Tallinn University

School of Digital Technologies

Human-Computer Interaction

Co-designing Mobile Music Making Apps for Novice Users

Master's Thesis

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Declaration page

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The thesis was finished under the supervision of Hans Põldoja

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Introduction

Current thesis focuses on designing mobile music making apps for novice users. The topic is part of the *music technology* research area in the wider Human-Computer Interaction (HCI) field. The term novice user, that sometimes outside of this thesis is referred to as non-expert user, is defined as a user with no prior music making experience.

A continuing trend in the music technology industry in recent years has been the approach of targeting the musical instruments to be used by users of varying skill level. While to some extent true also for the hardware side, one of the main grounds for this trend has been mobile music making apps, especially for the iOS platform. The number of high-quality music making apps available on iOS has grown remarkably and most of the big music technology companies, from Korg[1] and Yamaha[2] to Native Instruments[3] have entered the market with their apps. The intent of these apps is often not tied to producing and releasing music commercially, but rather to enable the users to have fun and enjoy the process of creating something - music in this instance.

Often various design techniques and approaches are used to make the instrument easily usable by people with no prior music making experience, while at the same time keeping the functionality in place that makes the same instrument desirable for semi-pro and in some cases also professional users as well. The challenge of achieving this is considerable.

For music technology companies the main rationale of lowering the entry barrier for users, so that anyone regardless of their prior musical experience could use their products, is clear: to widen their potential customers base. Other than that, some researchers and organisations[4] see the potential of this in the music therapy context. Regardless of the rationale behind it, the enabling technology available for designing intuitive music apps, so that more and more people could take part in the fun and rewarding process of making music, is here. But the question is, how to use it.

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[1] http://www.korg.com/us/products/software/

[2] http://usa.yamaha.com/products/musical-instruments/

[3] https://www.native-instruments.com/en/

[4] http://www.makeyoursoundlab.org/

Problem

Designing music technology for users with varying skill level (including novice users) is a complex task (Barraclough, Carnegie, & Kapur 2015; Deng et al., 2014; Jakobsen et al., 2016). The instrument has to be clear, simple and intuitive enough so that anyone, regardless of their prior musical experience could use it. But at the same time, it should not be too simple, so that it becomes boring to use. Finding the exact balance between functionality and ease-of-use is hard (Barraclough et al., 2015).

Another problem, that was discovered during the literature review, was that although related works on the topic of developing musical interfaces for novice users exist, they all report on the design process of a single prototype. Each new endeavour cites a handful of related efforts that have been undertaken before, but no cohesive overview of the topic exists. The knowledge is fragmented.

Aims

To address the problems above the following two aims were set for this thesis:

1. To identify design patterns in academia and the industry by analysing and systematising previous works on the topic.

2. To evaluate the identified design patterns with users and use them as a starting point in the co-designing process to gain a deeper understanding of the topic through designing new mobile music making prototypes with the target users.

Research Questions

To reach the set aims, current thesis seeks for answers for the following research questions:

RQ 1: What are the musical interface representation patterns in academic literature and released music making apps targeting novice users?

RQ 2: What design techniques are used in academic literature and in released apps to make the musical instrument accessible to novice users?

RQ 3: What are the common preferences and perceptions of novice users about mobile music making apps?

RQ 4: What are the challenges of co-designing mobile music making instruments for novice users?

Research Methods

The thesis uses various methods for seeking answers to the formulated research questions. In the first part of the thesis, literature and competitive review is used to analyse and systematise the previous work and knowledge on the topic. The second part of the thesis takes the outcome of the first part as a starting point to dive deeper into the topic by using various methods from the co-design approach. The first chapter will discuss the chosen methods in more detail.

Structure of the thesis

The thesis consists of four main chapters and is structured as follows:
Introduction, introduces the context and rationale behind the work. It covers the problem area and sets the aims for the thesis alongside with the research questions to focus on. The first chapter - **Methodology**, discusses the chosen research methods used to seek answers to the research questions and reach the objectives of the thesis set out in the first chapter. The second chapter - **Literature Review: Design Patterns In Academic Literature,** looks into the academia side of the first two research questions. In the third chapter - **Competitive Review: Design Patterns In The Industry**, the released apps side of the first two research questions is answered and a combined categorisation with descriptions and analysis of the various identified design patterns of the two areas of interest are presented. The fourth chapter - **Co-Design Process**, describes the co-design workshops that were carried out and reports their outcomes. In chapter five, **Discussion**, an analysis of the methods used and the results of the undertaken endeavours of the thesis is given and finally in the last chapter - **Conclusion**, a summary of the whole thesis is presented.

Figure 1 illustrates the main components of the thesis, their relationship and in which chapter each of the research questions are addressed:

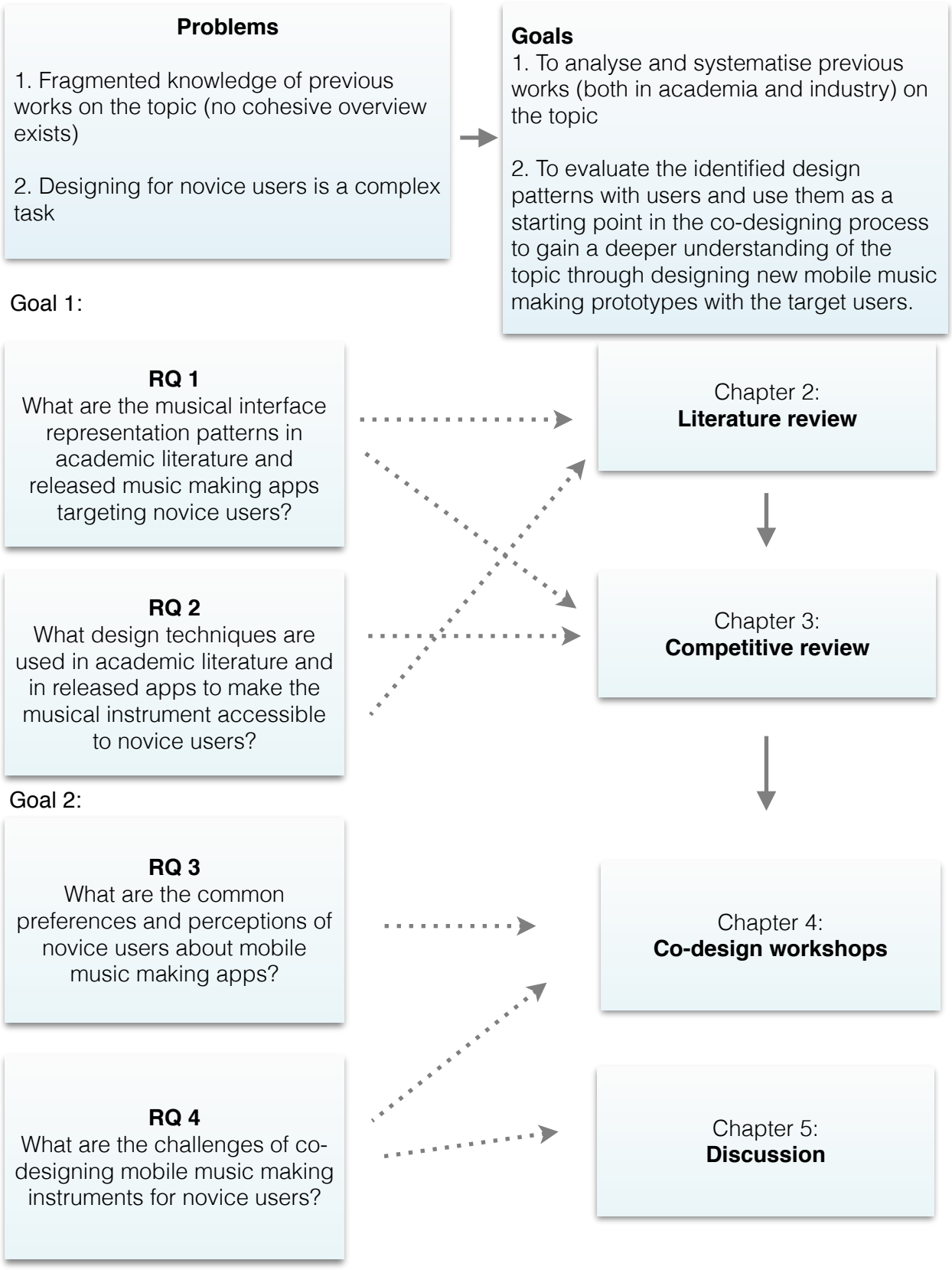

Figure 1. Main components of the thesis, their relationship, and in which chapter each of the research questions are addressed.

1. Methodology

The focus of this thesis is on design. Fallman (2007) argues that the design of new technologies through software and hardware prototypes is the core of activities in Human–computer interaction (HCI) research field. Faste and Faste (2012), among others, describe design as a practice-based discipline. In the design of music technology, Dahl (2015) stresses the importance of practice-based research in the New Interfaces for Musical Expression (NIME) community. For the current thesis, the research component is embedded in the overall design process and is used to gain more knowledge about the topic and to provide a starting point for the design process, while at the same time the knowledge gained from the practical design process can be seen as generating new research knowledge.

In that perspective, it can be said that in general, the work falls into the category of what Fallman (2007) refers to as *Design Oriented Research* culture within HCI. In Design Oriented Research the main focus is on the knowledge gained from the process of designing the artefact. The artefact itself, in this context, is more seen as a means rather than an end. The second part of the thesis follows the main principle behind the co-design approach: to include the end users to the design process as much as possible.

In the first part of the thesis, literature and competitive review are used as sources for systematising the previous endeavours on the topic by analysing and categorising the reoccurring patterns in academic literature, prototypes and released apps. This combined knowledge is then used as a starting point in the second part of the thesis where co-design workshops (that include design, prototype and evaluation sessions) with the users are used to design new prototypes of mobile music making apps aimed for novice users.

1.1 Co-Design

The main idea behind co-design is to include all of the stakeholders (including end users) of the project in the design process as much as possible. In contrary to iterative ‘human centred' design the stakeholders are seen as partners who should be involved throughout the whole design process, not just as ‘subjects’ who are brought in only in the ‘evaluation’ phase of the process (Sanders & Stappers, 2008).

One of the main advantages of involving end users (and other stakeholders if applicable) to the design process is the potential depth of knowledge that could be obtained from this collaboration. When looked at separately, the things that people say and do might often contradict. By introducing the third, *make*, dimension into the picture, co-design can reveal deeper knowledge of user expressions (Sanders, 2002).

