcaster Pro, Virtual DJ, RadioDJ, ProppFrexx ONAIR, and Mixxx. For each program, a screenshot of the main application screen was obtained (Appendix C) and used along with the questions created beforehand (Appendix B) to construct the survey. The survey was then distributed to all the WICN hosts to be taken by those who consented (Appendix D).

c. Music Conversion and Storage

The third objective, which is to develop a plan for the conversion and storage of large amounts of music of varying media formats by determining the process of converting music from physical to digital, the creation of a database and a back-end, and how to synergize the database and the software, was accomplished through independent online research. Prior to conducting the research, general manager David Ginsburg was consulted to determine the focus direction of the research in terms of cost and storage mediums and formats. The focus given was to create a recommendation across multiple price brackets with varying storage options. To initialize the

research, the general background research accompanied by UMWML's research were reviewed to create an initial list of options concerning ripping solutions (hardware and software) and storage solutions. Using this list, research was conducted to discover further ripping solutions and their compatibility with WICN's technological ecosystem.

4. Results

To logically introduce the results of the research, the sections will be ordered chronologically based on the order they occurred. To understand the information relayed within the results, the setup of the DJ booth at WICN is described first.

a. WICN DJ Booth Setup

WICN's equipment currently includes a three deck CD tray player (one Denon DN-C635 and two Tascam CD-500B), two turntables (DP DJ 151 Denon), a computer with two monitors, two mixer audio consoles (Axia iQ), microphones (the host uses a dynamic cardioid microphone), headphones, an audio interface (PreSonus Audiobox USB), and speakers (EV MS-802 and Fostex 6301). The DJ booth setup from UMWML (Figure 2) shows a good representation of what the DJ booth setup currently is, besides the fact that the mixing board has been switched to two Axia iQ mixing consoles. All audio devices are connected to the mixing console (Figure 4).



Figure 2. WICN's DJ Booth Setup (Nanabeka et al., 2017)

b. DJ Workflow

When observing three radio hosts at WICN, the general process of DJing became understood. The process may vary slightly per each host, but generally their actions fall under five categories: music selection, music playback, music logging, spot playback, and live commentary. Music selection is a category which is often favored by radio hosts as a primary source of motivation for working. This category is comprised of the time spent searching for and selecting songs. When selecting songs, some hosts prefer to plan out their music in advance while others do not. The process of picking songs is personal, but hosts tend not to play songs the host who went before them had played; which they can check with Spinriton. Also, hosts tend to adhere to the theme of their show, for example, WICN's "Latin Jazz Now!" host will primarily play latin jazz (*Show Schedule – 90.5 WICN Public Radio*, n.d.). In addition to adhering to their program's theme, hosts often consider alternate factors such as the pace of the song (slow vs. fast), the size of the group performing (big band vs. solo acts), artists (well known and beloved vs. new or less well known), and time period (modern vs. classic). One host plays mostly new music, which arrives each week. When it comes to selecting music, some hosts either find they spend the most time on that task or would like to, and some hosts find it to be the most difficult part of hosting. Some hosts emphasized issues discussed in the background regarding CDs and CD libraries and their physical nature. A large shared physical music library lends itself to accidents such as CDs being misplaced, disorganized, rearranged, and damaged. In the occurrence of these issues, those CDs affected cannot be utilized by the hosts. One host also believes they get stuck in a pattern of playing certain music due to factors such as habits when looking for songs in the physical library or the inability or lack of time to find CDs. Every host observed stated they often receive requests for music, which they tend to oblige. Music selection presides as one of the most important categories as it is often the reason listeners tune in to the radio. The importance of this category impacted further research into radio DJ software by emphasizing the importance of the music library functionality (and determining what beneficial music library functionality necessitates) as a main feature.



Figure 3. WICN's Three Disc Tray CD Player

After the hosts select songs, they must queue them up using their chosen platform (via CD player, Vinyl player, or computer). For one host, this means queueing the song in the iTunes player, while for others it means utilizing the three disc tray CD player (Figure 3) or the two vinyl record players. For the host utilizing iTunes, their iTunes library serves as a tracker of how frequently songs are played by using the built in “Last Played” category. Some hosts find CDs more intuitive than computers while for others the CD player acts as a hindrance due to its confusing nature. It is difficult to know which CD is in which slot and it is also difficult to know which song is selected due to the minimal interface of the device. Therefore, the CD player is often prone to causing accidents as hosts may queue a song using its track number only to discover the CD sleeve is mislabeled or perhaps the wrong track may be selected. Hosts may also discover that the sleeve has incorrect track times or no track times at all, which would interfere with scheduling and may result in a song getting cut off. Unlike in the iTunes player, the hosts are not able to quickly read the names of the songs they have queued when they are played via the CD or Vinyl players.

After the song has been queued up in either the CD or Vinyl player, the hosts must utilize the mixer. The mixer is essentially composed of channels for various inputs which may be controlled by a volume slider, an activation button, and a preview button. At the transition of each song, the hosts manually perform a crossfade on the mixer (Figure 4). Hosts first lower the volume and turn off one CD player's channel and then turn on and increase the volume for the channel with the next song. For hosts with digital workflows, the process is simpler. As an example, iTunes transitions songs automatically and outputs from a computer and therefore does not require track switching. One host noted the room for error when using the mixer as the physical task of moving sliders and pressing buttons may not occur effectively or the wrong channel may be

modified on accidentally. The importance of smooth and error-free music playback lends itself to pursuing a non-error-prone radio DJ software meaning clear song selection and smooth track switching to ensure smooth transitions and queueing of songs.



