Not a Timeless Piece

ERIK SKANS MÄCHS 2022
BACHELOR'S THESIS

LUNDS UNIVERSITET

Degree Project for Bachelor of Fine Arts in Design.
Main field of study: Industrial Design .
From Lund University School of Industrial Design,
Department of Design Sciences

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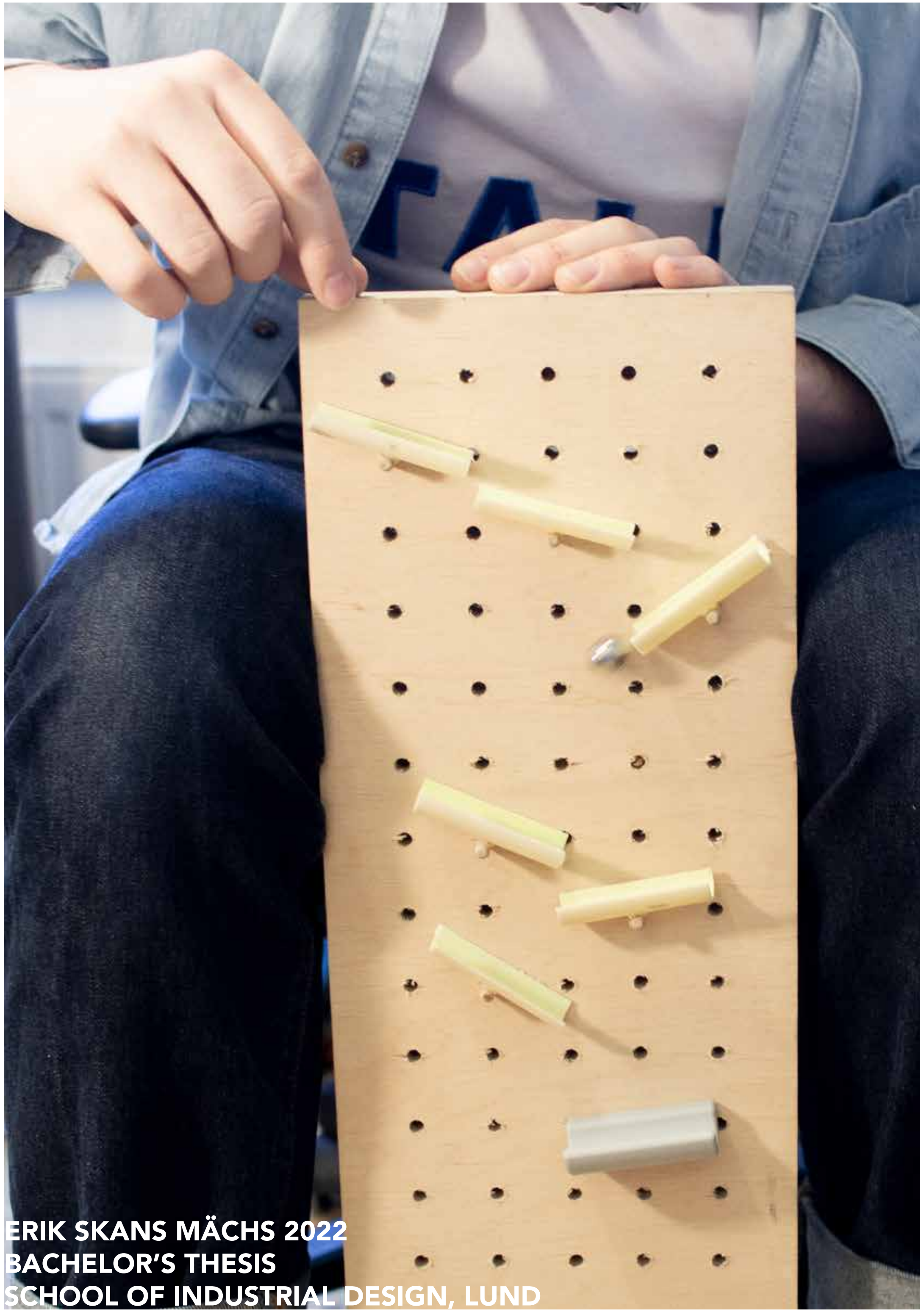
ISRN: LUT-DVIDE/EX--23/50671-SE

ABSTRACT

Is there a way to visualise time in an efficient way? This project explores how children perceive and visualise time, with the goal to create an educational calendar that will give children in the ages of 7 to 10 a tool to visualise how to count with time and how a calendar year ”looks”. To achieve this, a mix of education and play is used to trick the children into learning how time counting works. The element of play is introduced to the user by a marble path that they get to build, leading a marble into a slot. Each marble represents a day and each slot represents a month. This makes the users associate the fun of the play with the learning of how a year is built up by days, weeks, months and seasons.



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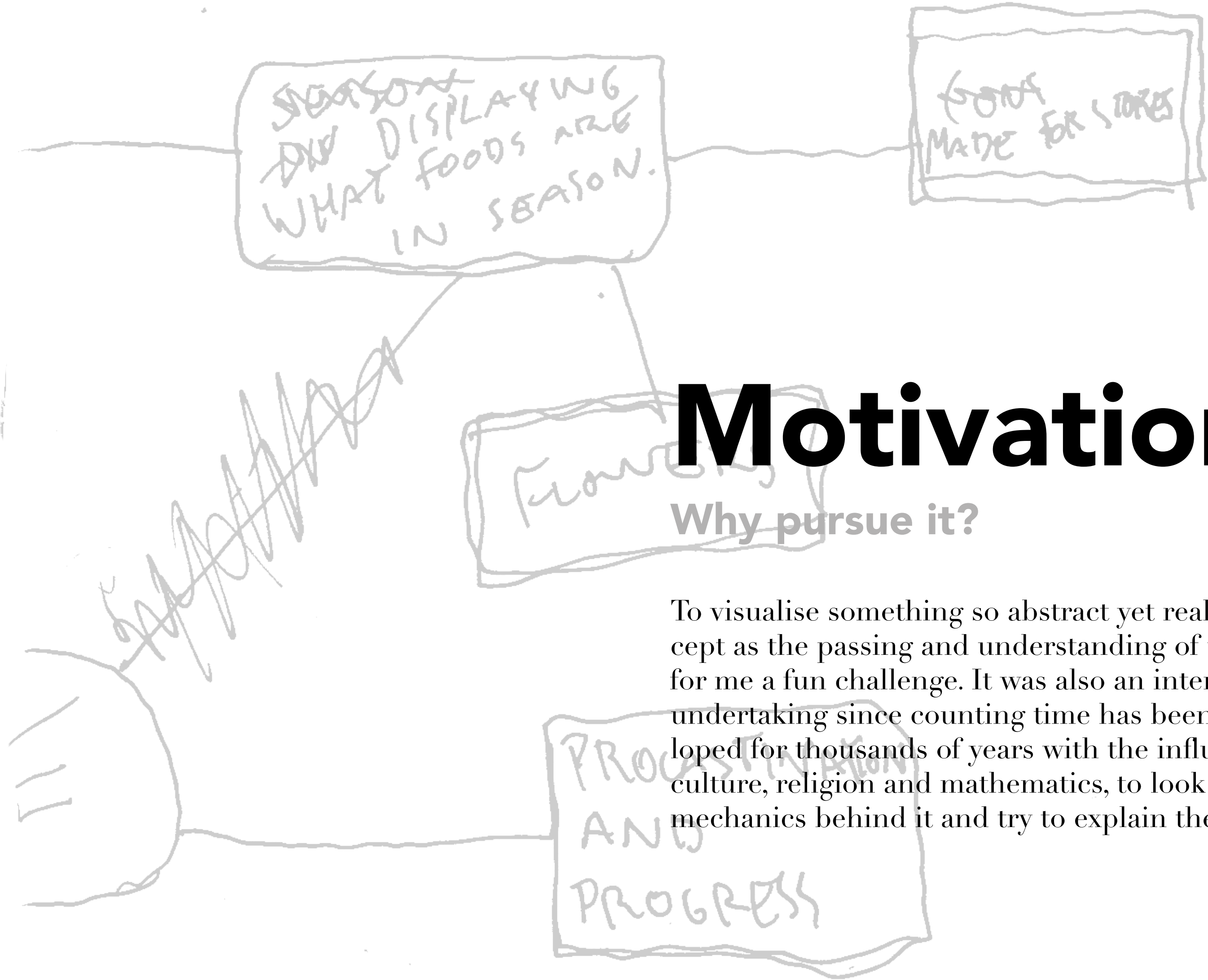
Background

Where it all started

To work with a project revolving around time was nothing that I decided to do overnight. It has been something that I've wanted to explore for a couple of years due to the challenge of finding a way to communicate a universal way of visualising time. Since everyone has an individual way of imagining time in their minds, it gave me the opportunity to dwell into the mathematics, history and culture behind our calendar as well as explore how people see time.



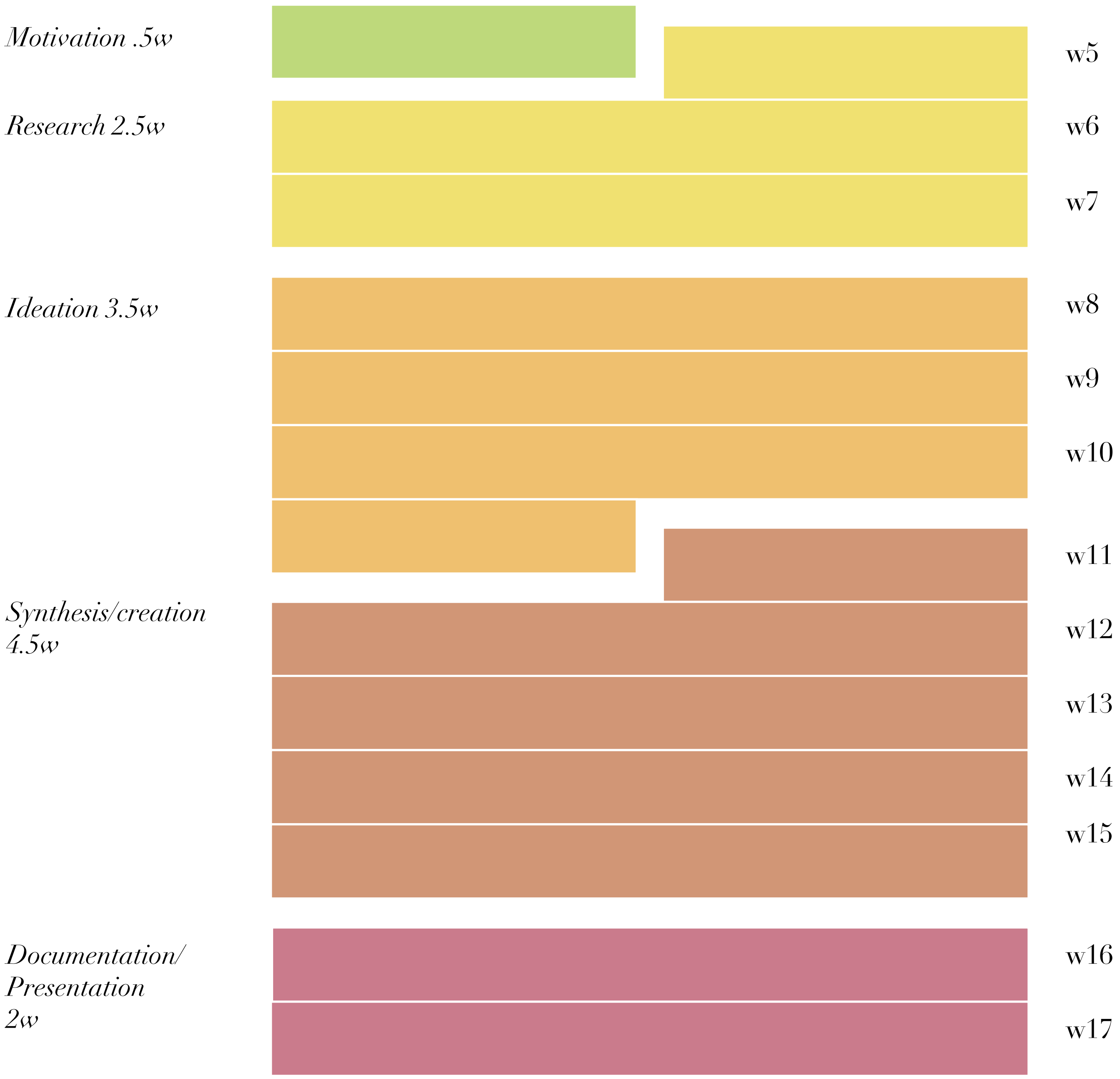
Motivation

Why pursue it?

To visualise something so abstract yet real concept as the passing and understanding of time was for me a fun challenge. It was also an interesting undertaking since counting time has been developed for thousands of years with the influence of culture, religion and mathematics, to look into the mechanics behind it and try to explain them.

BRIEF

Based on childrens perception of time, create a tool that will help them understand how counting time works. The tool should be suited for public schools.