While conventionally most of the research projects in the NIME community seem to follow the iterative human-centred approach of design, various examples of the usage of the Co-Design approach could be found as well. Especially in cases where the end users of the instruments did not have any previous musical experience, for example in the context of tools and instruments for children (Shapiro, Fiebrink, Ahrens, & Kelly, 2016) or for users with physical or intellectual disabilities (Favilla & Pedell, 2014; Grierson & Kiefer, 2013; Jense & Leeuw, 2015).

1.2 Design Patterns

Design patterns in the context of this thesis are defined as reoccurring ways of doing something (e.g. solving a specific design challenge, representing the user interface (UI) in a certain way, etc.). In the NIME community, Flores, Miletto, Pimenta, Miranda, and Keller (2010) identified four general musical interaction patterns for communication purposes inside a multidisciplinary team. The first part of the thesis will focus on the reoccurring patterns (as in design choices) in the UI of mobile music making apps and also the technical design considerations ‘behind the scenes’ that enable the instrument to be used by users with varying previous experience and musical skill level.

1.3 Research Methods

To address the various challenges of the specific context of the topic, the thesis uses the following research methods to answer the research questions and reach the set aims of the study.

1.3.1 Literature Review

In addition to the conventional use of literature review where it serves the purpose of establishing the previously done work in the field of the topic and positioning the

current endeavour, in the context of current thesis the literature review can also be seen as a separate method. In this case the academic literature documenting the development of musical interfaces for novice users is used as a source to find, categorise and analyse reoccurring patterns in the set two focus areas of interest - the user interface and underlying, enabling design techniques.

1.3.2 Competitive Review

Brown (2010) describes competitive review as analysis of other digital products to see how other people have solved similar design challenges and explore the various possibilities. In this case, 42 released apps were reviewed to analyse and systematise the previous work done in the industry on the topic.

1.3.3 Co-Design Workshops

The format of co-design workshop was used to involve the end user into the design process and through that obtain deeper knowledge of participants expressions. The workshop was comprised of two main sessions:

- evaluation session
- prototyping session

In the evaluation session, the results of the first part of the thesis were presented to the participant and various topics discussed. This serves as an introduction to the topic and context. In an iterative manner the step was repeated in the end of the workshop to competitively evaluate the designed prototype against other existing apps and design possibilities.

In the prototyping session a new prototype of a mobile music making app was developed with the user, using the rapid UI prototyping tools prepared for the session. In the context of designing mobile music making apps, the commonly used prototyping methods such as sketching, paper prototypes, wireframes and even high-fidelity UI mockups are often not sufficient enough to communicate the various design nuances of the instrument to the users. The lack of sonic feedback that is essential to musical instruments is hard to overcome with just the graphical representation of the UI and explanations about how it works.

Dahl (2015) argues that to evaluate if the proposed design is appropriate we need a performance with the designed instrument and to do it we need ‘the whole thing’. The challenge here, however, is to find the most appropriate tools for this task, as spending too much time on creating the (sonic hi-fidelity) prototype can go against the whole idea of prototyping - a fast, low cost way of testing different design ideas. In the beginning of chapter 4, the challenge of choosing the most appropriate prototyping tool for the context is addressed in more detail.

2. Literature Review: Design Patterns In Academic Literature

"The need to uncover what is already known in the body of knowledge prior to initiating any research study should not be underestimated" (Hart, 1998).

The aim of this chapter is to give an overview of the academic literature on the topic of mobile musical instruments for novice users and to address the academia part of the first goal of the thesis:

To analyse and systematise previous works *(both* ***in academia*** *and industry)* ***on the topic.***

This is done through seeking answers for the academic literature related side of research questions 1 and 2 of the thesis:

RQ 1: ***What are the musical interface representation patterns in academic literature*** *and released music making apps* ***targeting novice users?***

RQ 2 : ***What design techniques are used in academic literature*** *and in released apps* ***to make the musical instrument accessible to novice users?***

The chapter is predominantly based on the publications of the NIME[5] (New Interfaces for Musical Expression) conference, which is the highest ranking music technology publication in the 'Music & Musicology' subcategory in Google Scholar Metrics[6]. In addition to that some other published articles on the topic from various other journals and conferences were found.

2.1 Design for Novice Users

Music technology for novices has been one of the multiple focus areas in the NIME community for quite some time now. Alongside with 'mobile music making', 'music

[5] http://www.nime.org/

[6] https://scholar.google.com/citations?view_op=top_venues&hl=en&vq=hum_musicmusicology

technology for novices' was one of the topics in the 2013 ACM Special interest group (SIG) meeting for NIME and HCI communities (Bevilacqua et al., 2013).

Similarly to other creative areas, the advances and availability of technology is seen as an enabler to lower the entry barrier for making music. Some of the closely related focus areas inside the NIME community, that share the approach where no previous musical experience is expected from the user, are music technology for therapy, audience participation, and to some extent also gaming and education.

A common reoccurring theme in various research papers for musical interfaces targeting the novice users is the notion of the designed instrument to "sound good" regardless the players skill level (Buschert, 2012; Jakobsen et al., 2016; Lee, Srinivasamurthy, Tronel, Shen, & Freeman, 2012). With note-based instruments, the 'behind the scenes' design technique that enables that 'sound good' criteria is commonly implemented by locking the scale and root key to a particular setting, so that the possibility of the user to play dissonant (not "good" sounding) notes is eliminated. Subchapter 2.2.2 and the combined subchapter 3.2 in the next chapter will look at this and some other design techniques used to cater for the novice user in more detail.

In terms of the functionality of the instruments, one of the main design challenge seems to be finding the right balance of the amount of features the interface enables (Barraclough et al., 2015; Deng et al., 2014). While limiting the functionality of the instrument can lead to better understandability and easier usage, having an instrument with too little functionality is likely to be not engaging enough for the users over longer periods of time.

Dahl and Robaszkiewicz (2012) report from their study of placing constraints (what notes and how often can be played) to novice users that while with such constraints in place by the system the subjectively perceived likeability of the resulting music might be higher, the enjoyment level of using the system is higher without them.

As stated in the introduction chapter of the thesis, the main goal of designing musical instruments for novice users is to enable them to take part in the fun process of making music. Thus, the quality of the musical output or what other people think about it, is a secondary concern. The fun and the enjoyment of the process of making music comes before the perceived subjective quality of the musical output - the resulting music itself.

2.2 Prototypes in Academic Literature

Given the prevalence of predominantly practice-based research approaches in the NIME community, multiple examples of research papers reporting the design process of various mobile music making prototypes targeting the novice users could be found.

As stated in the ‘Problem’ section of the Introduction chapter of the thesis, no cohesive overview of the topic of designing instruments for novice users exists. From analysing all the research papers that could be found on the topic, it could be said that while most authors refer to the origins of mobile music making and in some cases also a handful of related attempts for targeting specifically the novice user, the overall research knowledge about the topic is still fragmented.

The following two subchapters try to improve the situation and report the results of the analysis of 13 research papers related to the topic of music making interfaces for novice users with the aim to find reoccurring design patterns about the following two specific points of interest:

1) How the musical user interface is represented (RQ 1)
2) What design techniques are used to make the musical instrument accessible to novice users (RQ 2)

2.2.1 Interface Representation Patterns

This subchapter looks into the reoccurring patterns in musical user interface representation choices in the prototypes of research projects targeting the novice user. It is a starting point for the categorisation and analysis that combines the patterns identified in both research projects and released apps, that is presented in the third chapter.

One of the prevalent interface representation patterns in academic projects was the usage of XY touch area for note triggering (used by Dahl et al., 2012; Deng et al., 2014 among others). Barraclough et al., (2015) use the XY area in the node-based sequencing context. Nishibori and Iwai (2006) report on the development of Yamaha Tenori-on instrument (also available as an app) that uses multiple sequencing layers, including the conventional steps sequencer layout. Trump and Bullock (2014) report on the development of a relatively popular released app - Orphion that uses abstract,

spheres with no visual reference to existing musical instruments as note triggering areas.

The complete, combined categorisation with descriptions and analysis of the various UI representation patterns is presented in chapter 3.1.

2.2.2 Design Techniques Targeting Novice Users

This subchapter looks into the reoccurring patterns of the design techniques and approaches used in the prototypes of research projects to make the instrument more accessible to novice users. It is a starting point for the categorisation and analysis that combines the patterns identified in both research projects and released apps.

The most prevalent design technique used for making the prototype more accessible to novice users in the academic projects was the usage of 'backing track' to help in keeping timing and providing musical context (used by Barraclough et al., 2015; Deng et al., 2014; Lee et al., 2012 among others). Another widely used technique to prevent the user of playing musically wrong (dissonant) notes is the usage of scale and root key locking (used by Dahl et al., 2012; Trump & Bullock, 2014; Weinberg, Beck & Godfrey, 2009, among others).

The complete, combined categorisation with descriptions and analysis of the various techniques and approaches used to make the instrument more accessible for novice users is presented in chapter 3.2.

Summary

This chapter addressed the academia side of the first set goal of the thesis:

To analyse and systematise previous works *(both* ***in academia*** *and industry)* ***on the topic.***

By seeking answers for the academia side of the first two research questions:

RQ1 : ***What are the musical interface representation patterns in academic literature*** *and released music making apps* ***targeting novice users?***

RQ 2: ***What design techniques are used in academic literature*** *and in released apps* ***to make the musical instrument accessible to novice users?***

An overview of prior research in the field related to the topic was presented. Research papers reporting on the development of prototypes related to the topic were analysed and the process of categorising the reoccurring patterns in the two research questions' areas of interest was started.

While research papers reporting on the development of music making prototypes can provide valuable insight into the design process, rationale and challenges faced when designing the musical instrument prototype, one of the shortcomings of the above was that except for the case of Orphion (Trump & Bullock 2014) and Tenori-on (Nishibori & Iwai, 2006) none of the prototypes are available for testing and further evaluation. Thus the analysis of this chapter was relying only on the information that was presented about the prototype instruments in the corresponding research papers.

To overcome and complement this, the next chapter will look into released apps that are available for evaluation. And combine the results with the findings from this chapter to categorise, describe and analyse all the identified patterns in academic prototypes and released apps in the two areas of interests that the first two research questions address.