Figure 4. WICN's Mixer Console

Music logging currently exists as the largest hindrance for the hosts at WICN. The current system utilizes Spinitron, which stores their playlist information. Each host has their own Spinitron account and can access and view the radio station's playlist. The task of music logging consists of hosts manually typing and entering each song they play. All hosts observed selected Spinitron logging as their least favorite task and noted it as a substantial time consumer. One host mitigates the tedium of manually entering playlists by utilizing the export playlist feature on iTunes. WICN recently started using a newer version of Spinitron which resulted in changes some hosts did not prefer. Changes such as search assistance, which often suggests songs the hosts may be trying to enter by displaying a popup window with several song options to choose from. This feature slows DJs down by making them stop to ensure the song is added to the playlist. The time spent on logging to Spinitron takes time away from hosts to do the tasks they would like to spend more time on and are deemed more important, namely music selection and live commentary. Therefore, radio DJ software with some sort of support for Spinitron or exporting playlists will be important.

Spot playback consists of the advertisements, prerecorded messages, and assorted audio clips which hosts may have to play during their session. For example, WICN has a timetable set for hosts to play certain messages, such as an advertisement for a recurring sponsor. In addition to prerecorded messages, WICN broadcasts NPR news at the top of every hour, which the hosts must work around. Currently, WICN uses AudioVault for the storage and playback of prerecorded messages. One host said they found AudioVault to be the easiest technology to use in the DJ booth. Therefore, the ability to store prerecorded messages and play them is an important feature for radio DJ software.

Live commentary, the final category, is arguably the other most important category besides music selection. During hosting sessions, hosts are typically expected to speak. This may mean a weather report, which one host reads off the dual monitors in the DJ booth, reading the radio ID, to comply with the law and identify the station, or wishing someone happy birthday. Usually, it means announcing the songs which have been played and will be played along with relevant information. Each host collects the information required to comment on songs, whether it be from the internet, album jackets, or song information in iTunes. The process of getting information about artists and songs is the task which takes the longest for one host, though one host notes the convenience of the DJ booth computer which allows for quick searching for information. There exist many resources on the internet for convenient song information collection such as: allmusic.com, discogs.com, wikipedia.org, and genius.com. Therefore, it would appear beneficial to attempt to provide song information within the radio DJ software if possible.

The hosts observed added additional comments on the topic of digitization, which they generally viewed in a positive light. One host would like to be able to sort the music library similarly to the hierarchy of CDs, meaning by album, artist, and track. Another would like to be able to sort by track time and genre. Lastly, one host commented on the importance of song information being in the software. These comments were taken into consideration when researching radio DJ software.

c. DJ Software Interface

Of the thirty one hosts at WICN who received the survey, seventeen consented, though they did not all complete it. First, hosts were asked how they felt about the current DJ software used at WICN; which is AudioVault, for playing spots, and Spinitron, for logging playlists. The majority of hosts were either neutral or somewhat satisfied, with only two hosts reporting dissatisfaction. As mentioned previously, WICN hosts were presented five software options within the survey: SAM Broadcaster Pro, Virtual DJ, RadioDJ, ProppFrexx ONAIR, and Mixxxx. For each software, hosts were asked whether they had heard of each software option prior to the survey. Mixxxx and Virtual DJ were known by five hosts, SAM Broadcaster Pro and RadioDJ were known by three hosts, and no hosts had heard of ProppFrexx ONAIR. The fact that all the software options were

unknown to the majority of the respondents (Figure 5) may indicate diminished response bias favoring any particular software as each software had a majority of new viewers rating them.

