

A Step Out of the Grid

Interaction with Touch-Based Alternative Rhythm Programming
Layouts in Drum Machine User Interfaces

Master's Thesis in Interaction Design and Technologies

ANDRÉ AMORIM

JOHANNES KJELLBERG

This thesis is essentially worth the music, of which we hope, it will inspire towards.

MASTER'S THESIS 2020

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UNIVERSITY OF
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Gothenburg, Sweden 2020

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Master's Thesis 2020

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Cover: An alternative rhythm programming layout, illustration by the authors.

Typeset in L^AT_EX

Gothenburg, Sweden 2020

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Abstract

Drum Machines have been popular tools in music creation since their great penetration in the 80^s. Even though this was 40 years ago, the layout used for step programming still looks and works the same - 16 binary steps distributed in a row or a matrix. This research and project investigate how alternative step programming layouts based on touchscreen interaction possibilities can affect user experience, player behaviour and usability. An initial investigation of how expert users utilise and interact with drum machines was executed. The result from the user study shows that the use of drum machines is subjective and individually dependent on user preference, previous experience, context and user goal. Drum machines are used to realise specific goals as well as perform open-ended musical exploration. Full control over a device is expressed as desirable, even though the users wish the interaction to result in unpredictable outcomes in certain situations. Four alternative layouts were developed and integrated into a web application. For comparison, a traditional layout was also integrated within the prototype. The layouts were compared and evaluated with both expert and beginner/intermediate users. The evaluation of the alternative layouts concludes that alternative step programming layouts based on touchscreen interaction affects user experience and player behaviour. Gestures were used as a way to explore, experiment, find inspiration and reach for unpredictable results. Alternative layouts, designed to utilise the possibilities touchscreen user interfaces provide, have the potential to enhance the cumulative user experience when step programming rhythms in action mode.

Keywords: Alternative step programming layouts, Rhythm programming, Drum machine, Step sequencer, Interaction design, User experience, Touchscreen interaction, Human computer interaction, Player behaviour, Digital musical instruments

Acknowledgements

We would like to thank our supervisor Palle Dahlstedt from Chalmers University of Technology for support, guidance, absorbing discussions and not least, for inviting us to elaborate and further investigate your ideas.

Furthermore, we would like to express our gratefulness towards all users that participated in the user study and the user tests. Your contributions have been essential and fundamental for this project.

André Amorim and Johannes Kjellberg, Gothenburg, October, 2020

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1

Introduction

Music has always been an important part of human life. Throughout history, various instruments have been invented and used to create and play music (Montagu, 2017). The design and layout of the instruments have had an impact on which sounds they can produce but also on what actions they afford to the player, which in turn affects how they feel to play as well as the music being created (Nilsson, 2011). In acoustic instruments, the mapping of parameters to different controls has often been closely connected to their acoustic properties, but with the introduction of digital instruments, this does not need to be the case anymore (Hunt et al., 2017).

This has created a new field in interaction design where the new interactions with musical instruments and sound are explored and researched. NIME (The International Conference on New Interfaces for Musical Expression) which emerged from CHI (The ACM CHI Conference on Human Factors in Computing Systems) in 2001 is one of the biggest conferences in the field. Audio Mostly, ICLI (International Conference on Live Interfaces) and ICMC (International Computer Music Conference) are also conferences that treat the area of interaction design in the field of sound and music.

Rhythm and repetition of patterns are essential parts of music. As a result of this, the step sequencer has become a popular tool in music-making. A sequencer lets the user define a loop of steps that is repeated over and over. A modern sequencer often

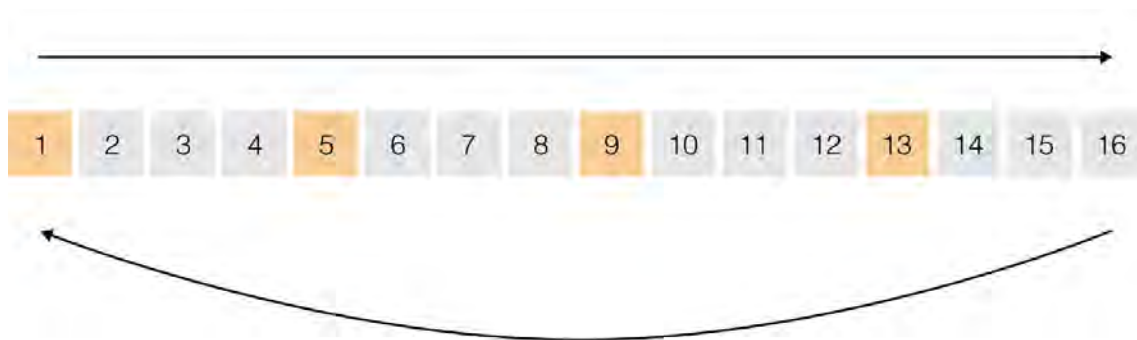


Figure 1.1: *How the layout of a standard sequencer works. The sequencer steps through every step and plays the steps that are active (in this case step 1, 5, 9 & 13). When it reaches step 16 it jumps back to step one and start over again.*

1. Introduction

consists of 16 steps that can be either on or off, the sequencer then cycles through the different steps and plays the steps that are enabled (Figure 1.1) (Arar & Kapur, 2013).

A drum machine is a sort of sequencer that is specified for sequencing drum and percussion sounds to create rhythms. In this project, we aim to look closer at the beat programming part of the drum machine. More specifically, the arrangement and control mapping for the different steps in the sequencer.

The initial seed of this project was born from an idea by the supervisor of this thesis, Palle Dahlstedt. Some years ago, he sketched on ideas for alternatives to the grid layout commonly represented on step sequencers. These ideas were distinguished from the grid layout mainly due to their non-linear representations. One of the ideas, which has also been a starting point in this project, gives the player alternative ways to interact with a step sequencer. This concept layout is illustrated in figure 1.2. The curiosity of how new type of non-linear layouts can change the player behaviour and user experience is the driving force in this project.

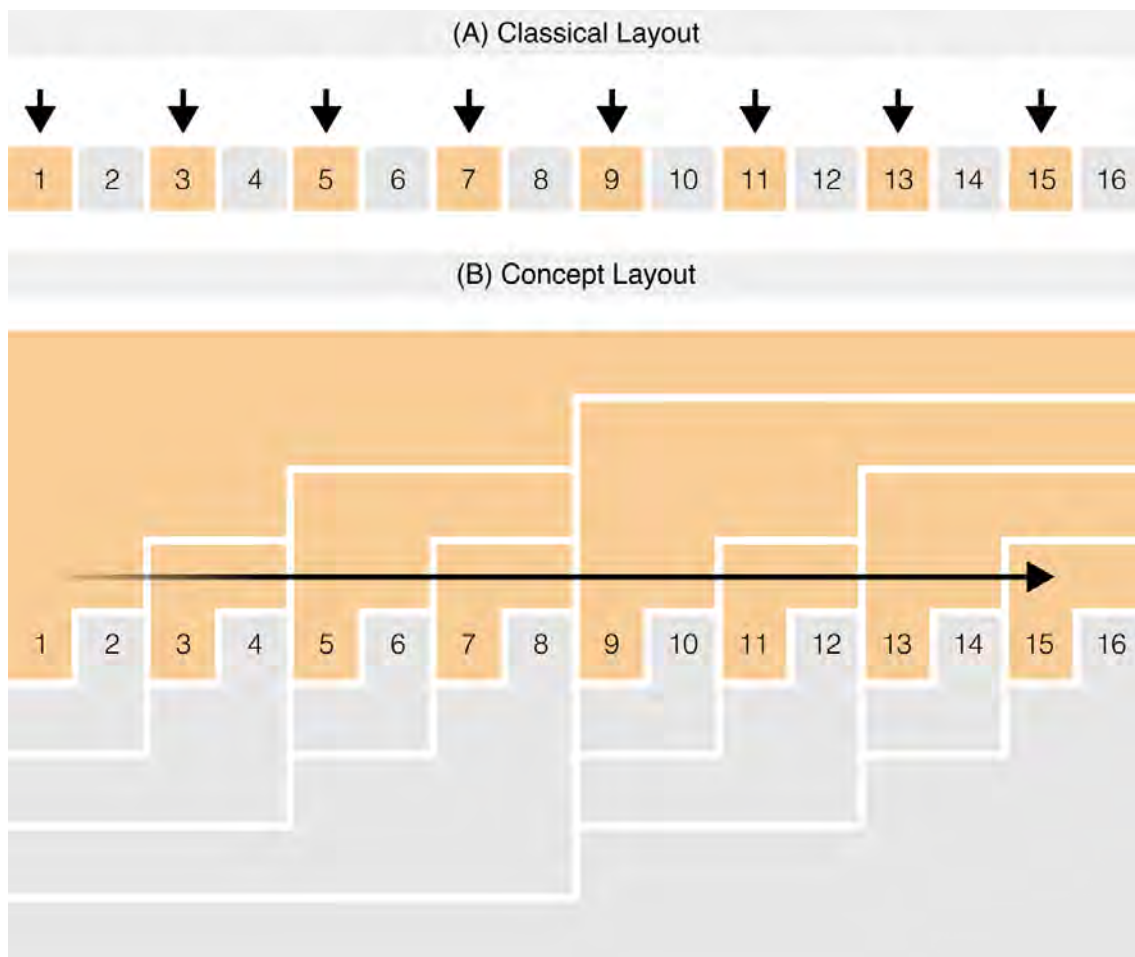


Figure 1.2: *The difference in turning every other step on between the standard layout (A) and the concept layout (B). In layout (A) the arrows represent tapping gestures. In layout (B) the arrow represents a swiping gesture.*

1.1 Research Question

With today's technical possibilities, there are few restrictions and limitations regarding how an interface can be designed in order to represent its functions. Touch-based inputs open up for direct manipulation as well as multi-touch gestures. With this in mind as well as the fact that most of the step sequencers available today is based on the same type of linear layouts and interactions, we propose an investigation on how new step sequencer interfaces can change how users interact and behave and therefore change the user experience. To achieve this, an analysis of how expert users utilise and interact with drum machines as well as how users perceive drum machines and their interactions will be carried out.

1. *How do expert users utilise and interact with drum machines?*

Are drum machines mainly used in goal mode as effective goal-oriented tools to achieve specific goals or action mode as tools for gaining inspiration through interactions?

How do users perceive drum machines and their interactions?

2. *How can alternative rhythm programming layouts in drum machine interfaces change player behaviour and user experience?*

Can alternative step programming layouts enhance the efficiency of goal mode usage by utilising touchscreen interaction possibilities?

Can alternative step programming layouts enhance the overall cumulative user experience by utilising touchscreen interaction possibilities?

1.2 Goals and Deliverables

1. An expert user study
2. New alternative design concepts for rhythm programming
3. An implemented prototype
4. Evaluation of design concepts
5. Evaluation of design concepts compared to standard linear rhythm programming regarding user experience and player behaviour

1.3 User Group and Context

This thesis will mainly revolve around expert users which typically includes music producers and musicians that specialise in electronic music and instruments. The initial user study will be based on interviews with expert users and the final design

concepts will then be user tested with expert users. A smaller user test will also be conducted with users ranging from beginners to intermediates.

A step sequencer or drum machine is routinely used in two main situations - in *live performances* and in *studio environments*. The contexts in these two situations can vary from small to huge concerts, from music production in home studios to grand recordings. In these scenarios, the user experience and player behaviour are expected to be affected by the user goal as well as the situational context. The behavioural differences can essentially be distributed on a continuum that stretches from a scenario where the player knows exactly what pattern to play, to a scenario where the player is improvising. Any scenario on this continuum can happen in any situational context. Improvisation and experimentation can be found in both live performances and in studio environments. The same goes for scenarios where the player knows exactly what patterns to play. As these scenarios are dependent of but not exclusive to the situational context, this project aims to isolate the user tests and explore user experience and player behaviour relative to user goal and user mode rather than to specific spatial contexts. This approach is necessary and facilitates the execution of the process. Including the natural contexts of use would require a longitudinal evaluation and fully compatible prototypes which the time constraint in this project does not allow.

2

Background

Drum machines and step sequencers are widespread tools among musicians and music producers. They are being utilised across genres for composing music, performances and have played a large role in music evolution. A vast majority of the step sequencers available on the market is based on the same type of layouts, user interfaces and interactions. The step programming layout is often represented as a rigid matrix where the steps, their input controls and visual output, are oriented as a row in a linear¹ orientation. This type of pattern-based input is associated with the very nature of how the early mechanical predecessors to modern step sequencers were built. The music box and the player piano, dated to the 17th and the 18th century respectively, are two early mechanical step sequencers that influenced the development of modern-day sequencers (Arar & Kapur, 2013). Later, the analogue and software sequencers developed have re-enforced the idea of using this type of grid as a representation and input method for repeating rhythmic and melodic motives.

Even though the rigid grid interface is the most common solution, other types of interfaces have also been introduced throughout the years. The steps distributed alongside a circle can be found in multiple examples. Two of the more well-known examples are Buchla 250e and 252e. The previous is a one channel step sequencer where input and outputs are visually separated (figure 2.1). The latter is a step sequencer specified for polyrhythms where the output is visually represented as multiple circles. Later software step sequencers such as the drum machine *Patterning* by Olympia Noise Co.² and *Cync*³ by Jon Tiburzi also make use of a cyclic interface. One can argue that visualising a loop or length of a repeating measure as a circumference is a good representation that matches the user's mental model⁴. Despite this, the cyclic layout is not nearly as represented as the layout with 16 steps in a row when looking at step sequencers available on the market. The traditional step programming layout is deeply rooted in users' mental models, how users interact with and perceive step sequencers. One of the first sequencers that introduced this type of linear layout was the EKO ComputeRhythm drum machine from early 70^s. Later, drum machines like TR-808 and TR-909 (figure 2.2) by Roland made

¹All objects aligned horizontally (Google, 2019)

²*Patterning*, <https://www.olympianoiseco.com/apps/patterning/>

³*Cync*, <https://cync.app/>

⁴Cooper et al. (2014) emphasizes that an interface of a system, i.e. the represented model, should represent the user's mental model which in turn reflects the user's vision.

this 16-in-a-row layout the standard for interacting with step sequencers during the 80^s.

When interacting with a step sequencer, the user goal is defined by the user and dependent of the context. A goal can be considered a short-term or a long-term goal, more or less concrete. An instrument is a tool used to achieve these goals. Cooper et al. (2014) describe a goal as an end condition whereas the tasks are parts of the process leading to a specific goal. Changing the interface on a step sequencer but maintaining its functions may not change the user goals per se. It can, however, change how the user interacts and behaves to complete the tasks and therefore end up in different results as well as different user experience and player behaviour. When alternating interfaces, the user may behave differently towards both concrete short-term goals and abstract goals. An example of a concrete goal could be that the user wants to program the step sequencer to play a specific pattern, a task which is more usability-driven. An abstract goal is less dependent on efficient interaction and can include parameters such as improvisation, exploration and unpredictability. Nilsson (2011) uses the theory of affordances (Gibson, 1979) to describe that an instrument and its defined set of rules result in a certain playing behaviour. Changing these affordances can, therefore, lead to a different kind of user behaviour which in turn leads to new kinds of user experiences.



Figure 2.1: *Buchla-250e - one of the earliest sequencers with a circular layout. Press photo from Buchla.*

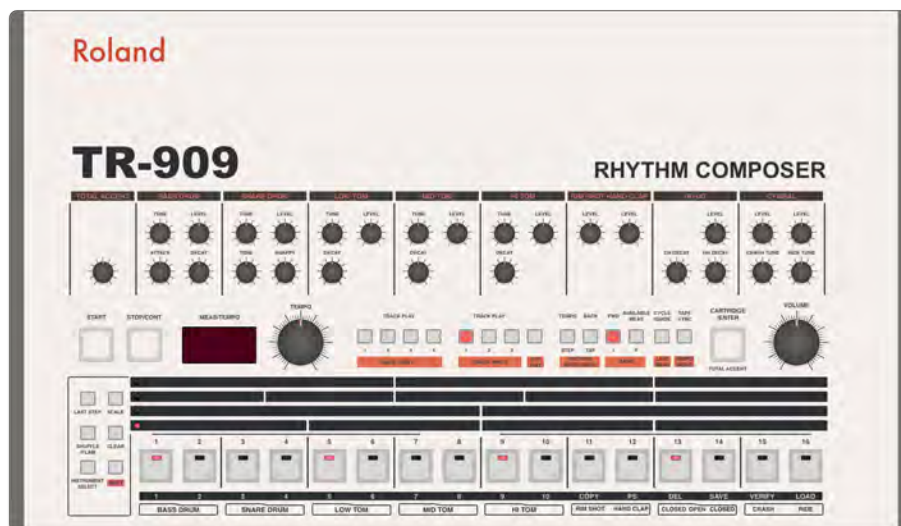


Figure 2.2: *Illustration of Roland's TR-909 - a drum machine that utilises the standard 16-in-a-row layout.*

2. Background

3

Theory

In this chapter, theory relevant to the thesis such as design theory, music theory and other domain specific theory will be introduced.

3.1 Interaction Design

Preece et al. (2015) describe *interaction design* as "designing interactive products to support the way people communicate and interact in their everyday and working lives" (p. 8). They mention that the focus of interaction design is not on a particular way of designing. It is rather a more wide-ranging approach that is concerned with practice, i.e designing user experiences that enhance the way we interact, communicate and work (Preece et al., 2015). In the following sub-chapters, design theory related to interaction design and the thesis per se will be introduced.

3.1.1 Affordance

The term *affordance* was coined by Gibson (1979) as all possible actions an object or an environment affords to an animal or human. For a human a chair affords sitting, a pen writing and a glass of water drinking. Clarke (2005) describes how the perceived affordance of an object can change depending on the needs: "to a person, a wooden chair affords sitting, while to a termite it affords eating. Equally, the same chair affords self-defense to a person under attack" (p. 37). While the chair can afford both self-defence and sitting to a human, it can never afford eating. Hence the affordance depends on the properties of both the object and the user which is why Norman (2013) describes affordance as a relationship between an object and a user rather than a property of the object. Even if an object affords actions it is not sure they are perceived by the user. Signifiers, introduced by Norman (2013), are objects or signs that hint and communicate possible affordances. For example, in a touch interface, the whole screen affords touch, but only certain areas will have an action. A button in the interface will signify where the action "touch" can take place. Cooper et al. (2014) refers to objects or areas on the screen that react to input as *pliant* and argues that it is important to visually communicate pliancy, or as Norman (2013) would put it, use signifiers.

3.1.2 Touchscreen Interaction & Digital Interfaces

Touch-based interfaces are used more and more within music production (Altinsoy & Merchel, 2018). Touchscreen interfaces enable directness to the interaction and make it possible to interact with gestures such as tapping and swiping. Interaction gestures is by Cooper et al. (2014) described as rich, immersive and the heart of a touch-based experience. Two advantages of touch user interfaces are flexibility (Lindemann, 2010) and scalability. The flexibility is an effect of the endless opportunities that are given as screen content can easily be produced and modified according to the developer's needs (and in turn to the user's needs). The given flexibility is reflected in manufacturing expenses. Compared to a physical controller or interface, the shapes, sizes and number of controls (i.e. screen objects such as buttons, sliders and knobs) in a digital interface does not directly affect the manufacturing costs. Multi-touch is another advantage which enables the use of two hands and multiple fingers (Lindemann, 2010).

One main drawback of using touchscreens is the loss of haptic feedback (Altinsoy & Merchel, 2018). The absence of haptic feedback (in combination with the fact that controls and visual feedback share the same surface) forces the users to look on the screen when interacting with the interface. Moreover, the natural directness of touchscreen interaction may imply occlusion (i.e. covering visual elements with the hands when interacting). These drawbacks need to be considered when designing user interfaces for touchscreens.

3.1.3 Gestalt Laws

Ware (2012) presents eight *gestalt laws* that describe basic perceptual phenomena. The gestalt laws define how we can see and perceive patterns in visual display. The following list summarises a few of these gestalt laws relevant to this thesis.

- *Proximity*, one of the more powerful laws, describes that things that are spatially close to each other are also perceptually grouped together (Ware, 2012).
- The gestalt law of *similarity* states that the shapes of individual pattern elements can affect how the elements themselves are grouped together. Similar elements are usually perceptually grouped together (Ware, 2012).
- *Connectedness*, applied by connecting different elements with lines or ribbons and therefore enhancing their relationship, is another gestalt law that Ware (2012) emphasizes.
- The gestalt law of *continuity* states that it is more likely to "construct visual entities" of elements that are "smooth and continuous" (Ware, 2012, p. 183).
- A closed countour is usually seen as an object and this can be defined as the gestalt law of *closure*. Ware (2012) also mentions that there is a tendency to perceptually close contours that possesses gaps.
- *Symmetry* can be a strong organising principle and can be used to make pattern

comparisons easier (Ware, 2012). Ware also stresses that symmetries about vertical and horizontal axes are more easily perceived.

3.1.4 Space- and Time-Multiplex Input

The input in user interfaces can be referred to as space-multiplex or time-multiplex. In an interface with space-multiplex inputs, each function has its own designated input controller. This, according to Shaer and Hornecker (2009), can decrease complexity of interaction by increasing the directness of manipulation, allowing the controllers to be expressive and therefore provide stronger affordances dependent on each specific function. Moreover, space-multiplex inputs can eliminate the dependency of redundant action selection and instead provide the ability for parallel actions as well as consistent mappings. Shaer and Hornecker (2009) also mention that space-multiplex interfaces may allow the user to interact with "eyes-free interactions", as these types of interfaces are easier acquired by the user's muscle memory.

Time-multiplex inputs, on the other hand, utilize one controller to achieve different types of functions. The input objects in such an interface are forced to be generic (Shaer & Hornecker, 2009), meaning they can many times become abstract and compromised in affordances. However, using time-multiplex inputs in user interfaces can help reduce physical clutter by compressing its functions onto a smaller workspace. Providing space-multiplex inputs for a large set of functions could increase complexity of interaction simply by the large physical space required and the physical clutter it may result in. Scalability, which is highly related to the physical space, is a strength of time-multiplex inputs and also described by Shaer and Hornecker (2009) as one of the limitations of space-multiplex inputs. Scaling up a user interface (i.e. extending the set of functions) based on space-multiplex inputs may highly likely result in space management problems and physical clutter.

3.1.5 Usability

The International Organization for Standardization [ISO] (2019) define *usability* as "to which extent a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (§ 3.13). Usability as a subject have different definitions and Preece et al. (2015) describe good usability as ensuring that products are enjoyable, easy to learn, effective, efficient, safe to use and provide good utility. Nielsen (2012) define usability as a quality attribute that determines how easy a user interface is to use. This attribute is divided into five quality components: learnability, efficiency, memorability, errors and satisfaction. Nielsen separates utility, which refers to the functionality of the product, from usability. Together, usability and utility form a product's usefulness.

Independent of what definition to apply, its components and related elements can be summarized as the following.

- *Effectiveness* and *utility* is similar as they refer to the level of accuracy and completeness a product provides relative to the user goal.
- *Efficiency* can be outlined as the resources used relative to the results accomplished.
- The attribute *satisfaction* is used to measure how pleasant the product is to use. It can be described as the user's emotional, physical and cognitive responses from the use of a system, relative to user needs and expectations.
- *Learnability* simply refers to how easy a system is to learn and *memorability* indicates how easy the system is to, once learned, use after a period of not using it.
- The attribute *errors* is closely related to efficiency as it measures how many errors and how easy it is to recover from them as the user progresses towards the goal.

Usability addresses specific objectives with a specific user in a specific context. Therefore, evaluating a system's usability results in quantitative data that can be used to improve the user's performance. It will not, however, address the overall quality of the user experience (Preece et al., 2015).

3.1.6 User Experience

User experience, or UX, can be defined as "user's perceptions and responses that result from the use and/or anticipated use of a system, product or service" (The International Organization for Standardization [ISO], 2019, § 3.15). There are several definitions for user experience and what most of them have in common is that user experience is a result of how a user perceives a system. In other words, user experience is a consequence of different factors such as context, the user's current mood, the designed system etc. Hassenzahl and Tractinsky (2006, p. 95) describe user experience as:

"UX is a consequence of a user's internal state (predispositions, expectations, needs, motivation, mood, etc.), the characteristics of the designed system (e.g. complexity, purpose, usability, functionality, etc.) and the context (or the environment) within which the interaction occurs (e.g. organisational/social setting, meaningfulness of the activity, voluntariness of use, etc.)"

With this in mind, user experience can be considered dynamic. Roto et al. (2011) emphasize that user experience may change if the context changes. They also state that user experience does not only vary from user to user, it is also affected by user state. Just like Hassenzahl and Tractinsky (2006), they mean that user experience depends on the user's current mood, mental and physical resources as well as expectations. The resulting emotions derived from a certain interaction does not only affect user experience in a direct way. Norman (2002) writes that emotions also

change how the cognitive system performs. Consequently, Norman presents findings that suggest that products with attractive aesthetics make people feel good which in turn leads to creative thinking. Thus, the aesthetic properties of a product are important factors to consider when designing and evaluating a product, both in relation to user experience and usability.

Hassenzahl (2005) presents a model that refers to the character of a product. The product character is based on different attributes that are either *pragmatic* or *hedonic*. If a product has pragmatic attributes it is primarily instrumental and often used to complete externally or internally behavioural goals. Hedonic attributes, on the other hand, emphasize psychological well-being by stimulation, communicating identity and provoking valued memories. They are attributes that can surprise or make the users express themselves through the product. Attributes that provide emotional value can also be considered as hedonic. In the same paper, Hassenzahl (2005) presents two different categories of usage modes, *goal mode* and *action mode*. When in goal mode, the user's quest to fulfil the behavioural goal is primary. This mode is usually usability oriented. On the other hand, when the user is in action mode, the action itself is in the fore. Goals are variable and volatile as the user determines the goals during usage. When in this mode, using the product can become an end in itself. Efficiency and effectiveness do not play an important role comparing to when in goal mode. It is important to note that the usage mode is triggered by the context and situation and not only dependent on the product itself.

Roto et al. (2011) writes about different time spans in user experience. Even if the major part of the user experience will be affected by the actual experience of usage, user experience is a result of different stages and encounters. Users may have an indirect experience before usage that can affect the overall experience. This is described as *anticipated user experience* and the outcome of imaging the experience before usage. The experience resulting from usage is what they call *momentary user experience*. After usage experience, when the user has time to reflect on the experience, is introduced as *episodic user experience*. *Cumulative user experience* is described by Roto et al. (2011) as experience formed by repeatedly usage and periods of non-use over time.

Karapanos et al. (2009) divide the temporality of experience into three phases: *orientation*, *incorporation* and *identification*. The first one refers to the initial usage of the system or product where the main force is familiarity. It can imbue the user with feelings such as excitement and frustration, or anything in between, as they experience and learn novel features. The incorporation phase is when the user reflects on the usefulness of the product or system. In this phase, long-term usability is an important factor that gets reflected in the user experience. The experience in this phase is pervaded on the level of functional dependency the product or system provides. The last phase, identification, is when the user experience is shifted by emotional attachment. As the product can become more personal with use over time, it can create a sense of community by either connecting or differentiate the user from others. These three phases are succeeding the initial experience that is instantiated through *anticipation*. The anticipated usage of a product forms expectations and

will, therefore, become part of the user experience.

Frijda (1988) presents a theory where emotions are described as lawful phenomena and thus expressed as a series of laws, *the laws of emotion*. One of the laws presented is the *law of comparative feeling*: "*the intensity of emotion depends on the relationship between an event and some frame of reference against which the event is evaluated*" (p. 353). The frame of reference can be expectations based on previous experiences.

Preece et al. (2015) states that the distinction between usability and user experience is not clear-cut. Usability affects, and is fundamental to, the user experience while certain hedonic attributes might affect how usable a product is in terms of usability.

3.2 Domain Related Theory

In this sub-chapter, domain specific theory related to drum machines, step sequencers and digital instruments will be presented.

3.2.1 Interactive Digital Systems

The design and interactions of traditional acoustic instruments have been bound to the nature of sound generating process. Bongers (2000) and Drummond (2009) mention this and highlight that this constraint is no longer the case as digital instrument interfaces could be mapped to any sound generation process. There is no simple answer on how to deal with this total freedom as a digital music interface designer (Bongers, 2000). As the link between interface and sound source has disappeared, Bongers (2000) mentions that a lot of the naturally produced feedback that can be found in acoustic instruments has been lost.

Both Bongers (2000) and Drummond (2009) define the term *interactive* and specify that for a system to be interactive, the interaction between human and the system must be a two-way influential process, including control and feedback (figure 3.1). To achieve this type of interaction, the system needs to possess memory and cognition. If cognition is absent from the system, the system is described to be rather *reactive* than *interactive*. Drummond (2009) remarks that "a traditional acoustic instrument implies a significant degree of control, repeatability and a sense that with increasing practice time and experience one can become an expert with the instrument" (p. 124). An interactive system on the other hand is described to open up variation and unpredictability. According to this definition, many drum machines today can be seen as more or less *reactive*. Regardless, interactive or not, the use of a drum machine can still be referred to as an interaction. It is important to remember that despite the lack of instrument cognition, parameters such as degree of control, repeatability, learnability, variation and unpredictability can still vary greatly depending on the design of the instrument (not least by the control surface or interface).

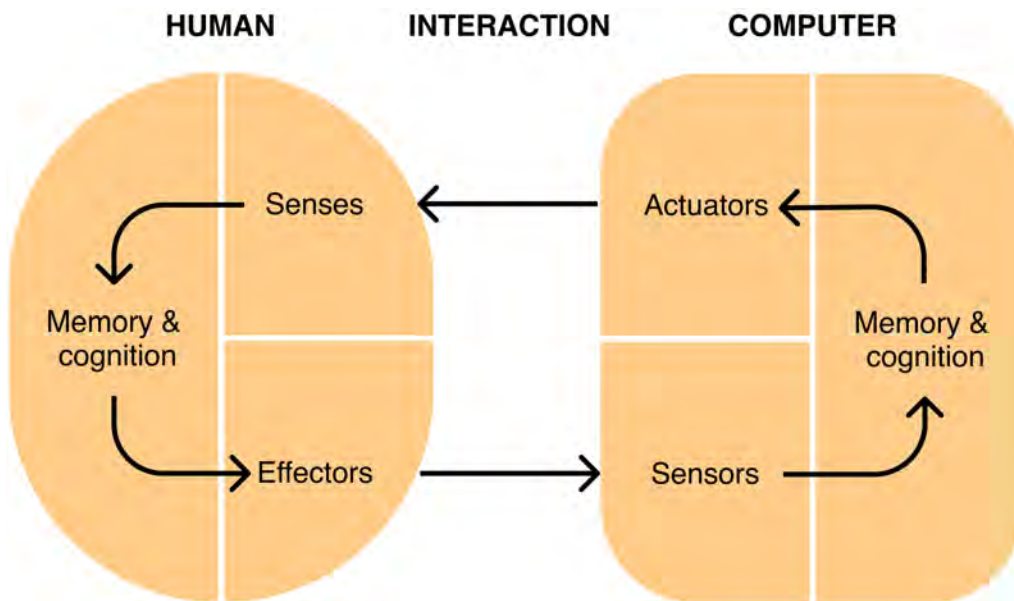


Figure 3.1: *The human-machine interaction, adapted from Bongers (2000).*

3.2.2 Evaluation of New Instruments

Orio et al. (2001) discuss and elaborate on how knowledge from Human-Computer Interaction (HCI) can be extracted and applied when designing and evaluating new interfaces for musical expressions. They describe interaction within computer music "as a highly specialised field of HCI" (p. 1), mentioning timing, rhythm and training as important topics to consider. Moreover, unlike designs of input devices within HCI, Orio et al. (2001) state that the design of input devices for musical expression (i.e. controllers) often tend to be designed with an idiosyncratic approach. However, Orio et al. (2001) emphasise that evaluation methods from the area of HCI can be beneficial when evaluating controllers as long as differences within the two areas are being considered. Two noteworthy examples of these differences are the main channel for feedback (auditory vs. visual) and user goal of interaction (effectiveness vs. artistic expression). When evaluating digital musical controllers with methodologies derived from the HCI community, Orio et al. (2001) as well as Young and Murphy (2015) highlight four aspects that must be taken into consideration:

- *Learnability* is described as *the time needed to learn* how to control and perform with a certain controller. It is mentioned here that mastering a musical instrument can in many cases take more than ten years. Such a protracted process is far too long for measurement and evaluation within exclusively one study. Nevertheless, the factor of learnability is important to consider when evaluating digital musical controllers.
- *Explorability*, or exploration of the capabilities of the controller (i.e. number of different *gestures* possibilities), is another factor that should be taken into consideration when evaluating a controller.
- *Feature Controllability* is described as "the accuracy, resolution, and range of

features perceived by the user when performing musical tasks" (p. 3).

- *Timing Controllability* needs to be considered due to the fact that *time* is a characteristic of music that differs from the context of HCI evaluation. Control in relation to tempo speed and temporal precision should therefore be taken into consideration.

Young and Murphy (2015) also draw a strong connection between HCI and Digital Musical Instruments (DMIs). They recommend evaluation of DMIs by looking into functionality (i.e. the technical capabilities of the device), usability and user experience. It is highlighted that these three factors are not independent of each other. Additionally, it is mentioned that the aesthetics of the DMI also affect usability and user experience. Like Orio et al. (2001), Young and Murphy (2015) also identify variables that affect the user experience and need to be considered when evaluating a DMI: "the consideration of simultaneous timing and rhythmic patterns, a performer's previous training with a specific instrument and their familiarity with other instruments within a collective ensemble" (p. 2). Longitudinally studies can favourably be executed in order to evaluate the usability and user experience. The user's previous training with specific and similar instruments should be reflected upon. A noteworthy additional comment is that the evaluation and data collection of user experience will by nature be subjective (Young & Murphy, 2015) due to parameters such as personal preferences such as aesthetics, desirability and previous experience. Last, but not least, Young and Murphy (2015) emphasises the importance of evaluating with a high-fidelity prototype, close to final form factor. Being able to capture gestures with high precision and deliver generated sound with low latency is a necessity for a successful evaluation.

"The evaluation of a musical device is often far more complex in practice than a conventional computer interface or device. Therefore, experimentation must be undertaken to find an appropriate evaluation technique that best fits the device." - Young and Murphy (2015, p. 10)

Malloch et al. (2019) elaborate on the same theme and discuss evaluation of new instruments. Compared to evaluation of interactive technologies within HCI which is more focused on efficiency and effectiveness, music creation is mentioned to value aspects such as creativity, engagement and personalisation. As already mentioned, evaluation of new instruments tends to be rather subjective (Malloch et al., 2019; Young & Murphy, 2015), personal and instrument-specific (Malloch et al., 2019). This means that it is difficult to generalise and make standard evaluation templates for future designs. Malloch et al. (2019) state that it is not an easy task to isolate aspects of interest when performing quantitative evaluations as it is hard to judge whether a musical interaction is successful or not. Evaluation techniques that are mentioned to be applicable when studying new instruments are questionnaires, interviews and field studies with open-ended explorations. Just like Young and Murphy (2015), Malloch et al. (2019) highlights the importance of longitudinal studies. To consider the learnability parameter, longitudinal studies including both qualitative and quantitative data are preferable (Malloch et al., 2019) in order to evaluate

more than only the anticipation and orientation phases (section 3.1.6) of the user experience.

Oore (2005) sums it up well and writes that "the expressiveness of an instrument implies a wide range of possible ways of using it" (p. 61). The path a user will take and the choices a user will make are very much dependent on personal preferences and will be motivated by parameters such as user goal, learning style and deconstruction of the task. Oore (2005) also adds that prototyping an instrument can be done relatively quick while mastering it can take years. It is stated, however, that if an instrument designed to be mastered quickly it is quite possible that it would not be interesting to play or listen to. The same topic is elaborated by Jordà (2004) who discusses what makes a good instrument and highlights that there needs to be the right balance between challenge, frustration and boredom. If an instrument is too simple there is a high probability that it will not lead to a rich experience. On the other hand, if an instrument is too complex the user might abandon the instrument before reaching a moment of rich experience.

A good instrument should not impose its music to its player. A good instrument should not be able to produce only good music! (What is good music anyway?) A good instrument should also be able to produce "terribly bad" music, either at the player's will or at the player's misuse.
- Jordà (2004, p. 4)

3.2.3 Design and Play Time

Nilsson (2011) describes his development of some digital instruments mainly used for improvisation. He presents two different phases - *design time* and *play time*. Design time is the phase outside of linear time, where ideas are conceptualised and realised. Play time happens in real-time, where the instruments are played and involves interaction and movements of the body. He proposes that the choices made during design time affect the choices in play time. In other words, the instruments will afford different playing behaviour, and in turn, affect what music being created in playtime. Nilsson (2011) describes composition as an activity that takes place during design time: "during the composition process, which goes on at design time, a composer has time to select, test, listen, reflect and refine, while an improviser at play time must make all decisions on the spot" (p. 27). Playing a drum machine or a sequencer often take place in between play time and design time. On one hand, the instrument is controlled in real-time and the choices that are made affect the sounds, on the other hand, there is no direct connection between the player's movements and the audible input (Nilsson, 2011).

3.2.4 Tempo and Rhythm

Music theory is the study of music and its elements. According to Fallows (2011) the term is used in three different ways. The first one is about the rudiments in music, the second one is the study of music and the last one is about defining and understanding processes and universal principles in music. Levitin (2008) says that

a sound or piece can be described by the following attributes: *pitch*, *rhythm*, *tempo*, *contour*, *timbre*, *loudness* and *reverberation*, where each one of these parameters can be altered without affecting the others. The most relevant attributes in this project are *tempo* & *rhythm*. Tempo describes the speed of a piece, in other words, how fast or slow it is. It can be exemplified in how fast you would tap the foot when listening to a song. One common way to measure tempo is in BPM (beats per minute) (McAuley, 2010). Rhythm relates to the temporal aspects of music and how a series of sounds groups together into patterns.

3.2.5 Visualising Rhythm

Sethares (2007) says that there are two approaches when it comes to representing a rhythm, or music in general, *literal* and *symbolic*. The literal allows us to recreate the rhythm. An example would be a recording that captures (almost) every parameter of a performance. The symbolic describes high-level information about the rhythm. Sheet music is an example of a symbolic representation, where certain parameters (such as pitch, tempo, duration, speed) are noted down. Sethares (2007) concludes the paradox that by capturing all parameters in a literal representation it may be hard to distinguish certain parameters that would be easy to identify in a symbolic representation.

Sheet music is one of the most common ways of transferring information about how a piece should be performed. They are read left to right and simplified you could say that the shapes of the notes show relative duration and the vertical placement show pitch. Figure 3.2 shows the relative values for different notes, rests (silence) and ways they can be combined to describe different rhythms. The following theory will be focused on rhythm.

The sheets are divided into measures (also called metres) and how many notes that fit into a measure is decided by the time signature. The time signature always consists of two numbers (see figure 3.3) where the upper number defines how many beats there will be in a measure and the lower defines which value the beat has (Coppenger, 2014). How the beats are grouped has a large impact on how the music feels. For example, a waltz is often divided into groups of three and a march in groups of two or four (Levitin, 2008).

With these building blocks, different rhythms can be described and recreated. However, there are other ways of describing rhythm. Since the measures repeat in cycles the idea of describing a rhythm with a circular notation goes far back in history. One early example is the necklace notation that was developed in Arab music theory in 13th century (Boenn, 2018; Sethares, 2007). The necklace notation consists of small and big circles distributed along an even larger circle (or "necklace"). The big ones indicate a note and the small ones show the space between the notes (fig 3.4.c). A similar idea is the box notation (Boenn, 2018) or drum tablature (Sethares, 2007). In this type of notation the meter is linearly represented and each step is represented by a box which can either have a note or not (fig 3.4.b). This way of visualising and programming rhythm is common in drum-machines. In figure 3.4 the same rhythm




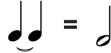






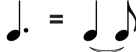
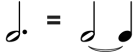




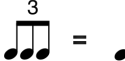

Note	Name (value)	Rest	Ties	
	Whole (1)			
	Half (1/2)			
	Quarter (1/4)		Dotted	
	Eighth (1/8)			
	Sixteenth (1/16)		Tuplets	
	Thirty-second (1/32)			

Figure 3.2: Different notes and their relative time value, as well as their corresponding rests (silence). Two or more notes can be tied together to combine their duration. If a note or a rest is followed by a dot, the duration is increased by half of its original value. Tuplets indicate that all the notes under the bracket should be played in a different fraction, in this case, the same duration as two of them.

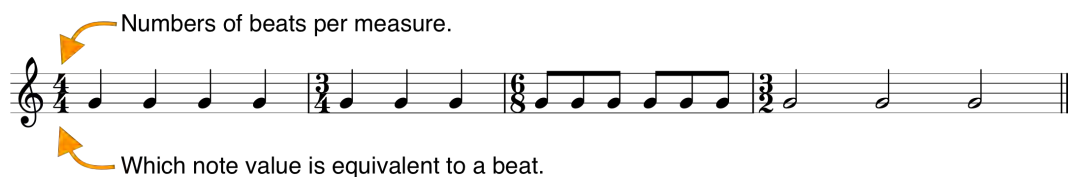


Figure 3.3: The time signature defines how many beats there are per measure, and also which kind of note that gets the beat. Notice that this figure is made to show different time signatures, it is not common to change the time signature for each measure.

is shown with classical, box and necklace notation.

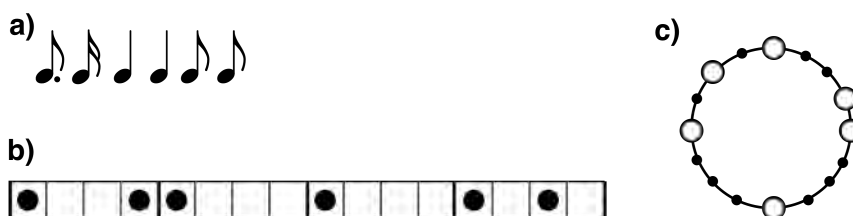


Figure 3.4: Different ways of describing the same rhythm: a) with classical notes, b) with drum tablature or matrix, the one common in sequencers and drum machines & c) a circular notation.

Even if the necklace notation and the box notation may be easier to program and

understand, especially the box notation becomes problematic when trying to notate notes that are "off the grid". For example, a triplet (a tuple of three) would be hard to visualize since only the first note is on the grid.

A percussive rhythm is rarely only based on one type of sound. In figure 3.5 a four on the floor beat with three different sound sources is illustrated with different notation techniques.

