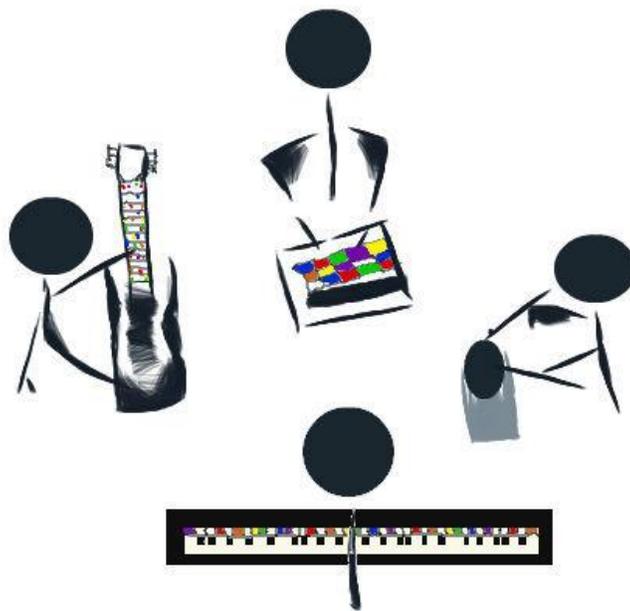


# M3: Jam Tabs

## The Design



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# 1. Summary

Jam Tabs are a new musical system. This system takes advantage of musical data and theoretical analysis to organize songs based on their similarity in chord structure and rhythmic qualities. Databases like this do exist and are presently used for the purposes of what musicians call “music theory analysis”. HookTheory (See Appendix A) is a system that utilizes color, pattern recognition, and a database of previously analyzed music to organize music by similarity regarding their chord structure. The HookTheory website will serve a good comparison for navigability of a music database of this sort.

There are phone applications that provide jam tracks such as the Guitar Tunes app. This phone application features a JamBar™ by Optek Music Systems that displays scales that can be used for improvisation while a Jam Track is played. This application requires the use of a Fretlight™ guitar to be useful and does not provide similar information on a keyboard instrument.

Although HookTheory does have a database of chord progressions and Optek has created a phone application to aid in improvisation, there is no current way to coordinate this information visually during a jam session. Therefore the musical performance component of this testing procedure cannot be compared to any other hardware or current technology. The current graphical user interface designs reflect essential elements present in both HookTheory and Optek’s user interfaces. This is designed to preserve well known features while enhancing usability of the system.

Jam Tabs have incorporated the use of LED cubes, colored instruments, and a phone application to provide a visual aid for jamming scenarios. The phone application is the main focus of UI design although every component needs some degree of user testing to verify the functionality of the system as a whole.

## 2. Requirements

Need	System Requirement
User needs to search for a progression.	Give user as many search options as possible. Offer default search parameters.
User should be able to select how they would like to search.	A drop down arrow will be provided for the selection of another search parameter.
User needs to be able to customize lights at any point in application.	Have light customization tool on every screen within the application. Customization will always be available.
User needs to be able to relate Jam Tracks to popular music.	Allow users to search by song name, artist, and genre. Also show album art while jam tracks are playing.
User needs to be able to go back to a previous screen.	After the home screen the user will be afforded a back button in the top left corner of the screen.
User needs to see changes in the light display immediately.	Upon connecting the lights the lights will display a light show. The light customization tool will allow users to flash a light by pressing the light being tested once.
User needs to make sure the lights are connected to the app.	Upon connecting the lights the lights will display a brief light show.
Once a search method has been selected user needs to be able to select from multiple Jam Tracks.	A customizable list will be afforded to the user for a comparable selection.

<p>Jam Tracks need to be comparable.</p>	<p>The list will display all features of the song that are contained within the database and will remain frozen at the top of the screen as the user scrolls downward.</p>
<p>Sorting Jam Tracks should be easy.</p>	<p>Users will be able to sort the tracks by parameter by clicking on the parameter at the top of the list.</p>
<p>User needs to be able to slow down a Jam Track if it is too fast to play with.</p>	<p>A tempo controller will be made available while in play mode.</p>
<p>User needs to be able to loop a track continuously.</p>	<p>User will be afforded a loop function that will keep the jam track playing continuously.</p>
<p>User needs to be able to pause the track and still have light display be functional.</p>	<p>User will be able to pause and play the track at will. Lights will remain until they are changed by a jam track selection.</p>
<p>User needs to see the information regarding the current Jam Track.</p>	<p>Information regarding the jam track will be provided underneath the play bar.</p>
<p>User needs to be able to change the key of the Jam Track.</p>	<p>User will be afforded the capability to change the jam track to any key.</p>
<p>User should feel connected to the Jam Track.</p>	<p>Album art and pictures of artists that are tagged to the jam track will be displayed above the jam track during play.</p>
<p>User should be able to toggle Jam Tracks from the Jam Tracks page.</p>	<p>There will be a forward and back button available to toggle the jam tracks without changing screens.</p>

