



WPI

Audio Filters For Music Styles

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Abstract

With today's digital audio workstations, novice audio engineers may find themselves overwhelmed by the number of options when applying audio effects to enhance their recording. Experienced engineers, by contrast, purposefully apply large numbers of audio effects to achieve intended sonic outcomes. The objective of this project was to review the effect chains used by professionals in well-known styles and create a technology-based resource to help novice engineers apply and manage sets of effects over multiple tracks. We identified stylistic elements related to effects used in established musical genres, and created a prototype that provides users a drop-down menu with a set of preset effects associated with those music genres. We then surveyed a group of novice audio engineers about their experience using the prototype with an audio project that initially had no effects. Results from our survey showed a generally positive reception to using such a prototype.

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We would like to sincerely thank Professor Vincent J. Manzo for helping and advising this project. We are grateful that he met with us each week to discuss details about idea, research, implementations and evaluations in the past three terms.

We are thankful to Professor Daniel Manzo for taking time out of his class to help us arrange and conduct our survey. Without him, we would have never been able to get a successful response from potential users.

Authorship

This report was written collaboratively by Thomas Lourenco, Joseph Martin, and Aleksa Perucic.

Executive Summary

Introduction

Recording a song digitally can take a long time, and computer software creates a obstacle to musicians that may not be technologically adept. This is a common difficulty, and various software has been developed in attempt to resolve the struggles of many musicians. Two popular examples are iZotope Ozone and the Fabfilter plugin pack.

While this software is useful in some cases, there are cases where it might not be the most intuitive approach. Instead of making the presets involve vague and subtle changes, we decided to create software that would involve presets tailored to a specific artists sound. The user would simply select the preset of the artist they want to emulate, and the software would automatically apply all the relevant effects.

Background

iZotope Ozone and FabFilter make it difficult for new users to select the right filters for the sound they're going for. A new user might not know how to use iZotope's Control Dynamics or Emphasize Midrange presets, since the names don't describe much and use music production terms that might not be immediately obvious to beginners.

Ableton Live shares the same problem. New users most likely won't understand what an equalizer or a compressor effect is, and so using these presets is difficult. Beginners need simpler

presets that they can associate with descriptions of sounds they already know, not confusing industry terminology.

Experienced users also have problems with this software. Specifically, it is difficult for them to easily apply these plugins over multiple tracks quickly and easily. iZotope Ozone requires a lot of processing power, so it cannot be easily applied to multiple tracks. On the flipside, Fabfilter allows filters to be applied on individual tracks without much issue, but it requires the user to apply them individually. Due to these constraints, this severely limits the speed at which experienced users can create projects, slowing their workflow. This functionality is also missing from Ableton Live itself, severely limiting users.

Methodology

After reviewing the previous work in our research space, we set out to collect data on the artists we would consider making our presets for. We decided the simplest way was to select artists based on popularity. To this effect, we used two popular music charts: The Billboard Hot 100 and Official Charts UK Top 60. Both of these are long-standing indicators of popular singles and albums throughout history. We cross-referenced the singles in the Hot 100 with the albums in the Top 60 to find the final artist picks used in our software. The final list of artists included The Beatles, Madonna, Michael Jackson, Queen, Pink Floyd and Simon and Garfunkel.

After creating our list of prominent artists, we began researching their respective musical styles, and the studio work behind it. This involved reading interviews with the sound engineers and analysis of the artist's most popular songs. Alongside the research, we were also working on

the coding aspect behind the software. All the programming was done in Max for Live, including the user interface. Once the software was functional, we began with creating the filters.

Once the software was complete, we surveyed Ableton Live users to see what they think about our solution.

Findings

Overall, there was a positive reception to our system and the presets we provided. Most felt that the provided presets improved the sound of the stems, and many found the system helpful in applying filters and improved the speed of their workflow. Unfortunately, most inexperienced users found it difficult to modify their filters, but this was expected.

Conclusions and Future Work

During the implementation of our system and presets we ran into a few limitations. Among these were limitations were functionality that was not accessible through the Max for Live API which prevented us from implementing some features as well as we would have liked. Our survey also had a relatively small sample size. Despite these limitations, because of the general positive reception, we believe there is room for future work and research in this area. The two main directions for future work are in further developing the user interface and the functionality provided by the system and in the improvement of the presets themselves.

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1 Introduction

Music production is a time expensive process. Inexperienced musicians can spend hours tweaking a single plugin, trying to get “the sound” of a certain artist. For someone new to Digital Audio Workstations, the plethora of VST effect software can be overwhelming. This often leaves musicians tired, frustrated, and creatively drained.

A good musician is one whose workflow is quick and effortless. Computer software creates a barrier, since it is no longer as simple as plugging your guitar into an amp and strumming away. There is an infinite amount of configurations one could arrange digital effects, and this sort of choice can be straining on someone who doesn’t know how to apply them properly. This is especially the case for bedroom musicians simply trying to put their sounds to a digital medium, who may not have any experience with audio effects and how they work.

This problem has been recognized in the music industry, and various software has been released in attempt to resolve the struggles of many musicians. Two popular examples are iZotope Ozone and the Fabfilter pack, and while this software is being actively used in the music industry, it is not a flawless solution, and still presents many hurdles for new musicians. iZotope Ozone comes with various presets that users can use, such as “Brighten Sound” and “Amplify Bass”. While these presets are useful in some cases, they also cover very broad categories, which may not be useful if you’re trying to emulate a specific sound. The Fabfilter pack consists of dozens of plugins which are used for mastering, but this adds the complexity of having to mix and match various plugins, and assumes the user knows how to tweak them.

For our project, we decided to take a different approach to mastering software. Instead of making the presets involve vague and subtle changes, the software would involve presets tailored to a specific artists sound. If a musician wanted to make his song sound like Pink Floyd, all he would have to do is record the guitar, and click “Pink Floyd” on the preset selection; our software would handle the rest.

Our software would hold a database of different effects racks: Equalizers, Compressors, Delays, Reverbs, Limiters, Phasers and Saturators arranged in different configurations would work to emulate the signature sounds of popular artists. This “one button” approach would incredibly simplify the general workflow, and allow artists to get their vision across painlessly and efficiently.

2 Background

In the field of music production the sound of each artist can vary incredibly depending on the techniques used. A common problem that people run into when they start recording music digitally is the cornucopia of different audio effects they can apply to their recordings. This amount of choice can be extremely overwhelming to a new user.

For instance, a new user that wants to replicate the sound of an artist will undoubtedly have a hard time with the numerous effects that can be applied to tracks in software like Ableton Live. In order to create their desired sound, the user would need to select the proper effect, apply it to the correct track, modify the preset values to match what they need, and repeat the process for each effect across all the tracks. This creates a bar of entry that is unreasonable to ask any new user to handle when trying to enter the field.

Meanwhile, more experienced users run into a separate issue of having no good starting point when creating a new project. They still have to comb through all the known effects and apply them individually to each track to create their new project. This process can be very time-consuming and ultimately limits the user when their trying to start on their new song.

An experienced user may want a way to quickly set up and maintain project files, however, there is no way to apply associated effect chains over multiple tracks in Ableton Live. The users would have to apply the same effects over and over every time they start a new project file. This large overhead from starting new projects can prevent experienced users from creating new projects, due to lack of commitment on the idea.

The existing solutions to these problems include iZotope Ozone and Fabfilter. iZotope Ozone offers a “mastering suite” which is applied to the master channel. It has dozens of presets that can instantly apply several different effects onto the master track, including compressors, filters, equalizers, saturators, distortions and more. This can potentially provide new users with more understandable filters to use when first creating music, while also giving experienced users a starting point for their projects. Although it offers many different presets, it is very hardware intensive and is only meant to be applied to the master channel.

The other solution available is the Fabfilter effect pack. It consists of several modular VST effects that can be applied to any track. It offers plenty of software you can use, but you have to apply every effect individually to every effect. This is different from Ozone, since Ozone can apply multiple different effects at once when you select a preset. With Fabfilter, you have to do this manually.

Both of these programs provide amazing services, but simply do not provide easy ways for new users to get into music production. In the case of iZotope Ozone and FabFilter, new users may not know what filters they need to get closer to the sound for their project. For instance, a new user will likely not know when to use iZotope’s Control Dynamics or Emphasize Midrange presets. Instead new users need filters that are more obvious and easy to apply and understand.

Additionally, Ableton Live only provides presets inside on its preexisting effects. New users don’t understand what an EQ8 or a Phaser effect are, so effectively using their presets becomes an even more difficult task. The new users need a set of higher level presets to get

themselves associated with the software, rather than more complex presets that they won't understand.

