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Columbia

A non-mimicking digital musical interface as a music composition aid

Bachelor thesis

To obtain the academic degree of Bachelor of Science in Digital Media

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"The old computing is about what computers can do;
the new computing is about what people can do."
- Ben Shneiderman

Executive Summary

This thesis yields feedback on advantages, disadvantages, usability problems and suggested improvements of a non-mimicking digital musical interface with an integrated music composition aid.
For this thesis, a non-mimicking musical interface with an integrated music composition aid was designed, implemented and evaluated. The music composition aid is based on templates derived from an analysis of a set of pop songs regarding their chord progression in terms of functional theory. The interface and the music composition aid were evaluated in a Thinking-aloud study with six users and analysed with a qualitative approach according to Mayring.

Introduction

Intention

The topic of this thesis is to develop a music composition aid as a non-mimicking digital musical interface. This interface will be a software application running on a touchscreen-based tablet. The interface will help composing music by visually and spatially indicating the diatonic functions of each chord in a certain key. The diatonic function is the role of a chord in relation to the diatonic key (e.g. subdominant or dominant). Each chord fulfills a certain role – e.g. emphasizing that a certain key is used or creating suspense by using a leading tone (Prinz 269). The interface indicates the roles of chords spatially and by the colour of the button. Users can directly play all tones and chords by touching them.

For this thesis, I compiled a collection of certain combinations of diatonic chords I associated with certain feelings (such as sadness). The user can choose one of these combinations (called "template"), which he or she then follows as strict as he or she likes to.

The aim of this thesis is to make the process of expressing oneself through music more approachable and straightforward. Approachable, as the music theory has not to be learned and memorized but is visually and spatially indicated. Straightforward, as the chords can be played directly through the interface. In contrast to a guidebook or sheet music, the musical interface can be used to directly play music.

This thesis has two leading questions. On the one hand I want to find out how a non-mimicking interface is perceived by the users and what advantages and disadvantages a non-mimicking interface has. On the other hand I want to evaluate my approach towards developing a music composition aid based on predefined templates.

Inventing a new musical interface, which assists music composition, is a complex task. It requires knowledge about music theory, sound design, programming and interface design. As music composition is also a creative task, I found it hard to define measurable goals. Defining a way to judge what a good composition is, would at least go well beyond the scope of this thesis.

Motivation

It is argued that making music is not a physical but a mental skill (Lehmann, Sloboda and Woody 19) and that internal mental representations mediate the execution of skills. Based on this I concluded that making a virtual, non-mimicking touchscreen-based software application is possible and beneficial, because it provides an already pre-processed representation of music theory. In my case a pre-processed representation of chords and the role each chord plays in a diatonic key.
Contemporary music applications, especially those on tablets, often directly mimic the interfaces of existing, physical instruments such as the piano or the flute. This inherits the complexity and physical limitations of instruments like the piano. On a piano, the notes are arranged in a linear fashion due to steel strings, which are struck by a hammer. To play the piano, a musician has to memorize how to combine certain notes to form chords. These requirements and the complexity of the piano result from physical limitations. I believe that digital media and digital musical interfaces can reduce this complexity.
A fundamentally new, non-mimicking musical interface could not only incorporate knowledge about chords, but also knowledge about chord progressions. This thesis aims to increase the approachability of music theory by incorporating the theory directly into the interface and by indicating music theory both visually and spatially.
In this thesis, I want to develop a music composition aid as a non-mimicking digital musical interface. Concepts and patterns from interaction design will be applied to the domain of music. A similar approach was used while discussing the "WorldBeat project" which enabled people to interact with music in new ways via infrared batons (Brochers). Brochers formulated user interface design goals, implemented a solution and evaluated it via user feedback, observations and surveys.
The goal of my thesis is to develop a fully functional prototype. Based on Koyani, Bailey and Nall's guidelines towards Web Design and Usability, I decided to develop the prototype iteratively (189). While I still think that developing a prototype iteratively is a good approach, I ended up developing only one prototype. My initial plan was it to integrate the feedback from the first two user tests, but most of the requested changes were too fundamental to implement. They were also very different from what my intention and scope was.

Koyani, Bailey and Nall emphasize the importance of the appropriate prototyping technology (193). I decided against paper-prototyping or prototyping on a computer. I think it is fundamental to my design that there is not only a new layer of abstraction (buttons for chords, functional theory, layout of the buttons), but that this abstraction is directly usable by touch. If I had conducted my user tests with a prototype on a computer or on paper, this immediate response would have been very hard to emulate. I could have conducted a Wizard of Oz experiment, but I eventually found it to be more straightforward to implement the concept on an actual tablet computer.
My approach followed the four basic activities of interaction design (Preece et al.). I identified the needs of the non-mimicking musical interface, established the requirements, and developed an alternative design to traditional mimicking interface and how they represent music theory.

Approach

In my evaluation, I decided to use a qualitative method via user tests with a Thinking-aloud study (Hertzum and Jacobsen). The evaluation was conduced individually with six people. Each interview was done as an open interview using the Thinking-aloud method. The evaluation was guided by tasks I defined. These tasks provided a common thread. In the Thinking-aloud study, I determined what problems in my implementation of a non-mimicking interface existed and what advantages and disadvantages my implementation had. The insights I gained while evaluating #my specific implementation of a non-mimicking interface were then discussed in regard to the problem of designing non-mimicking interfaces in a musical context.
The interview's purpose was to gain an understanding of how well the approach of a non-mimicking musical interface with integrated music theory works for people with different levels of music theory knowledge.

Terminology

I use the term non-mimicking interface to differentiate my application from an interface that directly mimics an existing, physical interface in different media such as a tablet computer. Many existing music apps directly copy the interface of the piano by drawing piano keys on a screen. I wanted to develop a radically different and new interface that has added benefit for the user.

Music composition aid

Composing is a rule-based yet complex and free creative task. It takes a lot of training to write interesting songs. The idea of this application is to integrate a music composition aid directly into the interface of an app. Therefore the music composition aid can't be too complex and must be of immediate use. In my opinion, an interactive or digitally enhanced music theory textbook would provide little benefit in terms of user experience. Especially as in music education, it is already very common to illustrate musical features with examples of actual symphonies, which are played to the students from recordings (judging from my music education in the German school system).

My composition aid will be mostly aimed at pop music and disregard classical music. This is because most of my experience with listening, playing and writing music is in pop music. Another important consideration for this is the relative complexity of classical music, both in terms of music theory and instrumentation. A majority of pop music can be played with only a piano, but classical music is often written for a string quartet or an orchestra.

I personally play guitar and bass guitar and I have some experience playing in bands. From that experience and from having played hundreds and hundreds of popular songs, I observed that many songs share certain features. Many songs use the exact same chord progressions or even chords. A striking demonstration of this is provided by the Australian comedy group "Axis of Awesome" with their song "Four Chord Song" (http://www.youtube.com/watch?v=5pidokakU4I). As exemplified by their song, "Let it be" by the Beatles, "Forever Young" by Alphaville, "Can You Feel The Love Tonight" by Elton John, "No Women No Cry" by Bob Marley, "Africa" by

Toto, “Wish you were here” by Pink Floyd and “Torn” by Natalie Imbruglia all share the same four chords. Yet they are all unique and special songs and most people wouldn’t suspect them to have anything in common.
My music composition aid is based on the fact that while they all share the same basic chords, they are all unique and individual songs. I analysed a variety of songs in terms of their harmonic structure and their chord progressions. These combinations of chords are called templates. The term template is used in a variety of software applications such as Microsoft Word, where a basic document layout is already provided, so the user doesn’t have to start from scratch when writing a letter. The same is true for the templates in this music composition aid. Like the woodblock in wood carving, the templates provide a fixed field for creativity and individuality. The use case I thought about while designing this application would be that somebody comes up with a melody, but doesn’t know the scales by heart and wants to find chords to accompany his melody. My application will enable him or her to set the first note of his or her melody as a starting point and then use the templates to find chords that fit the melody. I’m aware that this approach limits the user to some extend, but I think that it might be useful to musicians and people who like to learn by imitation. I learned a lot about chord progression by imitation and learning by doing.

Related research

Music theory

My composition aid is based on the functional theory ("Funktionstheorie") developed by Hugo Riemann in 1893. Functional theory describes the relationship of major and minor chords and assigns each chord a diatonic function in a diatonic key.
According to the functional theory, each chord has a certain function and role in relation to the key. This determines which chords can be played in association with certain chords. All chords in a key have Roman numbers assigned: I (Tonic), II (Supertonic), III (Mediant), IV (Subdominant), V (Dominant), VI (Submediant), VI (Leading Tone).
A cadence, for instance, is the configuration of the scale degrees I (Tonic) – IV (Subdominant) – V (Dominant). If these three chords of a diatonic key are played at the same time, all tones of the basic key resound (Prinz). By playing them successively, the basic key of a composition is emphasized, which is especially useful for ending a composition.
Many songs, especially in commercial music such as pop, are based on particular schemes and combinations of certain diatonic functions. For this thesis, I will compile a set of certain schemes and assign them with a certain label such as "sad ballad" or "progressive rock song".

Chord progressions

The chord progressions in 1300 popular songs were analysed to look for patterns (Carlton). They for instance found out that C/am is the most used key in their set, being used 26% of the time, while G/em, the second most popular, was used 12% and Eb/cm, the third most popular, 10% of the time. They also transposed all the songs to C to then compare how often certain diatonic functions are used. They found out that in C Major, C Major was used 68% of the time, while F Major and G Major were both used 73% of the time. Thus the Dominant and the Subdominant

of the key are just as commonly used and eventually as important as the key (even slightly more important in their set). They pointed out the practical value of their findings and how research like this is apparently applied in software applications like Apple's "Garageband of iOS" "smart instruments" (Carlton 1).
They also researched which chords are most commonly used to get back to the basic key. Again, the IV (F Major) and the V (G Major) were the most popular chords. The most popular chord progression they found in their database of 13000 songs was I-V-vi-IV.

Mimesis and skeuomorphism

Mimesis describes the imitation of traditional instruments in sound and appearance. Imitating a traditional instrument is seen as a first step in the design process. These instruments are then transformed and lead to "new paradigms of making music" (Marrin 28). Teresa Anne Marrin discusses the "issue of mimesis" in her Master's thesis "Toward an Understanding of Musical Gesture" (28). She also talks about "Overcoming Cultural Inertia" (Marrin 113) and how, for example, the piano keys influenced how people think about digital control of complex objects (Marrin 111).
In a broader context, digital musical interfaces that mimic existing applications can be understood as skeuomorphs. In the Wikitionary, the term skeuomorph (Greek: skeuos - tool, morphe - shape) is defined as: "A design feature copied from a similar artifact in another material, even when not functionally necessary" (Wikitionary contributors). A common example for a skeuomorph is the audio file of a click sound that is played by digital cameras when a picture is taken (Wikitionary contributors). While technically not required, it is played because the users are used to this sound as a feedback mechanism.
A different and for the purpose of this thesis more fitting definition of the term skeuomorph is provided by George Basalla. He defines skeuomophs as "an element of design or structure that serves little or no purpose in the artifact fashioned from the new material but was essential to the object made from the original material" (Basalla).
Skeuomorphs are apparent in many digital designs such as the calendar app "iCal" on Apple Mac OS X Lion. The application looks like a pocket calendar and the

leather finish of a notebook is imitated by the digital design. Skeuomorphs benefit from "a psychodynamic that finds the new more acceptable when it recalls the old that it is in the process of displacing and finds the traditional more comfortable when it is presented in a context that reminds us we can escape from it into the new" (Felluga).

Musical interfaces on tablet computers rely heavily on skeuomorphs. In the direct and simple sense, they copy the texture and colours of musical instruments such as the piano. They copy the design and colours of the keys, but they also let the surroundings look as if they were made from leather or wood. Also inherited is how chords are formed and put together. On the piano, the way chords are formed and how the keyboard is aligned results from physical limitations. The piano keys are connected to hammers, which trigger a wire and thus make it sound. On a tablet computer, the sound comes from an audio file or synthesis.

Many people know how to play the piano and how to use its keys to forms chords. Therefore there is an incentive to let a digital musical interface behave in a skeuomorphic fashion. This might be why many digital musical interfaces for tablet computers like the iPad were designed skeuomorphic.

I, on the other hand, want to develop a new, non-mimicking, non-skeuomorphic interface that simplifies the interface and the handling of the musical interface. I want to do this because of all the unused potential in that regard. When I first used the iPhone I was very excited about the possibilities of the touchscreen, but after using it for a while and trying out dozens of apps, I am very tired and bored because there is little innovation, especially in terms of music apps.