<p>User should be able to affect the parameters of the next most similar track.</p>	<p>Users will be able to change the next track to contain any similar or different element categorized by the database.</p>
<p>User should be able to affect the mix of the current Jam Track being played.</p>	<p>The volume of any instrument can be changed by clicking on the mix icon on the right of the play screen.</p>
<p>User needs to be able to queue up a jam track without it affecting the lights or jam track being played.</p>	<p>A queue button will be provided within the jam screen that takes the player back to the home screen without affecting the current jam track. The next track selected will be placed in line as the next jam track either after completion of the current jam track or when the forward button is selected.</p>

# 3. Design Space

Design Trade-offs:

## 3.1 Light Display

The goal for the light display is simply to maintain viewability among a group of players. This entails distances of up to 20ft in a jam scenario.

### 3.1.1 One Display vs Multiple Displays

One display is preferred for Jam Tabs in order to keep communication between devices simple. If operating in a group it is possible that too many competing commands could increase processing time and have negative effects on group dynamics (Brewer, 1986). If one person can access the lights and is in control of the selection other players will have more cognitive resources to focus on jamming.

### 3.1.2 Light Display vs Projection Screen

A light display was chosen as opposed to a screen for a few reasons. Screens are limited to 2 dimensions requiring that the screen be placed on the periphery of the jam location. This maximizes the possible distances from players to view points. A centrally located display is optimal in order to minimize the distance and size of the display.

### 3.1.3 Vertical arrangement vs. Horizontal arrangement of lights

In written music time is notated on the horizontal axis. It has been shown that time does not need to be arranged on the horizontal axis in all musical interfaces (Flores, 2014). The horizontal axis is the most common axis for time information in music, however the readability from a centrally located display will be compromised if a horizontal axis is implemented. Players from opposite sides of a 360° jam arrangement would perceive a flipped sequence. One of the players would have to perform a mental transformation that would be cause a lot of unnecessary cognitive load.

## 3.2 The Application

### 3.2.1 Button Interface on lights vs Phone application

The design decision for the phone application was made based on the ability to combine a search engine, Jam Track list, and light display controller on a singular interface. Maintaining a small number of interfaces is desirable when designing for small

group interaction (Brewer, 1986). A phone application consolidates the functions of an entire interface. If a button arrangement were chosen for the light display a separate application would still likely have to manage the search functions requiring at least one more device.

### 3.2.2 Information Color vs Aesthetic Color

Over using color is a very large concern with this system. Color perception can be non-reliable in peripheral (non-foveal) sight (De Valois, 1973). Color perception can change based on surrounding color profile (Winkler, 2015). Colors differentiate in meaning across cultures (Franklin, 2017). For these and other reasons colors will only be used to convey musical information. Aesthetic colors will be in grayscale and backgrounds will be black whenever possible to avoid confusion.

Red-Green color blindness is the most common form (Lillo, 2014). An approximated 10% of the population has this form of color-blindness (Lillo, 2014)). For this reason alternative modalities in the differentiation of red, such as shape, may be implemented.

### 3.2.3 Custom light display always present vs menu arrangement

A custom light display in every screen was chosen to make the ability to change the lights at any point possible. In most LED controlled musical interfaces the lights are controlled in settings. This does not allow the player the flexibility to change the lights while jamming. Keeping this function available promotes learnability between in-app screens and flexibility to improvise freely whenever it is desired (Burkolter, 2014).

### 3.2.4 MIDI vs Real Jam Tracks

The current market has been trending away from MIDI or computer generated sounds in the last few years mostly because of lacking quality. Live recordings are very useful for the live feel of practice (Davidson, 2017). They may not be necessary if the intention is to jam with a group of musicians. The sounds that are currently available will work well for the purposes of keeping players on-time or to convey general ideas (Davidson, 2017).