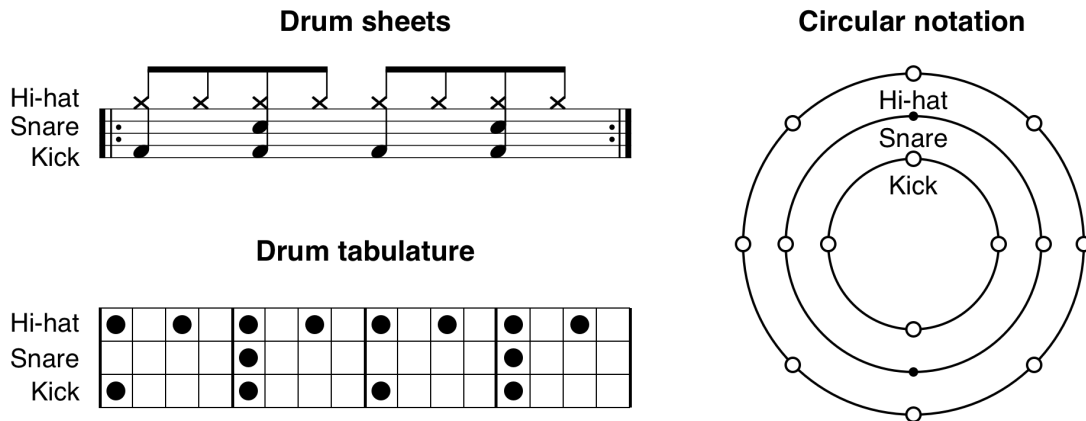


Figure 3.5: A classical four on the floor beat, visualised in three different ways.

3.2.6 Drum Machines

A drum machine is an instrument that lets the user sequence different sounds in order to play and compose rhythms. There are mainly two ways of sequencing the sounds, either by manually activating the steps that should sound or by recording while playing them live in real time. Even if the possibility to sequence sounds may be one of the main functions for the drum machines, there are several other functions that are needed in order to control and shape the rhythm. In the following list some general themes of functionality often found in drum machines are presented:

- **Sequence sounds:** In other words specify when a sound should sound or not. Often this is done by activating or deactivating steps. In many cases, this can also be done by recording the sounds in real time. This is often done by tapping buttons that represent different sounds. Many drum machines allow for micro timing a step on or off the grid, as well as quantize recorded steps (automatically align them to the grid).
- **Tempo and rhythm properties:** Specify how fast the drum machine should step through the steps (tempo). Specify the amount of swing/shuffle. Specify how many steps that should be included in a loop. If it is more than 16 steps, many drum machines allow for browsing between multiple pages. Some drum machines allow polymeter, which means that the different tracks contain different amounts of steps.

- **Save and jump between patterns:** Allows the user to save patterns, jump between them, trigger parts of them or chain them together into longer loops.
- **Control parameters of the sounds:** A drum machine can be either synth-based (e.g. Roland TR-808, Arturia DrumBrute), sample-based (e.g. LinnDrum, Roland TR-707, Elektron Digitakt) or both (e.g. Roland TR-909, Elektron Analog Rytm). Depending on this, the sounds can be sculpted in different ways (e.g. time, tone, pitch, volume, panning). The user can often change which sound a track should have. Many drum machines also have global effect sends that allow for further colourisation of the sounds. Some drum machines allow these parameters to be not only track-specific, but also step-specific.
- **Dynamic:** Simplified you could say that velocity affects the volume, but it also affects other characteristics of the sound (i.e. how soft or hard it is perceived). For example, the level of velocity on an acoustic drum would be defined from how hard it is being hit. Another way to control dynamic that is common in many drum machines is to allow the user to specify if a step should have accent or not.
- **Performance and mixing:** Such as muting or soloing tracks.

The purpose of this list is not to describe every function in every drum machine, it is rather to give an overview of the most common functions. There are drum machines that do not have every function mentioned in this list and there are drum machines that have more functions. However, it becomes clear that most drum machines are competent machines with many possibilities to shape the sound. Since there is often a limitation of physical space, it is common that many functions share the same controls. By changing mode or holding down a function button the action of a specific control may change. For three examples of drum machine interfaces, see figure 3.6.

To control the drum machine's step sequencer, many manufacturers have a grid layout that consists of 16 buttons. The buttons can be either activated or deactivated. The drum machine plays the sound on the steps that are active as it steps through the buttons as shown in figure 3.7. However, this grid of buttons is not only used to program the step sequencer. Depending on mode they can, for example, be used to:

- Selecting which track to program
- Programming the step sequencer for a specific sound
- Playing the different sounds by tapping
- Change memory bank and pattern
- Chain patterns together
- Map parameter-values to a specific step



Figure 3.6: Illustration of three drum machines. From top to bottom: Roland TR-909, a synth and sample-based drum machine from 1983. Elektron’s Digitakt, a sample-based drum machine from 2017. Roland TR-08, Roland’s replica of their synth-based TR-808 from the 80s, has the same interface but in a smaller form-factor, released 2017. Notice how the step sequencer, consisting of 16 buttons in a grid or row, is present on all interfaces.

- Select number of steps per meter
- Mute or solo tracks
- Playing and transposing a specific sound in a chromatic scale
- Select where to save, clear, copy or paste a pattern
- Selecting parameter values (e.g. volume, swing/shuffle)

To summarize, the drum machine is a powerful tool with many functions that allow the user to be in both design and play time. Preparing patterns is closely related to design time whereas tapping in a beat in real-time is related to play time. When performing with predefined patterns, jumping between them, adjusting the steps and the parameters, the user jumps between design and play time. Some motions will affect the sound with direct feedback and other motions are telling the drum machine how to play in the future, although the future may appear in a really short time.

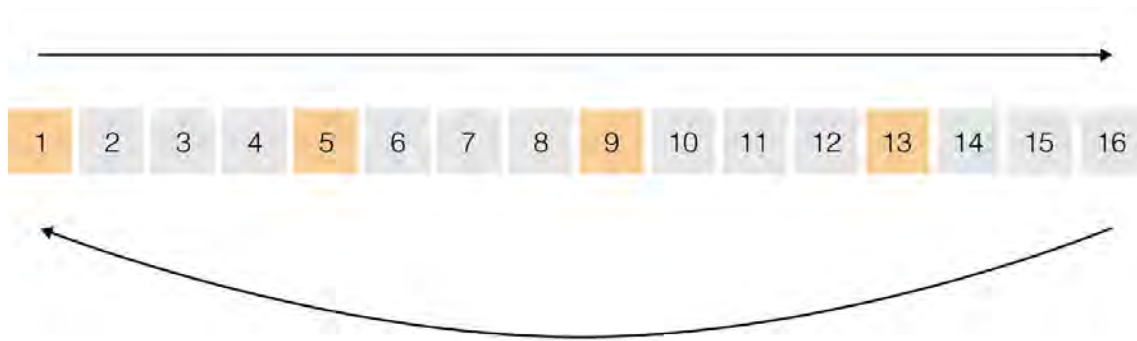


Figure 3.7: *How the layout of a standard sequencer works. The sequencer steps through every step and plays the steps that are active (in this case step 1, 5, 9 & 13). When it reaches step 16 it jumps back to step one and start over again.*

4

Methodology

The design process is often described as an iterative process with different phases or activities (Cooper et al., 2014; Dam & Teo, 2020; Hartson & Pyla, 2012; Norman, 2013; Preece et al., 2015). Hartson and Pyla (2012) divide the design process into four different activities: *analyse*, *design*, *prototype* and *evaluate*. Hasso-Plattner Institute of Design at Stanford describes it as five stages: *emphasize*, *define*, *ideate*, *prototype*, and *test* (Dam & Teo, 2020). Dam and Teo (2020) emphasizes the fact that the design process is non-linear, and should not be seen as a sequential process. Some stages often appear at the same time and the result from one stage may start a revisit to an earlier stage. The stages could rather be seen as different modes that occur during the design process (Dam & Teo, 2020). Since the different activities will result in new knowledge, a need for iteration appears. Preece et al. (2015) states that an iterative process "allows designs to be refined based on feedback" (p. 330). In this chapter, different methods regarded as suitable for this thesis will be presented.

4.1 Research Through Design

Research through design can be seen as design activities that play a formative role in the generation of new knowledge (Stappers & Giaccardi, 2014). The design process and its stages help and require the practitioner to understand and frame complex situations. By combining secondary design research with data gathered from exploratory research such as interviews and observations, designers can produce prototypes and models through ideation. This iterative process can help the designer re-frame the problem statement in order to come up with a proper solution (Martin & Hanington, 2012). Martin and Hanington (2012) state that research through design is "constituted by the design process itself" (p. 146) and emphasise the act of recording and communicating the steps of the iterative process.

Gaver (2012) argues that design and research through design are generative and therefore concerned with statements such as *what might be* rather than *what is*. Accordingly, Gaver mentions that the goal of conceptual work in research through design is to create theories that are *sometimes right* rather than theories that are never wrong. This concept is closely related to what Rittel and Webber (2017) refer to as a *wicked problem*. A wicked problem can be defined as a problem that has no

definite formulation nor a definite solution. A design problem is by nature a wicked problem as there can be more than one possible formulations and more than one possible solution to each formulation. Rittel and Webber (2017) specify that unlike *tame* mathematical problems, solutions to wicked problems can be seen as better or worse rather than true or false. Since wicked problems have no definite solution, they have no inherent stopping rule (Rittel & Webber, 2017).

The research question in this thesis is very much formulated around the theory of research through design and wicked problems. The investigation is formed around the hypothesis that the existing rhythm programming layouts in drum machine interfaces do not have to be definite solutions. The research will be based and carried forward through an iterative design process. It is important to support a design project with relevant design methods. The following sub-chapters cover methods relevant for this thesis.

4.2 Analysis

The purpose of the analysis phase is to gather information about the domain, users and previous work in order to have a strong foundation to build the design upon (Hartson & Pyla, 2012). In this section, methods suitable for gathering, as well as, synthesising data will be presented.

4.2.1 Literature Review

A literature review is a common method to collect background data in the beginning of a project (Bligård, 2015). Martin and Hanington (2012) states that even though literature reviews are an essential part of academic writing it can also be useful in the context of a design project. In a literature review, previous work and theories relevant for the project are being reviewed and synthesised. The references used can vary, but often consist of "books, chapters, journal and magazine articles, theses and dissertations, corporate and academic websites and blogs, and documented design projects" (Martin & Hanington, 2012, p. 112). It is important to consider credibility when selecting sources (Martin & Hanington, 2012).

A literature review will be carried out early in the project to form a strong foundation of theory and methodology which the rest of the project can rest upon.

4.2.2 Interviews

An interview is a qualitative data gathering method used to collect data such as experience, attitudes, opinions and perceptions (Martin & Hanington, 2012). Kahn and Cannell describe (as cited in Preece et al., 2015, p. 233) an interview as a "conversation with a purpose". Depending on the purpose, interviews can be customised and conducted in different ways, more or less structured. When performing a structured interview, the script and questions are already prepared and defined. Structured interviews are easier to control in terms of time spent as well as easier to analyse

(Martin & Hanington, 2012). Structured interviews are typically based on closed questions, meaning they require answers from predetermined alternatives, similar to questions in a questionnaire (Preece et al., 2015). On the other hand, unstructured interviews are more exploratory as they are based on open-ended questions and conversation rather than predetermined questions. The data gathered from such interviews can be a good basis to understand the topic as it can be considered as rich. However, the data is also complex and vary across participants, meaning it can be time-consuming and difficult to analyse (Preece et al., 2015). An interview that includes both open-ended and closed questions can be described as a semi-structured interview (Preece et al., 2015). This type of interview is based on a simple script so that the same questions and topics are explored across participants (Preece et al., 2015). However, asking follow-up questions or so-called probes can be good tools to dive deeper into the topic and make the interview more exploratory. When performing an interview it is important not to pre-empt an answer when phrasing a question as it can bias the interviewee (Preece et al., 2015). When conducting qualitative interviews it is not possible to know in advance how many participants are needed to gain saturated data (Preece et al., 2019). Having more participants is generally better, however, selecting number of interviewees based on feasibility constraints is justifiable (Preece et al., 2019).

Interviews are planned to be carried out in early design stages to emphasise with potential users and other stakeholders such as digital instrument designers. The data gathered from these early interviews will help define and refine the research question and the project approach. These interviews are intended to be conducted as semi-structured interviews. Predetermined questions will help to keep the focus on relevant topics that concern the project. However, to be able to emphasise and collect rich qualitative data, these questions are meant to be open-ended and only a basis for a deeper conversation. Most importantly, these interviews will be performed mainly to gather qualitative data that can be seen as food for the following ideation stage.

Interviews are not only supposed to be carried out early in the project. The iterative process will open up for interview situations throughout other phases, mainly in the evaluation phases. As a complement, interviews will be executed alongside user tests. The interviews will be performed principally to get a better understanding and to evaluate the user experience. These interviews are planned to be divided into a more or less structured part and a semi-structured part. The closed-ended questions will be the basis for user experience and usability analysis and the open-ended questions are added not to overlook any relevant information and data.

4.2.3 Questionnaires

Questionnaires are used to gather users' opinions (Preece et al., 2015) such as thoughts, feelings, perceptions, attitudes and behaviours (Martin & Hanington, 2012). They are typically used in written form but can also be performed as structured interviews. The way a questionnaire is constructed will affect the type of response and therefore the analysis (Martin & Hanington, 2012). Open-ended ques-

tions can provide in-depth data whereas, as Martin and Hanington (2012) mention, closed-ended questions are easier to numerically analyse. To open up the possibility for both question neutrality and strength-indication of response, Likert scales are recommended by Martin and Hanington (2012). For example, by providing possible responses on a five-point scale from strongly disagree to strongly agree, the opportunity to respond with a certain strength of response as well as with full neutrality is given.

Questionnaires are planned to be used as an evaluation method alongside user tests. The questions included will mainly be used to evaluate user experience. UEQ (User Experience Questionnaire) (Schrepp et al., 2017) and AttrakDiff (Hassenzahl et al., 2015) are two predetermined questionnaire methods that are designed to evaluate user experience. Both methods evaluate user experience in both pragmatic and hedonic dimensions using semantic differential scales. These two methods will be used as references when formulating the questionnaires. The purpose of using semantic differential scales in this project is to produce quantitative and comparative data regarding the user experience.

4.2.4 Observations

In the observation method, the investigator observes when the user performs tasks. The observation can either be done on the field or in a predefined test environment. The goal of the observation is to get a better understanding of the user context, without affecting the user (Bligård, 2015). With observation as a method, it is possible to see what the users actually do and not only what they say they do (Bligård, 2015). According to Preece et al. (2015) observations are useful throughout the different stages of the design process. Initially, to get a better understanding of the user context, tasks and goals, and in the later stages to evaluate how well a prototype suits user needs.

Observations as methods are planned to be applied alongside interviews and user tests. The former will help to get a better understanding of the user context whereas the latter will work as a complement when evaluating prototypes.

4.2.5 Affinity Diagram

Affinity diagram is a way to synthesise and group large amounts of qualitative data in order to get an overview and draw conclusions (Martin & Hanington, 2012). After conducting several interviews or tests, observations are written down to sticky notes. Each interview or test get a specific colour or are marked so that the observation can be traced back in case a question should arise. The sticky notes are then placed on a wall one by one and organized into themes. Once every observation is grouped into a theme, the participants writes down a name for each theme which can then be summarized. Affinity diagram is a bottom-up method since the data is organized by themes created during the process instead of predefined ones (Martin & Hanington, 2012).

This method is anticipated to help group the data gathered from the early interviews with musicians, music producers and digital instrument designers.

4.3 Ideation

The ideation phase often takes place after the initial study of the context is done. The goal is to generate a lot of different ideas (Norman, 2013). According to Hartson and Pyla (2012) it is an "active, creative, exploratory, highly iterative, fast-moving collaborative group process for forming ideas for design" (p. 259). Norman (2013) outlines some general rules for ideation:

- Strive for many ideas, it can be problematic to lock down to a few ideas in the beginning.
- Have an open mind and try not to criticise ideas, even crazy ideas can lead to new insights and concepts.

4.3.1 Sketching

Sketching is a fast way to communicate and build ideas upon. Many quick sketches that explore different designs is an important part of the ideation phase (Hartson & Pyla, 2012). The sketches should focus on communicating "concepts rather than details" (Hartson & Pyla, 2012, p. 256). Buxton (2007) discusses the ambiguous nature of sketches and states that "much of their value derives from their being able to be interpreted in different ways" (p. 113). Further, Buxton emphasises the importance of not adding more detail than needed. Too much details could give the impression that certain things already are decided. Too little details, on the other hand, could make it hard to perceive the message. Sketching is not only a way to communicate ideas to other people - it could also be seen as a conversation between the mind and the sketch (Buxton, 2007). Seeing the idea on paper allows for new knowledge which can then be embodied as a new sketch in an iterative flow.

Sketching will be an important part of the early design stage and throughout the whole project. It will work as a method to generate new ideas, test and evaluate these ideas and as a communication tool.

4.3.2 Crazy 8's

Crazy 8's is an ideation method that is used to quickly generate multiple ideas within a specific topic. The idea is to explore the design space with a quantitative approach, reaching ideas beyond initial solutions (Google Design Sprint Kit, 2020). Before the session, a design problem or question is formulated. At the session, each participant takes a paper and folds it three times, turning it into a canvas divided into eight squares. A timer is set to eight minutes and each participant gets one minute of sketching per square. This results in eight ideas generated per participant within eight minutes. When the timer is out, the generated ideas can be discussed among the participants. As each participant produces eight ideas at each session, a

large quantity of possible solutions is generated. The ideas do not need to be great, they can be impractical, unfeasible or, as the name suggests, crazy (Google Design Sprint Kit, 2020). Even an idea that seems crazy at first sight can be the seed to a good solution. Crazy 8's will be used to generate ideas within the topics that arise from the user study.

4.3.3 Creative Toolkits

Martin and Hanington (2012) describe creative toolkits as "collections of physical elements conveniently organized for participatory modeling, visualization, or creative play by users, to inform and inspire design and business teams" (p.45). The idea is to use physical props to ideate, generate and communicate ideas. In this project props such as Lego, clay and papers cut into different geometrical shapes will be used to ideate around new patterns that can be used for step programming.

4.4 Prototyping

A prototype is a manifestation (Preece et al., 2015) or a representation (Hartson & Pyla, 2012) of a design. Prototypes allow stakeholders to interact and explore ideas during the design process. Lim et al. (2008, p. 29) broadly categorise the purposes of prototyping into the following areas:

"(1) evaluation and testing; (2) the understanding of user experience, needs, and values; (3) idea generation; and (4) communication among designers."

They state that these categories are not mutually exclusive, as one prototype can be used for multiple purposes. It is important to be aware that the purpose of the prototype should influence what kind of prototype to build (Preece et al., 2015). Different kinds of prototypes can be categorised as low- or high-fidelity prototypes, or anything in between.

In this project, low-fidelity prototypes will be built during the early design stages. As Lim et al. (2008) describe, the prototypes will be used to test and evaluate ideas, to understand the user experience, as communication tools and to help with the idea generation. Later in the process, one high-fidelity prototype will be built in order to test, evaluate and compare proposed final designs against an existing linear design.

4.4.1 Low-Fidelity Prototyping

Low-fidelity prototypes are explorative prototypes that provide a limited set of functions or representations of functions. These types of prototypes are useful due to their simplicity as they are cheap and quick to produce (Preece et al., 2015). Because of the flexibility, low-fidelity prototypes are commonly used during the early stages of the design process. They are not only good tools for internal development communication but also great tools for early user testing (Martin & Hanington, 2012). *Paper prototypes* are commonly used low-fidelity prototypes in interface and

software design (Martin & Hanington, 2012). The user interface is represented in paper and work as a mean of communication between the test user and the designer.

4.4.2 High-Fidelity Prototyping

High-fidelity prototypes look more like the final product and provide more functionality compared to low-fidelity prototypes (Preece et al., 2015). Prototyping high-fidelity representations can be useful in the later stages of the design process as they can provide feedback based on aesthetics, interaction and usability. In software design, high-fidelity prototypes can generate feedback in the form of real user experience (Martin & Hanington, 2012). This is possible since a high-fidelity prototype many times allow high interactivity (Hartson & Pyla, 2012).

4.5 Evaluation

In the evaluation phase, data regarding the users' experiences when interacting with a design artefact is gathered (Preece et al., 2015). The focus can be on both usability and user experience. The collected data is later analysed in order to improve the design. There are two types of evaluations - *summative* and *formative*. The summative evaluation extensively evaluates finished products. They can be done as a start for a re-design, before release as quality control or to be able to compare products. However, it can be hard to resolve major problems if they are found in the later stages of the design process (Cooper et al., 2014). Therefore, it is important to perform formative evaluations, which are done during the iterative design process. The formative evaluation is quicker, more targeted and focuses on improving the design. Generally, summative evaluations focus on producing quantitative data, while the formative evaluations focus on qualitative data (Cooper et al., 2014). There are also evaluation methods that can be performed without the users involved. Examples of this are Heuristic Evaluation (Nielsen & Molich, 1990) and Cognitive Walkthrough (Polson et al., 1992).

This project will consist of many formative evaluations during the design and development phase. These will be used to quickly evaluate and improve the design. Initially, they will be sketch and theory-based where different solutions are evaluated by the team in short iterations. In the later design stages, users will be involved in a summative evaluation. Multiple alternative layout concepts will be evaluated and compared to a traditional linear layout.

4.5.1 User Tests

One of the primary methods for evaluating a design in the later stages of the process is *user testing* (Preece et al., 2015). By observing a user perform specified tasks, insights can be drawn on how the user experiences the system. Insights regarding specific troublesome interaction moments that may be perceived as confusing can also be discovered (Martin & Hanington, 2012). The user test is often complemented

with interviews (section 4.2.2) and/or questionnaires (section 4.2.3) to get a better understanding and to evaluate the experience (Preece et al., 2015).

User experience and usability can not be measured per se. Instead, things that can indicate usability and user experience are measured (Hartson & Pyla, 2012). Data being collocated spans from how long time a task takes to complete, the number of errors, amount of clicks, gestures and swipes, to how the user reacts and experiences the system. Nielsen and Landauer (1993) discovered that the number of identified usability problems as a function of number of test users follows a logarithmic growth. This means that the data will become saturated after a certain amount of user tests. After user tests with five users, somewhere around 85% of the usability problems will generally be discovered (Nielsen & Landauer, 1993). Around 90% of the usability problems will be discovered somewhere between six and eight test users. Around 15 user tests are generally required in order to discover all usability problems. However, Nielsen and Landauer (1993) argues that after five user tests, the trade-off between discovered usability problems and time/budget is normally not worth it. A user test is often recorded to allow further analysis. The recorded material can also be used as support material for interviews with the participant after the test. However, if the test is to be recorded it is always important to inform and ask for consent from the participant before the test starts (Preece et al., 2015). For evaluating user experience, questionnaires are often used as a complement to observations, focusing on what the user feels (Hartson & Pyla, 2012).

It is always important to ensure the user that it is the usability or the user experience of the product that is being evaluated and not the user. Because of this, Hartson and Pyla (2012) argues that it should not be called user testing, but instead usability testing or user experience evaluation.

In this project, user tests alongside interviews, observations and questionnaires are intended to be the basis for evaluating proposed alternative layout concepts. User tests will be carried out to make summative evaluations and comparisons between the concept layouts and one existing traditional layout. The tasks that will be carried out in the user tests will involve both tasks with concrete specific goals as well as tasks with more open abstract goals. The idea with this is to gather data that can be the basis for evaluations in terms of both user experience and usability.

4.5.2 Covid-19 and Current Circumstances

Because of the ongoing coronavirus Covid-19 pandemic and its contingency, this thesis will have to be carried on with certain flexibility. Some of the planned events such as initial interviews with designers and potential users, evaluation with user tests etc. will have to be executed online or remotely. The ongoing outbreak will be followed closely and current circumstances will be taken into consideration when making decisions throughout the project. With a flexible approach, this project can be executed and lead to results that do not deviate significantly from those first intended.

5

Execution and Process

The design process that has been executed can be described as iterative. Different design phases including analysis, ideation, prototyping and evaluation have been carried out and built upon each other. Some of the phases have been conducted in parallel. The whole process is based on design decisions, some grounded in theory and theoretical evaluation, others grounded in thoroughly executed methods such as user studies, user tests, ideation and prototyping methods. In figure 5.1 the process is visualised.

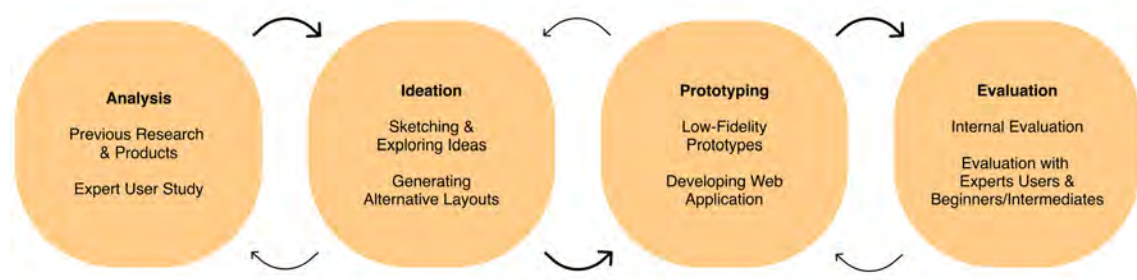


Figure 5.1: *The different phases of the iterative design process and the activities they consisted of.*

5.1 Project Initiation

To become acquainted with the domain, the initial phase of the project was focused around exploring drum machines by gathering information such as relevant theory, previous work within the domain, and how expert users use drum machines today. In this section, the execution of these analyses will be described and presented.

5.1.1 Project Planning

The project was planned to be performed during 20 weeks in the spring and early autumn of 2020. The distribution between preparation, execution and finalisation was based on the recommendations provided by the institution. The execution phase consisted of a user study, ideation, prototyping and evaluation. Supervising was planned to be held once a week or when required. However, the project was carried out during 24 weeks instead of the scheduled 20. An extensive initial user

study was the main reason for the extension of the project. Moreover, the situation of Covid-19 did also prolong some phases of the project. In appendix A a Gantt chart over the planned and executed process can be found.

5.1.2 Exploration

The first phase included exploration within the domain based on discussions, research and a field trip. The authors involved the supervisor, Palle Dahlstedt, in the initial discussions that covered drum machines in general and, more specifically, different types of user interfaces for step programming.

A field trip to one music store was made to explore and get more hands-on experiences with drum machines on the market. This visit resulted in an unstructured interview with one of the staff members that further introduced the authors to already existing drum machines, including drum machines with alternative user interfaces.

Additionally, YouTube-videos¹ of electronic musicians playing and interacting with drum machines as well as tutorials made by content creators have been noteworthy resources throughout the project. This has been the case especially due to the limitation of field observations the situation of Covid-19 has implied.

5.1.3 Literature Review

Literature reviews were carried out to initiate the thesis and have been ongoing throughout the project. These literature reviews have been covering theory and methods within the interaction design field as well as more domain-specific fields. As more knowledge has been gained, more literature reviews have been executed in order to assemble and utilise theory and methods that apply to the subject.

Theory and methods from the field of interaction design have to a notable extent been assembled from books that have been in either the possession of the authors or the institution where the thesis is written. Complementary, the online division of Chalmers Library² has constituted an important resource for gathering information. Domain-specific literature has mainly been gathered online through Chalmers Library, ResearchGate³ and Google Search⁴. Other domain-specific resources have been books borrowed from the supervisor of the project and research papers that have been distributed as course literature in the authors' previous studies.

In some cases, the authors have been searching for resources that they know exist, while in other cases, the search has been rather exploitative. In the latter cases, the authors have been searching for domain-related keywords, using Google Search and Chalmers Library. The result of all literature reviews is presented in the two sections, Theory and Methodology.

¹Youtube, <https://www.youtube.com/>

²Chalmers Library, <http://www.lib.chalmers.se/>

³ResearchGate, <https://www.researchgate.net>

⁴Google Search, <https://www.google.com>

5.2 Expert User Study

Interviews (section 4.2.2) were held with expert users in order to get a deeper understanding of the context and the users. The interviews were semi-structured to allow for spontaneous delving into unexpected topics, while at the same time provide answers to certain questions. There were both broad questions regarding the topic in general and more narrow questions regarding interfaces and layouts of step sequencers. The interview script can be found in appendix B.

The interviews consisted of the following five parts:

- Introduction of the project, purpose of the interview and consent confirmation
- Warm-up questions
- Main session
- Optional session regarding designing/manufacturing drum machines
- Final questions

5.2.1 Participants and Sample Selection

The contacts to the first five interviewees were mediated by the supervisor of this thesis. They were selected because of their long experience of working and performing with drum machines. Besides this, some of them had experience with developing drum machines. At the end of each interview, the interviewees were asked if they wanted to recommend someone else for an interview, which resulted in three more interviewees and interviews.

All of the eight interviewees (IA, IB, IC, ID, IE, IF, IG and IH) produce and perform electronic music and have long experience when it comes to physical drum machines. IB, ID, IE & IF were at the time of the interviews employed by four different manufactures of synths and drum machines. IG also has experience in building instruments and drum machines. Five of the interviewees lived in Sweden, two of them in the United States of America, and one in Germany. All of the interviewees are males in the age between 30 and 55.

5.2.2 Execution

Eight interviews were executed with an average time of 1 hour and 16 minutes. Both of the authors participated in every interview and took turns in leading the interview. Due to the Covid-19 pandemic, all of the interviews were executed remotely via the video-conferencing software Zoom. The interviews were recorded with the permission of the interviewees to allow further analysis. After seven interviews the data started to become saturated.

During the interviews, the interviewees were encouraged to demonstrate how they do and interact with certain things on the drum machines, which added an observation

(section 4.2.4) aspect to the interviews.

5.2.3 Analysis

Out of the eight interviews, seven were transcribed in order to allow further analysis. The last interview was not transcribed due to time constraints but still contributed to this thesis, even though it was not included in the analysis.

In total, 8 hours and 48 minutes were transcribed, which resulted in 68 891 words or 130 pages⁵ of material. Parts of the transcribed material that regarded interactions and user needs were marked with a unique colour for each interviewee. Both authors went through all material once independently of each other. In total, 394 quotes, equal to 21 673 words or 41 pages, was extracted from the interviews. In table 5.1, the process of filtering and narrowing down data is shown.

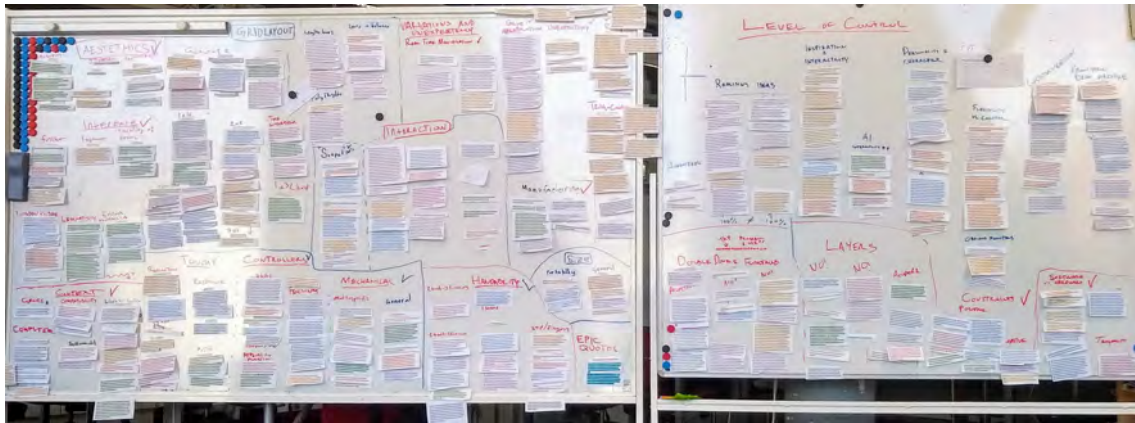


Figure 5.2: *Affinity Diagram: The quotes were organised in themes that emerged during the process. Each quote was colour-coded to be able to differentiate between different interviewees*

The quotes were printed out and an affinity diagram (section 4.2.5) was constructed (see figure 5.2). During the process, 54 quotes were discarded since they did not fit into the scope of the project. The quotes were organised into themes that emerged during the process. When all quotes were categorised the first time, the authors went through them one more time and re-organised them into new themes. In this process, sub-themes emerged. The process resulted in 14 themes, and 62 sub-themes. In table 5.2 each theme and sub-theme is presented. The table also shows how many quotes there are per theme as well as their sources (i.e. the interviewee that said it). Some of the quotes concerned multiple themes. When possible, these quotes were divided into new quotes. When not possible, the quotes have been placed in the most relevant theme but also included in the analysis of the other themes it concerned. The themes are described closer in section 6.1

⁵font, margins and page size same as in this report

	Executed	Transcribed	Quotes	Afinity diagram
Interviews	8	7	7	7
Time	10 h 11 min	8 h 48 min	-	-
Words	-	68891	21673	-
Pages*	-	130	41	-
Quotes	-	-	394	340
Themes	-	-	-	14
Sub-themes	-	-	-	62

Table 5.1: How the data from the interviews was narrowed down. *One page equals one page in this report

Theme	Quotes	Interviewees	Interviewee						
			A	B	C	D	E	F	G
Context	28	7							
Live vs. Studio	7	6							
Computer	6	2							
Self-Contained	2	1							
Compatibility	3	3							
Genre	1	1							
Software vs. Hardware	9	4							
Drum Machine Interaction	17	6							
User Interface	20	7							
Listen vs. See	6	4							
Inspiring User Interfaces	4	4							
Learnability	4	2							
Visibility of System Status	3	1							
"5 o' clock at the techno club"	3	2							
Layout of Controllers	1	1							
Time-Multiplex Input	29	6							
Step Programming & Tapping Controllers	16	4							
Acceptable	3	1							
Negative	13	3							
Layers	13	4							
Acceptable	4	3							
Negative	9	4							
Layout of the Step Sequencer	48	7							
General	9	6							
1x16	16	5							
2x8	7	3							
4x4	1	1							
1x32	1	1							
Space in Between	5	3							
Length of Bars	3	2							
Time Signatures	3	2							

Table 5.2 continued from previous page

Theme	Quotes	Interviewees	Interviewee						
			A	B	C	D	E	F	G
Polymer/Polyrhythm	3	2							
Buttons & Controls	28	7							
General	1	1							
Feeling	6	2							
Function Dependent	2	2							
Mechanical	14	5							
General	6	5							
Model Specific	8	4							
Pads	5	4							
Touchscreen Interfaces	13	6							
Reflection	2	2							
Response	3	1							
Positive	3	2							
Negative	5	3							
Hand Interactions	31	7							
General	1	1							
Two Hands - Two Functions	1	1							
Two Hands - One Function	7	3							
One Hand	5	4							
Step Programming	8	5							
Swiping Mechanical Buttons	9	5							
Size	7	4							
General	4	2							
Portability	3	3							
Manufacturing	7	3							
Aesthetics	11	5							
General	4	2							
Bad Examples	4	1							
Good Expamples	3	3							
Constraints	10	5							
Positive	7	4							
Negative	3	3							
Level of Control	66	7							
Realising Ideas	14	2							
Inspiration and Interactivity	12	4							
Personality and Character	10	3							
Customisation	8	4							
Skill	8	3							
Flexibility and Control	6	2							
Artificial Intelligence	5	2							
Human Feel	3	2							
Variations and Unpredictability	32	4							
Trig Conditions	8	2							

Table 5.2 continued from previous page

Theme	Quotes	Interviewees	Interviewee							
			A	B	C	D	E	F	G	
Grid Manipulation	7	3	■					■	■	■
Randomness	4	2						■	■	■
Unpredictability	3	2				■	■			
Real-Time Manipulation	2	1						■	■	
Uncategorised	8	2						■	■	■
Total	340	7	■■■■■■■							

Table 5.2: All the themes and sub-themes that emerged from the affinity diagram of the interviews. The table describes how many quotes and which of the interviewees that contributed to the different themes. When a quote has concerned multiple themes, the quote has been placed in the most relevant theme but been included in the discussion of the other themes it concerned.

5.3 Producing Alternative Layouts

With a deeper understanding of drum machines, the expert user group and the context, the project carried on into an ideation phase. The ideation revolved mainly around producing different layout patterns that could be used for step programming. The scope was limited to mainly investigate and produce layouts with 16 steps in measure. To furthermore explore the domain, the authors also ideated on broader topics that arose from the user study. The ideation phase resulted in 12 new alternative layouts.

5.3.1 Initial Ideation

The initial user study resulted in many themes that could act as the foundation for a design project. To get a better understanding of the context it was decided to ideate on a selection of these topics. Some topics were more relevant to the project scope than others. The ideation method Crazy 8's (section 4.3.2) was used. To generate ideas with an even more quantitative approach, a window of 30 seconds was utilised per idea. The ideation evolved around the following eight questions:

- How can alternative layouts used for step programming look?
- How can touchscreens be used for interacting with drum machines?
- How can unpredictability be integrated into a drum machine?
- How can the possibility to "escape the grid" be provided (i.e. placing steps with higher fidelity and not just be locked to the 16 steps)?
- How can the buttons for a drum machine look and function?
- How can the state of the drum machine be indicated (i.e. feedback of activated steps)?

- How can manipulation of different parameters be provided?
- How can time-multiplex input be utilised in a good way (i.e use the same control for multiple functions)?

The procedure resulted in 56 new ideas. None of these specific ideas were used in the later stages of the project. However, the ideation resulted in a broader understanding of the context.

5.3.2 Alternative Layout Ideation

Sketching has been an important part when generating new alternative layouts. Sketches have been made to quickly explore, improve and evaluate ideas. In figure 5.3 some early sketches can be seen.

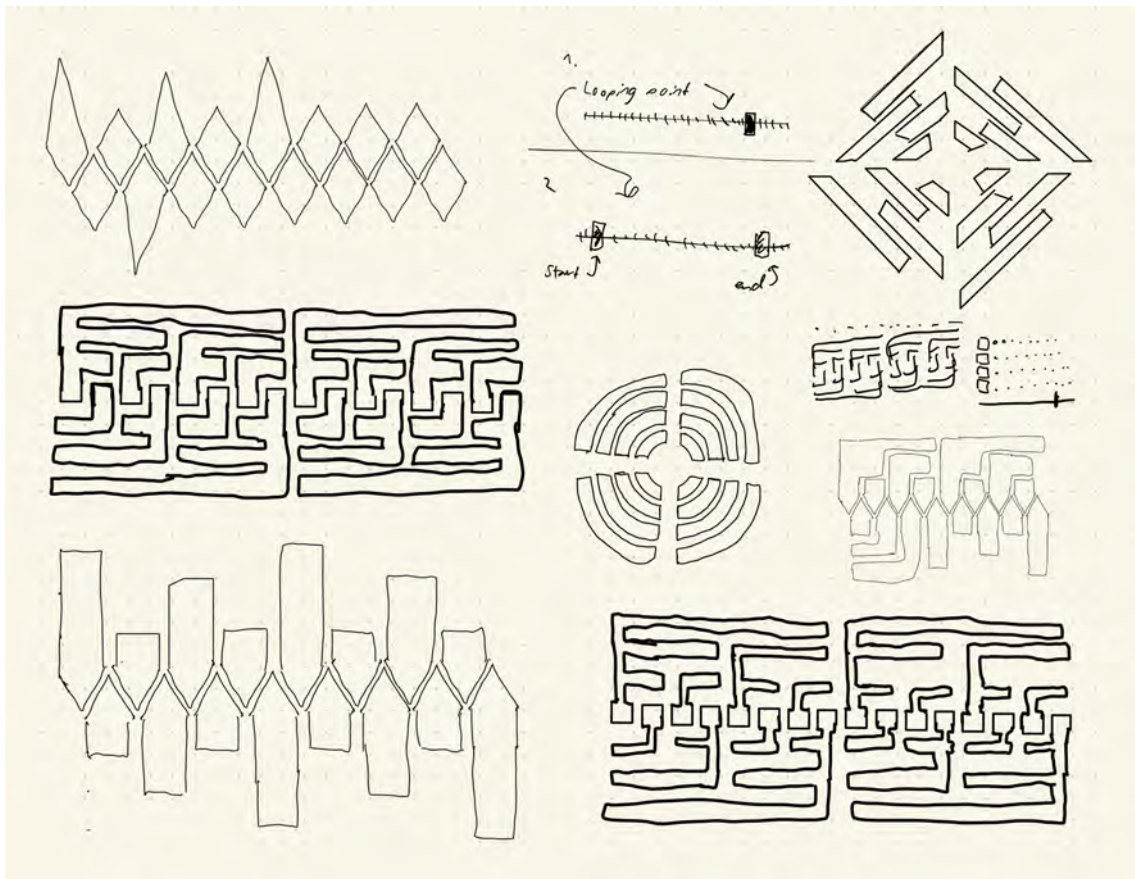


Figure 5.3: *Early sketches of alternative step programming layouts.*

As a way to come up with more patterns, a creative toolkit (section 4.3.3) was created. Different geometrical shapes⁶ were collected, printed out and cut into pieces. The shapes were used to explore how different shapes could be combined to form new patterns (figure 5.4). The procedure resulted in the seed to one new pattern where diamond shapes were used to make a more condensed pattern.

⁶The shapes were collected from <https://www.math-salamanders.com/printable-shapes.html>

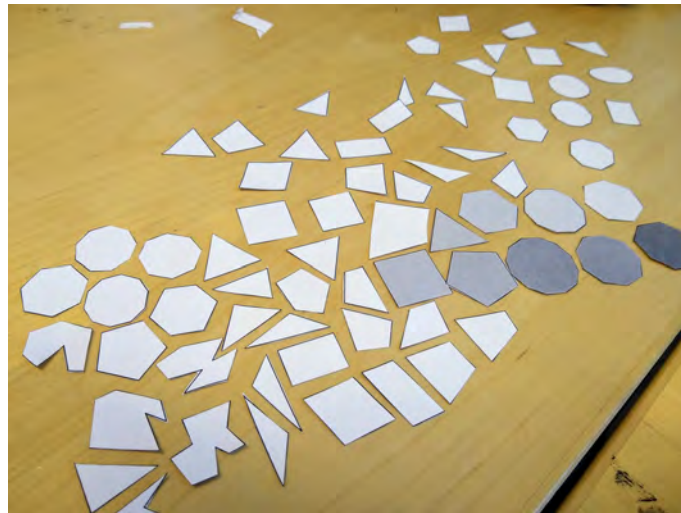


Figure 5.4: *Some of the different shapes that were used during the creative toolkit ideation.*

5.4 Prototyping Alternative Layouts

Prototypes were created to be able to evaluate the different ideas. Early on in the project, the prototypes consisted of paper, sketches and Lego and were used to quickly evaluate ideas internally. Later, a web application was built to allow more in-depth evaluations, both internally and externally (i.e. with test users).