This software also fails to address all the needs of experienced users, who can't easily apply a large amount of filters across multiple tracks in their projects. For example, iZotope Ozone requires a lot of processing power, making it unrealistic to use the program on multiple tracks. In the case of FabFilter, the program allows filters to be applied on individual tracks without much issue, but the user has to apply each filter separately. This limits the amount of ways an experienced user can start a project, which slows down their workflow significantly. Ableton Live doesn't provide this functionality as well, since users have to apply individual effects to each individual track in order to create their desired sound.

3 Methodology

The objective of this project was to create a simple way to apply filters to tracks in Ableton Live by using Max for Live. It was decided early in the planning phase that the filters would be based on popular artists' style in order to be more accessible to less knowledgeable users. We also determined that a Max Patch for the master track should control the filters for all other tracks in order to keep the program relatively simple for users. The following list were the objectives set to complete the project, while keeping in mind our previous constants.

1. Determine popular artists to use as a base for the filters.
2. Research the artists' production techniques and musical styles.
3. Develop a Max Patch for Ableton Live that applied filters over multiple tracks and allowed for filters to be created easily.
4. Create filters based on the collected artists for a single set of stems.
5. Verify filter quality and make adjustments using a larger set of stems.
6. Collecting data via a survey of a class.

3.1 Establishing the Artists

The first step in filter creation was to determine the artists that should be replicated. In order to do this the team decided to select artists based on popularity.

3.1.1 The Billboard Hot 100

The modern Hot 100 list from Billboard judges a song's popularity by industry metrics. According to Trust (2013), the modern list uses sales numbers, radio airplay, and streaming data to determine which songs are the most popular at any given time. This quantitative approach gave the team confidence in the validity of the list and led us to compile artist data from it.

Billboard provides a long history of their Hot 100 list online. Although their system of grading and the length of the list varies on the year, data from as far back as 1958 is readily available on their website. The data, however, is split out onto a separate page for each year, and there is not a convenient aggregation. In order to properly compile all of this data we developed a script that fetched the charts for each year and counted how many times each artist appeared. A listing of the script used can be found in Appendix A.

A few issues appeared with this technique, however they were easily accounted for when both lists were cross referenced.

The first issue was that some artists would collaborate on tracks together and therefore the script would create a new "artist" for both of them. This issue, however, was negligible because the artists that were generally collaborating were already very high on the list - for instance, Mariah Carey and Boyz II Men, who appear at spots number 1 and 3 respectively also appear together at number 20 as "Mariah Carey and Boyz II Men". In addition, the cross reference should pick up on any artists that might be too low on the script's list due to multiple collaborations.

The second issue is that the charts only list the top single each week. Therefore, any artists that consistently get top ten rankings, but never a number one, would be absent from the list. This issue is again addressed by the cross referencing of the lists, since it accounts for artists that sold well, but may have weak singles.

Below are the top twenty artists produced by the script when it ran through the Billboard Hot 100 from 1958 to 2016. Some of the artists are double due to collaborations, but overall the list is a good metric for which artists have been popular over that period of time.

Pos	Artist	Total #1 Songs
1	Mariah Carey	60
2	The Beatles	54
3	Boyz II Men	34
4	Madonna	32
5	Whitney Houston	31
6	Michael Jackson	30
7	The Black Eyed Peas	28
8	Bee Gees	27
9	Elton John	23
10	Usher	22
11	Adele	21
12	Elvis Presley with The Jordanares	21
13	Janet Jackson	21
14	The Supremes	19
15	TLC	18

16	Katy Perry	18
17	The Rolling Stones	17
18	Rod Stewart	17
19	Olivia Newton-John	17
20	Mariah Carey and Boyz II Men	16

Table 1: Compilation of artists appearing most frequently on the Billboard Hot 100

3.1.2 Official Charts UK Top 60 Best Selling Albums

After sixty years of existence the Official Albums Chart released a list of the top 60 biggest selling albums in the United Kingdom. Since the list was based on quantitative data collected from an official source the team deemed it an acceptable source for our paper (Copsey, 2016).

The only issue the use of this chart poses is that these are the album sales for the United Kingdom alone, which shows favoritism to UK artists as over half of the entries come from the islands. However, since the list is being cross referenced with the Billboard Hot 100 the favoritism shouldn't affect the filters created.

Table 2 shows the top twenty-five albums listed on the chart for reference on the selection process.

Pos	Title	Artist	Year
1	Greatest Hits	Queen	1981
2	Gold - Greatest Hits	ABBA	1992
3	Sgt Pepper's Lonely Hearts Club Band	The Beatles	1967
4	21	Adele	2011

5	What's the Story Morning Glory	Oasis	1995
6	Thriller	Michael Jackson	1982
7	The Dark Side of the Moon	Pink Floyd	1973
8	Brothers in Arms	Dire Straits	1985
9	Bad	Michael Jackson	1987
10	Greatest Hits II	Queen	1991
11	Rumors	Fleetwood Mac	1977
12	The Immaculate Collection	Madonna	1990
13	Back to Black	Amy Winehouse	2006
14	Stars	Simply Red	1991
15	Come on Over	Shania Twain	1997
16	Legend	Bob Marley and the Whalers	1984
17	Back to Bedlam	James Blunt	2004
18	Urban Hymns	Verve	1997
19	Bat Out of Hell	Meat Loaf	1977
20	1	The Beatles	2000
21	Bridge Over Troubled Water	Simon and Garfunkel	1970
22	Dirty Dancing	Original Soundtrack	1987
23	Spirit	Leona Lewis	2007
24	Crazy Love	Michael Buble	2009
25	No Angel	Dido	2000

Table 2: Subset of Official Charts UK Top 60 Best Selling Albums

3.1.3 Cross-referencing the Lists

With the data compiled from both Billboard's Hot 100 and Official Charts' Biggest Selling UK Albums the group decided to note any artists that appear on both lists. Three artists fit in this category very well, with The Beatles, Madonna, and Michael Jackson appearing on both lists.

In addition to the three artists selected the group decided to pull a few other high ranking artists from the Official Chart's list. Two artists were selected: Queen and Pink Floyd. Finally, for the final artist selection the team determined that the artist's style of music should be unique and different when compared to the other artists. This led to the selection of Simon and Garfunkel to be the final artist the group would be producing filters for.

3.2 Research Artist Styles

Once the artists were selected the group needed to research the styles and production methods of each individual artist. If the team would be able to find good information on how the artists did their work then some of the methods may be replicable in Ableton Live for the filters.

3.2.1 The Beatles

As noted by [Hertsgaard](#) (1995), the work of Geoff Emerick, the recording engineer of The Beatles, greatly shaped their highly distinctive and signature sound. In an age of recording where the goal was to have your song sound similar to the stuff being played on the radio, Emerick's experimental and forward thinking recording techniques changed the way radio music was heard and enjoyed.

Lewisohn (1988) mentions some of the work by another engineer, Ken Townsend. Townsend would have a 4-track recorder in the control room, which he would overdrive the preamplifier gain to add distortion to John Lennon's vocals, adding a crisp tone to the vocal track. He was also a pioneer of modern equalizing, where he would greatly increase the presence of the kick drum and bass guitar compared to most music at the time, which was mostly focused

on mid-frequencies and not a lot of bass and treble.

One very noticeable aspect of the Beatles sound is the intense compression on mostly all of the dry tracks. This was done in an effort to give every instrument its due presence in the song, and would provide much-needed clarity to the mix, during a time where most mixing techniques would result in a muddled product.

3.2.2 Madonna

When Madonna recorded her popular song “Like a Virgin” her producer Nile Rodgers helped put together a rhythm track with more of a street-wise sound. This track utilized a guitar, bass, and drums which were played strongly and well miked. In particular the drummer played so loudly that almost none of the microphones available at the time could survive the volume. This loud and strong rhythm needs to be taken into consideration when creating a proper filter for Madonna’s music.

Along with the rhythm track saxophone, keyboard, and backup vocals were recorded. This array of instrumentation will also require representation in our audio filter. (Buskin, 2007)

3.2.3 Michael Jackson

Bruce Swedien, the sound engineer for many of Michael Jackson's recordings used a number of techniques to produce a distinct sound. For example, Senior (2009) notes that the drums recorded for “Billie Jean” were recorded together, but with physical separation to produce a clean sound; additionally, all the drums were on a wooden platform raised off the floor, which helped prevented coupling between the low frequencies of the drums and the floor, keeping the drums from being picked up by other microphones as much.

Many of the recording techniques employed by Swedien were, as in the case of the drums done through physical means. For instance, Senior (2009) explains that the background vocals in “Rock With You” were recorded in multiple passes at varying distances from the microphones, but all amplified to the same level and combined to produce a unique sound because of the pattern of early reflections.

