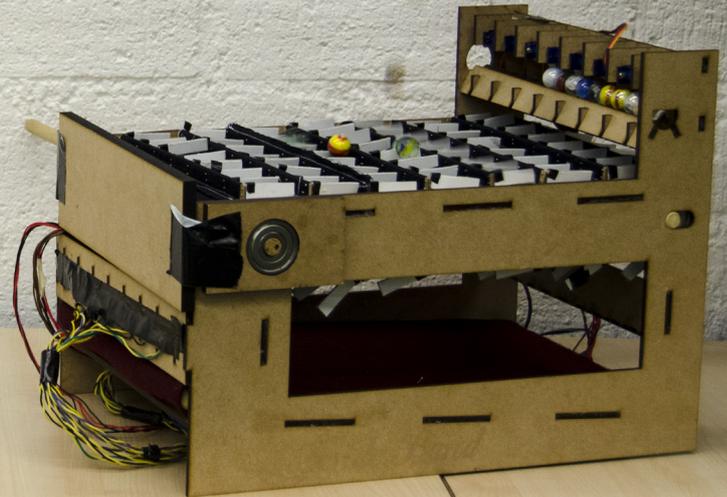


Loopende Band - group music improvisation systems

Bart Jakobs, Bas Bakx- B2.1

outofcontrol

BUILD, REBUILD AND CREATE REAL MUSIC



Coach: Maurits de Koning

Wauw, wat een apparaat
Physical sequencer
“Loopende Band” is toch een
prachtig ding

Matthias Funk vindt ons
improviseersysteem
(en zeer terecht)
Zuper Fascinating

ABSTRACT

This is the project report of the Loopende Band, a project by Bart Jakobs and Bas Bakx.

The loopende band is a new way of interacting with music. At the heart is a physical sequencer, it allows users to intuitively build measures of music, which are repeated infinitely until the user decides to add to, change or remove the measure.

CONTENTS

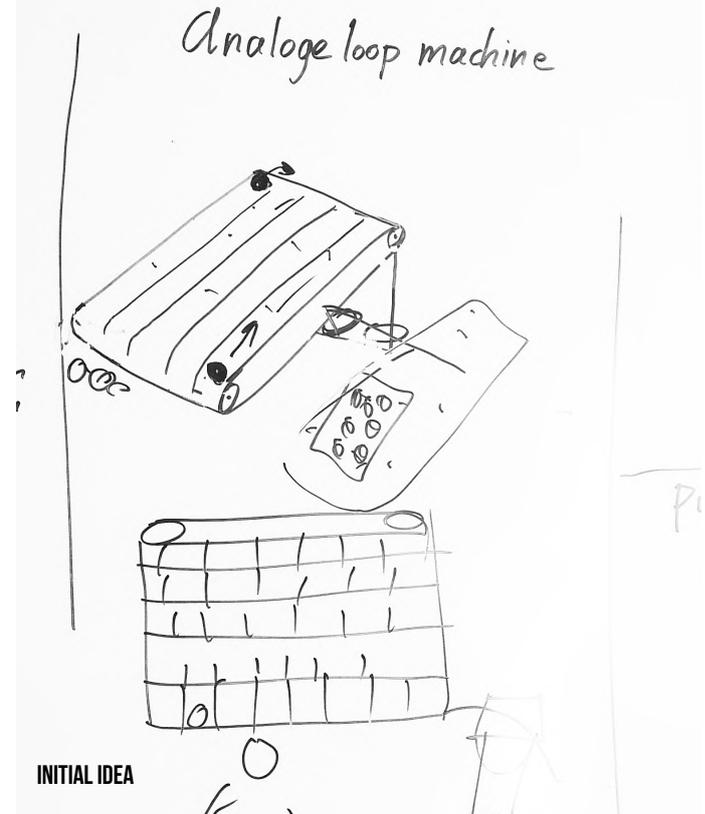
ABSTRACT	3	USERS	15
INTRODUCTION	5	PROJECT FOCUS	15
DESIGN PROCESS	6	USER RESEARCH APPROACHES AND FINDINGS	16
FIRST ITERATION	6		
SECOND ITERATION	7	CONCLUSION	17
FINAL ITERATION	8	BART	18
FINAL PROTOTYPE	10	BAS	19
FINAL DESIGN SPECIFICATION	11		
FUTURE PLANNING	11		
TECHNOLOGY	12		
CURRENT ISSUES	14		