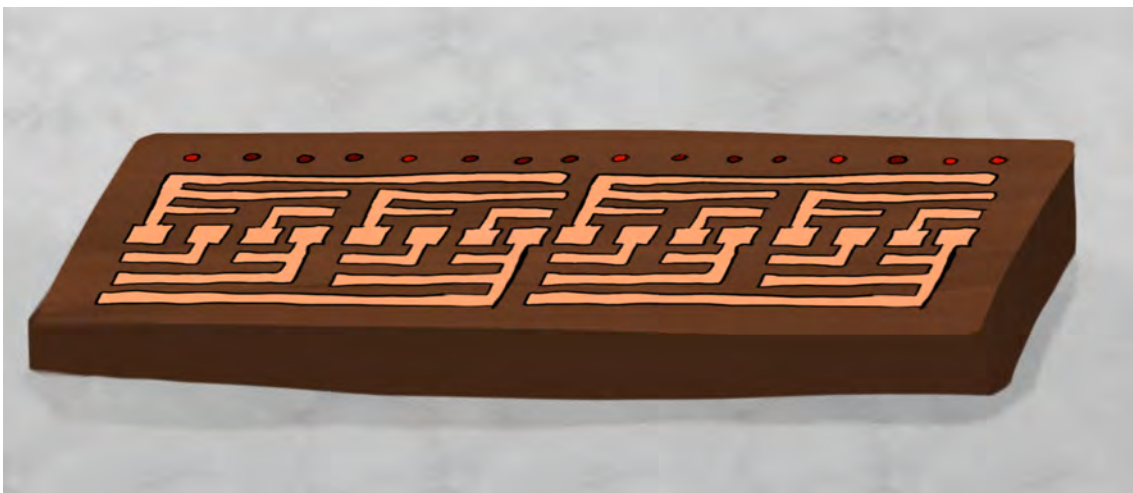


Figure 5.5: *Early sketch of how a physical prototype could look.*

5.4.1 Low-Fidelity Prototyping

Low-fidelity prototypes were created with Lego and sketches at an early stage to evaluate if an idea was feasible or could be further developed. More detailed digital sketches were used to evaluate the patterns.

5.4.2 High-Fidelity Prototyping

In order to test how the new layouts affect user experience and player behaviour, a high-fidelity prototype was built. In the beginning of the project it was not yet decided if the final prototype should consist of a physical or digital interface. Different ways of building both physical and digital prototypes were investigated. In the end, it was decided that the first prototype should be digital. A digital prototype allows for higher flexibility when it comes to testing multiple layouts. It is also easier to add new layouts as the project progresses. A digital prototype would also allow for remotely conducted user tests. This would be advantageous due to both Covid-19 and the fact that multiple of our potential test users were based in different geographical locations.

Several ways of building the prototype were considered:

- Build a native application for iOS or Android-based on either its own sound engine, OSC or MIDI
- Use TouchOSC, Lemur, MobMuPlat or Mira to build a custom interface that could control a DAW, MAX or pure data via MIDI or OSC
- Build an application using Unity
- Build a web application that either had its own sound engine or sent OSC or MIDI

After investigating each option it was decided to build a web application with its own sound engine. A web application is platform-independent and does not require any extra equipment or installation which made it suitable for remote user tests. This option also provided the flexibility needed to test multiple layouts.

Web Application

The web application was built using HTML, CSS and JavaScript. The library Tone.js⁷ was used to implement the sound engine and the logic of the step sequencer. The layouts used for step sequencing was made in a vector graphics software and saved as SVG-files. The SVG-files were then connected to the sequencer using JavaScript. This approach made it possible to create detailed layouts, but also to test and modify them as the project progressed.

The functionality that was implemented was formed around the possibility to evaluate the step programming layouts. Too much functionality would make it harder to isolate and evaluate only the step programming layout. On the other hand, too little functionality could also make it harder to evaluate as some functions are required to create a realistic user context.

The application was optimised for use on devices with touchscreens. It was ensured that it was responsive for different screen resolutions and that it functioned on both

⁷<https://tonejs.github.io/>

iOS and Android (figure 6.18).

5.5 Evaluation of Concepts

Evaluations have been apparent throughout the whole design process. Early on, quick, small and formative evaluations of sketches and ideas were executed. In the latter stage of the process, a web application was built to allow for summative evaluations of a collection of selected layouts. The goal in this phase was to evaluate user experience, usability and functionality of the new alternative step programming layouts.

To be able to evaluate how alternative step programming layouts affect user experience and player behaviour user tests were executed. The main evaluation consisted of interviews with expert users that have had access to the prototype for at least one week, in some cases more. As a complement to this, a more quantitative study was performed where the users' previous experience with drum machines ranged from beginners to experts.

5.5.1 Early Concept Evaluation

Before the web application was built, the different layouts for step programming were evaluated by logical thinking. Questions like: "*What gestures are required to create a specific rhythm?*", "*Is it possible to activate these steps in a single swipe?*", "*What happens if you perform a given or specific gesture?*" were asked. In some cases, paper prototypes were used to analyse what kind of rhythms different gestures (i.e different kinds of swipe directions and non-linear swipes) would generate. The gesture was drawn with a pen in order to localise the steps that would be activated. These steps were later programmed into another drum machine to produce and give auditory feedback from the generated rhythm (Figure 5.6).

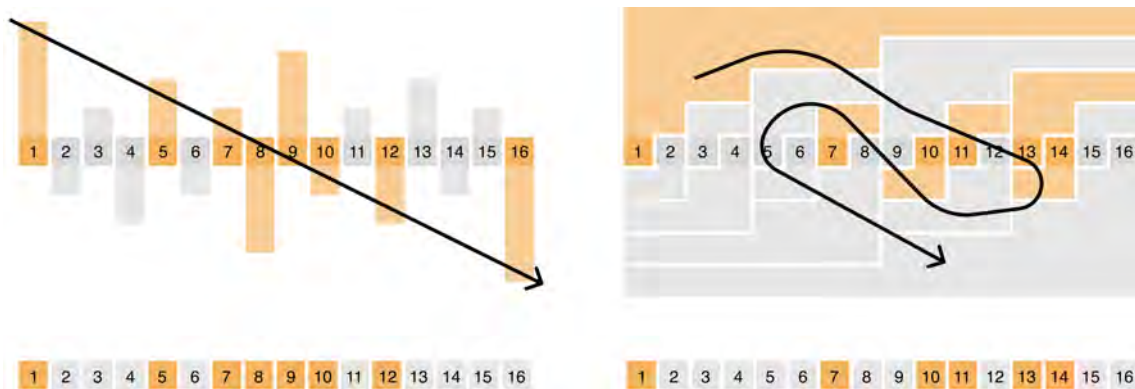


Figure 5.6: *Layouts were evaluated by drawing lines of potential gestures (i.e different kinds of swipe directions and non-linear swipes) on paper prototypes.*

When the web application was created, the same type of questions was asked. However, being able to play (with real-time auditory feedback) with the layouts allowed for quicker and more in-depth evaluation of the different layouts.

5.5.2 Selecting Layouts for External Evaluation

At the end of the prototyping phase, 11 layouts were implemented within the prototype. Due to time constraints and the fact that some layouts were similar it would not be efficient to evaluate all of them with test users. Four of these 11 layouts were selected.

The layouts were selected based on the following criteria:

- **Promising interaction possibilities:** layouts that made it possible to swipe in different directions or use non-linear swipes to access different rhythms were prioritised over layouts with few or limited interaction possibilities.
- **Different interaction principles:** some of the layouts were based on the same interaction principle. To test a range of different layouts, diversity was prioritised. Therefore, layouts with different interaction principles that stood out from each other were selected.
- **Aesthetics:** In cases where two layouts were equivalent in functionality the one that the authors found most aesthetically appealing were chosen.

In addition to these four layouts, the traditional standard layout with 16 steps in a row was implemented in the final prototype. This was done to be able to, not only compare the four concept layouts, but also use the traditional layout as a reference. Even though all test users already had high expertise and experience with the traditional layout, it was decided to include it to maintain the same level of fidelity as the other concepts.

5.5.3 Evaluation with Expert Users

A drum machine is a musical instrument, and common for the majority of musical instruments is that the user often spends time to learn to play them - you do not expect to master it the first time. Through the lens of Karapanos et al. (2009), the user goes through the orientation and incorporation phase to hopefully end in the identification phase. While the orientation phase and initial experience still are interesting to evaluate, one could argue that the full potential of an instrument first can be evaluated after a long time of use.

The expert evaluation was designed to aim beyond the orientation phase and episodic user experience, trying to reach and evaluate the incorporating phase and a more cumulative user experience. To achieve this purpose and be able to evaluate the layouts after longer use rather than only the first impression, the following evaluation process was executed:

- Provide the participants with instructions and documentation of how the prototype and the different non-linear layouts work.
- Let the participants use the prototype on their own during a period of at least a week, preferably longer.

- Conduct semi-structured interviews with the participants including questions regarding the participants' experiences and findings.

To be able to evaluate and investigate multiple parameters such as hedonic, pragmatic, functional and user experience aspects, the participants were asked to do both open-ended musical explorations (i.e play freely) and try to realise specific goals (i.e. reconstructing specific rhythms and ideas the users thought of) with each layout. This also allowed the usability aspects effectiveness, efficiency and satisfaction to be evaluated to some degree.

Participants and Sample Selection

All of the participants from the initial user study were asked to participate in the evaluation. Five of them had the possibility to participate. One expert user (II) that did not participate in the user study was participating in the user test.

All of the participants (IB, IE, IF, IG, IH and II) produce and perform electronic music and have long experience of playing drum machines. IB, IE, and IF were at the time of the evaluation employed by three different manufacturers of drum machines and synths.

The reason to evaluate the layouts with expert users in this part of the evaluation was the following:

- Expert users will breach through the orientation phase quicker as they have long experience of using other drum machines.
- With their previous experience and knowledge, expert users will come with valuable feedback and input.

Execution

The participants got the prototype, documentation and instructions sent to them by e-mail. The instructions and documentations explained what to test and explore, basics on how the prototype worked and how the steps were distributed on each layout. The participants were encouraged to spend time on each layout, both trying to realise ideas and explore freely. The instructions and documentation can be found in appendix D.

In the same e-mail conversation, a date for the following interview was scheduled. Due to vacations that summertime implies, it was not always easy to find time for the interview. This led to that some interviews took place 1-2 months after the user got access to the prototype while others only got one week to test the prototype.

The interviews took approximately one hour and were conducted remotely via the video-conferencing software Zoom. The interviews with IB, IE and IF were conducted by one of the authors. The other author watched the recorded material afterwards and took notes. Both of the authors were present during the interviews with IG, IH and II, one asked the questions and the other one took notes. With

the permission of the interviewees, the interviews were recorded to allow further analysis.

As the sounds included with the prototype were limited to samples selected by the authors, the participants were offered to send eight samples in advance that could be included in the prototype. None of the participants chose to do so.

Interviews

The interviews with the test users were more structured compared to the ones conducted in the exploration phase. However, the interviews were semi-structured in the sense that the interviewer still had the freedom to ask complementary questions on the fly, if needed. The interview consisted of three parts: an introduction, questions regarding specific layouts and lastly some general questions regarding the prototype and the concept.

As an initial question, the test users were asked how it had been to interact with the prototype in general. This question was asked to initialise the conversation and gather the participants' first thoughts of the prototype.

One group of questions were asked for every layout. In this part, the participants were first asked to briefly describe the layout. Other questions asked were the following: What type of gestures were mainly used? Amount of control experienced? How it was to realise specific goals (i.e. reconstruct specific ideas)? Did the layout invite to play differently? Was the interaction perceived as a dialogue or as instructing the tool? Did the layout invite to variations or lead to repetitiveness? At the end of this part, the participants were asked if there were something they wanted to add.

After each layout had been discussed, the interview was concluded with some general questions regarding the prototype as a whole. Questions were asked such as: How was it to interact with alternative step sequencer layouts on a touch screen? Which layout did they enjoy the most? Could they see themselves using an interface like this in the future? The complete interview template can be found in appendix C.

Analysis

The notes from the interviews were printed out. Statements and quotes were marked. The interview notes were supplemented by going back to the recorded material when needed. The participants' answers to each question were then compared and summarised. All quotes used are transcribed from the recorded material and the quotes from IB, IG, IH are translated from Swedish to English.

5.5.4 Evaluation with Beginners & Intermediates

As a complement to the qualitative expert evaluation, more or less quantitative user tests were executed. While the expert evaluation aimed more at the experience after a period of use, this evaluation was more focused on the initial experience as well as the semiotic attributes of the different layouts.

The participants were asked to do open-ended musical explorations and create rhythms using all different layouts. When the participants felt they had explored all layouts they filled in a questionnaire including general questions and specific questions regarding each layout.

The expert users' previous experience of using drum machines make them qualified for evaluating the layouts. However, their previous experience may result in an expectation of data being presented in the same way they are used to. Liu et al. (2010) write that expert users' previous experience can influence users' interaction in both positive and negative ways. Previous use experience may benefit users through richer interaction knowledge. However, it is also mentioned that previous use experience can make expert users rely upon and stick to earlier constructed mental models. These previous mental models of task completion can have a negative influence on the adaption of new interfaces and new types of interaction. All of the expert users in this study have been using and mastering the traditional 16-in-a-row layout for many years. This background will most likely affect the way they perceive, reflect and evaluate the alternative non-linear layouts. With this in mind, one can ask the question, is there a significant difference in which type of layout the users' prefer given the users' varying experience with drum machines? Therefore, the goal of this complimentary evaluation was to study and involve a span of participants that ranged from beginners to intermediates.

Participants and Sample Selection

In total, 21 persons participated in this evaluation. The participants were friends and colleagues to the authors with different backgrounds. The participants had different amount of previous experience in playing and creating music, both with and without drum machines.

To be able to do comparisons between different groups of participants, the participants were asked to self evaluate their previous experience. The participants reported their previous experience of playing and creating music on a scale from 1 (none) to 5 (high). A majority (11 participants) selected option 3 and the rest of the participants were equally distributed between option 1/2 and option 4/5. The answers can be found in figure 5.7.

The users got to define their experience by using six different statements. The users had the possibility of selecting no, one or multiple roles. Most participants (16) considered themselves instrumentalists. Three of the participants did not identify themselves in any of the provided roles. The answers can be found in figure 5.8.

The users also got to specify their previous experience with using drum machines on a scale from 1 (none) to 5 (expert). The result can be found in figure 5.9. A majority (eleven participants) had no previous experience with use of drum machines. The rest ranged from 2 to 5. To be able to compare the results between the users with and the users without previous experience, the participants who rated themselves between 2-5 were grouped into one group. The group with no previous experience will be referred to as beginners and the group with previous experience will referred

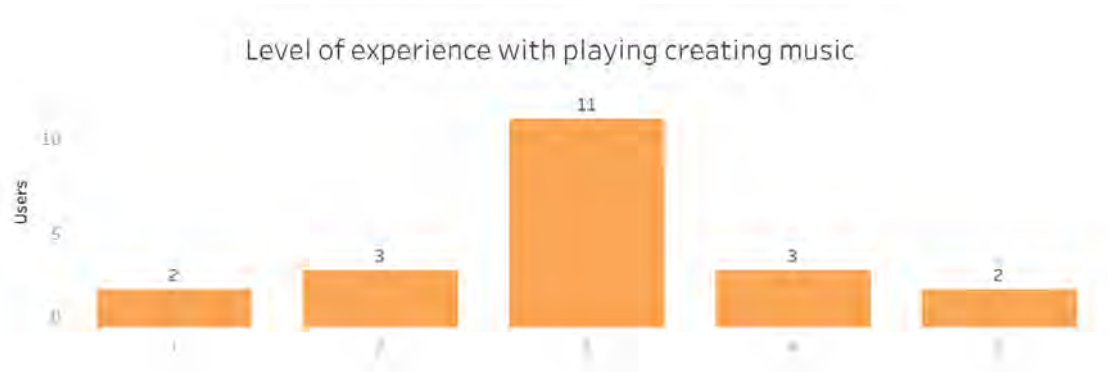


Figure 5.7: *The self-reported previous experience with playing/creating music for the users in the evaluation with beginners/intermediates*

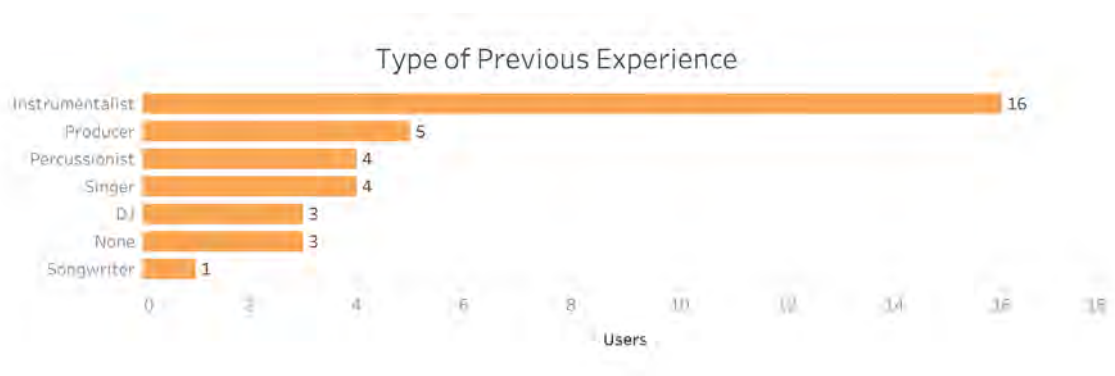


Figure 5.8: *What roles the participants in the evaluation with beginners/intermediates identified themselves with*

to as intermediates.

Execution

The procedure for the majority of tests (13) was executed as follows:

1. The participant was shortly introduced to the prototype
2. The participant was asked to musically explore and create rhythms open-ended until they felt satisfied.
3. One of the authors asked the questions and filled out the form for the participant.

The execution allowed the authors to observe the test users while interacting with the different layouts (figure 5.10). These observations were valuable as no observations could be performed during the remotely conducted expert user tests. In some cases, the participant could not be present because of Covid-19 or other reasons. Nine participants tested the prototype without the presence of the authors. In these specific user tests, instructions were sent to the participant and the questionnaire was filled out single-handedly by the participant. Seven of the participants used



Figure 5.9: *The self-reported previous experience with playing drum machines for the participants in the evaluation with beginners/intermediates*

smaller touchscreens as they did not have access to any tablet device. All types of possible interaction gestures are feasible even on smaller touch screens whereas the most noteworthy downside is the decreasing accuracy.

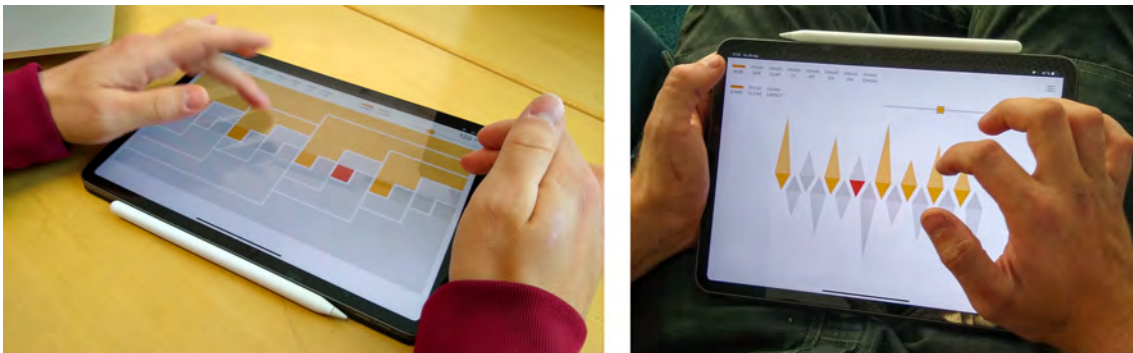


Figure 5.10: *Users who interact with the prototype*

The Questionnaire

The questionnaire (see appendix E) was created in Google Form⁸ and consisted of three parts. The first section of questions covered the participants' previous experiences in playing or creating music, and more specifically, experiences with drum machines. These questions were included to investigate if there is a correlation between previous experience and opinions about the layouts.

The second part consisted of semantic word scales asked for each layout. The scales ranged from one to seven and the users were forced to select a number. An odd number for the scale-range was chosen, meaning a neutral option was provided. The semantic word pairs were the following:

Clear - Confusing
Uninspiring - Inspiring
Simple - Complex

⁸<https://docs.google.com/forms> - A service to create surveys and questionnaires online

Appealing - Unappealing
Unorganized - Organized
Predictable - Unpredictable

These categories were partly derived from the themes identified in the expert user study but also selected as they capture both pragmatic and more hedonic attributes.

An optional text field where the participants could express further experiences and opinions was provided for each layout.

In the last part, the participants were asked which layout they preferred and if there were any layouts they did not like. Both questions provided the possibility to motivate their choices. The user could select none on each question, and select multiple layouts on the second question.

Analysis

The data from the questionnaires were compiled and analysed by using the software Tableau⁹ to create visualisations of the semantic word scales. The visualisations were used to identify patterns in the results. The software was also used to connect different data-points to allow further analysis. A majority of the participant quotes presented in the report are translated from Swedish to English by the authors.

⁹Software for analysing and visualising data, <https://www.tableau.com/>

6

Results

In this chapter the results from the expert user study and the evaluation with expert users and beginners/intermediates are presented as well as the alternative step programming layouts and the web application prototype.

6.1 Expert User Study

The following section is the result and summarises what emerged through iterations of analysis (i.e affinity diagram) of the interviews. The themes and sub-themes that evolved throughout the process are here presented and substantiated with content from the interviews. The main themes are divided into sections and the sub-themes were created during the process to facilitate and concretise data, but are here condensed and presented as paragraphs to retain the context.

To outline the use of drum machines, which can be described as an interaction between the user and the device within a specific context, different subjects are covered. For example, the system of usage is dependent on the user goal, user preferences, user skill and environment. The functions, interface, size and hedonic attributes of a drum machine are other examples of factors that affect the interaction and user experience (figure 6.1).

The result from the interviews includes how and why

- the users interact with drum machines
- interaction differs within different contexts
- the users perceive drum machines and their interactions

All the quotes from interviewee IA, IB, IC, ID & IG are translated from Swedish to English by the authors.

6.1.1 Context

All of the interviewees talk about the difference in playing with drum machines in a live performance and in the studio. Two of them (IB & IC) say specifically that they make things easier for themselves while playing live. For example, IC mentions

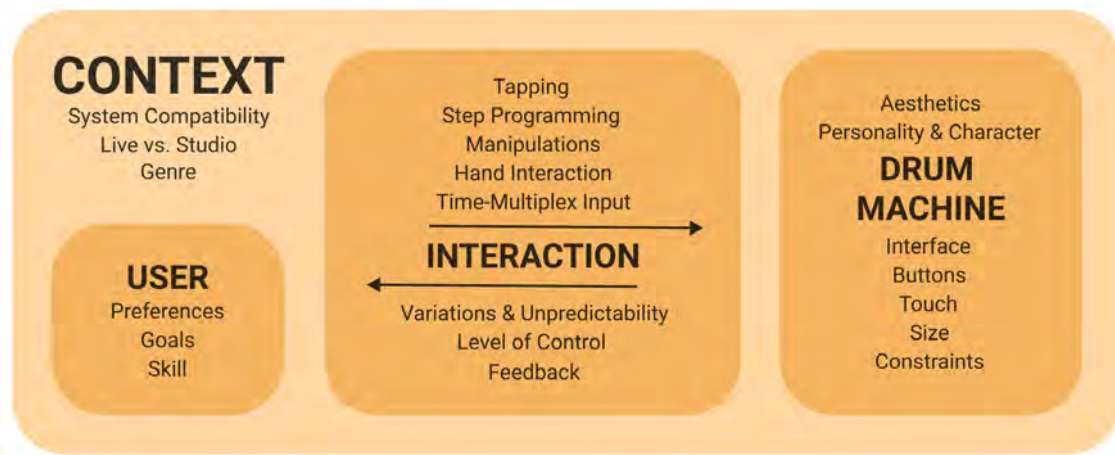


Figure 6.1: *The Themes that evolved from the user study mapped to the Human-Machine Interaction Model. The user interacts with the drum machine in a context.*

that there is not much step programming going on live. The patterns are instead prepared and the user tends to perform more by playing with mutes and other parameters. It is also mentioned that this depends on how confident the user feels with their data. In contrast to IC, IG usually uses step programming when playing live. This user proceeds from fewer prepared patterns and manipulates these in order to create variations. Another interviewee (IF) talks about live performances and says that, when playing live, a certain interaction with the audience emerges. This is mentioned to result in performance "tricks" that usually do not happen in a studio environment. ID brings a new device to every live performance to "keep it interesting".

The interviews made it clear that drum machines are often used as a part of a larger system. The machines are many times described as complements to each other rather than self-contained systems. All of the interviewees talk about how they connect drum machines not only to computers but also to other drum machines and synthesizers. For example, when playing live, IC uses three different machines from Elektron that complement each other. IE gave another example of a live setup including Digitone Keys and Analog Rytm MKII from Elektron, Toraiz Squid from Pioneer as well as other external sound processing devices. IB even says that sometimes it is more valuable to, in a simple way, be able to connect the machines to each other rather than them being easy to interact with.

"I use the Pioneer product if I want to do something that the Elektron sequencers can't do, for example." - Interviewee E

In contrast, IC describes that some of the advantages with Digitone and Monomachine from Elektron are that they are self-contained. They are described as independent machines that stand out for themselves. The same interviewee emphasises the attraction towards limitations such as interacting with only one or two machines at the same time.

IA says that the computer always has been central when working with drum machines and sequencing. However, the last live performances, this user has removed the computer from the setup and instead replaced it with Digitakt from Elektron as the central part of the setup. The same interviewee mentions that an iPad sometimes is included in the studio setup in order to control "extra stuff" when interacting with drum machines. Four interviewees (IB, IC, IE & IF) explicitly express that they prefer interacting with physical hardware drum machines over computer software drum machines. IF describes software plugins as "not really fun" and that "you need to have it on a machine, where you actually interact with it as an instrument". Interacting with physical drum machines is described as more natural and inspiring. IE expresses frustration towards computers in general and IB says that selecting a physical device is easier because the constraints are more familiar. The latter user has purchased several music iPad applications but mentions that they often lack personality and do not provide the desirable inspiration. It is important to add that the same interviewee says that this reflection has nothing to do with the sound that the software is producing, but rather the interaction.

"Even though a computer is supposed to be more flexible and you can do anything with it, it actually feels more rigid" - Interviewee B

IF gives an example in the perspective of the live performance audience. If the audience can see that the performer is manipulating the device and this interaction "reflects the changes of the sound", this adds to the experience. The interviewee contrasts this with an example of live performing with a laptop and says that this does not add to the experience as the laptop becomes a wall between the performer and the audience instead of linking them together.

In summary, the users interact with drum machines differently depending on the context. The compatibility with computers, instruments and drum machines is expressed as important but independency is also mentioned as an attractive attribute. Even though computer software drum machines are described as interesting, physical drum machines seem to be more preferable in terms of interaction. Additionally, IA expresses that music genre can also affect how the user experiences the interaction.

6.1.2 Drum Machine Interaction

Six out of seven interviewees mention that they go back and forth between step programming and finger tapping while IG rarely uses the tap function at all. IE usually starts the working procedure by first step programming a "small element" such as a hi-hat that will mediate the tempo. The user then switches to real-time input mode and starts to record quantized rhythms through finger tapping input. Being able to enter in exactly what is on the user's mind is mentioned as important and velocity-sensitive recording is given as an example. The next step is described as once again entering step programming-mode to get visual feedback and see what steps are activated. In the same mode, the user can now edit or move these steps as desired. IF is primarily using step programming mode but switches between this mode and finger tapping occasionally. Finger tapping in real-time input mode is

mentioned to be used mainly when the user wants to record rhythms unquantized. The same interviewee, however, mentions that step programming in combination with nudging the step in order to achieve the same type of unquantized result is used more often. IB, however, thinks that emulating these "errors" (i.e. unquantized results) by step programming and then nudging individual steps will not give the same result as if it were to be inputted directly by finger tapping. The user expresses this as: "having to think that extra step destroys the fundamental idea". The same user says that both finger tapping and step programming have their advantages but selects one of them based on the device rather on the goal. If the machine has a grid that invites for and affords step programming, this type of interaction is preferable. However, if the device invites for finger tapping, such as an MPC, the interviewee prefers this type of interaction. IC is also switching back and forth between the two types of input methods. Whether the user is using step programming or finger tapping depends on the user's goal and the interaction required to achieve this goal. For example, recording a melody is achieved easier by finger tapping. If the goal is to record complex rhythms the user prefers to input this by step programming. It is also mentioned that the two types of input interactions are sometimes combined to achieve a short-term goal. As an example, the user sometimes outlines a rough recording by using finger tapping mode and then switches to step programming mode to correct and add steps afterwards. The same user also says that the choice between step programming and finger tapping affects the outcome, meaning the same type of goal can lead to different results depending on which type of input interaction the user selects. IA is primarily using step programming as input method but mentions that velocity-sensitive finger tapping is sometimes used to achieve rhythms with dynamics and variations.

6.1.3 User Interface

All of the interviewees talk about general strengths and weaknesses regarding user interfaces of drum machines. IF highlights the importance of the user interface and mentions that a layout of controls can become the weakness of a specific drum machine. As an example, drum machines from Arturia (figure 6.2) are mentioned as "weird" due to the placement of the step programming grid which is placed above the sound engine knobs. This emphasises the importance of placement of layout elements relative to each other.

Four interviewees (IA, ID, IF & IG) mention that a user interface does not have to follow any standard layout paradigm in order to be appealing. Two of them (IA & IG) mention various interfaces from Buchla as "cool" and "very interesting" whereas IF mentions Pulsar-23 from Soma Laboratory (figure 6.2) as the most inspiring sequencer on the market today. It is described as a "very inspirational device" with a sequencer which is "totally upside down". ID expresses an openness for surprises regarding the user interface:

"I am a drum machinist. I am interested in any kind of invention... and I like to be surprised" - Interviewee D

IG emphasizes the importance of visibility of system status. One negative example mentioned is the fact that on most drum machines, it is not possible to see all patterns at the same time. The user has to turn or press a button or two in order to move between different patterns and sounds. As a solution to this problem, the interviewee mentions devices with a screen that provides this information. The same interviewee also refers to bad design when talking about a machine that provides system status but the placement of it forces the user to cover the state feedback when interacting with the device. In this specific example, feedback diodes were placed underneath pads which were covered when pressing them.

Four of the interviewees (IA, IB, ID & IE) talk about interacting with drum machines without looking at them. IB and IE emphasise the importance of interacting with the hearing. They describe the auditory feedback as interacting with the actual result and one of them (IB) mentions that too much visual feedback can sometimes interfere when in a creative phase. The same interviewee mentions that when working with an MPC machine (figure 6.8) the user tends to "use the ears a lot more" than when working with a sequencer drum machine.

"You know, being able to shut your eyes and still know where you have your stuff" - Interviewee A

Two of the interview participants (IA & IG) mention that it is important to be able to interact with the drum machine in darkness and referred to live performances at dark venues as an example of why. One of them (IG) exemplifies this with OP-Z from Teenage Engineering which is mentioned as a good example as the buttons are represented with different colours and make them stand out from each other. Moreover, Roland TR-606 and TR-808 (figure 6.5) are also mentioned as good examples due to the button heights that make them recognisable. The same interviewee mentions that drum machines from Teenage Engineering's Pocket Operator series (figure 6.2) are hard to interact with in dark environments due to the small-sized buttons. Layered functions is also mentioned as an aspect of why interacting with these machines can be hard in a dark environment. In summary, the combination small buttons and having to use a shift button in a dark environment "may result in anything, it's not easy...".

IA wants to be able to interact with the controls even with eyes shut and defines this as part of a good drum machine interface. ID watches the instrument as much as possible when playing. An example that is mentioned is that the user experienced slower interaction when using the external app connected to the OP-Z from Teenage Engineering. This external display is mentioned as a good tool to learn new functionalities with a new machine. IG talks about the OP-Z from Teenage Engineering and describes it as "very intuitive". The user says that, even though there is no internal screen, the interaction with the machine is still experienced as fast. The interviewee also feels that the learning curve is less steep on this device compared to machines from, for instance, Elektron. It is worth to mention that the same interviewee reflects and mentions that it is strange that the interface from Teenage Engineering is interpreted as easier to interact with since it is also experienced as

more "cryptic". IC says that the visual interface is very important and then adds that "some things you'll learn", regarding the fact that after a while, the user will learn how and where to interact with a desirable function. A conclusion that can be drawn from these statements is that some visuals and feedback within the interface can be very important when learning the instrument but be less focused on when the user has been using the instrument for a while.



Figure 6.2: From left to right: Arturia DrumBrute, SOMA Laboratory's Pulsar-23, Teenage Engineering's Pocket Operator Tonic. Press photos from Arturia, SOMA Laboratory and Teenage Engineering. DrumBrute has a "strange" placement of the step sequencer according to IF. Pulsar-23 is, according to IF, one of the most inspiring interfaces on the market today. The Pocket Operators can be hard to operate in dark environments according to IG.

6.1.4 Time-Multiplex Input

"It can become a bit too many layers I think. It does not become so quick and intuitive to shift between them, so that is... well the brain is a bit limited in how many things it can hold at the same time..." - Interviewee C

A drum machine has often many functions and parameters, but since the space is limited and controls are expensive it is not common to have one control per function. Instead, the same control steers different functions depending on mode. Changing mode can be achieved by either pressing a button, hold down a shift/function button or by using a combination of buttons. It is also common to hide some functions in menus. By using the same controls for different functions many drum machines can be considered to be controlled through time-multiplex input.

Six of the interviewees (IA, IB, IC, IE, IF & IG) mention that it can be problematic to use the same controls for different functions and that it should be avoided when possible, especially when it comes to performance parameters. Some examples and reasons mentioned by the interviewees are the following:

- The user wants to be able to control multiple things at the same time, and the parameters that they want to control at the same time may be placed in different layers. (IA, IB, IE, IF)

- The user does not want to waste a precious finger or hand to hold down a button just to activate a layer of functions. The other hand may be busy controlling another instrument or parameters. (IA, IB, IE, IF)
- The interface can become complex and the learning curve increases. The flow can be broken when the user needs to switch between layers and the controls change function. The interaction is not as smooth and fast. (IA, IC, IE, IG)

The interviewees express an understanding of why certain controls are time-multiplex. However, some functions are considered more important and should preferably be placed in the top layer.

IA accepts some layers and menus: "Since the buttons are there it is good to use them for functions". However, there should be a balance and not too many different layers per button and the performance controls should be placed at the top layer. To be able to control parameters from different layers at the same time, IA maps those to external MIDI-controllers when possible. However, IA says that it would be better to have control over those parameters directly from the drum machine. Functions that are not as time-critical such as "save" and "load" can preferably be placed in menus. The user does not like to scroll through long menus to reach a time-critical function and states that, even though the user loves machines from Elektron, there can be a bit too much time spent in menus. IG agrees and states that "menu diving" and multiple layers in combination with the small and "cryptic" screen are some of the reasons the user does not use gear from Elektron as much: "they are really fast-manoeuvred when you've learned them... but the first impression for me is like 'totally-impossible-to-use'". The user compares it to OP-Z from Teenage Engineering where the user experiences that there are little menu diving and that the layers do not go as deep.

IC thinks Elektron's way of using eight knobs to control multiple parameters is smart and allows for smooth interaction (first two machines in figure 6.6). The knobs are arranged in a two by four grid that is mapped to eight parameters presented on the screen. This screen changes functions depending on which of eight pages the user has selected. The user is positive to use of layers as long as they not are too many and too deep and mentions that this could make the learning curve steeper. As an example of when layers can be too complicated, the user talks about how Elektron's Octatrack has one layer for internal samples and one for MIDI-tracks and describes how the transition between them does not become fast or intuitive. However, IC also states that Octatrack is the Elektron-machine that the user spent the least time with and that this may be a reason why the user thinks so.

Three of the interviewees (IB, IE & IF) mention that it is extra important to keep the buttons used for finger tapping and step programming free from other functions, or as IE puts it:

"I don't like having to use those keys for something else. Those should always be available in my opinion"- Interviewee E

Even using the same keys for playing and step programming should be avoided if possible: "I think it really makes sense when you have playable buttons and a sequencer on the same interface [but separated]" says IF. This is because of the same reasons mentioned above, but also because the users interact with them in different ways. IE describes how the buttons used for tapping should be velocity-sensitive and the ones used for step programming should preferably have a "clicky" mechanical feel - two things that are hard to combine. The pads used for tapping are traditionally organized four by four, which provides a more condensed interface and allows for better reach when tapping. The buttons used for step programming are often organised as 16 in a row and this is, according to some of the interviewees, giving a better overview. However, this layout is described as less efficient for tapping. IB mentions that the layout affects the way the user is interacting with the drum machine. If it consists of a row with 16 buttons, the user rarely uses the tap function even if it is possible. On the other hand, if the layout is distributed in a four by four grid, the user would use the tap function more frequently. The user also describes how different interaction methods result in different feel to the beat. IE describes how the flow can be broken by having to use the same controls for tapping and programming by saying:

"Switching back and forth is just...i think it is a little bit of sand in the brain" - Interviewee E

All of the three interviewees mention that using the same control for multiple functions is understandable because of cost and size reasons. However, they prefer drum machines that have one separated area for tapping and one separated area for programming. On the other hand, IA thinks that it can be beneficial to map other functions to the buttons used for tapping and step programming. The user reasons that, since they already are there, it is practical to use them for other things as well. Examples that are given are entering numerical values or manipulating the beat. The user, however, says that it should be a balance and it can become messy if there are too many functions mapped to one single button.

The interviewees mention Elektron's Analog Rytm (IE & IF) and Model:Cycles (IF) (figure 6.6) as examples that they think are good because they provide different controls for tapping and step programming. IF also thinks that this is one of the reasons that Model:Cycles and Model:Samples are easier to grasp for first time users in comparison to Digitakt and Digitone, which both have combined controls for tapping and step programming.

6.1.5 Layout of the Step Sequencer

"One of the strengths is that it's so easy to understand. You can put this thing in front of a kid, I've done it myself, and then you explain: 'This is how it works, every time a light flashes it sounds boom', and then they start making music, it takes a couple of seconds and they're on it!" - Interviewee G

IG explains that the concept of a step sequencer is easy to grasp. However, the layout

of the sixteen buttons can be arranged in different ways. The most straightforward variations are sixteen in a row, eight in two rows and four in four rows (Figure 6.3). However, circular interfaces and other alternatives are also discussed. It becomes clear that the way the buttons are arranged affects the user experience of the drum machine.

"The design of having it eight by two, four by four or sixteen on one line does actually change a lot of things" - Interviewee F



Figure 6.3: From top to bottom, left to right. The "16-in-a-row"-layout on a Roland TR-606, the "2-by-8"-layout on Elektron Digitakt and the "4-by-4"-layout on Teenage Engineering Pocket Operator. Picture of TR-606 by Midas Wouters under CC BY-SA 3.0 license: https://commons.wikimedia.org/wiki/File:Roland_TR-606.jpg, the other pictures are press photos from Elektron and Teenage Engineering

All of the interviewees mention that they feel comfortable with sixteen steps in one row. This layout can be seen as a standard that other layouts are compared to. Five of the interviewees (IA, IB, ID, IE & IG) prefer this layout over the others when it comes to step programming. Here are the reasons brought up during the interview:

- It feels like it gives a better overview and it is easier to visualize one bar of music as a row (AI, IE & IG)
- Quicker realisation of ideas. The interviewees are used to this layout and therefore know where to press to achieve the result they want. (AI, ID, IE)

IF brings up that it is a great layout because it can be considered the standard and it is easy to understand. However, it requires more physical space along one axis compared to other layouts. IE thinks it clearly visualises the musical space and is good if you know where you want to place a particular step. IA says it allows to place steps quicker compared to other layouts and thinks it is possible to hear how the rhythm sounds just by looking at the row. The user prefers this layout for tapping as well. ID is comfortable with the "16-in-a-row" layout and thinks it allows for more freedom when improvising live.

"The more familiar with that interface that you become, the more you can take an idea and quickly locate and point, you know, and program where

you want these things to happen. So, the better you get at using the one by sixteen format, the quicker it will be to have a musical idea, and then to place the notes where you want. But, if you're a total beginner it's kind of a nice thing to have because you can sort of put random notes in and it will give you the feedback very quickly[...] That's why it has withstood the test of time. [...] It's because it works for beginners and it works for advanced players, I guess." - Interviewee E

IC and IF prefer the "eight in two rows"-layout. IC thinks it is "smooth" to interact with it and prefers it because it is easier to manoeuvre with one hand. IF describes when the user interacted with the layout for the first time on Elektron's Digitakt and Digitone: "I was like: 'yeah, it will be the same thing', [...] but when I started using it I realised: 'holy shit, this is actually a different way'". The user explains how it allows for interaction with one hand which is not possible to the same extent with the "16-in-a-row" layout. The user thinks this layout allows for unexpected and random input, however, this is also described as a bit of a drawback with this layout: "You can't really tell where is what sometimes, and I'm pretty sure that with the four by four, that must be much more confusing". IB thinks this layout is interesting since it allows for better interaction with one hand but clearly states that the user prefers sixteen steps in a row which is described as more clear. IA thinks this layout, as well as the "four by four"-layout, is more difficult to interact with, and would rather prefer two or four rows with sixteen steps.

The general opinion of the interviewees is that the "four by four"-layout is better suited for tapping than programming. If the user is used to the "16-in-a-row" layout, it becomes hard to grasp where the steps are placed. However, having it four by four allows for some new ways of manipulating the beat by changing playback-direction. IE and IF mention Pioneer's ToraiZ Squid (6.4) as a sequencer that makes good use of the four by four layout. On this device, the playback direction is one of many ways the user can manipulate the grid. René from Make Noise, which also uses the four by four grid for manipulating the playback direction in various ways, is also mentioned by IA and IE.

The fact that step sequencers often consist of 16 steps make them efficient for working with four by four as time signatures. However, it can be limiting when working with other time signatures. IC often works with time signatures such as five by four and seven by four. In those projects, however, the user seldom uses drum machines because it is hard to get an overview when each measure does not start on the first step. IG also points at this fact and says that the "16-in-a-row" layout works good for genres that are usually based on four by four time signature. However, the user mentions that you need 32nd- and 64th-notes as well as shuffle-functions to be able to program music within some other genres. Even if it is not as straightforward, many drum machines allow the user to work in other time signatures, often per track. This feature is often used to make polymetric rhythms, something that both IE and IF uses both to realise ideas, but also as a way to add some unpredictability and randomness to the beat.



Figure 6.4: From left to right: Pioneer’s ToraiZ Squid & René from Make Noise. Press photos from Pioneer and Make Noise. Both these machines make good use of the four by four pattern according to the interviews. René has conductive touch buttons that IA talks about in section 6.1.7

The limitations that follow from only having 16 buttons is something that the interviewees talk about. IA says that it should be at least 16 buttons, preferably more. IB is comfortable with 16 buttons and thinks it is a good compromise, but would like to have 32 buttons, or even 64, if the space was available. IG sometimes uses two machines in a row to have physical access to 32 steps. It allows for more variation and better fidelity. However, the user points out that 32 buttons does not provide as good overview as 16 buttons, which results in that it sometimes can be hard to know which step is what.

"Another stupid limitation that a lot of drum machines have is that they limit the length of your overall pattern to four bars. Like why? Why, why why? It’s so stupid" - Interviewee E

Even if most drum machines only have 16 buttons, they often allow the user to program longer patterns. The user can specify a pattern length and then browse through the pattern to access the different steps. However, there is often a limitation that allows the pattern to be a maximum of 64 steps (i.e four bars in four by four). IC and IE refer to this as a negative limitation. IC describes how the user often likes to work with longer patterns and that the limitation of 64 steps makes it hard to work, not only with other time signature, but also with variations. IE used a KORG Electribe ESX for many years and liked that it allowed for pattern lengths up to eight bars. This allowed the user to add variations to the beat and made it feel less repetitive.