Swedien also very rarely used any substantial compression while mixing, “I want all that transient information there. And no compression or limiting on any drums or percussion. That's one of the biggest mistakes that I hear, I think, in modern pop recording.” (as cited in Senior, 2009).

3.2.4 Queen

One distinct component of Queen's sound was the way they recorded their background vocals. These were often three-part or four-part harmonies, sometimes even more. However, Braae (2015) points out that their recording process was unique in that each note of each part would be recorded multiple times, and by each singer, so that a three part arrangement might actually have been composed of over 30 tracks.

This kind of arrangement led to a very rich sound, since Freddie Mercury, Brian May, and Roger Taylor all had different vocal qualities, so having each sing all notes of each line created a spectrally diverse and rich sound.

Braae (2015) also notes that Queen applied the same kind of techniques to their guitar arrangements, the separate tracks of which would often be recorded on multiple different guitars, again creating a more diverse sound than if it had been recorded on a single guitar.

3.2.5 Pink Floyd

Alan Parsons started his career as a sound engineer working on The Beatles' last two albums, *Let It Be* and *Abbey Road*. He went on to do the sound design for Pink Floyd's most influential album, *Dark Side of the Moon*. The recording techniques used were very advanced at the time, which included a 16-track mixer, which was a rarity at the time and allowed the band to have a more expansive sound.

Gallagher (2012) notes Parsons was known to use unconventional mic placement, heavy effect use and a wide array of instruments. He would apply phase shifting and flanging on vocals and instruments, and would drown the mix in reverb.

One of the more interesting effects used was the holophonic system, an audio processing technique used to simulate a three-dimensional effect. The system used a conventional stereo tape to produce an effect that seemed to move the sound around the listener's head when they were wearing headphones.

3.2.6 Simon and Garfunkel

"The Sound of Silence" of silence is known as one of Simon and Garfunkel's most popular tracks, but the version that became popular in the United States was not the original incarnation of the track. Instead, producer Tom Wilson had the track overdubbed with an electric bass, two electric guitars, and a drumset. This drastically changed the sound of the track and Wilson even expressed some regret on the matter.

Therefore, to keep true to the sound of Simon and Garfunkel the basis of our filter will focus on the more acoustic sound that the duo preferred. Along with the acoustic sound that

usually went with their songs, there was also a lot of echoing. Paul Simon even wrote “The Sound of Silence” while in his bathroom due to the echo the tiles provided. (Mastropolo, 2016)

Even with this in mind, however, emulating Simon and Garfunkel’s style will likely still be difficult. The musicians used some weird techniques at time for recording. During the recording of “The Boxer” Paul Simon almost had a concertina record the opening to the track, emphasizing the multitude of instruments that might need to filters to accommodate this style. Additionally, there will be sounds we can’t replicate, such as the sound of a snare drum being hit next to an open elevator shaft, which the duo also used in the recording of “The Boxer.” (Simons, 2012)

3.3 Building a User Interface

Once the artists were established and researched the only task limiting the production of audio filters was the lack of a user interface. The team determined that the best system for the project was to produce a master patch and a slave patch to implement on separate tracks.

3.3.1 The Patch

The patch was created with simplicity in mind and only uses 2 major UI elements. The first element is a drop down list of filters that can be applied to the tracks. When a filter is selected the patch has every other track mute all their filters and then unmute the selected filter.

The second major UI element is a button that refreshes the list of filters. When the button is pressed the master checks the chains in all the tracks and creates a new drop down options for

that filter. The master track also verifies that there are no duplicates in the list, although it does not currently account for typos.

This system allows not only for filters to be applied across all of the active tracks, but also allows filters to be limited to specific instruments. For instance, if an artist doesn't have a rhythm part in most of their music then for their filter no rhythm track would be created. When applying filters, even if the user has added a rhythm track it will be muted and better match the artist's style of music.

The interface itself can be seen in figures 1 and 2. The interface consist of two effects racks and a Max for Live patch. The outer effects rack is used simply group the patch and the other effects rack together, making it easier to copy and paste or save as a preset in Live. The patch communicates with all other instances of the patch so they can coordinate which preset is active, and the inner effects rack contains the audio effects presets. When using the drop-down menu to select a preset, as shown in figures 1 and 2, the patch sends a message to all instances of the patch (including itself) to activate the chain corresponding to the selected preset, and deactivate all other chains. It also sets the effects rack view to show the active chain.



Figure 1: The main UI of the patch



Figure 2: After switching presets

The implementation is grouped into 3 main sections, shown in figures 3, 4, and 5. Figure 3 shows the UI related components of the patch, including the button that sends a message to all instances of the patch to output the list of presets and a way to receive that data and repopulate the drop-down menu, as well as the drop-down menu that sends a message to all instances of the patch to update the active preset.

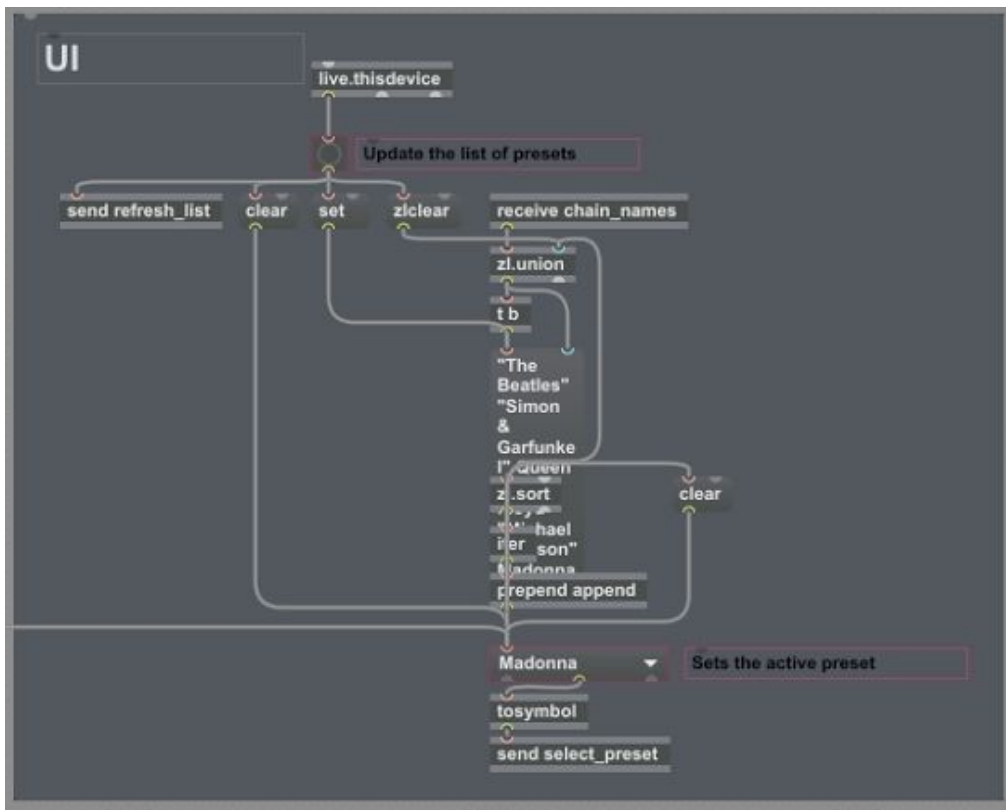


Figure 3: UI related patch components

Figure 4 shows the components of the patch that integrate with the Max for Live API. This portion of the patch listens for messages to update the active preset and does so by unmuting chains matching the requested preset and muting all other chains, as well as requesting that Live change the currently selected chain (the one displayed to the user) to the one corresponding to the requested preset.