### 3.2.5 Song Name, Genre, or Popularity as the Default Search Parameter

Even though all search parameters are legitimate the default search parameter in most music search engines is by song name (Ortiz-Cordova, 2015). Players are often inspired by what they hear during a part of a song or performance. This can often be the driving force behind a player wanting to play in the first place. Therefore, in order to

make the most personal experience possible, it will be essential for players to be able to look up songs in the style of an artist or song name.

### 3.3 Musical Ability Prior to Use

#### 3.3.1 Motor skills of Beginners

Playing music requires physical effort. In order to play an instrument well it first takes a period of training that often comes with fatigue, stress, and sometimes disappointment. If a player's expectations are to play fast and accurately on a new instrument then they are sure to experience this. It is near impossible to design functions of the application that will make players fast and accurate on their first few attempts. Therefore it is necessary to encourage practice in order to attain more skills. It is also necessary to encourage beginners to try very simple tasks and not overburden them (Sloboda, 1976).

#### 3.3.2 Cognitive skills of beginners

Musicians all have a varying degree of working knowledge when it comes to music. Varying styles of music also require the use of different techniques, muscle development, attention to musical elements, and speed. The application is not designed to teach players the elements of music or how to use them in a jam because that would render the scope too large. The application will be designed to organize songs based on similarity and communicate the simplest elements via a light display. For this reason, it is necessary to direct users to the appropriate locations to get information on how to improve their jamming skills. This will also promote players to communicate with one another and to learn from other members of the group.

## 4. The Design

The task of coordinating musical ideas in a jam setting usually requires highly developed auditory skills. Well trained musicians may be able to pick up on auditory cues and respond with appropriate chords and scales. This skill is not available for those who do not have highly developed auditory recognition for musical elements. For these musicians visual cues should be an appropriate modality to receive musical information.

For the scope of the Jam Tabs Application two main interfaces will be tested. The first being a phone application interface. This section entails selecting a chord progression

for display, select a jam track to listen to, and placing a SolJAMM® piano bar on a keyboard instrument.

The second activity to be tested will be the effectiveness of the Jam Tabs for the purpose of jamming using a colored instrument and a light display. This section of testing will require users to play a keyboard instrument. The UI for Jam Tabs consists of an application interface, but also the colored instrument which they are playing. Therefore the effect of color coordination for jamming is an essential part of the Jam Tabs system.

## 4.1 Accessing Jam Tabs

Users will access Jam Tabs by setting up a light display and manipulate the light display through a phone application. This assumes user has purchased the prerequisite materials from SolJAMM® and has set them up appropriately.

## 4.2 The Light Display

The light display is an essential part of the Jam Tabs system. It is the display that informs the musicians of the chord progression. In order to maintain 360° visibility of the display the lights will have a uniform vertical arrangement (Flores, 2014). This arrangement will be mapped out in a light display tool contained within the Jam Tabs application. The scope of this project will not include the user engagement with the light display other than setting the colors and the assessment of their usefulness in a jam setting.



Fig.1 A set of 3 LED cubes on display for Jam Tabs.

## 4.3 The Phone Application

This section of Jam Tabs is a simple UI for those who want to manipulate the lights from a singular device. The phone application is a necessary part of the system because visually displaying the origin of chord progressions (songs, genres, or difficulties) and operating the lights from a distance are necessary component features of Jam Tabs. If a simple button arrangement were used, cost of the device would increase, usability would suffer, and updating the software would be much a more involved process.

The phone application (GUI) portion of the interface is primarily used for operating the lights. The application also accomplishes the difficult task of organizing Jam Tabs by common musical elements. The application will be utilizing color as the main source of musical information, therefore the application will not contain much color outside of its primary uses.

The application will use pre-loaded data that has been analyzed by the functions made available on the HookTheory API. Several functions will allow the user to customize the search parameters. Chord progressions will be playable once selected and various musical elements, such as tempo, will be customizable. The core steps within the phone application include:

1. Custom light display
2. Searching for a jam track by song name (Path 1)
3. Searching for a jam track by genre, popularity, new, or difficulty (Path 2)
4. Selecting a jam track
5. Playing a jam track

### 4.3.1 Custom Light Display

The custom light display allows users to access the color of the lights at any point in their engagement with the application. The consistency of this function will promote the learnability of the application and its relationship to the light display. The custom light display tool will be a direct mapping of the light display in physical space. The light product that is purchased consists of 4 or more LED cubes that are stacked vertically. This orientation, along with numbers are visible on the application itself.