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Calendar

There are several different ways of counting time in different cultures. The most widely used calendar is the Gregorian calendar. It is an updated version of the Julian calendar, with updated calculations regarding leap years, so that the dates wouldn't slip forward. This was decided to be changed when the catholic church wanted all christians to celebrate Easter the same day all across the world, as well as the calendar falling out of sync with astronomical events such as equinoxes and solstices [1][8].
An Gregorian leap year is decided by the following rules:
The year is divisible with for.
If that is divisible by 100, it is not a leap year.
If it is divisible by 400, it is a leap year.
The Gregorian calendar was adopted at first by only catholic nations since other orientations such as protestants were sceptical. Some orthodox national churches are yet to implement it.
The Julian calendar itself is Roman, with a lot of inspiration and mathematics tracing back to the Babylonians and ancient Egyptians. The Babylonians counted with a base of 12 and not 10, therefore an hour 5x12=60 min and a day 12x2=24 hrs. Weeks are most probably 7 days long due to the moon's four 7 day long phases.

There are also both religious and astronomical reasons behind the seven day week, as the seven known planets in the ancient world and Babylonians considered 7 a sacred number [1][8].
A month is based on lunation, which is the time it takes for a moon to complete the cycle. The Babylonians approximated this to 29.5 days, while the Romans further developed this into precise the amount of days for all the months, ranging between 28 and 31[2][10].

The Gregorian calendar is a so called solar based calendar, which means that one year lasts for one orbit of the sun, which becomes 11 days longer than a lunar calendar which is based on 12 full moon cycles. It was designed by the italian astronomer Aloysius Lilius and implemented by pope Gregory XIII in 1582.
A tropical year is the time it takes for the earth to orbit the sun, which is approximately 365.24219 days. However, it varies every year. Therefore further leap years were added to the Gregorian calendar, so that it would be more in sync with the tropical year which works as an astronomical reference. The Gregorian calendar is exact to 1 day fault in every 3236 years[1].

Learning

As humans, and most of the creatures on planet earth, we learn the most when young. We are fed with information, and as we grow we can process it better and better, until a point where we do not learn as much, and it gets harder and harder to learn something new.
As this project is focused around children's perception of time, the early research revolve around how children learn counting time and perceive a timeline. Children learn counting time and get an understanding of time passing at around 6-8 years. In the latter, they can use time describing vocabulary as well as comparing minutes, seconds and hours from each other [3].
Visualising how time moves with the help from timelines and similar, is very efficient, since it helps the children get an overview of something as abstract as time. Giving them models of clocks, learning them to think with the base of twelve and letting them place events on a timeline makes it easier for them to see that a thursday is further away from a monday than a tuesday as an example. They create a reference picture from the tools we give them [4].
It is vital to take this into account when creating a pedagogical calendar that visualises how a year passes. However, as mentioned by Lillian Katz, it should not just be a calendar but has to be something where the kids can see how time passes and describe events. Marking out birthdays, marking out events that have happened and displaying pictures connected to events.
This gives children an understanding of time and the concept of how it progresses, as well as how long a day, month or year is. A universal way of understanding time.
Based upon this research, the target group could be set to 7-10 year olds, since that is the age when it is reasonable to learn the calendar properly.
This is also based on the research made by T. Pathman and co about young children's memory for the time of personal events. Its shown in their research that children's perception of time differs a lot between the ages 4-8, and that after 12 years of age the age is no longer a factor [5].
It is also shown in the research of Roseanne L. Flores that children that grow up in homes with bad socioeconomic background have worse perception of time and events than children with better background. This is a problem since it is very vital to be able to describe events and have a good temporal sense both further on in school and higher education as well as in then individuals work life [5].

Groundworks

After doing research, I could narrow down my target group, as well as finding that there is a need and room in the market for a tool that can help children to learn the calendar properly. It is an important and complex knowledge for children to learn, since it affects how they learn history as well as how they can plan their life, both professional and private.
Even though children learn how the calendar works growing up, there are differences between children that grow up in an unsafe environment and children that grow up in a safe environment. The children that grow up in a more insecure setting are learning the calendar slower and have a more difficult time to get a good understanding of it as their peers [5].
Therefore I decided to create a tool for public schools, so that children from all socioeconomic backgrounds can laborate with it.
The age of the target group is 7-10 years old. This is based on the fact that children start to master seconds, minutes and hours by the age of 6, as well as starting to understand the difference between time and distance. At 7 however, they start to learn basic things about weeks, months and seasons.
That is where my tool will be a support for the child, so it can see how a year is structured and how it's related to days and months. The ability to plan different events and look at placing past events on some sort of timeline is also important.
At the age of 11, the child usually masters the calendar, and after 12 years of age, there is no difference in knowledge that can be connected to age [6][11].

TARGET GROUP

- Children in year 1-4
- Ages 7-10
- Started to learn the calendar
- Swedish public school

Inspiration

Pedagogic clocks

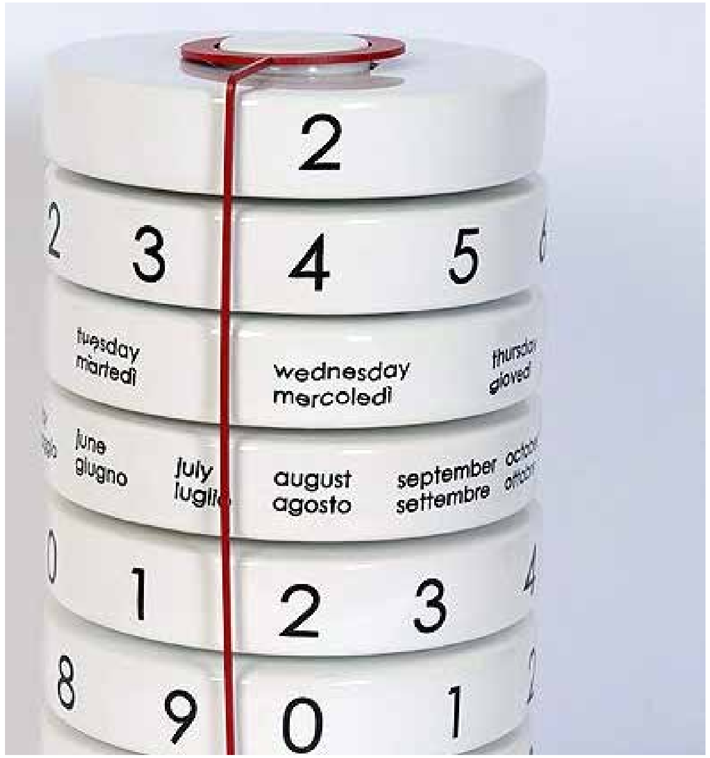
Existing Tools

Pedagogic clocks are clocks that children use to learn to tell and count with minutes and hours. They are not functioning, so that children can set the time themselves and move around the hands however they want to.
I was inspired by these clocks in the project since they are well functioning tools for teaching children how counting time works. As of now, there is no real tool showing how a calendar works, only different ways that teachers themselves come up with.

Perpetual Calendars

Resetability

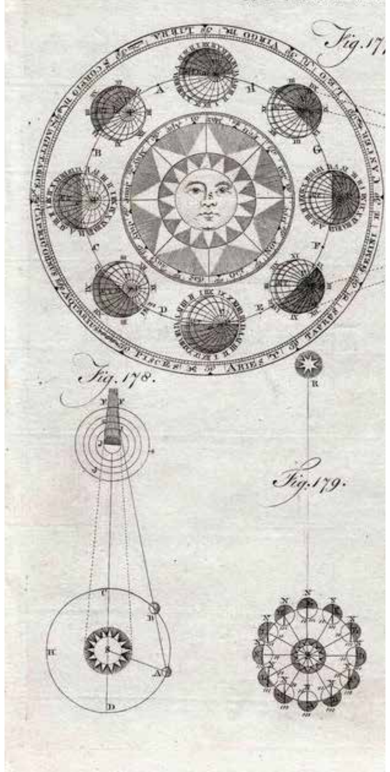
Perpetual calendars are calendars that can be reset year after year. It is not like a pocket calendar or a wall calendar where you have to get a new one each year. These calendars are often decorative and have a different way of visualising a year.
I decided to work with repeatability early on in the project to enable the calendar to be used for several years. No need to buy a new one, buy once and use it for as long time as possible.

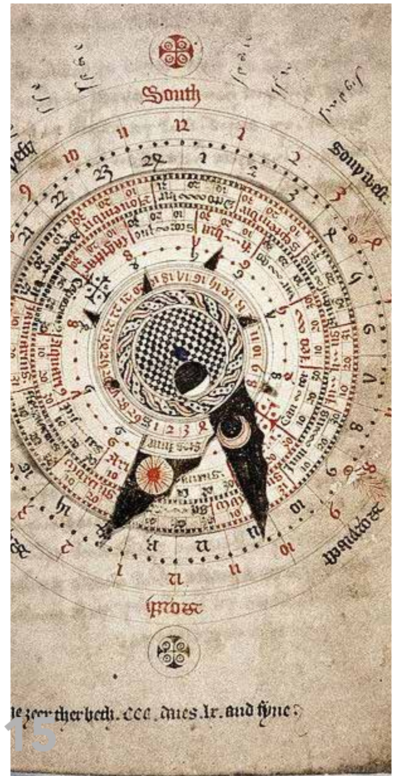


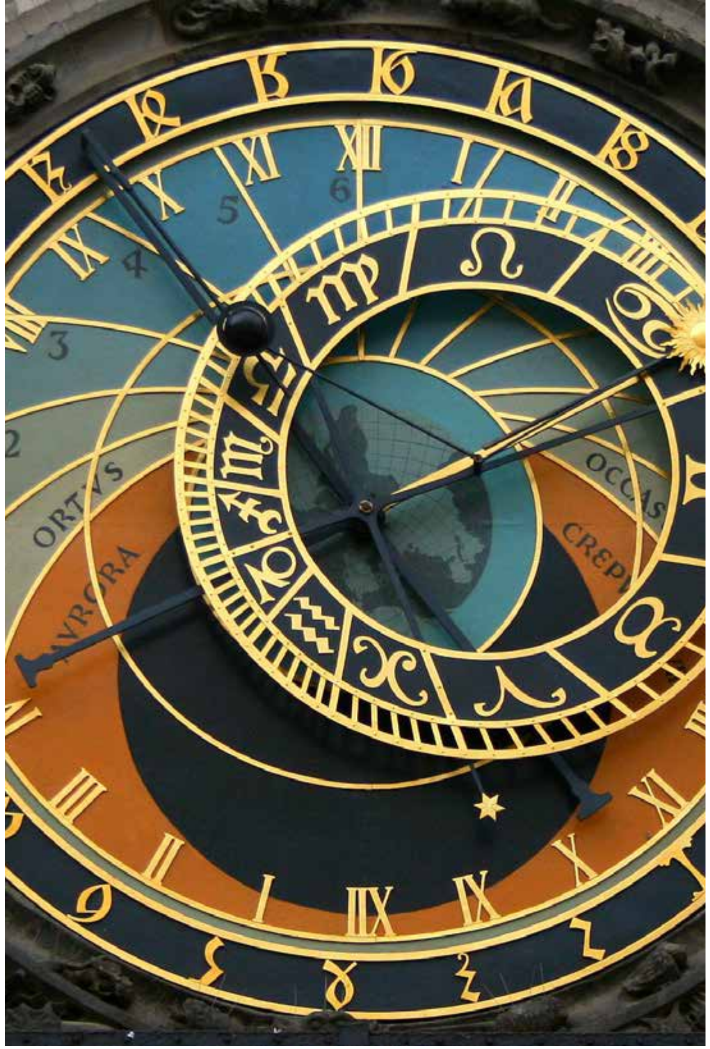
Astronomical Calendars

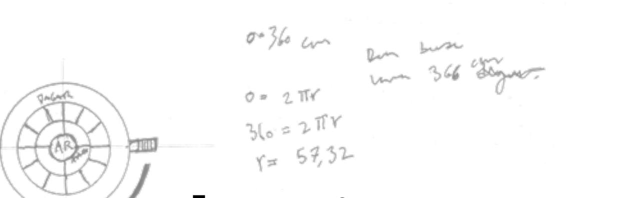
Mechanical computers

Before there were computers we had astronomical calendars. They were mechanical marvels telling the time, month, year, season and much more. This is a both satisfactory and efficient way of showing how the different phases of a year are connected to one and other.[9]