INTRODUCTION

This report details the design and technology of the Loopende Band, a physical sequencer, after the exploration phase. The concept was made in a group exploration, the group split up, pursuing different ideas.

The Loopende Band is a new way of creating music, it takes the digital character musical looping has had up to now and rejects it. The concept involves enabling a user to dynamically or statically build and rebuild music, while actually being able to observe how the music looks and happens. While retaining the versatility and possibilities sequencers and computers offer we want to give full control and understanding to the user. It is as much a performance tool as an educational instrument.

To achieve a physical looper we took a conveyor belt as starting point.



INITIAL IDEA

DESIGN PROCESS

FIRST ITERATION

When the concept was decided on, our first step was prototyping: start to build and create something.

For making the first prototype, the focus laid on making sound completely physical. Marbles would fall on real instruments, directly causing the sound. The sound and interaction with the Loopende Band were completely physical.

After an expert meeting with Frank Delbressine, the idea how to lead the marbles through the Loopende Band was made. A conveyor belt needed to be made which, on it, had a grid. This way the marbles can stay in place. It was decided to make use of the laser cutter in Vertigo, because of the great precision we need for a conveyor belt to stay in place.

In our first iteration we decided to make the conveyor belt out of three elastic bands which were connected by cardboard to hold the marbles.

To the right is the first prototype that was presented at the midterm demo days. It only had a single part of the grid, just to illustrate the idea.



PHYSICAL INSTRUMENTS



HIGH BUILD TO INCREASE MARBLE VELOCITY

SECOND ITERATION

At the demo days most of the visitors were very positive about our project. But above all very interested. This new way of interacting with music clearly had potential. After talking to some experts, coaches and other students that day, it was decided that that best course of action was to make the instruments possibilities as big as possible. Enlarging the possibilities involved making the switch from analogue to digital. This opened up a practically endless world of sounds to be used in the Loopende band.

At this point the design of the first iteration was redone to fit the new decisions made. It was lowered because we did not have to take real instruments in account. the switch was made to a conveyor belt covering the entire surface, to reduce friction and improve reliability. Pre made conveyor belts proved not to be an option, they needed to be a very specific size to accommodate the marbles, we also wanted exactly one measure to be visible on top of the machine, and there had to be 7 channels, to have a one-octave range.

All of the sizes were determined by the 16m marbles,for example, every box had to be twice the width of a marble, and with seven of them the total width of the Loopende Band was 255mm, including a safety margin.

After experimenting with car tires, latex rubber, paper, duct tape and different kinds of fabric, a strong and rubbery textile was decided on. Out of the textile a belt was sown with a grid of 16 horizontal barriers to make sense in a 4/4 beat.

6 servos were added at the beginning of the conveyor belt, to put the marbles back in the beat where you left them. each of them connected to an ir led and ir receiver, which, when obstructed, caused the servos to put a marble on the belt at a set time.