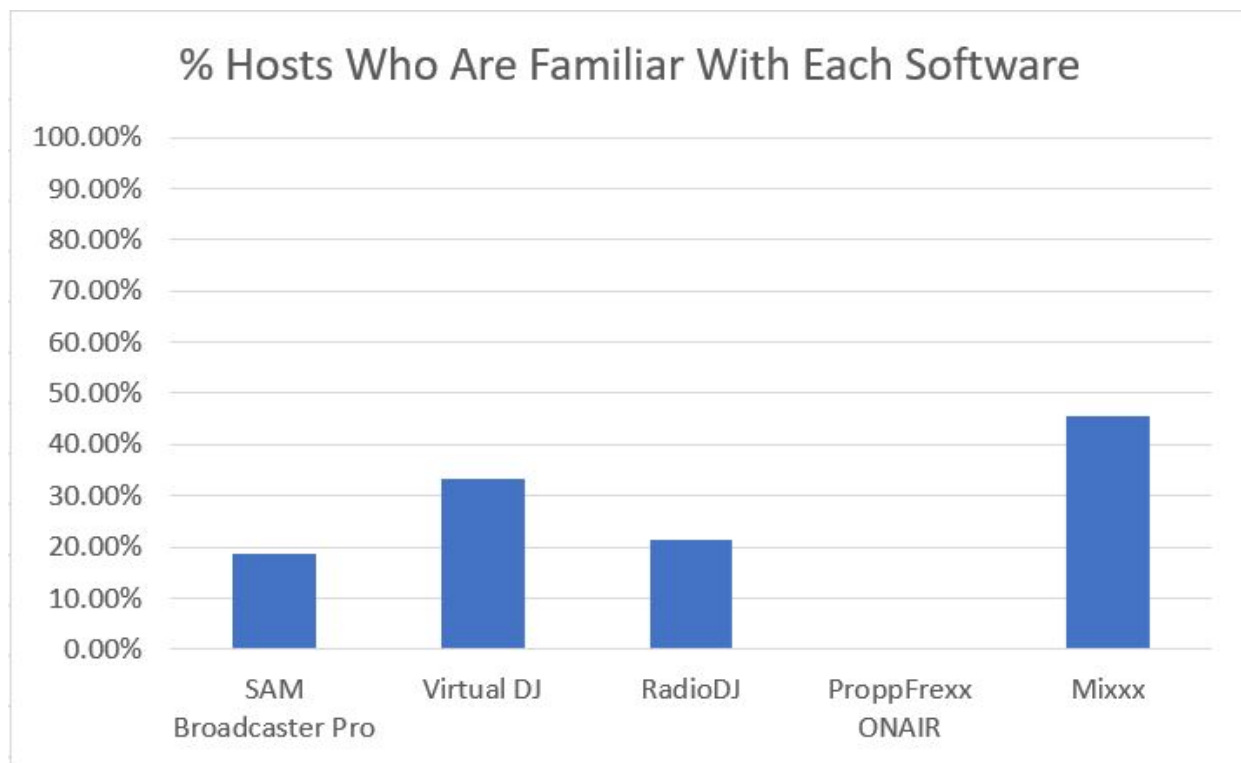


Figure 5. Number of Hosts who Know Each Software

Next, hosts were asked to give an overall rating out of ten for each software option. The information gained from this was utilized to gauge the overall reception of the software and to provide context for the questions which follow which focused on specific aspects of the software. Each option was generally neutrally received with a slight positive trend, though SAM Broadcaster Pro was a clear winner with an average rating of 6.08 with a standard deviation of 2.14. In decreasing order, ProppFrexx ONAIR received a 5.80 mean rating with a standard deviation of 2.09, Mixxx received a mean rating of 5.40 with a standard deviation of 1.91, RadioDJ also received a mean of 5.40 but with a higher deviation of 2.62, and finally Virtual DJ received a mean of 5.18 with a standard deviation of 2.25 (Figure 6).