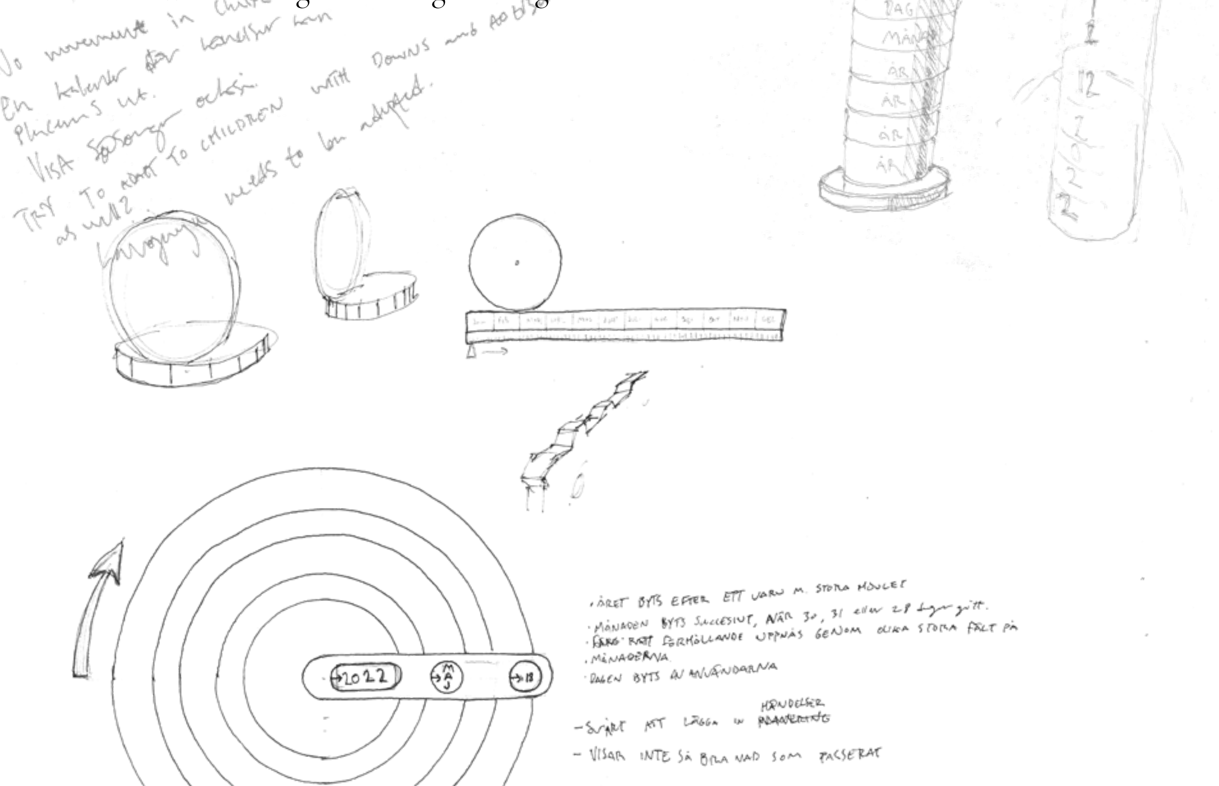


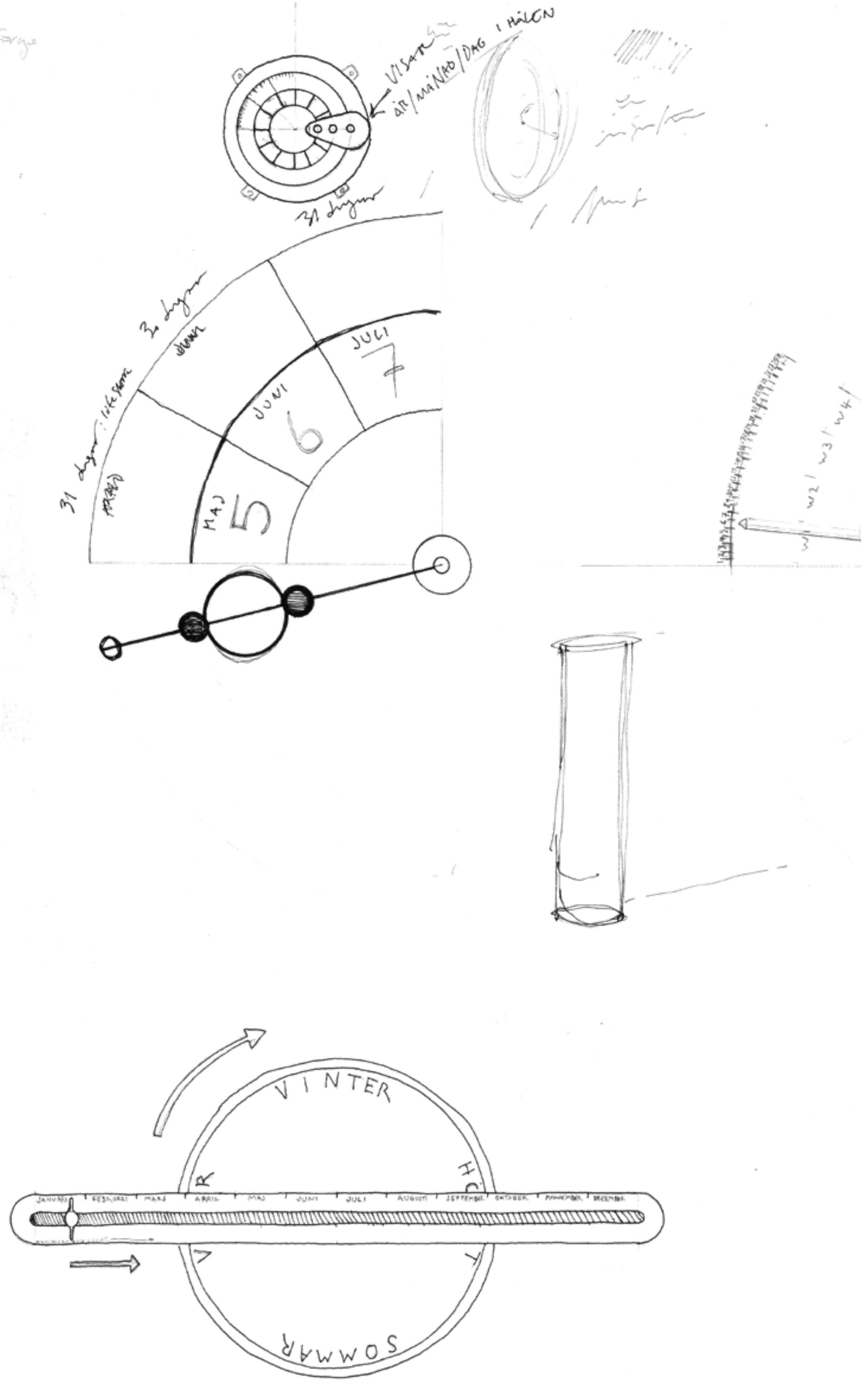




Ideation

The ideation began with some very crude sketching. Basic concepts with just the basic movements incorporated. Timelines, wheels that move in correlation with each other and other ways of visualising time moving. I wanted to get the learning clock simplicity yet give the calendar a well thought through design.

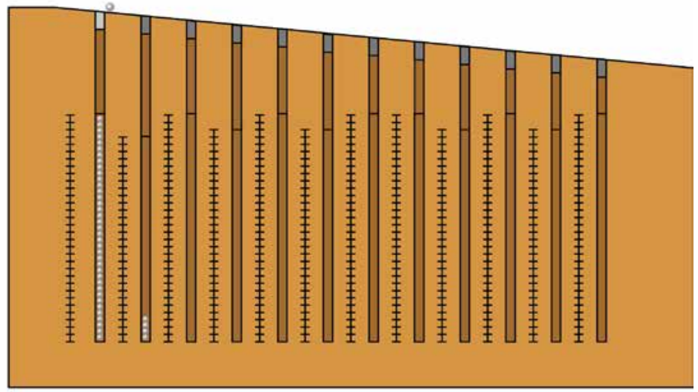


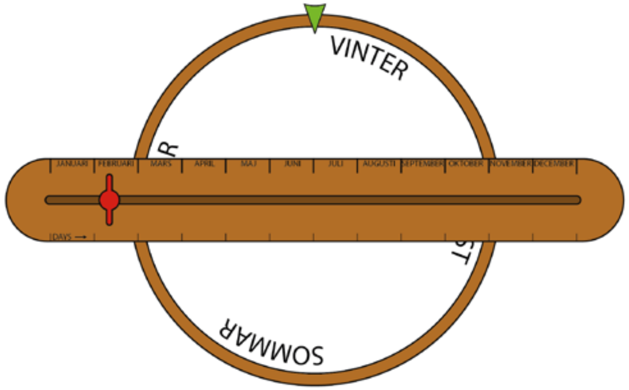


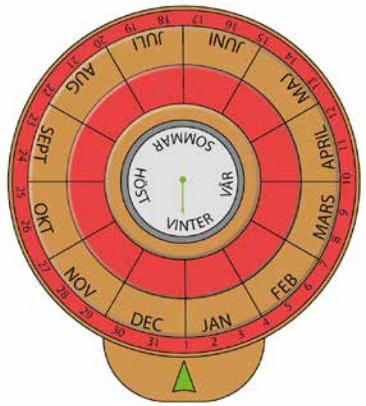
Ideation

First concepts

The first three concepts that I decided to develop further were based on three different ways of visualising time. The first one consists of three wheels, where all the wheels would turn in correlation with each other, so that when a day has passed, 1/30th of the month moves and 1/366th of the year moves.
The second concept was based on marbles representing each day, filling up tracks representing the months as they roll down a slope.
Concept number three consisted of a slider on a timeline, that would point out the correct date and where in the month that is, as well as which season it is..
All three concepts show how the year passes by, how much that has passed and how much that is left. They also allow for planning, which is an important factor when learning the calendar.



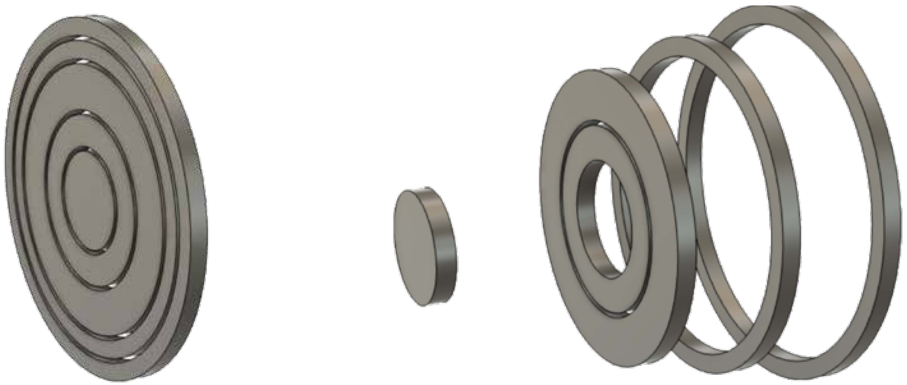




The Wheel

Concept no.1

The wheel concept is based on the idea to show how a day correlates with a month and a month with a year. When the day ring is turned, so is the month ring and year wheel, in proportion to how much a day is compared to them. So the month ring movies 1/30 of a turn and the year ring turns 1/365 of a turn. To adapt this for the fact that every month has different lengths and that there are leap years, the months would need to be shown graphically.



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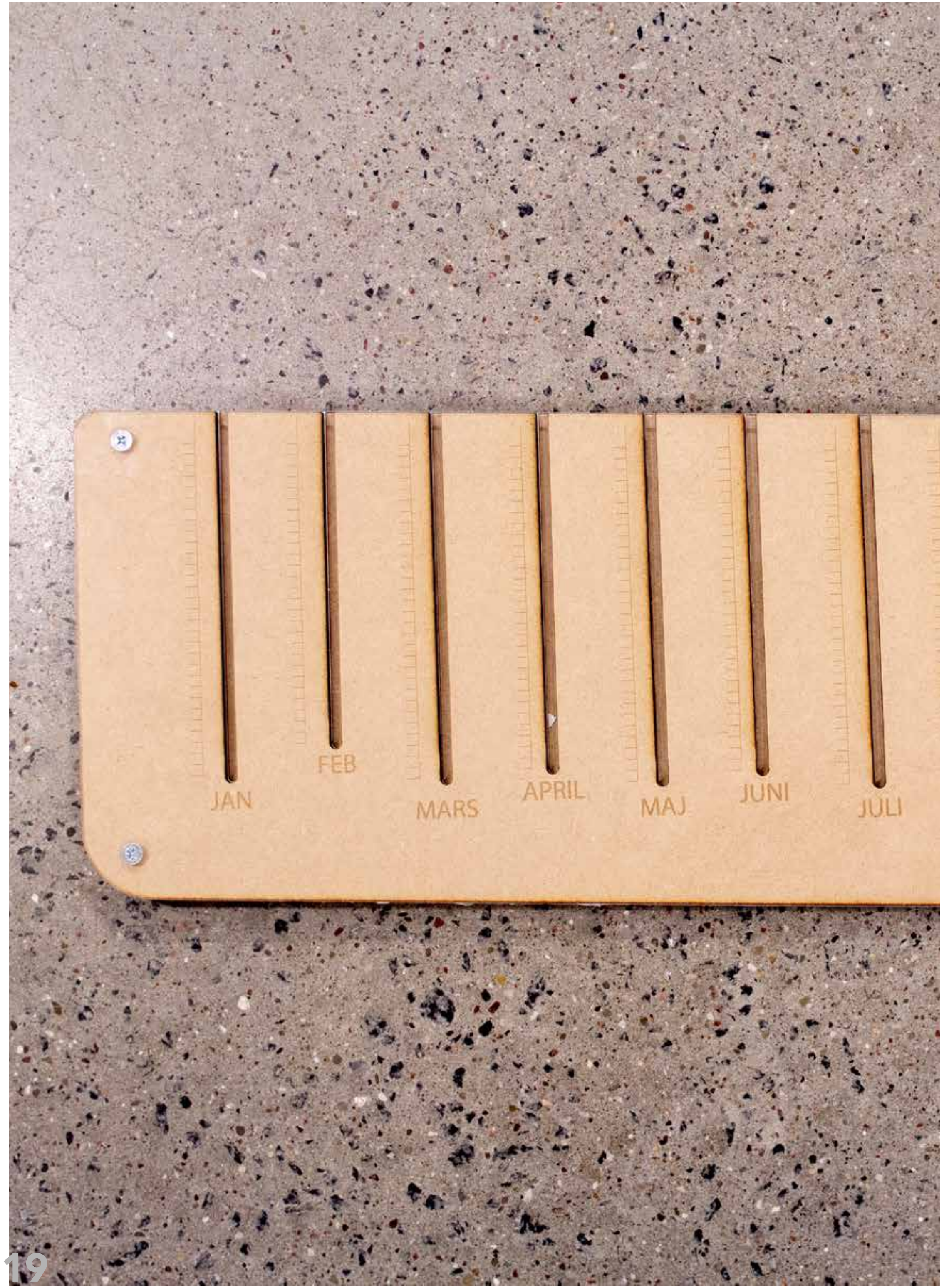
The Marble Path

Concept no.2

Working with marbles, I wanted to integrate some fun into the product. Going away from the circles, moving towards a timeline, a calendar with marbles representing each day became the result. This integrated fun, allowed for planning as well as a clear visualisation of how much time has passed and how much of a year is left.
Just as concept no.1, this calendar is perpetual.