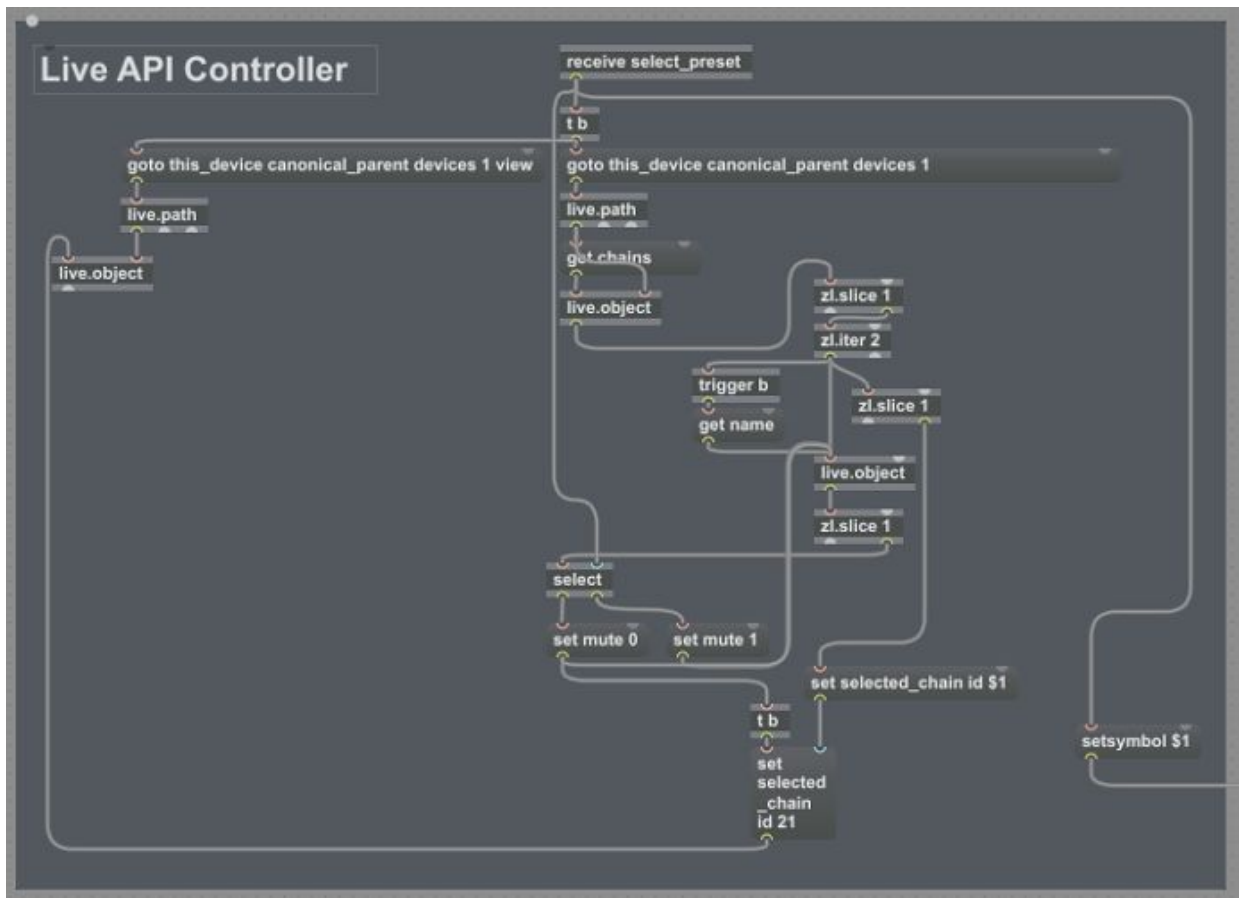


Figure 4: Patch components interacting with the Ableton Live API

Figure 5 shows the components of the patch that listen for requests to get the list of available presets. This is accomplished by querying the Max for Live API to determine the list of chains available on the corresponding effects rack (the effects rack sitting to the right of the

patch receiving the request) and sends this data back to the portion of the patch that manages the UI. Because a “send x” object broadcasts the message to all instances of the corresponding “receive x” objects, when the user clicks the button to refresh the list of presets, a message is sent to each instance of the patch. Each instance then checks the list of presets it has and broadcasts this list to each instance. In this manner, every instance receives aggregation of all presets across all instances of the patch. Each instance of the patch then deduplicates and sorts this list and then repopulates the dropdown menu.



Figure 5: Patch components for retrieving the list of presets

This design using effects racks controlled by a Max patch was chosen for two main reasons: it makes adding new presets very easy, and it may be intuitive to those with experience

using Live. To add a new preset, all that must be done is to add a chain with the desired name to the effects rack on each track, and add the desired effects within those chains. While using a similar workflow is possible without a patch similar to the one described here, the patch greatly simplifies the orchestration of keeping many such effects racks synchronized across multiple tracks. Doing this manually requires multiple clicks for every track to enable the right chains in all the effects racks. The patch automates this with a minimal amount of effort on the part of the user. Also, because the patch builds on the native Live effects racks, and provides a simple interface, it is aimed at being intuitive to use, especially for those who have some experience with Live already.

3.4 Creating the Filters

For the filter creation process we made sure to utilize the same set of stems for every artist's filter. The stems we selected were purposely used since they are a middle ground between all the other artist's styles and have a fairly neutral sound. This gave us a good starting point for every artist and allowed us to compare the subtleties of each artist's styles.

3.4.1 The Beatles

The Beatles have a very recognizable sound of their era. Since they used analog recording, we would have to apply various effects to mimic the effects of this in a digital medium. The first change would be applying a slight vinyl distortion to the master channel. This would give it a crisp, grainy sound that is reminiscent of the tapes used for recording at the time.

The next obvious change would be to EQ out some of the lower frequencies. The technology used in recording Beatles songs didn't allow for most bass frequencies to be captured, so we remove most of them in the filter. Another effect applied on the master is a compressor with a decently high ratio, but a lower threshold.

These effects in tandem replicate the wall of sound recording approach that was used at the time. The result is a crisp, resonant sound with all the characteristics of a typical Beatles song.

3.4.2 Madonna

Madonna songs feature a typical 80s pop sound. To replicate, we start by boosting the bass frequencies on the drums to give the kick drum more punch. We also boost the higher frequencies on the drums to give the hi-hats more presence. We then increase the mid-high frequencies on the vocal track, and lower the bass frequencies.

3.4.3 Michael Jackson

Michael Jackson's music was recognized for some of the punchiest and most impactful instruments and vocals. To begin recreating his sound, we would increase the drum track EQ on the higher frequencies to make the hi-hats louder and more apparent. The hi-hats of a pop song are used to add groove and personality. We then increase the drum track EQ on the lower frequencies to make the kick drum stronger.

Next, we applied a short delay to the vocals to give a little more presence to them. We then apply an EQ to the vocals, that boosts the higher frequencies to give them a more crisp

sound. Likewise, we slightly increase the higher frequencies on the master channel EQ to add brightness to the track.

3.4.4 Queen

Queen are known for their ‘epic’ sound, with bombastic percussion and symphonic vibrant instruments. We imitated this sound with various effects.

On the drum track, we applied an EQ to increase highs and mids. This gave the drums a louder, more “in your face” sound. We applied a compressor with a high ratio and low threshold to make the drums more impactful.

For vocals, we increased EQ on higher frequencies to give the vocals a more piercing place in the mix. We applied pre-delay and post-delay to the vocals to give it a roomy, epic feel.

3.4.5 Pink Floyd

Pink Floyd are known for their iconic psychedelic sound. The sound engineers that worked on some of their most notable projects have all become industry legends as a result. Replicating this sound is tricky, as it encompasses several genres and techniques. Pink Floyd’s sound also evolved during their career, making this even more complicated.

We decided to go for a general “Dark Side of The Moon” psychedelic mix. To start, we apply a flanger, phaser and a delay to the rhythm guitar to get a “tripper” effect. We also take out a lot of the lower frequencies on the EQ in order to make it more airy and light. We apply a generous amount of delay and reverb to the vocals. For the drums, we decrease the EQ on the lower frequencies to create a softer sound, as we did with the rhythm guitar. We also EQ out some of the mid frequencies to reduce the prominence of the snare.

The final touch is a healthy amount of reverb on the master channel.

3.4.6 Simon and Garfunkel

Simon and Garfunkel are known for their soft and mellow tracks, such as “The Sound of Silence”. In order to recreate this sound, we applied multiple effects across the tracks. First, we applied an EQ to the guitar track, removing most of the higher frequencies. We did this in order to greatly soften the sound of the guitar, creating an “acoustic” sound, even if the guitar track is an electric guitar. We then applied the same equalizing to the drums, and additionally took out the bass frequencies in order to soften the kick drum. Finally, we applied a heavy reverb to the master channel, in order to recreate the roomy ambience Simon & Garfunkel are known for.

3.5 Surveying Users on the Software and Filters

In the case of our software, we wanted to find a way to evaluate its usefulness in a way that would give us the direct opinions of users. We decided that a survey was the most appropriate method of acquiring usability information. A survey would give the participants direct questions that would assess the usability in a way that is easily interpretable by us. It would consist of two parts: the first part would involve users testing our software, and the second would involve them evaluating the usefulness of the software through questions.

3.5.1 Creating the Survey

For the survey itself, we wanted to guide users through a basic set of tasks in a Digital Audio Workstation. The users would use our software to improve and speed up their workflow.

We would assess how much of an improvement users found from using our software compared to not using our software.

In the first part, users would be provided “stems” (audio files of various instruments that combine to make a song), and would be told to apply effects to them, in order to improve the sound.

In the second part, users would take the same stems from before, but instead of applying effects on their own, they would use our software. The software would automatically apply effects onto the stems, depending on what style the users choose.