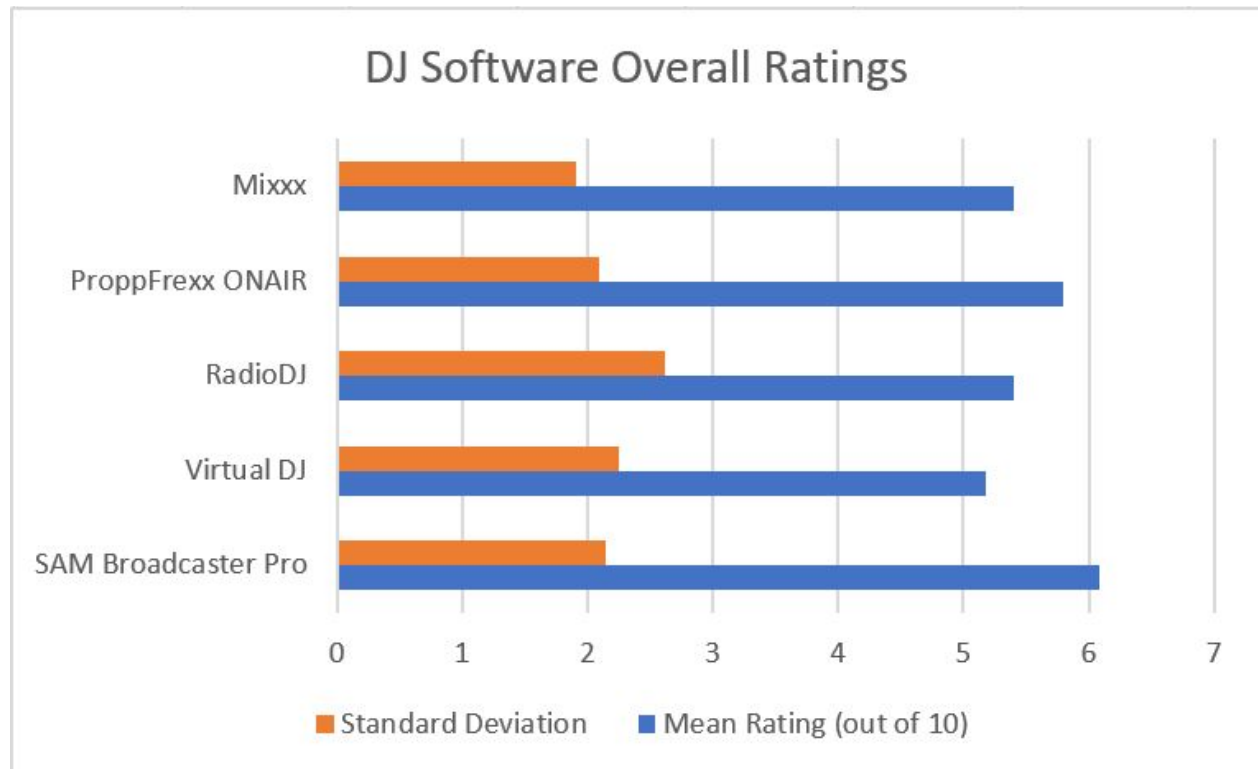


Figure 6. DJ Software Overall Ratings

Each software option was accompanied by the choice for hosts to list anything they may have liked or disliked about the software screenshots. For the highest overall rated software, SAM Broadcaster Pro, hosts were conflicted between the clarity due to the simple layout and large areas and the potential complexity of the interface. This suggests that software with large interface options that are clear to see is desirable for WICN's hosts. A common theme which occurred amongst the four other (besides SAM Broadcaster Pro) software options was the opposition to the dark interface themes which many DJ applications don. Due to this, whether or not software had a light mode was added as a criteria when considering software. When analyzing the more poorly reviewed software options, hosts emphasized the importance of a simple layout with large areas and large buttons to ensure minimal error would occur when attempting to press said buttons. Hosts also noted the difficulties presented when the software's layout appeared too complex or busy, as in the four alternatives to SAM Broadcaster Pro. Therefore, the simplicity of a DJ software was considered to be a primary criteria. In addition to simplicity and light themes, additional criteria were considered. These criteria were conglomerated through consideration of the criteria present in UMWML, requests from general manager David Ginsburg, and the investigator's personal opinions.

d. DJ Software

Upon completion of the participant observation and survey, thorough research of DJ software was completed. A broad survey of the market of available DJ software yielded many results and therefore required elimination of software options. After careful consideration, twenty four software options (Appendix E) were selected from the pool of available options to be the main group of focus. From that group of twenty four, twelve software options were selected to ensure competitive comparisons were made to provide WICN with a reasonably sized list of options. Eliminating twelve software options was accomplished by removing software which was significantly more complex or less feature packed than the rest. The twelve DJ applications selected (Figure 7) were used to consider recommendations.

To be able to decide between the twelve software options, appropriate criteria had to be created. The criteria considered (Appendix F) were: (1) price, (2) shift screen presets; indicating the ability to customize the interface layout in some way, (3) listener statistics; indicating the ability to receive radio listener statistics, (4) metadata integration, (5) metadata creation, (6) free trial, if there is one, (7) simplicity; this category represents the investigator's opinion on the simplicity on the app with consideration for WICN hosts, (8) library; this category represents the investigator's opinion on the quality of functionality for the software's music library, focusing on readability, accessibility, and simplicity, (9) multi-lingual support, specifically for spanish as per requested by David Ginsburg, (10) Spinitron compatibility, as per requested by WICN hosts; whether or not the software natively supports exporting playlists to Spinitron, (11) remote access, as per requested by David Ginsburg; whether or not the software may be controlled remotely, (12) light mode; whether or not the application has a light interface theme, and (13) DJ rating; indicating the rating WICN hosts gave the software if any. The status of each criterion for each software option (Figure 7, 8) will be used in the recommendations.

Software	Price (USD\$)	Shift Screen Presets	Listener Statistics	Metadata Integration	Metadata Creation	Free Trial
AudioVault	Unavailable	✓	✓	X	X	X
Sam Broadcaster Pro	299	✓	✓	✓	✓	✓
Virtual DJ	19/99 /mo 166/299 once	✓	X	✓	X	✓
RadioDJ	Free	X	X	✓	X	✓
ProppFrexx ONAIR	383-657 (at time of conversion)	✓	X	✓	✓	✓
RadioBOSS	239.95	X	X	✓	X	✓
Mixxx	Free	✓	X	✓	✓	✓
Traktor Pro 3	99	✓	X	✓	X	✓
ENCO DAD	Unavailable	✓	X	✓	✓	X
iMediaTouch	Unavailable	✓	X	✓	✓	X
RCS Zetta	Unavailable	✓	Unavailable	✓	✓	X
WideOrbit	Unavailable	✓	✓	✓	✓	X

Figure 7. DJ Software Comparison Table

Software	Simplicity	Library	Multi-Lingual Support (Spanish)	Spinitron Compatibility	Remote Access	Light Mode?	DJ Rating
AudioVault	8	9	Unavailable	✓	✓	✓	-
Sam Broadcaster Pro	5	6	X	✓	X	✓	6.08
Virtual DJ	8	9	✓	X	✓	✓	5.18
RadioDJ	8	9	✓	✓	✓	✓	5.4
ProppFrexx ONAIR	3	5	X	X	✓	✓	5.8
RadioBOSS	7	7	✓	✓	✓	✓	-
Mixxx	8	9	✓	X	X	X	5.4
Traktor Pro 3	8	9	X	X	X	X	-
ENCO DAD	9	9	✓	✓	✓	✓	-
iMediaTouch	9	7	X	✓	✓	X	-
RCS Zetta	5	6	✓	✓	✓	X	-
WideOrbit	6	7	✓	✓	X	X	-