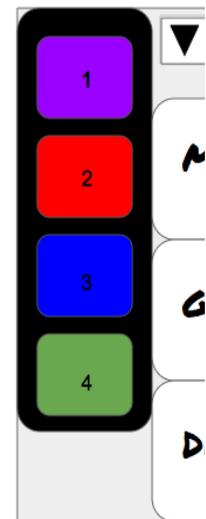


Fig.2 Light Controller

## 1. Custom Light Display

- a. Upon opening the application the number of connected lights will register along the top of the screen.
  - i. Each connected light will be lightly labeled both on the display light and in the application. (1,2,3 and 4)
  - ii. Each light will be customizable upon pressing and holding the light, represented by a box in the application, and a selection of colors will be viewable and clickable. These will change the light arrangement instantly both on the light display and in the application.

### 4.3.2 Search by Similarity to a Song

The application itself will be designed to have jam tracks that are pre-recorded. The pre-recorded jam track lists will have varying degrees of similarity to most songs that are being searched for. Users will be able to type in a song title and a list will be generated with related jam tracks.

1. Default search parameters of “song title” will be made viewable. These appear as a drop down located underneath the light coordination tool.
  - a. The customization function will be made conspicuous by placing a clickable drop down arrow next to the default search parameter of “Search Jam Tracks by Song Name”.
  - b. A horizontal bar will show each each parameter with a few small examples next to it. This layout will be similar to the HookTheory Tabs page. The drop down menu will include the following selections:
    - i. Popularity
    - ii. Genre
    - iii. New
    - iv. Difficulty
  - c. The user will be able to access tabs underneath the search bar by scrolling downwards. The search function will remain frozen at the top of the screen underneath the light coordination tool.