3. Competitive Review: Design Patterns in Released Apps

The aim of this chapter is to address the industry (released apps) part of the first set goal of the thesis:

To analyse and systematise previous works *(both in academia and* ***industry****)* ***on the topic.***

This is done through seeking answers for the released apps related side of research questions 1 and 2 of the thesis:

RQ 1: ***What are the musical interface representation patterns in*** *academic literature and* ***released music making apps targeting novice users?***

RQ 2: ***What design techniques are used*** *in academic literature and* ***in released apps to make the musical instrument accessible to novice users?***

The chapter is based on the analysis of 42 released apps in the iOS App Store. Android apps were left aside as the size of the market in terms of the number of apps available on that platform compared to iOS in the context of music making apps is trivial. Also, adding Android (or any other mobile platform) would not bring anything new to the table as the platforms, in the context of current thesis' focus on UI design and general design approaches for novice users, are technically the same.

The first selection criteria for the apps was whether the app could be easily used by users without any musical experience. Complete music production apps and the ones that can not be easily used by novice users were left out.

The second, consecutive selection criteria was the relative success and popularity of the app. Thus the main methods for finding the apps to evaluate them against the set criteria was through the App Store top, featured and related sections. Also, the Appannie[7] app analytics and data platforms' music apps top for the main App Store markets (US, China, UK, Japan) was used.

[7] https://www.appannie.com/

iOS devices come in two form factors – (smaller) iPhone and (larger) iPad (tablet). Although they share a common operating system and hardware capabilities, in the context of designing musical interfaces for the platform the available screen 'real estate' is a crucial factor and introduces a considerable design challenge for the interface.

To see how the challenges of interface design between iPad and iPhone versions have been addressed by different developers, current section looks at apps made to be used by users on both of the device families. Some developers have developed 'universal' apps that use identical interface for both of the device families (using UI scaling to match various screen sizes). Some, more recently have moved to developing separate versions of the app for phone and tablet devices.

As the first two research questions of the thesis are interested in the combined results of both released apps and academic projects, and as this chapter follows the previous one, that focused on the academic projects, the following two subchapters report the combined results of the two chapters.[8]

3.1 Interface Representation Patterns

This subchapter categorises, describes and analyses the combined different identified musical user interface representation choices of the released apps analysed in this chapter and also in the research projects of the previous chapter. The subchapter starts with an overview figure of the different identified instrument types and their musical user interface representation categories. After that, each category is described and analysed in more detail.

Figure 2 categorises the different musical user interface representations identified in both released apps and academic research projects. The categorisation in some cases can be somewhat superficial as different apps can use multiple interface representation ways and belong somewhere in the 'hybrid' area between being a 'sound triggering' and 'sequencing' instrument. But nonetheless, it gives an overview of the different UI options being used and in most cases of the hybrid instruments the essence of the

[8] *iOS apps are subject to frequent updates. Although rarely drastic in terms of graphical layout and interaction approaches, the information below could be somewhat different at the time of reading this thesis than it was at the time of writing it. The information and screenshots are up to date as of December 2016.*

instrument type, whether it is a sound triggering instrument with some supporting sequencing features or a sequencing instrument with some sound triggering features, is clearly present in the interface. The way the interface in mobile music making apps is represented is rooted into the type of the specific musical instrument it is.

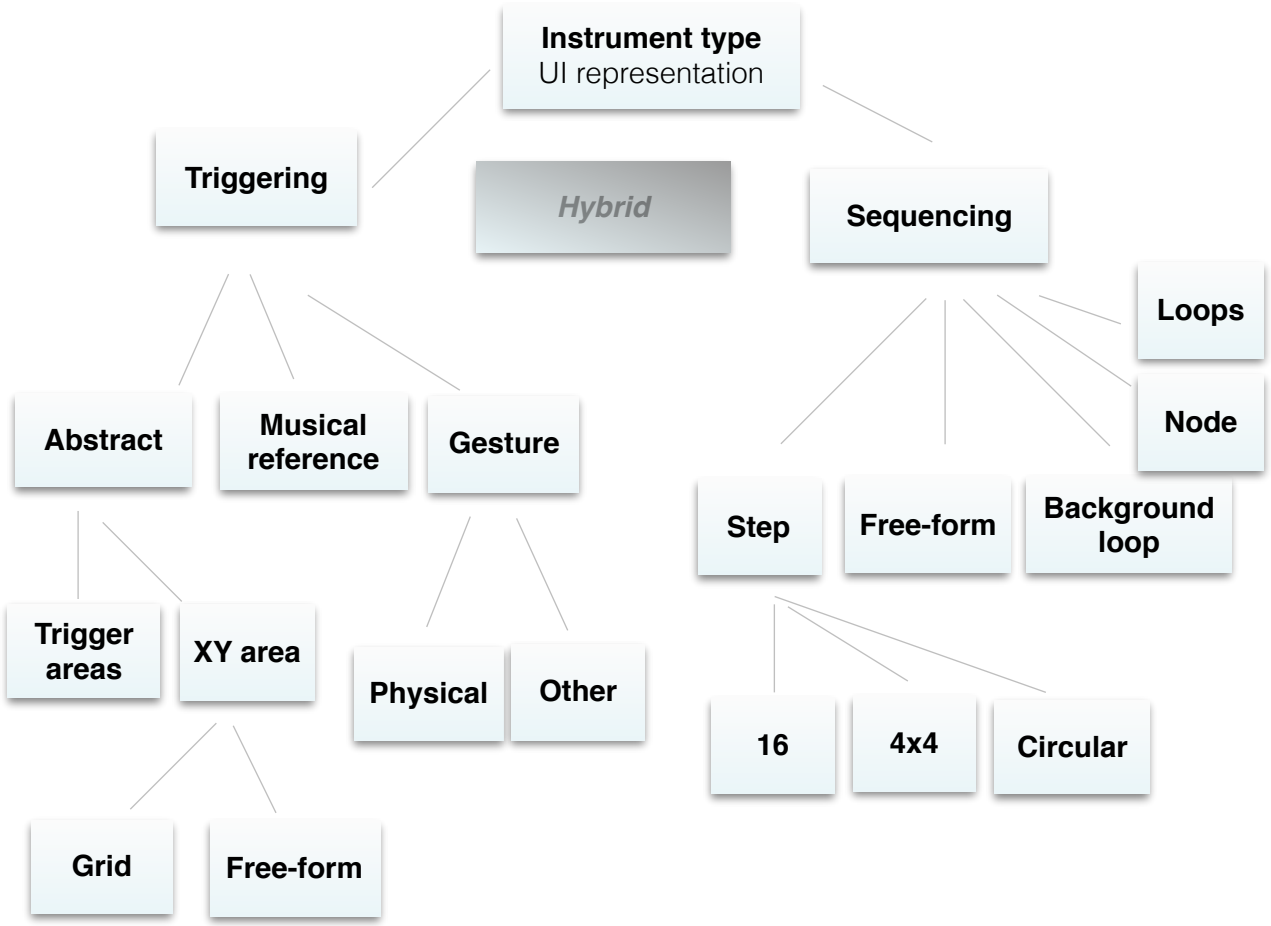

Figure 2. User interface representation patterns in mobile music making apps.

3.1.1 Triggering

In this instrument category, the underlying principle of producing the sound is based on direct mapping of users' action to the reproduction of sound by the instrument. Whenever the user initiates the action, for example by touching an UI element or performing a specific physical gesture (like shaking the phone) a sound that is connected to that action is instantly played. The sounds that are triggered can be specific notes or in some cases chords of a specific musical instrument or drum or abstract sounds in either sampled of synthesised format.

The following subcategories show how the interface is represented to the user in the different instrument types that belong to the overall sound triggering category.

3.1.1.1 Musical Reference

In this category, the UI visually signifies directly to an existing musical instrument (see Figure 3). This way the musical context and, to great extent, also how the app can be used is clearly established.

Figure 3.Three UI examples of triggering instruments with musical reference from GarageBand[9] app: Keyboard, Drums and Guitar.

One of the challenges with simple instrument modelling apps is how to translate the expressiveness of the real instrument into digital world and make the usage of the app engaging over longer periods of time. In some of the keyboard-based apps, for example Animoog[10] the touch point on the piano key's length (Y axis) is mapped to control the velocity parameter of the synthesiser, so that when the user touches the bottom part of the key the note is played at a low velocity value and for higher part of the key the same note but with higher note velocity value is played. This is a common technique to add some additional expressiveness to the instrument without adding any additional visible elements to the GUI. Discoverability nor understandability of that, somewhat hidden, feature is not a significant issue in this case, as the user will most likely figure it out shortly just by using it. And if not, it would not be a problem as nothing changes for them if they don't understand the feature.

Also the usage of the devices' gyro-meter and accelerometer data could be used to map some additional sound parameters to them for augmented expressiveness.

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[9] http://www.apple.com/lae/ios/garageband/

[10] https://www.moogmusic.com/products/apps/animoog-0

3.1.1.2 Abstract

In this category (contrary to 3.1.1.1: ‘Musical reference’) the UI does not use a visual reference to an existing musical instrument, but instead is represented with more abstract, geometrical (round, rectangular, hexagon, etc.) trigger areas (see Figure 4).

Figure 4. Three examples of triggering instruments with abstract UI, with no direct reference to existing, physical musical instruments: SoundPrism[11], PolyChord[12], Hex OSC S[13]

One of the potential advantages of using a layout that does not resemble any particular existing musical instrument (like piano keys for example) is that it might be more inviting and less daunting for a person without any musical experience to try and use it. From the author’s personal experience on working with different public installations of interactive musical interfaces, it can be said that the presentation of a classical musical interface as an input can be a turn off for many users (psychological barrier: “Oh, a piano – I don’t play that”). Deng et al. (2014) argue that an abstract interface is more intuitive for the novice users as it does not display the complicated musical context and frees the players imagination.

On the other hand, in terms of clarity of the interface itself – what it does and how it can be used, the association with something so widely understandable as piano keys, for example, can be more beneficial than an abstract layout of pads (that in itself does not visually communicate any hints to the user about the potential usage of the app).

In the current case of iOS apps, it could be said, however, that in terms of the general understandability, the context (music making) has usually been already established in the app store through descriptions and categorisations, before the user starts using the app. Although, on the other hand, it can also be argued that the visual understandability

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[11] http://audanika.com/

[12] http://polychordapp.com/

[13] http://www.sky-light.jp/hex/

side of the UI impacts greatly the discoverability of the app in the app store as the screenshots section has a very dominant place in the app description page.