Figure 8. DJ Software Comparison Table 2

e. Digitization

In terms of digitization, the investigator considered the options considered in UMWML plus a new alternative of external digitization, meaning outsourcing the digitization to a different company. For external digitization there exists two options; external digitization and storage with cloud access, and external digitization and return. The first option, as discussed briefly in the background, exists from companies like Murfie who offer a service which allows customers to

send in their large music libraries in exchange for a fee. Once the library is received, the company will digitize the music and store it securely within their warehouse. After it is digitized, the music is then available to be streamed in high quality in exchange for a fee for the storage and cloud access (*Murfie Music*, n.d.). During the research period of this IQP, Murfie Music shut down and was acquired by a similar company, Crossies. At the time of writing, Murfie is currently out of service and access to the millions of CDs within their warehouse is inactive. This example displays the large potential negatives of external storage of a large CD library for a radio station like WICN, as should they have had their music stored with Murfie Music, they would not have had access for the past couple months. The current proposed pricing from Crossies is \$0.01 per disc per month and \$0.001 for each disc after the first 100, \$0.01 per month per disc for cloud access, \$0.10 per gigabyte downloaded or streamed, and \$1 per item for incoming media (*Crossies*, n.d.).

The alternative form of external digitization consists of sending CDs to a company who will digitize the discs to the format selected and the discs will be returned along with the digital files. This method also poses risks due to the risk of losing CDs when mailing them to external digitization companies and the same risk posed by the first option. The other downside of external digitization services is the steep cost. For cheaper options, such as that offered by MusicShifter.com, digitizing just 2000 CDs with the \$0.69/CD package comes to \$1380 total. On the other hand, more premium options, like ReadyToPlay.com offer a more comprehensive service for an increased premium, starting at \$1.30/CD. These costs will add up quickly for a radio station like WICN with thousands of CDs. For example, digitizing 2000 CDs would cost \$2600.

5. Recommendations

When considering recommendations for WICN, arguably the most important factor is the price of the digitization options and the software options. Therefore, as per requested by general manager David Ginsburg, the recommendations proposed will be structured in a hierarchy of price tiers: low, mid, and high. All recommendations will focus on the FLAC format. FLAC's relatively recent creation in 2001 combined with its abundant popularity and high quality audio at an efficient size suggest it will remain a relevant format for the foreseeable future. Should WICN wish to expand its library, purchasing digital songs and utilizing them will be easy to implement with the software suggestions which follow, as the songs simply must be added to the database. It is also recommended that interested WICN hosts attempt to utilize external music sources such as SoundCloud should they desire additional music. In terms of storage of the digitized music, it is recommended that WICN incorporate the files into their existing servers or with several large hard drives added to their DJ booth computer. In either case, it is highly recommended that backups of each drive are made to ensure no music is lost.

a. Low-Tier Recommendations

For the low-tier recommendations manual CD digitization could be done by volunteers by utilizing CD disc drives and dBpoweramp to be accompanied by RadioDJ (Appendix C). This combination will result in overall very low costs. In terms of cost, external optical drives are available for anywhere from \$20 to \$100 on Amazon.com, dBpoweramp's single PC package combined with the PerfectTUNES package comes to a total of \$57, and RadioDJ is free software. The reason external optical drives were selected instead of official ripping hardware is the extremely reduced cost. Compared to CD ripping hardware options like the Acronova Nimble, which costs \$760 at the time of writing, external optical drives offer a cost effective but slow solution. In addition, the ripping software dBpoweramp provides powerful functionality, allowing for ripping to FLAC, creation of metadata and tags, and increased ripping speeds. Finally, RadioDJ was selected due to its extensive feature set.

When considering free software options, it was a contest between RadioDJ and Mixxx, both of which were presented to WICN hosts in the survey. Although RadioDJ does not allow for shifting screen presets, unlike Mixxx, it does allow for minor customization by allowing reordering of tabs within each working section (Appendix C). Neither option offers listener statistics, but both options offer metadata integration. RadioDJ may not have the ability to create metadata, but this should not be necessary with the ripping solution selected as all metadata should be created upon rip. In terms of simplicity, RadioDJ has a significant advantage over Mixxx due to its minimal interface with large sections with easy to view text and large buttons. Mixxx also has large sections with easy to view text, but the addition of many features creates complexity and business within the interface which works against the hosts' desires. Both software options offer fantastic library functionality, providing large windows with easy to use

search and navigation features. A significant advantage that RadioDJ has over Mixxxx is its built in Spinitron compatibility. The ability to quickly export playlists and song history to Spinitron should save WICN hosts an invaluable amount of time, freeing them to focus on tasks they would rather focus on. Another significant pro for RadioDJ is its remote control functionality, which Mixxxx lacks. Finally, Mixxxx lacks a light theme, which may hinder many hosts who have difficulty viewing applications with dark backgrounds, therefore once again giving the advantage to RadioDJ with its fully color customizable interface.