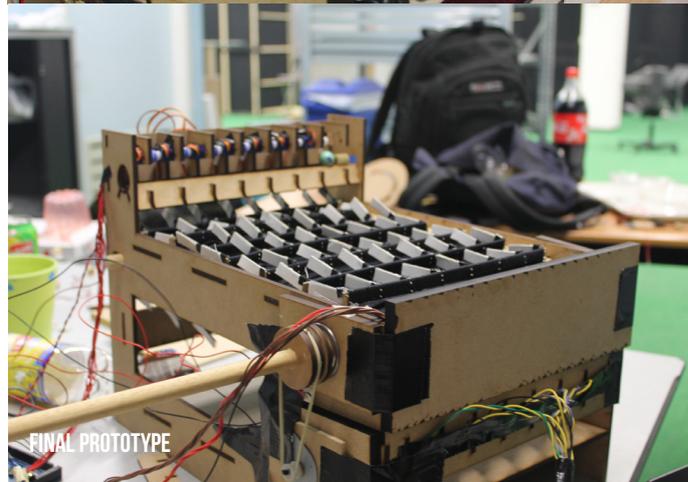


FINAL ITERATION

In the final iteration the placement of the bearings holding the rollers was optimised, so the motor could drive the conveyor belt from the outside the construction, without obstructing the actual belt. Vertical barriers were placed on the horizontal barriers, creating a grid of 16 x 7 boxes for marbles to be placed in. And the rollers got a little tweaking space, so the belt could always be put straight and tight.

The array of servos got a last update and all of the design got cleaned up and finished for the Demo days. Sadly the speed with which the marbles dropped of the conveyor belt was not accounted for, which made it crucial to put a barrier at the end to stop the marbles from overshooting their sensor-holes. Because this barrier was not accounted for until the last moment it had to be taped on.

The Loopende Band performed well during the demo day and even had to sustain some abuse, aside from some minor errors it held up very well, it still is in working order at the time of writing. It demonstrated the concept very well, spoke to the imagination and turned men into little kids while playing with musical marbles and experimenting with wide ranges of sound.





FINAL PROTOTYPE

The concept of the Loopende Band is based of the concepts of a sequencer.

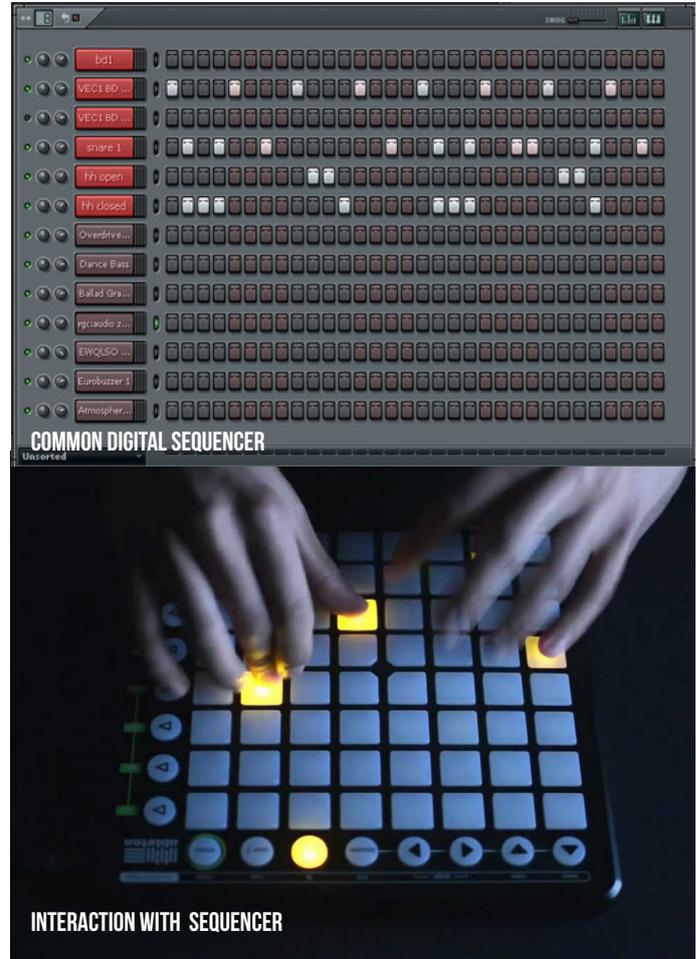
A sequencer is one of the most popular ways of making music on a computer: by placing notes in a grid, a sequence is made. When played, the notes play from left to right on the computer screen, and loops until it's stopped.