"You know you got 16 steps here, but if you only can enter in data in these 16 steps you’re missing all the space in between. So it is very important that you have access to place notes anywhere in a bar of music, not just in the 16 slots" - Interviewee E

Another thing that is brought up is the space in between the steps. As IE states in the quote above, it is critical to be able to access it. ID brings up the lack of

possibility to "escape the grid" as one of the drawbacks of Elektron's Machinedrum, which otherwise is one of the user's favourite drum machines. The user explains how a lot of the "human feel" lies in the space between the steps and gives the high fidelity of Teenage Engineer's OP-Z as an example. IF talks about the importance of being able to nudge the steps to achieve human feel. IF, however, misses a straightforward way of doing so. IC would like to be able to zoom into a selection of the grid to place the steps with more fidelity.

"Alternative layout? No, I mean, I've looked at many, but I find them annoying. You know, again it's like, the visual layout can be good for like, it can be good for certain types of interactions, [...] but I think the one by sixteen or maybe two by eight, I think those are... you should always have those. I mean, they are just so clear " - Interviewee E

When it comes to alternative layouts of steps sequencers, IE is a bit sceptical. Even if they can open up for interesting interactions, IE says that it is always good to provide a standard layout with 16 steps in a row. IC has tried some circular layouts, but since they still have 16 steps, the user does not think it is very different, even if they allow for other interaction possibilities.

In summary, all of the interviewees are comfortable with the "16-in-a-row" layout for step programming. Other layouts can provide interesting interaction possibilities, but do not provide the same overview for a majority of the interviewees. It is not as smooth to work with other time signatures as with four by four, especially if they are longer. The step sequencer should preferably allow for patterns longer than four bars to allow variations. It is important to access the space in-between the steps in order to give a human touch to the rhythm. Alternative layouts can provide interesting interaction possibilities. However, when it comes to quickly realise an idea the standard layout is preferred by most of the interviewees.

6.1.6 Buttons & Controls

"I am a creep when it comes to buttons, yes, it's everything, cause that is what you do with these machines, you press the buttons, you turn those knobs, you look at this. That's really the thing you do, and they need to be on point." - Interviewee F

The controls used for entering data in drum machines vary, but the ones often used are buttons, pads, knobs, sliders and in some cases touch-screens. All of the interviewees express opinions regarding the controls used in drum machines on some level, but most of the discussion concerns the "feeling of a good button".

When it comes to step programming, a majority (6 out of 7) emphasises that the use of mechanical buttons is the way to go. The buttons should have a mechanical click sound that is distinct but not too loud. They should have the right amount of resistance but not be too hard to press down. When it comes to material selection they should not be too soft or plastic. IE mentions the surface friction of the buttons as an important factor that can make the difference between a good and a



Figure 6.5: From left to right: Roland TR-808, a drum machine that lacks quality regarding its buttons according to IA. Roland TR-909, which has computer-like buttons that are considered good by the interviewees. Picture of TR-808 by Eriq under the CC BY-SA 3.0 license: https://commons.wikimedia.org/wiki/File:Roland_TR-808_drum_machine.jpg. Picture of TR-909 by Emho under the CC BY-SA 3.0 license: https://commons.wikimedia.org/wiki/File:Roland_TR-909.jpg

bad button. In general, the computer-like buttons of Roland's TR-909 (figure 6.5) are mentioned as an example of good buttons. Others prefer the buttons used on Elektron's Analog Rytm MKII and Digitakt and consider them as better because they do not have to be pushed as far, but still provide the same feel and sound (Figure 6.6).

"The TR-909, you know, everyone used to love that because it was very much like 1980s IBM computer buttons, right? But I think finally the Elektron is superior because you don't have to push down as much" - Interviewee E

Four of the interviewees mention the Elektron Digitakt buttons as good, with the right sound and feel. IE describes the texture of Elektron's Analog Rytm Mark II's buttons as:

"It [the texture of the button] is very hard but it has a little bit of a grip, like a mountain climbing shoe. It's rubberised but it's not squishy. So it's great because your fingers don't slip. You can make contact with anywhere on the button and it's just... they are great, great buttons" - Interviewee E

Alongside Elektron's buttons, IF brings up the buttons of Teenage Engineering's OP-1 (Figure 6.7) as an example of good buttons: "[OP-1] is really good [...] I can't get enough of those [buttons]". The Polyend Tracker's buttons (Figure 6.7) are also mentioned as good by Interviewee F :

"The buttons are really nice, it's a bit like Elektron, but it has lesser travel, so it is thinner, less place to press, and it is a bit harder, but it makes this really nice click-clack sound, so you just want to press and play all time" - Interviewee F



Figure 6.6: From left to right: Elektron Analog Rytm MKII, Elektron Digitakt, Elektron Model:Cycles. Press photos from Elektron. Both Rytm and Digitakt have the same type of buttons and those are considered, by some of the interviewees, better than the buttons on Roland's TR-909. Model:Cycles has rubberised buttons which IF and IA mention as undesirable.

It becomes clear that the buttons play an important role and affects user experience when playing with drum machines. IA describes the buttons as one of the weaknesses of Roland's TR-808 (figure 6.5): "It's very bad quality on buttons and such things, they are not very tactile. It is a lot of hitting hard, physically, on the buttons. In that sense, it's not as fun programming old machines". IF describes how the buttons can decrease the user experience of an otherwise promising machine and brings up Teenage Engineering's OP-Z (Figure 6.7) as an example:

"The sequencer is insanely good, they really took it so far, but those buttons, no I can't, I have one here, but it's in the box..." - IF

Nevertheless, it is worth to mention that two other interviewees bring up OP-Z as one of their favourite machines even if they do not specifically mention the buttons. Two of the interviewees also mention that they do not like buttons that are too rubberised, especially if they are not determined for tapping. IF mentions that the rubberised buttons on Elektron's Model:Cycles (Figure 6.6) are one of the flaws on an otherwise really good instrument: "[the buttons are] really bad, these ones are just a big no, no". IA says that the rhythm often becomes less dynamic by default when working with mechanical buttons and calls for velocity-sensitive mechanical button just to get rid of the pads. Otherwise, the general opinion seems to be that pads are good for tapping since they are velocity-sensitive. However, if the users had to choose one of the types for both step programming and finger tapping, mechanical buttons would be the choice. IC, however, thinks that it is hard to choose between pads and buttons since they are different things, used for different functions. ID does not work very much with velocity but says it depends on the machine. IB likes to use the pads and says it reminds a bit of hitting real drums.

6.1.7 Touchscreen Interfaces

"I get the impression that I lose some feeling. It's like the distance between what I want to do and the machine grows [when using touch-based interfaces]" - Interviewee D



Figure 6.7: *From left to right, top to bottom: Polyend Tracker, Teenage Engineering's OP-1 and OP-Z. Press photos from Polyend & Teenage Engineering. Both Polyend Tracker and OP-1 have good buttons according to IF, however the interviewee does not like the buttons on OP-Z.*

Using touchscreens in the music-making process does not seem to be preferable according to the interviewees. Out of seven interviewees, six talk about touchscreen-based interactions. The problem with touch interfaces seems to be a lack of inspiration and physical feedback. According to ID, it does not feel as satisfying using touch screens compared to physical controls, however, the experience depends on the type of screen. IB has several drum machine apps on an iPad and has many times had the intention to create music using this setup, but describes how it does not work: "It doesn't have to do with it sounding bad or anything like that, it is rather the interaction and the lack of inspiration". The user further describes that it is a personal preference and that it might have to do with what types of interactions you used growing up and refers to the fact that there is indeed great music produced solely on the iPad today. IF reflects within the same trajectories and says that age and background experience with physical devices might be the reason for not preferring touchscreens.

Even if interfaces that solely relies on touch is not praised by the interviewees, it can be an interesting control to add to a hardware device. IF describes that the use of a square touchpad for controlling multiple effects at once can be inspirational. IG says that as long as you get good feedback-response from the controls, touch can be beneficial, especially for performance applications: "It's quite fun actually, to use it as an improvisational tool". In that case, however, the user states that it is important to get clear visual feedback to let the user know which steps are active. IA is a bit more critical when it comes to touch-controls on physical devices. The user talks about the conductive touch buttons used on some of Make Noise's modules (Figure 6.4) and thinks it is reasonable but explains how it sometimes is bad at registering touches. Examples mentioned are if swipe gestures are too fast, the fingers are damp, the surface is dirty or if you touch the button too soft or hard.

It can be tricky to use touch-based interfaces in the context of drum machines. The key and main reason to utilise such controls should not be to imitate hardware components, it should rather be used to add new interaction possibilities.

6.1.8 Hand Interactions

"At that point, I had my hands full, so I started tweaking the cut-off with my feet" - Interviewee B

How the users interact with the drum machine, of course, depends on the layout of the controls. IC describes how the left hand often is used for controlling the sequencer and the right hand is used for everything else when interacting with machines from Elektron. IE wants to use both hands while playing but empathises that, just because two hands are used they do not need to control the same machine at the same time. IA puts it as:

"Sometimes I use both hands, but sometimes when performing live I find myself wanting to keep one hand free, I want to use it for controlling other stuff" - Interviewee A

The drum machine is often a part of a larger system, where the interaction-points are many but the hands are just two. Therefore it is preferable if the drum machine can be controlled with just one hand. IF expresses that it "should be one hand if it can be" and IB says: "For me, it is ultimate if you can use only one hand, [...] you want to be able to do something else with the other hand at the same time, maybe controlling the parameter of another machine". IC mentions Elektron's Digitakt and Digitone as an example of a good layout: "When you perform live you reach every button from one position, that's good".

A common way to add more functions without adding more controls to a drum machine is to use a shift button. The shift button can be held down to activate another layer of functions. However, hiding some functions behind a shift button can be problematic when the user wants to control them with just one hand. IG describes how one finger almost always rests on the shift button which occupies that hand. IA calls for a function that lets the user lock the shift button: "Maybe you could lock down the shift-button by double-tapping it or something and then deactivate it by double tap-again? [...] that would really help". To solve the problem and access desirable functions with one hand, the user is mapping certain functions to an external MIDI-controller. IE also experiences this problem:

"You don't want to have to like, press a shift or a function button with one of your fingers and only have 4 remaining because that completely destroys your expressive capability. I mean, you definitely don't want to hold down shift with... You don't want to waste a precious finger to just activate a layer of functions if you're only using one hand" - Interviewee E

IE has even installed a switch on Roland's TR-707 that holds down a button for the

user: "So by flipping this switch, it's like you're holding down the last step button. So that means with one hand, you can change pattern length in real-time. And then with the other hand, you can be doing something else". The same user says that it would be nice to be able to control the shift button via a foot pedal or something equal.

Which fingers are being used for interacting with a drum machine depends both on the user and on the drum machine itself. ID likes to use all of the fingers when step programming and describes how multiple steps can be activated at the same time by pressing multiple buttons simultaneously. ID, however, usually uses the right hand and enters steps one by one. IC explains how both hands are used if multiple steps need to be changed quickly. IE uses the index fingers for tapping, and a combination of the index finger and the little finger when quickly entering every four steps. IF explains that multiple fingers are being used to hold certain steps down while adjusting the parameters for those steps (on Elektron devices).

Five of the interviewees (IA, IB, ID, IE & IF) mention how they sometimes use one finger to swipe across the steps in order to quickly turn them on or off. IB also explains how this can be used to invert the current steps, which can add unpredictable results, but also mentions that it may be a bit "silly" if overused. IF says that this gesture of sliding one finger over multiple steps works well on Elektron buttons which are quite low and rounded. The same interviewee adds that this could work even better on a touch device, and highlights that one of the advantages with touchscreens is that it opens up for other types of interactions.

6.1.9 Size

Four of the interviewees (IA, IB, IE & IF) mention size as an important factor of the drum machine. It should not be too big, making it less portable and hard to travel with and not too small, so that interaction gets cramped. IA talks about the balance between size and portability, and mentions Elektron's Digitakt as a good example:

"You can sit with it in the bed, or have it on your knees, just connect the headphones and you're ready" - Interviewee A

The user also points out how important it is to not have too big equipment when you are out travelling. IF also brings up Digitakt as an example of "good size" but thinks Elektron's Machinedrum MKI possesses the "perfect size" (figure 6.8). IF also describes how the user has started to use Elektron's Model:Cycles (figure 6.6) more and more in favour of Elektron's Analog Rytm and mentions portability as one of the reasons. IE describes Elektron Analog Rytm MKI as a machine with a "good size", but thinks that MKII (figure 6.6) is a bit too big. IB describes the size of MPC 2000 XL from Akai (figure 6.8):

"It's like playing on a cash register, it is really heavy [...] but it is great" - Interviewee B

IB adds that the user would not like it as much if it was not so heavy, even if it makes it less portable. However, the size has not stopped the user from touring with it.

As with many other aspects of the drum machine, the perfect size of a drum machine depends on the user and the application. However, if it is too big it can harm the user experience. A schematic figure with relative sizes for almost all of the drum machines mentioned by the interviewees can be found in appendix F.



Figure 6.8: From left to right: Akai MPC 2000XL and Elektron Machinedrum. Press photos from Akai and Elektron. MPC 2000XL is heavy, however it adds to the user experience according to IB. Machinedrum is the perfect size according to IF. In this figure, the dimensions of the products are correct, relative to each other.

6.1.10 Manufacturing

"I mean, the hardware is really important, everything that is tactile, it really needs to be good quality" - Interviewee A

The interviewees mention that it is important to have good quality on components and buttons: "It should be good durability, so it can handle all of the 10 000 button presses" (IA). From a manufacturing perspective, there is always a balance between cost and quality. Three of the interviewees (IA, IB & IG) mention that manufacturers often compromise user interface, user experience and quality to hold down the manufacturing costs. This is something the interviewees accept on what one of them mentions as a budget product. However, it would not be considered good to pay a high price for a product that lacks the feeling of quality. IG expressed this as: "It's horrible with bad buttons, they appear on some expensive instruments as well, and that's not good".

6.1.11 Aesthetics

"Yeah, looks is very important, yes!" - Interviewee F

Throughout the interviews, the interviewees are mentioning aesthetics as an important factor in how drum machines are perceived and experienced. It is indicated that the aesthetics of a machine does not only affect the anticipated user experience but also the momentary user experience and, therefore, in the end, the cumulative user experience. The aesthetics of the machines seem to be important throughout the whole period of usage and do not only act as a deal-breaker when purchasing a new device. Instead, the aesthetics and feel of the machines are mentioned as hedonic factors that affect interaction and overall user experience.

IF among others expresses the looks of a drum machine as "very important" and it is notable that when users describe their favourite machines it is not only because of the interaction and functions they provide, but also the appealing aesthetics of the machines. The aesthetics is also a factor why IF prefers physical devices over computer software and mentions Elektron's Machinedrum MKI as the absolute favourite in terms of looks. IA says that the visual aesthetics and uniqueness of the alternative interfaces Buchla machines provide makes the user enjoy them even more. IB says that the admiration for Akai's MPC 2000 XL would not be the same if it did not possess its hedonic attributes and mentions the weight as an example.

IG gives a few examples of how aesthetics perceived as poor can affect the user experience negatively. Ableton Push is mentioned as a device where the user can accomplish many things. However, the visual aesthetics are described as "taking too much attention". Another example given by the same interviewee is Roland's TR-8. Even though "it sounds nice", it is also described as "horrible" which in turn makes it an undesirable product for this user. The display on a given Elektron device is also described as "horrible" which demonstrates that specific components can lower overall impression.

6.1.12 Constraints

"I see it more like, all drum machines are bad but in different ways. All of them just have different constraints, that's how I see it." - Interviewee G

Constraints is a recurring subject throughout the interviews. Overall, the interviewees talk about constraints within drum machines as a positive thing. IB expresses that small separate machines with specific tasks are preferable and refers to the constraints these provide as the reason. The same interviewee mentions Roland TR-606 as one of the favourites of drum machines due to the fact that it is "small and simple". One other constraint that is mentioned by the same user is the inability for recalls some physical drum machines possess. This is mentioned to add variation to the result when trying to reconstruct sounds or beats. IG mentions the Volca series from Korg as machines that benefit from their own constraints and describes them as "good for being such small and cheap products".

"If there are far too many parameters it's easy to... it's like getting a new plug-in that has everything... very little music will be created then..." - Interviewee G

IC mentions the lack of the song mode-function in the Digi-series by Elektron as a weakness. However, it is also added that this becomes a constraint which invites the user to "play more live". ID says that "the smaller and simpler device, the more constraints.. which, I don't know.. everything has its charm".

IB expresses doubtfulness regarding drum machines in general and refers to the grid as a constraint that does not invite for flexibility. As an example, the user mentions MPC-devices as machines where the grid still exists, but the lines are blurred out, making it possible to move more freely within the grid. Another constraint that is, by IF, mentioned as negative is exemplified with Model:Samples from Elektron. The interviewee says that "you're stuck with the samples that you loaded in" and expresses frustration over the fact that you can not alter the sounds to a certain extent. This constraint is, however, one of the reasons TR-606 is one of IB's favourite drum machines. The user mentions that TR-606 is often used as a foundation when creating rhythms and the lack of sound parameter controls is expressed as a positive thing within the context.

It is evident that the same constraint can be perceived as both positive and negative depending on user goals and context. In general, the constraints of simple machines with determined tasks are perceived as positive when they are part of a larger setup and perceived as negative when they are not part of a larger system.

6.1.13 Level of Control

It is inevitable to make comparisons between interacting with a drum machine and playing an acoustic drum set. When talking to users, the interaction with an acoustic drum machine is often used as a reference when describing thoughts and reflections on drum machines. IF says that a drum machine needs irregularities to have enough human feel and describes the absence of this as a weakness of a drum machine.

"What makes a drum machine good is, you know, the ability to capture human feel" - Interviewee E

IE and IF both mention playing on an acoustic drum set as a reference when talking about drum machines. IE says that one weakness of drum machines, in general, is the inability to improvise as deeply as you would be able to if you were playing on an acoustic drum set. IF mentions that one of the weaknesses is that it is hard to make the drum machine sound like a "real drum". The interviewee mentions that it is today possible to micro-time steps by nudging them, but adds that this procedure involves quite a few steps and wishes this to become "a bit more closer to the brain". IE mentions that, with some drum machines, it is easier to improvise in real-time. However, it is not as easy to improvise as when interacting with "real drums". This is something that is mentioned as a negative limitation when it comes to drum machines in general. IE wants to be able to modify sequences in real-time more direct and mentions examples such as timing, velocity and adding fills or flams. The same user compares this real-time manipulation that is called for with the ability a jazz drummer has to directly manipulate and improvise when interacting with an acoustic drum set. The same two users (IE & IF) that express desire towards the

ability to improvise with real-time manipulations also mention the importance of being able to realise an idea in the same manner. IE says that being able to realise an idea that is in your mind should be achievable as quickly as possible. The same user refers to a good drum machine as a device that can, in an efficient and effective way, help you realise "a rhythm idea that's in your head or in your body".

"If the user can interact with it and get close into what he or she has in mind, and you do that without any friction, that is what makes a drum machine really good" - Interviewee F

ID talks about the combination of full control without losing the ability to be surprised and refers to a balance between flexibility and control. IE mentions the importance of being able to rely on the machine in the sense that it always takes the user back to "where the music should be" after instances of real-time manipulation. However, the same interviewee also says that the machine should not be limiting in terms of deciding what route to go. The user wants to be able to commit to real-time manipulates in a flexible way. As an example, the user mentions that Toraiz Squid from Pioneer records all actions taken on the machine which means that the user can later commit to any manipulations. There was a discussion with ID regarding the sense of control versus actual control and how pre-designed complex effects and functions can affect the user experience. ID mentions the mapping of the swing function to a knob as an example that feels "close" and gives the sense of full control. The user describes this direct manipulation as, not only control over the function but as control over the dance floor when playing live. ID also gives an example when the sense of control seems further away. The example involves controlling a filter sweep effect which is bound to the 16 steps and not possible to re-trig. The user does not express this as something negative but mentions that the pre-decided factors create the sense that it is not the user playing and controlling how it should sound. ID, however, mentions that the user experience can be on top even if the sense of control is absent and exemplifies this with functions that completely randomise output.

"It's a combination of having full control but still being able to get surprised" - Interviewee D

Four of the interviewees (IB, ID, IE & IF) emphasise that the communication between the user and the drum machine should be a two-way communication based on interactivity. IF gives an example of how drummers in the 80^s reacted to drum machines with quotes such as: "We're gonna lose our work" and added that it is not like that at all. The same interviewee expresses that it is not always about using the drum machine to realise an idea, but many times quite the opposite: "Most of the times I do sit down to make music, I don't know what I am going to make. This user emphasises that there should be an interaction between the user and the machine and adds that "the machine should talk to you".

"You don't need to have an idea, because you will get an idea from the machine" - Interviewee F

The drum machine Pulsar-23 and the synth Lyra-8 from SOMA Laboratory are two examples of music instruments that IF describes as highly inspirational and "unsafe" in a positive way: "That is something that I like in music, it can not be safe, break it you know, you need to make it strange". A good drum machine is described as a machine that, as the user manipulates it in real-time, the user should be affected by the feedback and interaction which in turn should affect the continued interaction and result. IE also prefers the ability to be able to interact with the music in real-time rather than just realising an existing idea. IE, however, adds that some users "are more excited about how you can program something to do exactly what you wanted to do". IB says that "playfulness" is "interesting and important" and refers to the communication and interaction between the machine and the user as a big part of music production. The description of getting affected by the output and then reacting to this in order to shape the result is recurring throughout the interviews.

"If the interaction with the stuff you're creating is not inspiring you, then for me, that would be a bad drum machine" - Interviewee F

In some situations, the users refer to a drum machine as a substitute for a drum kit while in other situations, the same user can refer to a drum machine as a substitute for a drummer. The usability and user experience is clearly affected by the context-specific user goal. If the goal is to realise an existing idea, the user wants the drum machine to behave like a drum set, while if the goal is to get inspiration and come up with ideas, the user wants the drum machine to behave more like a drummer. However, regardless of the goal, the users talk about the character and personalities of drum machines. IB mentions that the master clock of a Roland TR-606 can add its own flavour and personality to the rhythm, ID refers to Machinedrum from Elektron as a device that "lives its own life" and IF describes Pulsar-23 from SOMA Laboratory as a machine with a special character that can provide the user with inspiration. IB adds: "When you are trying to take a lot of good stuff and put it together, it doesn't automatically become the worlds best product" which emphasises that the personalities, characters and constraints of drum machines are factors that can make them unique and successful.

"Different machines have different characters, different personalities, different ways to provide its services" - Interviewee D

Artificial intelligence is mentioned by two of the interviewees (ID & IG) as a possibility to add personality and interactivity to drum machines. IG says that it could be used to help the user keep track of interactions and ID mentions that it could be used to develop different styles together with the user based on input and interactions.

"What I miss is about making the machines more alive... I like to be surprised" - Interviewee D

Four of the interviewees talk about the importance of customisation of the drum machine. IA describes multiple times during the interview the importance of allowing the user to decide which parameters should be available in the top layer. The user thinks that the performance parameters that affect multiple tracks at once are

important during live performances, and would like to be able to have a layer where the user can map certain parameters that are often used during the performance. For the programming and composition phase this is not as critical according to the user. Today the user has mapped these parameters to an external MIDI-controller.

"Every single button, it doesn't matter what the manufacturer thinks you should be able to do or not do. Every single thing that you can do with a finger, you should be able to control the machine electronically and therefore, set up some kind of foot pedal" - Interviewee E

IE explains how important it is that the manufacturer allows every function that can be accessed through the interface to also be controlled by MIDI or similar. As an example, the user talks about the function button on machines from Elektron. The user would like to be able to control it with a foot pedal to free up a hand. However, since the function button cannot be controlled through MIDI, this is not possible. Nevertheless, if there are too many options for customisation, it can act as a barrier for creativity. ID bought Lemur from Liine and describes it as really promising but adds that it required too much time to set it up, leading it to never be used in its full potential. IC talks about Buchla's Thunder and says that even though it possesses a fascinating interface, it takes a lot of time to program and set everything up before you can use it.

"It's actually very very important to develop a relationship with one instrument. There's a lot of people who are just like, 'Oh I'm gonna get this, I'm gonna get that', and 'Oh what should my live-setup be today?' and it's like, they think it's a luxury but I think it's a hindrance [...] Because the more you develop, you know, the muscle-memory and the relationship with your instruments, the more fun you gonna have. The more you'll get into the state of flow" - Interviewee E

IE explains that it is important to spend time and form a relationship with your drum machine. Not until things start to settle in the muscle memory can you interact with the drum machine seamlessly and stay in the "right" side of the brain. IA also talks about the importance of fully learning the machine to be able to interact without having to look at it all the time. The user adds that a layout with smaller controls can make the process of getting the interface into the muscle memory harder.

"I think that ease of use is a bit overrated... It should be a bit of a challenge. [...] I think it should be a bit hard. You need to learn. It's not easy to learn to play the guitar either, and it's not just about intonation, it's about how you hold it, how hard you hit... It has to do with the whole experience " - Interviewee B

IB thinks that ease of use can sometimes be overrated. The drum machines should be a bit complicated as long as there is a flow in the interaction. The user explains that, even though a simple interface and flow are factors that relate to each other, one must not lead to the other. Sometimes a simple interface does not allow for advanced functions and interactions. The user says that it is not easy to master

other instruments and thinks it should be the same with drum machines: "Some things you need to know, you need to learn".

6.1.14 Variations and Unpredictability

"It should be a way to be able to add that 'unexpectedness'" - Interviewee F

Another recurring topic throughout the interviews is the possibility for variations and unpredictable results. Everything from rule-based conditions to completely randomised functions was mentioned as desirable functions. A drum machine that does not provide such possibilities is described by IF as a "bad drum machine": "If it just plays a four-four steady beat, you can't make these weird fills when you're not expecting. That would be the proper downfall of a drum machine for me". IE describes this unpredictability as being able to "jam even more with the machine", providing more real-time manipulation of the data the user already entered. Real-time manipulation with performance controls are mentioned by all interviewees and are generally seen as an important part of a drum machine. ID also mentions that pushing boundaries and existing functions, i.e. using the drum machine in a way it is not supposed or designed to be used, is a way to add unpredictability when playing. Variation and unpredictability are not only mentioned to be added through the use of functions such as performance controls, chance knobs, trig conditions, song mode or polymeter functions but also through interaction gestures. IF says that one interesting way of interacting with drum machines, especially for live performances, is by clearing a track and then, in step programming mode, use both hands to aimlessly press down steps. This is described as a way to "randomly" create a rhythm. Based on the generated output, the user can then make sense out of the rhythm by starting to further interact with it.

"But I like random buttons sometimes, pushing the random button..." - Interviewee A

IE and IF both emphasise different ways of real-time manipulations as key to variations and unpredictability. IE mentions that one important factor is the ability to add variations without losing sense and timing of the beat. For example, when interacting with real-time manipulations such as track-specific playback speed, stutters, rolls and reverse functions, the sequencer should always be able to go "back to where it should be" (i.e. relative to time signature and bpm). Another example given by the same interviewee is the ability to change the length of the pattern by changing the start- and the endpoint. TR-707 provides the function "Last Step" and IE mentions this as a good function, but misses the possibility to select not only the endpoint but also the start point, which IE also mentions is possible on some modern drum machines.

Other ways that are mentioned to add variations and unpredictability is by manipulating the grid. One example mentioned is making use of polymeters. IF uses polymeters, not to realise specific ideas, but rather as an inspirational tool to produce variations and unexpected results. IA says that mathematical logic and rule-

based conditions are very interesting when aiming to create variations and mentions functions as polymeters and trig-conditions. When IE talks about variations and unpredictability, playback direction is mentioned. An example given is the function "Running Direction" that Pioneer provides on their sequencer Toraiiz Squid. In addition, to reverse playback, the four by four grid enables the possibility to step through the steps in multiple different variations.

"So the ability to change the playback direction and get new ideas that are still loosely based on the ideas that you actually input, that's cool" - IE

The repetitive sequencing is by IF described as a general problem with drum machines and creating variations is expressed as a challenge when working within the domain. The user uses trig conditions to achieve variations and unpredictable results as this removes the feeling of an "endless loop" being played again and again. The same interviewee describes the usage of trig conditions as making it "a little bit more humane". When talking about the "humane feeling", not only trig conditions whether or not to play a step is being mentioned, but also when the step is playing. The user mentions that it is today possible to nudge the steps in micro-steps, but wishes more control and mentions a desire to being able to modulate the timing parameter. IA also mentions the usage of trig conditions in order to make the rhythm less repetitive. However, this user expresses that adding the function to set conditions with Boolean logic could open up for even more possibilities when working with conditions and variations.

"That's a problem with sequencers, they're so boring actually. You listen to it for 15 seconds and that's it, rest of the four minutes you just gonna hear that looping all the time. And that's where the magic is if you're able to add those little intricate stuff into that 15 seconds of loop. Then that can be listened to for 18 minutes." - Interviewee F

6.2 Alternative Step Programming Layouts

The seed for this thesis was an idea of an alternative layout for step programming that looks much like the lower layout in figure 6.9. The idea builds on the principle that, instead of pressing multiple times to activate certain patterns, one could use a single swipe. It is not unusual that this interaction is used to activate all steps on many traditional drum machines. From this idea, several other layouts emerged. In this section, the different alternative non-linear layouts that evolved through ideation will be presented and discussed. The four layouts included in the final evaluation are also presented. All figures of the layouts are illustrated with step 1, 5, 9 & 13 activated. This way, functionality and the interaction possibilities they offer are easier to compare.

In figure 6.10, the traditional layout "16-in-a-row" (Layout A) and its two closely related siblings "two-by-eight" (Layout B) and "four-by-four" (Layout C) are shown next to the first alternative layout of this project (Layout D). These layouts were the

6. Results

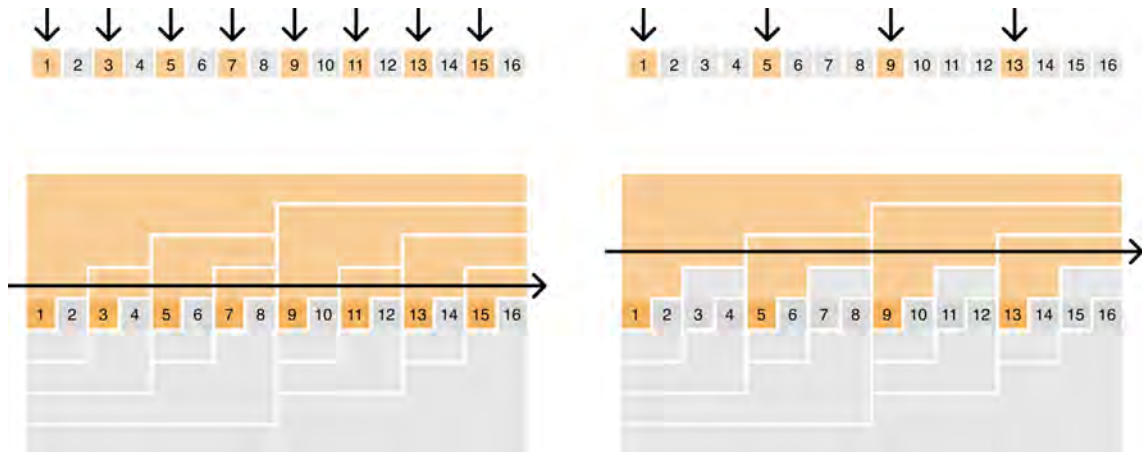


Figure 6.9: *The main idea of the non-linear layouts is to offer an alternative way to interact with the step sequencer. The top layout is the standard "16-in-a-row" and the bottom is an alternative layout. Each arrow in the upper layout represents a tap while the arrow in the lower layout represents a swipe. The figures show the number of gestures needed to activate every other step or every fourth step.*

starting point for the ideation. Layout D offers the possibility to swipe horizontally in order to activate either just a whole note, four fourth notes, eight eighth-notes or sixteen sixteen-notes. These can be either "on" or "off" the beat. The area and shapes for each step depend on their placement in the measure, resulting in different lengths both in horizontal and vertical directions. This act as a visual cue for their note value but also enables interesting and somewhat unpredictable results when swiping vertically, diagonally and non-linearly. It is also interesting to point out that Layout C, which is common in many drum machines, also offers interesting gesture possibilities if the buttons afford that. However, it is harder to activate all 16 steps in one gesture.

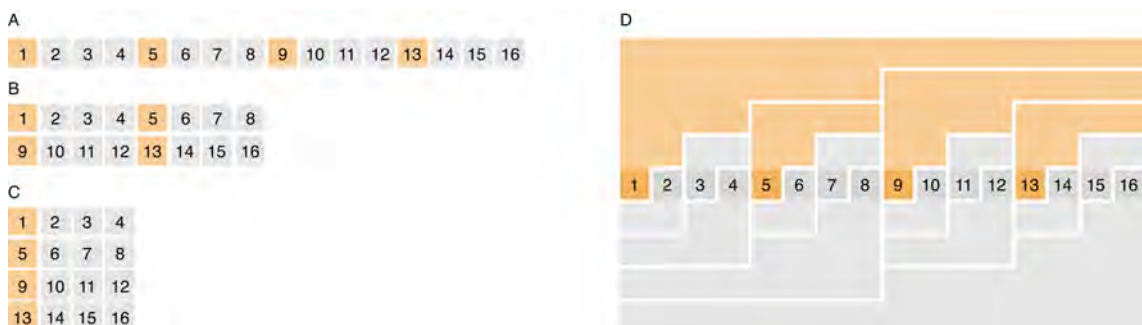


Figure 6.10: *Layout A is the most common step programming layout closely followed by Layout B and Layout C. Layout D is the first alternative non-linear step programming layout in this project and can be seen as a foundation of this thesis. The idea is that, instead of pressing multiple times as on Layout A, the user can activate the same pattern in one gesture. For comparison, step 1, 5, 9 and 13 are activated in the illustration.*

6.2.1 The Semi-Non-Linear Layouts

As the whole area in Layout D was filled with visual feedback, the question if the layout could be simplified and still provide the same functionality was asked. Layout E, F, G and H (figure 6.11) offer the same horizontal interactions as Layout D, but with less visual excise. However, compared to Layout D, it may be harder to activate the same steps as there is no built-in *visual guiding* as the finger moves horizontally. The simplistic design provides a more clear overview but does not offer as many vertical interactions. Layout G and F make use of the triangular shape to make the layout more compact. This shape also separates the steps that are "on" and "off" the beat visually. While all of these layouts offer the same functionality, they have different aesthetic expressions. The fact that each step takes up the same horizontal space and that the steps proceed linearly makes them more similar to the standard "16-in-a-row" layout. Therefore, they will be referred to as semi-non-linear layouts.

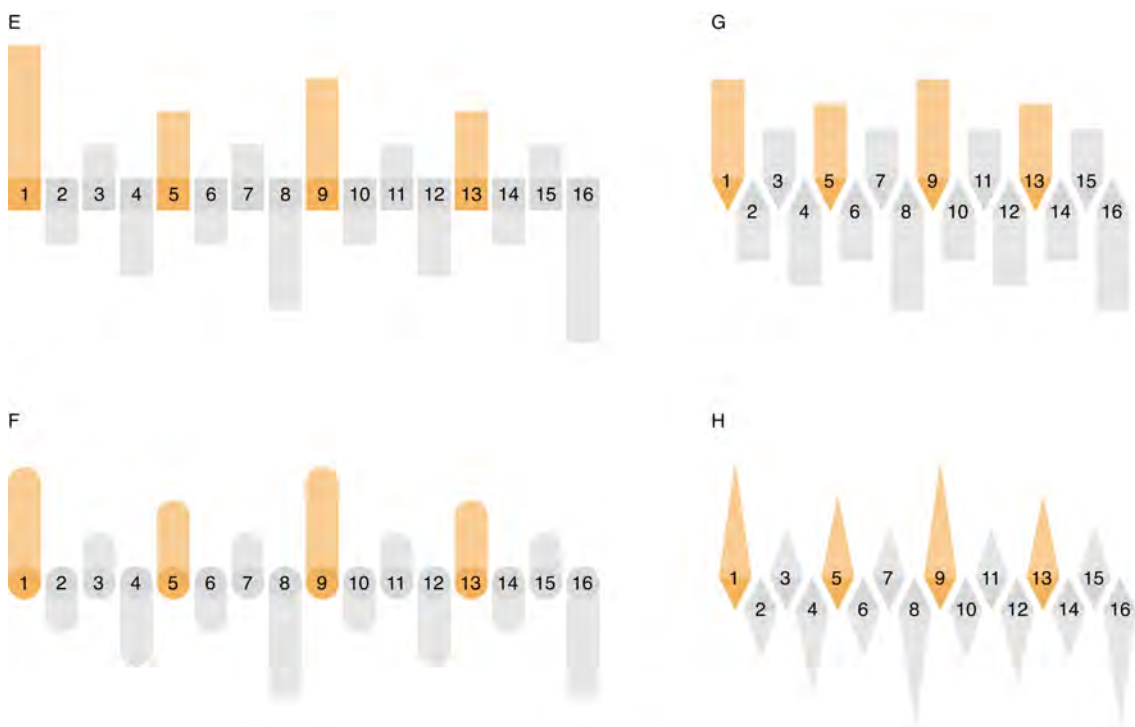


Figure 6.11: *Layout E, F, G and H are derived from Layout D. They still offer the same horizontal gesture possibilities, but with less visual excise. However, it may be harder to activate the same steps as there is no naturally built-in visual guiding. Layout G and F make use of the triangular shape to make the layout more compact. The fact that each step takes up the same horizontal space and that the steps proceed linearly makes them more similar to the traditional "16-in-a-row" layout.*

6.2.2 The Circular Layouts

Layout I, J, and K build on an idea that arose early in the process, that is, the idea of the steps proceeding inwards following the shape of a spiral. The steps moving inwards as a spiral opens up for the possibility and functionality to activate each fourth or eighth note of a measure in one gesture. They have similar interaction

possibilities as Layout C, however, it may be harder to access individual steps. One advantage of the circular layouts is that they are easier to adjust to other time signatures compared to the other non-linear layouts.

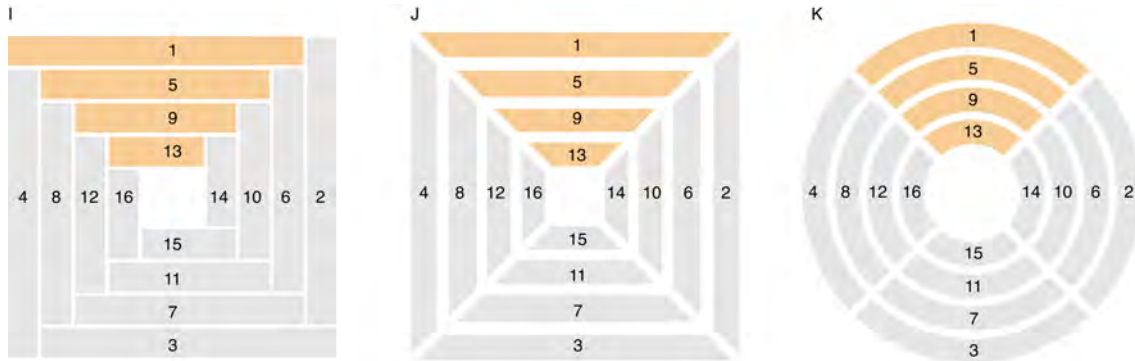


Figure 6.12: In Layout I, J and K the steps are distributed as a spiral. This enables the possibility to activate each fourth or eighth note of a measure in one gesture.

6.2.3 The Functional Layouts

In many rhythms and beats, step five and thirteen are an integral part, often with sounds such as snare and claps. When evaluating the previously presented layouts it became clear that step five and thirteen cannot be activated in one straight gesture. Was there a symmetrical pattern that would offer the possibility to activate those steps in one swipe? By combining the circular layouts with the semi-linear layouts, Layout L (figure 6.13.L) arose. This layout offered the possibility to reach step five and thirteen, among others, with a single straight gesture. Layout M (figure 6.13.M) is a combination of Layout L with the more square-like Layout J. Layout N (figure 6.13.N) can be seen as a more abstract version of Layout L and M. In this layout, the four pieces of the circle are arranged in a grid. It offers the same interaction possibilities and functionality, however, as the steps are not visually sequenced together, this layout can be perceived as more abstract.

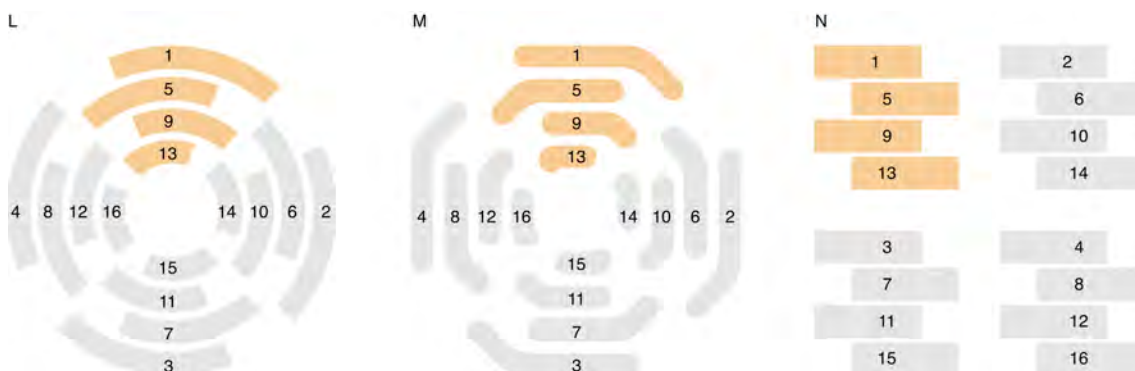


Figure 6.13: Layout L and M are combinations of the circular layouts and the semi-non-linear layouts. They were designed to be able to activate step 5 and 13 in one gesture. Layout N can be seen as a more abstract version of L and M, where the four pieces of the circle are distributed in a grid.)

6.2.4 The Asymmetrical Layouts

Until this point, all layouts designed have had an more or less symmetrical appearance. With functionality in mind, Layout D was altered to offer one-gesture-accessibility to step five and thirteen. This resulted in Layout O and P. These layouts are the only layouts that are strongly asymmetrical, which can be seen as a result of the strive for single gesture possibilities and functionality. In these layouts, the accessibility of the steps that are distributed in the lower half of Layout D was removed in favour of step 5 and 13.

The asymmetrical layouts (O and P) were designed with a functional approach, focusing on specific gestures to activate specific combinations of steps. This was the case for all the layouts to a certain degree but as Layout O and P were not symmetric, they were perceived as more complex. Another fear was that the larger areas of step 1, 5, 9 and 13 could compel the user towards predetermined patterns. Therefore, these layouts were not included in the later stages of the evaluation.