Existing apps

For the Apple iPhone, a variety of mimicking music apps exists. In terms of the piano, for instance "Piano+", "Piano!", "Virtuoso Piano Free 2 HD" (Figure 1). The guitar is mimicked as well, e.g. by "OMGuitar".

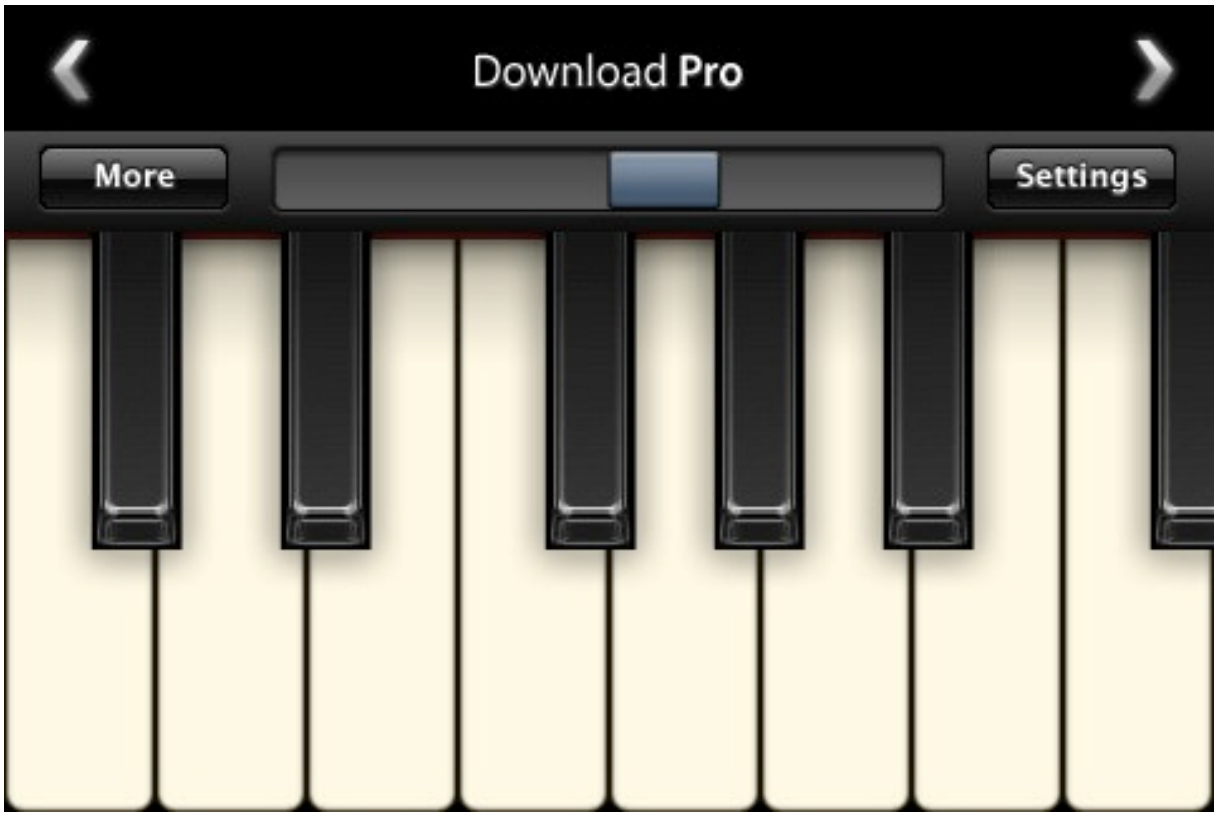


Figure 1. Virtuoso Piano Free 2 HD

"Steinway Etude for iPad" attempts to teach reading score music. The iPad app features notes falling down the screen. Once they hit the piano keyboard on the bottom of the screen, the user has to play the right key as soon as a note hits it. This approach is strongly based on mimesis and aimed at learning the temporal dimension of music.

An interesting new way in making music is described by the "Reactable" and its tablet version, "Reactable mobile", which allows multi-touch sequencing. Different sequencers can be combined by spatially organizing them.

Moreover do apps like "Auditorium", "Circuli" or "Otomata" provide different ways to generate and organize sounds in a non-mimicking fashion although none specifically addresses music theory.

With "Garageband" for the iPhone and the iPad, Apple provides a Digital Audio Workstation that includes features such as the "Smart Piano", "Smart Guitar" and "Smart Bass" (Figure 2). These "smart" instruments provide an interesting level of abstraction. For a bass guitar, for instance, not all note are available, but only a small subset (although there is no information which and how the notes are chosen).

Figure 2. “Smart Bass” in “Garageband for iOS”

Existing physical instruments

Some physical music instruments tried to make music theory and chords more approachable. One example is the accordion, which was developed in the early 19th century. While technically an aerophone, it shares certain characteristics with the piano. The right hand manual of the accordion consists of a piano-styled keyboard. It is used primarily to play a melody. The left hand manual is used to play the accompaniment with small buttons. The left hand manual features a button for the root note as well as a button for the major third note. Additionally, the accordion features individual buttons for the major chord, minor chord, dominant seventh chord and diminished seventh chord of a certain note. All notes are arranged according to the circle of fifths.

The “Akkordzither” (German: “chord zither”), is a mixture of a zither and a guitar (Figure 3). What makes the “Akkordzither” unique is how sheets music is incorporated into the instrument. The sheet music is located beneath the strings, so the player of the “Akkordzither” can always sees which notes and chords have to be plugged. While a piano player has to know to how read sheet music and which keys corresponds to which note, the player of an “Akkordzither” just follows the instructions and does what is displayed on the sheet music.

Figure 3. Akkordzither

Music composition aid

One of the most prominent examples of a music composition aid is “Hyperscore”, a graphical, computer-assisted composition system developed at the MIT Media Lab (Farbood, Pasztor and Jennings). Hyperscore enables users to compose short melodies and describe the large-scale shape of a piece by drawing (Figure 4). Hyperscore provides visual analogies and facilitates composing by mapping musical features to graphical abstractions (Farbood, Pasztor and Jennings).

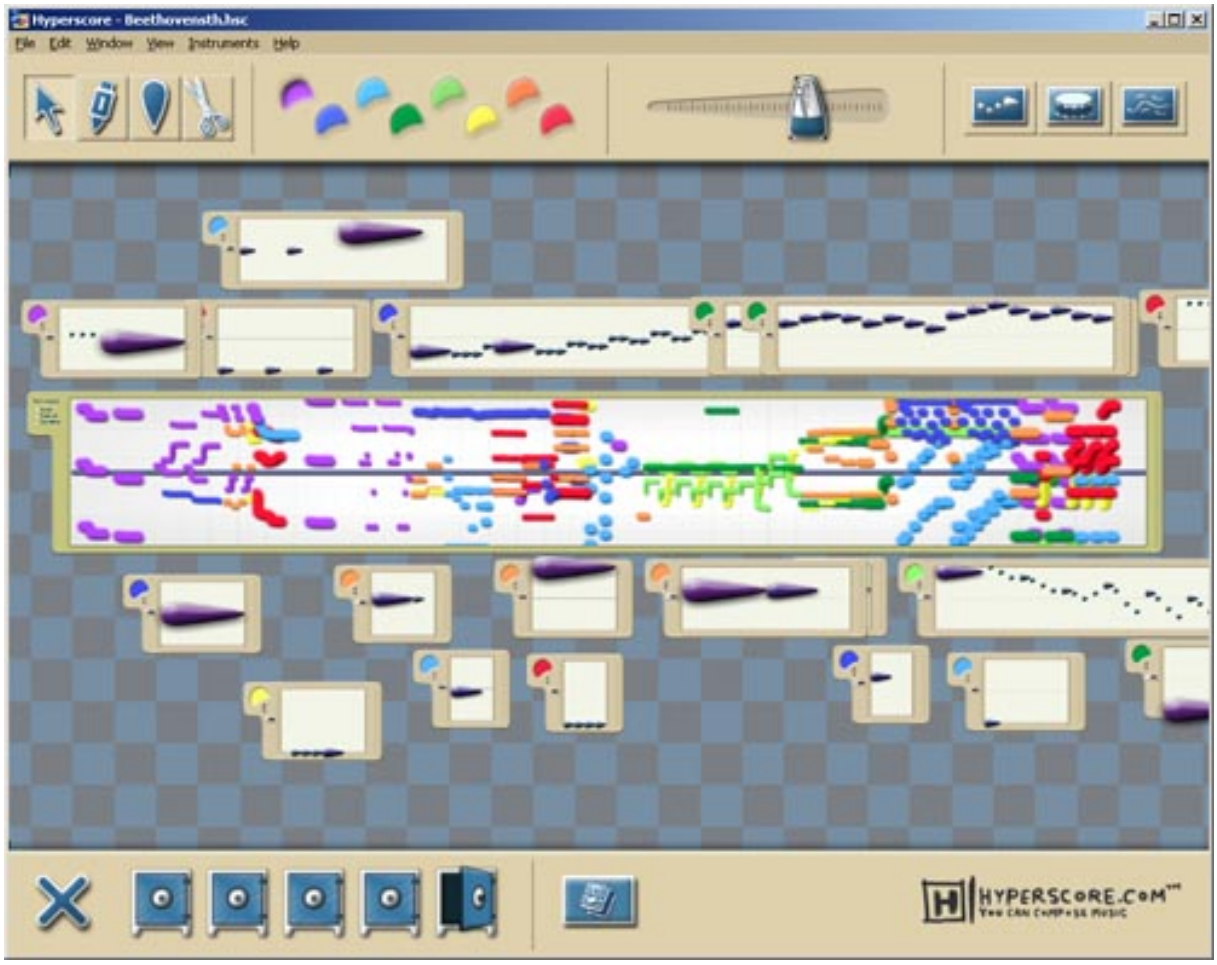


Figure 4. Hyperscore rendering the exposition of the first movement of Beethoven's Fifth Symphony

The usage of graphical objects to represent musical functions can also be found in many professional graphical computer-assisted composition systems such as Steinberg Cubase or Apple Logic.

Another important project in computer-assisted composition is "Patchwork/Openmusic", designed at the "Institut de Recherche et Coordination Acoustique / Musique" (IRCAM). It uses visual analogies and helps composing by connecting together modules, which are then transformed into music notation (Wikipedia contributors).

"Harmony Improvisator" is a commercial plugin for the Virtual Studio Technology interface (Figure 5). It was developed by Synleor and it provides a composition aid based on functional theory. "Harmony Improvisator" provides general suggestions of chords as well as derivatives of dominants and subdominants and suspensions. It is a tool aimed at professional music composers and helps arranging multiple voices.

Figure 5. Harmony Improvisator

Harmony & genre classification

For the music composition aid, a set of templates had to be compiled. Therefore, it was important to find a way to associate songs and chord progressions with certain feelings and moods (such as “sounds like a sad ballad”). In music, this mapping is normally called genre (although it is less strict and a heavy metal band can for instance compose a sad ballad).

The concept that a certain chord progression can be named and that a certain chord progression has a certain meaning, can be for instance found in a psychological study from 1936 that showed the affective value and the expressiveness of music (Heyner). Computer scientists as well as mathematicians have investigated the tonal structure of musical pieces in the quest of tagging songs to a specific genre. It was shown that a genre classification of music can be done based on tonal harmony using a symbolic classification system and language models (Pérez-Sancho et al.). Pérez-Sancho transformed the audio signals of songs into a symbolic representation of harmony using a chord transcription algorithm. The scientists then utilized language models to classify musical genres. They showed that chord progressions are “suitable” to represent musical genre (Pérez-Sancho et al.).

Another group of scientists utilized audio content analysis to map songs to a “psychological-based emotion space” (Singh et al). They analysed musical parameters such as intensity, timbre and rhythm and looked for keywords in the lyrics to assign a mood to a song (Singh et al).

In another approach involving grammar, the diatonic harmonic structure has been formalized by a generative grammar, which took structural properties such as key, functional, scale and surface level into account (Rohrmeier). This linguistic approach allowed formalization of music theory. Unfortunately, these approaches were too complex to apply in this thesis.

An important question in designing the music composition aid was on what to base the templates I planned to incorporate into the interface. The doctrine of affections, popular in the Baroque era, defined that certain feelings such as passion, tristesse or love can be directly associated with certain musical figures. Unfortunately, this was only aimed at certain musical details. A unified theory towards genre apparently doesn’t exist.