b. Mid-Tier Recommendations

The investigator would like to recommend the Acronova Nimbie combined with dBpoweramp and RadioBOSS as the mid-tier recommendation. As explained in the previous section, although the Acronova Nimbie, at \$760, is significantly more expensive than most external optical drives, the increased speed and automation provided offer a significant advantage and will save countless hours of manual labor. The Acronova Nimbie's write speed for CDs is 40x whereas the average CD drive has a maximum write speed of 12x. This means the Nimbie is about 3.34x faster and could rip a CD in an average of 1.85 minutes, versus 6.166 minutes for a 12x CD drive (*Burning CDs - How long?*, 2004). For a library of five thousand CDs, that adds up to about 360 hours saved, not including the time difference between manually loading CDs into a cd drive versus placing a stack of one hundred CDs to be automatically ripped in the Acronova Nimbie. When choosing software for the mid-tier recommendation, there were five options to choose from: RadioBOSS, Virtual DJ, ProppFrexx ONAIR, SAM Broadcaster Pro, and Traktor Pro 3. At \$239.95, RadioBOSS is priced similarly to the other options, the exception being Traktor Pro 3, which is only \$99. Therefore, price was not a major consideration. Similar to the low-tier recommendation, RadioBOSS's lack of metadata creation should not be a hindrance as the metadata should all be generated upon digitization. Therefore the primary flaw of RadioBOSS is the lack of listener statistics; which, of the five in the mid-tier, only SAM Broadcaster Pro offers. Although RadioBOSS may be lacking in certain categories, namely its inability to shift screen presets, its lack of listener statistics, and lack of metadata creation, it makes up for these losses in important ways. RadioBOSS offers a clean, light themed interface with a fairly intuitive layout which partially makes up for the lack of interface customization options. The reason RadioBOSS was selected instead of SAM Broadcaster Pro is its two additional features which SAM Broadcaster Pro lacks; multi-lingual support and remote access. The simple and fairly intuitive layout of RadioBOSS, combined with the ability to control it remotely and its accommodation for speakers of foreign languages provides it a significant boost over SAM Broadcaster Pro, earning it the pick for the mid tier.

c. High-Tier Recommendations

For the high-tier recommendations, the investigator would like to recommend digitizing the library through the premium service, ReadyToPlay.com, to be accompanied by ENCO DAD (price unavailable). The focus of the high-tier recommendations is functionality, regardless of price. Therefore, the options selected for this category will not be judged based on price (within reason). Digitization through ReadyToPlay.com was selected due to the ease of transition and support which is offered through the purchase of their services. ReadyToPlay offers support which will walk customers through the selection of digital storage options (NAS, HDDs, etc.), format & compression options, shipping of CD's (Jewel Cases, Spindles, etc.), and pricing options (*CD to MP3 Conversion | ReadyToPlay | United States*, n.d.). The level of support offered with the purchase of their services is a valuable asset in conjunction with the convenience of allowing an external source to digitize the entirety of the large music library within WICN. Though it is recommended that the library be shipped in small portions at a time to ensure CDs are still available for hosts during the transition and to ensure in the event of an accident, some CDs will still be available for use.

In terms of software options, ENCO DAD was considered alongside AudioVault, iMediaTouch, RCS Zetta, and WideOrbit. When considering software options for the high-tier, the maximum combination of functionality of usability was required for an application to be selected. A major negative for iMediaTouch, RCS Zetta, and WideOrbit is the lack of a light mode, which could be a major hindrance for WICN hosts who have trouble viewing dark mode applications. Therefore the decision was split between AudioVault and ENCO DAD. Although AudioVault has listener statistics, while ENCO DAD does not, ENCO DAD has metadata integration and the ability to create metadata, which AudioVault is lacking. In addition, ENCO DAD offers multilingual support, Spintron compatibility, remote access, and light mode. Lastly, although both applications have very usable interfaces, the simplicity and intuitiveness of the ENCO DAD software provides an additional slight edge above AudioVault and therefore earns it its spot as the choice for the high-tier recommendation. It should be noted, of the criteria considered, ENCO DAD only lacked listener statistics and a free trial.

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Appendix

Appendix A - *Consent Form*

INFORMED CONSENT FORM (VIDEOTAPE)

Consent Form For Videotaping and Transcribing Interviews

“The Modern Music Library”

Researcher: Jean-Luc Pierre-Louis, Worcester Polytechnic Institute

This study involves the video taping of your observation session and interview with the researcher. Neither your name nor any other identifying information will be associated with the video or the transcript. Only the researcher will be able to view the video.

The video will be analyzed and potentially transcribed by the researcher and erased. Transcripts of your interview may be reproduced in whole or in part for use in presentations or written products that result from this study. Neither your name nor any other identifying information (such as your voice) will be used in presentations or in written products resulting from this study.

Immediately following the interview, you will be given the opportunity to have the video erased if you wish to withdraw your consent to recording or participation in this study.

By signing this form you are consenting to:

- having your observation session and interview recorded;
- having the video analyzed and transcribed;
- use of the written transcript in presentations and written products

This consent for taping is effective until March 7, 2020. On or before that date, the video will be destroyed.

Participant's Signature: _____

Date: _____

Appendix B - *Research Questions*

Interview Questions

1. What is the most difficult/frustrating part of your hosting session?
2. What is your least favorite task?
3. What task do you spend the most time on?
4. What would you like to spend the most time on?
5. How do you choose music/ prepare playlists?
6. Where do you get information about songs?
7. Is there information you wish you had access to in the booth?
8. Do you have any unique rituals which are part of your DJing process? If so, what?
9. Is there anything about the way you currently work that you'd like to change?
10. What piece of equipment is the most complicated for you to use?
11. What piece of equipment is the easiest for you to use?
12. Is there any technology that you don't understand which hinders your use of it?

Survey Questions

1. How do you feel about the current DJ software used at WICN? (Audiovault)
2. For each software option: have you heard of this software?
3. For each software option: please give an overall rating out of 10.
4. For each software option: please list anything you like about it (if anything).
5. For each software option: please list anything you don't like about it (if anything).
6. For each software option: would you use this software?
7. Please list any features missing in the options shown which you feel are important (if any).
8. Please list any general features you are looking for in radio software (if any).