The Timeline

Concept no.3

With concept no.3 my idea was to combine a timeline and a circle, since those are the two most common ways to visualise a year (see surveys further on). With this concept I also emphasised on the seasons, so that they could be integrated in the understanding of a year. This concept would allow for planning really well, with the possibility to see both past and future events.

Conclusion

Which is worth exploring?

All the three concepts have different benefits. No.1 shows the relation between days, months and year, as well as showing the year in a circle which is a common way to visualise a year. However, it does not enable planning as the other two options at the same time as it can't show past events that happened the month before.
Concept no.2 shows how much of the year is left and how much has passed, how long each month is as well as enabling planning for the entire year. The downside is that a full scale version would get expensive, large and heavy. The timeline is also somewhat broken into two axis since the month tracks are vertical and the year itself is horizontal.
Concept no.3 has a very logical timeline, enables planning for the entire year and shows all the seasons. Unfortunately it would have to be huge if realised in full scale, as well as being complex mechanically resulting in a time consuming assembly.

Interview With Juan Mendoza

Advice from an expert

Juan Mendoza is an industrial designer and doctoral student, focusing on the area of semiotics and artefact learning. His work spans from designing cars, teaching design and researching different subjects connected to artefact learning and semiotics, among other fields.
I contacted Juan to discuss which concept to further develop and what to think about when designing products for children.
Juan liked the idea and the concepts, and found that no.1 and no.2 were the best ones, but that no.3 also had potential for a development using a lot more graphics. Discussing the different concepts, he emphasised on how important gamification, creating a narrative and working with fun factors are.
These three pillars became leading words for the further development.

We also discussed the different concepts from the viewpoint of what they enable. Concept no.2 showed most potential, since there is so much that can be developed from the marble system. The marbles can become characters, they can be colour coded, they can be used in a marble path system and marbles are an artefact that children connect to fun and games. Concept no.2 was possible to develop with all three pillars in mind.

Specifications

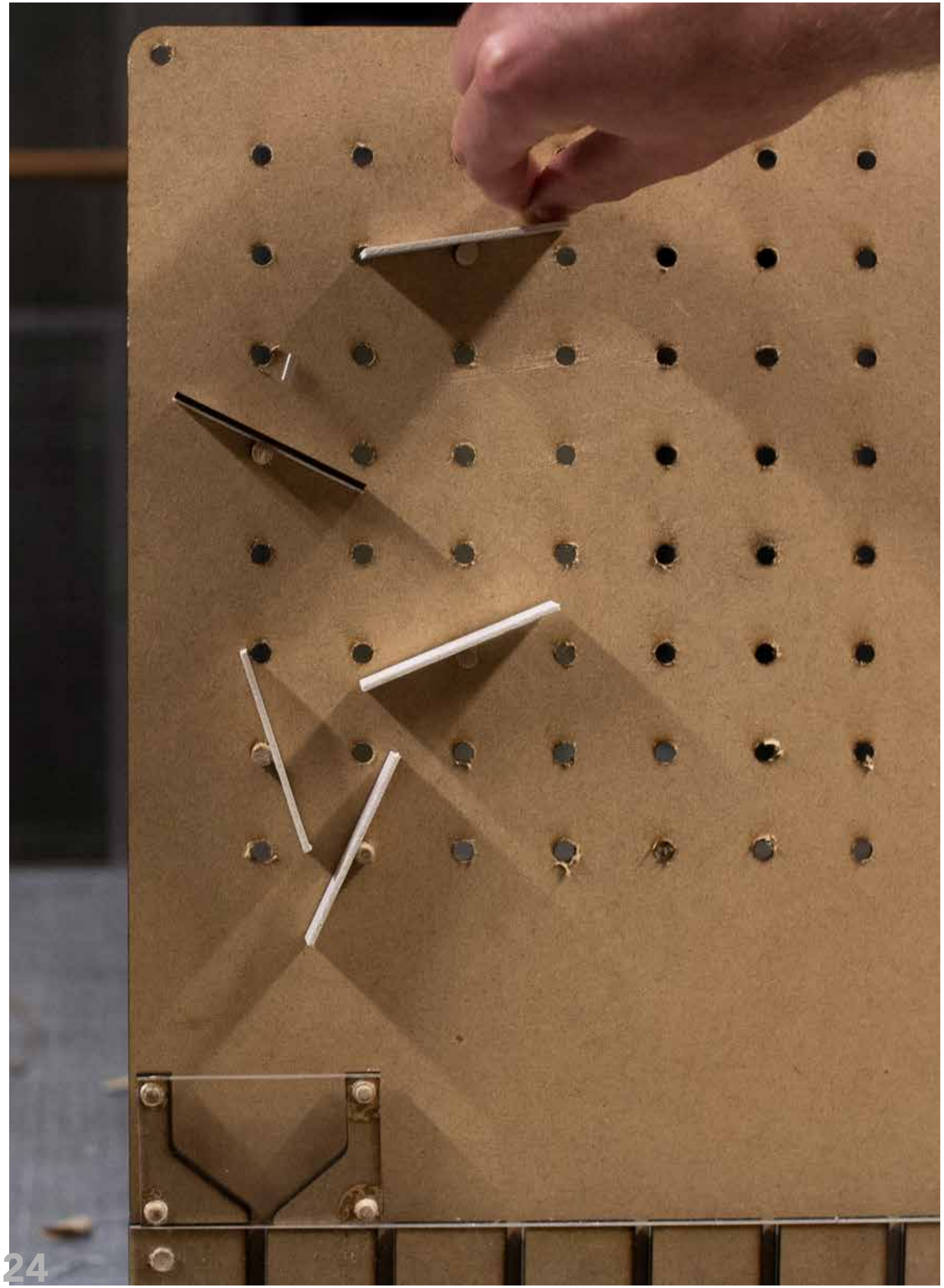
Base to work with

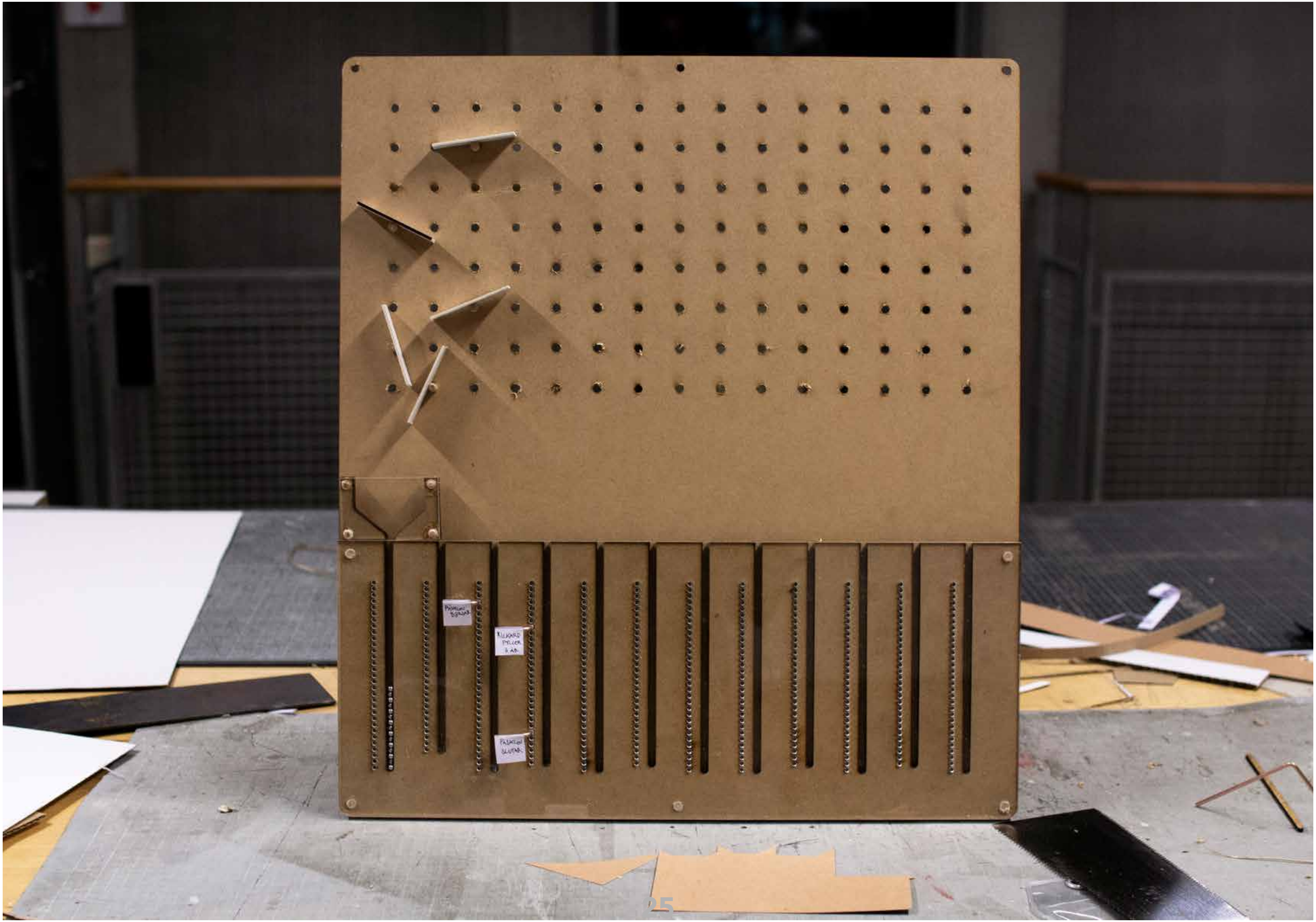
After the interview with Juan, I had a better idea of what to work with and what kind of features that the calendar needed to become an efficient tool for learning.
Gamification-To intrigue the children and make them engaged in the usage, use gamification. This leads to them remembering using it at the same time as it increases the fun factor of the calendar.
Create a narrative- Connected to the gamification, I was recommended to create a narrative. This makes the users emotionally invested in the calendar and could give children the possibility to create their own worlds connected to the calendar and therefore remembering it even better. The efficiency of communicating knowledge to children is also proven in a study conducted by Ulrika Palm and Sandra Berggren for Malmö University [7].

Concept

For further development

The concept that I derived from my ideation and interviews became a calendar where the children get to create a marble path to lead down a marble representing a day down into a track representing the month. The month slot has all days marked out with the ability to attach notes for planning. The marble path enables a fun element for the child and a sense of accomplishment when managing to lead the marble into the right track. It also creates anticipation, since only one marble is dropped per day. Planning wise, the child can see how long a year is, how much that has passed and how much is left. They can also clearly see which months are 28 (sometimes 29) days, 30 days and 31 days. There is also a possibility to involve colour coding and graphical development.





What the Calendar Should Enable

Enable planning of
- Past events (monthly and daily)
- Future events (monthly and daily)

Events such as
- Birthdays
- School breaks
- School trips
- Days when mom/dad picks up from school
- Extraordinary happenings

Why?
- Helps to get a natural sense of planning
- Gives the ability to compre time (days, weeks and months)
- Compare how long ago something was to when something is happening in the future
- Count days, weeks and months

Visualize
- Passing of time
- Relation between months, days and years
- Seasons

Seasons
- What signifies them
- What fruit and vegetables are ripe
- Approximate duration

Visualization
- Movement of the day changes the month equally, which changes year equally
- Layout fitted for children, graphics with simple motives
- How seasons and how different events correleate with them

Why?
- It shows the mathematical and logical relation between days and months. That will help the child
- grasp the concept better
- Showing seasons improves the child to connect different climate and foods to different months.