One way to deal with this problem is to use a technique called category membership and family resemblance to form genres (Levitin 142). Philosopher Ludwig Wittgenstein formulated this approach. Wittgenstein's basic idea is that members of a family share certain features, although not all features have to be present in every family member. To define a genre like Heavy Metal, one might define certain aspects, which have to be present: distorted electrical guitars, heavy and loud drums, and umlauts in the group names. But this definition can be easily refuted (Levitin 142). Questions of membership are eventually the result of debate and opinion.

Application

Implementation

The music composition aid was developed for an Apple iPad tablet computer using Objective-C and iOS 5. The sounds are produced by preloaded samples, which are pitched using the OpenAL sound library and the SoundBankPlayer library. The SoundBankPlayer library is provided by Matthijs Hollemans and licensed under MIT License. I used the included piano samples from the Fluid R3 SoundFont.
The source code of the application is attached to this thesis. It was developed and tested using XCode 4.3 on Mac OS X Lion. The application can be tested using the iPad Simulator provided by XCode. To test the application on an actual iPad, both the device and the compiled binary have to be signed by a developer certificate. To obtain such a certificate, users have to be registered Apple iOS Developers.

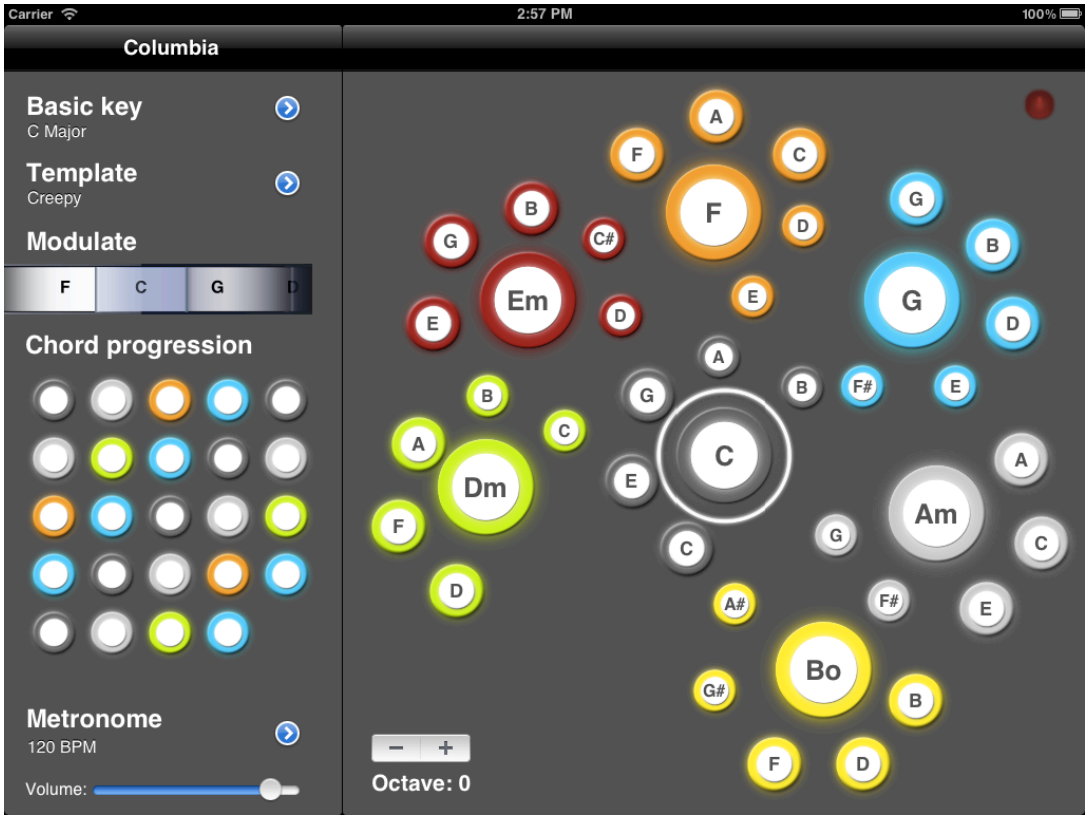


Figure 6. Columbia Main Screen

The application is called Columbia. This name is a tribute to Columbia Records, a record label from New York City, NY, USA, which was founded in 1888. Columbia produced and published many important artists in music history including Bob Dylan, Miles Davis, Weather Report, Johnny Cash, The Clash, Ray Charles, Marvin Gaye, Pink Floyd, David Bowie and The Rolling Stones.

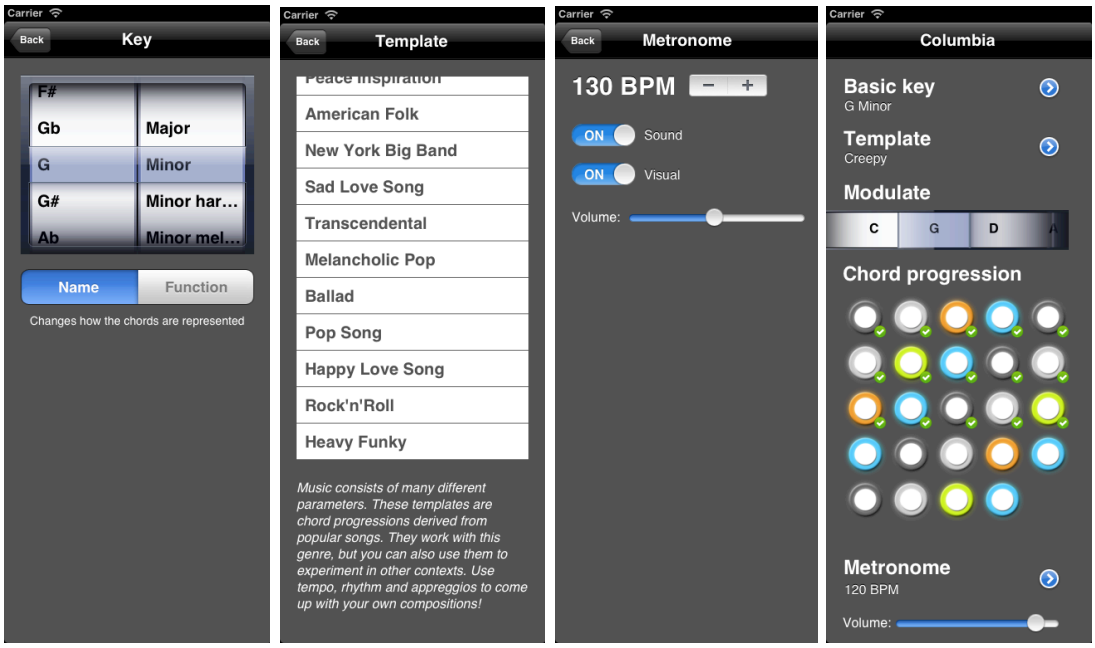
Interface Design

The interface is divided into two parts (Figure 6) – a sidebar (left) and a main window (right). The sidebar allows users to change the settings, e.g. choose a basic key (Figure 7) and a template on which the composition will be based (Figure 8). It also features a modulate wheel, which allows to quickly change the key based on the circle of fifths (Figure 10). It displays the selected template and the chord progression, which have to be played according to the selected template. Moreover does it include a metronome (Figure 9), which visually – by a blinking light - and acoustically – by a sound - helps to keep a rhythm.
The main window features seven groups of buttons, each one representing one role in the current diatonic key (Figure 6). Each section features a button to play the main chord (the triad). Clockwise, five buttons are aligned around this main chord button. The first three buttons are slightly bigger than the other two. These three feature the three notes, which are part of the main chord (the triad). The two small buttons represent the sixte ajoutée and the seventh note of the chord. Each note is a button and directly playable by the user. The whole interface can be immediately used to play music and to compose songs.
The interface helps composing by visually indicating the diatonic functions of each chord in a certain key. The intention of this is to reduce the user's workload (see Koyani, Bailey and Nall 12). With traditional musical instruments, the user has to memorize a variety of things and think of many things at the same. But the human's working memory is limited. I tried to take these limitations of the working memory into account (see Koyani, Bailey and Nall 13). The user can touch each chord at any time to make it sound. In contrast to a book or guide, the user can directly and immediately use the information presented to create a sound. The information is therefore displayed in a directly usable format (see Koyani, Bailey and Nall 15). The

user freely chooses rhythm and accent. These are important to make the composition individual and unique.

The most important indicator of the musical relationship of the chords is colour. But this is not the only way to convey information (see Koyani, Bailey and Nall 24), as the location and the spatial relation of the chords communicate the same information.

A modulation wheel is included as well. As modulation is complex and requires deep knowledge about music theory, I decided to only include abrupt modulation based on the circle of fifths. I added a control to the interface, which directly changes the key based on the circle of fifths. I decided to use the circle of fifths, because keys close to each other on the circle of fifths share many notes and therefore sound well together.



Figures 7-10 (from left to right). Key and mode selection sidebar, Template selection sidebar, Metronome sidebar, Template overview / Main sidebar

Tablet

The application was developed for a tablet computer (Apple iPad 3rd Generation). The most important difference between a personal computer and a touchscreen-based tablet computer is that the user's interaction with a tablet is more direct. There is no mouse that has to be used to translate the user's intention. With a classical

Graphical User Interface, the user has to first identify the input device, then identify the graphical object on the screen and then use the physical device to manipulate the graphical object (Buxton). With a tablet, the user only has to identify the graphical object. After that, he or she can directly manipulate the graphical object as desired. This reduces the time and mental effort necessary to perform certain tasks. Especially in the domain of music, where timing is crucial, this is an important distinction to make. Users - as inexperienced with tablet computers they may be - have to be able to play the notes and chords with precise timing.

Possible additions

Recording

The most obvious possible addition would be to include recording features into the interface to enables musicians to record sections or entire songs. But as this bachelor's thesis is focused on interface, no recording or export option was included. It is also already possible to record the output from Columbia by connecting it via a cable with a TRS connector to a computer's line input.

MIDI Integration

With the introduction of the CoreMIDI Framework in iOS 5 in 2010, the app could also provide a MIDI interfaces and thus use any MIDI compatible synthesizer or software as an output. This includes professional and state-of-the-art synthesizer as well as software, which exports MIDI notation to printable music scores (e.g. musescore http://musescore.org/).

Additional instruments

As the SoundBankPlayer library is based on samples and as it works well even with a small set of audio samples, it is technically very easy to add additional instruments such as organs, brass or wood. The biggest problem is to find appropriate audio samples or to obtain licenses of Soundfonts.
I tried to add more instruments using free audio samples available on FreeSounds (http://freesounds.org), but the free samples were too noisy. In my experience, even

noise, which can't be heard while just listening to the audio samples, will eventually cause distortions when pitched by OpenAL. Therefore I tested the application with piano sounds only.

Velocity sensitivity

Another feature I'd love to add is velocity sensitivity. Velocity sensitivity describes how for instance the piano responds to the force with which keys are played by a louder or softer tone. I read about implementations on the iPad, which utilize data from the accelerometer to achieve this effect. Unfortunately, the API to access this information is not public and can't be used in App Store applications.

Template derivation

A difficult task was how to decide which songs to include as templates and how to classify them. The intention was to provide a variety of different genres. I consulted music scientist Prof. Dr. Lehmann-Wermser about the issues of genre and I eventually decided to define the templates myself. I subjectively chose a small set of songs, each representing a certain musical idea or concept such as "sad ballad". I then based my templates on these songs in the knowledge that while this particular song and its harmony represent this certain musical idea, this is not a bijection. A new song with the same chord progression as the song the template is based on may not automatically evoke the feelings associated with the song the template is based on.

All songs, on which the templates are based on, were either on the Billboard charts or from lists compiled by music critics like the staff of Rolling Stone Magazine. In the following table I will present the songs and their generic names (Table 1). In terms of analysis, I used the same approach as Temperley and de Clercq, who analysed 200 songs from Rolling Stone magazine's list of the "500 Greatest Songs of All Time" (Temperley and de Clercq) to gather statistics about patterns in rock harmony. The approach for analysis is simple and straightforward. The first chord played usually determines the diatonic key of a song. Based on that, each chord has a certain role in the diatonic key, which determines the chord progressions.

In terms of song selection, I tried to provide many different genre and different moods. In terms of genre, it is also noteworthy that there was no point to include for instance a genre like reggae, as the feeling of reggae is mostly rhythm-based. Thus any of the templates can be used to compose a reggae song, while there would be no point in analyzing a specific reggae song.