Appendix C - Survey Software Images

SAM Broadcaster Pro Interface



Virtual DJ Interface



RadioDJ Interface

RadioDJ v1.6.4.3

Station Name: Your Station Name - Your Slogan - RadioDJ v1.6.4.3

Host: HUN HAN DSACHINGIS KHAN

Intro: 00:00:51

Outro: 22:28:26

Remaining: 00:00:51

Current Song: 00:00:50 ACAPELA - LIVE

WEDNESDAY, 25 SEPTEMBER 2013

Daily Sweepers

1. Paradise Bailando [S] [V] [X] 22:29:18 00:00 00:06:46

2. Jingle 2008 Radio DJ 01 [S] [V] [X] 22:36:04 00:00 00:00:10

3. Samantha Sang Emotion [S] [V] [X] 22:36:14 00:00 00:03:51

4. Smoke Oh Carol [S] [V] [X] 22:40:06 00:00 00:03:25

5. Hermes House Band Que Sera Sera [S] [V] [X] 22:43:32 00:00 00:04:19

AUTODJ

AUTOMATED

ROBERT

REPLACE

CLEAR

INPUT

SEARCH

INSTANT PLAYERS

ONLINE REQUESTS

Any Category	Any Subcategory	Any Genre	Artist	Title	Album	Info	Duration
			Aerosmith	Amazing			00:00:00 00:05:52
			Aerosmith	Cryin' [1993]	Get A Grip		00:00:00 00:04:59
			Aerosmith	I Don't Want To Miss ...	"Armageddon" Soundtrack		00:00:00 00:04:45
			Aerosmith	Love In Elevator			00:00:00 00:05:20
			Aerosmith	Sunshine			00:00:00 00:03:34
			Aerosmith	Walk This Way	The Rolling Stone Magazin...		00:00:00 00:03:32
			Afrika Bambaataa & Th...	Planet Rock	The Rolling Stone Magazin...		00:00:00 00:05:17
			Afrejack	As Your Friend (Radio ...	As Your Friend (Radio Edit...		00:00:00 00:03:54
			After 7	Till U Do Me Right (19...			00:00:00 00:04:43
			After the Fire	Der Kommissar	Sounds of the Eighties - T...		00:00:00 00:04:01
			Air Supply	The One That You Love	Sounds of the Eighties - 1...		00:00:00 00:04:01
			Air Supply	Making Love Out of No...	Sounds of the Eighties - T...		00:00:00 00:04:48
			Air Supply	Lost in Love	Sounds of the Eighties - T...		00:00:00 00:03:44
			Alabama Featuring 'n S...	God Must Have Spent ...			00:00:00 00:03:10
			Alan Jackson	Summertime Blues	34 Number Ones		00:00:12 00:03:09

1-100/2857

AUXILIARY PLAYERS

Player 1 00:00:00 00:00:00 00:00:00

Player 2 00:00:00 00:00:00 00:00:00

Player 3 00:00:00 00:00:00 00:00:00

HISTORY

NOTES

SONG DETAILS

Play Date	Artist	Title	Duration
9/25/2013 10:25:25 PM	Dsachingis Khan	Hun Han Dsachingis Khan	00:03:53
9/25/2013 10:25:18 PM	Jingle 2007	Radio DJ 15	00:00:07
9/25/2013 10:22:27 PM	Ace Frehley	New York Groove	00:02:52
9/25/2013 10:20:04 PM	Jessica Jay	Denpasar Moon	00:04:56
9/25/2013 10:15:57 PM	Icehouse	Electric Blue	00:04:12
9/25/2013 10:12:40 PM	Wayne Newton	Daddy Don't You Walk So Fast	00:03:19
9/25/2013 10:12:18 PM	Jingle 2008	Radio DJ 16	00:00:22
9/25/2013 10:08:45 PM	Mark 'oh	Tears Dont Lie	00:03:34
9/25/2013 10:04:38 PM	Boney M	Rivers Of Babylon	00:04:10
9/25/2013 10:02:05 PM	Hamilton, Joe Frank & Reynol...	Don't Pull Your Love	00:02:36