User Survey

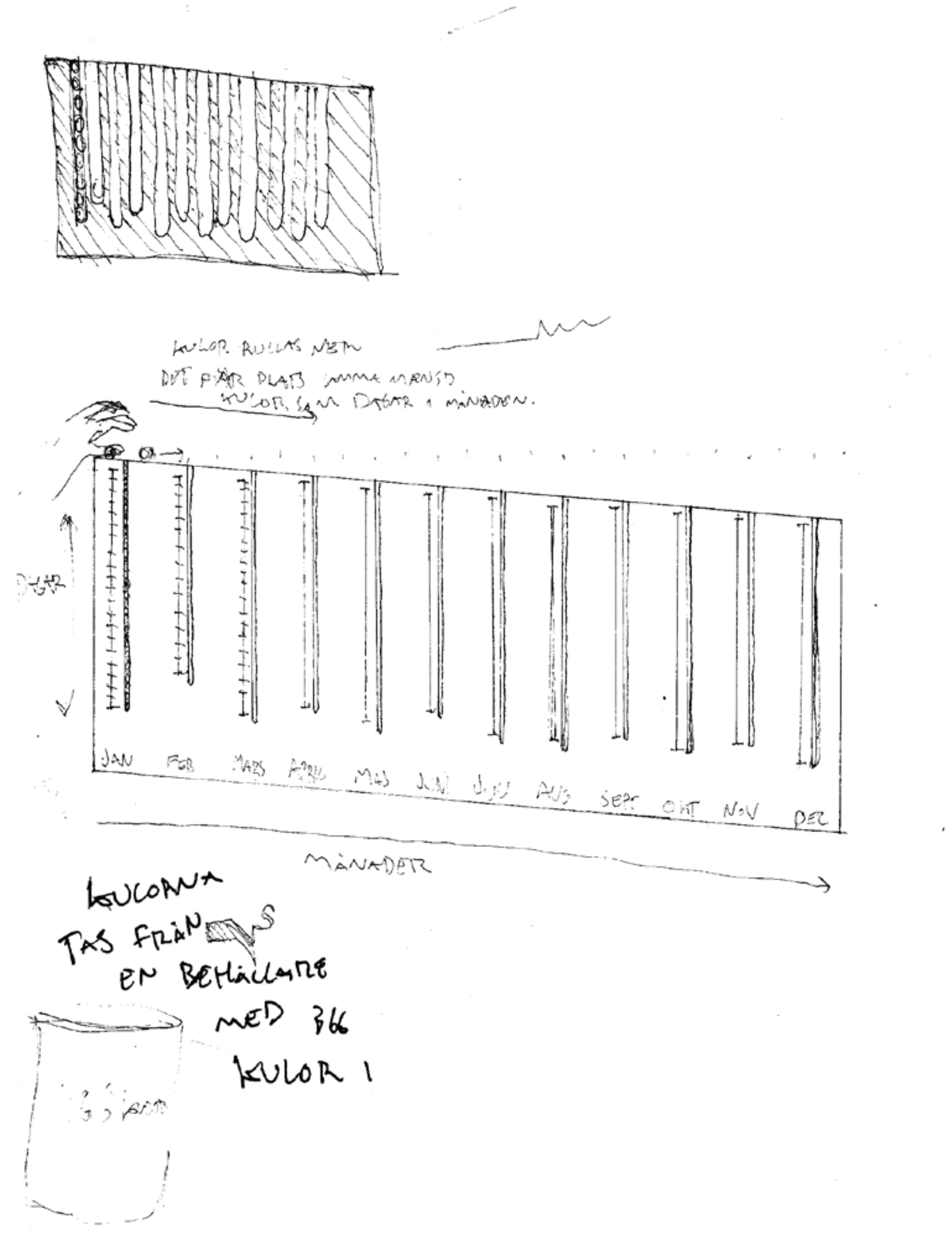
To be able to further develop my concept, taking it from a blank canvas to a product that intrigues children, I had to convey a user survey. I wanted both the input from adults and children, to see if the visualisation of time differs between the ages.
The surveys were designed to answer the following questions:

- *How do individuals visualise time?*
- *How do individuals visualise a year?*
- *Which colours are associated with which months and seasons?*
- *What do children look forward to in a year, festivities, birthdays, events and such?*

By answering these questions, I was able to come up with colours and graphics, see if there is any common way that people visualises time as well as finding out what children want to be able to plan for.
To find people to do the survey, I sent out the survey on social media and to a third year elementary school class of 9 year olds.
The results showed that most people, both children and adults, saw a year as a circle or a timeline. While adults showed many different ways of visualising time that has passed, their own timeline, the answers varied a lot. Everything from imagining time as clusters representing different walks of life to timelines and stairs. However I choose not to include this in the design, since the way of imagining a calendar year was the most important for my design. If there would have been a more clear consensus I would have included it. Noteworthy is also that the children couldn't even answer a simplified version of the question, which points in the direction that it is a bit too advanced for them to understand.
As for the association of colours, both children and adults choose quite similar. The children had a larger spread of colours and more playful colours, such as pink and bright turquoise, while adults were more gathered and unified in their responses. The colour pallete on the opposite page is a conclusion of both the children and adults responses. The colour of the four seasons are above the twelve months.
The different festivities that the children looked forward to proved that the ability to place out notes will be helpful to enable them to calculate different time spans. It will clearly display the difference between two days and one week while tricking the children that they're just comparing fun activities.

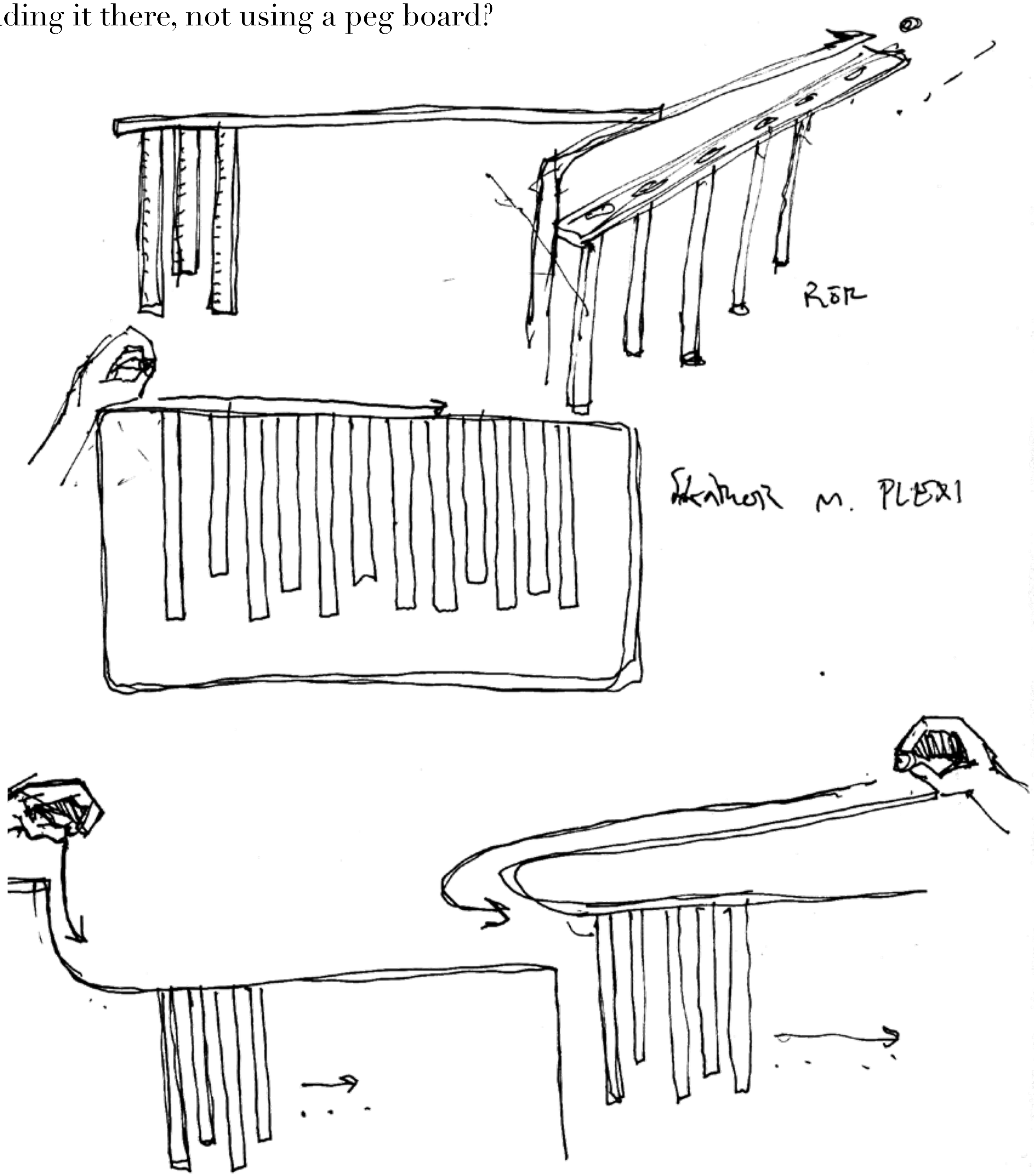
Further Ideation

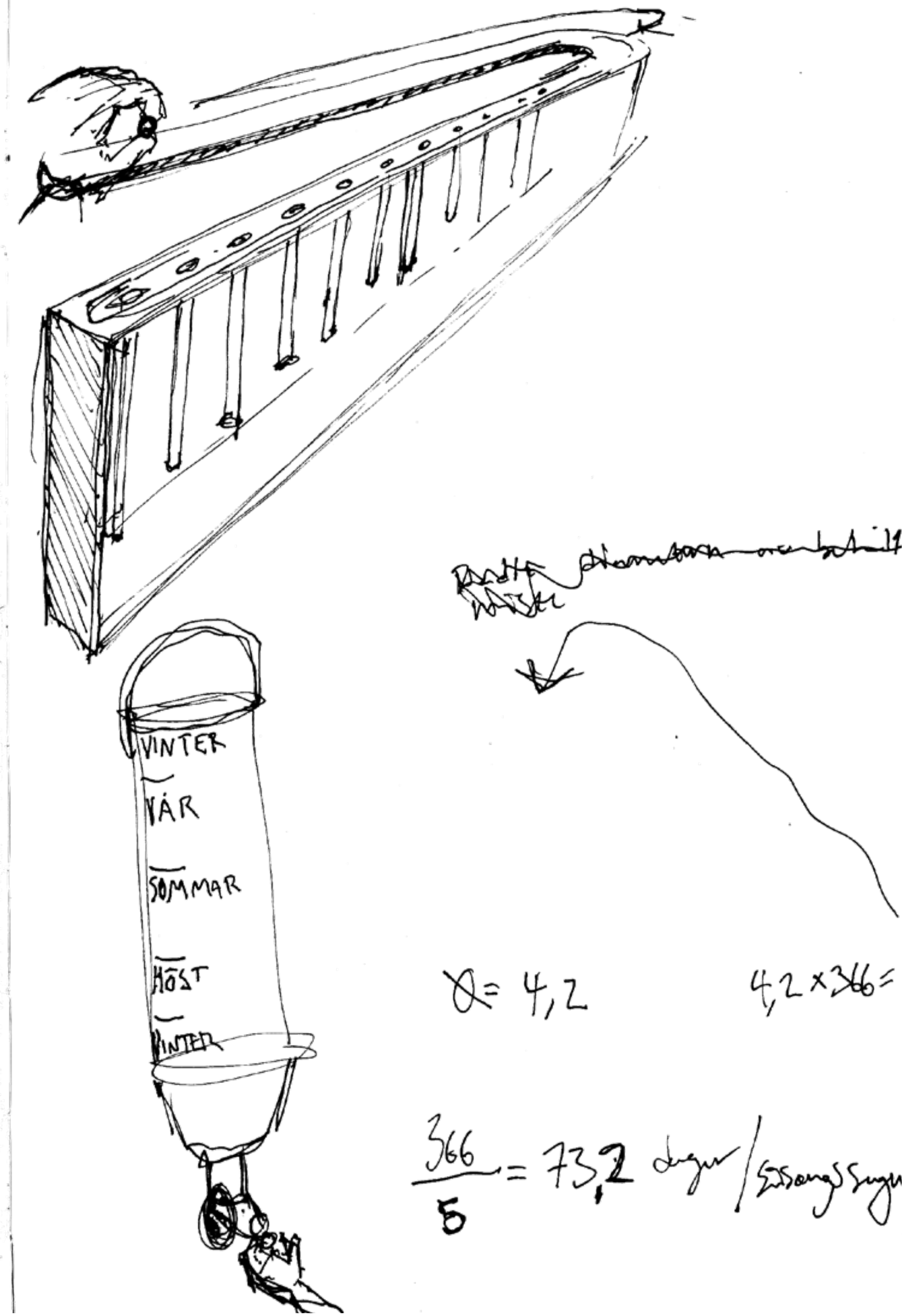
With the concept set, I could continue the ideation. The focus was to explore if there were any better solutions than having a peg board or if the pegboard was the way to go. Furthermore, I contemplated using a sloped design so that the marbles would fill up the channels by themselves without using a pegboard with a track to lead them down.
Different ways of blocking the month channels to enable planning were also evaluated, as well as the marble container system and if it was necessary to have a separate marble catcher to lead down the marbles into the slots.



Shape of the Calendar

Just drop the marble on a sloped surface or have a small path leading it there, not using a peg board?