3.1.1.2.1 Trigger Areas

In this subcategory the different trigger areas of the UI are visually distinctive and directly mapped to produce a specific note or sound of the instrument when touched (see Figure 5). Sometimes, in the case of triggering musical notes, the trigger areas can be marked with the corresponding note names (like visible on the right side image of Figure 5). While for novice users this can be seen as a distraction, for users with some music theory knowledge it provides additional visual clarification about the app. In most cases, the note names can be toggled on or off from the settings of the app and the default state varies from app to app, probably depending on where the developer stands on this point.

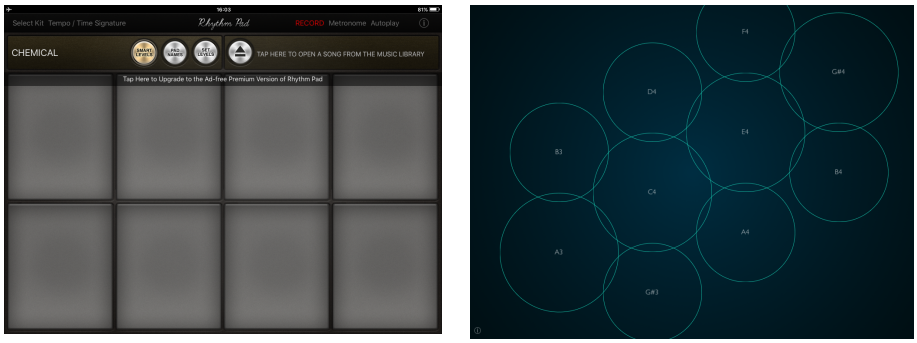

Figure 5. Two examples of triggering apps with specific triggering areas: RhythmPad[14] and Orphion[15]

In the case of 'Orphion' for example the touch position inside the circular trigger area is mapped to modulate the triggered sound, so that when the user touches the area in the centre the note is played with a lower modulation setting and when the user touches the same triggering area somewhere closer to the edge of the circle the same note, but with higher modulation setting is played. This is a widely used technique and can be seen as a good way to extend the functionality and expressivity of the instrument without clogging the UI.

[14] http://www.rhythmpad.com/

[15] http://www.orphion.de/

3.1.1.2.2 XY Area

In this subcategory the UI is represented as a single square or rectangular XY touch area that is mapped to two separate sound parameters. The first one, usually mapped to the vertical Y axis is often the pitch of the note. The second parameter is commonly mapped to either note velocity, filter cut-off or some sound modulation parameter.

3.1.1.2.2.1 Grid

Here the grid that divides the overall XY touch area to specific triggering areas is visible (often implemented as an option). Thus the intentional playing of the instrument is simplified. See Figure 6.

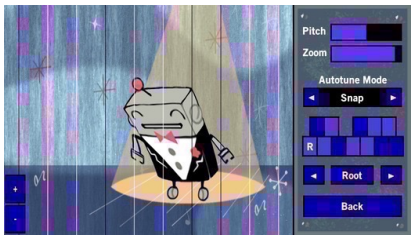

Figure 6. Bebot Robot Synth[16] with the visible separation lines (grid) on the horizontal axis separating the different notes that can be triggered.

3.1.1.2.2.2 Free-form

In this subcategory the individual trigger areas inside the overall XY touch area are not visible (see Figure 7). This could potentially support more free, unintentional playing style of the instrument.

Figure 7. The interface of Korg iKaossilator [17] with no visible separation points of the XY touch area.

[16] http://www.normalware.com/

[17] http://www.korg.com/us/products/software/ikaossilator/

3.1.1.3 Gesture

In this category the production (or often manipulation) of sound is mapped to a specific user gesture (other than the conventional touching of an UI element to trigger the sound).

3.1.1.3.1 Physical

Here the triggering of sounds is mapped to a physical action of moving the mobile device by for example shaking or tilting it. Thus the UI itself is mostly just informative text or in some cases like the NinjaJamm[18] effects module, an two-dimensional XY area animation of the current tilting position. The interaction is enabled by the built-it gyro- and accelerometer of the devices.

This subcategory is a somewhat experimental and special case, and brought out separately only to highlight this possibility. It was not the essence of any of the released apps under analysis in this chapter but there are some experimental ones out there and some of the popular music making apps use this approach in conjunction with other representations. Most common is the option of mapping the device's tilt position to modulate a sound parameter. In the academic side, Weinberg, Beck and Godfrey (2009) used physical gestures as a central part of the instrument in their released ZOOZbeat app, that unfortunately is not anymore available in the App store. In a presentation[19] at the first Loop conference, Norbert Schnell from IRCAM[20] demonstrates the ongoing research project CoSiMa[21], that in one example, successfully uses the physical gesture interaction for triggering samples.

3.1.1.3.2 Other

In the distinctive and original Playground[22] app, for example, the UI consists of different and in some instances movable UI elements that act either as triggering zones or the triggers themselves. The main interaction, in addition to conventional touch, is to swipe

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[18] http://ninjajamm.com/

[19] https://www.ableton.com/en/blog/all-together-now/

[20] Institute for Research and Coordination in Acoustics/Music https://www.ircam.fr/

[21] http://cosima.ircam.fr/

[22] http://www.getplayground.com/

and move the different UI elements around to produce the sound. The triggered sound and the background sounds depend on the speed of the swiping gesture and also the direction of the point where the trigger UI element and the sound producing UI trigger element collide.

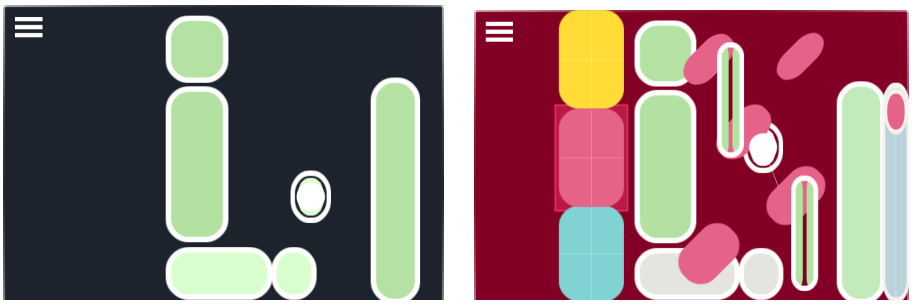

Figure 8. The UI of the Playground app uses various movable UI elements for triggering different musical material.

3.1.2 Sequencing

In this category, the main focus of the interface is not on sound creation through triggering but instead on sound creation through sequencing the available musical material to create the music. Often apps combine both sequencing and triggering, although in most cases the balance is clearly towards either of the two approaches.

3.1.2.1 Step

Step sequencing is one of the most commonly used ways of representing musical material in the time domain. The moving playhead that triggers a sound when colliding with an activated step (on/off button) in the looping grid provides a good combination of both visual and sonic feedback for the user, that helps to understand how the interface works (see Figure 9). Conventionally on/off buttons forming the vertical axis represent either specific sounds (for example different drum sounds per row) or different notes in the case when the whole grid represents a single instrument. The horizontal axis conventionally represents the time domain (with the same note or sound mapped to each button in the row).

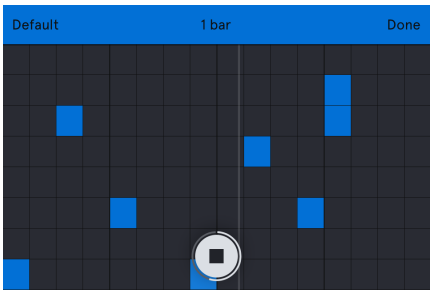

Figure 9. Example of an app where the step sequencing approach is used: Auxy[23]

In one of the multiple variations of step sequencing the on/off button is replaced with a vertical slider. In that case the position of the slider controls the pitch of the note for that step.

3.1.2.1.1 16 Step Grid

Although 16 horizontal steps is the most conventional way of representing a step sequencer, in the case of a smaller screen iPhone devices, it is hard to fit all the UI elements (on/off switches) to the screen, even in landscape mode. In the TNR-i[24] app, the interface (see Figure 10, left) consists of a 16x16 grid in portrait mode, which makes the accurate operation of the app on small screen iPhones (like 4s, 5 and SE) extremely difficult, as the buttons are too small. The developers of DM1[25] app have addressed the issue by placing the 16 on/off switches of the step sequencer in 4 x 4 rows on the iPhone version (see Figure 11). For the iPad version all the 16 steps are placed horizontally (see Figure 10, right).

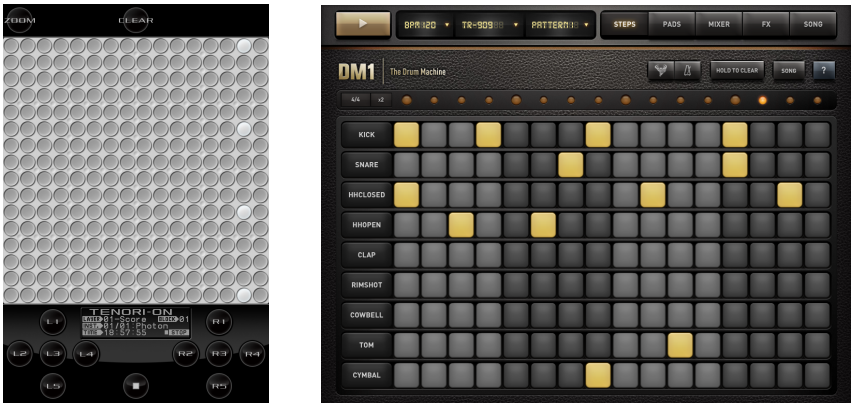

Figure 10. Left: TNR-i iPhone app with 16x16 step grid and right: DM1 drum machine for iPad.

[23] http://auxy.co/

[24] https://uk.yamaha.com/en/products/music_production/apps/tnr-i/?mode=model

[25] http://fingerlab.net/portfolio/dm1

3.1.2.1.2 4x4 Step Grid

In this case, the challenge of fitting the UI to the limited screen space of the phone device family, in the case of step sequencing, is addressed by breaking the conventional 16 step grid into 4x4 grid, so that the buttons can be bigger and thus are more easily touchable. The downside of this, however, is that the overall view of all the other rows (sounds) is not available anymore and the view has to be switched from one row to the next (see the examples of DM1 iPad vs iPhone UI, figures 10 right and 11, respectively).