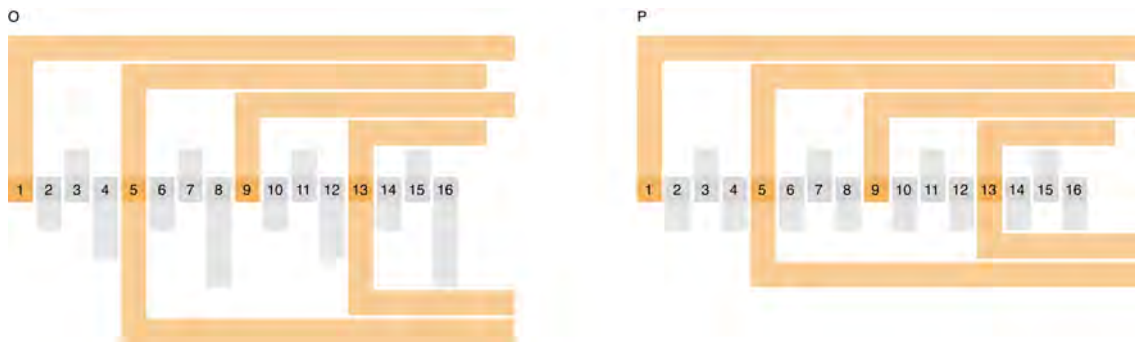


Figure 6.14: *Layout O and P are the only asymmetrical layouts. They explored how both vertical and horizontal swiping gestures could be used in order to reach step 5 and 13 for example.*

6.2.5 Final Concept Layouts and Reference Layout

All of the layouts presented above were implemented in the prototype and evaluated by the authors. However, when evaluating the layouts externally, four of the layouts considered as more promising were selected to allow for efficient evaluation. In this section, the result of the analytical evaluation, as well as the result of the concept selection, will be presented. The selection criteria is described in section 5.5.2.

The four selected alternative layouts were Layout D, H, M and N. In the following text, the layouts will be referred to as the following concept names: *Tetris (D)*, *Crystal (H)*, *Spring (M)* and *Blocks (N)*. These concept names were added in the report to make the text easier to follow and were not integrated within the prototype. In figure 6.15, the layouts are presented in the order they appeared in the final prototype. The "16-in-a-row" layout was also included as a reference. The layouts were ordered so that layouts with similar interaction possibilities should not come right after each other.

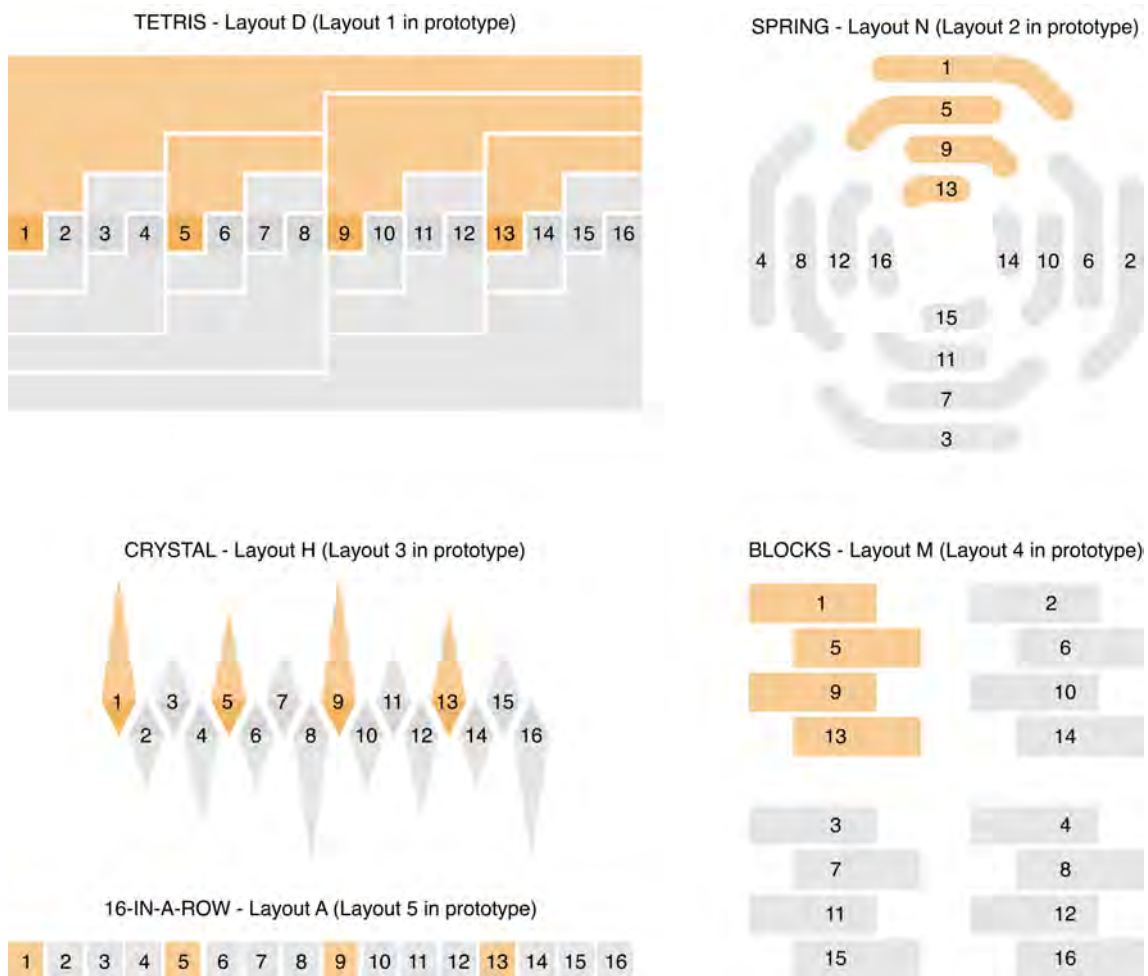


Figure 6.15: All of the layouts included in the external evaluation presented in the order which they appear in the final prototype.

These layouts were selected as they had different aesthetic expressions and interaction principles. In figure 6.16, some of the basic interaction possibilities are illustrated for each layout.

Tetris

The concept Tetris provided interesting gesture possibilities, both vertical, horizontal, diagonal and non-linear. The horizontal gesture possibilities are the most prominent ones but as more time was spent with the layout, interesting combinations arose. One example is activating step 5 and 13 by first activating step 1, 5, 9 and 13 and then continue the swipe upwards to deactivate step 1 and 9. The steps' different shapes and sizes and the gesture possibilities is also a good foundation for, by human-generated, "randomness" (i.e. swiping "randomly" to achieve unpredictable results, figure 6.17). The shapes of the steps also allow for some happy accidents, variations and, of course, undesired results. The main reason for this is mainly because the accuracy of a long-distance swipe can be difficult to maintain.

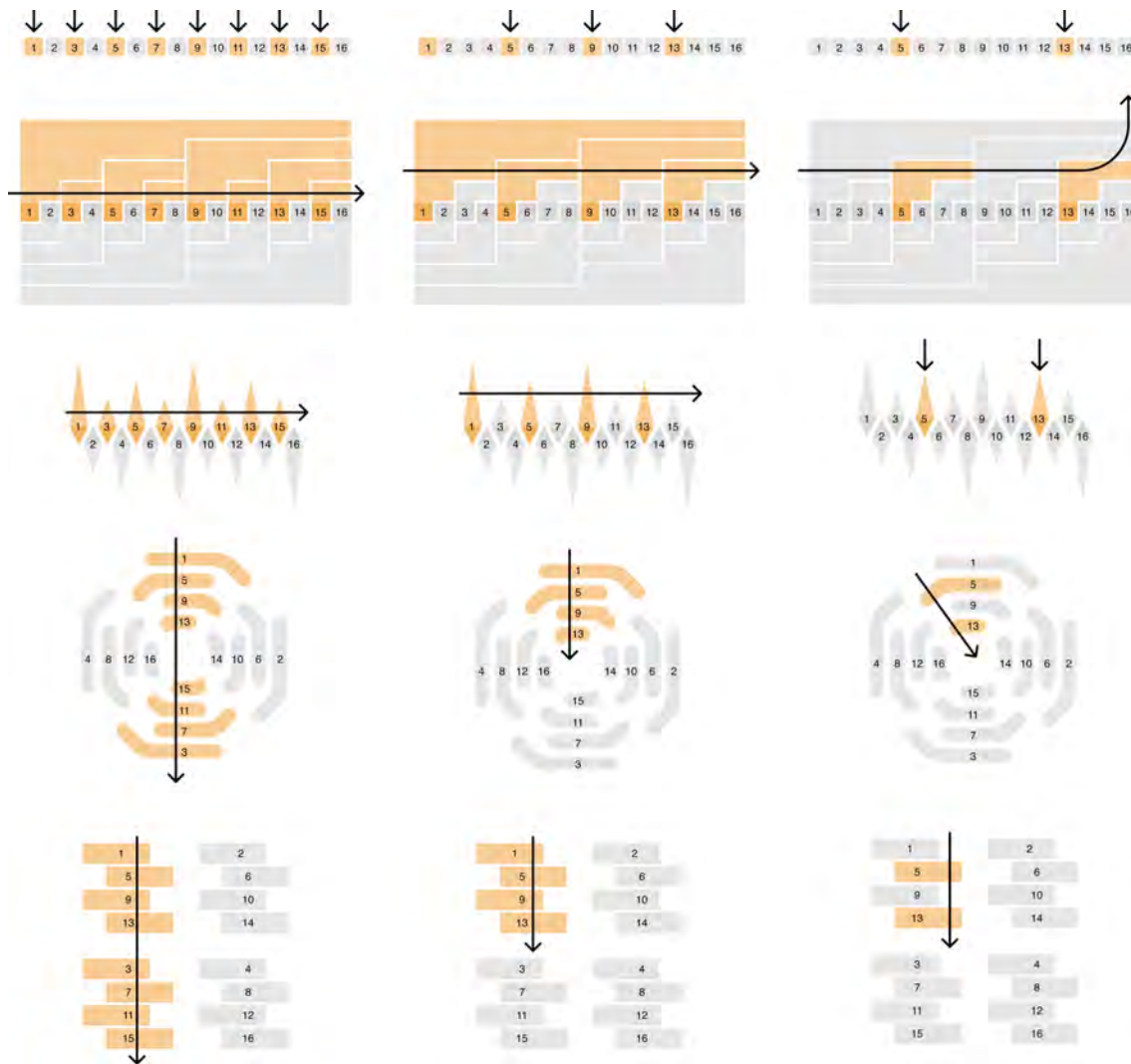


Figure 6.16: Shows how to activate every eighth note, fourth note and step five and thirteen for each of the five layouts that were included in the user test. The standard "16-in-a-row" was integrated as reference.



Figure 6.17: Variation could be added by swiping randomly

Crystal

All of the semi-non-linear layouts (E, F, G and H) provided the same kind of functionality. However, they communicated different aesthetic expressions and affor-

dances. They offered the same horizontal swipe possibilities as Tetris but were more limited from a vertical perspective. This made these layouts more similar to the ordinary "16-in-a-row"-layout. The layout Crystal (H) was selected because, compared to the other similar alternative layouts, it utilised the triangular shape to make it more compact. It also provided an aesthetic expression different from the other layouts.

Spiral

All of the circular layouts (I, J and K) had different shapes and forms but provided the same functionality. In one swipe one could easily activate the same steps that could be activated by horizontal swipes in Tetris with one exception - activating all steps in one swipe. However, it felt harder to activate individual steps in the circular layouts. The reason for this could be that it had a different representation of the measure and the fact that the steps were rather thin. Layout L and M are also circular and provide the same interaction possibilities as Layout I, J and K. However, they also give access to other types of gestures. For example, step 5 and 13 can be activated in one swipe. The gaps between some of the steps also make a "random" swipe less predictable as it is a greater chance that the gesture will pass some steps untouched. Therefore, Layout L and M (Spring) were selected in favour of Layout I, J and K. The concept Spring (M) was chosen over Layout L because of its more defined corners which made the interaction possibilities and affordances stand out.

Blocks

In theory, the concept Blocks (N) provided access to the same functionality (i.e quick shortcut gestures to certain rhythm patterns) as Spring. In practice, however, it was harder to grasp how the steps proceeded and the sequential order of the steps. This allowed for unpredictability such as happy accidents and of course, unwanted results, depending on the user goal. Blocks were the most abstract layout and took a step further away from the linear time representation apparent in all the other layouts. As it was different from the other layouts but yet promising from an interaction perspective it was included in the final prototype.

16-in-a-row

Out of all the standard layouts (A, B and C), the "16-in-a-row" layout was included as a reference in the prototype. This layout was the one most of the interviewees from the user study had the longest experience with. As none of the provided alternative concept layouts had indications such as numbers or colours, no numbers or markings were added to this layout. However, it is worth to mention that the alternative layouts possess identifiers naturally by the shape and size differences of the steps.

6.3 Web Application

To evaluate how different alternative non-linear step programming layouts affect user experience and player behaviour a high-fidelity prototype was necessary. Therefore, a web application was built in order to capture gestures with high precision and deliver sound with low latency. This section will describe *how* the prototype works, but also *why* it works the way it does.

The prototype is a web-based drum machine optimised for touchscreen devices. Web applications are platform-independent and do not rely on specific equipment. Another reason to build a web application was that a majority of the user tests was going to be executed remotely, partly because of Covid-19, but also as many of the participants were based in different locations. A digital prototype also provides certain flexibility when it comes to updating and adding new step programming layouts which is something that was important in this stage of the project. The idea and foundation of all designed alternative step programming layouts were based on gestures. This was the main reason to optimise the prototype for touchscreen devices. The prototype was built to work on different touchscreen devices, screen resolutions and orientations (figure 6.18).



Figure 6.18: *The prototype was built to work on different touchscreen devices, screen resolutions and orientations.*

6.3.1 Functionality

The drum machine has eight programmable tracks, each with its own drum sound. Together they form a drum-kit which can be used to create rhythms and beats. The user selects which track to program and then activate the steps they want by swiping or tapping on the step programming layout. Other than programming each track, the interface provides the following functionality:

- Start/stop the sequencer
- Change the tempo of the sequencer
- Change step programming layout

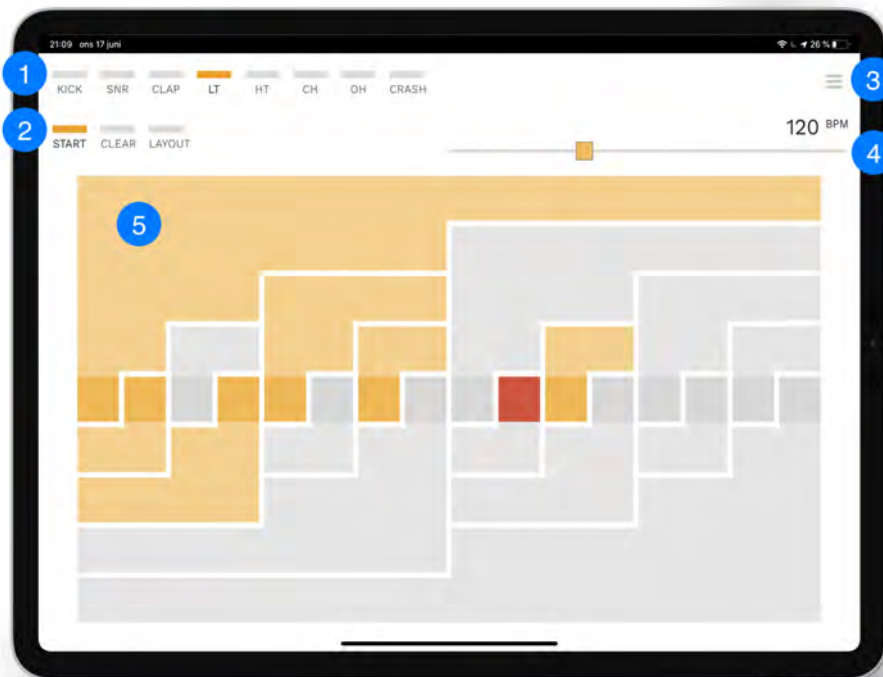


Figure 6.19: An overview of the prototype. 1: The eight instrument tracks. 2: Buttons for starting or stopping the sequencer, clear every track from active steps and switch layout. 3: Menu where the user can change sounds and layout (see figure 6.20). 4: Slider that adjusts the tempo (bpm) of the sequencer. 5: The step programming layout, orange steps are active, grey are inactive. The red square indicates at which step the sequencer is at the moment

- Change how the drum machine sound by altering drum-kit.

Figure 6.19 explains how the different functions and controls are mapped in the interface.

The number of functions included in the prototype was limited to the ones that are necessary in order to evaluate the non-linear step programming layouts but still provide a context. Too much functionality could draw the attention away from the step programming layouts, while too little could make it harder to evaluate. Another constraint was the time limit. The development of the prototype had to be efficient. The time limit was the main reason for not providing the functionality of synchronising the prototype with other musical equipment (i.e. Digital Audio Workstations, other drum machines, synths etc.)

Samples and Sounds

The experience of a drum machine will most certainly be affected by the sounds it can produce. Since designing and creating a sound engine was not in the scope

of this project, samples from old famous drum machines were included within the prototype. To allow for some customisation in terms of sound, the user can select five different drum sample kits. The drum-kits that were provided are sounds from Roland TR-808, Roland TR-909, two versions of LinnDrum and E-Mu Drumulator. 6.20.

The eight instrument tracks are loaded with the following samples:

- Kick
- Snare (SNR)
- Clap
- Low tom (LT)
- High tom (HT)
- Closed hi-hat (CH)
- Open hi-hat (OH)
- Crash/cymbal

Step Programming Layouts

The user can alter between the layouts by tapping the "layout-button" (figure 6.19) or by entering the hamburger menu (figure 6.20). When the user selects another layout, the active steps remain active and the sequencer continues to play. In this way, the users can continue with their current workflow and also be able to compare how different programmed patterns look on the different layouts. If the user wants to start all over, the "clear-button" can be used which simply clears every active step from the sequencer.

When a user touches an inactive step it becomes active. The feedback of this action is indicated by changing the colour of the step, from grey to orange. If the user touches the step again it becomes inactive. The state of the steps toggles regardless if the finger is lifted in between or not. This allows the user to play around by activating or deactivating multiple steps within the same gesture (i.e. swipe). This opens up for unpredictable results when swiping in random directions or non-linearly.

The one control that is time-multiplex is the step programming layout as it only controls one track at the time. This is mainly because of its size - each step would simply be too small to interact with if eight versions of the layout always would be visible. The user selects which track to program by tapping it. The active track is indicated as the button turns orange. When there are active steps in another track, their corresponding track button will light up each time they play a sound. This will give the user feedback of which tracks are being played.

From a development perspective, the prototype is flexible in terms of adding new

step programming layouts. From an evaluation perspective, this was an important necessity. The layouts are implemented as SVG-files. To add a new layout, the only thing required is to create it in a vector graphics software, make sure the layers are named and ordered correctly and then export it as an SVG-file.

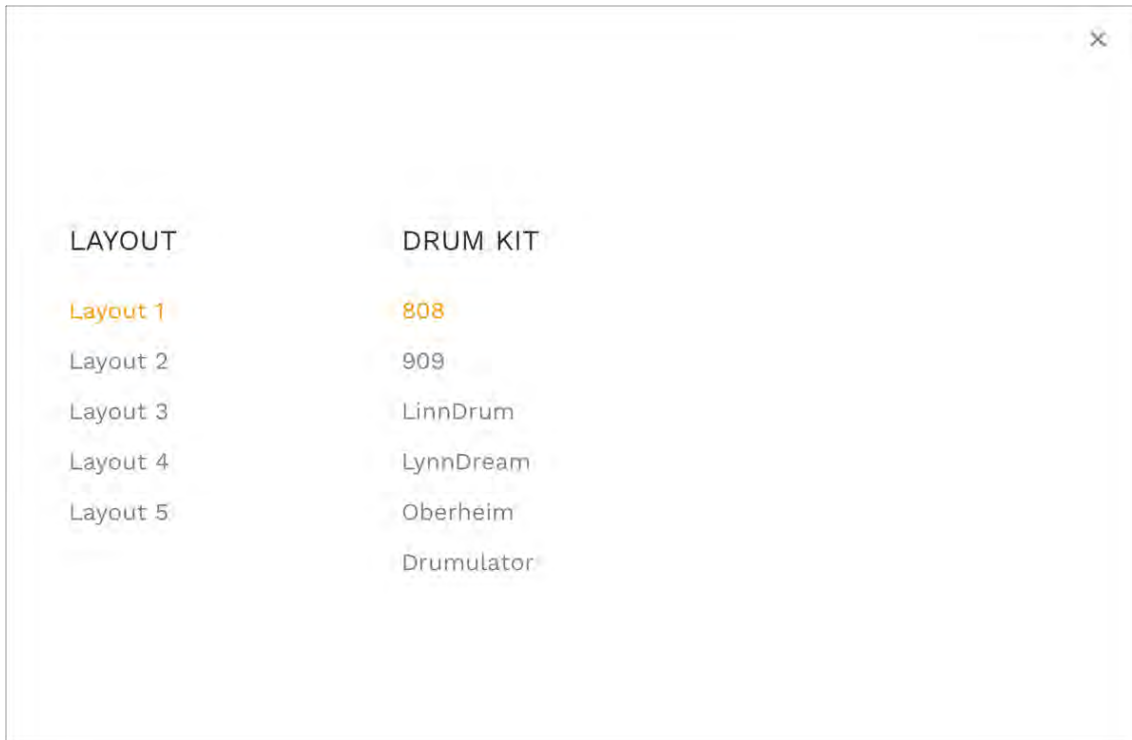


Figure 6.20: *If the user presses the menu icon, this menu window will appear. In this menu, the user can change between different drum-kits. Instead of browsing through the layouts in the main view, the user can also select layouts from a list within this menu. The layout and drum-kit that are active are indicated by an orange text-colour.*

6.3.2 Design Decisions

The aim was to design a clean and clear interface with the step programming layouts in focus. This was achieved by minimising the number of functions reachable on the main view to the ones necessary while playing. There is one button per function and functions that are not used as often were placed in a context menu. The buttons are grouped by function.

The system uses a clear colour scheme with few colours. Active steps and functions are orange, while inactive steps and functions are grey. The current step is marked as red to indicate where the step-sequencer is in its cycle. The area that turns red is limited to a smaller area of the steps as marking the whole area on some of the large steps could become overwhelming and result in unwanted excise. The shapes of the buttons and controls consist of minimalistic shapes and colours to work well with and not steal the focus from the different step programming layouts.

6.4 Evaluation with Expert Users

None of the test users experienced general difficulties when interacting with the prototype. The functionality and implementation for this type of interactions were described as "really good" by IF, "very good and responsive" by IE, "user friendly" by IB and "very easy" by IH. Both IB and IH expressed that they were missing functionality. For example, IB was trying to perform actions that were not implemented in the prototype by tapping and holding different areas.

"When I realised why, and that this is not just a good looking layout, I can see this as useful" - II

The different alternative layouts are described to possess "their own charm" by IG and IB. Two of the interviewees (IH & II) mentioned that the different layouts were not perceived to contribute with any additional functionality or purpose beyond aesthetic expression and orientation at first sight. However, when II realised that the different layouts allow for additional interaction possibilities, the interviewee experienced the advantages of this type of layouts. It was mentioned that the interviewee, until now, had not thought that this type of alternative layouts were something that is needed. However, after testing the prototype, the user said that "this actually feels like a very smart thing". The same type of initial reaction was expressed by IH. At first sight, the layouts were perceived to not provide any extra benefits. After interacting with the prototype, however, the layouts were described to contribute "pretty much by visualising in different ways". The visualisations and their different orientations resulted in using visual patterns to achieve rhythms. IF likes the idea of combining the different layouts together: "Maybe you should be able to see all the different layouts at the same time with different tracks? This could be a cool product, or a cool way to produce music". This is something IE suggests and elaborates on as well.

"The human is lazy and conservative with its energy. It's good with things that make you move out from your comfort zone" - IH

IH mentioned that the possible gestures resulted in "pretty interesting results". The interviewee expressed it as "something happened there, you got away from the usual patterns and went back to *listening* once again". IF said that no barriers were experienced with the interaction. Instead, the interaction was described as "the opposite, a bit of inspirational". The same user was not completely sure if the layouts "made musically sense" but added that they forced the user to use the brain in order to make sense. This is something the interviewee expressed as "kind of inspiring". The way IE make electronic music "is not really compatible with having alternative layouts". The interviewee's workflow is mainly based on having specific ideas and instructing the machine to realise those ideas: "I almost always know what I want to do, so 16 steps in a row [...] is the best and fastest way for me". However, IH added that other users "really like to be surprised" and that the benefits for interaction and surprise with these types of layouts were noticed immediately. The same interviewee said that there is "kind of a connection between the visual look

and the feel of the beat" and that "each kind of different shape is like a different feel".

"It could be good in the beginning phase [of a project]. If you want to start that conversation with your machines. If you sit as a songwriter and just want to create your stuff, maybe all of this is in the way. But if you want to explore the conversation and create electronic jazz, then it's really nice" - IH

IB mentioned that alternative layouts like these would not only have potential in touchscreen devices, but could also be beneficial within a physical product. Products with capacitive touch sensing are mentioned as a reference and products from Make Noise are mentioned as examples.

"I get those vibes from these layouts, they could work well in a physical format also" - IB

6.4.1 Tetris

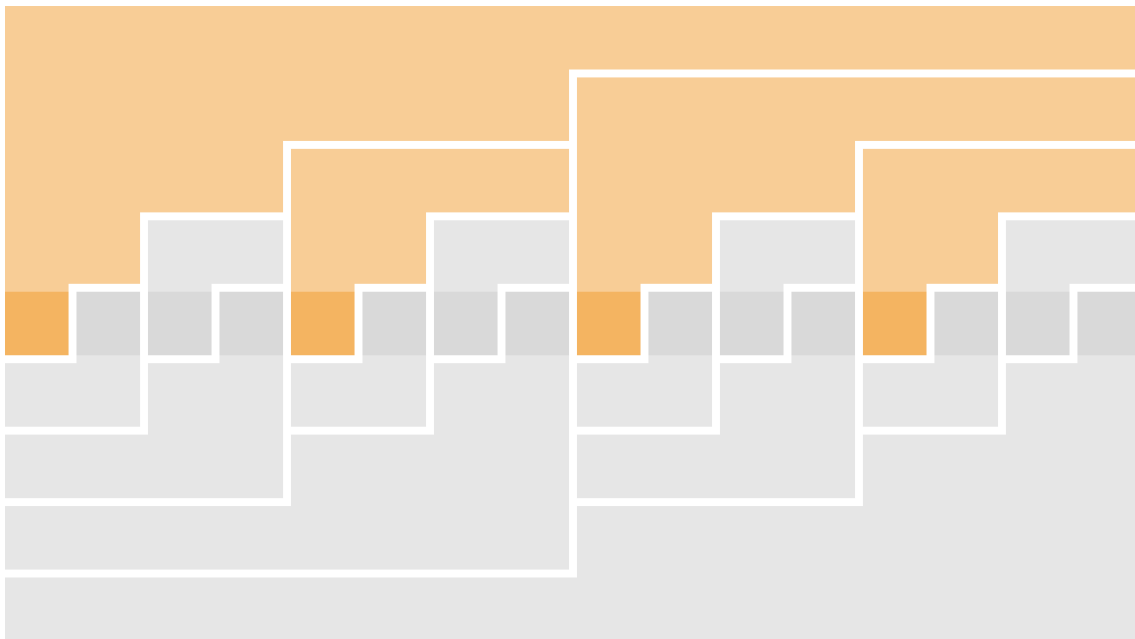


Figure 6.21: *The Layout Tetris*

"What I think is clever with this one is that it has several layers vertically. If you want to program a kick you just draw like this [horizontal swiping gesture]" - II

Three of the interviewees (IB, IF & IG) describe Tetris as aesthetically appealing. IB says: "Aesthetically, it is very nice", IF says that it has a "very cool graphic design" and IG says that "it clearly appeals aesthetically". IG thinks it was "pretty fun" to program rhythms on Tetris, although a bit strange at first.

"It has a certain playful charm. Absolutely" - IB

IB describes Tetris as a "very interesting concept" with an appealing look. However, to make it work better with the user's mental model some of the steps would need to be reshaped. IB would like step one to have the same size as step nine: "the first and ninth step should be equal, they just play an important role in how rhythm should be visualised". IG also thinks that "it was strange that number one was bigger" at first. Apart from step number one, IB thinks that the different sizes and shapes for the upper steps (the odd numbers) make sense from a rhythmical perspective. However, for the lower part of the layout (the even numbers), IB does not think their size and shape rhyme with their musical value. Even though IB thinks the symmetry is nice from an aesthetic perspective it does not make sense to give the first and last step the same visual importance. IE likes that the shape of the layout gives clear indications of where the fours and eights are. However, the user thinks it is hard to find a "strong relationship" between their shape and their "musical value".

IE thinks the proximity of the stems that goes out from each step "encourages you to identify visual patterns and then try them out [...] to see what kind of musical pattern that makes" by utilising swiping gestures. However, IE does not think that this layout is more efficient for realising specific goals: "If I have a groove in my head, this would not get me any faster to the groove. A normal grid would". The user rather sees it as a layout that encourages experimentation.

IF likes the graphics of Tetris but does not think the form of the layout adds anything musically. The interviewee mentions that there is not a big difference from "16-in-a-row" except for the graphics: "I like what I see, but playing around with it, musically I'm not finding myself in any other place".

IH spent some time thinking about the logic of Tetris but realised quickly how the steps break up into smaller parts based on their placement and that this allows for practical swiping. IH thinks that just the fact that it looks different from what the user is used to makes room for new ways of creating rhythms: "start as a two-year-old and just fiddle around and when you got a foundation you could place your steps more thoughtfully". The user concludes that "it was exciting how little is required to get away from the traditional". IH would like to be able to change the sizes of the steps based on preference. The interviewee also thinks it would be interesting to be able to change the number of steps for each track. IB describes how the user wants to be able to modify the steps even further: "I get a lot of funny ideas when I see it, maybe you could rotate the blocks in some way or create things that make the blocks change in size [...] I found myself trying to drag on them to alter the sound". IF thinks that colour-coding, in general, would make the layout more usable.

Interaction Gestures

"Yeah, that trick I really like, you can swipe from the top and you get a four on the floor really easy, and the bottom is the off-beats. " - IF

When it comes to interaction, all of the interviewees used both swiping and tapping gestures. However, if they used mainly swiping or tapping differed among the users. II "swiped in many different diagonals and directions" and also tried tapping to

activate single steps but states that "the whole purpose of the programming method disappears" when doing so. IF has been using both swiping and tapping gestures and explains that "in this mode, swiping makes a big difference". However, the user was expecting more from the swiping and explains that it was not as interesting musically as the user thought it would be. IG has mostly activated the steps one by one using tapping gestures but also used swiping gestures to add variation to the rhythm: "If I create a beat, then I remove the hi-hat and swipe around to get certain randomness. Since it has bigger segments it becomes weighted in a certain way, which I enjoy". IH and IE mostly tapped to activate steps. IE says that swiping gestures were only executed vertically to explore how the layout behaves and that the layout does not afford horizontal swiping gestures: "I can see how that [swiping horizontally] would activate certain notes but I did not feel encouraged to swipe like that". IB started out by using tapping gestures as this is what the interviewee is used to: "But after a while, I realized that you can drag your finger over it, which is also kind of fun. It goes much faster". However, the user is not sure if this approach is more efficient compared to using tapping gestures. Accuracy problems may arise as some gestures are long straight swipes which can result in activating the wrong steps: "in one way it is cool, but it's not as useful for me compared to the other layouts, but absolutely a cool concept".

Perceived Control

II says that Tetris behaves as expected once the user got a grip of it: "It does what I think it should when I swipe". However, the same user experienced accuracy difficulties for the same reason IB mentioned: there is a risk of missing steps or activating wrong steps when executing long straight swiping gestures. IG describes the perceived control as "pretty good". The user thinks that the control could be better if the smaller steps were a bit larger, even if it would break the symmetry. The steps are described to be weighted because of their different shapes and sizes and the user adds that this has its advantages. IB says that the control of the layout is somewhere above middle compared to the other layouts and explains that one of Tetris' weaknesses is that it is hard to get a clear visual overview as the steps are woven into each other. IH is happy with the control that Tetris offers. The user thinks that it was "pretty predictable" how the steps proceed. However, the user had to think a little extra when creating rhythms the user usually produces. IE thinks that this is the layout that allowed for most control out of the alternative layouts and explains it as follows: "I still see one bar of music represented in a linear way and for me, that's the most control". IE explains how the user can see that this layout could improve efficiency in some ways. However, the user does not want to be "forced" to learn it and says that if there was a good sound engine integrated, the user would consider utilising "this additional functionality" over time. IF experiences "good control" over Tetris and describes how the design "doesn't hinder playability" but rather improves it by just being aesthetically appealing. The user thinks that it is "very easy to activate a lot of stuff quickly" when using swiping gestures.

Realising Specific Goals

IE and II think it was easy to realise specific goals using Tetris. II refers to the user's long experience of step programming. IE thinks that the "receptive nature of the shapes" and that different note-values have certain shapes may make people perceive it as a functional enhancement: "I can almost see how it might be a functional enhancement, like a more direct and faster way but only for certain kind of beats". The user further explains that a "16-in-a-row" layout "doesn't lead you in any particular direction" and says that even a four-by-four or two-by-eight layout makes it harder to realise certain kind of rhythms that are not as straight and repetitive. IG also thinks that it depends on the rhythm you want to create. The different shapes make it quite easy to create some rhythms while others are harder to achieve. IG explains that this can make you feel constrained visually and that the rhythms created on Tetris tend to get pretty straight. However, IG continues and says that it is quite easy to fix by just "swiping around a bit randomly" to add some variation. According to IH, Tetris is not "ultimate to realise a specific goal" but explains that if this is the goal, you may use a more traditional layout. The reason for using a layout like Tetris is rather to break free from old ways of doing things. IB thinks it went "pretty well" to realise specific goals on Tetris but not as easy compared to some of the other alternative layouts: "I need to stop and think a bit with it. I don't get the same flow as with some of the other layouts". IF did not think it was difficult to realise goals on Tetris as it was easy to understand. On the other hand, the user says that this leads to less happy accidents compared to when using some of the other alternative layouts.

"The layout makes me assume there is a more ergonomic way to program drums. That's the way I feel about it when I look at it, cause it's very mathematical and very, it looks very intentional and it looks very calculated. So my assumption was 'oh, this might actually be a more ergonomic way to get my ideas into a sequencer' but after using it, I felt no, there is a different purpose for this. The purpose is to encourage experimentation rather than facilitate faster programming" - IE

Player Behaviour

"It made you do something different, not necessarily what you thought at first, but it was pretty refreshing" - IH

The users II, IH and IB think that Tetris invited for a different playing behaviour. II thinks Tetris invites to play differently from what the user is used to, especially when it comes to sounds such as claps as the user could use swiping gestures to explore different rhythmical patterns. The user used this technique for all tracks except for the kick track where the user rather would have wanted a traditional layout. IH says: "It made you do something different, not necessarily what you thought at first, but it was pretty refreshing". IB says: "It becomes something else. I experience it as more playful actually [...] it is computer-game-like. I think of [the computer game] Tetris when I see it". IF is not sure if the layout changes how the user plays but adds that it certainly changes how the user reacts to the sequencer:

"You press it and different things happen than the usual". IG, on the other hand, does not think that the user played very different: "It was much like playing the 808. However, IG mentions that this layout leads to more electro-oriented rhythms rather than rhythms related to four-on-the-floor genres. IE experienced that Tetris "didn't invite" to play differently, at least not compared to the other layouts.

Dialogue or Command

"It's a lot of conversation. I think that's what I like about it [...] A conversation is a really good way to describe it" - IH

Four of the interviewees (IB, IF, IG and IH) describe the interaction with Tetris as a dialogue rather than the feeling of only instructing the layout. IB says that the reason is partly because the layout is "playful" and "you're like painting blocks". IG describes it as follows: "Since this layout is not standard, it becomes a bit of a new thing. A little bit like a puzzle". IF describes it as more of a conversation: "especially when you bring in the swipe elements because it is not exactly going the way you want, so that's like a dialogue. It is actually a cool way of adding happy accidents". IF also adds that another way of seeing this could be that the user is "wrestling the graphical interface" to activate the steps the user wants and continues: "I would not think like that, but I can see others thinking like that".

"It definitely highlights happy accidents and that can be thought of as a conversation in a way" - IF

Two of the interviewees (IE and II) describe the interaction more as instructing the sequencer to behave in a certain way. IE thinks that "it's more of a tool" and II explains it as: "I think it's more like I instruct it but there are some feedback as well since it sometimes ends up differently than I first thought".

Variations or Repetitiveness

"It looks mathematical, but the result didn't become as repetitive as the graphic may suggest" - IG

6.4.2 Spiral

IF thinks that this layout is "much more interesting" compared to Tetris and reasons as follows: "This layout really makes sense", "The way it looks", "I was quite fascinated about this", "This layout is really cool", "Sliding your fingers really works, you can easily get a 'four-on-the-floor' kick, really easy". IH describes Spiral as the favourite layout and expresses it as "the one that felt most exciting" among the layouts. One reason is the gesture possibilities and affordances it allows: "If you draw a straight line here, you'll get a straight beat [...] in my brain this became much easier". The same user says that, when using the traditional "16-in-a-row" layout, "I still need to think for a brief moment, there is nothing that indicates each step". In Spiral, however, IH mentions that the interaction becomes clear because of the pattern it provides. IE also mentions that because of the visual shapes, the



Figure 6.22: *The Layout Spiral - name proposed by IF*

user's eyes identify patterns that encourage gestures like swiping. The interviewee specifically mentions that the "little fingers" or the visual "extensions" of each step affordance and encourage swiping.

Another thing IH likes about Spiral is that it is not obvious which step is the first one in the sequence. This is something the user sees as beneficial in the context of live performances: "Because you could create gestures, it becomes very clear in a live perspective, [...] nice to not know where you are in the loop. For live performances, I think that could be very good. You draw a line [with a swiping gesture] and you will have something to start with". IE states that the sequence visually goes "down this spiral" and that this does not match with the user's mental model: "It does not connect for me". However, the same user adds: "But as far as experimentation is concerned [...] it's more fun, it's fun to use this when you are just kind of like identifying visual patterns because there is a lot of visual patterns here [...] so it's good for that". IG does not like sequencers visually represented as circles in general and mentions a sequencer from Buchla as an example. IH enjoys the steps being distributed circularly and requests additional functions such as being able to limit the playback to a certain part, twist a circle with certain steps or divide the whole sequence: "Then it could be even more strange results [...] then what would happen?".

II expressed this layout as "more difficult for me to do things I think of" but added that the results can be interesting anyway. The same interviewee said that it would not be wished for to be left with *only* this layout in a product. IE "understands" the layout "on an intellectual level" but adds that the interaction "is about pure

experimentation". When the user tries to place a beat or a specific idea, the layout does not provide any benefits: "But the moment I try and place a beat where I want to in my mind, oh a snare drum needs to go right there, I have no patience for that. That's me because I need to make my beat you know". IG experienced the same thing. Trying to realise a four-on-the-floor rhythm pattern was something the user experienced as difficult, but "just swiping through" was perceived as "fun". II understands that the sequence moves inwards as a spiral but still gets confused over how the sequence proceeds. The user says that this layout is not a favourite but adds that it is comprehensible that it can be interesting. IB, on the other hand, expressed Spiral as "super-functional". It is described to possess a visual grouping of the steps that "suits very well for a certain type of music": "I lay out my steady kick by just swiping the finger, then it's done". It is described as "very cool, very functional", "very interesting" and that it "doesn't have the same type of playfulness as the previous one [Tetris]. I can, in a faster way, achieve the results I am thinking of". IB describes Spiral as "funnier" with a "different approach". The fact that the layout requires larger space in both horizontal and vertical axes forces the user to interact with longer gestures and sometimes two gestures to activate all steps (i.e. swiping the shape of a cross). This is not mentioned as a "bad thing" but rather "different" and "airier" making "everything easier to do".

"Subjective or not, I am pretty sure people are 'geeking' into this stuff in music production. They will like this type of stuff. [...] I think their heads will turn like, 'Oh, what is that?'" - IF

To be able to see where a step belongs in the sequence, II would like, to a certain degree, be able to see indications of each step. IF also mentions that the layout is not perceived to be clear enough and suggests that some separation or colour coding could solve this. IH also elaborates that reshaping, colour coding and playing around with graphics of the steps could make the user relate even more to the pattern of the layout. IG says that if more functionality was added, the layout could serve better as a compensation tool and exemplifies this with functions such as shuffle, repeat and syncopé. In this layout, IF thinks that features such as ping pong, random or pendulum playback functions could "look very interesting" visually.

"It was interesting. I mean, consider how shallow the editing possibilities are, but the result was still interesting" - IF

Interaction Gestures

Regarding interaction gestures both swiping and tapping were performed by the test users. IB used mainly tapping gestures while swiping gestures were executed to accomplish fundamental rhythms: "For some things, swiping is very nice in this layout. It takes care of the fundamental rhythms that you want. Then you might have to think a little, if I want a snare drum on step 5 and 13, you have to think a little, but then you press it in. I don't swipe like that". IB also adds that the layout is not as "swipe-friendly" compared to the other layouts. IH interacted with the same approach as IB, starting with a few swiping gestures to then activate

steps more sparsely by tapping them. IE used swiping gestures more than tapping gestures but says that with time, the user would also start to tap the "extensions" of the steps. IE also mentions that the "extensions" in the most inner circle are too small and "almost useless". IF mentions that swiping gestures were not utilised as much as tapping gestures: "I did not do so much swiping. It was more like putting the steps in and figuring out how the whole thing was presented. It was really good actually. I totally enjoyed this one. I like this spiral type of thing". IG, who enjoyed the graphics but "did not really connect with it [the layout]", mainly used tapping gestures. II, however, sees the swiping possibilities as the whole purpose of this layout (and other evaluated layouts, but even more this one).

Perceived Control

The perceived control over this layout differentiated among the test users. While IB mentions that the perceived control was very high (80% control was expressed by the interviewee), IH describes the interaction as "a nice control of 'uncontrol' which is pretty comfortable. You could enhance the control but it was pretty nice not having that and just create and see what you end up with". IF says: "I had pretty much control over everything I wanted" and mentions that the level of control was perceived to be equal as when interacting with Tetris: "At the end of the day it's 16 steps laid out in a different graphic manner, and different type of playback [...] Playability-wise [...] I didn't have any issues and actually, it was interesting. This one was interesting. When I switched to this one I thought 'now my brain cells are kicking'". II says that this layout is harder to control because "it does not really behave like" the user "thought it would" at first sight. IE reflects similarly and says: "I felt I have no control" and IG says that the perceived control is a "little less" compared to Tetris.