The Loopende Band is a physical sequencer: instead of putting notes in a grid using the mouse and keyboard, marbles are placed in a physical moving grid, made on a conveyor belt. When the marble falls off the belt, it triggers a sound, and a new marble is put at the start of the belt.

The different rows of the grid correspond with different sounds or pitches, and the different columns correspond with different bars in the beat.

With the Loopende Band, a user has the interaction of building music and seeing it happen.

The marbles are notes and the belt is the sequence which is played.



FINAL DESIGN SPECIFICATION

At the final demo days, the prototype was not yet the finished product or the final design.

The looks of the prototype had not changed much.

The prototype had a working array of servo motors and sensors in combination with a computer that made the sound. Also the whole conveyor belt with grid was finished. As a result, the interaction with the device was clear and could be experienced with this last prototype.

The final design will also have a system that brings the fallen marbles back to the reservoir at the top. This part was not present in the final prototype, because of a lack of time and because the decision was made to focus on the interaction rather than on making everything work.

Furthermore, the final design will look better than the current prototypes, which all look like the next laser cut prototype.

The system aspect within the prototypes on the demo days is something that could be improved by doing more user tests, and anticipating on these.

FUTURE PLANNING

If this concept would be further developed, some things need to improve.

Firstly, there are a couple of technical issues that have to be solved, but these are all described in chapter 6.1

One of the design aspects that could use improvement is the communication and interaction between different parts in the system: the Loop Machine communicates with other parts of the system to influence their musical improvisation.

This interaction has not been user tested very much and when it was, there already have been some small things that could be improved.

In order to find this out, more comprehensive user tests should be done and more iterations on this aspect should be made.

Another aspect that could use some improvement is of course the finish.

Besides that the Loopende Band looks like ‘just’ a laser cut design, there were ideas to change the size. A prototype that was much larger was found interesting, making it an interactive installation for children for instance. However, for the demo days and because of the context we used (using the device in a studio or on a table on a stage), the current size was chosen for now.

TECHNOLOGY

The concept and prototype of the Loopende Band require some technical components.

Generally, this part of the musical improvisation system consists of the Loopende Band and a computer (the computer is for synthesizing sounds and connecting to the network with other musical instruments).

Because of the moving parts, a choice of a motor had to be made.

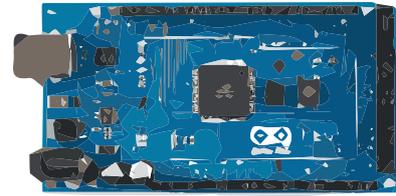
A stepper motor was the easiest way to make something move at a constant speed. In order to use a stepper motor, a motor controller had to be used.

The motor controller was driven by an Arduino (a small, easily programmable computer).

An electronic piece of the system was the Loop Machine itself. It had to notice falling marbles and it had to push marbles just a little later. In order to do this, another Arduino was used which controlled 7 stepper motors to put the marbles on the track. It also controlled 7 sets of an infrared sender and receiver, between which the marbles would fall. If a marble falls, the infrared signal is interrupted.

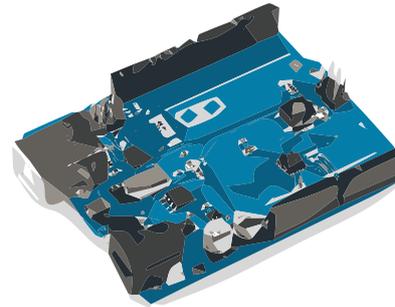
The Arduino was not only programmed to put marbles back and send the computer signals that it had to play a note, it also had the possibility to receive new notes from the computer, from other connected instruments. The Arduino code is in the appendix.

For the communication between the different instruments in the system, a server-client program called OOCSE was used, which was written for this project.