The questions would assess how much of an improvement users saw in using our software in part 2 compared to applying the effects on their own in part 1.

The survey instructions and questions can be found in Appendix B. Our survey will be conducted with a group of 20 WPI students taking the course “Topics in Interactive Programming”.

3.5.2 Implementing the Survey

The survey was done on a class of 20 WPI students, who were taking the “Topics in Interactive Programming” class with Professor Dan Manzo. Four people opted not to take the survey, so the actual number of survey responses was 16.

The location of the survey was B30 in Alden Hall. Our team came in before the class started, and set up our software on all the computers in the Lab. This software used was Ableton Live for the user testing, and Google Forms was used to create and implement the survey.

4 Findings

The findings of the survey were generally positive. Most people said the filters improved the sound of the song, and most said that the software increased the speed of their workflow. A large number of our survey participants had almost no experience with Ableton Live. The participants with higher experience found a larger improvement, while participants with lower experience didn't notice a difference.

4.1.1 Survey Results

The survey results were promising in some regards, but also showed what issues may appear on a larger scale. From the 16 results recorded, 6 provided additional feedback in the form of comments. The large concern here was that three of the comments were addressing a potential bug in the program, which still needs to be investigated.

Numerical responses were then recorded and counted to create the graphs below. Each table notes the question asked, the scale ends provided, and the aggregated responses.

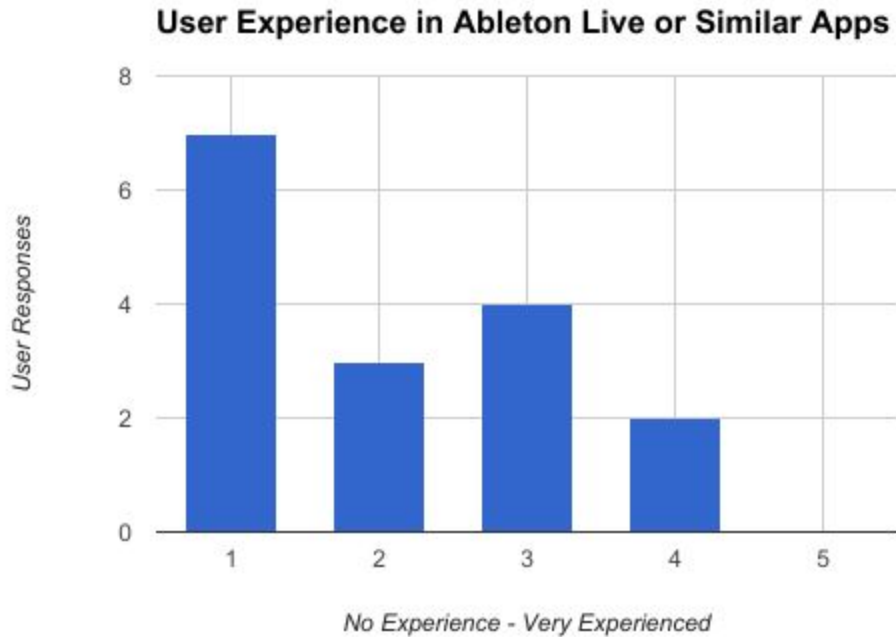


Figure 6: User responses on user experience.

This survey determined the amount of experience in Ableton Live or similar software that survey participants had prior to the survey. This data was gathered in order to filter the other questions based on user experience and determine the significance user experience had when using the provided patch.

For user experience the group was primarily low experience users, with over half citing low or no experience with Ableton Live or similar software. Unfortunately, this made filtering the data based on user experience weaker, since there were very few high experience users. If more surveys were planned then it would be important to try and obtain a more balanced user base, or have separate surveys for experienced users and inexperienced users.

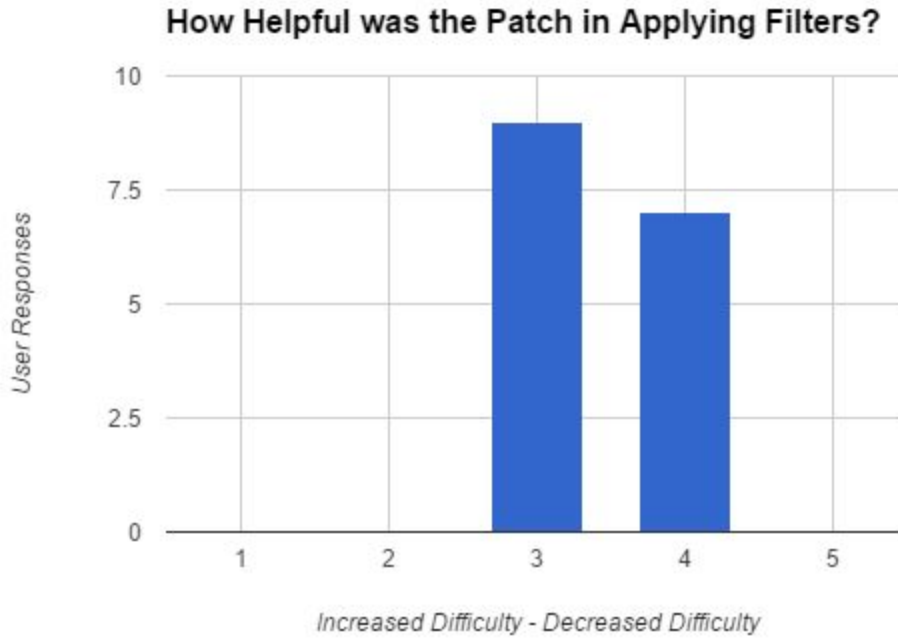


Figure 7: User responses on how helpful the patch was.

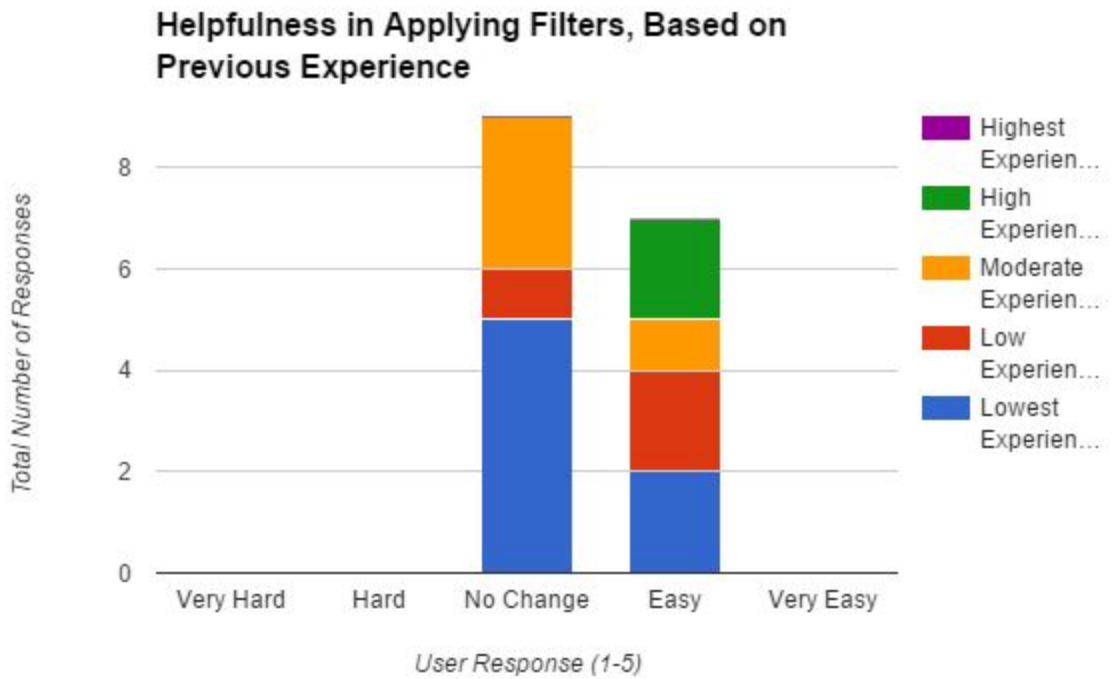


Figure 8: User responses on how helpful the patch was, based on user experience.

About half of survey participants felt that the patch made applying filters to the tracks easier, while the other half determined that it didn't make the task easier or harder. These results are overall positive, since no users reported the patch making the task more difficult, but still show that the patch has room for improvement.

In this specific case, filtering responses by user experience did not show any strong trend. While both high experience users thought the patch was helpful in applying filters, three of the four moderate experience users felt the patch was unhelpful. A similar pattern is seen in the difference between low experience user responses and the lowest experience user responses.