Template name in Columbia	*Derived from…*
Pop Song	The Ronettes – Be My Baby
Rock'n'Roll	Jerry Lee Lewis – Great Balls of Fire
Religious	Jeff Buckley – Hallelujah
American Folk	Traditional – House of the Rising Sun
Peace Inspiration	John Lennon – Imagine
Melancholic Pop	The Beatles – In my life
Happy Love Song	Bob Dylan – I want you
Transcendental	The Beatles – Across the Universe
Ballad	The Killers – Mr. Brightside
Sad Love Song	Blink 182 – Adams Song
Wistful Ballad	My Chemical Romance – The Black Parade
Heavy Funk	Generic Rage Against the Machine song
Energetic Rock	Franz Ferdinand – Take me out
Creepy	Radiohead – Creep
New York Big Band	Frank Sinatra – That's life

Table 1. The songs on which the templates in Columbia are based on.

Methods

Methodical approach

The musical interface will be evaluated by a qualitative method (Mayring 66) via user tests as a Thinking-aloud study (see Hertzum and Jacobsen). I decided in favor of the Thinking-aloud method as it is know to provide timely, genuine and applicable feedback to the designer (Jørgensen). One of the main benefits Jørgensens describes is that in his experience the views of the users did often differ profoundly from his own conceptions. Being the designer of the systems I evaluate, I think it is crucial to understand how other people perceive the system I designed.
In the Thinking-aloud method, the user is working with the tablet while "thinking-aloud", which means "spontaneously verbalizing ideas, facts, plans, beliefs, expectations, doubt, anxiety etc. that come(…) to mind during the work" (Jørgensen 3). The Thinking-aloud method helps to make psychological issues obvious but also helps identify organizational, methodological, and usability issues.
The approach of a cognitive walkthrough was used informally while designing the interface and while determining the tasks for the user tests. An expert other than myself could also have done a cognitive walkthrough to evaluate the entire application.
A heuristic evaluation would have been another alternative, but it seemed hard to conduct, as this application not only requires knowledge about interaction design, but also about music theory.
Eventually, I preferred the open format of the Thinking-aloud study. Moreover did I want to gather feedback about how to improve the interface and I decided this was the easiest in an open interview setting.
The Thinking-aloud user tests were conducted individually with six users. This number is based on Nielsen's graph, which regards five users as sufficient in terms of finding usability problems in a design (Nielsen). Hertzum and Jacobsen recommend at least 4 to 5 users to detect the majority of the problems in a system (Hertzum and Jacobsen). Nielsen estimates that a study with five users finds 85% of all problems

(Nielsen). With six users in total I believe to gain a sufficient amount of user feedback for a good evaluation. According to Nielsen, the first user adds the most insight to a problem and the insight gained from each individual test subsequently decreases with the number of testers (Nielsen).

In a recorded lab setting, where the people are encouraged to think aloud, they were asked to make themselves familiar with the application and its features while describing their first impressions (Koyani, Bailey and Nall 190). They were encouraged to just play music and to explore the interface. The user test was guided by tasks, which provided a common thread. While fulfilling these tasks, the people were asked about their experience and how to improve the interface. The user tests were recorded both in audio and video.

The leading questions were how the users liked the non-mimicking interface and if the music composition aid was helpful. The users were encouraged to name the advantages and disadvantages of the non-mimicking musical interface and the advantages and disadvantages of the music composition aid.

I evaluated the results from the Thinking-aloud study according to the systematic, rule-based qualitative approach by Mayring (see Mayring). My aim was to gain as much insights from the conducted interviews as possible. Given the relatively small number of testers, forming generalizations from my findings is not possible. But the user tests were used to learn about advantages and disadvantages of the implementation and usability problems that might occur in other non-mimicking interfaces as well.

Mayring's method was initially aimed to solve the problem of making a qualitative analysis of 600 open interviews with about 20000 pages of transcript (Mayring). Crucial to this approach is the categorization. All aspects of the analysis are classified into certain categories. The approach has to be comprehensible and replicable (see Mayring).

Mayring basically proposes two approaches to define the categories – one way to form them is inductive, the other one is deductive. While being aware of the inductive approach, I eventually solely based my main categories on the deduction I did beforehand as no new major categories emerged from the material. I looked at all the aspects of the interface and deducted four categories: advantages of the interface, disadvantages of the interface, user experience and user experience

problems and suggested improvements. After my analysis, I used an inductive approach to organize the feedback into subgroups. Each paragraph in the Results section contains feedback to a certain category. Each headline names the subgroup, which was derived from induction.
I decided against doing a phonetic transcription of all the interviews (Mayring 90) as five of the six interviews were conducted in German (I conducted them in German to make it easier for the study participants). I listened to the recordings and looked for interesting statements. Whenever I found one that fit my predefined categories, I translated the remark and wrote a timestamp and a translation down in a dedicated log (see Appendix). Considering what I was trying to gather from my user tests and considering that many users said similar things, I decided to discuss the results in a coherent text rather than discussing each test individually.
The interviews were done as open interviews with a lot of freedom for the study participants. The interviews were structured into tasks although I did not keep people from anticipating tasks while exploring the interface.

Sample Group

My first approach was to do the user tests with two groups – people with a strong background in music theory, who study music or composition, and people without knowledge about music theory. While doing my first user test with a composer, I got the impression that the music composition aid as it is was not really suitable for trained composers.
This, on the one hand, was due to the fact that composers in general are very familiar with the piano and have memorized most of the music theory. On the other hand, the music theory I included in the interface is basic and mostly aimed at pop music, whereas most composers at art schools write classical or new music.
This alone was no reason to abandon the idea of testing with two groups, as the music composer's feedback was still valuable and important in terms of usability and the non-mimicking interface on a tablet.
What made me change my approach was the realization that the people I tested with all had different levels of music proficiency.

The Composition student was the only one with academic and professional musical training. One study participants had experience playing guitar and reading sheet music. One study participant had some experience playing piano and no knowledge about music theory. One study participant couldn't play any instrument and had little knowledge about music theory. Two study participants couldn't play any instrument and had no knowledge about music theory.
So in this group of six people, half could play an instrument to at least some degree. Their age ranged from 22 years up to 32 years. Half of the group was female, half was male. Their background was diverse and included Composing, Digital Media, Engineering Economics, Sociology, Political Sciences and Education.

Recruitment of the study participants

I recruited the composer by asking one of my professors in the music department of the University of the Arts, Bremen. The other study participants were approached by me either in the cafeteria or the halls of the GW2 building (Geisteswissenschaften 2), a building at the University of Bremen populated mostly by students who study Humanities (although because of the cafeteria also a meeting point for all disciplines). Convincing people to participate in a 30 minute long study was harder than I assumed, as many students didn't have time or interest in participating. Therefore, it took me many tries and the right timing. Right after the start of a class (e.g. 10:15) turned out to be a good time, as I could approach people who had a gap in between classes.
Eventually, randomly asking people was worth the effort as it led to a diverse group of people with different backgrounds and different levels of music and technology experience.
Five out of six interviews were conducted in German in the native tongue of the study participants. The sixth interview was conducted in English with a Serbian native speaker.
As I did not know any of the study participants prior to my tests, I limited the bias, which may have occurred with study participants I know.

Tasks in the user tests

Each study participant in the user tests was asked to complete a set of tasks with the applications. I oriented these tasks on how I imagined a typical user would use the app, as tasks should be typical for real users (Lewis and Rieman). Lewis and Rieman stated that a common problem in task-centered user interface design are tasks which are too fragmented or which just single out specific actions. I tried to avoid this by doing an informal cognitive walkthrough and planning an entire sessions for each subject. Thus each task is part of the big picture and leads to composing a whole song all while maintaining small tasks I can evaluate individually. This at the same times allows very open interviews, as even if users fulfill tasks in advance, I can still evaluate the outcome. While getting to know the interface, users e.g. spontaneously changed the key, which was fine.

To illustrate why it is important to test with the big picture in mind, Lewis and Rieman provide the example of a bank where individual tasks like checking a balance or transferring funds was tested, but not the combination of these services, which led to problems. By connecting the tasks and integrating them into the big picture I think I avoided this problem.

Here are the tasks I evaluated the application with. I defined three phases or groups of tasks, which provided a common thread for all user tests and which had to be completed in consecutive order (First look, then Playing around, then Composition).

Main Task 1 – First look

- Identify the controls of the non-mimicking musical interface.
- What do the big buttons do, what do the other buttons do?

Main Task 2 – Playing around

- Use the sidebar to change the key and mode.
- Use the sidebar to change the template.
- Play with different templates and get a feeling for the music composition aid.

Main Task 3 - Composition

- Choose a genre for a song you want to compose.
  Keep in mind that the songs are only based on a certain genre - you're still free to compose whatever you want to.
- Follow the directions on the screen – only play chords right now. All chords should be played equally long.
- Follow the directions on the screen - only play chords right now. Vary the length of certain chords to add rhythm to the composition.
- Now also add single notes to your composition and finalize a version.

Results

These results have been compiled from the six users tests I conducted.

Disadvantages

In this section I will collect remarks, which stated that certain aspects of the music composition aid or the non-mimicking interface were perceived negative.

The basic idea

A problem for some users was the fact that it took some time to understand the approach of the interface and get used to the music composition aid (Niklas 6:22). From the composer's perspective, the basic idea of the music composition aid – to enable people with no or little musical knowledge to easily compose simple song structures - was perceived as negative and wrong. He stated: "I don't think you understand the music, when you are told which button to press" (Jan 7:44). He as a composer had a "desire to understand this [why a chord progression is there]" (Jan 7:58). For the composer, how the music composition aid tried to help people compose clashed with his philosophy of what composing was all about (Jan 13:55). But the composer also stated that this might be perceived as an advantage by other users. Some of the users with little musical background didn't quite know what to do with the interface either. Playing was easy and straightforward, but the music composition aid was not helpful to some users. One user said: "I frankly don't get how it assists you composing" (Niklas 27:18).

Overwhelming interface

The alignment of the buttons and the non-mimicking interface, which didn't resemble any other interface, was "scary" for some users (Stefan 0:35). One user perceived the interface as overwhelming (Steffi 14:53), which led her to entirely disregard the sidebar. After I pointed out that she ignored the options on the sidebar, she declared: "Oh, I don't deal with that yet. Too many infos!" (Steffi 15:40).

Limitation in creativity

The templates forced the user to play certain chord progressions and the interface only provided direct access to the seven chords of a diatonic key. This was not always well perceived. To some users, it felt like a limitation (Steffi 17:23): "I am limited in my creativity" (Steffi 17:45). The composer perceived this as a disadvantage as well (Jan 15:48). The composer stated that it was his professional ambition to use more than seven chords and that the interface was thus too limited to be useful to him (Jan 15:48).

No support for melodies

Commonly criticized was also the fact that it wasn't possible to properly compose melodies (Jan 30:34, Sophia 18:18, Sophia 26:32, Steffi 13:08). Composing melodies wasn't possible, as only a subset of notes was available at a given time and because there wasn't a way to play notes in a chromatic way. This also made it harder to connect chords (Sophia 18:18), e.g. by chromatic notes.

Focus on pop music

The composer also criticized the interface for being limited to pop music (Jan 28:35), as it lacked advanced music theory such as a dominant seventh chord with a ninth (Jan 16:00). He also mentioned the problem of being easily bored because the music theory is so limited and repetitive (Jan 22:57). Another critique by the composer was the fact that only the basic position and no inversion were available (Jan 17:50).

Only piano sounds

The version of Columbia I conducted the users tests with only included piano sounds, which was perceived as negative (Jan 13:32, Niklas 7:01). Especially as some users expected the sound of the interface to change according to the selected template (Niklas 7:01). A template called "Rock'n'Roll" was e.g. expected to feature a distorted electrical guitar (Niklas 7:01).

Touchscreen

One user couldn't imagine playing the interface blindly or without looking at it (Ricarda 22:30), although she said she generally dislikes touchscreens for that reason

(she e.g. favors a keypad-based cellphone over touchscreen-based smartphones). Therefore she thought the app was not well suited for performance (Ricarda 21:40). Another user said that the touchscreen on the tablet computer forces her to mostly use her index finger (Steffi 13:00) and that there were no fingerings like on the piano (Steffi 12:29).

Abstraction

One former piano player criticized the abstraction of thinking in chords, as the single keys were seemingly lacking (Sophia 20:10). The same user said she couldn't "get a flow" (Sophia 20:30), because of the alignment of the buttons.
Unlike the piano or other instruments, the interface added another level of abstraction by making the chords directly playable. This was perceived as a disadvantage by the composer (Jan 17:13), who felt too limited in terms of possible chords and sounds (Jan 18:25).