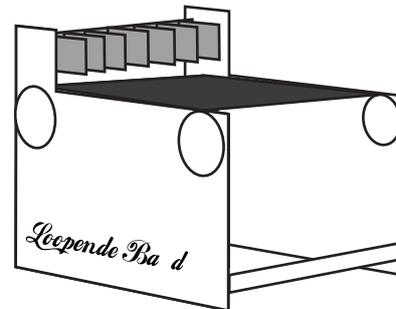
ARDUINO MEGA

- Controls servomotor
- Measures sensors
- Sends fallen marble data to the computer
- Receives tempo and new falling marbles from computer



ARDUINO UNO

- Controls stepper motor
- Changes speed when signal received from Arduino Mega



LOOPENDE BAND

- Sensors check when marbles fall
- Servomotors move to push new marbles
- Stepper motor moves the belt

This program consists of a server and a client. The client connects to the server and starts sending and receiving values. Every client connected can receive anything sent, and everything sent can be read by any client listening.

This made OOC SI an excellent program to use for the project.

The OOC SI program was driven by Processing. The Processing program was the bridge between the Loopende Band, the actual musical software (Apple Mainstage 3.0) and the network program OOC SI. The final Processing code can be read in the appendix.

Another piece of technology that had to be mastered was the MIDI protocol.

Since the 80's, MIDI has been the standard for transmitting electronically generated music.

In order to make music from an Arduino or generate music from a computer program, MIDI commands have to be sent and received somewhere.

After a lot of research, enough knowledge was collected to achieve this.

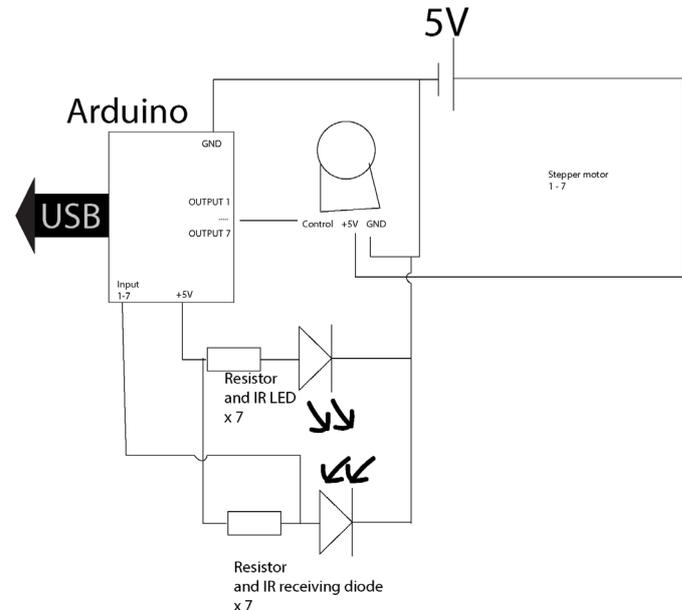
In the first iteration, the system aspect was not yet made. This meant that the computer that would only make the music, not communicate with a network, and the Arduino had to generate the MIDI signals.

In further iterations, the computer had to communicate through OOC SI, and the Arduino had to react on that. Because of this, the decision was made that the Arduino would only sent where a marble fell and that it would react on a signal from the computer when a new marble had to be put on the track, that had not been fallen.



COMPUTER

- Generates sound when marbles fall
- Connected with other objects via OOC SI
- Sends tempo changes and received data to Arduino Mega
- Notifies other objects when marble falls