Realising Specific Goals

"If my goal was to take one idea from my mind and realise it, it was not easy at all. But if my goal was to come up with something unpredictable, [...] if I had a drum machine that I was more comfortable with and using it for the basic beat, this would be really fun to add something additionally" - IE

In the same way the perceived control of this layout differed between the test users, the ability to easily command the layout to realise specific ideas also varied among the users. IB thinks that Spiral allows the user to "in a quicker way" realise and translate rhythms that are thought of. After some time of use, IH started to see the patterns and could also realise rhythms efficiently: "It is almost even more clear than a 909 [which has a 16-in-a-row layout], because here they [the steps] are oriented closer to each other, but in circles". IF is reasoning in the same direction and says that realising specific goals and rhythms with this layout "was easy" and adds that "all of them [the alternative layouts] were easy, it's just ordinary step-sequencing". II, however, says that it was hard realising ideas using this layout and adds that the user experienced Tetris to be easier if realising a specific idea is the goal. IE says

that realising ideas "was not easy at all". However, the interviewee thinks that with time and more use, the user might change this opinion. For IG, this layout is not about realising ideas but rather about playing around, trying out different gestures to see what happens.

Player Behavior

Spiral invited some users to play and behave differently more than others. IB, for example, says that it "probably doesn't" change the player behaviour and highlights that it is "not as playful" but rather "functional" leading it to be more "compatible". IH expresses the difference in player behaviour as follows: "If not anything else, you can change stuff up very quickly and keep it alive. Sometimes you can paint yourself into a corner and you don't want to change things around, but in this case, it wasn't like that". The main reason for this behaviour is described by IH as a result of the visual cues and patterns. The way the steps are oriented makes it easier to visually remember what steps are being activated as they together form a pattern. As a result, IH feels more comfortable of changing steps by activating or deactivating them, as the visual patterns make them easier to remember and, therefore, return to. IF also says that this layout invites to play and behave different from the usual playing behaviour and adds that, for this reason, Spiral and Blocks are the two layouts that the user "really enjoyed". II says that this layout definitely changes the normal behaviour as there is a moment of surprise each time the user makes a swiping gesture. The rhythms that evolved from this layout is, however, described by II as: "not as interesting [as rhythms created with other alternative layouts]". This layout also invites IG to play and behave differently and IE says: "Yes it definitely invited me to play differently, definitely. I had no choice".

Dialogue or Command

There was also a diversity of perception among the interviewees when discussing if interaction with this layout was perceived to be more of a dialogue and conversation or more as a way to perform instructions and commanding the layout. For IB, the interaction is more about instructing the sequencer: "I am pretty used to the 16 steps, the one that goes from left to right. In a way, this one is the same except that it's just twisted around itself [...] In my brain its obvious". IH says that the interaction is a mixture of instructing and conversating: "You could say that you are instructing it. At the same time, it was like a conversation because the thing behaves in a certain way". IE describes the interaction as a dialogue and IF says it is "a dialogue because it was kind of hard to understand how it really worked [...] it was a really good dialogue actually". When asked if this layout could still be perceived as a dialogue after several years of use, IF answered: "That's hard to say. For that to happen, it needs to be more fleshed out. I was saying it earlier, there is something about layouts like this". The interviewee adds that you get new results when you get to use alternative layouts like this one: "If you work differently, you'll get different results". II, on the other hand, describes the interaction as "sort of a conversation" but also says that it feels like it is rather the layout that instructs the user: "It is definitely that one instructing me. It doesn't work as I think. We have

sort of a conversation but it has the advantage over me. I ask a question but it answers in a completely different way". The same experience was described by IG who adds that it could work well as a compositional tool if you want to do something you usually do not.

Variations or Repetitiveness

How this layout is experienced is obviously, like all layouts, different depending on the user. This is also the case when discussing if the layout invites for variations or lead to repetitiveness. IB says that this layout is an efficient tool and as described earlier, IB thinks that Spiral is a "vert functional" layout. The same user thinks that the rhythms created with this layout become "more repetitive". II who earlier described the layout to be difficult to understand also says that the rhythms produced with this layout felt more repetitive. The same kind of repetitiveness derived from the difficulty to understand the layout was described by IG. However, the user adds that the layout could work well as an "inspirational tool". IH thinks that Spiral invites for variations because of the patterns the user proceeds from and IE says: "Of course it invites for variations".

6.4.3 Crystal



Figure 6.23: *The Layout Crystal*

Five of the interviewees (IB, IE, IF, IG & II) specifically mention the aesthetics of Crystal. The aesthetic expression gives IB a playful "computer-game-vibe" and according to IF Crystal has "very cool graphics" that reminds the user of old Commodore 64 games. IG says that it "looks very nice" and thinks it "looks pretty metal". II says that it "is good-looking, really good-looking". IE says that "it got high aesthetic value" and talks about how there are lots of different shapes integrated within the layout. However, the user is not fond of the sharp and triangle-like expression: "There is potential with this [concept], but it's just the ice-cream-cone or the French-crepe-to-go that isn't visually pleasing for me".

All of the interviewees think that it is clear that you can swipe your finger on different heights horizontally to activate different rhythms on Crystal. II thinks that it is "extremely simple" to activate eighth-notes and forth-notes. IB likes the fact that step one and nine has the same height on Crystal compared to Tetris and describe the layout as both "interesting and useful" as well as more efficient. IE also thinks this is clearer on Crystal compared to Tetris and can see how this could improve the efficiency: "I see the potential with this kind of grouping". IF describes Crystal as "inspirational" and thinks that it is clear how you can swipe to achieve different rhythms. IH says that "even if it was quite simple, it was exciting to swipe" and describes it as "a smooth way to access the most important" steps while at the same time distinguish them visually. The user also thinks it would be interesting to be able to change the height of the steps manually based on song or instrument and have different modes with Boolean logic.

The sharp edges are considered problematical by both IB and IE. Both interviewees say that the sharpness makes the contact surface too small at the edges. This results in uncertainty for if a step will be activated or not when swiping. IE also thinks it is problematical from an affordance perspective: "My fingers do not want to touch something sharp". The user talks about the fact that the shape is "continuously getting smaller". The user says that if the shapes provided different functionality for different areas this would be comprehensible but as it is now it is not clear in which area of each step the user should interact. IE also thinks that the "zig-zag"-pattern is problematical. The fact that the steps consist of up- and downward pointing arrows stops the user from "feeling that things are flowing". As they have "the same musical value" it becomes "kind of confusing". IE describes that if the shapes were more organic the layout would work better. IB likes the fact that the lined up triangles create a more compact layout and thinks that these shapes clearly distinguish the steps from each other. However, the user would prefer round or square-like shapes at the edges of the steps.

At first, IG thought there were different functions integrated at different parts of the steps. After realising that it was not, the user thought that this layout is "pretty similar" to the ordinary 16-in-a-row layout: "it feels like a 909 with new graphics". IF thinks the drawback of this layout is that it "looks too similar to an ordinary sequencer".

Interaction Gestures

II and IH mostly swiped on Crystal. IF used both tapping and swiping gestures: "sliding to activate steps is an interesting trick" and thinks it is visually clear what will happen if you swipe at different places. IG and IB mostly used tapping gestures on this layout but think that they would have swiped more if it was not for the sharp edges. IB describes how some steps did not become activated when swiping fast: "I still press on this one, I avoid swiping because I'm uncertain of the contact surfaces". However, when the user used tapping gestures around the middle section of the steps the spikes worked as good visual feedback when the steps were activated: "For me a big part is to see what is going on visually when I program [...] I can kind

of hear the rhythm in my head without the need to listen to it".

Perceived Control

"Before I swiped my finger I already understood which steps that would light up and become activated" - II

All of the interviewees experienced good control over Crystal as it is similar to the standard layout. IE says: "I felt like I had good control. I was satisfied with the control I had. If I had to program drums on this I would because I can see the 16 steps right". IF thinks the difference from a standard layout is that you can press "outside" of the steps: "If it had numbers it would be the same thing, you haven't used numbers, that's cool". II compares the layout to the layouts of 808 or 909 but thinks it is "smarter" as it is efficient to program fourth, eighth and sixteenth notes. IB says that the control "was pretty high, a nine out of ten. It would get a ten if they were blocks [instead of triangular shapes]".

Realising Specific Goals

IB, IF, IG, II and IH thought it was easy to realise specific goals since the layout is similar to the 16-in-a-row layout. IF says: "I could make a beat really easy on this one, my brain was recognising this layout" and IG says: "I know what beats I like and they are pretty easy to realise". II says that it is easier to realise ideas from your head but also more difficult to get surprised and adds: "I like to surprise myself when it comes to music". IB says that "it is not as playful, but I feel that I quickly can get down my ideas and in that process I rather press than swipe". IE thinks it was "a little bit difficult" to realise goals since "the visual shapes kind of lead you in a certain direction".

Player Behaviour

IF, IG, II and IH mention that they program like "usual" using Crystal. IG says that "it's pretty conventional". IF agrees but adds that it is easier to distinguish between odd and even steps. IH thinks that it "is like usual but it feels like you could become more efficient, especially if you could have different heights on the steps for different instruments". IB also thinks the layout is similar to a traditional sequencer but that the visualisation, despite the sharp edges, makes it work "really good" for the user: "Maybe I even play better on this one". IE thinks Crystal invited the user to play differently compared to an ordinary drum machine.

Dialogue or Instruction

IB, IF, IG, II and IH think the interaction is based more on instructing and commanding the layout. IF says it is the layout with "least dialogue" apart from the 16-in-a-row layout. II says that interacting with this layout "is not a conversation. Here it feels like I give the directives and it behaves as I thought it would". IE, however, experienced conversation and dialogue when interacting with Crystal.

Variations or repetitiveness

IG and II think that playing with Crystal tends to result in more repetitive rhythms. II thinks the reason for this is because the user can "think out how it will behave". IH says that "it was pretty repetitive but just by breaking it up in the way it is it creates the possibility to dare to try more variations". IF says: "I didn't see myself doing happy accidents with it". IB mentions that it goes fast to achieve variations using Crystal and refers to long experience with the similar 16-in-a-row layout. IE says that using Crystal "sadly" results somewhere in between variations and repetitiveness: "it doesn't go one way or the other compared to the other ones of these layouts".

6.4.4 Blocks

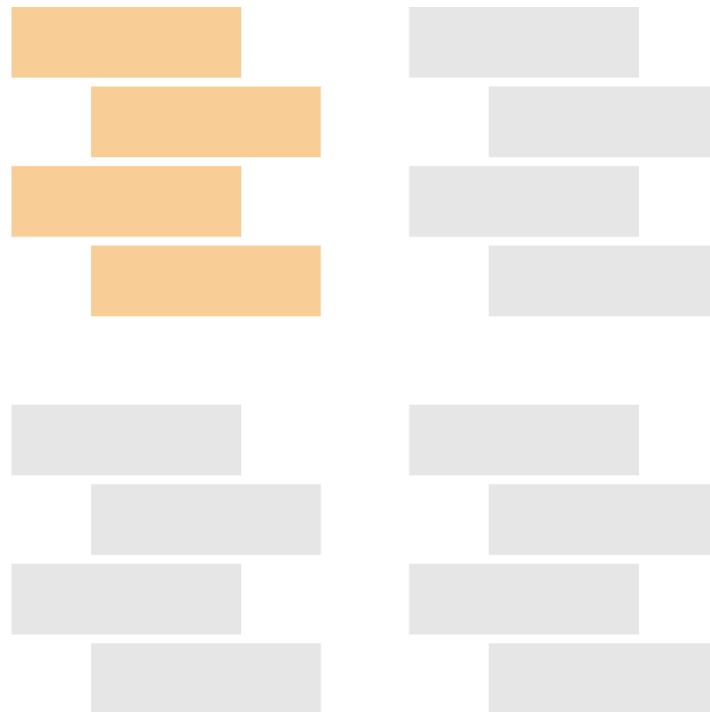


Figure 6.24: *The Layout Blocks*

IB notes similarities between Blocks and Spiral and mentions that this layout "separates the four 'timing elements'" in the same way. It is, just like Spiral, described as "ultra-functional" with the additional comment that this layout is "pretty interesting" and expresses more playfulness. At the time of the interview, the interviewee has not yet learned how the sequencer proceeds through the steps which makes this layout more difficult to grasp. However, it is described as efficient as it affords more swiping gestures than tapping. The user says that the layout does not possess "the obvious" initially but adds that after some time of use, this layout could be very clear. It is more difficult to achieve "easier stuff" but its playfulness makes it possible to discover new patterns quickly. The user also expresses satisfaction over the fact that every other vertical step is aligned, allowing the user to activate certain patterns with a swiping gesture: "This makes it fast to program a snare drum".

IF also says that it is hard to follow the sequence as it proceeds. However, this is mentioned as beneficial: "This is awesome. Because it makes you guess which is the next step. I really enjoyed that. It's a little bit like a puzzle game. I really like this. It's lacking in the industry" and adds: "I would like to have a sequencer that had those different layouts". The interviewee mentions that you need to figure the layout out and that this process does not feel like wasting time. Instead, the process of learning and getting to know the layout is described as something positive and the user refers to that there are many products out there that are competent but not fun to learn. The interviewee highlights the importance of a good balance between the interaction being too difficult and too easy in the learning phase and adds that the alternative layouts provided is promising regarding this matter. IF mentions that Blocks is the favourite layout among the provided alternative layouts.

"I really, really dig this. Really cool. Confusing at times [...] but if you add a little bit of clever confusion in there, that is going to make you think differently, this is really, really up that street. So I really enjoyed this one. This was like having a dialogue" - IF

As earlier described, IE prefers full control when interacting with step programming layouts. Nevertheless, this layout is described as IE's favourite among the four alternative layouts. This is not because the user perceived to have control over the layout but rather the opposite: "It was totally unpredictable. I gave up trying to program my own beat, but the thing is, there is something about this that makes it more fun to use than that damn spiral [the layout Spiral]. There is something that is more, I just completely surrendered because it was so, I wasn't trying to do my own thing, I was just, 'oh, what does this shape do?'. If full control is not provided, the user rather prefers having as little control as possible. IE mentions that the layout encourages experimentation and says: "This one was really interesting. Ouf, I love it, I love it. Yeah, it's so, it's pretty cool. I mean maybe I just like the lights go across. Maybe it's as simple as that" while interacting with the layout during the interview. II mentions the anticipated experience and says that the user initially thought the layout would not be as enjoyable as the other layouts. However, after some use, the user started to think the layout was exciting. II describes this layout as "almost the craziest one" and IH thinks it "feels like an IQ-problem" and that there was a noticeable threshold for getting started. However, after some time of use, the user imagines that this layout could become more efficient. IH could see that there is "some kind of logic" to it and thinks that interacting with it was fun. The same user says that interacting with the layout "was really a conversation. If you laid something out, you got to see how it behaves". Just as with Spiral, the interviewee likes that the layout is divided into four different areas as it helps the user to "create patterns by swiping and easily return to previous patterns". The sequence indicator blinking around in a non-linear pattern is described as "slightly hysterical": "One should probably work more with making its expressions less 'epileptic'. But it had something. I like it. Some chaos is needed to break your habits". IH adds that if the aesthetics of the layout were to be "something more organic it might have been a little nicer to work with". On the same subject, IE prefers rounded corners: "squares feel like, inhumane to me, that's just me". IG expresses this layout as "a

bit strange". It was described to be difficult to achieve an overview: "I pressed in one place and it didn't result in what I thought it would. In some way I got tricked time after time which also has its charm". The layout is, according to IG, interesting because it is unconventional and the user says that it could work well as a tool to find inspiration.

"I like this one because it's unpredictable so far. It's still very surprising, but the way your buttons are arranged makes me feel like I'm never gonna do anything wrong. It really makes me feel like I'm gonna come up with something cool and different" - IE

IH would like the ability to in some way change the orientation or step sequence within the user interface in order to make the interaction even more unpredictable. IG says that functions that for example would allow tones or integrating a layout like this in a modular system could be interesting. IB expresses that the size of the layout and steps afford more control than implemented. The user gets the feeling that it should be possible to tap, hold and drag on a step in order to control other parameters: "It could be velocity with different levels that I control with my fingertip". IE would like to be able to combine this layout with the 16-in-a-row layout. For example, the user proposes a function that graphically transitions back and forth between these two layouts.

Interaction Gestures

All interviewees but IG and IH mainly used swiping gestures to interact with this layout. Instead, IG mainly tapped to activate and deactivate steps but the user also tried swiping gestures such as drawing a circle over the layout. IH used both tapping and swiping equally to experiment and test the layout. IB mainly interacted with swiping gestures and IF says that "swiping is great on this one [...] I swiped a lot". II used swiping and not tapping gestures and IE says that this layout affords swiping gestures: "This was swiping, it's all swiping because that's, yeah swiping is really encouraged in this. That's just what I want to do". The user describes that the four groups of four steps were utilised by swiping the whole groups or every other step.

Perceived Control

The perceived control of Blocks varied among the test users but generally, less control was perceived. IG uses Crystal as a reference and says that Blocks allows less control which is something that can be beneficial if you want to "do something different". IH describes the control as "imaginary": "Yeah, 'imaginary control'. Well, you had a little control. At first you felt that you didn't". The same interviewee mentions that since the sequence indicator visually jumps around non-linearly, the sixteenth notes are perceived to play in a faster tempo. IF refers to the control being "delusional" or "experimental". The layout is described to make the user perceive control but still end up in different results: "I felt I had control, but it wasn't the one that I was thinking and that allowed me to experiment in a different way, experiment easier. Yeah, because if you give a guy an 808 drum machine and you tell him to experiment, what's he gonna do? There is not much you can do on that. The

sequencer is pretty fixed". IB does not experience very much control over this layout (50% control is expressed by the user): "It lives its own little life, which doesn't have to be bad". The user describes the layout as "more playful" and that you, in order to realise specific rhythms, need to "think multiple times" because the sequence order is visually non-linear. IE experienced no control over this layout. However, when the interviewee defines control as having control if the "objective is to experiment", the user experienced "lots of control". II also experienced little control: "When I swipe my finger in different directions I get surprised".

Realising Specific Goals

When discussing the difficulty level of realising specific ideas and rhythms, Blocks was generally mentioned to be more difficult. IG says that it works but "you have to think a little" and adds that when the user programs a four-on-the-floor rhythm using this layout it "becomes graphical". IH says that "it's probably not the best system" in order to realise specific rhythms. IB also has to "think a little" when realising ideas. However, the interviewee adds that the functionality of the layout allows the user to quickly swipe and realise specific patterns: "It's like an intermediate position between having control and not having control". IE says that it is difficult to program and realise a musical idea but adds that if the user got more time with the layout, this would probably become easier. II says that it takes a long time to realise how the layout works and that it is "very difficult" to translate an idea from the mind into the sequencer. IF describes the interaction as follows:

"You think that you are doing something, four-four kick or an offbeat hi-hat, and it turns into something different and that is really, really cool [...] when you see that, oh, this is actually doing something different than a normal sequencer. Then you accept that fact, that you are actually kind of wrestling to do something that you have in your mind and that wrestle produces something unique and different that you didn't have in the first place" - IF

Player Behaviour

IG says that the layout invites to behave and play differently from the usual: "Yes, it became different for sure, because it feels a little like it [the layout] wants something itself. It suggests some things". IH also mentions that the interaction with this layout results in different player behaviour from the usual. In some ways, this was perceived as positive but it was also described to sometimes be perceived as "mean". Regarding the same matter, IB says: "I think so because I am not as used to this one, so I have to think an extra step, but then new stuff turns up". This layout invited IF to learn it: "Yeah the layout invited me to learn it, you know, to figure it out, where the numbers are. So I, yeah, I got the feeling of like, I'm learning this and I'm not wasting time. I'm doing something useful and cool here. That was very prominent and this was my favourite". II also expresses that the layout invites for variations in a positive way and IE, who shares the same experience, says: "I just kind of gave up and enjoyed trying new shapes. The enjoyment of trying new

shapes, it actually goes away the more I understand how things work musically. Then the enjoyment of surprise goes away, little by little because it's less and less of surprise, but because this is so abstracted, a lot of the shapes is surprises, a lot of the gestures is surprises, a lot of combinations of buttons is surprises". Similar to IE, II mentions that the user does not really want to learn how to master this layout - "then a part of the purpose would disappear".

Dialogue or Command

All of the interviewees describe the interaction more as a dialogue rather than instructing the layout. IG mentions that it results in more dialogue compared to the other layouts. IH experienced "a lot more conversation" and the user had to be more focused and perceptive during the interaction: "Unpredictability can sometimes be scary and sometimes be rewarding [...] if you are looking for control, it's acting mean, but if you want to break your habits, it's rewarding". IB also describes the interaction to be more based on dialogue: "A little more dialogue with this one, because I have to, when I lay out triggers I have to listen to it and understand what it does, so it becomes more back and forth with this one". IF, who thinks Blocks allows for more dialogue than Spiral, says that the dialogue the user experienced was "very good" and "unexpected": "I didn't know where it was going, trying to figure it out, and that's really fun I think. Yeah, when you're learning something and you're making something creative with it at the same time. I think it's the best feeling". The same interviewee describes the dialogue as "improving" as the user would understand the layout more and more. The layout is also described to possess a balance: "not too confusing, not too straight forward, and actually fun". Structured chaos, or "controlled random", is described by IF to be "the best thing in electronic music" and the user is surprised that this parameter is not utilised more by manufacturers. II describes the interaction as follows: "It tells me how it should sound. I suggest something but it answers with another suggestion" and describes it as that the layout has the advantage, leading the dialogue. IE describes the interaction in a similar way: "Definitely a dialogue, or I just listen to it, it's the opposite of instruction, you know, it is instructing me".

Variations or Repetitiveness

When discussing if the layout invites for variations or lead to repetitiveness, all test users say that this layout invites for variations. IH says that there are "a lot of varying results" because the layout invites the user to try different things and interactions. IF is along the same lines and says that the user came up with "cool variations" when "trying to figure it out" and adds: "and I was actually getting interesting beats, considering how interesting it can be in a very basic feature set". II thinks that variations are achieved "very easily" because of how some gestures do not result in what the user thinks it will. The user also mentions that the gestures the layout affords result in variations.



Figure 6.25: *The Traditional Layout "16-in-a-row"*

6.4.5 16-in-a-row

As a reference, the same topics were briefly discussed regarding the 16-in-a-row layout provided in the prototype. Swiping gestures are only mentioned to be used in specific cases when the users want to activate all 16 steps or a range of steps that are oriented next to each other. All users agree that this layout provides the feeling of control: Both IB and IG describe that they have "a lot of control" and refer to their long experience with this layout. IF describes it as "a very traditional one. So you get full control of what you want to do. A lot of people would recognise this [...] very easy to use, very straight forward, very traditional. You can slide really good on this one". However, the user adds that, unlike the alternative layouts provided, the 16-in-a-row layout is lacking gesture-based functionalities: "But again, this is lacking on every single sequencer [on the market]". IB, IF, IE and IH discuss how the provided 16-in-a-row layout lacks "divisions", "numbers or extra graphics". The alternative layouts, on the other hand, have steps that differ in shapes and sizes and can be visually distinguished by nature. In the provided 16-in-a-row layout, IE describes the feeling of control to be "90% or 88%" because it has "no divisions at all". IB says that "there is no visual information indicating the 'crucial steps' compared to the other layouts but that the user still knows that "there are three steps between them, so I know what I have". IF says that the 16-in-a-row layout is "harder to control without the numbers" and IH describes it as: "It is interesting because when it is presented in the same way as the others, no numbers or extra graphics, it's quite the worst. It doesn't possess that predictability in the right way and you won't get as happy if you fail to place something specific".

"When I started with music and got to meet others that worked with music, you got to learn that you program music, I would've said that you are turning and twisting¹ a sound. Then you realised that it was engineers that worked with this: It should be exactly like this and this is how you program it. But then it becomes pretty boring. What do I want to say with this? These little boxes really become a way of programming. The other stuff that you are exploring, yeah, it becomes something different. Maybe you add conversation in something that has been based on programming before" - IH

IG says that it is "really easy" to achieve and realise specific ideas using the 16-in-a-row layout but adds that "you have to put in more effort to come up with something new". IF describes the layout to be "really easy to understand" and, therefore, makes it a good tool to realise ideas with. IE and IH also think it is easy to use the layout to realise ideas. IE says that the perceived control is "like 90%, it's pretty easy" and IH says that "you can discuss if it's the best way or not, but it's what I have gotten

¹Translated from the Swedish expression *skruva till*

used to".

The users describe this layout to be more about instructing it rather than having a conversation with it. IB describes this type of layout as "the best drummer in the world that does whatever you tell it to do and never shows up with a hungover" but adds that there is not much of a dialogue going on. IE says that the interaction is perceived to be "mostly instruction" and the user is not sure if the mistakes resulting from activating the wrong step because "there are no divisions" can be considered a conversation or not.

The users are expressing that they generally achieve less variations when interacting with this layout compared to the alternative layouts. IH describes it as follows: "With this one, I feel that you can get stuck and do the same things over and over because it's hard to break free". One trick the interviewee uses to break free in systems and layouts like these is to use complex sounds: "then it could get interesting again, but in a 909-world, yeah, you easily get stuck in the same patterns".

6.4.6 Alternative Layouts using Touchscreens

All users express the experience of interacting with alternative step programming layouts on a touchscreen as positive. Regarding the anticipated experience, IG says that the provided layouts initially looked rather strange but after some use they were "nice" and "fun" to use. The user thinks that the experience of using touchscreen specifically for step programming was "pretty good actually" and adds that providing haptic feedback in the future could enhance the experience even more. IE, on the other hand, mentions that the immediate visual feedback is so strong that the user does not miss any haptic feedback. IB expresses the general experience as "interesting" and that the alternative concepts work well on a touchscreen. The user mentions that the concept of touchscreen interaction could be utilised even further in terms of working with and creating variations as the interviewee sees potential in the interaction possibilities. IG also mentions that visualising multiple tracks at the same time using alternative layouts would be interesting. IE describes the experience as follows: "Oh, it was fun, it was fun. It was fun to do. I don't normally do this kind of thing. It's fun and I see the potential of it". II expresses the experience as positive because of the way the layouts surprised the user: "I think that it's been nice, as I said earlier, I like being surprised, programming in a way I haven't thought of earlier [...] I'm pretty used to program in one way and then it's very nice to be able to get surprised and I did get surprised by all these layouts". IH describes the experience as a mix of feelings but says that if the system could be integrated with the user's studio setup, these types of layouts could be "really justified" on touchscreens.

6.4.7 Potential of Alternative Layouts

The test users were asked if they had any favourite out of the four alternative layouts. IG prefers Tetris and refers to its visual expression and aesthetics as a factor. The way the steps are graphically woven into each other is mentioned to propose different

kinds of rhythms from what the interviewee is used to. II also likes Tetris the most and motivates this: "There is a balance between getting surprised and it acting as I thought". II adds that in some cases you want to be fully surprised as a user but a certain amount of control is desirable which is something the user experiences with Tetris. However, switching between the different layouts to get new input and learn the different layouts is something II value in the prototype. IB favours Spiral and describes it as "futuristic" and that it reminds a little of a "space dashboard". IB also thinks that this layout "works well as an app in itself" and that "it is very good looking". The user also likes Crystal but does not fancy the spikes and their visual expression. However, the user mentions that the layout as a whole is visually satisfying: "But the thing that's cool with this one is that it visually looks a little like a waveform. It also possesses a visual expression which is appealing". IH favours Spiral as the layout and the patterns that result from activating steps provide a good overview. IH experiences a potential in Spiral and Crystal but would like to be able to modify the different shapes and sizes of the steps within the interface in order to give them user-tailored expression and value. Blocks was the favourite layout for both IE and IF. As earlier described, IE mentions that it is enjoyable because of its unpredictability. Nevertheless, the arrangement of the steps provides a comfort: "But the way your buttons are arranged makes me feel like I'm never gonna do anything wrong". One reason that IF favoured Blocks is because the sequencer does proceed visually non-linear which enables more dialogue. The layout made IF happy because it goes in a direction that the user always has asked for in the industry.

"It was a good experience, [...] a touchscreen and this type of innovation in music sequencing, or pushing forward, yeah, it felt totally correct and good" - IF

The interviewees were asked if they could see themselves using alternative interfaces like these integrated in their studio- or live setups. IG says: "Yes, I think I could" and that this type of layout could work well in physical standalone products as well as a tablet application. Some of them are mentioned to work well integrated into a physical product because of their appealing aesthetics while some could work better as inspirational tools. IB, IE, IF and II say that they could see themselves using layouts like these if they were to be technically implemented effectively. IB says: "I think that this whole concept could be very exciting to make as a controller that you connect to Ableton Live". Connecting a tablet to an existing system and using these type of layouts could result in "a very interesting drum machine, or what should I say, control surface, sequencer that you can use. I think that would work pretty good". The user describes that the concepts could also work well as a physical drum machine using conductive control surfaces but mentions that manufacturer limitations quickly tend to make products like this very niche. IF expresses that the user would "absolutely" use a tablet application like this if it would be possible to connect it to other drum machines. The interviewee describes that this would advantageously force the user to "do stuff in a different way". If IE was sure that the interface would be synchronised with the user's other equipment with high accuracy and no sign of latency, the user "would maybe start to use some of these sequencers on a touchscreen". The interviewee, however, states that it, in this case, would be

desirable to be able to "take advantage of the touchscreen surface in many, many more ways. I would also want some more colours, yeah, I would want it to be more aesthetically pleasing". II says: "Yes, I could imagine that. I would like to see that it has MIDI-out". The interviewee has previously been using tablet applications mainly to control other equipment rather than using their internal sound engines. On the other hand, IH who rarely uses separate sequencer controllers would preferably use this type of layout if it had its own sound engine: "I would want an exciting sound engine so that it can stand for itself". The user mentions that a sequencer preferably should have at least a small integrated sound engine for the user to connect it to other equipment and says that if these types of alternative layouts would come packaged with an interesting sound engine, the user would use it for live performances.

6.5 Evaluation of Concept Layouts with Beginners and Intermediates

In this section, the result from the user tests with beginners and intermediates will be presented. The results from the semantic word scales are presented in diverging bars with neutral split to provide an overview of the participants' opinions.

6.5.1 Tetris

For Tetris, a majority (17 participants) thought it was either in the middle of clear and confusing (eight participants) or more towards clear (option 5 by one participant, option 6 by five participants and option 7 by three participants). One novice user thought it was confusing (option 1), while three of the users with some experience thought it was slightly more confusing than clear (option 3). One intermediate user who chose options 7 says that "this layout adds great value to the classic four beats/bar layout. It makes it easier to see where you are and where you should put your triggers". A beginner, who also selected option 7, says: "It felt very intuitive, very logical feedback. It visualised what happens in a good way, for one that does not play the drums, independent on sound".

A vast majority (20 participants) thought the layout was inspiring (option 5 or 6). An intermediate user, who selected option 5, says that "it divides them [the steps] differently. If I want two: take the big ones, if I want four: take the smaller ones. One gets help to choose the right steps to get a straight rhythm". A beginner that chose option 6 says: "I liked that it was different sized patterns for the different steps and that you can swipe to easy access different rhythms". Another beginner, who also selected option 6, says that it was "easy to understand".

Is Tetris perceived as complex or simple? The average score lands at 4.5 (i.e slightly more simple than complex), however, there is a diversity in how it is perceived among the participants as the answers are spread between rather complex (option 2) and simple (option 7). The same goes for unpredictable/predictable. The average is 4.3, but the answers range from 2 to 7. It can be interesting to note that none of the intermediate users chose option 7 while three of the beginners did. One beginner

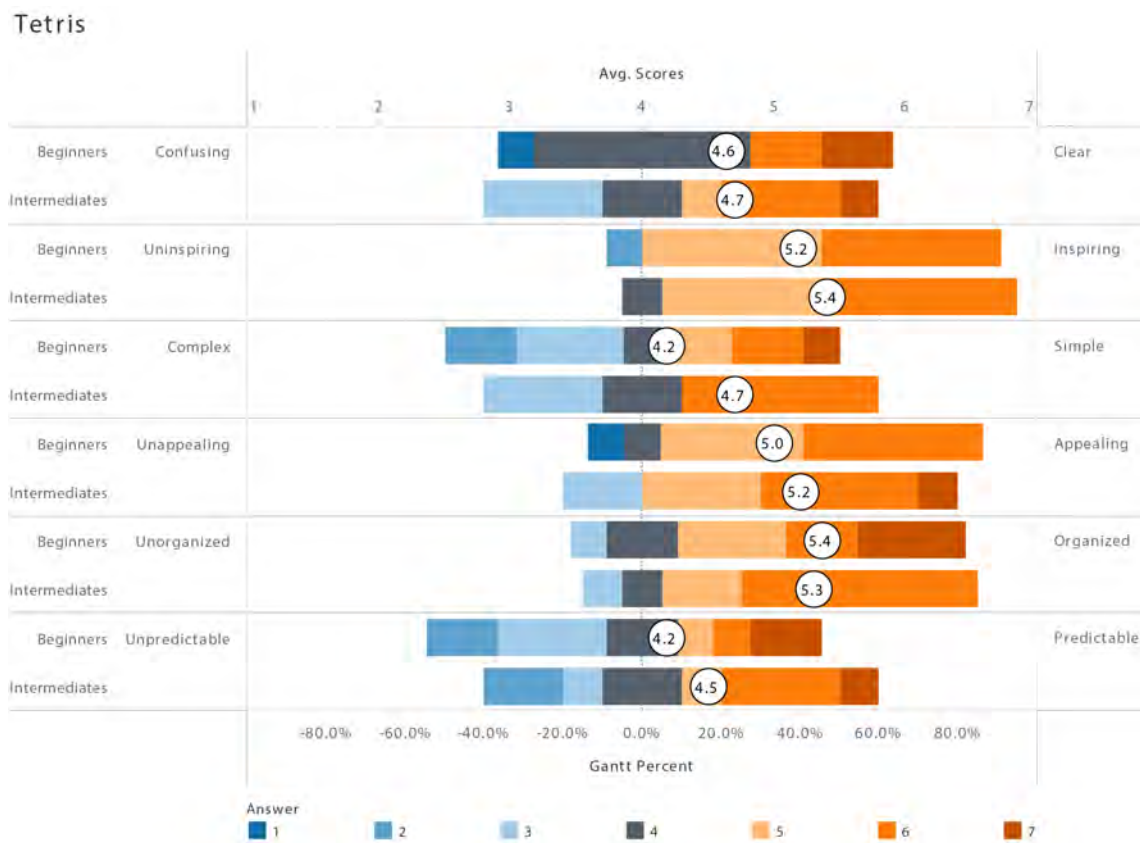


Figure 6.26: How the participants from the beginner and intermediate evaluation rated Tetris. The answers are separated between users that have no previous experience with drum machines (beginners) and users that have some previous experience with drum machines (intermediates)

says that it was "a bit hard to swipe since I don't know what will happen and you can not reach all combinations by swiping". The same participant, however, considered Tetris as predictable. An intermediate user who thought it was rather unpredictable (option 2) says: "Initially I thought that the bigger steps should take more space [in the rhythm]". A beginner that thought it was both rather complex and unpredictable (option 2 on both questions) says: "If you use it for a while I think you will like it more, for example, it was a bit difficult that [step] number one was bigger than the rest of them, it takes some time to understand where it leads". Another beginner also thinks it could be "cool to use when you have used it more and learnt how it works" and an intermediate says: "I would want to spend more time with all of the layouts to be able to evaluate them fairly".

A majority (15 out of 21) thinks Tetris is more appealing than unappealing. The average is 5.1. Two of the participants with previous experience selected option 2 and two of the participants without experience selected option 1 and 4 respectively. One of the participants that put the lowest score on each category (except for unorganized/organized and unpredictable/predictable where the user was neutral) says: "I do not see music linearly and it is too far between 4:4 and 1:1". This user had no previous experience of using drum machines.

6. Results

A majority of the users (16 participants) thinks Tetris is more organized than unorganized. Three participants were neutral and two thought it was slightly more unorganized (option 2).

To summarise, the average user thought that Tetris was rather inspiring, appealing and organized. It was considered to be in the middle between confusing/clear, complex/simple and unpredictable/predictable with a slight weighting towards the latter of the words. All scores can be found in figure 6.26 and 6.31.

6.5.2 Spiral

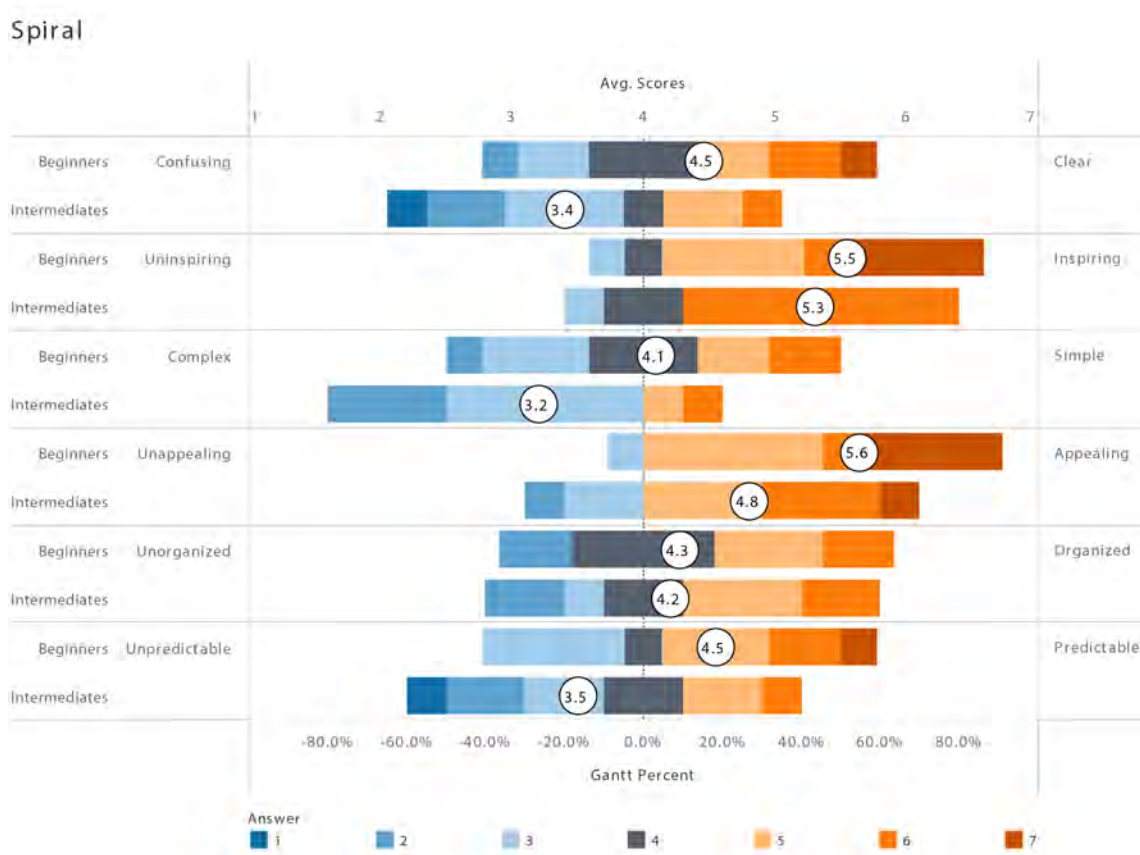


Figure 6.27: How the participants from the beginner and intermediate evaluation rated Spiral. The answers are separated between users that have no previous experience with drum machines (beginners) and some previous experience with drum machines (intermediates)

For Spiral the response was spread between confusing and clear, making the overall average land at a 4. The average for the beginners was 4.5 which is slightly higher than the average for the intermediates which was 3.4. However, there were participants in both groups that rated the layout as confusing as well as clear. One intermediate user that rated Spiral as rather clear (option 6) says that it was "interesting and structured in a circle but still a bit confusing as it doesn't feel like a regular timeline".

A majority of the users (16 out of 21) thought Spiral was more inspiring than uninspiring. There was one person in each group that rated it with option 3. A majority of the beginners rated it as either 5 (four participants) or 7 (four participants). A majority (seven participants) of the intermediates selected option 6 on the scale and no user from this group rated it as a 7. One intermediate that rated it as 6 says: "I had great fun playing around with it. Got me out of my ordinary way of thinking which was inspiring. I felt like I was playing a game which was nice". One beginner that also thought Spiral was inspiring (option 6) says: "It felt fun and creative. I like that it spins around". One beginner, who rated it as a 7, says: "This one made me most creative" and another beginner who also selected option 7 describes Spiral as follows:

"It was inspiring. I felt like it gave depth to the sound image in an abstract way. It's harder than the previous one [Tetris], less intuitive at the beginning but it grew on me. [...] It felt logical to play in a sphere, it is a circle, it is a loop"

For the words complex and simple the beginners are more or less evenly spread out between option 2 (rather complex) and 6 (rather simple) with an average at 4.1. The intermediates rate it as more complex with an average at 3.2. None of the intermediates chose to respond with the neutral option 4 while four of the beginners selected this option.

A majority of the users (17 out of 21) thought Spiral was more appealing than unappealing with an average at 5.6 for beginners and 4.8 for intermediates. No user selected option 4. One beginner and two intermediates chose option 3 (slightly unappealing) and one intermediate selected option 2 (rather unappealing). More beginners (four participants) than intermediates (one participant) chose option 7. One beginner that rated it with option 7 says:

"Really nice that it spins inwards, it becomes easy to make 'up-beat-music', clear how to use it if you want to make a build-up or something. If it is a dance-song you can use it for the build-up since it makes it easy to escalate the beat. Easy to understand and nice to look at. More appealing for me"

The answers regarding the words unorganized and organized range between 2 (rather unorganized) and 6 (rather organized) for both groups. Option 4 was the most selected option by beginners (four participants) and option 5 was the most selected option by intermediates (three participants). An intermediate that ranked it with option 3 says that spiral is "smart when you understand it but it feels a bit messy to create something that doesn't have even space between each [activated step]".

There are mixed opinions when it comes to predictability. For the beginners, the average is leaning slightly more towards predictable (4.5). However, four of the users from this group rated it as a 3 (slightly unpredictable). Only one participant selected option 7 (predictable). For the intermediates, the average is 3.5 where one participant chose option 1 (unpredictable) and one selected option 6 (rather

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predictable). The rest were evenly spread out with two users on each option in between. One beginner, who rated it as a 4, says: "You got to think and see how it spun around. I felt like you needed to test it back and forth to understand how it worked. Test to hear which beats it produced. Then, when you had learned the pattern, it was easier". One intermediate, who chose option 3, says: "You work with different sizes [of the steps] and depth but it does not affect the sound. Visually it feels like it moves away from you, but the sound is the same. The visual mapping doesn't match the sound".

To summarise, the average user thought that Spiral was rather inspiring and appealing. For the other categories, the average was somewhere in the middle. However, the majority of answers were not neutral but instead spread out among the different options, meaning it was perceived differently by different users. The scores can be found in figure 6.27 and 6.31.