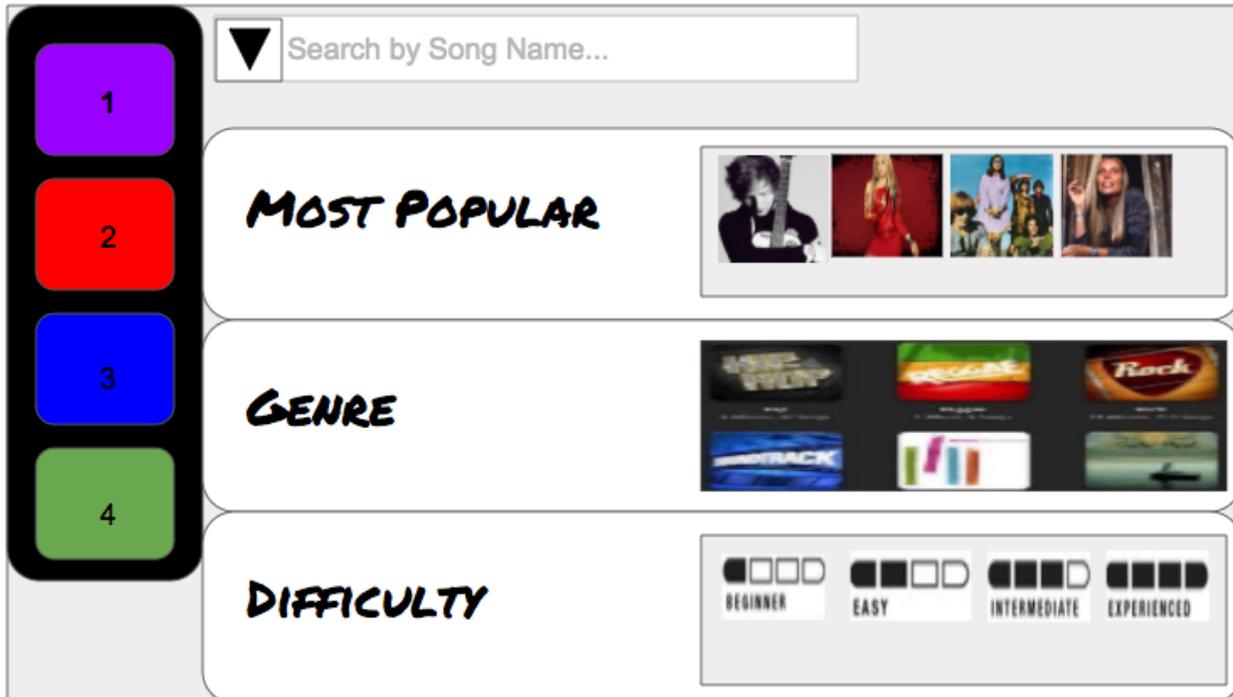


Fig. 3 Search Screen Example

### 4.3.3 Selecting a Jam Track

The second viewable screen is the lists of jam tracks that is generated after searching. The lists will be viewed as a grid with a frozen top menu that reads: chords, genre, difficulty, star rating, and number of plays. Clicking these menu headers will order the songs on the list by that parameter. The list is also generated differently depending on the search method. This is because searching by song title is a more specific request and there is a possibility that the song is not contained within the searchable database. Users have suggested that searching jam tracks by song similarity would make the jam more approachable and would likely be the commonly used search function. For this reason it will be important to include the search by song feature.

1. At this screen a back button is now made available
2. If the user searches for a song by clicking on the search tool
  - a. If a song is typed in (Path 1)
  - b. Jam Tracks are displayed in a list consisting of multiple versions, related songs, and songs by the artist
    - i. If the song is not contained within the database a message will appear and user can search again
  - c. All songs contain a 0-5 star ranking for user input

- d. If Genre or Difficulty is selected (Path 2)
  - i. A list of Genres or Difficulties (beginner-advanced) will appear
  - ii. After an option is selected a list of Jam Tracks sorted by popularity is generated
- e. If Popularity or New is selected
  - i. Another list of jam tracks is generated but is now pertaining to jam tracks that are specific to the parameter
  - ii. All jam tracks are ordered based on popularity or relevance regardless of parameter

#### 4.3.4 Playing a Jam Track

1. This screen consists of a larger view of the light coordination tool.
2. Light coordination tools operates in the same way as in the home and list screens.
3. Jam tracks are made available underneath the light coordination tool.
  - a. This appears as a large play button next to the title track.
  - b. Next to the play button appears the Jam Track
  - c. Tempo and looping functions are selectable
  - d. Change key function for Jam Track
    - i. This function allows the user to change the pitches of every Jam track to match the instruments being played
  - e. Two arrows are selectable to toggle related jam tracks
    - i. If a jam track is playing the next jam track will match in tempo and begin after the first full cycle of the progression
    - ii. If a jam track is not playing lights change immediately
  - f. Extra functions appear in upper right as a “+” sign
    - i. Related jam tracks by similarity in progression
    - ii. Related jam tracks by genre
    - iii. Related jam tracks by difficulty
    - iv. Related jam tracks by artist
  - g. Settings will appear as a gear in an upper corner
    - i. Mix
      1. Mix instruments in and out of jam tracks
    - ii. Volume of jam track
    - iii. Jam Track toggle settings
      1. Toggle to the same progression in a new genre
      2. Toggle to a similar progression in the same genre
      3. Toggle to a very different progression
      4. Timed toggling
        - a. Scroll bar in (0-20) min and (0-59) seconds