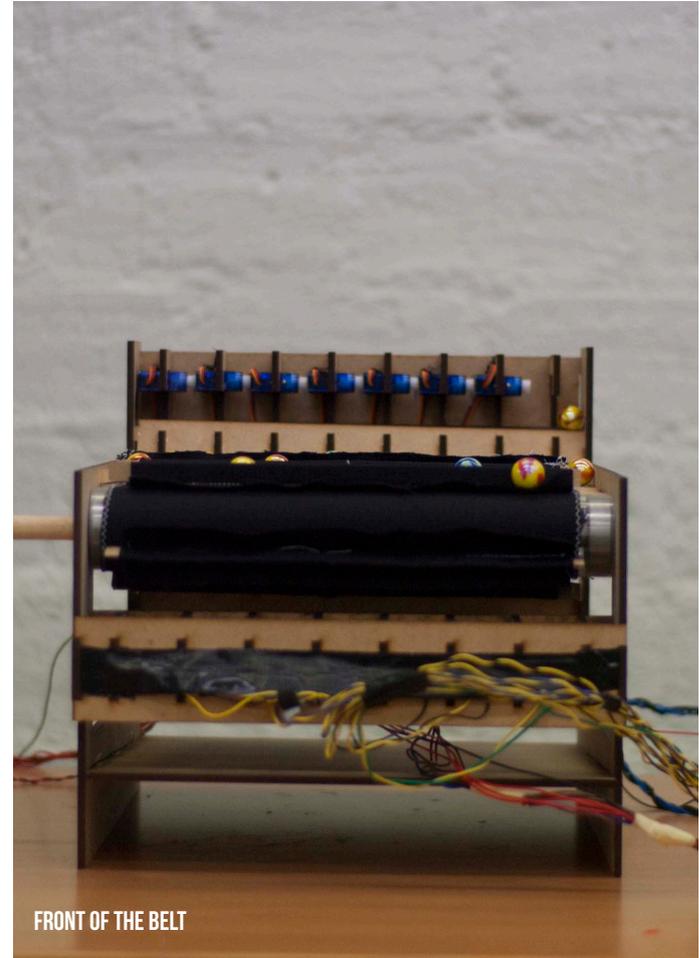
CURRENT ISSUES

One of the current technological issues in the prototype is the conveyor belt.

There is much improved in the belt during the second quartile, but it is not yet perfect for a final product. For a prototype that demonstrates the interaction, the current one was sufficient, but the belt could move, the transmission between the cylinders and the belt was not precise enough, and all of this caused that not all marbles were placed back exactly in the right time.

A possible solution would be to measure all these tolerances and make the software compensate it.

Another, better solution is to try with the help of experts to build a better working model to actually sell.



USERS

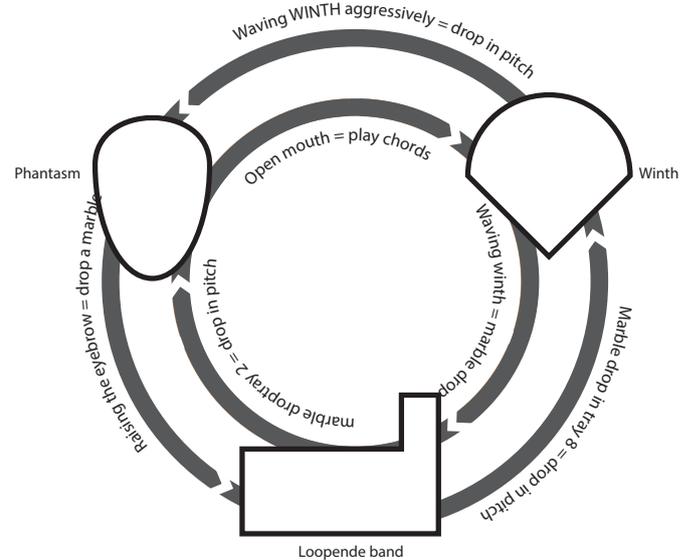
PROJECT FOCUS

While building the Loopende Band the target group was all around, musicians and people interested or working with music. Despite of this the main times data was collected about users was during both demo days. The first demo days focussed mainly on the concept itself because it couldn't be fully experienced yet. In the second demo day visitors also got to experience the interaction in a working order and we could observe how users of all kinds reacted to it.

Another big User focus is the improvising aspect of the Loopende Band. The instrument itself accommodates improvising, by setting a low bar in a very approachable context, users can easily try things out.