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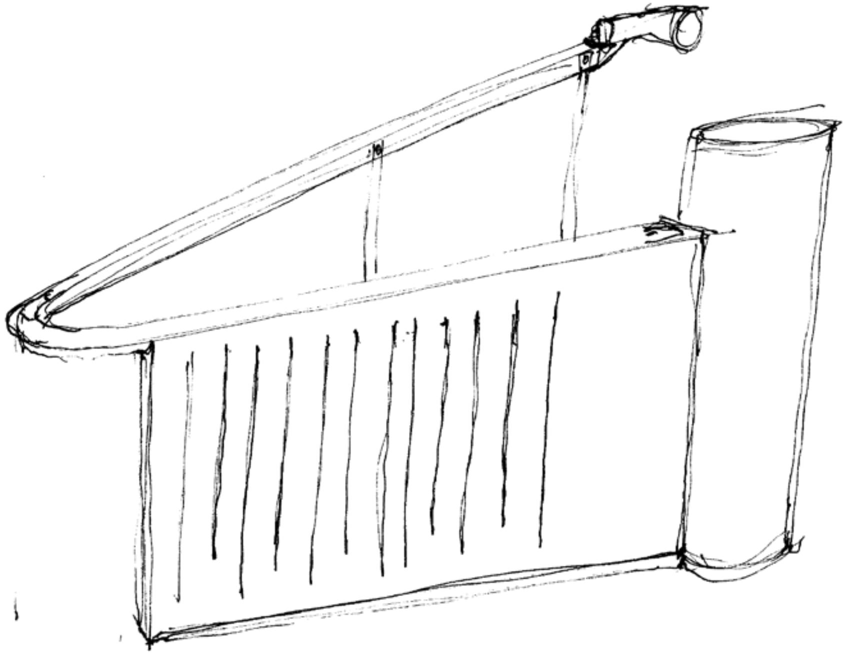
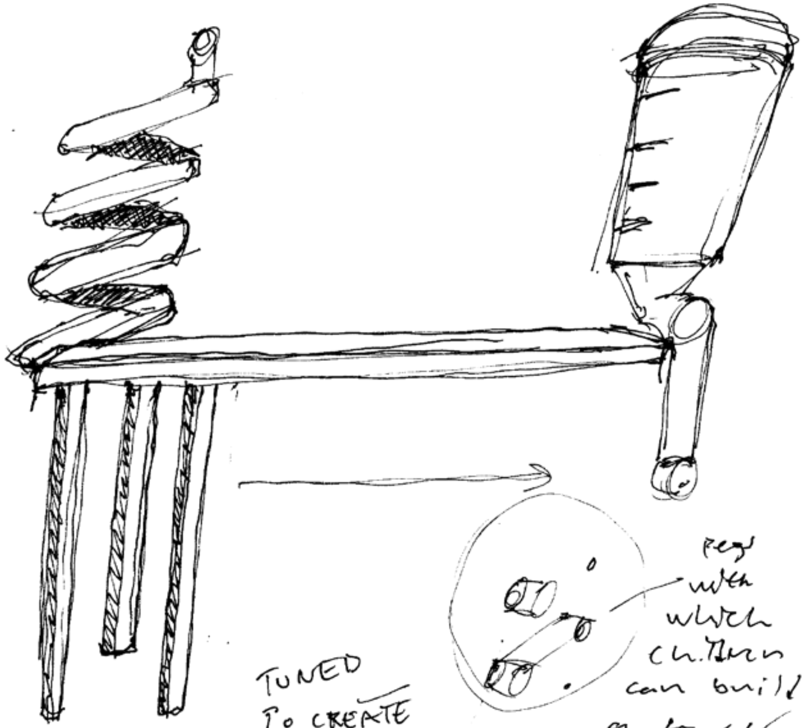
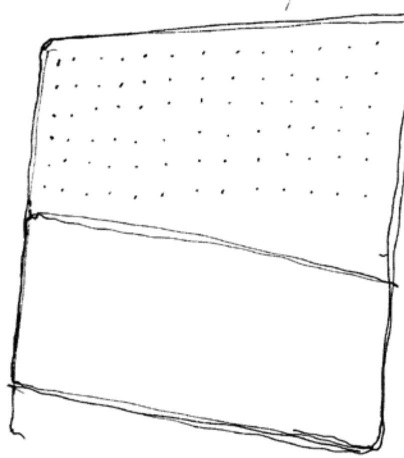


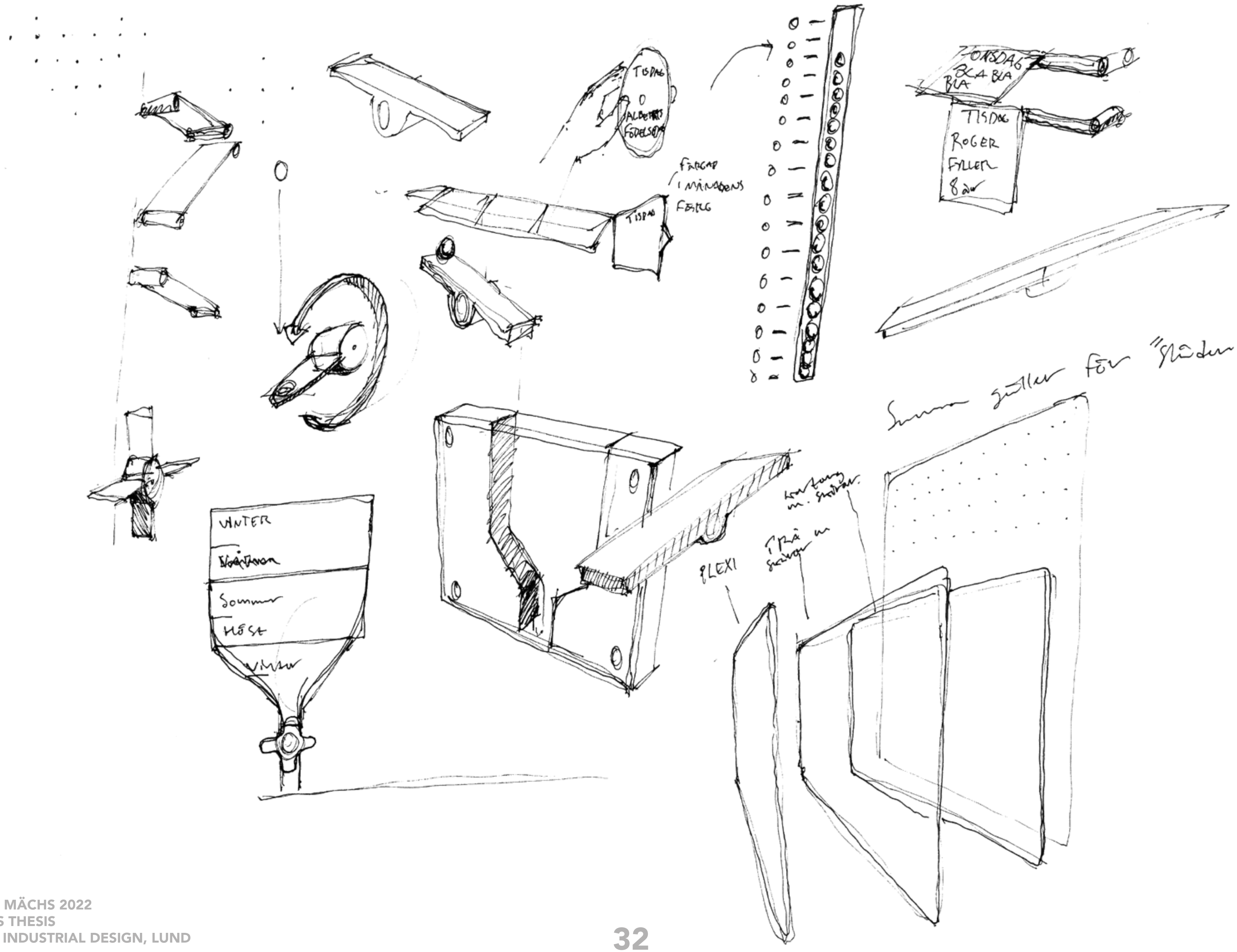


Pegs with which children can build a track

TUNED TO CREATE A MELODY?



Circles instead otherwise constant length won work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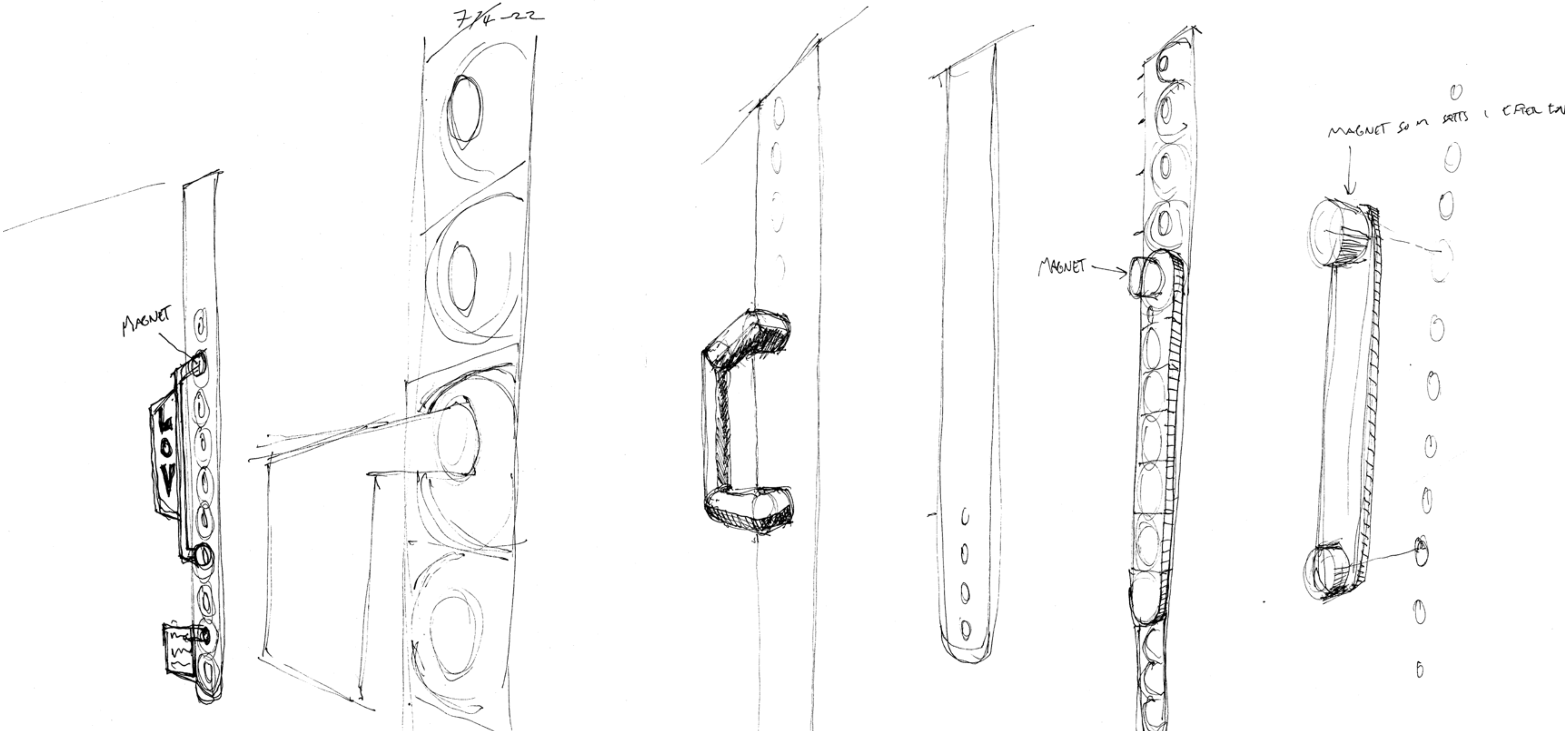
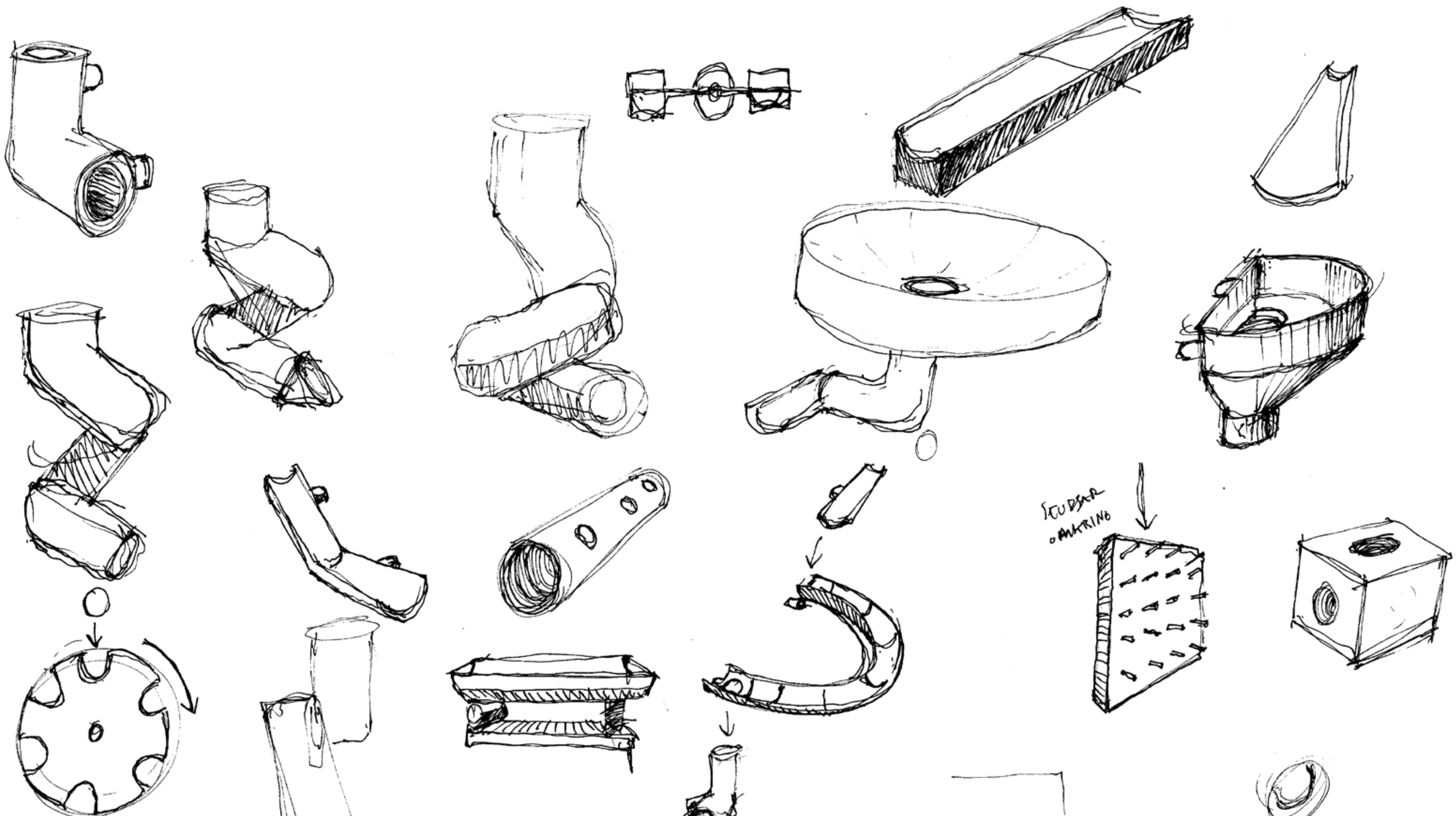


How to Enable Planning

Exploring options of how to enable planning. Blocking of the channels versus just placing the notes on top of the acrylic screen. This was also tested in the trial prototype as shown further on.