Miscellaneous

The approach of gathering the templates – by analyzing popular songs and then labeling them – led to the assumption that one might recognize said song by playing the chords in any key and led to disappointment, when one user couldn't recognize the song (Niklas 11:05). This of course only happened after I explained my approach, as it is nowhere indicated in the interface that the templates are derived from actual songs.
The sounds of the lowest and the highest octave were also criticized as "muddy" (Niklas 19:20).
Another disadvantages named, was that the option to choose a basic key and mode was perceived as "quite complex" (Niklas 22:23). One user said he had no idea what he was doing and how it affects the outcome (Niklas 22:23).

Advantages

Like with the disadvantages, I will collect remarks, which stated that certain aspects of the music composition aid or the non-mimicking interface were perceived positive.

Tablet

The touchscreen-based tablet computer I based my application on, an Apple iPad 3, was well perceived. One user commented on the accuracy of the iPad touchscreen and described it as "wonderfully precise" (Niklas 4:33). This was important to him, as the interface always played what he wanted to play (Niklas 4:33). People also liked that the touchscreen featured multitouch input (Jan 11:13, Steffi 12:08).

Colour coding

The usage of colours to differentiate between certain chords was well perceived (Jan 6:57, Niklas 6:05, Stefan 17:30). One user liked that the buttons were different in size and how this related to the button's function (Niklas 6:05).
The colour coding was intuitive to all users (e.g. Jan 21:34). Many users explicitly expressed that they like the colour coding and the choice of colours (Niklas 13:56).

Animation

Another aspect of the interface users liked was the animation of the chord progression indicator (Sophia 1:01). They liked that it wasn't an abrupt change, but that it was animated (Niklas 10:25). They described the movement of the indicator as "nice and smooth" (Niklas 10:25) and liked how it was moving (Sophia 1:01).

Immediacy

One of the main advantages the users remarked on was immediacy. Users liked that they could immediately play chords and make them sound (Niklas 1:01). Immediate response was also important in terms of the chord progression indicator. One user liked that she gets immediate feedback after pressing a button / playing a chord (Sophia 3:51).

Responsiveness

One thing that was generally well perceived was the responsiveness of the application. People liked that the application immediately reacted when a certain parameter such as mode or key was changed (Jan 3:23, Sophia 3:51, Sophia 17:15).

Templates

Users liked to follow the templates and play the chord progressions as indicated (Niklas 1:20, Stefan 1:02). One user said that she likes this approach because it involves learning by doing and learning by imitation (Sophia 22:13).

Chord progression indicator

The chord progression indicator was perceived as a good way to learn the chords of a certain song in a guided way and then adapt it to piano or guitar (Sophia 8:21). This user also stated that the application might be a good way to try out how different chord progressions would sound (Sophia 21:38).

Metronome

The integrated metronome was well perceived (Niklas 2:01, Stefan 5:10) and used by everybody involved in the tests. People especially liked the visual metronome (Niklas 2:26, Steffi 11:29), because with the visual metronome: "you don't only have to trust your ears" (Steffi 11:29).

Layout of the interface

The interface not only featured chords, but also single notes. Users liked that they were able to play notes separate from or in addition to the main chords (Sophia 2:03). They also liked how the buttons were aligned (Stefan 13:20).

Abstraction

The composer said the abstraction of the interface – organizing the sounds in chords – "makes a good impression on him" (Jan 17:05). He liked the idea that you only have to think in terms of function (Jan 33:30). Another user stated that "it's great that you directly have chords" (Niklas 14:28). Users especially liked that the chords always fit together, which minimized the risk of playing wrong chords (Niklas 14:28, Sophia 26:15).

Context

The composer commented on in what context he thinks the interface might be useful. He regarded it as useful in a pop music context (Jan 34:44) and thought it

might work well in a performance context (Jan 29:00). He also could imagine it being a nice tool for multiple musicians to jam with, given that different sounds were added (Jan 31:48).
Another user expressed that the interface might be used in education as part of multimedia in schools. He could imagine using the interface to teach music theory in schools (Niklas 30:24). It was also said that the application might be useful for practice and composing by just trying out ideas (Ricarda 22:53).

Miscellaneous
It was remarked that the Modulate picker view is a good way to "to mellow the composition and to make it less boring" (Jan 10:23).
The fact that the templates were independent from a certain chord and a certain mode was well perceived because, as one user explained, it enables bands to adapt the song to a singers favorite pitch and to transpose it to make it sound higher or lower (Sophia 27:17).

Suggested improvements

A variety of improvements and changes have been suggested. Many of them are similar to the improvements I envisioned before doing the user tests.

Recording and exporting
One of the most wanted features was a way for users to record what they were playing and to enable users to create their own templates (Jan 20:15, Jan 23:45, Ricarda 23:39, Steffi 16:01, Steffi 17:10). Users wanted a way to output a printable score as well as a way to export an audio recording (Ricarda 23:39). One interesting concept in addition to this was the idea of having a button that rewinds (like on a VCR) the recording for a certain amount of time (Ricarda 23:52), so that if a mistake is made, not the entire recording is lost.

Sounds from different instruments
The users expressed that they would like to have different instruments (Niklas 7:23, Niklas 16:57) and completely different sounds and noises (Jan 29:10).

Another interesting suggestion was to not only include a metronome, but to also add a drum computer (Jan 23:14) and different measurements like two-four time and three-four time / waltz time (Niklas 2:12).

Different chord lengths

Columbia knows only one chord length and multiple chords sound at the same time. Users expressed their interest in having this changed so that chords can be played longer or shorter (Niklas 26:57) and so they interrupt each other (Jan 1:41).

Complex music theory

The composer I tested with also endorsed to add more advanced and sophisticated music theory such as an alteration button, which makes notes higher or lower (Jan 17:31, Jan 25:25), secondary dominants (Jan 26:38), the circle of thirds known from Romanticism (Jan 27:50), or real modulation (Jan 15:00). Real modulation, as the current interface only allows "abrupt modulation".

Usage in education

One of the main fields the users could imagine the interface being used was teaching music theory (Jan 32:22). It might be a way to understand keys (Stefan 12:40). One approach would be to add tutorials, which explain certain features using historic examples and then make the users solve certain tasks (Jan 33:56). Another suggestion in terms of teaching music theory concepts was to have an indication of intervals like third or fifths displayed at any time (Sophia 24:20).
Another proposed application in the realm of education was to use the interface for ear training / aural training (Steffi 4:44).

Chord progression indicator

The chord progression indicator was subject to some debate. One user argued to include an option to turn the music composition aid off to freely play with the interface (Stefan 12:50). The chord progression indicator confused two of the users (Sophia, Steffi). One of them suggested to remove the blinking circle, because she felt the sidebar was sufficient for her (Sophia 11:55). The other one proposed to include

two indicators, one to indicate the current and one to indicate the next chord (Steffi 15:07).

Miscellaneous

There was interest in how the templates were compiled, as I had to explain to every study participant how the templates were derived.

One user expressed his wish to have the interface translated into German (Niklas 18:39).

On a technical level it was argued that one might include an option to hide the sidebar like in the Facebook iPad application (Stefan 13:55).

The possibilities of multitouch input inspired users. One user argued that one might extend the interface so that it uses two hands and enables users to play with their left and their right hand at the same time like on a guitar (Stefan 17:57). Another user argued that one might make the interface useable by something like a touch typing system and have all notes touchable by one hand to play faster (Ricarda 22:00).

Piano like fingerings where each button is assigned to a finger was proposed by another user (Steffi 12:29, Steffi 12:50).

The composer advocated to add multiple layers with different chords (Jan 37:20) and make the interface entirely customizable (Jan 41:02).

Usability

In this section I will discuss the usability of the interface. This is not limited to usability problems, but problems are the most obvious to perceive. I will also discuss how easily certain concepts and metaphors were understood. In my user tests, I did not provide an introduction or tutorial. The users had to figure out how to use the interface themselves. I did this to gain insight about how intuitive the metaphors and concepts I used are. Not all users (especially ones with low musical knowledge) immediately understood everything, but in all cases it was possible to understand the interface and the music composition aid after a short explanation.

Scope and intention

Some users said the scope and intention of the application was not self-explanatory (Jan 8:51). Although the task to explore and use the interface was easy to solve (Jan 1:08). The concept of a template was not always easy to grasp. Reading the description often helped (Jan 6:02, Stefan 9:45). In other cases I had to further or entirely explain the concept to the users (Niklas 2:50, Stefan 9:45). For some users, the term template itself was an issue (Sophia 9:40, Stefan 9:45). One user was not able to identify the panel to change the templates, because she couldn't remember the term (Sophia 9:40).

In that context, it is also important and interesting to note that even users who said they understood the concept and commented on the description text as helpful (Stefan 2:50), not quite understood what the concept of the template was (Stefan 9:45).

Illegible text

An obvious usability problem was the fact that the description of the modes in the mode selection screen was illegible. This was an issue with most users (Niklas 8:10, Ricarda 2:51, Steffi 3:19). The terms "Minor harmonic" and "Minor melodic" was illegible. The terms also appeared to be too specific for the users without musical training.

Missing reset button

The missing option to reset a template was another problem (Niklas 10:14). In the tested implementation, a user had to play through the entire template. There was no way to start over and go back to the beginning of a template.

Template names

The naming of the songs, especially general terms like "Religious" and poetic terms like "Peace Inspiration" or "Transcendental Meditation" raised a lot of interest and curiosity (Jan 12:13, Ricarda 17:57). They also confused users, who said the naming was unclear (Steffi 5:48). The names of the templates were perceived as not self-explanatory enough (Niklas 21:55). An example for an incomprehensible template name was "Creep", a template based on a popular Radiohead song.

The terms were also easily misunderstood. One of the users for instance criticized that he linked the term "Religious" to Baroque music, Johann Sebastian Bach and particular chord progression and felt that the name was "misleading" (Jan 19:27), when he learnt that the template "Religious" was based on the song "Hallelujah" by Jeff Buckley.

Confusing buttons

The small circles (the notes) surrounding the bigger circles (the chords) confused many users (Niklas 15:52, Sophia 15:55), if only at first glance. It was not always intuitive that the difference in size had a special meaning: "It occurred to me that some circles are bigger than others, but I didn't put too much meaning to it" (Niklas 15:52). One user said she didn't notice a size difference because the difference was not noticeable enough (Sophia 15:55). Some users also didn't expect single notes but related chords when they first pressed the small circles (Niklas 14:49).

Confusing chord progression indicator

The chord progression indicator was an issue with some users, who for instance were confused by the fact that the chord indicator directly and automatically indicates the next chord (Steffi 14:12). Some felt the need to immediately play a chord as soon as it popped up (Steffi 17:40). She said: "I am forced to change my chord and can't play a chord more than once". The concept of the indicator was an interesting thing to observe. Some people immediately understood what the indicator was good for, some completely ignored it and other were confused (Ricarda 5:33), but figured out herself what it was good for (Ricarda 6:40). One user said she would play one chord and then forget what chord she played (Steffi 15:25).

Confusing sidebar

In the sidebar of the interface, there is an overview of all the chords in a selected template. One user mistook this overview as a control. The user tried to use the images, who where smaller version of the ones used in the buttons, to play the songs (Sophia 6:50). The user was confused that nothing happened (Sophia 7:00). After I helped her, the user was able to use the interface as intended (Sophia 7:38). Another

user was confused by the green arrows, which appear in the sidebar overview to indicate a certain chord has been played (Steffi 3:19).
The same user who mistook the sidebar overview as the way to play sounds, tried to memorize the chord progressions before playing them (Sophia 9:40). When asked why, she said that this was to "prepare herself" and that this helps her to come up with a rhythm (Sophia 9:40).

Modulate wheel
One of the biggest issues with the interface was the modulate wheel. It was mistaken as the way to change the key and the mode several times (Niklas 4:46, Sophia 4:15). To those people, who had no or little musical training, the modulate wheel was confusing. Some people just ignored it and didn't use it.
It was only used as intended by the composer, who criticized it for not being a proper modulation (Jan 27:07). The composer's criticism is only partially applicable. While modulation is of course way more complex than what the wheel allows for, it still allows "abrupt modulation", which in German is called "Rückung" (he encouraged me to change the name from modulation to "Rückung").