The Loopende Band still provides traditional improvisation aspects, it can speed up and change instrument on the fly, which can influence band members around you. It can easily be incorporated in temporary music and existing genres, while offering so much more to explore.

The Loopende Band also enables new ways of improvisation together with Winth (project by Tijs Duel M1.1) and Phantasm (project by Joep Le Blanc B2.2). Via a server specific qualities of the music made could be sent around the three instruments. Phantasm and Winth were able to add marbles (and therefore sounds) to the Loopende Band, while the Loopende Band was able to lower the entire register of both projects when specific marbles were dropped. This way the project goes beyond possibilities that exist and opens up a new musical world.



USER RESEARCH APPROACHES AND FINDINGS

During the demo days there was a format in which we let visitors meet the Loopende Band. At first they got an introduction to the concept because it was not entirely stable, it was shown that the Loopende Band can repeat a single note or simple melody as long as new marbles keep being fed to the servos. After this short demonstration users got to try it out themselves while Bart or Bas filled up the machine continuously.

Some users wanted to observe how the servos did their jobs, while others went on a rampage route, to test how well this device could handle complicated music. All the while the servos kept doing their jobs very well, though the human factor proved to be a problem. Since there was no system to feed marbles to the servos and manually feeding could not keep up with the demand of marbles, the servos regularly ran dry.

Because of the human factor problem it sometimes seemed like the loopmachine randomly added marbles to the belt. While this was of course not on purpose but did speak to the imagination of some. One of the users dropped as many marbles on as possible, causing near-random melodies to return, he found this “Super Fascinating”. The Loopende Band did always trigger the sound but the looping factor got eliminated this way and the Loopende Band became a cross robot/human performance machine. The complex motion of the Loopende Band causes it to be a hard to fabricate product but also to become a real eyecatcher. Even with the modest amount of sound it made, the experimentability of a physically moving measure attracted attention.

With the Loopende Band catching the imagination of all, imaginations ran wild. What if we could control note length? Timbre? Velocity?.

It was suggested to use marbles of different color and materials to control certain aspects of the actual tones made. This proves that the context is solid but should be explored further to allow users even more control of the music, without making it more complicated.



CONCLUSION

After splitting up, we decided to start building the prototype as fast as possible.

We wanted the first iteration to be finished before the midterm demo days so that we could get as much feedback as possible from other students and coaches. Building allowed us to take a lot of choices based on the design as it was taking shape, resulting in a well thought out project.

After the midterm demo days, we started the second iteration using feedback we recieved: we decided not to use physical instruments in the Loopende Band, but really using it as a sequencer, opening up a big world of possibilities we set out to explore.

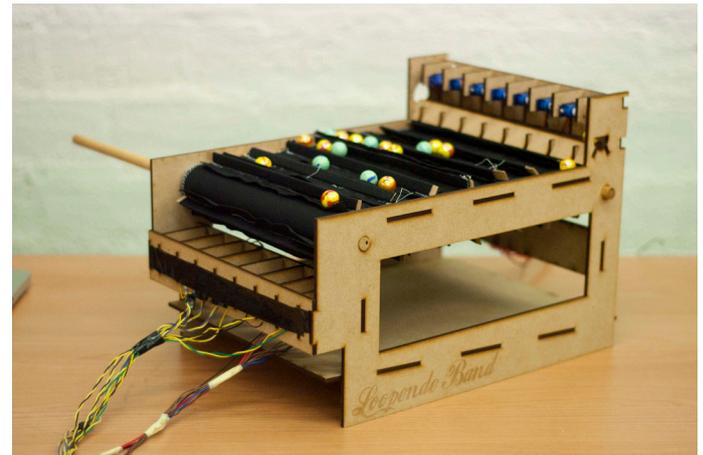
Eventually user input shaped the idea. We took a huge detour from our concept after the first demo day which did cause some friction but resulted in a direction we were both agreeing with. When we decided to use the user feedback to change our idea and direction and went building the first iteration of the final Loopende Band. During the last weeks and on the final demo days, we have had many users playing with it. Because we anticipated on what users wanted with the first prototype, the users, and especially those who saw it before, of the final prototype were very positive about it. Users explored what could be done with the Loopende Band and we saw users coming up with new possibilities and ideas.