Figure 11. The iPhone version of the DM1 breaks the 16 step grid into 4 x 4 rows.

3.1.2.1.3 Circular

Here the layout of the step sequencer grid is not a conventional horizontal line, but the steps (buttons) are arranged in a circle (see Figure 12). Although subjective, at some instances this can be seen as a more more playful way of presenting the interface. Also, when comparing to the conventional horizontal line placement, it can be said that the looping nature of the sequencer is in circular placement visually more natural.

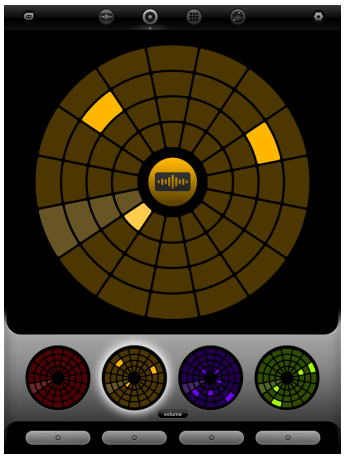

Figure 12. In the Loopseque[26] app, the 16 steps are arranged in a circular way.

[26] https://loopseque.com/

3.1.2.2 Free-form

In this, rather experimental subcategory, the steps of the sequencer are not fixed to a grid but are free, allowing the placement of musical material timing-wise also in places between the set steps of the step sequencer for example. This resembles the conventional timeline approach in Digital Audio Workstations but in the case of mobile music apps, especially for novice users, it is conventionally avoided by design (see subchapter 3.2.2 for details). Depending on the type of the instrument, in some cases, like the free-form drawing app FluXpad[27], showed in Figure 13 (that also has quantisation as an option) a loose, free-form grid might be appropriate and can provide a more playful experience.

Figure 13. FluXpad app with the interface that allows the notes to be 'drawn' in a free-form way, without restrictions.

3.1.2.3 Background Loop

Here, the sequencing of the previously performed (recorded) musical material happens in the background and is not represented visually in the UI. Thus the focus would be on the sound triggering side of the interface. The user can record and play back the recorded loops but they can not see or edit it in the same way as it is possible for example in the case of step sequencing. In the example of Korgs' iKaossilator[28] the interface is represented as the XY Free-form area (see subchapter 3.1.1.2.2.2 for details) and the sequencing functionality is hidden in the background.

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[27] http://mominstruments.com/fluxpad/

[28] http://www.korg.com/us/products/software/ikaossilator/

3.1.2.4 Loops

This subcategory represents a recent trend in rise of different loops-based sound board apps. Here, the music is not made from triggering or sequencing individual notes, but rather from selecting, combining and manipulating already available prerecorded musical material - loops. Thus, it is easily usable by users of any previous musical experience, but at the same time also limiting in terms of musical expressivity due to only enabling the music making through manipulation of preexisting loops. Some apps, like Auxy[29] for example (that itself belongs to the step sequencing category) manage to combine both the easy, synchronised triggering aspect of the loops based apps presented here and also the ability to create the loops by step sequencing.

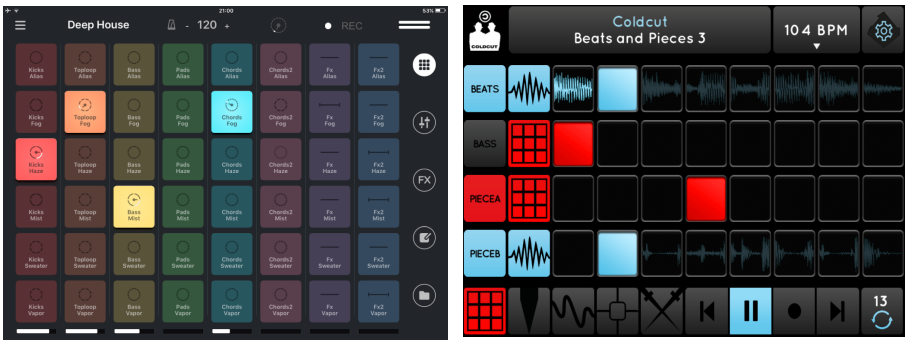

Figure 14. Left: Remixlive[30] loops based soundboard app. Right: Ninja Jamm[31] loops based live remixing app.

Technically these apps copy how legato trigger mode enabled clips in Ableton Live's[32] session view work - the playheads' position takes over from the same relative time position of the loop when a new loop is triggered. This way the different loops stays always in sync with each other. The UI in most cases is a grid of buttons where either the rows or columns represent the instrument group type (bass, drums, keyboard, etc.) and the other axis represents the different loops of that particular instrument group (see Figure 14).

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[29] http://auxy.co/

[30] http://www.mixvibes.com/remixlive-ios-android

[31] http://ninjajamm.com/

[32] https://www.ableton.com/en/

3.1.2.5 Node

In this subcategory, the playing musical sequence is represented as connected ‘nodes’ where some of the nodes emit ‘pulses’ that trigger a note when colliding with sound producing nodes. The distance between the nodes represents the time between each note in the sequence. A slight variation of this, is the ‘random layer’ in TNR-i[33] app that does not have separate sound emitting nodes, but just plays the inserted sequence according to the location of and distance between activated steps. In dot Melody[34], the time duration between the notes (and their length) in the sequence is not mapped to the physical distance between the nodes but rather to the vertical axis of the screen.

Similarly to step sequencing the node based approach provides a good combination of visual and sonic feedback of the currently playing musical material. However, because of the lack of formal visual structure in the case of nodes, the visual feedback overload (too much happening at the same time) is likely to happen when many sequences with a high number of nodes are present (see Figure 15).

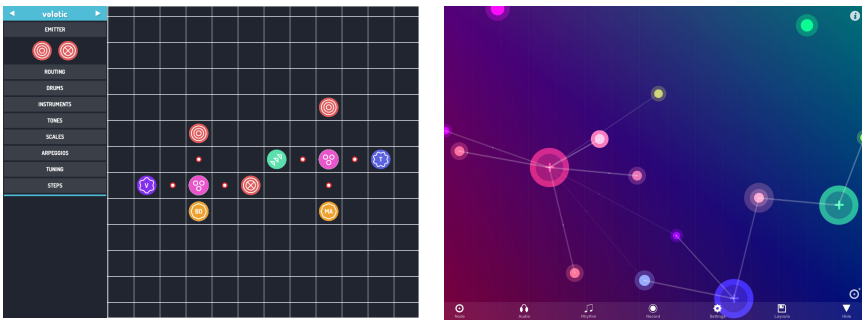

Figure 15. Left: Volotic[35] nodes based sequencer app. Right: NodeBeat[36]

Also, in most cases, the nodes approach tend to lead to somewhat experimental sounding music, as the loop lengths of the different sequencing materials are likely to be different (resulting in asynchronous loops). But depending on the instrument type and its goal the choice of node-based sequencing can lead to unconventional and interestingly sounding results.

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[33] http://usa.yamaha.com/products/apps/tnr-i/

[34] http://www.olympianoiseco.com/apps/dot-melody/

[35] http://www.scottmadethis.net/interactive/volotic/

[36] http://nodebeat.com/

3.2 Design Techniques Targeting Novice Users

This subchapter categorises, describes and analyses the combined identified design techniques used in the released apps and in prototypes of research projects to make the instrument more accessible to novice users. These ‘techniques’ range from specific technical implementations to general approaches.

3.2.1 Fixed Key and Scale

This technique ‘locks’ the scale and the root key of the instrument to a particular setting, so that the possibility of the user to play dissonant (not “good” sounding) notes is eliminated. It is a standard technique (implemented often with customisable settings) used in almost all of the note based apps to enable the musical output to sound musically ‘correct’ regardless of the users’ actions.

Figure 16 illustrates the implementation of this this technique in the Animoog[37] app. On the left hand picture the scale is set as chromatic, meaning that all the 12 possible notes are available for triggering via the keyboard section on the lower part of the UI. While appropriate for people with musical background, in the case of a novice user with no knowledge about music theory, depending on the sequence in which the individual notes are played by the user, some of them might sound dissonant (out of scale) in relation to the previously triggered notes.

On the right hand picture of Figure 16, this scenario is eliminated by locking the scale and consequently the available keys to trigger the notes of only the Major Blues scale.

Figure 16. Root key and scale locking in Animoog. Left: chromatic, right: Major Blues scale.

[37] https://www.moogmusic.com/products/apps/animoog-0

3.2.2 Time Domain Quantisation

For sequencing apps that allow recording of the users' performance, the usage of quantisation is as widely used as the previous 'Fixed Key and Scale' technique for note based instruments.

In this case the timing of the recorded notes will be 'fixed' in real time so that all of the notes the user triggered fall into the closest predefined value of the grid. Although generally desirable and appropriate in the context of novice users as it corrects the 'wrong' timing of the performance, depending on the type of instrument and the musical genre it caters for, this feature can be seen as making the results too exact and robotic or mechanical sounding. In this case a humanisation (de-quantisation) feature that either leaves in or brings back some of the 'swing' or 'groove' caused by slight off-timing could be added. Or in some cases some of the quantisation parameters (like strength) are open to adjust. However, this is more for advanced users.

Closely related to quantisation is the usage of synchronous loops in loops-based apps and sequencing. Although asynchronous loops can create interesting polyrhythms and sonic results, in the context of non-experimental instruments the usage of synchronous loops leads to musically more conventionally sounding results.

3.2.3 Looping of Material

Following from the last point, the usage of looping material in general can be seen as a way to make the instrument more accessible to novice users. Whether it is a type of sequencing that is used for recording or inserting the musical material into it or ready-made loops, the usage of looping can be helpful for the novice user as it keeps the music 'going' (in contrast to purely trigger based instruments). Also, as the majority of popular music is based on repetition and the usage of loops in various lengths that comprise the music, the reference is there and the essence of it is already familiar.

3.2.4 Backing Track

Related to the previous technique but brought out separately, is the usage of backing tracks in sound triggering instruments. This enables the user to 'play along' with the backing track that could be either an instrument group (like drums or keyboards) or a complete musical track. It can be seen as a potential way of boosting the fun and

relative quality of the output of the users' performance with the instrument, and also to help keep timing like the use of metronome does.

Rhythm Pad[38], for example, lets the user to import backing tracks from their own music library on the device. While for them the feature does not technically create new challenges, because it is a drum sound triggering app and drum sounds are generally less prone to create dissonance between the triggered sounds and the user selected backing track, in some other cases, like for example a note based triggering instrument the imported backing track should be analysed to find the key and scale of the track so that the 'Fixed Key and Scale' technique (3.2.1) could be applied on the instrument to mach it, to prevent dissonant sounding notes.