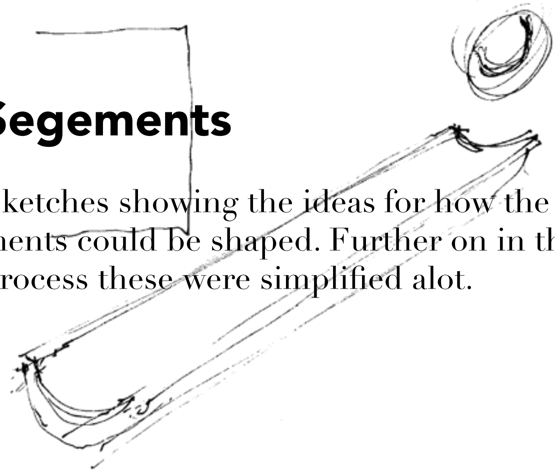
CAD-sketches

These are some early CAD models that where made to experiment with a variation of layouts and mechanisms. They are very crude renders, yet they provided a vital sense for dimensions, visuals and layout.



Segements

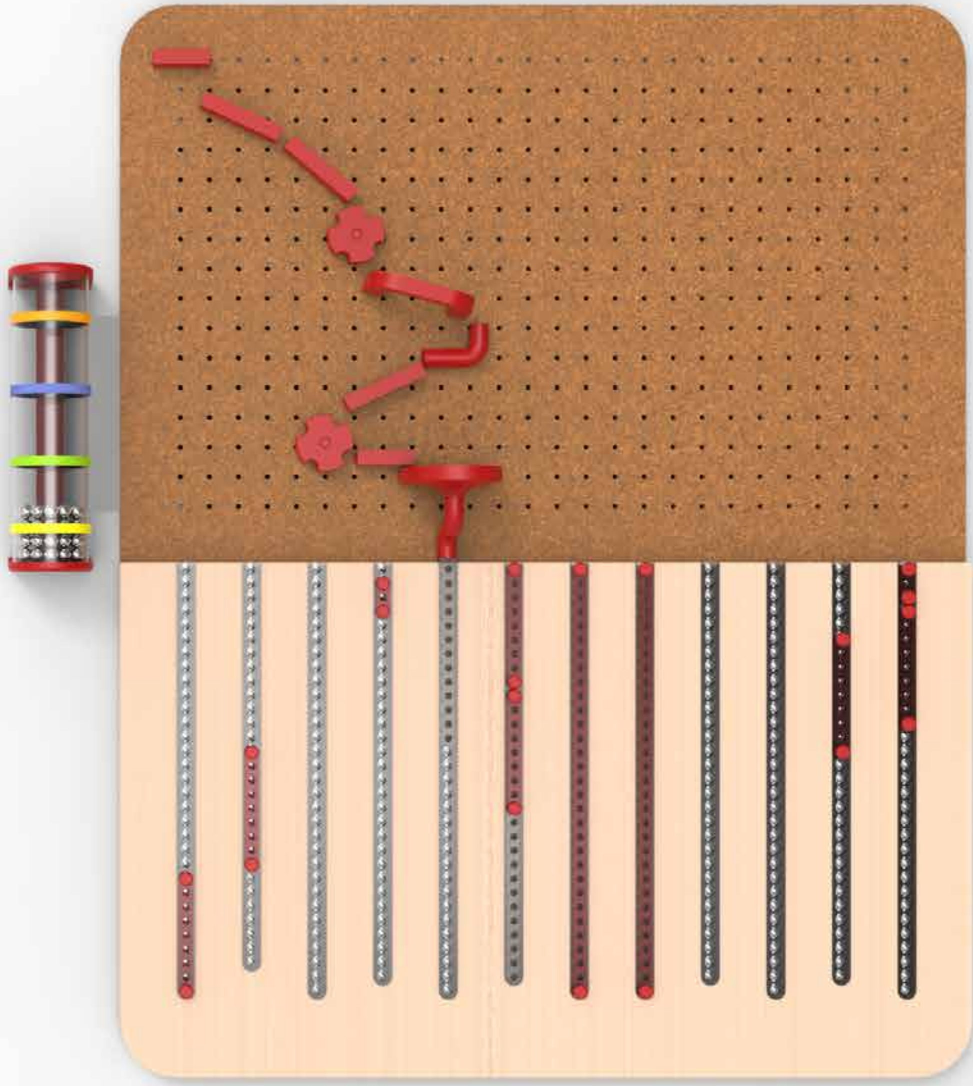
Sketches showing the ideas for how the segments could be shaped. Further on in the process these were simplified alot.



List of features

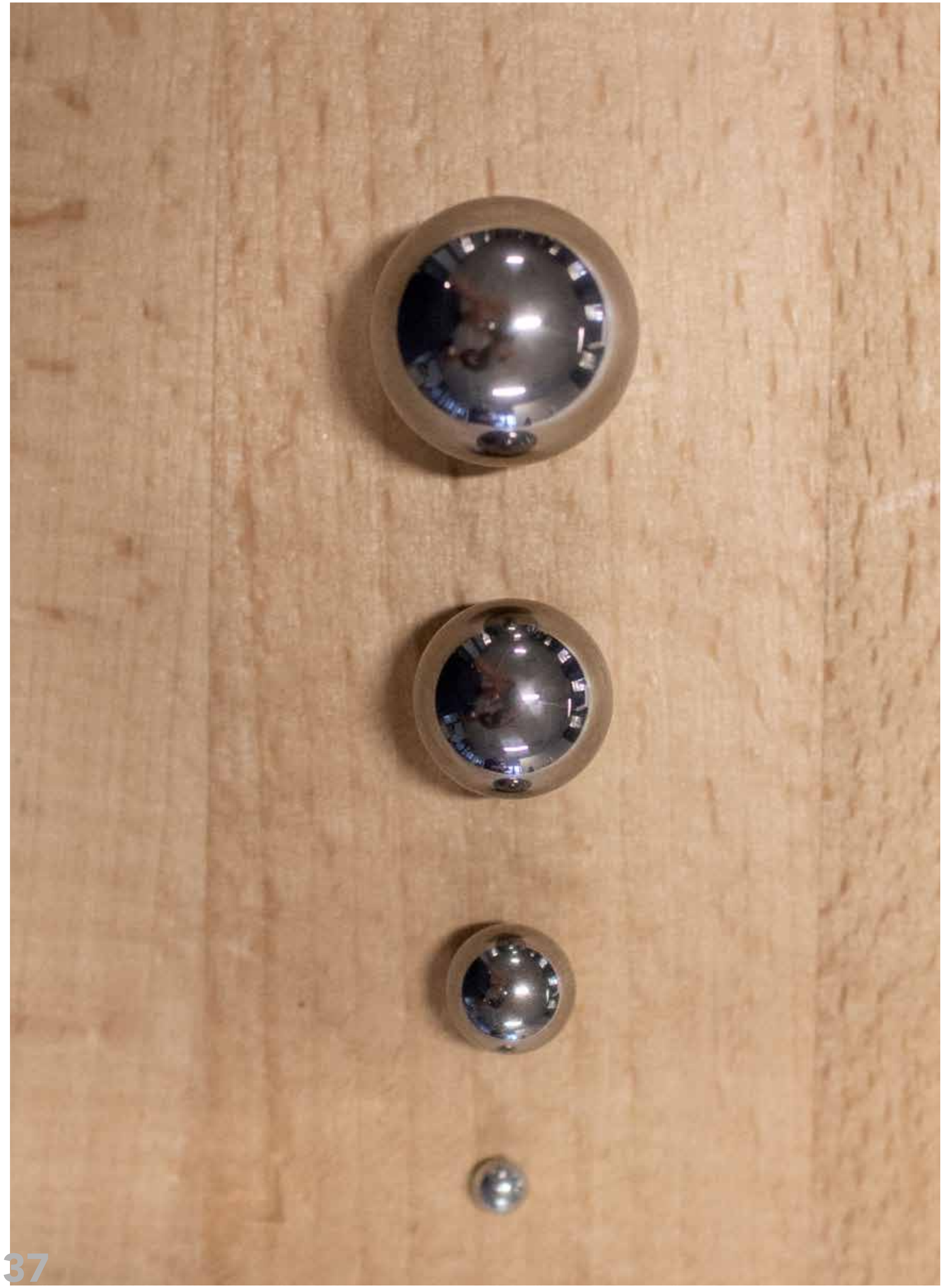
Finalized before prototyping

- *Fully customizable marble paths with a peg board system*
- *Placeable screens that enable planning of events such as breaks.*
- *Notes that can be attached to the screens for planning of events such as birthdays*
- *Seasons represented by rings on the container for the marbles.*



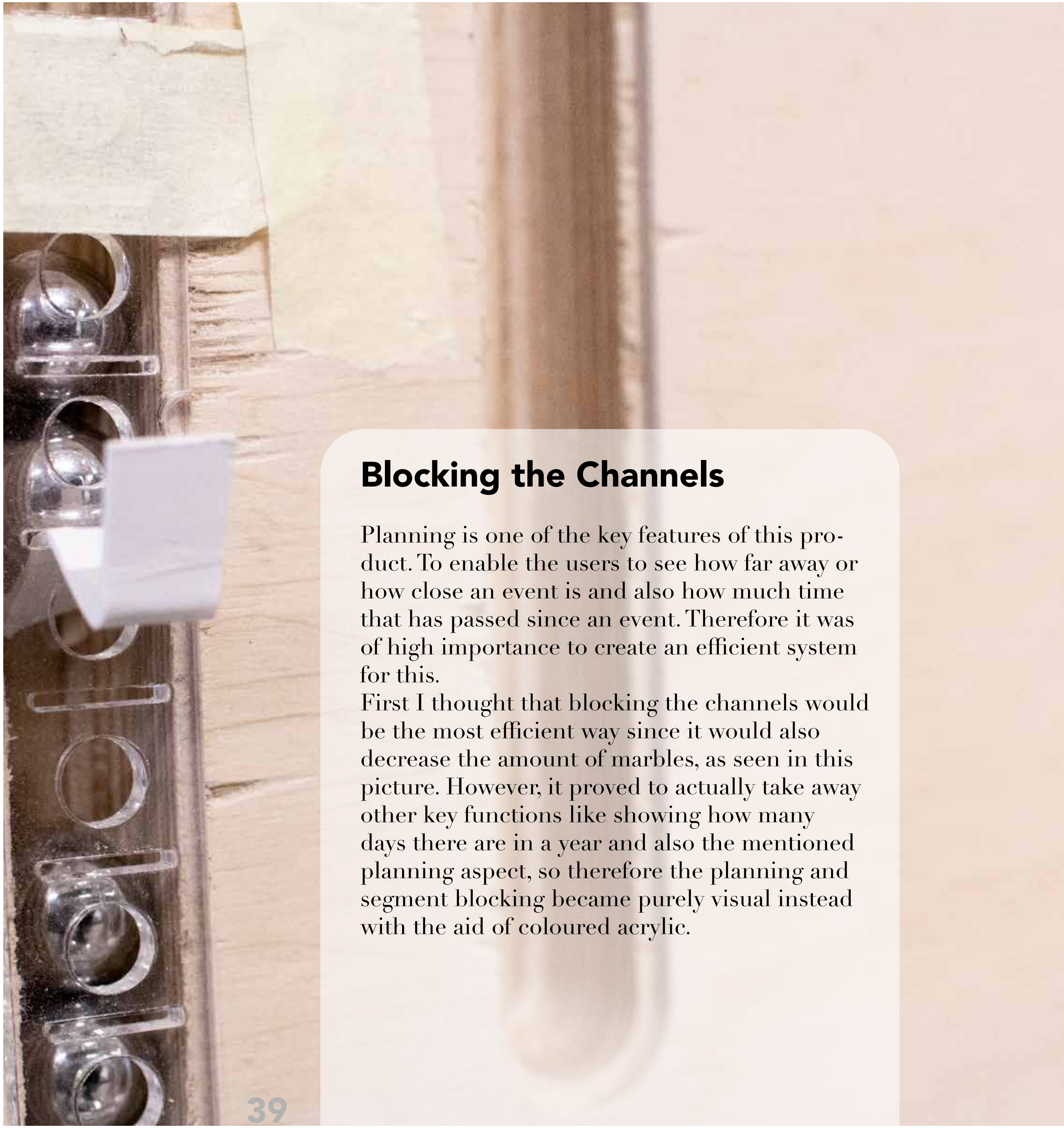
The Importance of Marble Size

To choose a size of marble was maybe not a challenge, but very vital for the project. If it's too small, the calendar loses its seriousness and if it's too big, the calendar would get too big and heavy. The marbles are the heart of the calendar and their dimensions are what decides the dimensions of the final piece. Even though 20mm marbles have a very satisfying feel to them, the calendar would become too big and heavy. When doing test tracks with the 20mm marbles, they showed that the dimensions and weight of the calendar would become completely oversized and unreasonably expensive for public schools. However, 10mm would become too small and easily get lost. It would also give less space for notes in the calendar. Therefore, 15mm showed to be the optimal size.