This led us to the conclusion that our idea could be a very good musical instrument. Other, existing instruments also often lead to new

possibilities and new ways to play with them, and our user testing made clear that this would also most certainly be the case with the Loopende Band.

Users also came up with the ideas of using different kinds of marbles for different sounds, velocities and such.

Also, in a band setup, with the other projects connected to it, users found interesting ways to make music with it. Our Loopende Band is absolutely not a finished product, but we think we have made a musical instrument that has a lot of potential, has opened up an entire new world of creating and deserves to be explored further.



BART

One of the most important parts in this project was the ideation and brainstorming part.

Although I have used some different brainstorm methods during my previous projects and assignments, I never specifically used a specific method. This first quartile, in the project group, we have had many brainstorm sessions, converging and diverging. I have learned a lot about ideation and the ideas and concepts competency area.

In the previous semester, I've learned a lot about user focus. This semester I have had some opportunities to put this theory to practice in the interaction between the user and the Loopende Band. Next semester I want to use this theory even more, and explore more in the area of interaction design.

During this project, I gave my teammates some lessons in Arduino programming, coding, MIDI, and other useful things which helped me developing the teamwork and communication competency.

I found it very interesting to work on a combination of music (which is one of my main interests) and design. Doing some research and small user tests with musical improvisation required some musical theory, which I know. I liked to combine those two and I hope that I will get that opportunity again sometimes soon.

Before starting the semester, I had the intention to develop my form and senses competency and to learn working with my hands and really making things.

At the end of the first quartile, it became clear that the final prototype would not necessarily be a very pretty one, so I decided to tackle those goals in some SDL activities.

This has also led to the goal for next semester to make a pretty prototype.



BAS

After having done a very research heavy project last semester it felt good to do a more intuitive project. I had a very different approach toward my third project in industrial design this semester because my last projects got randomly assigned to me.

GMIS was my first choice and already had my interest from the start, from the get-go I had more information ready, combined with very knowledgeable teammates and fellow students. All students had different specific interests, all with their own attitude and world. Me myself being into blues and indie it was great to talk to electronic artists, ambient lovers or the classically schooled about what is important in the massive social and cultural influence that is music.



Because of the creative and expressive nature of music it was immediately clear that the concept itself would be crucial, therefore we needed a good exploration phase. I have never before had a brainstorm period that was so thoroughly prepared. After the brainstorm we all fell in love with an idea, which was an amazing way to start out.

Teamwork was very important, it keeps proving to be hard to let important tasks to others but i think it is very important to realise the value teamwork can bring. During the project i realised i am definitely a teamplayer, i think it adds so much to discuss decisions and exchange knowledge. I have always been of an opinion that literally everyone is more qualified to judge your work than yourself. My main teammate of course being Bart, but we never lost contact with our former teammates Rachel and Willem and even included Tijs and Joep very closely in our project.

Another spearpoint this semester was creating. We started creating the week after we decided on our concept, at first with whatever we could find at first glance, but very quickly I got a crash course lasercutting. Some time later i also had to learn to sew which i did for hours on end to create the belt for de Loopende Band and I got to apply my newfound Indesign and Illustrator knowledge a lot. The second half of the semester this project was definitely a building project, we came in every day and could get our hands dirty or discuss how to give shape to a concept we knew had potential.

REFERENCES

References:

Thanks to the amazing Frank Delbressine and Chet Bangaru for sharing their experience with mechanical design.

Appendices:

Arduino code final Loopende Band:

<http://pastebin.com/as9acCb0>

Processing code final Loopende Band:

<http://pastebin.com/eSQxmgW2>