3.2.5 Sound Design and Pre-Mixed Sounds

In addition to the notes sounding musically "right" (see subchapter 3.2.1 for details) another factor, that is also likely to contribute to the notion of the instrument "sounding good", is the actual sonic quality of the sound that the instrument produces. With some of the apps, like SoundPrism[39] and TNR-i[40] for example the distinct quality of the sound they produce can be seen as a central part of the whole instrument. Thus the importance of the sound design stage in development should not be overlooked.

Another side of this approach is the usage of various audio production techniques to make the instrument sound 'technically' good. This includes the usage of audio equalisers, compression and limiting, adding effects like reverb and making sure the levels of the different sounds the instrument can produce will sound good together. This can either be done in the background with optionally some of the parameters available to users or in the case of sample based instruments the audio processing is done in the production stage of developing the app.

3.2.6 Limited Control Over Sound Design Parameters

While the previous point stressed the importance of sound design in the development stage of the app, when it comes to giving control over various sound design parameters to the user, in the case of mobile music making apps (especially for

[38] http://rhythmpad.com/

[39] http://audanika.com/

[40] http://usa.yamaha.com/products/apps/tnr-i/

novices) the overall pattern seems to be very limiting. If we take the conventional sound design parameters available in synthesisers for example (multiple parameters for oscillators, filters, envelopes, etc.) then in the context of a novice user they are likely to be too complex and confusing.

Instead, most of the apps place performance and expressiveness features of the app over users' ability to change the various sound design parameters. Often the usage of instrument or sound presets are used with limited access to some of the audio effects parameters for additional sound manipulation.

3.2.7 Minimal UI and Hidden Expressiveness Features

This, more of a general approach, is somewhat related to the previous one. Because of the scarce and limited screen space available, and the approach of using preset sounds with limited sound design control left for the user, the UI of mobile music making apps (especially for novices) tend to be rather minimal. While minimal UI in most cases can be linked to being clear and understandable, the challenge here lies in finding the right balance of functionality of the app that is behind the minimal UI. If the functionality is too minimal, the app might not be engaging enough. Especially over longer periods of time.

Some apps use somewhat hidden, added expressiveness features in their instruments without clogging the UI. Examples of this include mappings of different touch points in the trigger area to various sound modulation parameters or the usage of the device tilt position to do the same. Quite often these features are not explicitly present in the UI, thus can be seen as somewhat hidden extras.

3.2.8 Visual Feedback

When it comes to the representation of the musical material a strong and clear visual feedback in combination with the heard music seems to be crucial for the instrument to be understandable (especially for novice users). To some extent, all the various sequencing methods mentioned in this chapter seem to succeed in that.

Summary

This chapter addressed the first set goal of the thesis:

To analyse and systematise previous works (both in academia and industry) on the topic.

By seeking answers for the first two research questions:

RQ 1: What are the musical interface representation patterns in academic literature and released music making apps targeting novice users?

RQ 2: What design techniques are used in academic literature and in released apps to make the musical instrument accessible to novice users?

Combined results in the form of categorised patterns, their description and analysis of the two research questions' areas of interest were presented.

In the next chapter 'Co-Design Process', the combined knowledge of previous chapters is taken as a starting point in the co-design process to design new music making apps for novice users and to learn more about the topic from the target user's perspective during the process.

4. Co-Design Process

The aim of this chapter is to address the second set goal of the thesis:

To evaluate the identified design patterns with users and use them as a starting point in the co-designing process to gain a deeper understanding of the topic through designing new mobile music making prototypes with the target users.

This is done through seeking answers for research questions 3 and 4:

RQ 3: What are the common preferences and perceptions of novice users about mobile music making apps?

RQ 4: What are the challenges of co-designing mobile music making instruments for novice users?

The chapter also gives an overview of the undertaken co-design workshops and their preparation.

4.1 Preparations

This subchapter gives an overview of the activities carried out prior to the co-design workshops.

4.1.1 Rapid Prototyping Tools

In order to address the third research question of the thesis properly, and to be able to facilitate the co-design sessions with users of no prior development background, the right set of tools had to be found. Fortunately, various tools that are mostly meant for creating custom mobile music controller layouts exist, that can be also used for prototyping mobile UI in the context of developing new musical instruments. In this

[41] Real-time UI changes, 2 way osc/midi communication, interface builder, custom UI objects, gyro and accelerometer support, fast setup and UI creation, styling of UI objects, actively developed, etc.

42 Mira, MiraWeb, TouchOSC, MobMuPlat, BeatSurfing, Control, Lemur, Nexus OSC, Mrmr OSC controller

phase, a set of desired criteria[41] was set for the prototyping environment and 9[42] different options were evaluated.

At the time of the evaluation three of the most suitable options were Mira[43], MobMuPlat[44] and TouchOSC[45].

Mira being the most promising one with the ability to make real-time changes to the mobile UI through mirroring the interface inside the visual programming environment Max[46] that can be used as a sound engine and for programming the apps' operating logic. Unfortunately, they currently only have an iPad version of the app and not all the UI objects of max environment are currently supported by Mira. The recently introduced MiraWeb[47] allows a similar workflow on any mobile browser but has currently too long latency for two way communication, that is needed for example building visual feedback for sequencers.

Both TouchOSC and MobMuPlat have a dedicated interface builder desktop app from where the interface can be exported to the mobile device. They both have all the basic UI building blocks like buttons, toggles, sliders and knobs available with some degree of customisation and styling options. But as MobMuPlat is integrated with another visual programming environment called Pure Data[48], it means that more advanced functionality and operating logic can be developed to the prototype. Also, the universal mobile app is free and as the sound engine could be embedded into the app itself, the participant could take the developed prototype with them after the workshop. Thus MobMuPlat was chosen as the rapid prototyping environment for the co-design sessions and for recreating the basic UI representation patterns for evaluation.

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[43] https://cycling74.com/products/mira/

[44] http://danieliglesia.com/mobmuplat/

[45] https://hexler.net/software/touchosc

[46] https://cycling74.com/products/max/

[47] https://cycling74.com/2016/12/20/content-you-need-miraweb

[48] https://puredata.info/

4.1.2 Workshop Structure

The co-design workshops included the following 5 consecutive sessions, of varying length:

1. Introduction, where a brief overview of the history of musical instruments was given with the emphasis on electronic instruments and the new possibilities they introduced (like the sequencing of musical material for example). Also, in this short session, an overview of the iOS platform and its capabilities, limitations, possible interactions and challenges was given. The topic of smartphone apps usage, in general was discussed with the participant, including what apps they use, how often and where did they find out about them.

2. Discussion of common interface representation patterns. In this, also relatively short session, the main UI representation patterns of the first part of the thesis were presented to the participant, to introduce them to the topic and also to find out which patterns are most intuitive or other ways preferred and why. To eliminate other factors (like graphical design and sounds) that could influence the evaluation of various UI representations, this session used basic recreations of the interfaces in the selected prototyping environment, so that the UI elements, colours and sounds were consistent across the various UI representation patterns.

3. Prototyping session. In this session, the prototyping of a new musical instrument (app) started. The participant was given a short tutorial of the UI builder environment after which the ideation stage started, where the main direction of the instrument to be designed was formulated (triggering and/or sequencing, single or multi-sound instrument, what sounds are used, which interactions, etc.). If the participant felt more confident in sketching ideas out on paper first, then this was used as a starting point. If not then the UI prototyping in the digital environment started. At the end of the first iteration where a functional, sound producing prototype was finished, the author reminded the context of novice users to the participant and the topic of how the instrument could be made more intuitive was introduced. A discussion about the current functionality and whether it is sufficient enough to be engaging over a longer period of time followed, with focus on getting new ideas from the participant about this. After the discussion, an optional second design iteration stage of the instrument was planned to take place.

4. Comparative evaluation of existing apps. In this session, similar existing apps to the instrument that was being designed in the workshop were presented to the participant for evaluation. After the discussion another, optional, design iteration stage of the instrument was planned to take place.

5. Conclusion. In this closing session, the whole workshop and the designed prototype was evaluated. Some main topics were revisited while playing the newly designed instrument prototype. Throughout the workshop the discussion about the various points of interest was conducted in a semi-structured interview style.

Figure 17 visualises the co-design workshop structure, where the above-mentioned sessions are in blue, topics and activities that were introduced by the author are in orange and the various points of interest that were discussed throughout the sessions are marked in green.