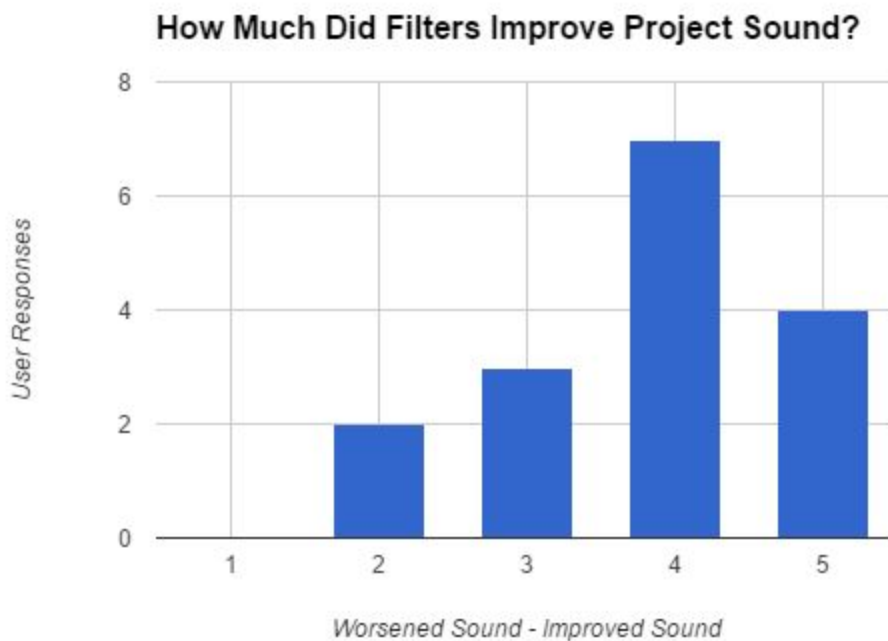


Figure 9: User responses on filter quality.

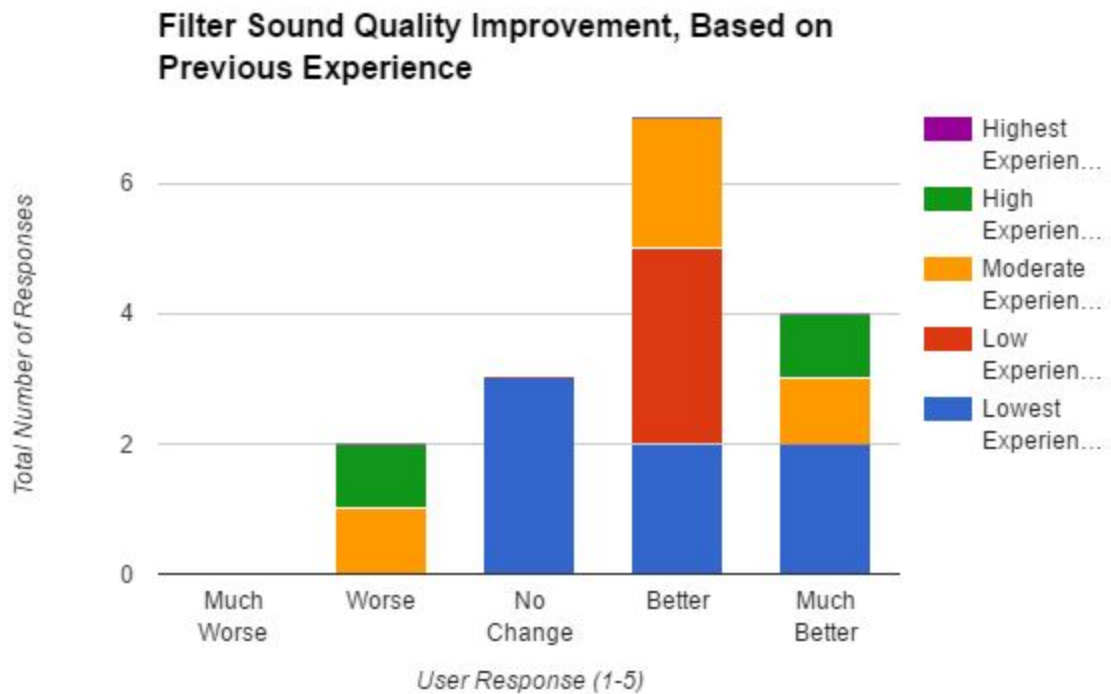


Figure 10: User responses on filter quality, based on user experience.

On the topic of whether filters improved project sound quality, a majority of users did find that there was improvement. Meanwhile, two users felt the filters worsened sound quality and three other felt the quality was unaffected by the filters. These results showed the filter quality was on the right track, but still has room for improvement.

Filtering results by user experience showed no concrete trends in whether users enjoyed or disliked the filter quality. This is clearly noted by the preferences of the high experience users, with one of the two feeling the filter improved sound quality significantly, while the other felt the filters worsened the sound quality of the project.

The theory for these results, as presented by the team, is that a user's personal preferences might play into whether the sound quality was good or bad much more heavily than experience. This theory can likely be tested by creating more filters to match more user

preferences and perform another survey with more participants to introduce more user preferences to the survey.

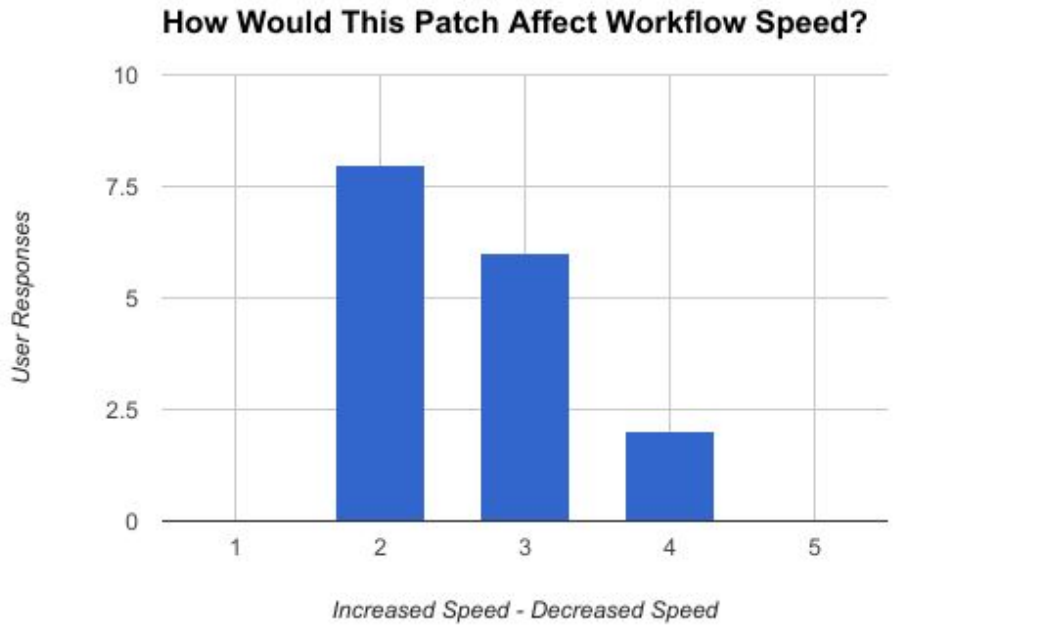


Figure 11: User responses on workflow speed.

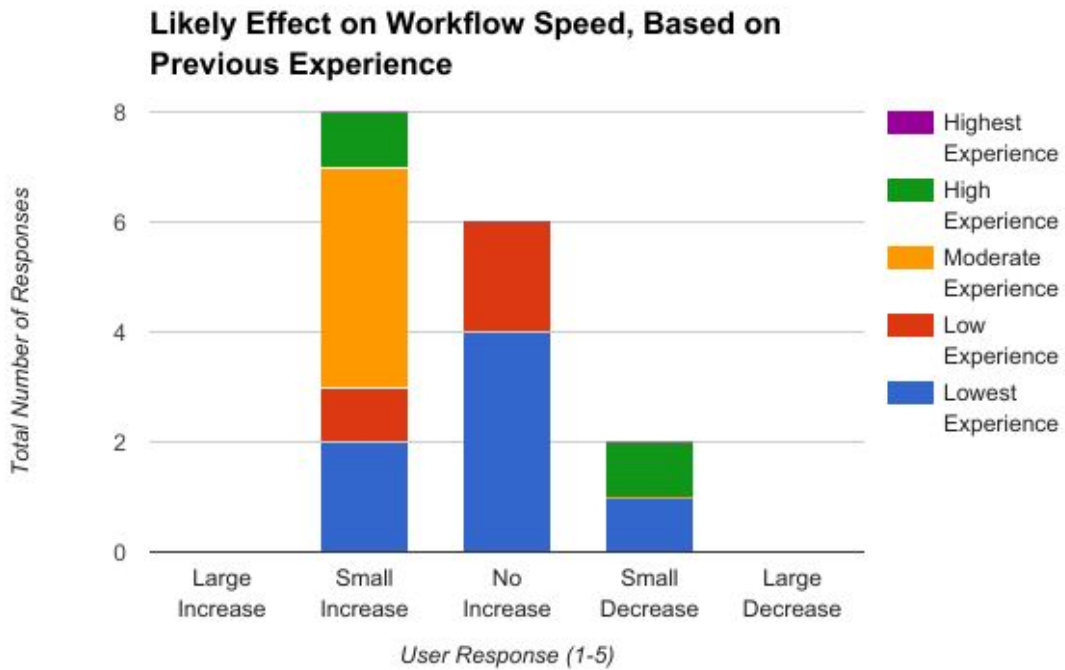


Figure 12: User responses on workflow speed, based on user experience.