Table View
Another technical problem was the inertia of the Table View in the template selection screen. It was hard to scroll down with the Table View, because it didn't rest on the bottom (Niklas 11:37, Stefan 6:25). I don't know why the Table View behaves like this, as I implemented it according to the specification given by Apple.

Miscellaneous
The fact that the interface was in English while none of the users were English native speakers was confusing (Ricarda 2:30), e.g. regarding the naming of the modes ("Major" and "Minor").
For the composer it was easy to grasp the concept of the added sixth and seventh (Jan 21:40).
The option to change how the chords are labeled – either by a chord name or by the name of their function and interval number – confused users with little or without a musical background (Niklas 12:21, Stefan 6:55).

The users gave little feedback on the alignment of the chords in terms of usability. The only problem was that one user expected the root of a chord to always be on top of the chord (Sophia 20:40).
The visual metronome was designed as a red button, which would blink. One user was confused by this and mistook it as a recording button (Stefan 4:05).
One user had problems to change the volume of the metronome. In the interface, there is a dedicated volume control for the metronome, which is only visible in the metronome panel. She tried to change the volume of the metronome using the global volume slider (Steffi 3:29).

Discussion

The results from the user tests will be discussed in two separate parts. The first part will focus on the non-mimicking interface. In this section I will discuss advantages, disadvantages and usability problems that are likely to occur in other non-mimicking interfaces. I will also point out which aspects are most important when designing a non-mimicking interface.
In the second part I will focus on the music composition aid. I will point out advantages and disadvantages of my approach towards a composition aid.
I think this distinction is necessary, as the music composition aid and how it was designed is independent from the non-mimicking interface.

Non-mimicking interface

Non-mimicking interface are independent and free to define their own metaphors. While mimicking interfaces may add certain features, they are fundamentally limited to their skeuomorphic nature. In a non-mimicking interface, on the other hand, the designer can analyse a problem and then come up with a solution that suits the problem without having to worry about breaking any rules or ignoring any metaphors, because there are no rules that limit him or her.
In my case, I took the music theory of diatonic function and designed my interface to suit this theory. I decided to limit the chords available according to music theory, not because I had to follow any conventions or because I was forced by cultural inertia. The outcome provided a higher level of abstraction, which was sometimes confusing to the user, if only at the start. As discussed earlier, skeuomorphs benefit from a psychodynamic that favors the old over the new. But this does not necessarily mean that everything new is wrong. My user tests showed that it took time and learning to use the non-mimicking interface. It also showed that after some time figuring out how the interface works, the new approach was received well. After familiarizing with the interface, all six users could effectively use the interface as such (I'll discuss the usefulness of the music composition aid in the next section).

From a usability point of view, it became also evident that different kinds of experience with touchscreens, digital media, and music theory require different degrees of training to effectively use the interface.
As mentioned, non-mimicking interfaces don't have to rely on existing metaphors, which enables designers and developers to introduce new metaphors. One metaphor successfully added to the interface of Columbia was colour. Most musical instruments and interfaces differentiate notes and chords only spatially. In this non-mimicking interface, the diatonic function of each chord was indicated by colour. This turned out to be a good decision, as it was well received by most users, which shows that it is beneficial to invent new metaphors.
Many mimicking interfaces and the instruments they mimic also tend to use the spatial organization of notes and chords only in one dimension. The one-dimensional organization on a piano for instances represents the pitch. Moving left on the keyboard leads to a lower pitch, moving right leads to a higher pitch. By arranging the chords in two dimensions, it was possible to visually group notes and chords.
In aggregate form, the approach of a non-mimicking interface enables designers and programmers to implement more Gestalt laws into their interface. These laws are derived from Gestalt theory, which is "a family of psychological theories, that have influenced many research areas since 1924, including visual design" (Chang, Dooley and Tuovinen). The fundamental idea of Gestalt theory is to perceive individual parts as "functional wholes" (Koffa). This was applied to visual design in the 30s and 40s (Soegaard) and led to "the gestalt laws of perceptual organization" (Soegaard), which include the "Law of Balance/Symmetry", "Law of Continuation", "Law of Closure", "Law of Figure-Ground", "Law of Focal Point", "Law of Isomorphic Correspondence", "Law of Prägnanz (Good Form)", "Law of Proximity", "Law of Similarity", "Law of Simplicity" and "Law of Unity/Harmony" (Chang, Dooley and Tuovinen).
Looking at the interface of Columbia, one can identify a variety of Gestalt laws at work. The colour groups as well as the fact that all small notes are arranged around the chord in the same way implement the Law of Similarity. The arrangement of the small notes around the chords also takes the Law of Closure into consideration, as the small notes form a semicircle. In combination with the Law of Proximity, this implements strong groups, which help to differentiate each diatonic function. There

was no user who ignored or didn't understand the groups of chords I laid out (although semantically, it wasn't always clear whether the small buttons represent notes or chords).
The Law of Unity/Harmony was fulfilled by placing the notes on an evenly spaced circle around each chord. These groups were then arranged around the tonic on a second, bigger evenly spaced circle.
All in all, I make a strong case to utilize Gestalt laws when designing a non-mimicking interface.
Another new possibility space in a non-mimicking, digital interface is time-based animation. The chord progression indicator for instance was a blinking, animated circle, which moved to the next chord that had to be played (according to the template). Most traditional, physical instruments don't have the possibility to change their shape to guide users. But designers and developers of non-mimicking musical interfaces should make use of animation and dynamic changes of the interface.
An important aspect about how I designed the non-mimicking interface was that I focused on chord progressions and harmony structure and disregarded melody. My design didn't feature any way to play notes that weren't somehow related to the basic key. This was not well perceived, as people wanted to compose melody and therefore needed the ability to also play chromatic tones.
Judging from the user tests, responsiveness and accuracy are very important when designing a musical interface. Playing music is a task that requires fast changes and the users need to trust an interface to execute these changes immediately. The device used in this test, an Apple iPad 3, was well perceived by the users. It might be interesting to further research how users react to an unresponsive and inaccurate interface.

Music composition aid

I think my approach towards the music composition aid was flawed. The users liked the basic idea of having a music composition aid integrated into the interface. But the current implementation was too limited and deterministic to be useful to the majority of the users. For the trained composer, too little musical features were available. For the novice users and people without musical training, there was also

no intrinsic motivation to compose a song, which made an evaluation of the usefulness of the music composition aid harder. When asked to compose, they followed the template, but they didn't really vary the rhythm and think of it as or their composition. This might be connected to the fact that users couldn't come up with a melody. As only notes that theoretically fit the chord were available, there was little room for variation and no way to move the pitch chromatically up and down.

As already stated, I was thinking of a musician who has a melody and who is looking for chords to accompany said melody. Eventually, none of the users I tested with were in this situation and fit this category (which is perfectly fine because I wanted to test the interface on a broader scope and with a variety of people, but it limits my results about my approach towards the music composition aid).

I aimed for a balance between creative freedom and guaranteed good results. The idea of displaying only the chords of the diatonic key kept the user from playing wrong chords and thus helped to produce better sounding results. It on the other hand limited creative freedom, as it removed chords, which were not directly related to a certain key. This made modulation and improvisation harder. User e.g. couldn't build up tension by leading tones.

I generally think that it is still a good approach to take common and popular songs as templates to base their own composition on, although the group of people for which such an interface in the current form might be helpful is way smaller that I had thought. In hindsight I'd make the music composition aid less restrictive and provide more freedom. I'd integrate a free play mode where everything the user plays is recorded, so the user can create his or her own templates and then visually identify interesting chord progression he or she discovered while playing.

The templates included in Columbia determine basic chord progressions derived from the analysis of different songs. In terms of chord progressions, Columbia limits the freedom to some degree, as it forces users to strictly follow a selected path of chord progressions. While the chord progressions are fixed, it is still the players choice to decide how often the individual chords sound. He or she decides about the rhythm as well as the overall structure. There is also the possibility to vary the volume of the output, thus utilizing dynamic differences.

The user test showed that the naming of the templates was problematic. The templates are named after the themes of the songs they are derived from. This was done in the knowledge that the relationship between the template name and the song is not bijective. Just by using the chords of "Imagine" one does not automatically write a song that fits the category "Peace Inspiration".
Knowing this approach was flawed, I still preferred it over just numbering the templates, which I thought was too confusing and technical. The user in one user test, whom I told the name of the song the template was based on, was disappointed he couldn't recognize the original. Judging from that, it was a good decision not to just name the templates after the songs they were derived from, because that might have led to confusion and disappointment.
I think that in the current form, my approach towards a music composition aid is too limited and restrictive. Starting with a template and adding personal touches might work for some musicians, but it wasn't well perceived by all users in the group I tested it with. Based on my observations from the tests, I'd rather modify the interface so that it helps people to learn about functional theory. It could also be used to help piano or guitar players memorize certain songs.

User tests

I would like to make some remarks about my experience with user tests and their quality. I think user tests are generally valuable and insightful. Yet some of the feedback and some strategies I observed were rather weird and strange. One user for instance tried to play all the chords and randomly added chords, which were not part of the template, to the template, because she thought this was a "question of balance" (Ricarda 17:16).
It was also interesting to observe that many statements contradict each other. Users sometimes expressed how much they liked an idea and then, five minutes later, explained that it was a bad idea (Jan, Niklas). This confused me and it also made me very careful what conclusions to draw from these user tests (if any, as the set of people is so small).
I did not test in a formal lab setting, but rather had a friendly and open conversation about the app I developed, using my tasks to guarantee a common thread. I gave

only a brief introduction in the beginning in which I said that it was a music app and how the Thinking-aloud method works. My goal was to see how self-explanatory the interface was and therefore I think this approach was suitable. This on the other hand made users spend a lot of time figuring out what the music composition aid was good for instead of providing feedback on the quality of that interface and the music composition aid itself.

In many cases, problems with the user interface where somewhat related to the medium. Some usability problems were not actually problems with the app or the interface, but problems because people where unfamiliar to tablet interfaces. Other problems occurred because of the way the user interface of the operation system behaved (e.g. the table view).

I felt it was important to test the application with users, which had no or little musical training to see what they think about the interface. I did not anticipate that this group of people was not always suited to comment on a composition aid. For some, judging music was hard because their ears lacked training and thus everything sounded the same to them (Stefan 11:46, Ricarda 17:49). This made it hard for them to effectively experiment with the templates and the interface. It also made it hard for me to gather feedback on the quality of the music composition aid.

Eventually, I think the user tests are best suited to find usability problems, such as illegible text and the problem with the table view.

The “Modulate” picker view in the main screen might be the biggest usability problem. As it displayed familiar chord names and as it was easily accessible, many users used it to change the key and the mode, without realizing that their choice was limited by the circle of fifths. I think this illustrates that testing an interface with different users is important, as different people interpret things differently. Especially as those problems are hard to anticipate.

Outlook

The music composition aid might be a good addition to traditional music theory courses. It is based on the theory of common music classes, but makes this theory immediately useable and approachable, as music students could use the interface to try out and listen to any combination of chord progressions. Using an app like Columbia in music education is supported by the user tests in which four users clearly stated that they could imagine using a similar non-mimicking interface with an integrated music composition aid in an education context.
John Ginocchio discusses the usage of melodic exercises and its benefits in the Music Educators Journal. He points out that melodic exercises are a great way to encourage creativity and teach many musical concepts (Ginocchio 52). While his approach is focused on melody, he also discusses how the chords can be used to explain the functions of different harmonies within a key (Ginocchio 54). His article does not specifically address technology but generally encourages using composition as part of a music program.
But with a non-mimicking interface like Columbia, the entrance threshold would be lower than without it, as the users wouldn't even have to learn how to read or write sheet music first (as a non-mimicking interface might teach it).

Evaluating creativity

The freedom of the non-mimicking user interface made it possible to integrate the music composition aid directly into the user interface. In my evaluation, I gathered qualitative feedback on how the music composition aid helps the composition process, but I didn't evaluate the resulting compositions. An interesting approach to evaluate the resulting compositions and thus the music composition aid as a whole would be the Consensual Assessment Technique (see Baer and McKool). The Consensual Assessment Technique would be a way to judge if a composition composed using Columbia would be regarded as more creative and interesting than a composition just based on the memorized knowledge of a musician. A possible hypothesis would be that a - maybe more sophisticated - music composition aid would lead to more interesting and diverse progressions and better compositions

altogether, as the composer could concentrate on interesting rhythms and structures because he or she wouldn't have to worry about basic harmony.
The Consensual Assessment Technique requires a panel of expert judges that rate the creativity of compositions. It is based on the idea that the best measure of the creativity of a work of art is the combined assessment of experts in that field (Baer and McKool). While this goes beyond the scope of this thesis, I think it would be an interesting research project. The Consensual Assessment Technique is not tied to a particular theory of creativity. Study participants produce a work of art, e.g. a composition, and a group of independent experts, who must not influence each other, judge the work's quality (see Baer and McKool).