6.5.3 Crystal

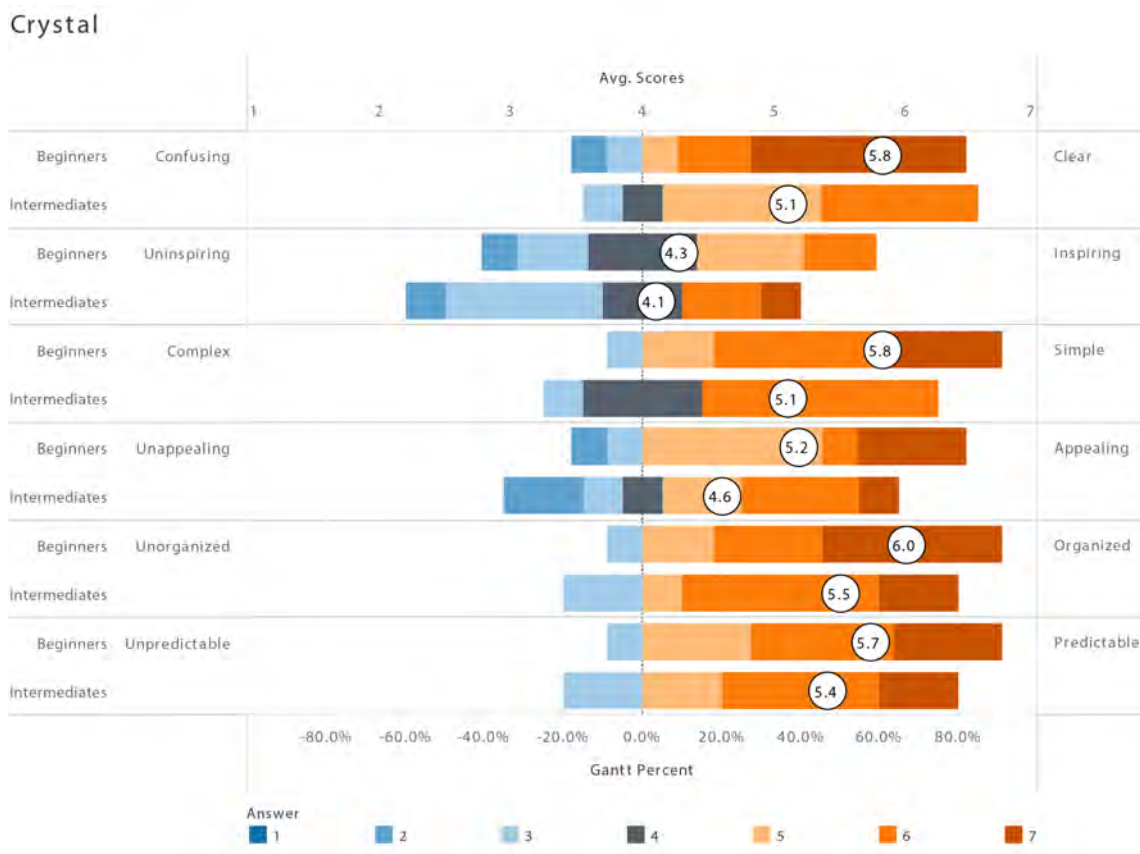


Figure 6.28: How the users from the beginner and intermediate evaluation rated Crystal. The answers are separated between participants that have no previous experience with drum machines (beginners) and participants that have some previous experience with drum machines (intermediates)

A majority of the participants (17 out of 21) thought Crystal was more clear than confusing. The majority of the beginners (six participants) marked it as a 7 (clear),

one marked it as 2 (rather confusing), one as 3 (slightly confusing), one as 5 (slightly clear) and two as 6 (rather clear). This gave it an average of 5.8. For the intermediates, a majority selected either option 5 or 6 (four users on each). One user marked it as 3, and another participant chose option 4. This leads to an average of 5.1. No intermediate marked it as a 7. One intermediate, who gave it a rating of 6, says that it is "a more clear direction on this one, it follows a mental model. The height of the steps could indicate volume but I don't think of it like that. It is not super-easy to access many of them [the steps], especially the small ones". A beginner, who marked it as a 7, says: "I like it because it is the one that feels most beginner-friendly".

The average user thought Crystal was in between uninspiring and inspiring. The answers for the beginners range between 2 (rather uninspiring) and 6 (rather inspiring), with most (three participants) at 5. The answers for intermediates range from 2 (rather inspiring) to 7 (inspiring), with most (four participants) at option 3. The one intermediate that marked it as 7 says: "This layout was extra inspiring when it came to hi-hats and toms. The sort of false idea that it would be easily mastered ended up in interesting syncopation that wouldn't have evolved from a more structured layout". One beginner, that marked it as 6, says: "The music created on this layout ended up being the best, it helps you to distribute the steps in a fair way without being visually complex". An intermediate participant that selected a neutral 4 on this question thinks that Crystal "did not add any greater value to the beat creation process".

A majority of the participants (16 out of 21) perceived Crystal as more simple than complex. One user from each of the groups thought it was slightly complex (option 3). Most of the users from both groups (eleven participants) chose option 6 (rather simple). However, three beginners marked it as a 7 (simple) while none of the intermediates selected this option. Three of the beginners and none of the intermediates gave it a neutral 4. The average is 5.8 for the beginners and 5.5 for the intermediates. One intermediate that selected option 4 thinks that the "shapes of the diamonds make it easier to map the steps to the beat". A beginner who selected option 5 says: "I used this one a lot. It felt obvious. Like I imagine drums. It felt intuitive, I don't know if the shapes added something from an interaction perspective, but it made it more inspiring".

A majority of the users (15 out of 21) thought Crystal was more appealing than unappealing. Three participants thought it was rather unappealing (option 2) and two thought it was slightly unappealing (option 3). One intermediate was neutral and selected option 4. The average score was 5.2 for the beginners and 4.6 for the intermediates. One of the beginners that marked it as a 5 says: "I didn't think it was appealing musically. I don't associate the spiky pattern to music". Another beginner that marked it as 2 agrees and says: "I don't like the sharp shapes, I prefer more round shapes". An intermediate that marked it as a 5 says: "Feels weird when it steps through like a timeline but the size of the triangles differs greatly which almost makes it a little annoying".

Overall the users thought Crystal was more organized than unorganized. Three users in total marked it as slightly unorganized. No participant selected option 4. The average score is 6 for beginners and 5.5 for intermediates. Option 7 (organized) was the most selected option by the beginners (five participants) and option 6 (rather organized) was the most selected option by the intermediates (five participants). One beginner who marked it as a 7 thought Crystal was the "nicest looking layout" but still thinks that, because of its linearity, the first and last step is too far away from each other.

A clear majority of the users (18 out of 21) thought Crystal was more predictable than unpredictable. Three participants marked it as a 3 (slightly unpredictable). The average was 5.7 for beginners, and 5.4 for intermediates. One beginner that marked it as a 7 says: "It looked cool and felt nice. You understand where the sound will end up. Easy to place steps".

To summarise, the average user thought that Crystal was rather clear, simple, organized, predictable and appealing. The average score shows that it was neither inspiring nor uninspiring. However, a majority of answers were not neutral but instead spread out. This means that there was a diversity in how the participants perceived the layout. The sharp edges are considered problematical by some and liked by others. All scores can be found in figure 6.28 and 6.31.

6.5.4 Blocks

A majority of the users (16 out of 21) considered Blocks as more confusing than clear. Four users thought it was rather clear (option 6) and one user thought it was slightly clear (option 5). Three of the intermediates thought it was confusing (option 1) while none of the beginners selected this option. No user chose the neutral option 4. One beginner who marked it as 3 says: "It looked a bit messy. I liked this one the least" and one intermediate who marked it as 1 says: "I did not grasp anything at the beginning, I needed to slow down the beat to understand. But even then it was hard to predict how it jumps. It feels smart but it's hard to work with". A beginner that chose option 3 says: "Easy to understand how it works, but messy in practice".

Ten users thought Blocks was more uninspiring than inspiring, six participants chose the neutral option 4 and five participants thought it was more inspiring than uninspiring. The two users that marked it as uninspiring (option 1) were intermediates and the one user that marked it as inspiring (option 7) was a beginner. An intermediate user that selected option 2 says: "Not as good looking compared to the others. That makes it uninspiring to use. It gives a heavy impression that doesn't feel slick. The buttons are too big for my fingers, it becomes strange. It gives a clumsy impression and doesn't feel like it's as much about precision".

A majority (15 out of 21) thought Blocks was more complex than simple. The two users that selected the lowest score (option 1) were intermediates and the two users that chose the highest score (option 7) were beginners. The average score is 3.2.

If Blocks is perceived as appealing or not depends on the user. All options are



Figure 6.29: How the users from the beginner and intermediate evaluation rated Blocks. The answers are separated between participants that have no previous experience with drum machines (beginners) and participants that have some previous experience with drum machines (intermediates)

represented by the users. In general, the beginners think it is more appealing with an average score at 4.7, and the intermediates think it is less appealing with an average at 3.1. The user that selected the lowest score (option 1) was an intermediate, and the two users that chose the highest score (option 7) were beginners. Five users thought it was neither appealing nor unappealing and selected a neutral score (option 4). One of the users that marked it as a 7 says the following:

"When it comes to intuitiveness there are some question-marks, but when you play there is a direct feedback that makes it feel logical. I don't associate the illustration with music/drums but when you play, something happens to your hand that makes it feel obvious. Because of this, I like it very much. The shapes feel repetitive, very techno. A good picture of the sound. Visualised what I was doing in a good way, even though I actually didn't really know"

Is Blocks perceived as unorganized or organized? The answers are spread out from one to seven which makes the average land at 4.1. Five users chose the neutral option 4. The highest and lowest scores are given by intermediates. One intermediate that marked it as a 2 thinks it was "hard to use" and continues: "I searched for symmetry

but didn't think it was reflected in the music. But probably it isn't true, if you figure out the symmetry, it will probably be reflected in the music".

A majority of the users (13 out of 21) thought that Blocks was more unpredictable than predictable. In general, the intermediates thought it was more unpredictable with an average of 2.6. The beginners' answers have an average score of 3.7. One intermediate that thought it was unpredictable (option 1) says: "It felt like it jumped around randomly (not from top left to bottom right over and over again)". A beginner that also selected option 1 says that it was "hard to see in which direction it was moving. I got to test several times to understand. I like this the least". One beginner that selected option 3 describes it as "minimal" and continues: "I like the simplicity of the shapes. A bit hard to get an overview by just looking at it but when I use it I think it becomes rather predictable in a good way". An intermediate that chose option 2 says: "I had to both think and test a few times before I got the results I expected. I think that this layout could work with a few modifications, perhaps adding numbers to each box". An intermediate who thought it was unpredictable (option 1) says:

"I felt like this was a little too unpredictable. Building a groove for me is trying something, evaluating over and over again and most of the times deleting your last move. This layout surely generated surprises in both good and bad ways but it was hard to go back and edit the less appreciated parts since it was not clear even when you concentrated really hard which hit referred to which button."

To summarise, Blocks was considered clear, inspiring, simple, appealing, organized and predictable by some participants. However, for most users, it was perceived as the opposite. The total scores can be found in figure 6.29 and 6.31.

6.5.5 Standard

A vast majority of the users (18 out of 21, were 14 chose option 7) considered the standard layout as clear. One of the beginners thought it was confusing (option 1). Two intermediates thought it was neither confusing nor clear. One intermediate that marked it as clear (option 7) says: "Although a little boring I like the clarity this traditional view gives me". A beginner who also chose option 7 describes the layout as "clear and simple" and says that it "feels a bit more ordinary".

A clear majority thought the standard layout was rather uninspiring (18 out of 21). Two users chose to put their mark in the middle and one intermediate thought it was inspirational (option 7). The lowest score (option 1) was placed by two beginners. One of these users says: "It does not feel like I create music, it becomes more like math". Another beginner who selected option 2 says: "It does not give me as a beginner so much inspiration. It does not give any clues on what may sound good". Another beginner that also selected option 2 says: "I didn't use this layout so much, I used the other ones, but I used it in the beginning since it feels accessible, [...] it feels safe. [It is the] easiest one to identify [the steps on], it feels like a keyboard".

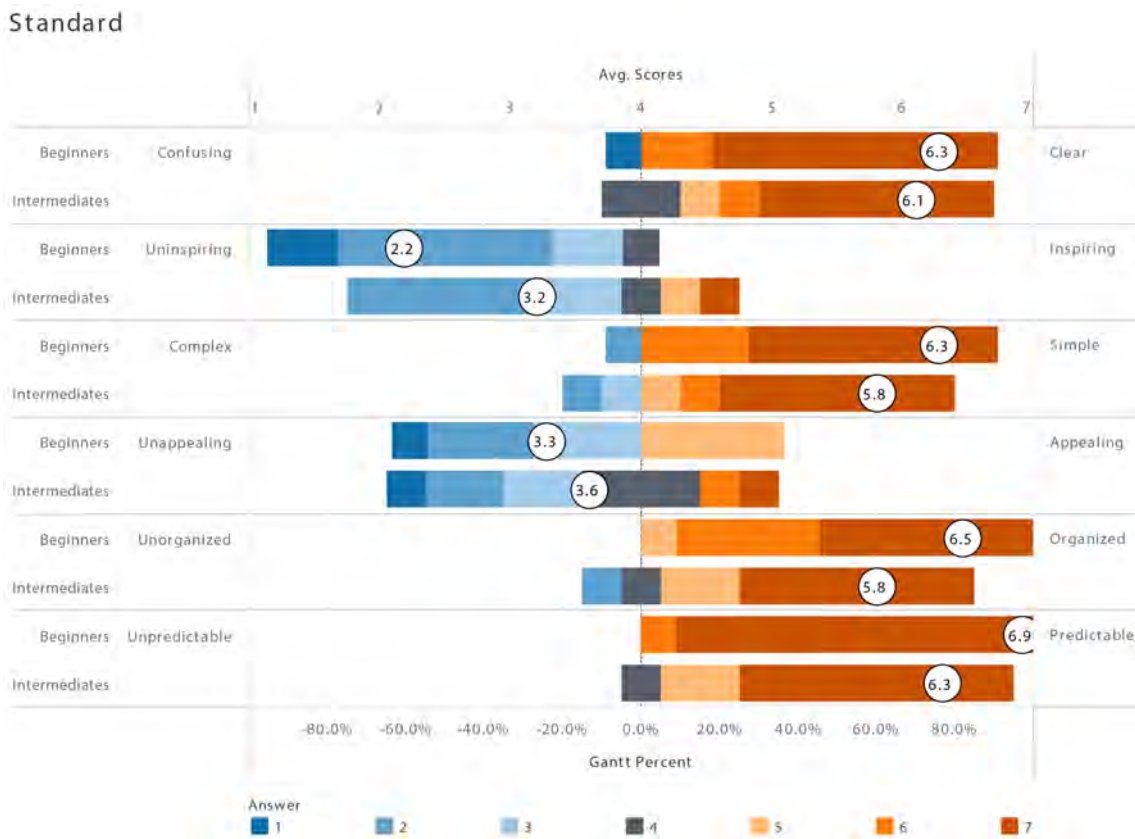


Figure 6.30: How the users from the beginner and intermediate evaluation rated the traditional 16-in-a-row layout. The answers are separated between users that have no previous experience with drum machines (beginners) and participants that have some previous experience with drum machines (intermediates)

A vast majority (18 out of 21 users, where 13 chose option 7) also thinks the standard layout is simple rather than complex. Two users thought it was rather complex (option 2), one with and one without previous experience of drum machines. The intermediate participant says that it is complex and unorganized since "it is hard to distinguish the different steps" and explains how the user is forced to remember the number of the steps the user works with instead of remembering their shapes and sizes. Another intermediate who selected option 3 also says it is complex because "it is hard to distinguish the different beats". The user continues: "It is easy to understand how it moves but hard to distinguish specific measures. It feels easier to make mistakes [when reaching for a specific goal]". A beginner, who marked it as simple (option 7), describes it as "plain and simple".

A majority of the users (12 out of 21) thought it was more unappealing than appealing. Three of the intermediates thought it was neither appealing nor unappealing. The highest scores given were 5 and 6 placed by two of the intermediate participants. The average score is 3.4.

Almost all participants (19 out of 21, where 12 chose option 7) thought the standard layout was organized. One of the intermediates thought it was rather unorganized

(option 2) since there was no clear grouping of the steps. One beginner also thinks this is problematical: "It is hard to distinguish between the different groups of four, everything melts together [...] It makes it hard to remember which steps I have activated with another sound". A third user agrees and says that "it was hard to distinguish each fourth step".

20 out of 21 users thought the standard layout was more predictable than unpredictable. Out of these 20 participants, 17 selected option 7. One intermediate chose the neutral option 4. One beginner that thought it was predictable (option 7) thinks it is "too predictable for improvising beats".

One beginner says that it "takes a long time to create a beat" and explains that the reason for this is that it is not possible to do swiping gestures in order to activate multiple steps. Another novice user says that the standard layout affords swiping gestures more than the other layouts even though it is not as efficient. One of the intermediate users thinks that the standard layout had a clear purpose in relation to the other layouts:

"In this context, it [the standard layout] has a clear purpose. When you get lost in the more complicated layouts but feel like you are close to something good it was nice to be able to enter this mode and easily clean up your groove. Although the more complex layouts took you to interesting places musically, they are not optimal for the smaller adjustments [for example when moving a hit one step back or forward]"

To summarise, a majority of the users thought the standard layout was clear, simple, organized and predictable. However, it was considered rather uninspiring and not so appealing. The overall scores can be found in figure 6.30 and 6.31.

6.5.6 Layout Comparison

In general, the alternative layouts were rated with higher scores by beginners compared to the intermediates, apart from Tetris where the intermediates rated it slightly higher. For the standard layout, the intermediates rated it as more inspiring and slightly more appealing than the beginners.

The layouts with most spread answers regarding the words confusing/clear, complex/simple, unorganized/organized and unpredictable/predictable were Tetris and Spiral. These two layouts also got the highest average score on inspiring and appealing. The layout with the highest score on the four categories: confusing/clear, complex/simple, unorganized/organized and unpredictable/predictable was the standard layout. However, this layout was rated as the least appealing and inspiring layout. Crystal also had high scores on the four categories mentioned above and was considered less inspiring and appealing compared to Tetris and Spiral. Blocks got the lowest score on the four categories mentioned above. However, it was considered less uninspiring than the standard layout and just slightly less appealing than Crystal. The scores of the layouts can be compared in figure 6.31 and figure 7.1.

During the observations, it was noticed that many of the participants used tapping gestures more than swiping gestures. When the participants used swiping gestures it was often being utilised to activate steps close to each other or to add variations. In many cases it seemed like the different shapes and sizes of the steps were used more as a visual aid for distinguishing the steps from each other. However, the whole area of all steps were also utilised for tapping gestures. The standard layout seemed to invite for swiping gestures. Two of the participants mentioned this and during observations, it was noticed that this was, by some participants, the only layout where swiping gestures were utilised.

Preferred and Disliked Layouts

The layouts the users considered their favourite and the layouts the users did not like are presented in figure 6.32. The participants could only select one layout as their favourite, but multiple layouts they did not like. The participants were also provided with the option "none" on both questions. All user selected a favourite. Four users, one beginner and three intermediates used the option "none" when asked if there were any layouts they did not like.

Tetris was considered the favourite layout for eight of the participants (three beginners and five intermediates). The users liked Tetris because it provided a good overview and was easy to understand but still allowed for happy accidents. One of the beginners says: "If I press at the steps that looks the same I know I will get an even rhythm" and another one says: "It gives a good overview but at the same time you find new rhythms. You know what you do but at the same time, you can be surprised, in a good way, at times. It was satisfying that there were large areas that became filled when you pressed [the steps]". A third participant says: "I can fast get a good overview. I see how everything is connected. I don't need to interpret it - I get it!". An intermediate participant says: "I think this one adds most clarity to what is going on. Very little resistance between thought and action". Two of the intermediates think that the fact that it is still represented as a linear timeline provides a good overview while it, at the same time, is perceived to be "something new". One of the intermediates describes Tetris as "a good combination of fun and useful" and continues: "I feel cool when I use it". Another intermediate participant describes it as "playful" because it allows for swiping gestures. The same participant thinks it is easier to distinguish the different steps from each other using Tetris and adds that it probably would be more fun to use Tetris once you have learned to master it.

Two users, one beginner and one intermediate, did not like Tetris. The beginner says that it was "too complicated" and the intermediate user thought Tetris would be good for the kick drum track but found Crystal to be even better suited for this purpose. For the other drum sounds the user says that "it sounds weird when the first punch is so dominating".

Two users, one beginner and one intermediate, had Spiral as their favourite. The intermediate motivates it as: "It felt slick. There was a clear direction and I quickly

6. Results

All Layouts

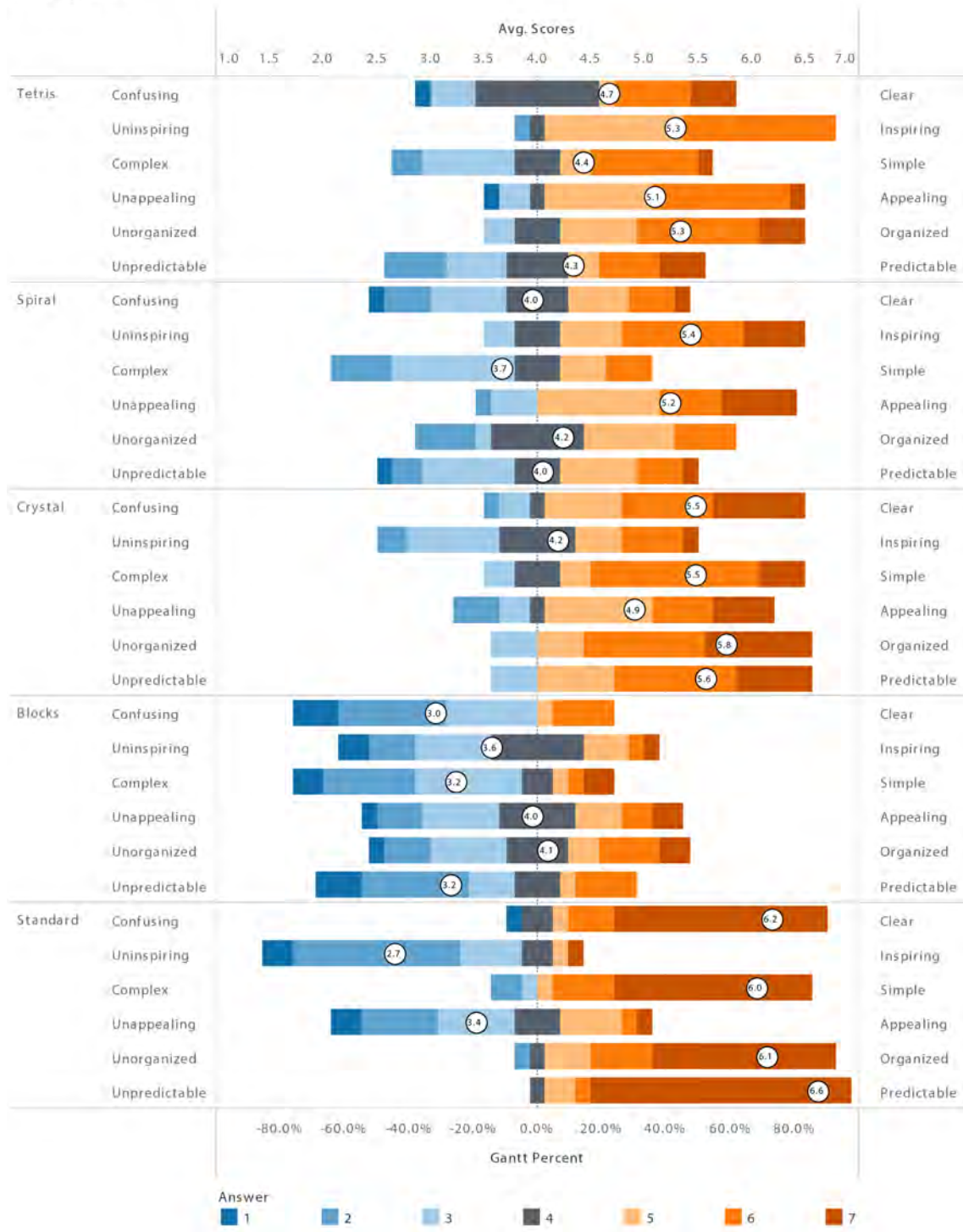


Figure 6.31: The results from the semantic word scale evaluation for all of the layouts in the same figure.

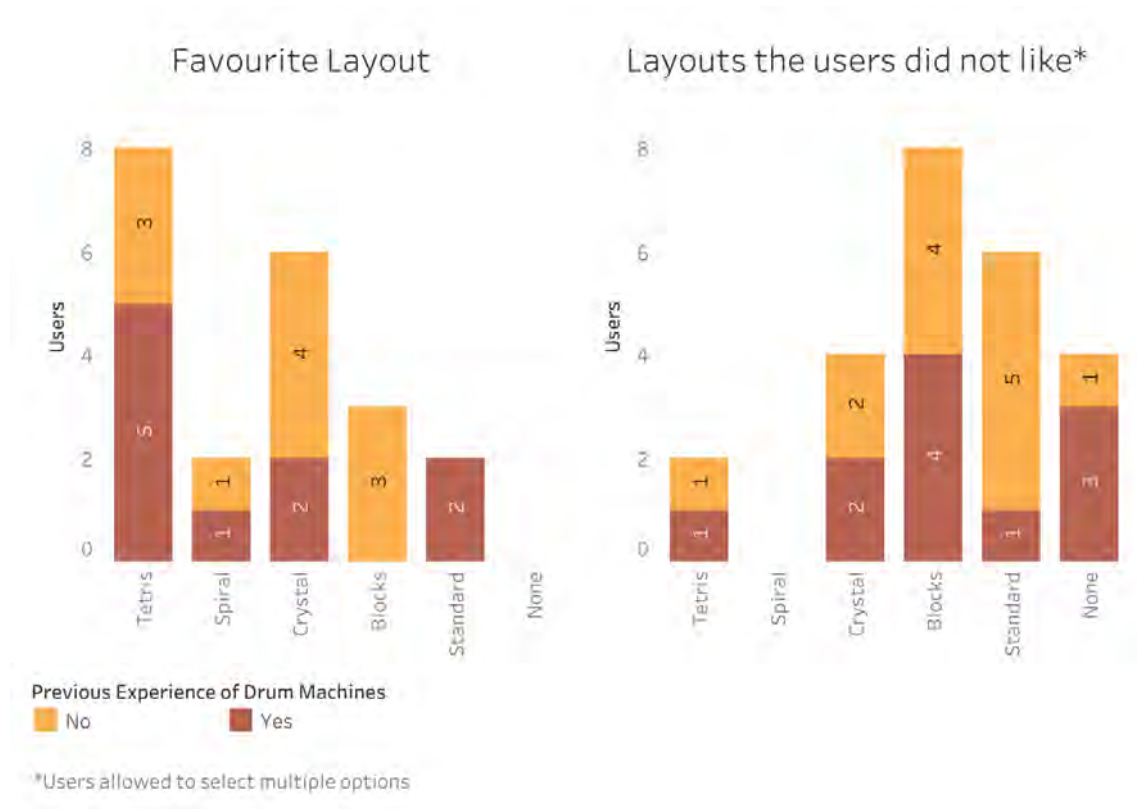


Figure 6.32: *Left: describes which of the layouts the users considered their favourite. Right: describes which layouts the users did not like.*

grasped how it should be used. It being round is a clear advantage". The beginner simply says that it was fun to use. Four other users mentioned Spiral as their second favourite. No user say that they disliked Spiral.

Six users had Crystal as their favourite, four beginners and two intermediates. One beginner says: "It gave clues on how you should do, but still felt fun". An intermediate participant says: "It helps me to organize it, the music becomes really good!". Another intermediate says: "It was very swipe-friendly and generated syncopation that I don't think I would have come up with deliberately. I still had an idea of where in the groove there was air and where it was crowded which made it easy to make good arrangements". The layout was also described to be "clear and cool" and "simple but yet innovative" by other participants that favoured Crystal. One participant mentioned Crystal as the second favourite.

Four users, two beginners and two intermediates, say that they did not like Crystal. One of the beginners says that crystal was "the most baffling and unclear layout, but at the same time this made it a bit funny since it becomes more random". The other beginner says that the user did not like the sharpness of the shapes: "It felt like there were more steps than there actually were" and one intermediate says: "I have a hard time with the pointy shapes".

Three users, all beginners, had Blocks as their favourite. One of them says: "It

made really unpredictable beats that were very groovy. I feel like I understood enough to be able to play around but little enough to be surprised, good mix". Another participant says: "It felt intuitive, even though I'm not familiar with the logic behind music. The feedback was really good. The visualisation made it easy to learn, the pattern amplified the experience of the music". The third participant liked it because it was considered to be the most non-linear layout.

Eight users, four beginners and four intermediates say that they did not like Blocks. One beginner says that "there was too much to think about and take in, it all jumped, but it still felt intuitive in some way". Another beginner says that Blocks was "hard to understand", however, the user thought it was "musically more appealing" than Crystal. Another beginner says that it was "unclear and hard to grasp". One of the intermediates says that Blocks "was just complicated" and another participant thought it was "a little bit too random and not as symmetrical". The third intermediate says "it was hard to look at" and the fourth says: "I didn't become inspired. It feels heavy. I don't see it as an instrument".

Two users, both intermediates, chose the standard layout as their favourite. One motivated this choice by simply saying that the standard layout was clear.

Four users, three beginners and one intermediate, did not like the standard layout. One beginner says: "It felt uninspiring. The other layouts became a motor for the music, this didn't. It didn't provide any flow". Another participant says: "Compared to the other ones I feel like I had too much control. It was hard to be spontaneous" and adds that the layout could be "nice" if the goal was to recreate existing rhythms. The third beginner says: "It was too simple. And difficult to distinguish the different steps". The intermediate participant felt like the standard layout did not provide any "assistance" compared to the other layouts. Two other participants mentioned the standard layout to be "too boring".

7

Discussion

This chapter discusses the execution and result of the thesis with a focus on the initial user study and the evaluation of the alternative layouts. The generalisability of the research and suggestions for future work are also discussed.

7.1 Process & Execution

This section discusses the execution of the expert user study and the evaluations with expert users and beginners/intermediates.

7.1.1 Expert User Study

The expert users involved in the initial user study are using drum machines and step sequencers as primary tools when producing and performing music. All the interviewees work with electronic music and genres such as electronica, techno and electro among others. It is important to note, however, that there are other users within *many* other genres that utilise drum machines as tools when producing and performing music. This means that the sample selection does not cover the whole spectrum of where drum machines regularly are being used. Users from genres such as hip-hop, pop music, post-disco, post-punk and alternative rock music, just to mention a few, are not represented in this user study. It is likely that, in the same way the user need is subjective and individual, the user need is also dependent on what style of music the user is working with as it is part of the context and user goal. Therefore, it is of the essence to note that users from other genres may prioritise other types of interactions, layouts and functions. The same remark is applicable to the following evaluation and user tests with expert users.

7.1.2 Evaluation with Expert Users

The evaluation of the alternative layouts is considered successful given its conditions. However, there are important parameters that might not be reflected in the result which needs to be discussed. Firstly, the execution of the user tests was carried out remotely for three reasons: (1) the majority of the test users were based in other geographical locations than the authors, (2) the Covid-19 situation made it impossible for the authors to physically attend the user tests and (3) remote user

tests allowed the users to test the prototype for an extended period of time. Based on these conditions, the user tests were decided to be carried out remotely and unmoderated. The first weakness of this approach is the lack of observation. The test users were asked *how* they interacted with the different layouts which led to a good coverage of what gestures were mainly utilised and afforded by the different layouts. However, due to the lack of observation it is not certain that all swiping gestures utilised were covered in the result. There is a probability that the test users utilised gestures and interactions that were neither described in the interviews nor predicted by the authors.

To be able to evaluate cumulative user experience (i.e. experience formed by repeatedly usage and periods of non-use over time) the users had access to the prototype for a period of time (i.e. a week or more). However, when evaluating musical controllers *learnability* is a crucial parameter to consider. It can take years to master an instrument or musical controller and the cumulative user experience will be dynamic through this process of evaluation. Evaluating the long-term cumulative user experience would require a longitudinal study which was simply not possible because of the given time constraint. This type of study would also require the prototype to be fully compatible with the expert users' existing systems in order to encourage and incentivise further evaluation within its intended context. In the end, some users did not dedicate more than a few minutes per layout which is nowhere near a long-term cumulative user experience. However, providing the prototype for a week (or more) did allow for a total evaluation of anticipated, momentary and episodic user experience as the users were able to have an indirect experience before usage, experience from usage and reflection after usage. The summative evaluation of the alternative layouts included the 16-in-a-row layout as a frame of reference. The reference layout was integrated in the prototype to give it the same level of fidelity as the alternative layouts. It is important to note, however, that because of the extent of its application, the users often referred to the 16-in-a-row layout as a general concept rather than to the one integrated in the prototype. The users' familiarity and previous training with the 16-in-a-row layout makes it difficult to draw comparative conclusions regarding the usability of the alternative layouts and if an alternative layout could work as a substitution for the traditional layout in the future. However, the executed evaluation and its format made it possible to evaluate how the different layouts, including the traditional layout, are perceived and what they may offer in terms of user experience.

The fact that the prototype was not compatible with the users' existing systems made some parts of the evaluation more theoretical. The users were asked to elaborate on how and in what situations they could see themselves using an alternative layout but did not get to explore and experience how it would be to use the layouts within a natural context. A longitudinal study using a compatible prototype would be necessary to strengthen the result which is now based on explorations isolated from the natural context and conceptions of use within the context of studio music production and live performances.

The outcome from the user tests were carefully reported by meditating all the users'

essential descriptions, reactions, interpretations, experiences and comments. The subjective nature of the results as well as the fact that it is generally difficult to evaluate whether a musical interaction is successful or not, the decision was made to describe the whole picture communicated by the expert users rather than just a general summary. This detailed outline makes a good foundation for the discussion and conclusion in this report but hopefully also for future investigation and further analysis.

7.1.3 Evaluation with Beginners & Intermediates

About the first half of the user tests that were carried out with beginners and intermediates was moderated by either one author present or both of the authors present. This approach made it possible to gather data beyond the provided questionnaire by simply observing the interaction and discussing the layouts with the participants. However, because of the Covid-19 pandemic, the decision was made to further execute unmoderated user tests by sending the prototype and questionnaire along with instructions to additional participants. The natural trade-off for this additional data was that some participants involved in the evaluation were not observed and further discussions were not carried out. Moreover, some of the participants that participated used smaller touchscreens as they did not have access to any tablet device. However, the screen size utilised by each user was registered in the questionnaire. Nevertheless, gathering more data points for this quantitative evaluation was considered valuable and worth the trade-off. The authors have during the process ensured that the prototype is responsive to any screen resolution and size. All types of possible interaction gestures are feasible even on smaller touch screens whereas the most noteworthy downside is the decreasing accuracy. The layouts were, however, evaluated in comparison to each other and presented with the same given conditions meaning the data is still considered to be credible. Nevertheless, more participants would be needed to be able to draw further conclusions and strengthen identified patterns.

None of the participants had the same level of expertise as the participants from the expert user evaluation. The participants were asked to report their previous experience with drum machines on a scale from 1 (i.e no experience) to 5 (i.e. high experience). The participants that communicated that they had no previous experience were categorised as beginners whereas participants that communicated their experience to be 2 or higher were categorised as intermediates. It can be arguable whether or not this categorisation can be justified as the level of previous experience was roughly estimated by the users. Nevertheless, the sample selection as a whole, including both beginners and intermediates, can be considered as a good basis for the complementary evaluation alongside the expert user evaluation.

The words utilised in the semantic world scales were not defined and the participants were asked to evaluate the layouts holistically. There are reasons to believe, however, that the layouts in some cases can express a certain degree of ambiguity. As an example, the visual expression of a layout could be experienced as simple and clear whereas the order of the steps could be complex and result in confusion. The

participants were provided with the opportunity to motivate their answers in the questionnaire. This was, however, optional which means that it is not always possible to locate the users' thoughts of the different layouts' internal attributes which could be anything between its aesthetics and functionality.

7.2 Result

In this chapter, the results from the expert user study and the evaluations with expert users and beginners/intermediate are being discussed.

7.2.1 Expert User Study

The results from the exploratory interviews with the expert users imply, as expected, that there is no simple solution or formula to create the optimal drum machine. Designing a drum machine with all its controls and functions can truly be considered a wicked problem dependent on many factors. The user experience evolving from using a drum machine is subjective and individually dependent on user preference, previous experiences, learning style, context, time of usage and user goal. Nevertheless, it is evident that there is a need for both drum machines that can be fully mastered and controlled as well as drum machines that open up for interaction and unpredictable results. Which one a user prefers is heavily dependent on user goal and context and the fact that drum machines are mostly connected and integrated into a larger system allows for the existence of different types of drum machines and their own purposes.

The results from the interviews with expert users are presented in detail to give a full reflection of expert users' current use of drum machines. The scope of the initial investigation was broad even though the final part of the project aimed to evaluate the potential of alternative step programming layouts. Some of the findings were not directly an underlying foundation for the continuation of the process. However, all data gathered during the initial interviews were considered valuable and provided a greater understanding of the context. Moreover, the findings are considered to have an intrinsic value that may stand as the foundation for future research addressing interaction with drum machines, not limited to step programming interactions.

7.2.2 Evaluation with Expert Users

The same users that during the initial user study interviews expressed a certain degree of scepticism regarding the use of touchscreen-based musical user interfaces did see advantages after the user tests. The reason for this is the interaction possibilities and gestures a user interface based on touch allows for. The alternative layouts provided within the prototype utilise advantages that touchscreen interaction allows and motivate its benefits by doing so. Allowing the users to use swiping gestures to activate different collections and groups of steps has proven to be an application of touchscreen possibilities that motivates expert users to consider using touchscreens to interact with step programming layouts.

The gestalt law of *proximity* (which is applied and evident in Spiral and Blocks) and the gestalt law of *similarity* (which is applied and evident in Tetris and Crystal) noticeably affected how users interact with the alternative layouts. In the case of Spiral and Blocks, the test users tend to utilise gestures to activate steps that are grouped together while in the case of Tetris and Crystal, the users applied gestures on steps that share the same size and shape. This was accomplished differently among the users by using both tapping and swiping gestures. However, the swiping gesture possibilities and the affordance of certain patterns based on the proximity and similarity of steps were not only providing functionality by allowing the users to access certain rhythm patterns efficiently. All test users also utilised gestures as a way to explore, experiment, find inspiration and reach for unpredictable results. Even though all layouts were mainly designed to provide new functionality by allowing swiping gestures and efficient access to certain pattern combinations, all users describe the interaction with the alternative layouts as more dialogue-based compared to the 16-in-a-row layout. The applied gestalt laws indicate, by nature, each step's value because of their differences in shape, size and orientation. Therefore, the alternative layouts are not as dependent on additional indicators such as numbers or colours often utilised on traditional sequencers. These indicators are shown to be important in traditional sequencers as the users experienced difficulties to locate specific steps when interacting with the 16-in-a-row layout included within the prototype (which did not possess any indicators apart from its orientation). The interaction and its visual feedback did not suffer from occlusion which can otherwise be a relevant weakness when interacting with touchscreen interfaces. The reason for this is simply that the steps' shapes and sizes extend beyond the area that is being touched by the finger. The same reason (i.e. the clear visual feedback) is also shown to help the users disregard the lack of haptic feedback.

How the layouts are experienced, perceived and utilised is affected by user preference and user goals. The different goals can be categorised into two usage modes: *goal mode* and *action mode*. When the user is in goal mode the interaction is performed to achieve specific goals such as realising ideas and reconstructing rhythms that are thought upon. When in goal mode, achieving the behavioural goal is primary. This mode is more usability oriented and in these certain situations, the users generally prefer full control over a step sequencer. Some users expressed that they perceived high control when interacting with Tetris, Spiral and Crystal. However, 16-in-a-row was still experienced to provide more control. The reason for this may partly be derived from its visual simplicity which reduces and avoids excise. Another reason is that the sequence proceeds linearly and the layout follows this linearity which means the user only needs to focus on one axis and one direction as the sequencer flows with time. All the steps in a 16-in-a-row layout share the same shape and size attributes. This means that visually it is mainly the order of the steps that affects the users' decisions and how they deconstruct their tasks. The layout's modest feedback in visual output makes the users experience more control as they are allowed to be in charge of the interaction. Last but definitely not least, the users' previous experiences with drum machines and step programming affect how they experience and perceive the alternative layouts. The 16-in-a-row layout and

other traditional layouts function as a frame of reference when the users evaluate the alternative layouts. This statement is not only rooted in the theory of user experience but was also mentioned by the users as they referred to long experience when they stated that the 16-in-a-row layout allows for a high amount of control. It is also notable that hedonic values such as aesthetic appearance and expressions affect the cumulative user experience. A clear example of this was found when evaluating Crystal as some test users expressed and perceived its interaction possibilities and functionality as beneficial but mentioned its aesthetic expressions as unappealing, lowering the cumulative user experience.

The users also mentioned that there are situations where the context allows for a certain degree of unpredictability, sometimes more and sometimes less. In this case, the users enter action mode when interacting which is less dependent on efficiency. In action mode, goals are variable and volatile as the user establish and determine new goals during usage. The alternative layouts are proven to provide the possibilities of achieving unexpected results and the users motivate this by referring to the interaction being based on conversation and dialogue rather than simply commanding the layout to behave in a certain way. The desire for unpredictable results and a higher degree of conversation was expressed by the expert users already in the user study interviews. Pushing boundaries by using functions such as performance controls, chance knobs, trig conditions, polymeter functions and even by aimlessly activating steps are examples of what the users today are utilising in order to achieve unpredictable results and variations. The alternative layouts provide new ways of fulfilling the goals of unpredictability simply by changing the visual appearance and orientation of the steps. The different alternative layouts allow for a different amount of control, unpredictability and variations depending on the user. Generally, Blocks is the layout that allows for least control but most surprises and unpredictability. Some users perceive Spiral in the same way as Blocks, however, this layout is also mentioned to be functional and easy to control by other users. Tetris and Crystal are layouts that offer a certain degree of both control and surprise as their sequencers proceeds linearly similar to the 16-in-a-row layout but provides more feedback because of their visual extensions.

In summary, alternative layouts are believed to suit as a complement and not as a replacement for the traditional layouts. Alternative layouts designed to make use of the possibilities touchscreen user interfaces provide have the potential to enhance expert user experience when step programming rhythms in action mode. It is important to state, however, that one layout suitable for one user can be considered unsuitable for another user as the experience highly depends on user preference, context and previous experience. Alternative layouts also have the potential to enhance usability by improving efficiency when users interact in goal mode. However, in this user test alternative layouts that have the potential for enhancing efficiency for reaching *specific* rhythms and patterns have been evaluated. It is not proven that an alternative layout could generally enhance usability compared to a traditional layout as it is very much dependent on user preference, context and previous experiences.

7.2.3 Evaluation with Beginners & Intermediates

Since only 21 users participated in the evaluation with beginners and intermediates it is hard to draw conclusions with certainty. Because of the small sample size, one user's answer affects the average notably. However, general patterns and possible conclusions can still be identified. In the cases where a vast majority answered the same things, the conclusions can be drawn with more certainty. It is, however, important to consider that other patterns may appear with an increasing sample rate.