The next survey question covered whether or not users felt using the patch would increase the speed of their general workflow. It's important to notice that when creating the survey, the scale here was accidentally flipped, so an increase of workflow speed was rated with a one, while a decrease was noted with a five.

Half of users reported that they felt the patch would increase the speed of their workflow a small amount, two users felt the patch would slow them down, and the rest felt it would not affect their speed. These results were generally positive and showed a larger trend when filtered by previous user experience.

Users with moderate to high previous experience found that the patch would increase their workflow speed, with the exception of one user. The theory the team established was more experienced users likely see themselves using the filters to get a strong starting point. Then, by using the filter closest representing their desired sound, they could modify the filter until they received the desired result.

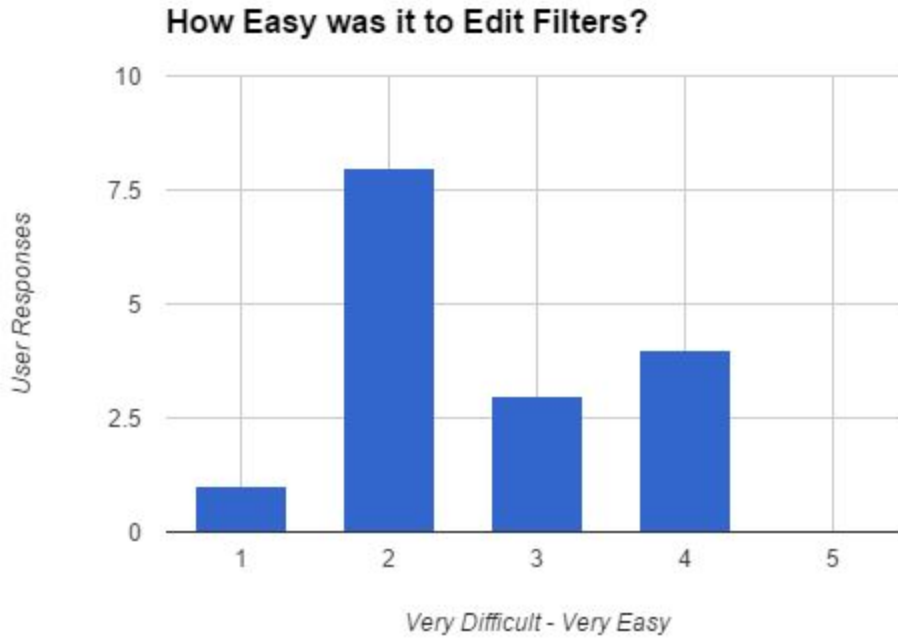


Figure 13: User responses on editing filters.

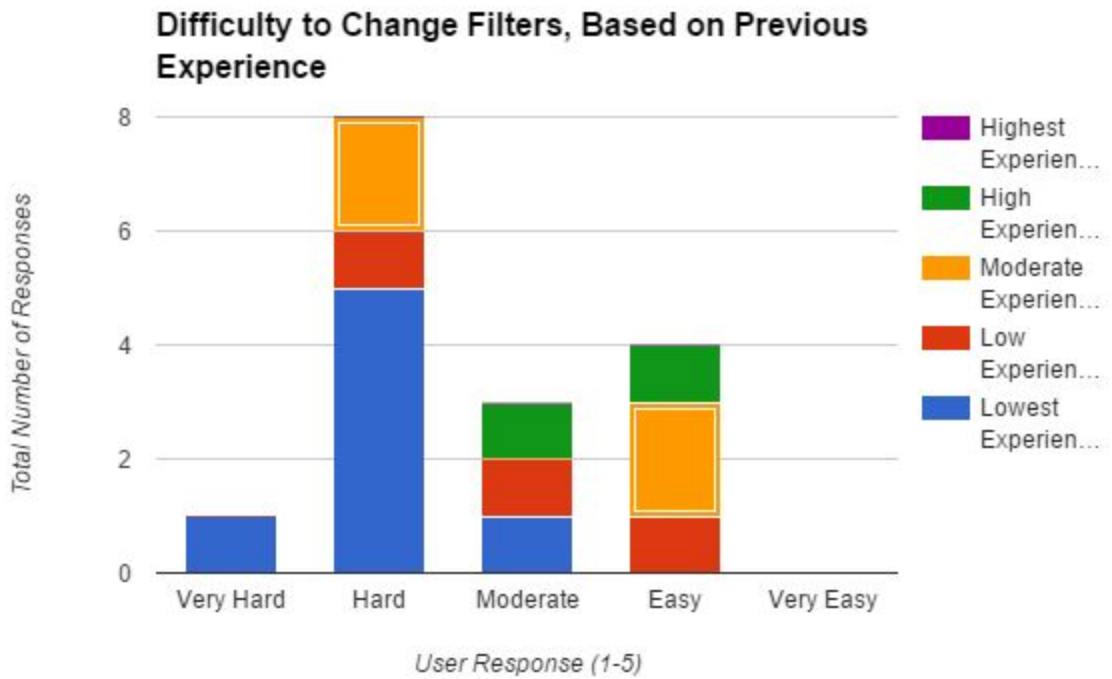


Figure 14: User responses on editing filters based on user experience.

The fifth question asked in the survey covered whether or not users felt it was easy to modify the filters. The patch performed the worst on this question in particular, with a majority of users believe the task was moderately difficult or worse. The reason behind this becomes more apparent, however, as the results are filtered by user experience.

When taking into account user experience, the reasoning behind the results become a bit clearer. First, most of the users that noted themselves as having the lowest level of experience felt that modifying the filters was hard. This is likely explained by the fact that modifying the filters requires a better understanding of Ableton Live and what effects can be applied through it. Users with little experience likely lack the capabilities to make these modifications. It's also important to note that, of the users that claimed modifying the filters were easy, two users had moderate experience, while one had a high level of experience. This further supports the theory that the more experience a user has, the easier it would be to modify the preset filters.

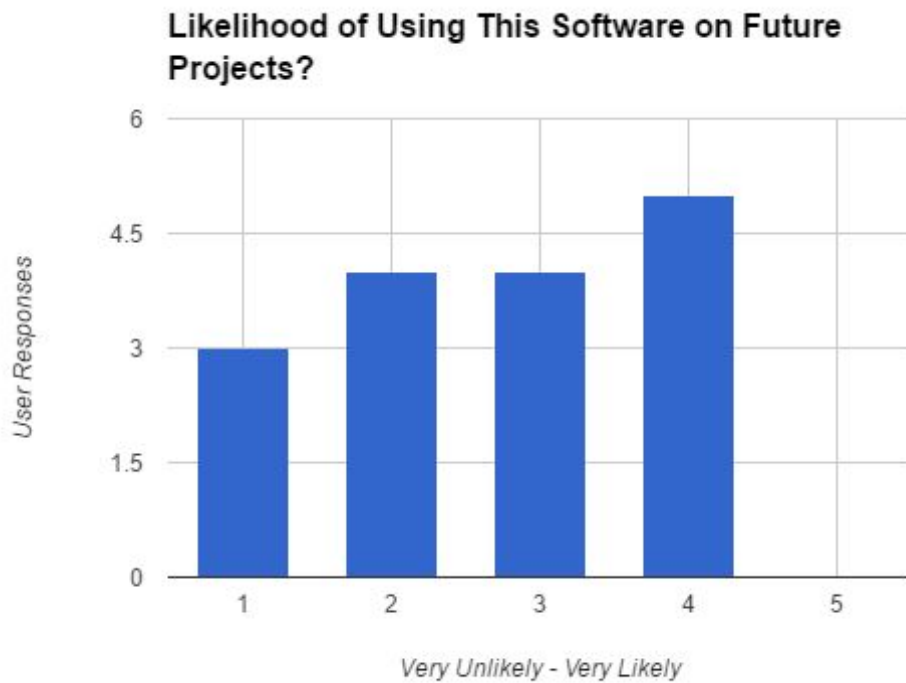


Figure 15: User responses on future project use.