Conclusion

My aim with thesis was to develop a non-mimicking interface with an integrated music composition aid. I tested this application by gathering qualitative feedback from user interviews. All in all, the non-mimicking interface worked remarkably well and could be easily played by all users I tested it with. Given the small set I tested the interface with, it is hard to draw any conclusion. The user tests made certain technical problems evident like the table view picker for the templates selection. It revealed logical problems like the modulate control that was mistaken as the way to change key and mode. And it also showed that this approach towards composition needs explanation and context.

I can't provide a definitive checklist what a non-mimicking interface needs, but the first and most important observation is that users don't fear new interfaces and that implementing musical interfaces in an abstract and not in a skeuomorphic fashion works, although not all users are equally open about it. Another important thing I observed is that when designing a musical interface, especially a non-mimicking one that is unique and very different from existing interfaces, it is still important or at least beneficial to follow well established rules and principles such as the Gestalt laws, as they help to understand an interface.

Another thing I would like to highlight is that the interface and my non-mimicking approach turned out to be thought provoking and inspiring to the users. When asked about what changes they would suggest, the users came up with many different interesting suggestion which all might be incorporated into a non-mimicking interface. An interesting approach would be to focus even more on usability and user experience and make an interface that would be played with both hands like a guitar, uses fingerings like a piano or is entirely configurable.

References

Baer, John, and Sharon S. McKool. “Assessing Creativity Using the Consensual Assessment Technique”. *Handbook of Research on Assessment Technologies, Methods, and Applicatsion in Higher Education*. Ed. Christopher S. Schreiner. Guam: IGI Global, 2009. 65-77. Print.

Basalla, George. *The Evolution of Technology*. Cambridge: Cambridge University Press, 1989. Print.

Brochers, Jan O. *A Pattern Approach to Interaction Design*. Hoboken: John Wiley and Sons, 2001. Print.

---. “WorldBeat: Designing a Baton-Based Interface for an Interactive Music Exhibit”. *Proceedings of the ACM CHI'97 Conference on Human Factors in Computing Systems* (1997): 131-138. Print.

Buxton, W. “A Three-State Model of Graphical Input”. *Proceedings of Human-Computer Interaction – INTERACT ’90* (1990): 449-456. Print.

Carlton, Dave. “I analysed the chords of 1300 popular songs for patterns. This is what I found”. *Hooktheory*. 6 Jun. 2012. Web. 1 Jul. 2012.

Chang, Dempsey, Laurence Dooley and Juhani E. Tuovinen. "Gestalt Theory in Visual Screen Design — A New Look at an old subject". *Selected Papers from the 7th World Conference on Computers in Education* (2002): 5-12. Web 23 Jul. 2012.

---. “Part 2: I analysed the chords of 1300 popular songs for patterns. This is what I found”. *Hooktheory*. 27 Jun. 2012. Web. 1 Jul. 2012.

Farbood, Morwaread M., Egon Pasztor Egon and Kevin Jannings. “Hyperscore: A Graphical Sketchpad for Novice Composers”. *IEEE Computer Graphics and Applications* 24 (2004): 50-54. Print.

Felluga, Dino Franco. "Introduction: Skeuomorphs and Anti-Time". Romanticism on the Net 1996-2006: Celebrating Ten Years of Online Publishing. Web. 4 Jul. 2012.

Ginocchio, John. “Making Composition Work in Your Music Program”. *Music Educators Journal* 90 (2003): 51-55. Print.

Hertzum, Morten, and Niels Ebbe Jacobsen. “The Evaluator Effect: A Chilling Fact about Usability Evaluation Methods”. *International Journal of Human-Computer Interaction* 13 (2001): 421-443. Print.

Heyner, Kate. “Experimental Studies of the Elements of Expression in Music”. *The American Journal of Psychology* 48 (1936): 248–268. Print.

Hollemans, Matthijs. “SoundBankPlayer: Using OpenAL to Play Musical Instruments in Your iOS App”. *Hollance iPad + iPhone App Development*. 6. Feb. 2012. Web. 6 Jun. 2012.

Jan. *Personal Interview*. 9 Jun. 2012. MP3 and MOV.

Jørgensen, Anker Helms. “Thinking-aloud in user interface design: a method promoting cognitive ergonomics”. *Ergonomics* 33 (1990): 501-507. Print.

Koffa, Kurt. Principles of Gestalt Psychology. London: Routledge and Kegan Paul. Print.

Koyani, Sanjay J., Robert W. Bailey, and Janice R. Nall: *The Research-Based Web Design and Usability Guidelines*. Computer Psychology, 2004. Print.

Lehmann, Andreas C., John A. Sloboda and Robert H. Woody. *Psychology for Musicians: Understanding and Acquiring the Skills*. Oxford: Oxford University Press, 2007. Print.

Levitin, Daniel J.: *This Is Your Brain On Music: The Science of a Human Obsession*. New York: Plume / Penguin Books, 2007. Print.

Lewis, Clayton, and John Rieman. "Task-Centered User Interface Design – A Practical Introduction". *HCI Bibliography : Human-Computer Interaction Resources*, 1993/94. Web. 7 Jun. 2012.

Marrin, Teresa Anne. *Towards an Understanding of Musical Gesture: Mapping Expressive Intention with the Digital Baton*. Boston: Massachusetts Institute of Technology, 1996. Print.

Mayring, Philipp. *Einführung in die qualitative Sozialforschung: Eine Anleitung zu qualitativem Denken*. Weinheimt: Beltz, 2002. Print.

Nielsen, Jakob. “Why you only need to test with 5 users”. *useit.com: Jakob Nielsen's Website*. 19 Mar. 2000. Web. 7 Jun. 2012.

Niklas. *Personal Interview*. 11 Jun. 2012. MP3 and MOV.

Pérez-Sancho, Carlos et al. "Genre classification of music by tonal harmony." *Intelligent Data Analysis* 14 (2010): 533-545. Print.

Preece, Jenny et al. *Interaction Design – Beyond Human-Computer Interaction*. Hoboken: John Wiley and Sons, 2002. Print.

Prinz, Ulrich et al. *Musik um uns – Sekundarbereich II*. Braunschweig: Schroedel, 1996. Print.

Ricarda. Personal Interview / User Test. 25 Jun 2012. MP3 and MOV.

Rohrmeier, Martin. "A generative grammar approach to diatonic harmonic structure". *Proceedings of the 4th Sound and Music Computing Conference* (2007): 97-100. Print.

Singh, Punett et al. "Architecture for Automated Tagging and Clustering of Song Files According to Mood". *International Journal of Computer Science Issues* 7 (2010): 11-17. Print.

Soegaard, Mads. "Gestalt principles of form perception". 22 Mar. 2010. Web. 23 Jul. 2012.

Sophia. *Personal Interview*. 11 Jun 2012. MP3 and MOV.

Stefan. *Personal Interview*. 25 Jun 2012. MP3 and MOV.

Steffi. *Personal Interview*. 8 Jun 2012. MP3 and MOV.

Temperley, David, and Trevor de Clercq: "A Corpus Analysis of Rock Harmony". *Popular Music* 30 (2011): 47-70. Print.

Wikipedia contributors. "OpenMusic." *Wikipedia, The Free Encyclopedia*. Wikipedia, The Free Encyclopedia, 5 Jul. 2012. Web. 4 Jul. 2012.

Wiktionary contributors. " skeuomorph." *Wiktionary, The Free Dictionary*. Wiktionary, The Free Dictionary, 5 Jul. 2012. Web. 4 Jul. 2012.

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Appendix

Recordings

Attached to this thesis you find a DVD including audio and video recordings of all six users tests as well as the source code of the app. In the appendix you find my log of each user test. I analysed all user tests according to my four predefined categories and added a timestamp for further reference. All user tests are referenced by the first name of the study participant and a timestamp. As a matter of fact the timestamps can't always be exact to the second, but the referred statement should in the area +/- 5 seconds around the timestamp.

Evaluation Jan

Student in Composing
University of the Arts, Bremen

Advantages of the interface	*Disadvantages of the interface*	*Usability*	*Suggested improvements*
3:15 Able to choose different keys 3:23 App immediately changes key and mode as he selects it in the sidebar 3:46 He is able to change from chord names to chord functions	7:44 "I don't think you understand the music, when you are told which button to press" (Lack of music theory understanding) 7:58 "I don't have to think about it". The user doesn't have to understand why a certain chord progression is there. "I have the desire to	0:48 Chord names are immediately recognizable 1:08 He can immediately use the interface 6:02 What is a template? He reads the description, which is helpful	1:41 Make chords interrupt each others / avoid chords sounding at the same time 1:57 Add additional chords to play a cadential with a leading tone 3:23 Add G Major as a Dominant in the chosen minor key

6:57 "Composing with colours" 7:37 "He is saying what I have to do. Not bad!" Understands the moving cursor and the indication of the next chord 10:23 The "Modulate" picker view is good to mellow the composition and to make it less boring 11:13 Multitouch, play different things at same time 14:35 Ability to add sixth and seventh 17:05 Abstraction makes a good impression on him. He likes it but he doesn't perceive the interface as an instrument, but as musical functions 19:14 As it's mostly aimed at pop music, the lack of inversions and altered chords make sense, as it keeps the interface from being bloated 24:09 Different timbres by changing the pitch	understand this" (might be advantage for others) 13:32 App is limited to piano sound 13:55 The music composition aid's concept clashes with his definition of composition 14:41 The interface is lacking secondary dominants. He can't do a proper modulation 15:48 His professional ambition is to use more than seven chords, he feels too limited by the interface 16:00 The app is lacking dominant seventh chords with an added ninth 17:13 He feels limited by the interface and the abstraction (only a small subset of chords is available) 18:25 Not all chords / sounds are possible 17:23 "Frankly spoken, you can't think in single notes here" 17:50 Everything in basic position, no inversions	7:13 "Are those really typically religious chord progressions?" 8:51 He thinks that it is hard to define the scope and the intention of the device, it's not self-explanatory 12:13 He likes the naming of the templates 13:40 Doesn't know what to do with the resulting composition 13:55 He thinks the app is abstract and easy to play, but it is hard to properly compose with the app. For him composition means bringing things together, understanding them and then changing them. 19:27 "Religious" could also relate to Johann Sebastian Bach, so the naming of the chords can be misleading 21:34 He uses the colour coding system intuitively 21:40 He adds sixth and seventh to chords	15:00 Modulation wheel does not allow for a complete modulation, but only abrupt modulation (but that's natural / ok for pop music according to his opinion) 16:45 Add ninth to interface 17:31 "Whats really missing are altered chords" 20:15 Function to slowly try out certain custom chord progressions and save them (maybe in combination with rhythm) 23:14 Add a drum computer to make the music making process more interesting. Enable people to build individual rhythm structures 23:45 Record and output the played songs and notes 25:25 Alteration button, which makes some notes higher or lower (like a shift key on the computer) 26:38 Add secondary dominants to enrich the interface

25:12 Can play arpeggio 29:00 Possible usage in a performance context 31:48 Great to improvise with multiple musicians 33:30 Level of abstraction, you only have to think of it in terms of functions 34:44 Application suitable for pop music	22:32 All tones have the same length, to make them sound longer you have to play them more than once 22:57 He is easily bored because the music theory is so limited and the templates are repetitive 24:27 He feels restricted and limited by the software. He can only vary the rhythm 28:35 The app is limited to pop music 30:34 He can't play a melody with the keys displayed / can't improvise	22:11 Varies rhythm 27:07 Explains why he thinks that "modulate" is not the right term for the modulate wheel	27:50 Go further and add e.g. not only the circle of fifths but also the circle of thirds known from Romanticism 29:10 Add more sound samples and not only include chords, but also other sounds and noises to the interface 32:22 The interface could be extended to assists in teaching musicology, if the templates are not limited to songs, but would also include certain forms of harmonic sequences and models of cadences, but they should also show the corresponding sheet music 33:56 Add tutorials with historic examples, which teach certain features of music theory including tasks the user has to fulfill 37:20 Add multiple layers 41:02 Make the interface customizable (the composer prepares certain layers by adding the chords he wants to play) Preparation phase to prepare layers