## 4.4 Sketches

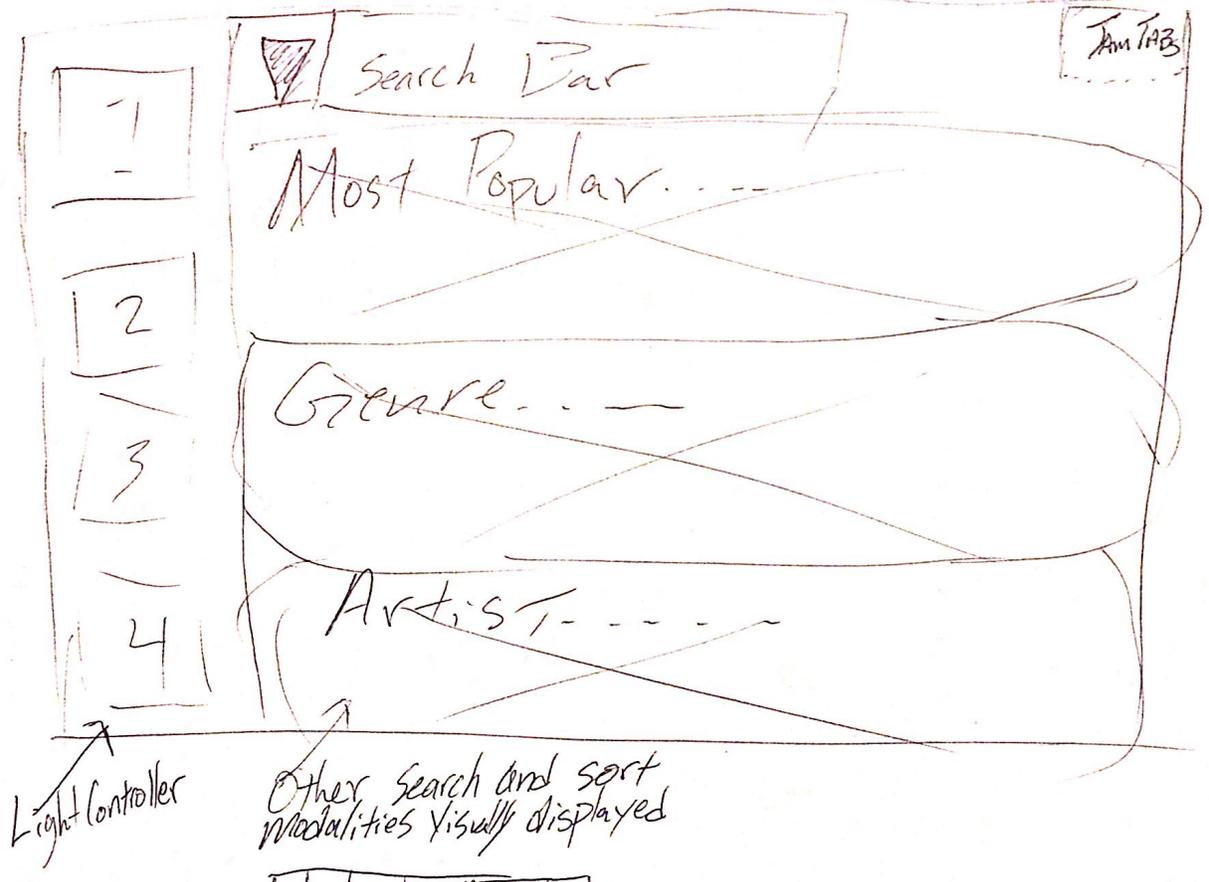


Fig. 4 Sketch of the Search Screen. Containing search options and Light Controller.

# List View

Back Button

	#	Progression	Genre	Artist's <sup>and</sup>	Rating	Difficulty	# of Plays
1	1	□□□□	Rock	James Brown Pharoah Rogers	****	<del>High</del>	500
2	2						
3	3						
4	4						
5	5						
6	6						
7	7						

After selecting search Parameter

Fig.5 List View Screen displaying song information for selection after searching. Light customization tool still present.

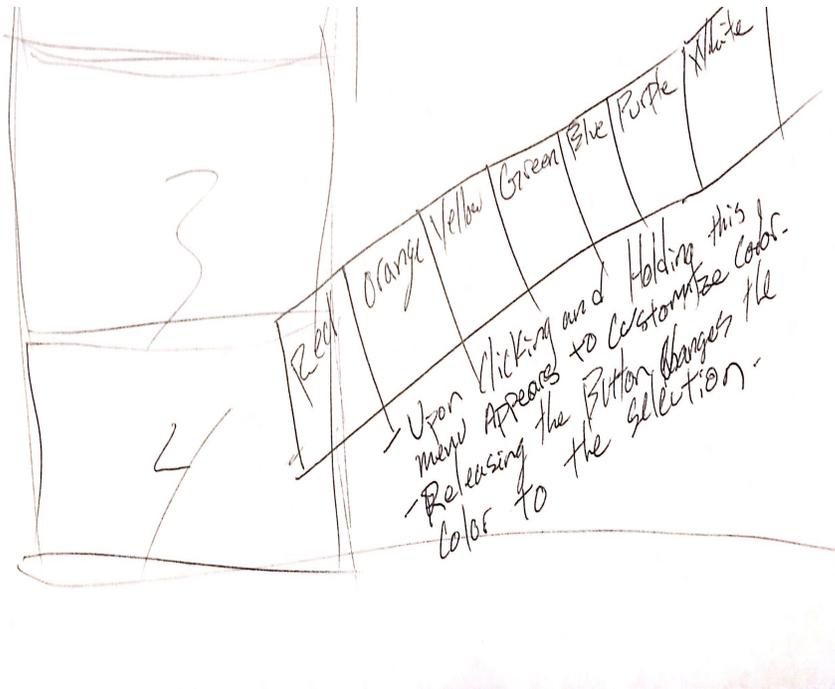


Fig. 6 After pressing and holding a light in the light controller the player is able to change the color.