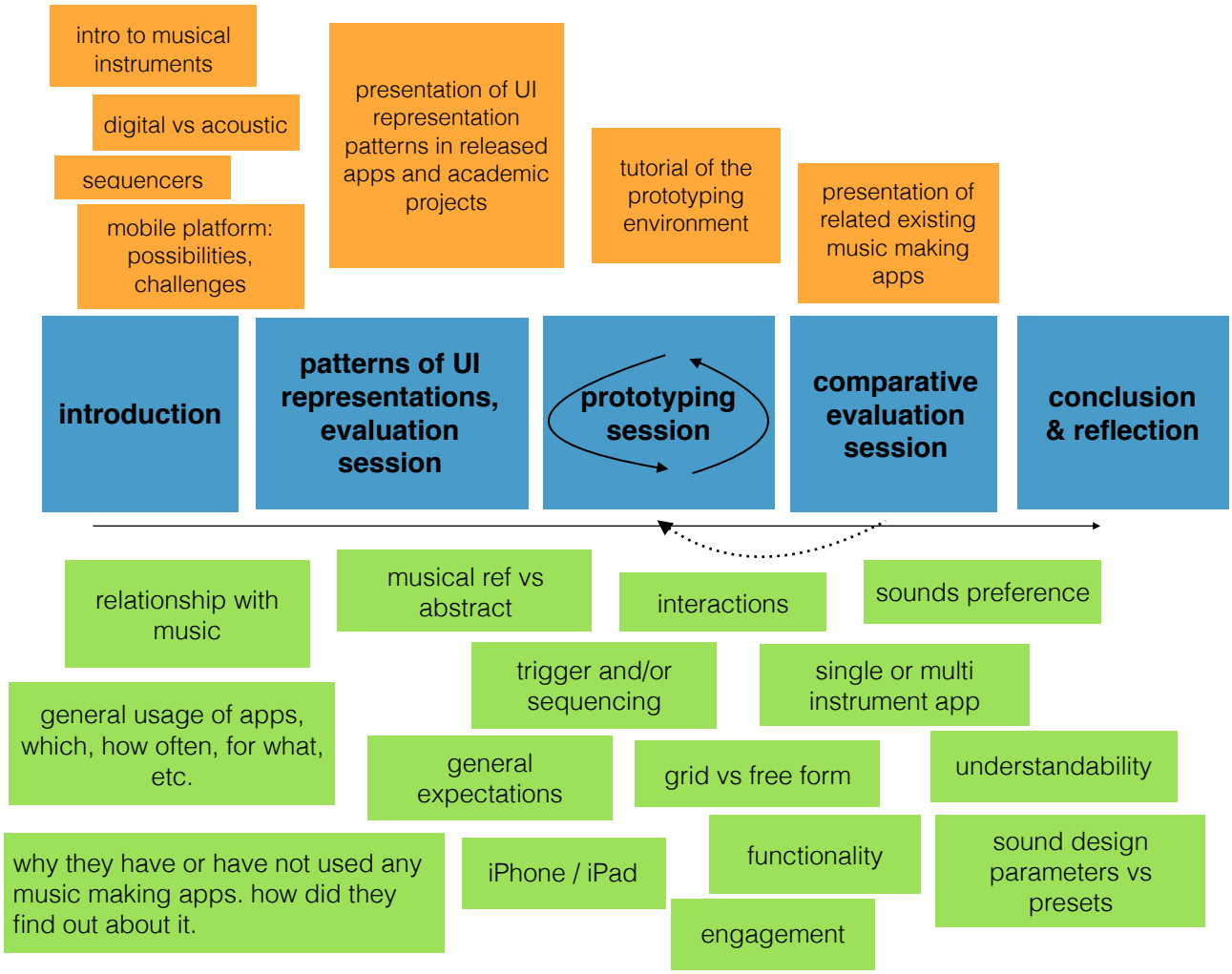

Figure 17. Structure of the co-design workshops, divided into sessions (in blue). In orange: topics and activities introduced by the author. Green: topics are the specific points of interest discussed and revisited throughout the workshop.

4.2 Co-Design Workshops and Results

This subchapter focuses on the insight gained from the co-design workshops. The choice of using co-design as the underlying principle in the sessions with target users will be analysed in the next, 'Discussion' chapter.

4.2.1 Workshops, participants and prototypes

Altogether five one-on-one co-design workshop sessions were held with participants who had no prior music-making experience. Due to the open-ended nature of the workshops the duration of the workshops varied from approximately 1 hour in the shortest case to over 4 hours in the longest case, depending on the interest level the participants had in the development session of the prototype. During the workshops, 4 basic sound producing musical instrument prototypes were developed. One session did not lead to a prototype due to the lack of interest of the participant in creating one.

Out of the four prototypes created, three can be categorised as sound triggering instruments. Two with pads (one of them with backing track) and one with the accelerometer input triggering various percussion sounds. One of the most complete prototypes ended up being a 16 step sequencer with some additional sound triggering possibilities (Figure 18).

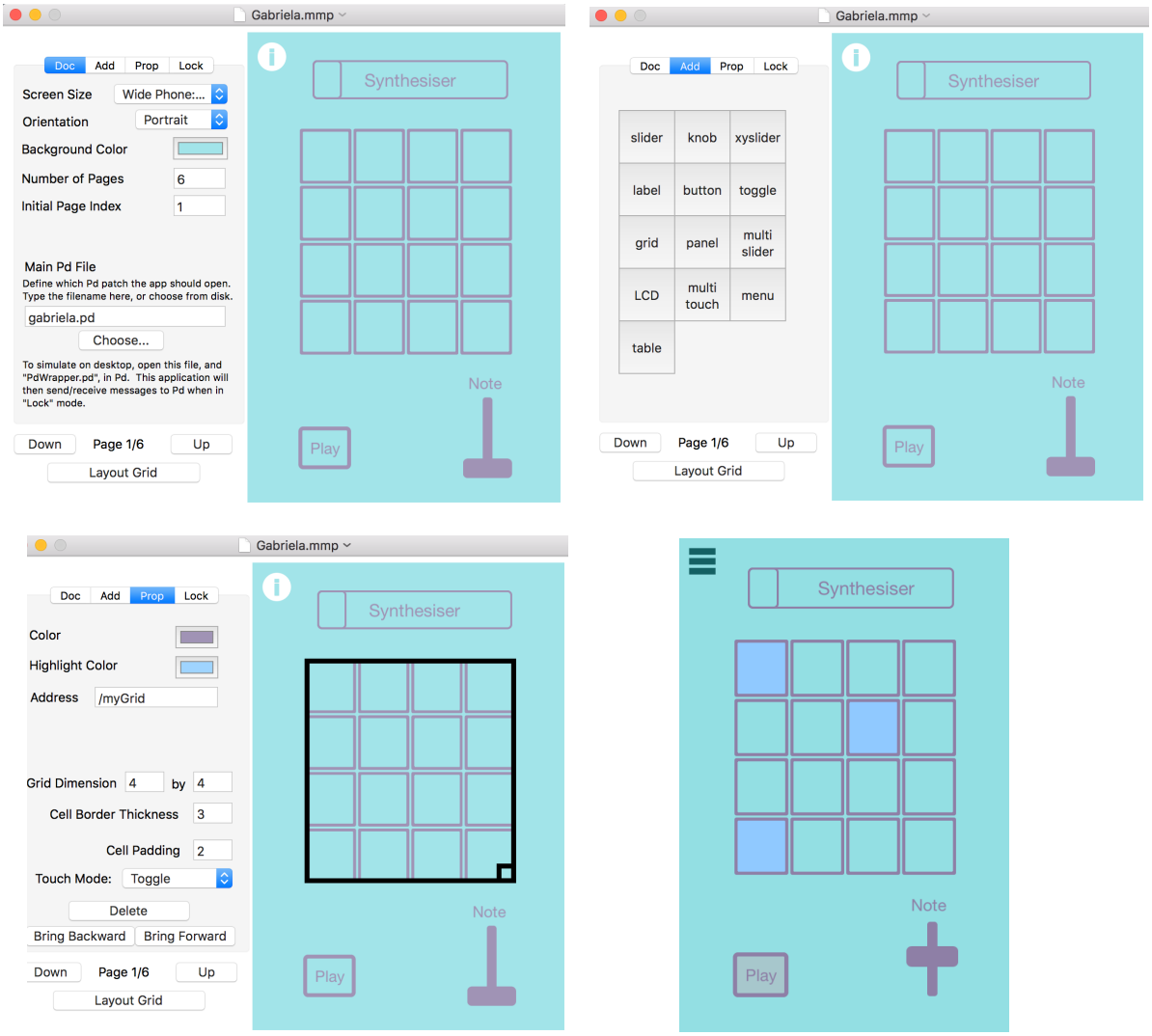

Figure 18. Top left: screenshot of the MobMuPlat interface builder application showing one of the prototypes. Top right: UI elements page, displaying the various building blocks that are available. Bottom left: the properties page, where some of the parameters of a chosen UI element can be changed. Bottom right: screenshot of one of the views of the built prototype running on an iPhone.

None of the prototypes created hold any significance on their own, nor provide any novelty as musical instruments. But the process of creating them proved to be a valuable vehicle for discussion and gaining insight into the participants' perspectives on different topics of interest of the study.

4.2.2 Thoughts About Commonly Used UI Representation Patterns

Abstract vs musical reference in UI

When given a choice between triggering instrument with musical reference present in the UI and without (abstract), 3 out of 5 participants initially preferred the one with

musical reference, because they thought it gives a better sense of context and in the case of the piano keys that were used in the example, also it hints where to touch on the screen to produce a sound. Interestingly this was not reflected in the prototyping stage of the workshop, where both of the participants who preferred the musical reference, and chose to design a triggering instrument, actually ended up using the abstract, pads layout. When asked about this at the end of the workshop, one participant said that during the workshop they realised that the musical reference layout would limit their ideas too much and the abstract would give more freedom in terms of the placement, size and shape of the individual trigger areas. The other participant who abandoned the musical reference preference during the prototyping session did not express any specific reasons for that other than just wanting to 'try the other way'.

One of the participants did not have strong opinion about either of the choices and one, who preferred the abstract layout, thought that the musical reference way would be too 'constraining and limiting', while the abstract way is more versatile, as it is not sonically tied to 'that particular instrument' that is visually present in the UI.

XY, physical gesture

Interestingly, none of the participants were too fond of the XY layout of triggering instruments, that was one of the most popular interface representation ways in the academic projects analysed in the first part of the thesis. One participant described it to be 'too strict' and one as 'unintuitive and difficult to play'. For the others, no further reasoning, apart from the expression that they just preferred the other ways of interface representation more, could be elicited. Three participants saw this as an appropriate way of controlling effects instead. But when it comes to triggering sounds, all of the participants preferred pads or some other form of buttons for producing the sounds.

One participant was particularly fond of the physical gesture interactions (using the accelerometer) for triggering sounds, as it 'gives a more active and fun experience of using the instrument'.

Triggering and/or sequencing instrument

All of the participants preferred at least some degree of direct sound triggering possibilities, in either the apps shown or in the prototypes developed. 3 out of 5 participants thought that some kind of backing track that accompanies the playing of

notes would make the instrument either ‘more engaging’ and ‘fun’ for the users or would help them keep the tempo while playing. 2 participants expressed interest in having some control over the backing track and one implemented it as a 16 step sequencer (with 4x4 layout to fit the mobile screen better). On the other hand, one participant thought that a fixed backing track with limited manipulation control over it would be better ‘as it would be simpler and would leave the main focus on the performance part of the instrument’.

Sequencing

All of the participants were able to grasp the idea of how the step sequencer works, and how to operate it, almost instantly. In terms of the layout of the steps, no clear preference emerged. Some participants tended to prefer the 4x4 or 2x8 layout where steps ‘move’ from left to right in a row, one participant a full 16 step row in landscape mode and one participant liked the circular layout as it ‘feels less strict’. But the preferences were not too strong in any of the cases, nor could any deeper reasoning behind them be elicited from the participants.

Single or multi-instrument apps

When given a choice between single or multi-instrument approach, 3 participants out of 5 initially expressed their preference towards a multi-instrument app. During the workshop, however, 2 of them abandoned the idea as being ‘too complex’ and wanted to focus on a single instrument approach instead.