Evaluation Niklas

Student in Engineering Economics

University of Bremen

Remarks: *Some experience playing guitar and reading sheet music*

Advantages of the interface	*Disadvantages interface*	*Usability*	*Suggested improvements*
1:01 "How funny" – He likes that he can immediately play chords and make them sound 1:04 "That's fun" 1:20 Conductor: "What's so fun?" Niklas: "Just playing the chords in the right (…) chord progression" 2:01 Likes the integrated metronome 2:20 Different octaves are available 2:26 Visual metronome is great 4:33 Interface and buttons are "wonderfully precise". "It always plays the note I want it to play"	6:22 It took him some time to understand the idea of chord progressions / templates 7:01 There is only piano sound. He expected that the sound of the instrument would change according to the selected template 9:36 He asks on what song the template "Religious" is based (Jeff Beck – Halleluja) 11:05 He tries to recognize the song, but he can't 19:20 Dislikes the sound of the highest and the lowest octaves, describes the low sound as "muddy and too low" 19:40 Especially in comparison to the preceding octave	2:50 "What is a template?" Didn't understand the concept directly, so I explained it to him upon being asked 4:46 I pointed out to him that he did not change the key and mode using the sidebar, but mistook the "modulate" picker view, which only provides the circle of fifths 8:10 Confused by illegible text (It's hard to read "Minor melodic" and "Minor harmonic") 10:14 Unable to reset the chord progressions / templates and to start from the beginning His workaround: Plays through the entire template	2:12 Allow for different measurements in the metronome (2/4, 3/4) 7:23 Adjust the sound according to the template, e.g. provide a distorted guitar for a "Rock'n'Roll" template 16:57 Add more sounds and different instruments 18:39 Provide a translation of the interface in German 21:15 Explain on what song each template is based on / provide a way to look it up 26:57 Be able to hold chords 30:24 He could imagine using it to teach music theory as part of multimedia in schools

6:05 Likes the colour coding and the size difference. “Playing with the interface is great” 10:25 Likes the next chord indicator, especially that it is not abrupt, but animated (“It’s nice and smooth how the circle moves”). The animation enables him to follow the circle with his finger 11:50 The naming of the templates made him curious / excited to try them out (“Heavy funky”) 14:22 Likes the colour of the different functions / chords 14:28 “It’s great that you directly have chords”. Especially that they fit together, although he didn’t know how they fit together	21:55 He thinks the names of the templates are not self-explanatory enough. He e.g. doesn’t have an idea what “Creepy” might be based on 22:23 The ability to choose a basic key and mode is “quite complex” in his opinion, because he doesn’t have an idea what it is doing (He can’t relate to certain options such as “Minor melodic”) 26:25 When a button is pressed, the notes or chords are played for a fixed amount of time. He’d prefer to be able to hold chords 27:18 He doesn’t really see any use in the templates and the chord progressions (“[But] I don’t write music”) “And I frankly don’t get how it is assisting you composing” 30:38 “Just looking at as a beginner, it is hard to understand all the functions” but as part of a curriculum / class in school it might be possible	11:37 The table view in the template selection sometimes flips to the top while scrolling down 12:21 He changes the display from name to function, thus displaying not the names of the chords but their function in the key. This confuses him 13:56 Likes the colours in the interface, except for the light gray and the dark gray 14:49 Thinks the little buttons surrounding the chords are chords themselves 15:13 After being encouraged to play around with the buttons, he recognizes them as notes which are part of the chord 15:52 “It occurred to me that some circles are bigger than others, but I didn’t put too much meaning to it” 25:29 He simultaneously tries to add notes, which are part of the chord, to the chord and expects those notes to sound louder	

Evaluation Ricarda

Student in Sociology

University of Bremen

Remarks: Can't play an instrument, little experience with music theory

Advantages of the interface	*Disadvantages interface*	*Usability*	*Suggested improvements*
8:35 After playing for some seconds, she just says: "Beautiful" 8:50 Can change the octave of the interface 16:35 Likes how all the chords work together. "You can play everything and it still sounds good together" 22:53 Good for practice and for composing by just trying out ideas (and then writing them down)	11:00 She did expect the interface to be more dynamic. She thought that the small buttons were the unused other chords ("class of chords") 17:16 She not always uses all buttons of the template and sometimes adds different chords ("A question of balance") 17:49 All the notes and chords sound similar to her 21:40 Thinks the interface is not really suited for performance 22:30 Can't imagine playing the instrument blindly / without looking at it, but she also generally dislikes touchscreens for that reason	2:30 The English names for Major and Minor are confusing to her (German native speaker) 2:51 In the key and mode selection, "Minor harmonic" and "Minor melodic" are illegible 5:33 She doesn't directly understand what the next chord indicator is good for 6:40 Figures out herself what the indicator is good for 17:57 Likes the naming of the templates and is observably excited about them 20:05 The indicator doesn't irritate her, but she doesn't always	22:00 Make the interface more convenient by something like a touch typing system, where each note is playable with one hand to play fast 23:39 Record what is played (not only as audio, but also as score) 23:52 "Multiline system", so that the user can go back a certain amount of time (without deleting the entire recording) or a correction key on the screen 26:09 Voice control to define certain parts and add them to a the whole composition

		follow the directions and changes the chords however she likes 20:17 Likes that the indicator is in the middle of the screen. If it was only on the side "there wouldn't be a flow"	

Evaluation Sophia

Student in Political Sciences

University of Bremen

Remarks: *Some experience playing piano, no experience with music theory*

Advantages of the interface	*Disadvantages interface*	*Usability*	*Suggested improvements*
1:01 Likes the animated indicator for the next chord. "It's cool that it's moving back and forth" 2:03 Likes that the root and the fundamental notes of a chord are separately playable and next to the full chord	9:05 "I ask myself how much sense this application makes if it is based on a certain song" 11:13 Confused by the animated chord indicator. She thinks that whenever the indicator moves, she has to play that chord immediately	4:15 Mistakes the "modulate" picker view as the way to set the basic key and the mode 6:50 Tries to play the chords of the template by pressing the overview in the sidebar	11:55 Have the chord progression indication only on the sidebar and remove the blinking circle altogether, because the sidebar is sufficient 24:20 To use the app to teach music theory it would be good to have labels indicating it's e.g. a third or a fifth

3:51 Likes the immediate feedback and how the interface directly changes (e.g. after changing the key) 8:21 The guidance might be a good way to learn a certain song and vary it (e.g. adapt it from guitar to piano) 17:15 While using the metronome, she noticeably likes how the interface immediately changes and adapts 18:50 "For bands it [the focus on harmony] might actually be a good thing" 21:38 The app is a good way to try out how different chord progressions sound 22:13 She expresses how she likes the idea of having a template, as an approach involving learning by doing (learning by imitating) 26:15 States that it is an advantage that it's not possible to play chords that sound bad / don't go well with the other chords, because it is limited (limitation keeps it	11:25 / 12:29 She complains that the circle is moving too fast. When asked what that means for herself, she says that she can't practice or vary a chord because she feels urged to change the chord whenever the circle moves to the next chord 15:50 It's hard to play an arpeggio because it is hard to properly position the fingers 18:18 It's hard to play a melody or to connect the chords with notes 20:10 As a former piano player, she is irritated by the lack of keys and the abstraction of thinking in chords 20:30 "I can't get a flow" because of the alignment of the buttons 26:32 "You can't really play melodies" 26:58 The circles are too small for her "thick" fingers	7:00 "I'm pressing the little circles, but nothing happens" 9:40 She can't find the template menu, because she can't remember the term template / wasn't familiar with the term 14:07 She tries to learn the chord progressions and colours before playing them, to prepare herself and to come up with a better rhythm 15:55 She initially didn't see a difference between the bigger (notes of the chord) and the slightly smaller buttons (sixth and seventh), because the difference in size "wasn't noticeable enough" 20:40 She expects the root of the chords to be always on top	

from being disharmonic) 27:17 Likes that changing the key and transposing is easy (e.g. when a band wants to play a particular song, but a singer can't sing high or low enough, it helps transposing a song)			

Evaluation Stefan

Student in Digital Media

University of the Arts, Bremen

Remarks: *No experience with instruments, no experience with music theory*

Advantages of the interface	*Disadvantages interface*	*Usability*	*Suggested improvements*
1:02 "Its kinda fun to follow this", "I like the melody" 5:10 The metronome is cool 5:51 The next chord indicator made him feel more comfortable with the interface	0:35 First impression: "So many buttons", the interface looks scary in the beginning 3:05 The chord names and modes don't mean much to him (he describes himself as a beginner) 11:46 The templates sound too similar to each other	1:31 "You can't really be creative. You have to follow this circle" 2:41 Changes the template 2:50 Info text about templates was helpful	12:40 The app might be a way to understand keys and music theory 12:50 Include an option to turn off the guide / to play around and make music on your own 13:55 Hide the sidebar (like with the Facebook iPad App)

13:20 The pattern of the buttons looks “cool” and resembles some instrument. Looks “promising” 17:30 He likes the colour scheme of the app. “It’s very striking and nice”		4:05 Thinks that the metronome indicator is a recording button 4:30 Doesn’t know how to turn on the metronome 5:35 States that he now understand the interface (“In the beginning it looked scary”) 6:25 Table view issue, can’t scroll through the templates without problems 6:55 Doesn’t understand the name and function option 9:45 He is confused by the term template (What is a template?)	16:50 The black title bar looks too “computerish”, hide it to make the interface more “free” 17:57 Use multitouch to include both hands / make the app playable with the left and the right hand like a guitar

Evaluation Steffi

Student in Education, German & Spanish (Teacher)

University of Bremen

Remarks: *Little knowledge about music theory, can’t hear a chord, can’t name chords*

Advantages of the interface	*Disadvantages of the interface*	*Usability*	*Suggested improvements*
2:19 Changing the key is easy and straightforward 11:29 The visual metronome is great, "so you don't have to trust only your ears" 12:00 Metronome is easily understandable and it's good that it's indicated in the sidebar that sound and visual feedback are activated 12:08 She likes that she can play different buttons at the same time (Multitouch) 13:45 Likes the guidance 19:31 Likes how she can add the sixth or the seventh to a chord via multitouch	7:15 "It's always the same. Why can't I change? I can't get out of this loop" (then switches to a template that provides more variety) 10:00 "I don't know what to pick, because I can't immediately imagine what each template would sound like" (Template names too abstract) 12:29 No fingering like on the piano 13:00 She uses mostly her index finger 13:08 Composing a melody is pretty hard 14:53 Next chord indication confuses her. "I am already mentally finished with a certain chord" (after the chord changes) 15:40 Interface is overwhelming. She disregards the sidebar on the left. After this was pointed out, she says: "Oh, I don't deal	2:06 "Is it a chord?" 2:30 In the mode and key selection, the mode names are illegible 2:39 App is easily navigable 3:19 What are the green arrows good for? (Indicating which chords have been played) 3:29 Tried to change the volume of the song by using the volume slide in the metronome sidebar 5:48 Template "creepy" – naming unclear 6:15 Can't figure out what the chord progression indicator is for 6:40 What's the use of templates? 14:12 Confused by the fact that the chord indicator directly and automatically	2:55 Include a rhythm in the template 4:44 Practice to recognize single notes (ear training / aural training) 12:29 Only five chords / buttons so each finger is mapped to a single button (fingering like on the piano) 12:50 Indicate fingerings (Which finger to use) 15:07 Provide two indicators - one for the current and one for the next chord 16:01 Record exactly what the user plays / save a certain composition

	with that yet. Too many infos". 17:10 "What I really want to know is what I do randomly" No recording of played notes and chords 17:23 "This is relatively limited". One can only follow the template 17:45 "I am limited in my creativity"	indicates the next chord 15:25 "I play a chord and then I forget the last chord I played" 17:40 "I am forced to change my chord and can't play a chord twice" 21:34 "Why this order?" (How are the templates derived)	

Technical highlights of the implementation

While I won't detail how the applications was designed, I still want to point out certain features of Objective-C that allowed me to write an music application that is both elegant and reliable. An important class, which made the implementation of the metronome really is, is NSTimer. NSTimer allows to periodically call a function and is way more flexible than comparable Java implementations in that it doesn't have to be a superclass of a class to be used.

Another important and elegant mechanism in object-oriented programming with Objective-C and the iOS framework are NSNotifications. NSNotifications can be posted and observed everywhere in the applications. This enables the developer to make changes anywhere in the app and easily notify other parts of the applications to update. This allows an efficient and elegant information exchange.