TRACKS MANAGER

PLAYLIST BUILDER

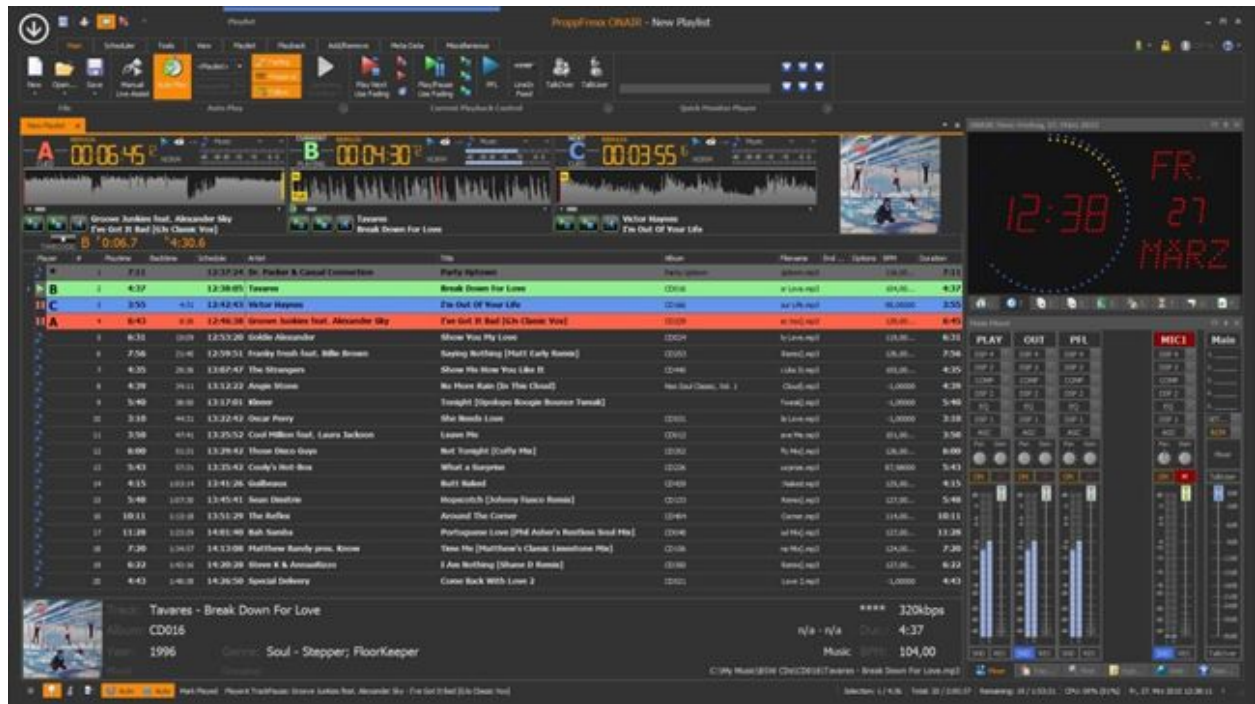
NOW PLAYING INFO

AUDIO PROCESSING

SAY TIME

OPTIONS

ProppFrexx ONAIR Interface



Mixxx Interface



Appendix D - *Survey Consent Form*

We are interested in understanding radio broadcasting software. You will be presented with information relevant to radio broadcasting software and asked to answer some questions about it. Please be assured that your responses will be kept completely confidential. The study should take you around seven minutes to complete. Your participation is voluntary. You have the right to withdraw at any point, for any reason, and without any prejudice. If you would like to contact the Principal Investigator in the study to discuss this research, please e-mail jdpierrelouis@wpi.edu. By clicking the button below, you acknowledge that your participation is voluntary, you are at least 18 years of age, and that you are aware that you may choose to terminate your participation at any time and for any reason. Please note that this survey will be best displayed on a laptop or desktop computer. Some features may be less compatible for use on a mobile device.

I consent, begin the survey

I do not consent. (Ends the survey)

Appendix E - *Total List of Software Considered*

Dalet - <https://www.dalet.com/>

AudioVault - <https://www.bdcast.com/products/studio-products/audiovault/>

SAM Broadcaster Pro - <https://spacial.com/sam-broadcaster-pro/>

PlayoutONE - <https://www.playoutone.com/>

Virtual DJ - <https://www.virtualdj.com/>

MediaMonkey - <https://www.mediamonkey.com/>

RadioDJ - <https://www.radiodj.ro/>

ProppFrexx ONAIR - <https://www.proppfrexx.radio42.com>

RadioBOSS - <https://www.djsoft.net/>

PlayIt Live - <https://www.playitsoftware.com/Products/Live>

mAirList - <https://www.mairlist.com/en/>

StationPlaylist Studio Pro - <https://stationplaylist.com/studio.html>

NextKast Pro - <https://www.nextkast.com/>

Mixxx - <https://mixxx.org>

Traktor Pro 3 - <https://www.native-instruments.com/en/products/traktor/dj-software/traktor-pro-3>

ENCO DAD - <https://www.enco.com/products/dad#features>

iMediaTouch - <http://www.omt.net/products.php>

MegaSeg - <https://www.megaseg.com/>

RCS Zetta - <https://www.rcsworks.com>

Radiologik DJ - <https://macinmind.com/?area=app&app=radiologik&pg=info>

Rivendell - <http://www.rivendellaudio.org/>

WinAmp - <https://www.winamp.com/>

Simian - https://www.bsiusa.com/software/simian_pro/overview.php

WideOrbit - <https://www.wideorbit.com/products/automation-radio/>

Appendix F - Software Criteria

- 1) **price**
- 2) **shift screen presets**; indicating the ability to customize the interface layout in some way
- 3) **listener statistics**; indicating the ability to receive radio listener statistics
- 4) **metadata integration**
- 5) **metadata creation**
- 6) **free trial** (if there is one or not)
- 7) **simplicity**; the investigator's opinion on the app's simplicity considering WICN's hosts
- 8) **library**; the investigator's opinion on the quality of functionality for the software's library
- 9) **multi-lingual support**, specifically for spanish
- 10) **Spinitron compatibility**
- 11) **remote access**; whether or not the software may be controlled remotely
- 12) **light mode**; whether the application has a light interface theme
- 13) **DJ rating**; the rating WICN hosts gave the software if any