4.2.3 Sounds

When asked about which sounds they prefer for the designed instrument and why, it emerged that in all of the three cases where the participant had strong opinions about the sounds they would like the instrument to produce, the reference point when evaluating the suitability of the different sounds made available to them, came from the music that they like. For example, one of the participants, who said they mostly listen to electronic music, described the sounds of a classical rock drum kit as ‘cheesy’ and settled for a drum machine sound kit that is widely used in various electronic music styles. One participant did not have strong opinion or preference about sounds and one had a specific sound in mind from the beginning that did not reflect her personal preference in music.

Presets vs access to all sound design parameters

All of the participants found the interface of classical synthesisers to be overly complex and in some cases ‘scary’ and ‘daunting’. Two participants said that they would like some control over the main parameters of sound, to change the sounds to be more ‘unique’ and ‘interesting’. Others did not see the advantage of access to sound design parameters and were satisfied with being able to choose from different sound parameters.

4.2.5 General expectations towards a music making app

One of the predominant themes from the participants was that the ability to get ‘good’ sounding results from the instrument without much effort from the user, should be a vital characteristic of the instrument. 2 participants were more ready and patient to put in some time and effort to master a new instrument. Other ideas, like ‘clear’, ‘nice’ and ‘beautiful’ graphics were also mentioned, alongside with the expectation for the apps to be ‘easily understandable’ and ‘intuitive’.

And as the participants did not see themselves as ‘serious musicians’ the notion of ‘fun’ and ‘easiness’ was expressed on multiple occasions.

Summary

This chapter gave an overview of the undertaken co-design workshops and their preparation and addressed the second set goal of the thesis:

To evaluate the identified design patterns with users and use them as a starting point in the co-designing process to gain a deeper understanding of the topic through designing new mobile music making prototypes with the target users.

This was done through seeking answers for research questions 3 and 4:

RQ 3: What are the common preferences and perceptions of novice users about mobile music making apps?

RQ 4: What are the challenges of co-designing mobile music making instruments for novice users?

During the co-design workshops, various topics of interest were discussed in detail with the participants and many previously unknown and interesting perceptions and preferences about the topic emerged. The next chapter ‘Discussion’ analyses the chosen methods and their appropriateness in more detail, alongside with the results of the whole thesis.

5. Discussion

This chapter analyses the chosen methods used in the thesis, tasks undertaken during the process and reflects upon the results.

5.1 Choice of methods

As the methods used in the first part of the thesis, literature and competitive review, are somewhat standard, there were no real alternatives to them. Especially given the set first aim of the thesis and the formulated first two research questions. For the second research question, about the design techniques that are used to make the apps more accessible to novice users, some additional methods, like interviews or questionnaires with app developers could have potentially been incorporated to study this aspect in more detail, but this would have been too time consuming at that phase of the thesis. Also, this would have shifted the focus of the whole thesis too much on that single aspect, that in itself could be a single point of interest of a thesis.

Because of the complexity of the topic, the qualitative approach, in the second part of the thesis, was most likely justified as it produced some valuable insight into participants perceptions and expectations towards mobile music making apps. Most of the areas of interest inside the topic (see Figure 17, green) that were addressed during the co-design workshops would have been extremely difficult to study just by asking the participants questions. Many concepts needed introduction and demonstration first to be evaluated at all.

An alternative to the co-design workshops would have been thorough usage sessions with the users but as some of the undertaken co-design workshops showed, the participants' perceptions about certain aspects can change during the creation phase. This would have been likely missed in a demonstration and usage session. Thus, the general claim that co-design can provide deeper and more comprehensive insight into the participants' perceptions about the topic could generally be echoed based on the experience of the user sessions of current thesis.

The workload for creating the various artefacts for the above-mentioned usage session and interviews, as an potential alternative approach, would have probably been similar

to the preparations of the co-design workshops. Thus no advantage in that aspect could be seen.

Technically, both of the approaches require a good knowledge of the chosen prototyping environment. In the case of MobMuPlat[49] that was chosen as the mobile UI prototyping environment for the co-design sessions, the interface builder desktop application itself is an easy to use drag and drop interface, but connecting the UI with sound and creating some more advanced functionality requires knowledge in operating the visual data flow programming environment Pure Data[50]. From Pure Data the input events from the UI can be passed on as MIDI messages, so that any Digital Audio Workstation could be used for sound creation. This proved to be a great time saver in the process as different sets of preset sound packs were quickly available for the prototyping sessions.

One of the criticisms of using complex rapid prototyping tools in the co-design approach, as pointed out by Muller (1993), is that if an 'expert' is involved in operating the rapid prototyping technology, the participant might feel alienated from the design process and their views might get distorted. And in the alternative approach, of training the participant to be self-sufficient in the rapid prototyping environment, they might alienate from other, regular users in that process as their "prototyping-environment-influenced views become associated with those of the designers and implementors" (Muller, 1993).

With that in mind, the involvement of the author in the technical aspects of linking the participant's created UI with the sounds was made as seamless as possible. And a relatively easy to use drag and drop interface builder was chosen for that purpose.

On one hand, one could, quite rightly, say that all the introductory activities, provided background information and the presented commonly used interface representation methods influenced the outcomes of the co-design sessions and at that point, there was already a distinction in knowledge of the participant and the target 'novice' user.

But on the other hand, without all the mentioned introduction activities to the topic, the co-design sessions would probably not have been possible at all. The prospect of

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[49] http://danieliglesia.com/mobmuplat/

[50] https://puredata.info/

involving a novice user in the design process and discussing the various aspects of the topic without providing any background information is too steep.

One of the challenges of using co-design sessions for something as relatively complex as designing a music making app was dealing with participants who did not have strong opinions and the occasional resistance towards making something on their own.

All in all, the choice of the methods was satisfactory to the author, at times pleasantly challenging and helped to reach the set aims of the thesis adequately.

5.2 Results

As pointed out previously, the prototypes designed during the co-design sessions hold little or any value as artefacts on their own. But the gained experience, knowledge and the insight from building them, do. Numerous new and interesting preferences and perceptions about the topic emerged that the author had not thought about before nor came across from literature (see chapter 4.2 for details).

Theoretical and Practical Implications

To the best of the author's knowledge, no previous attempts of analysing and systematising the various ways the UI is represented in mobile music making apps (chapter 3.1), have been carried out. Flores et al., (2010) identified four musical interaction patterns (natural interaction, sequencing of events, process control and sound mixing) to communicate computer music knowledge in a multidisciplinary team. Although the focus of their research (interactions) and the focus of the first RQ of current thesis (UI representation) are related and some overlapping of basic ideas behind the identified patterns exist, the general focus and scope of the endeavours, thus also the results are different. One focuses on interactions and computer music in general, and the other on UI representations, specifically in mobile music making apps for novice users.

Nor could any previous attempts, to identify and analyse the various design techniques that are used to make the music making apps accessible to novice users (chapter 3.2), be found. The above results, presented in the first part of the thesis (chapters 2 and 3), can provide a useful starting point for further research or practical value for anyone

interested in designing new artefacts in the field of mobile music making apps for novice users.

The discussion about using the co-design approach in the field of music making apps, presented in chapter 5, can also potentially provide some useful insight for other researchers and developers in the field.

Also, the brief analysis of rapid UI prototyping tools, that was presented in the beginning of the fourth and discussed in the fifth chapter, can provide useful practical information for people interested in building hi-fidelity mobile music making prototypes.

5.3 Limitations of the Study

One of the limitations of the study could be the similar background of the participants of the co-design sessions. As the writing of the thesis occurred in the period where the author was an exchange student in a non english speaking country, all the participants, except one, were recruited from the university. None of them had any interaction design or development background but three of them were studying (physical) product design. Thus, ideally more co-design sessions with participants from more varied backgrounds could have been done.

Also, another limitation was the time frame. Given that more time would have been at hand, some of the areas of the thesis could have been approached in more depth.

5.4 Recommendations for Further Research

The thesis acts as a solid starting point for further research. One of the areas that is closely related but was left out of current thesis' main focus is the different interactions used in the released apps. Also, an interesting and related area, that was planned in the beginning but due to various limitations was left out is the collaboration and multi-user aspect of mobile music making.

Conclusion

All in all, current thesis reached it's set aims, and in addition to providing a new experience in preparing and hosting co-design workshops and knowledge about previously unknown user perceptions about the topic to the author, the completion of the thesis has provided a somewhat meaningful contribution to the research knowledge on the topic in the following ways:

- The thesis has identified and analysed various ways of presenting the UI of mobile musical instruments to the novice user in academic research projects and in released apps.
- The thesis has identified and analysed various design techniques used in academic research projects and in released apps to make the musical instrument more accessible for novice users.
- The thesis has analysed the current state of rapid prototyping tools for mobile music UI development.
- The thesis has provided some new insight into the preferences and perceptions of novice users in the field of mobile music making apps.
- The thesis has analysed the appropriateness and challenges of using the co-design approach in the context of designing mobile music making apps for novice users.

All of the above can provide valuable insight into the topic for either researchers or designers and developers working in the field.

Kokkuvõte

Tavakasutajatele mõeldud mobiilsete muusika tegemise rakenduste koosdisain

Käesolev magistritöö keskendub tavakasutajatele mõeldud mobiilsetele muusika tegemise rakendustele. Töö esimene osa (peatükid 2 ja 3) annab ülevaate valdkonnas kasutusel olevatest kasutajaliidese disaini mustritest ning tehnilistest ja üldistest kasutusel olevatest võtetest, mis teevad disainitavad muusika tegemise rakendused lihtsamini kasutatavaks ka eelnevat muusika tegemise kogemust mitteomavate kasutajate jaoks.

Töö teises osas kasutatakse koosdisaini meetodeid, arendamaks lõppkasutajatega koos uusi mobiilseid muusika tegemise prototüüpe, et välja uurida eelnevat muusika tegemise kogemust mitteomavate kasutajate ootusi, hoiakuid ja mõtteid mobiilsete muusika tegemise rakenduste suhtes.

Antud töö täitis kõik eelnevalt püstitatud eesmärgid ja olles autorile teadaolevalt esimene taolise fookusega uurimus, võib käesolev magistritöö, nii teoreetiliselt kui ka praktiliselt kasulik olla erinevatele muusikatehnoloogia valdkonnas töötavatele teaduritele, disaineritele ja arendajatele.

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