In general, the beginners tend to give higher scores to the alternative layouts compared to the intermediates. One exception is the layout Tetris which was ranked slightly higher by the intermediates. The intermediates rated the standard layout as more inspiring and slightly more appealing than the beginners. One reason for this could be that the intermediates are more used to how it *should* be (i.e. having their mental models affected by the traditional layout) and that the alternative layouts behave in a different way from what they expect. The intermediates' higher experience of other drum machines may contribute to different expectations. While two of the intermediates selected the standard layout as their favourite, none of the beginners did. Five of the beginners and one of the intermediates said that they did not like the standard layout.

Among all the semantic word-pairs some are more related to each other than others. Grouping the more hedonic categories uninspiring/inspiring and unappealing/appealing into one grouped called *Appealingness & Inspiration* and the more pragmatic categories confusing/clear, complex/simple, unorganized/organized and unpredictable/predictable into one group called *Understandability & Clarity* can make comparison easier. The result can be found in figure 7.1.

The Standard layout was ranked highest in Understandability & Clarity but also got the lowest score in Appealingness & Inspiration. Crystal, which also got a high ranking in Understandability & Clarity, got a lower ranking in Appealingness & Inspiration compared to Tetris and Spiral. Blocks got the lowest score in Understandability & Clarity, however, it was ranked slightly higher in Appealingness & Inspiration compared to the Standard layout. Tetris and Spiral got the most diverse answers in Understandability & Clarity and also the highest score in Appealingness & Inspiration. It is not possible to conclude nor exclude that a diversity in opinions regarding Understandability & Clarity makes the layout more appealing and inspiring.

Since the participants were not provided with a definition of the semantic words-pairs, the participants were likely to interpret them slightly different. The expert evaluation also showed that the layouts could be interpreted differently depending on if the user was in goal or action mode. The participants in the beginner and intermediate evaluation were not given any specific tasks. Therefore, it is in many cases impossible to know if they tried to realise a specific rhythm or explored open-ended when they ranked the layouts. In a more extensive evaluation, it would be beneficial to include tasks and questions regarding both action and goal mode.

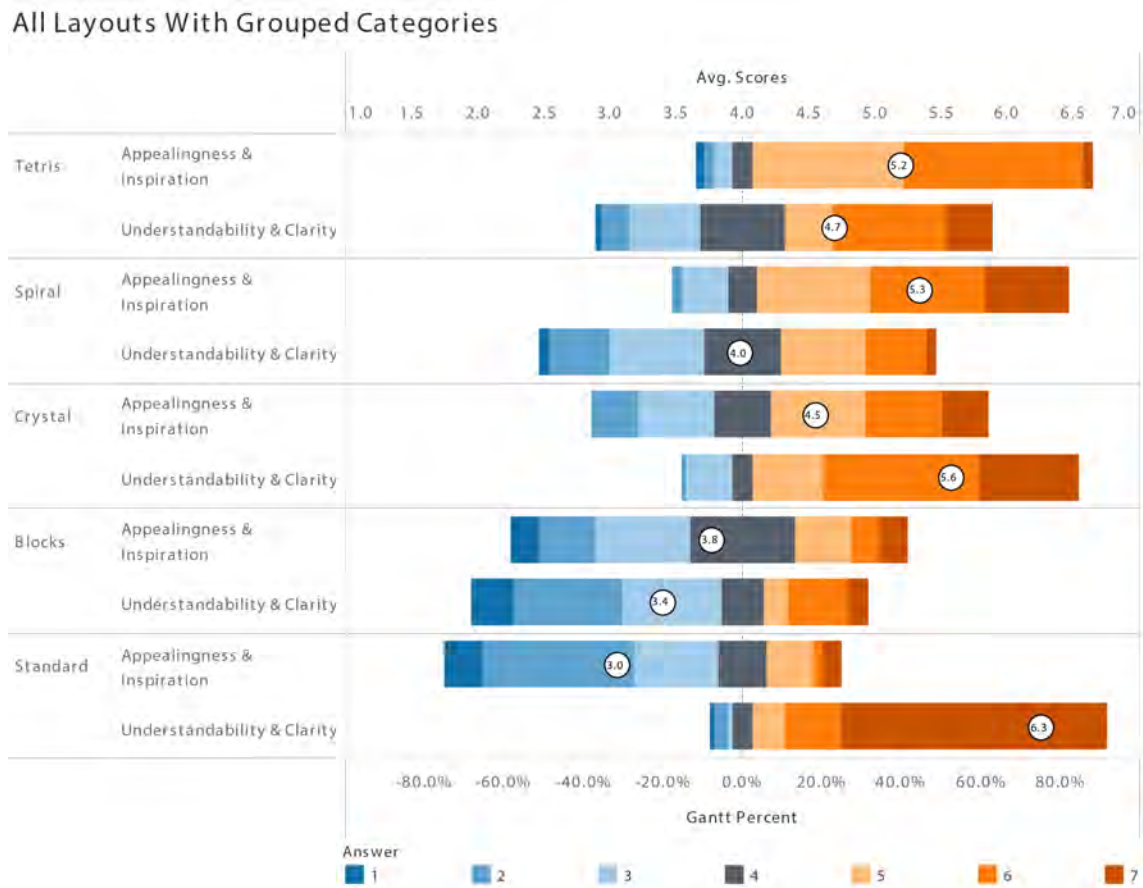


Figure 7.1: The semantic word scales for all of the layouts with the word-pairs *uninspiring/inspiring* and *unappealing/appealing* categorised into one grouped called *Appealingness & Inspiration* and the word-pairs *confusing/clear*, *complex/simple*, *unorganized/organized* and *unpredictable/predictable* categorised into one group called *Understandability & Clarity*.

Are there other things that can affect how the users ranked the layouts? The situational outcome (i.e. the rhythms and beats created by each participant) which affects the total experience can be dependent of factors such as context, user goal and user mood, factors that are dynamic through time. Some of the users mentioned that a specific layout created great music or allowed for happy accidents. It is possible that interacting with a layout could be experienced as positive because of its situational outcome. It is highly likely that the same user could as well perceive interaction with the same layout as a negative experience in a slightly different situation or context. Because most of the participants used each layout once in a short period of time it is impossible to exclude that the result from each participant could have been different in another situation. One thing noticed through observations was that many of the beginners succeeded in creating beats that did not start on step number one. The steps have different shapes and sizes depending on their order and if the beat is offsetted, the functionality of the alternative layouts alters which is something that could have affected how the users perceived some of the layouts.

To make the evaluation process more efficient, the layouts were presented in the same order to all participants. The two layouts presented first got the highest average score on "Appealingness & Inspiration" and the following layouts got lower and lower scores within this category. The order of the layouts could have affected the results. The other categories, however, had more varied results between the different layouts. Nevertheless, it would have been better to randomise the order of the layouts for each user test to avoid this risk of bias. The same solution of randomising the order should have been applied to the expert user tests.

7.3 Generalisability

As earlier discussed, the user study and evaluation were carried out with expert users that work within relatively narrow genres closely related to each other. This, in combination with the fact that evaluation of musical instruments tends to be rather subjective, gives reason to believe that the result would slightly differ by applying a different sample selection. Nevertheless, the user study's broad scope and detailed documentation with both diversity and similarities in responses among the expert users are not bound to the area of alternative step programming layouts. It can work as a foundation for development and investigation of drum machines, their functions, expressions and interactions in general.

The result of the evaluation is specific for the developed concepts of alternative step programming layouts. However, because the evaluation was based on the comparison of multiple layouts the result can also be generalised. It is notable that visual modifications can drastically affect how a user perceives a step programming layout holistically. The detailed documentation of how different characteristics of each specific layout changed user experience makes it possible to map how general concepts and changes in step programming layouts may affect player behaviour and user experience.

Apart from specific subjects related to touchscreen interactions and drum machines the theory, methodology and the process and execution of the project can be generalised and applied to other projects. The detailed description of the execution can work as a frame of reference when evaluating any types of new musical instruments or controllers. Because it is difficult to evaluate new musical instruments and controllers, especially in a short period of time, the documentation and reflections of processes like these are important and can contribute to future work within the area.

7.4 Ethical Issues

The interviews and user tests included collection and storing of personal data (video- and sound recordings). During the process, it was important to consider user integrity and privacy as storing this data was important for the following evaluation. To make sure that no violations in regulations such as GDPR were performed, data were stored anonymously. The test users were informed of the purpose of the data

collection and asked for consent. The execution of all interviews and user tests have also been following the authorities' recommendations and guidelines regarding the Covid-19 pandemic.

The main purpose of this project was to evaluate the potential of alternative step programming layouts. However, the designed concepts can be considered a cumulative outcome affected by different stakeholders including the authors, their supervisor and the expert users from the user study. All users from the user tests were later also involved in the project. The intellectual property of these results has not been discussed nor defined between the stakeholders. This fact needs to be taken into consideration for potential future elaboration and development that proceeds from the conceptualisation and ideas that have evolved from this project.

7.5 Future Work

For future work, it is important to ask ourselves what it is that we want to achieve. Looking at the evaluated concepts of alternative step programming layouts, three distinct potential paths can be identified. The first path would be to aim for full control and further investigate how utilizing touchscreen interaction could enhance the usability of a step programming layout. The second possible path would be to further investigate in what ways an alternative step programming layout based on touchscreen interactions can provide positively perceived unpredictability less dependent on usability. The third path could be a combination of the two paths previously mentioned and would aim to investigate how alternative step programming layouts and touchscreen interactions can improve the total user experience without compromising too much on efficiency. This path would aim to develop alternative step programming concepts that possess a balance between perceived control and unpredictability. In the result, there is an evident potential of a product that gives the users access to many different step programming layouts within the same user interface. Therefore, the different paths should not be mutually exclusive as the combination of layouts with different potential and attributes could, in the end, be the solution. Figure 7.2 shows how the next iteration of layouts could look like, building on the results from the evaluation.

When settled for a certain layout or combination of layouts a high-fidelity prototype would have to be built in order for it to be fully evaluated. The final product should be fully compatible with other drum machines and digital musical instruments and necessary functions should be integrated. Only then would the users be encouraged to participate in a longitudinal study. Decisions such as what functions should be integrated, whether the product should work as a standalone device or as a musical controller for other equipment would need to be further investigated.



Figure 7.2: How the next generation of the alternative layouts could look like. From top to bottom: 1: A slightly softer version of Tetris in which the first and last step do not stretch over all the steps. 2: A combination of Tetris and Crystal, with more focus on signifying where touch gestures can be applied. The round shapes aims to afford touch gestures. The swiping gesture could be further enhanced with animated lines connecting the dots that are being activated. 3: A version of Spiral that actually is a spiral. For example, the jump between step 4 and 5 was one thing that made this layout hard to grasp. This redesign is a possible solution to make the concept of Spiral more predictable. Spiral could be further graspable by using the gestalt law of connectedness, connecting the steps with lines.

8

Conclusion

The purpose of this project has been to investigate and answer the research question of how alternative step programming layouts based on touchscreen interactions can be utilised and how they can affect usability, user experience and player behaviour compared to existing layouts. Furthermore, an expert user study was conducted to answer the research question regarding how expert users utilise and interact with existing drum machines. The two formulated research questions and their sub-questions as a whole can be found in section 1.1. The conclusions relating to the research questions are presented in the following paragraphs.

The result from the expert user study confirms that the use of drum machines is subjective and individually dependent on user preference, previous experiences, context and user goal. Drum machines are often integrated in a larger system where each device has its own purpose, defined by the user. It can be concluded that a drum machine can and is often used in both goal mode (i.e. the user is working towards a specific goal) and action mode (i.e. the user explores the design space). Some drum machines are better suited to be utilised for achieving specific goals efficiently and some are better to reach unexpected and unpredictable results. It can be noted that expert users sometimes push boundaries in otherwise rigid functions to reach unpredictable results. Full control over a device is expressed to be desirable while at the same time, the expert users wish the interaction to result in unpredictable outcomes in certain situations.

The evaluations of the produced concept layouts conclude that alternative step programming layouts based on touchscreen interaction affects user experience and player behaviour. All expert users involved in the user tests utilised gestures to explore, experiment, find inspiration and reach for unpredictable results. This player behaviour is not possible to the same extent when using a standard 16-in-a-row layout. Therefore, alternative layouts designed to utilise the possibilities touchscreen user interfaces provide have the potential to enhance the cumulative user experience when step programming rhythms in action mode. How these new layouts and gesture possibilities are experienced by the users are heavily affected by the visual appearance and orientation of the layout, user preference, context and previous experiences. Gestures were also executed by users when reaching for specific goals (i.e. when working in goal mode). There are reasons to believe that efficiency for a specific task can be enhanced using alternative layouts if the user goal is to re-

8. Conclusion

alise a rhythm accessible within few swiping gestures. However, it is not possible to conclude that the overall usability can be improved by using a touchscreen-based alternative step programming layout instead of a traditional layout. Such a conclusion needs to be based on further investigation including task-based usability tests that takes learnability into account.

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A

Appendix: Gantt Chart for the Project

Figure A.1 describes the planned process of the project. Figure A.2 describes how the process looked in reality.

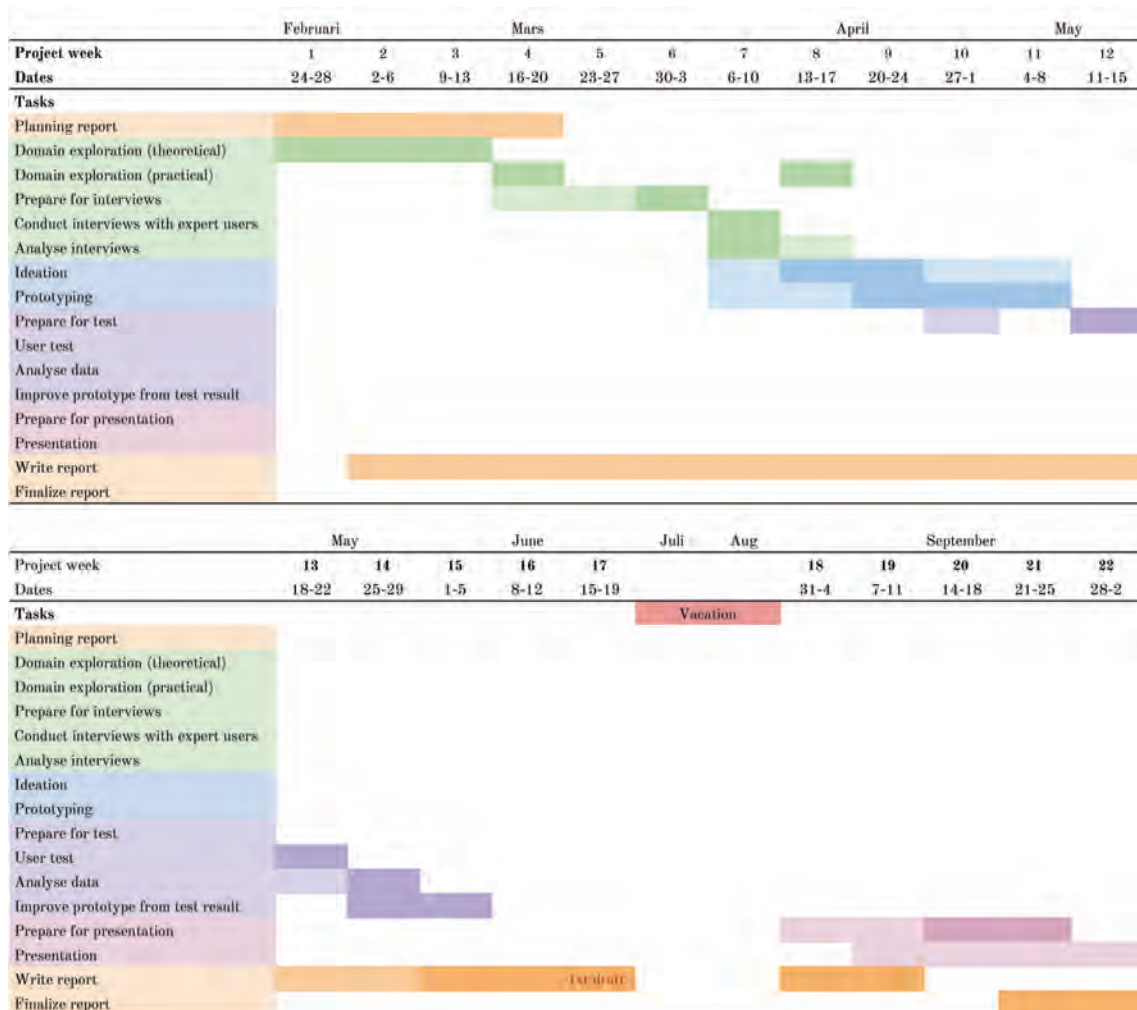


Figure A.1: Gantt chart describing the planned work process

A. Appendix: Gantt Chart for the Project

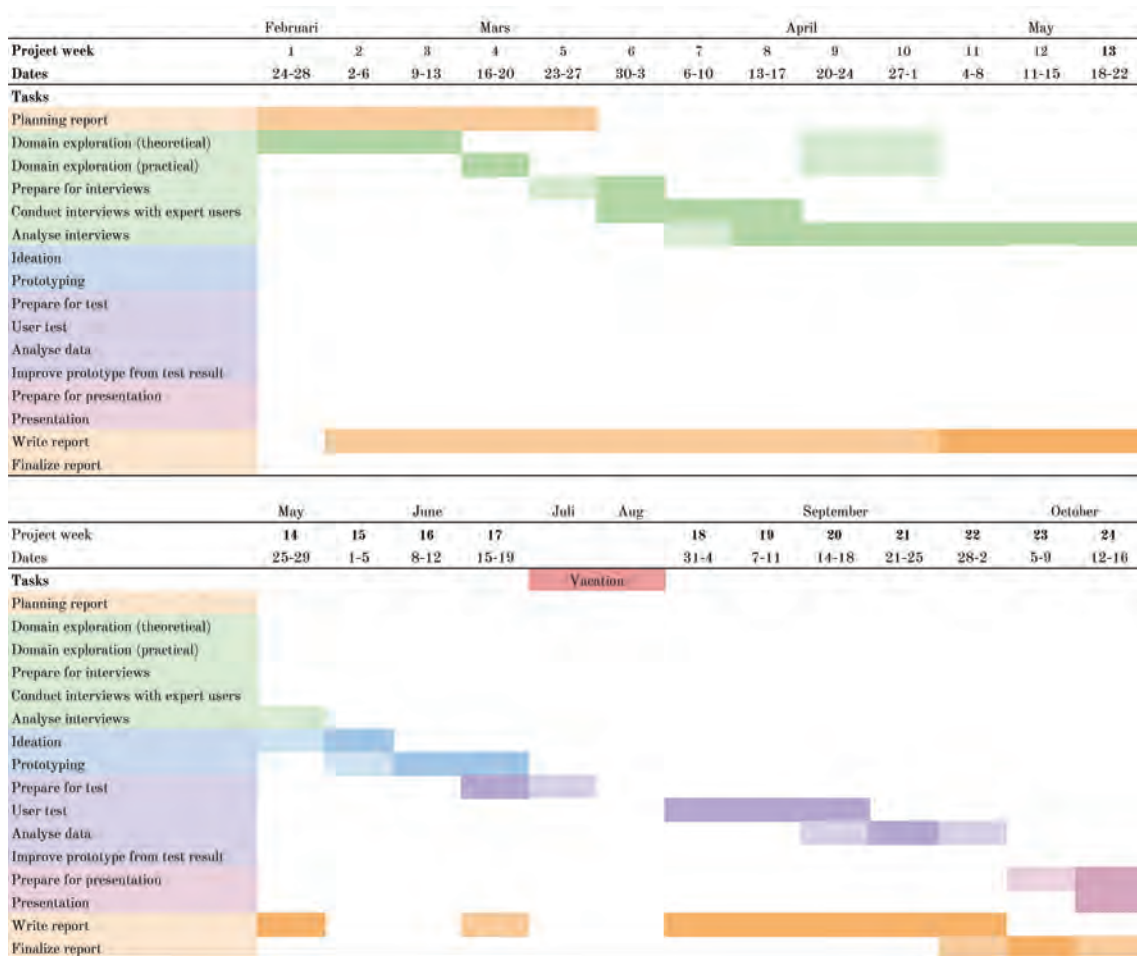


Figure A.2: Gantt chart describing how the process looked in reality

B

Appendix: Questions for the User Study Interviews

Introduction

- Who we are and what we do.
 - Master thesis at Interaction Design, Chalmers. Research project together with Palle Dahlstedt. Rhythm programming layouts in drum machines. Not commercial.
- The purpose of this interview.
 - Get a deeper understanding. You, users and context.
- Is it okay if we record the interview?
 - For transcribing and analysis
 - You are anonymous
 - The thesis will be published

Warm-up session

- How long have you been working with music?
- Producing music
 - What tools, instruments, genre
- Live performances
 - What tools?
 - Do they differ?

Main session

- Do you see yourself mainly as a designer or musician in the context of drum machines? Equally?

- How long have you been working with drum machines?
- What drum machines are you using regularly?
 - What drum machines have you been using?
 - Do you have any favourite?
 - * Why is it your favourite?
 - Hedonic/Pragmatic? (functions? emotions?)
- What are the strengths and weaknesses with a drum machine as a instrument?
- What makes a good drum machine? What makes a bad?
 - Why?
 - Functions?
 - Interface?
 - Interaction?
 - What is the most important? Easy to use without looking? Easy to reach or use with one hand? Ergonomics? Does size matter?
- How does the working process of programming a beat look? In what order do you do things? How is the process?
 - When in the studio?
 - When performing live?
- How do you prefer to program the rhythm?
 - Tap the beat, program the steps, presets
 - From blank slate to done. . . .
 - One finger? Many fingers? Two hands?
 - Gesture? Swipe, drag, press etc.
 - Prepared patterns, improvising, etc, what role does the drum machine have
- What do you think about interacting with the 16 grid layout in general?
 - Playing, programming, perform?
 - Do you use the grid for anything else than playing and programming?
- What type of interactions do you prefer?

- Buttons, pads, touch
- Have you tried alternative interfaces?
 - Other layouts? Circular? Apps?
 - * What did you think about that?
 - * Why?
 - * If not good: how could they be improved?
- Do you see something that could be improved with drum machines in general?
 - Something you miss?
 - Functions you never use?

Designer questions

- How long have you been working in this industry? How long have you been working in your current company?
 - Companies?
 - Roles?
- With designing, (been involved with designing) instruments and/or drum machines in particular?
- What is the initial seed to a new instrument? Why do you design a new instrument?
- How does the design process look?
 - Do you have an example?
 - What was your role in that project?
 - Were there any challenges or interesting takeaways?
- How do you prototype the instruments? Low/Hi-fidelity.
- How do you evaluate your final designs?
 - Which criteria are most important when you evaluate?
 - What methods do you use?
- What are the challenges in designing musical instruments?
- Something you've learnt during the years?

- Do you want to share some general experiences you've learnt through the years?

Final questions

- Would you like to be a part of testing a prototype in the near future, around May/June?
- Is there anyone else you know and think we should talk to?
- Anything more you want to add?

C

Appendix: Questions for the Expert Evaluation

Intro

- The purpose of this interview.
 - The focus will be on the different layouts
 - User Experience
 - Usability
- Is it okay if we record the interview?
 - For transcribing and analysis
 - You are anonymous
 - The thesis will be published

General

- What did you think about interacting with the prototype?
- What was hard?
- What was easy?

Layout

Asked for each layout.

- Describe the layout. (What do you think about it?)
- How did you interact with it? Press, swipe etc. (Can you show?)
- How much (perceived) control did you feel that you had when interacting with this layout?
- Do you feel that you could easily achieve specific goals (such as four on the

floor)

- and realise ideas? How easy/hard?
- Did this layout invite you to behave and play differently from what you are used to?
- Would you describe the interaction with this layout as a dialogue or more a tool to instruct the drum machine? (Inspiration vs realisation, reacting to output, happy accidents)
- Did the interaction invite for variations or repetitiveness (Rhythms)?
- Did this layout have any strengths? Any weaknesses?

Last round of questions

- How was it to interact with alternative layouts like these on a touch screen?
- Which layout did you enjoy the most? Why?
- Would you use an interface like this?
- How could it be better?
- Where there any functions did you miss or would want to add?
- Anything more you want to add?

D

Appendix: Evaluation Instructions

On the following pages in this appendix, the evaluation instructions used in the evaluation with expert users and some cases the evaluation with beginners/intermediates can be found.

Evaluation: Alternative step-sequencing layouts

Why?

In this part of the process we are focusing on evaluating four different alternative step sequencing layouts. In the prototype, which also includes a standard 16-step grid as reference, it is possible to switch between the layouts. We want to investigate how these layouts can affect things such as player behavior, user experience, level of control etc.

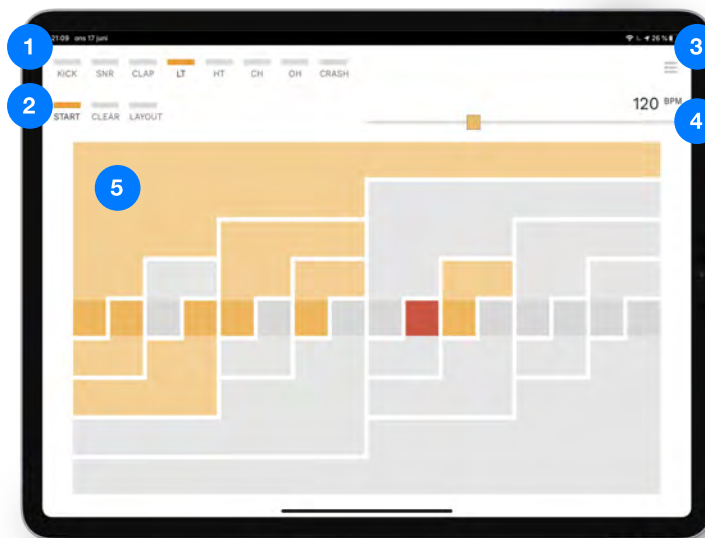
So, feel free to play around with the different layouts as much as you want and we will be very interested to discuss them with you later. Thank you very much for your participation!

Good to know

- The interface accepts **multi-touch gestures** meaning it is not only possible to **tap to toggle steps** but also **swipe in all directions to toggle steps**. Please play around with the gestures you prefer for each layout.
- Play around with the prototype and different layouts as much as you want
- Make sure you try all **five step-sequencing layouts**
- Try both to **realise ideas** and **jam** with the different layouts
- The order of steps for each layout is illustrated in the last two pages in this document
- If you want any specific samples, just e-mail us and we can add them for you

The interface

The prototype is available at gridstep.herokuapp.com and is meant to be used on a touch device. You can save it to the home screen to be able to use it in fullscreen.



1. Tracks: Select which track to program.

2. Global controls:

- Start/stop the sequencer
- Clear all tracks from steps
- Change to the next layout

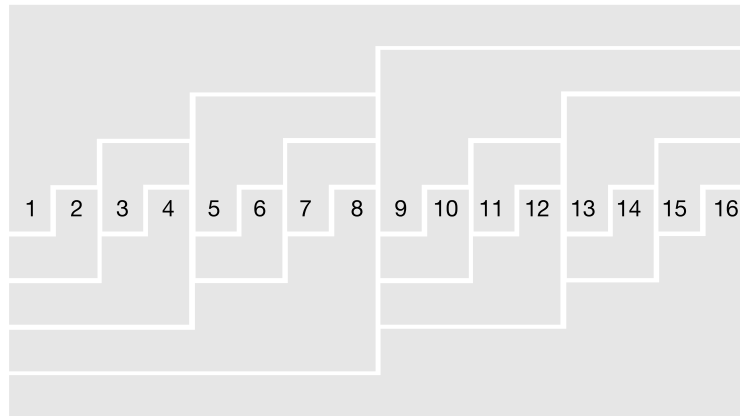
3. Hamburger menu: Change layout and drum-kit

4. BPM-slider: Change the tempo of the sequencer

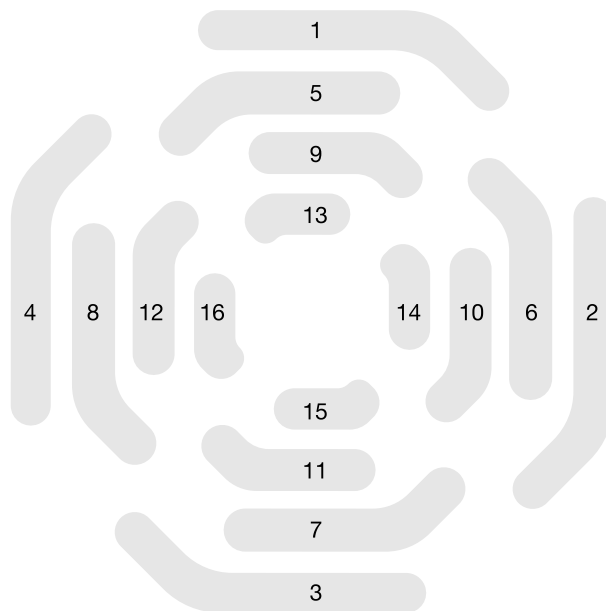
5. Step-sequencing layout:

Program the beat, by swiping, touching and tapping.

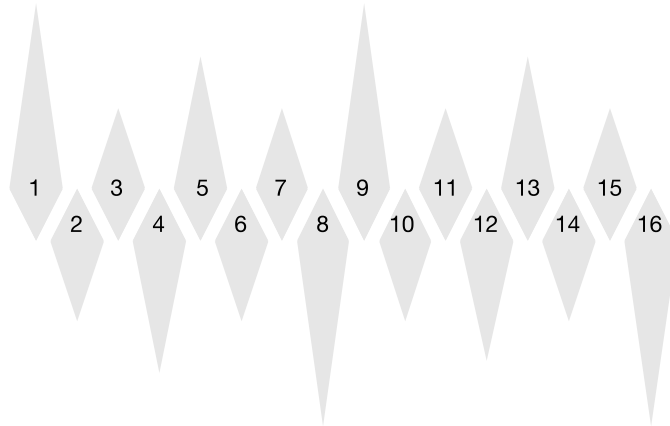
Layout 1



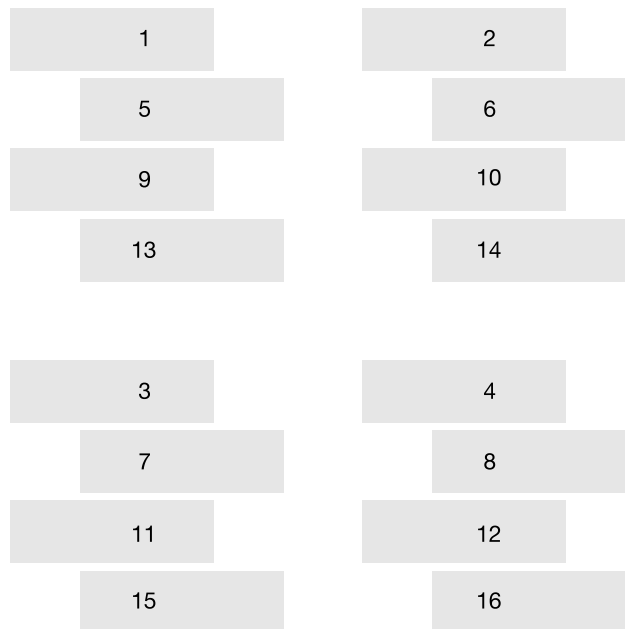
Layout 2



Layout 3



Layout 4



E

Appendix: Questionnaire Used in the Evaluation with Beginners/Intermediates

On the following pages in this appendix the questionnaire used in the evaluation with beginners & intermediates can be found. The form was filled in online. The attached documents are print version in Swedish.

2020-09-02

Drum Machine Test

Drum Machine Test

1. Name (optional)

2. Which screen size has the device you testing on

Markera endast en oval.

- Large (iPad or similar)
 Medium (iPad mini or similar)
 Small (Ordinary smartphone)
 Övrigt: _____

3. Level of experience with playing/creating music

Markera endast en oval.

- 1 2 3 4 5
-
- None High

4. What do you identify yourself with?

Markera alla som gäller.

- Instrumentalist
 Percussionist
 Singer
 Songwriter
 Producer
 DJ

E. Appendix: Questionnaire Used in the Evaluation with Beginners/Intermediates

2020-09-02

Drum Machine Test

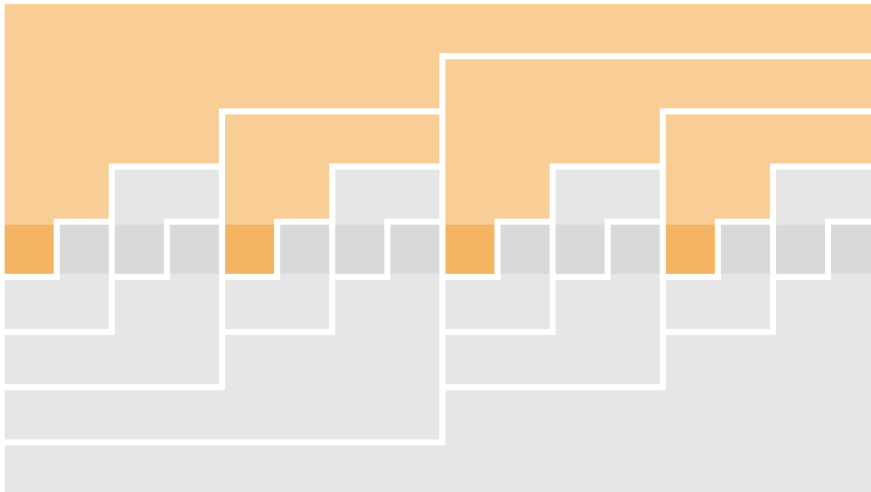
5. Previous experience with playing drum machines

Markera endast en oval.

	1	2	3	4	5	
None	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Expert

Layout 1

How do you experience the layout?



6.

Markera endast en oval.

	1	2	3	4	5	6	7	
Clear	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Confusing

E. Appendix: Questionnaire Used in the Evaluation with Beginners/Intermediates

2020-09-02

Drum Machine Test

7.

Markera endast en oval.

	1	2	3	4	5	6	7	
Uninspiring	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Inspiring

8.

Markera endast en oval.

	1	2	3	4	5	6	7	
Simple	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Complex

9.

Markera endast en oval.

	1	2	3	4	5	6	7	
Appealing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Unappealing

10.

Markera endast en oval.

	1	2	3	4	5	6	7	
Unorganized	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Organized

11.

Markera endast en oval.

	1	2	3	4	5	6	7	
Predictable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Unpredictable

E. Appendix: Questionnaire Used in the Evaluation with Beginners/Intermediates

2020-09-02

Drum Machine Test

12. Anything more you want to add about this layout in specific? (Optional)

Layout 2

How do you experience the layout?



E. Appendix: Questionnaire Used in the Evaluation with Beginners/Intermediates

2020-09-02

Drum Machine Test

13.

Markera endast en oval.

	1	2	3	4	5	6	7	
Clear	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Confusing

14.

Markera endast en oval.

	1	2	3	4	5	6	7	
Uninspiring	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Inspiring

15.

Markera endast en oval.

	1	2	3	4	5	6	7	
Simple	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Complex

16.

Markera endast en oval.

	1	2	3	4	5	6	7	
Appealing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Unappealing

17.

Markera endast en oval.

	1	2	3	4	5	6	7	
Unorganized	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Organized

E. Appendix: Questionnaire Used in the Evaluation with Beginners/Intermediates

2020-09-02

Drum Machine Test

18. *Markera endast en oval.*

	1	2	3	4	5	6	7	
Predictable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Unpredictable

19. Anything more you want to add about this layout in specific? (Optional)

Layout 3

How do you experience the layout?



E. Appendix: Questionnaire Used in the Evaluation with Beginners/Intermediates

2020-09-02

Drum Machine Test

20.

Markera endast en oval.

	1	2	3	4	5	6	7	
Clear	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Confusing

21.

Markera endast en oval.

	1	2	3	4	5	6	7	
Uninspiring	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Inspiring

22.

Markera endast en oval.

	1	2	3	4	5	6	7	
Simple	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Complex

23.

Markera endast en oval.

	1	2	3	4	5	6	7	
Appealing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Unappealing

24.

Markera endast en oval.

	1	2	3	4	5	6	7	
Unorganized	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Organized

E. Appendix: Questionnaire Used in the Evaluation with Beginners/Intermediates

2020-09-02

Drum Machine Test

25.

Markera endast en oval.

	1	2	3	4	5	6	7	
Predictable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Unpredictable

26. Anything more you want to add about this layout in specific? (Optional)

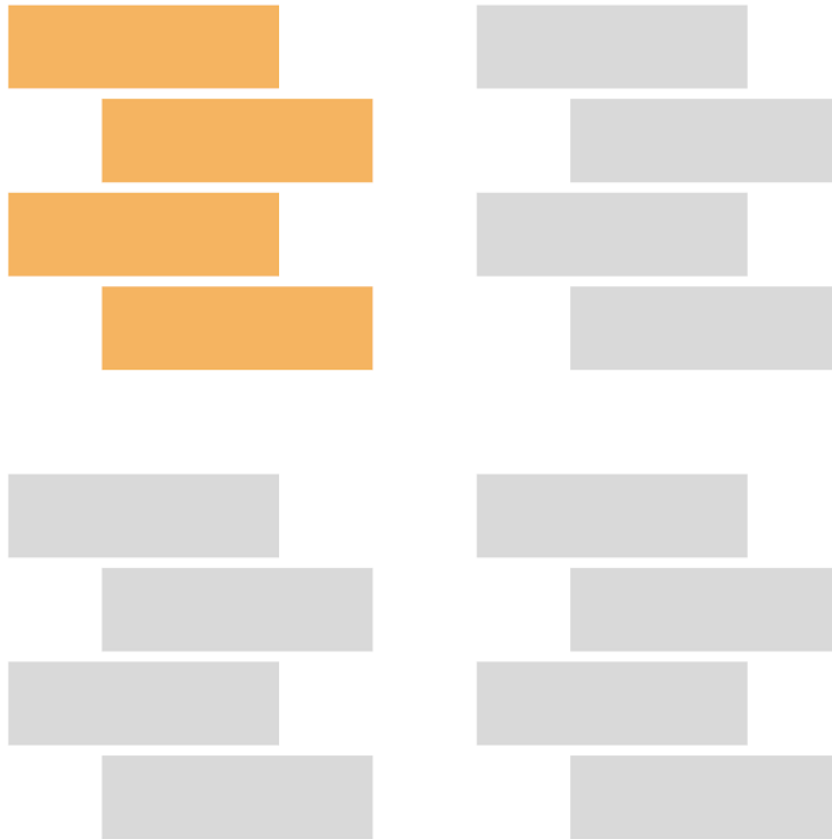
Layout 4

How do you experience the layout?

E. Appendix: Questionnaire Used in the Evaluation with Beginners/Intermediates

2020-09-02

Drum Machine Test



27. *Markera endast en oval.*

	1	2	3	4	5	6	7	
Clear	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Confusing

E. Appendix: Questionnaire Used in the Evaluation with Beginners/Intermediates

2020-09-02

Drum Machine Test

28.

Markera endast en oval.

	1	2	3	4	5	6	7	
Uninspiring	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Inspiring

29.

Markera endast en oval.

	1	2	3	4	5	6	7	
Simple	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Complex

30.

Markera endast en oval.

	1	2	3	4	5	6	7	
Appealing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Unappealing

31.

Markera endast en oval.

	1	2	3	4	5	6	7	
Unorganized	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Organized

32.

Markera endast en oval.

	1	2	3	4	5	6	7	
Predictable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Unpredictable

E. Appendix: Questionnaire Used in the Evaluation with Beginners/Intermediates

2020-09-02

Drum Machine Test

33. Anything more you want to add about this layout in specific? (Optional)

Layout 5

How do you experience the layout?



34. *Markera endast en oval.*

	1	2	3	4	5	6	7	
Clear	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Confusing

35. *Markera endast en oval.*

	1	2	3	4	5	6	7	
Uninspiring	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Inspiring

36. *Markera endast en oval.*

	1	2	3	4	5	6	7	
Simple	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Complex

E. Appendix: Questionnaire Used in the Evaluation with Beginners/Intermediates

2020-09-02

Drum Machine Test

37.

Markera endast en oval.

	1	2	3	4	5	6	7	
Appealing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Unappealing

38.

Markera endast en oval.

	1	2	3	4	5	6	7	
Unorganized	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Organized

39.

Markera endast en oval.

	1	2	3	4	5	6	7	
Predictable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Unpredictable

40. Anything more you want to add about this layout in specific? (Optional)

Last questions

E. Appendix: Questionnaire Used in the Evaluation with Beginners/Intermediates

2020-09-02

Drum Machine Test

1.



2.



3.



4.



5.



E. Appendix: Questionnaire Used in the Evaluation with Beginners/Intermediates

2020-09-02

Drum Machine Test

41. Which layout do you prefer?

Markera endast en oval.

- 1
- 2
- 3
- 4
- 5
- None

42. Why? (optional)

43. Is there any layout you don't like?

Markera alla som gäller.

- 1
- 2
- 3
- 4
- 5
- No

44. Why? (optional)

<https://docs.google.com/forms/d/1NqpgAmp1dT6iSczSW6N2hvGQoDS3cgZ3BzQ3v1CC0e0/edit>

14/15

E. Appendix: Questionnaire Used in the Evaluation with Beginners/Intermediates

2020-09-02

Drum Machine Test

45. Other thoughts (optional)

Det här innehållet har varken skapats eller godkänts av Google.

Google Formulär

F

Appendix: Drum Machine Sizes

On the next page, almost all drum machines mentioned by the interviewees can be found. The drum machines have the correct relative size to each other. The sizes are written in w x d x h (mm).



MPC 200XL
405 x 331 x 106



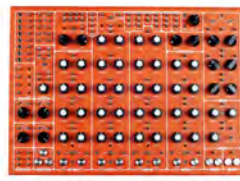
Roland TR-808
508 x 305 x 105



Roland TR-909
486 x 300 x 105



Arturia DrumBrute
418 x 276 x 40



SOMA PULSAR-23
380x280x80



Polyend Tracker
358 x 246 x 64



Pioneer DJ TORAIZ SQUID
375 x 224 x 72



Elektron Analog Rytm MKII
385 x 225 x 82



Elektron Machinedrum
340 x 181x 63



Roland TR-606
300 x 146 x 55



Elektron Model:Cycles
270 x 180 x 39



Elektron Digitakt
215 x 176 x 63



T-E OP-1
282 x 102 x 13.5



T-E OPZ
212.5 x 57.5 x 10



T-E Pocket Operator
60 x 127 x 27

Figure F.1: Almost all drum machines mentioned by the interviewees. The drum machines have the correct relative size to each other. The sizes are written in $w \times d \times h$ (mm). Press photos from the manufacturers except for Roland TR-606, TR-808 and TR-909. Picture of TR-808 by Eriq under the CC BY-SA 3.0 license: https://commons.wikimedia.org/wiki/File:Roland_TR-808_drum_machine.jpg. Picture of TR-909 by Emho under the CC BY-SA 3.0 license: https://commons.wikimedia.org/wiki/File:Roland_TR-909.jpg. Picture of TR-606 by Midas Wouters under CC BY-SA 3.0 license: https://commons.wikimedia.org/wiki/File:Roland_TR-606.jpg