Fig. 7 Jam Track play view. Looping, tempo key changes can be manipulated.

# 5. Future Technologies & Social Implications

## 5.1 Future Technology

Jam Tabs are reliant on technology and media that is not yet in existence. In order for Jam Tabs to work effectively:

- Jam Tabs must promote jamming between musicians
- Jam Tracks have to be stylistically organized
- Jam Tracks must sound realistic
- Each Jam Track needs to be available in every key
- Jam Tracks must be organized by tags, music theory and popularity
- Colored instruments need to be available for multiple instruments
- Colored instruments need to be able to change key

Jam Tracks must be produced that replicate sounds that are similar to the instruments used in the intended style of music. This can be done by professional recordings which take a lot of time and resources to produce. Alternatively, computer generated sounds can be used to create jam tracks quickly and methodically. Computer generated sounds that are realistic are becoming more and more prevalent in affordable sound packages available in digital audio workstation programs (DAW). These sounds can be used to make Jam Tracks that are stylistically organized but no such database is currently in existence.

Jam Tracks for guitar currently exist on a FretLight™ when using the Guitar Tunes application. The FretLight™ guitar has an LED circuit board built into the neck and displays notes on the fretboard. These notes can be rearranged on the guitar by using a smartphone while accessing the application.

Jam Tracks are also available through the application for purchase. These Jam Tracks are only a small part of the application and are referenced by style and genre. The Guitar Tunes application is primarily organized around real tracks that players can improvise over. This type of interaction does not promote visibility between players or playing with other musicians. The search functions also do not accomplish the same goal because the end result is a song not a Jam Track. Therefore an application that is primarily built around jamming with other musicians is not yet in existence.

Colored instruments are an integral part of Jam Tabs. FretLight™ guitars can only display red LED lights and are not compatible with HookTheory™ software. HookTheory™ uses color in order to reference differences between notes within a scale. This aspect of the HookTheory™ database is extremely useful for coordinating

simple ideas across musicians. The HookTheory™ database can also be easily indexed and referenced according to style, genre, popularity and relative musical principles. Accessing the database can be done through the HookTheory™ API, though there are currently no applications that do so.

HookTheory™ are solely a software company and do not sell instruments or instrument attachments. SolJAMM® sells instrument attachments that can be used for the piano but not appropriately for the guitar. The guitar requires the use of LED attachments so that the key can be changed at will. A product called Fret Zealot allows users to organize the colors and scales for any guitar by attaching LED stickers to the guitar's neck. This technology is will not be made available to consumers during the timeline of the project.

LED light displays that are controlled by phone application do exist but are large and cumbersome to use. None are currently in operation for a purpose such as communication, but there are no engineering barriers to overcome for it to be possible.

## 5.2 Social Implications

Musical applications are most subject to social problems across various age groups. It can be difficult to tailor content to people in all age groups. For example, young children are often interested in music applications but may be drawn to an application that is designed for a mature crowd. If lyrics can be read or heard there may be problems with censorship. The opposite effect can also occur when mature audiences are driven away by too much content being tailored for young crowds.

The likelihood that this application will work for non-visually based instruments, such as wind instruments, in the near future is not very good. With the emergence of new music technology it is an inevitability that certain instruments will be harder to accommodate than others. This will favor more popular and technologically capable instruments such as the keyboard.

Color blindness affects 8% of males and .05% of females globally (Deeb, 2015). The most common form of colorblindness by a large margin is those with red-green color blindness (deuteranopia). Even though effects can be see throughout the entire spectrum of color for those with deuteranopia colors can often be differentiated with changes in hue and other information bearing agents. By supplying a function that alters the color profile for deuteranopes in settings it is possible to have some using the application successfully. Even with a percentage of the population not able to use the application it is still very useful for the other much larger percentage of potential users.

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