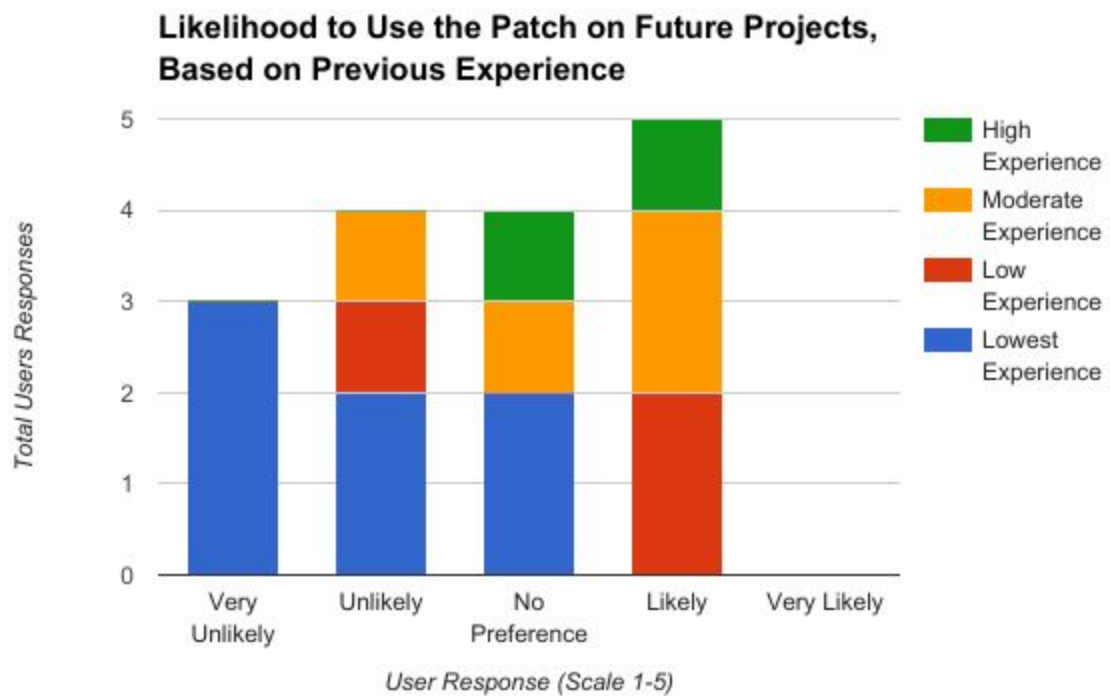


Figure 16: User responses on future project use, based on user experience

The final question from the survey asked users whether they would likely use the patch and filters in a future project. The results for this were more spread with a majority of users stating it was unlikely, but filtering the results by experience again opens a discussion on whether the patch is just more useful for users with more experience.

First, all users that answered with “Very Unlikely” were users that had the least experience of the survey participants. Meanwhile, none of the lowest experience users stated they were “Likely” going to use the patch in the future. This leads to an overall trend of users with more experience being more likely to use the patch for future projects. These results again support a theory, that more experienced users are more capable of using the patch effectively for their work.

5 Conclusions and Future Work

Overall, there was a positive reception to our system and the presets we provided. Most felt that the provided presets improved the sound of the stems, and many found the system helpful in applying filters and improved the speed of their workflow.

Because of the approach we took to designing the filters, we encountered a few limitations on our implementation. For example, through the Max for Live API we could not find a way to add new devices or chains; this meant that we could not provide a simpler way to create a new preset than having the user create a new chain for each track. Another limitation was in how Live displays the list of chains. We wanted to be able to hide the list of chains in the effects rack, but this is not currently possible in Live without hiding the contents of the active chain. This can be confusing because there end up being two lists showing the presets: one in our patch through the drop-down menu and one in the native Live UI for the effects rack. These limitations meant that we were unable to improve the user experience as much as we would have liked. Some of these limitations may eventually disappear as Live and Max improve; however it may be worth investigating other ways of implementing a similar system without these kinds of limitations.

The other main limitation was that our survey had a small sample size. This meant it was in some cases hard to extract generalizable conclusions. However, there was a generally positive reception indicating that it merits further study and improvement. There are two main directions further work could investigate: improving and extending the user interface and integration into Live, and improving the provided presets. Possible ways to extend the interface include making

it easier to add and remove the presets, providing higher level, simpler options to control some of the presets, or even implementations of a similar system into other DAWs. Providing a simple control over the presets could be useful for users who find the provided presets not quite what they are looking for, but may be overwhelmed by the large parameter space of the filters. In terms of improving the presets, there is certainly room for improvement, but it might also be worth investigating presets based genres, etc., as opposed to specific artists. This is because often times the distinctive sound of an artist is not easy to replicate through filters alone as it may include things such as the distinctive characteristics of a lead singer's voice, and choices of instrumentation or musical content.

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Appendix A: Billboard Hot 100 Compilation Script

```
var request = require("request");
var cheerio = require("cheerio");

table = {};
count = 0;
start = 1950;
end = 2016;

for(var year = start; year < end; year++) {
  request({
    uri: "http://www.billboard.com/archive/charts/"+year+"/hot-100",
  }, function(error, response, body) {
    var $ = cheerio.load(body);

    $(".views-field-field-chart-item-artist").each(function() {
      var link = $(this);
      var text = link.text().trim();
      var rowspan = link.attr("rowspan");
      if(text == "Artist") return;

      if(table[text]) {
        table[text] += +rowspan||1;
      } else {
        table[text] = +rowspan||1;
      }
    });
    count++;
    if(count == end-start) {
      tuples = [];
      for(i in table) {
        tuples.push([i, table[i]]);
      }
      tuples.sort(function(a,b) {
        if (a[1] > b[1]) return -1;
        if (a[1] < b[1]) return 1;
        return 0;
      });

      for(i in tuples) {
        console.log(tuples[i][0] + ", " + tuples[i][1], ",");
      }
    }
  });
}
```

Appendix B: Usability Survey

B.1 Survey Instructions

Introduction

This survey is testing a Max patch for the Ableton Live 9 Suite. During it you will run through how you'd normally replicate a sound in a project and then use the Max patch to create your own filter for a track. You've been provided with two Ableton Live projects. This survey will walk you through both of these projects and then ask you a few questions about your experience afterwards.

Normal Effects Work

First, open the Ableton Live project name "Survey Stems - Breezeblocks.als". This project contains multiple tracks.

For this part of the survey we'd like you to try and improve the stems by applying some of the audio filters available in Ableton Live (such as reverb) to these tracks. After a few minutes or once you're satisfied with your work, close the project and move on.

Work with the Max Patch

Now open the Ableton Live project named "Survey Stems With Patch - Breezeblocks.als". This project contains multiple audio tracks, each filled with a clean instrument stem to a larger song. Navigate to the master track and switch between the selected filters. Listen to how the different filters attempt to replicate the artist before moving on to the next step of the survey.

Once you're satisfied with listening to the various filters, select the first of the individual instrument tracks. Duplicate one of the desired chains and rename it "Effect." Make any adjustments that you'd like to the effects in this new chain and then repeat this process for every other instrument.

Navigate to the master track once again and click the refresh button next to the drop down menu. The drop down should now contain your filter, titled "Effect." Select this filter and

play through the song once again, noting that your changes to the filter are now being applied. Feel free to explore these changes more and then move on to the survey questions.

B.2 Survey Questions

1. How much experience do you have with Ableton Live or other digital audio workstations?
2. How helpful did you find the max patch in applying filters to your project?
3. How much did the filters improve the sound of the project?
4. How would this patch affect the overall speed of your workflow?
5. How easy did you find it to edit the filters?
6. How likely would you be to use this software for projects in the future?
7. Do you have any other comments on the software?

Appendix C: Survey Responses

Student	Q1	Q2	Q3	Q4	Q5	Q6
Student 1	4	4	5	2	4	4
Student 2	1	4	5	3	2	3
Student 3	3	4	2	2	2	4
Student 4	1	3	5	4	3	3
Student 5	4	4	2	4	3	3
Student 6	1	4	3	2	1	2
Student 7	3	3	5	2	4	4
Student 8	2	4	4	2	4	4
Student 9	1	3	3	2	2	2
Student 10	2	4	4	3	3	4
Student 11	1	3	3	3	2	1
Student 12	1	3	4	3	2	1
Student 13	2	3	4	3	2	2
Student 14	1	3	4	3	2	1
Student 15	3	3	4	2	4	3
Student 16	3	3	4	2	2	2