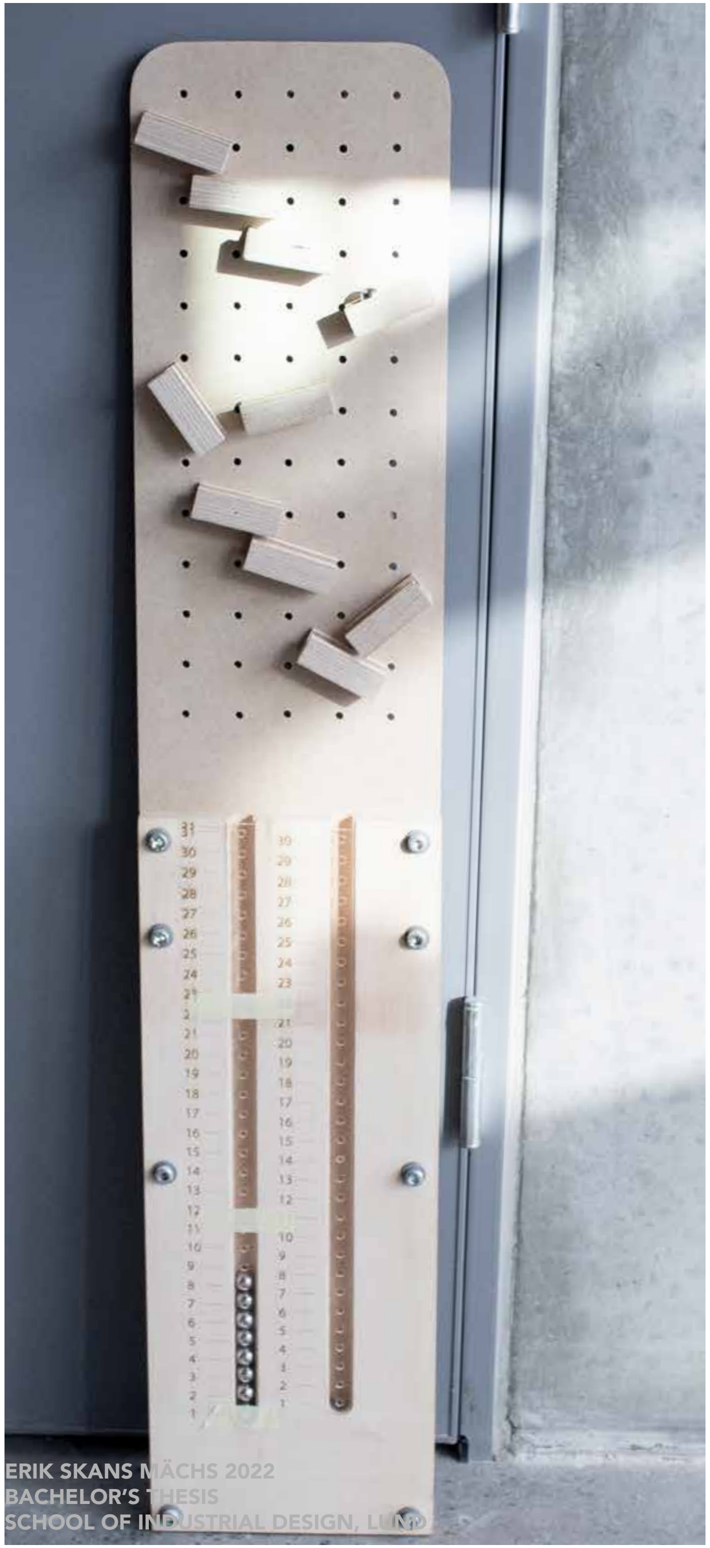
Trial Prototype

To try out the concept I created a section of the calendar. The goal was to evaluate dimensions, how to fasten the acrylic screens, how to create a functioning system for planning, trying out different kinds of marble segments, trying how well the pegboard holds up for usage, evaluating how to construct the full scale prototype as well as look into how to efficiently add the graphical elements to the calendar.
This was also a perfect opportunity to get comfortable with using the CNC-machines for milling out the marble path segments and the month slots.



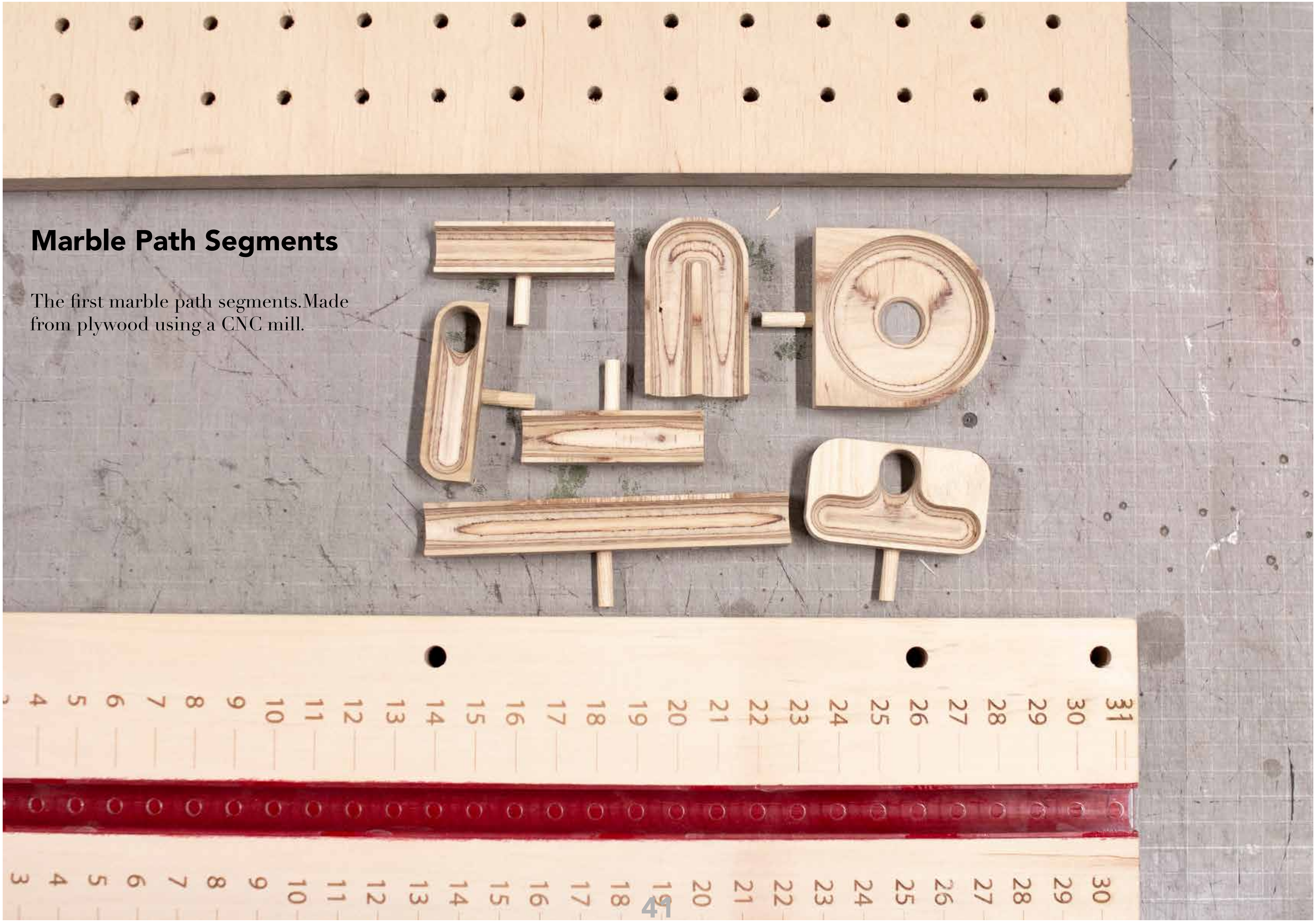
Blocking the Channels

Planning is one of the key features of this product. To enable the users to see how far away or how close an event is and also how much time that has passed since an event. Therefore it was of high importance to create an efficient system for this.
First I thought that blocking the channels would be the most efficient way since it would also decrease the amount of marbles, as seen in this picture. However, it proved to actually take away other key functions like showing how many days there are in a year and also the mentioned planning aspect, so therefore the planning and segment blocking became purely visual instead with the aid of coloured acrylic.



Marble Path Segments

The first marble path segments.Made from plywood using a CNC mill.

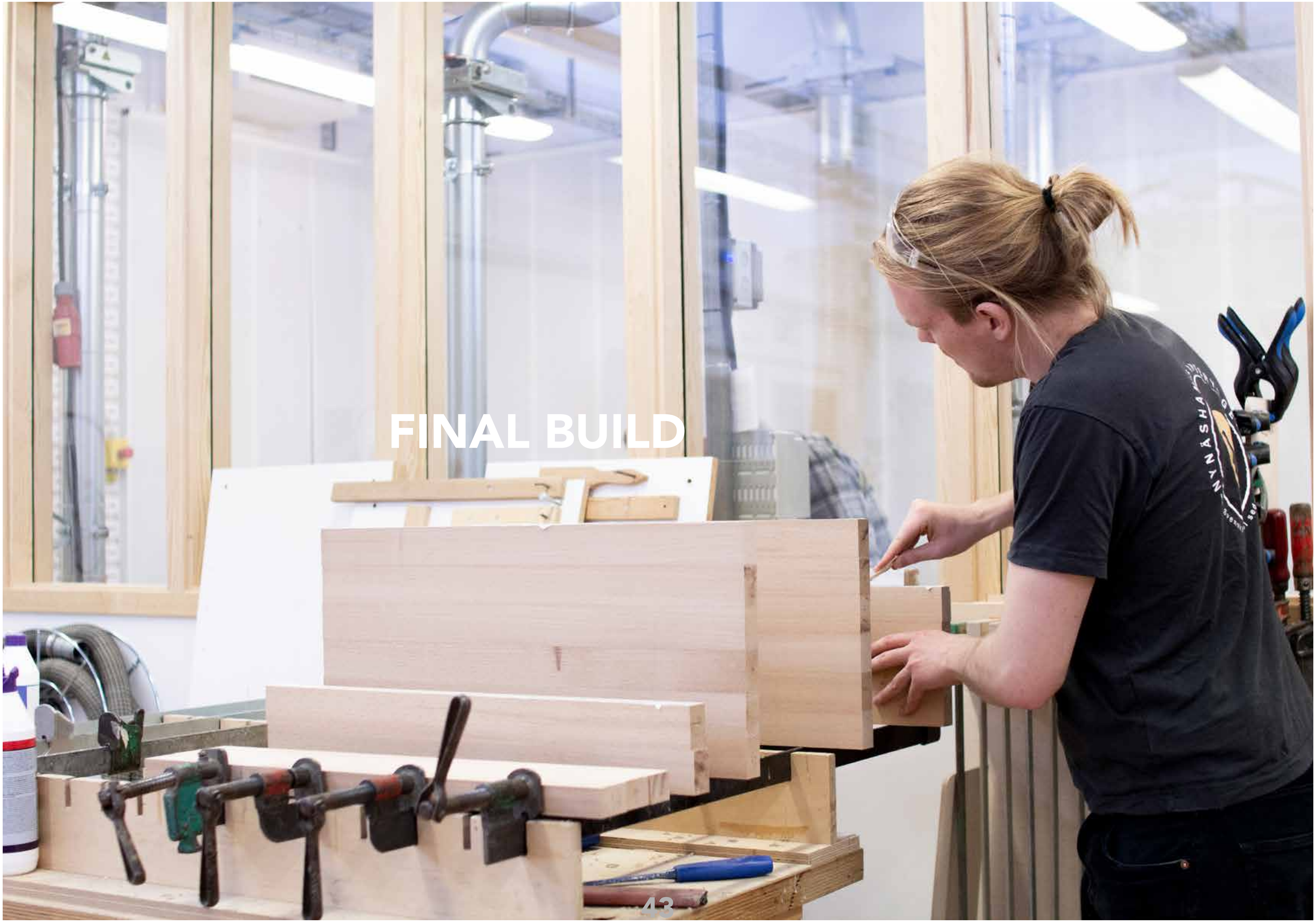


Evaluation

Of the Trial Prototype

Building the trial prototype brought light on several problems with the calendar. The first issue that came clear was size related. As mentioned previously, the dimensions of the marbles decide the dimensions of the entire piece. The trial prototype made it possible to explore and get a better understanding of the dimensions, and to find the balance between readability, safety, satisfaction and reasonable sizing.
It was also vital to try out which methods were most suitable to create the final version. Painting the marble channels, engraving the dates, machining the marble channels and many other parts of the construction.

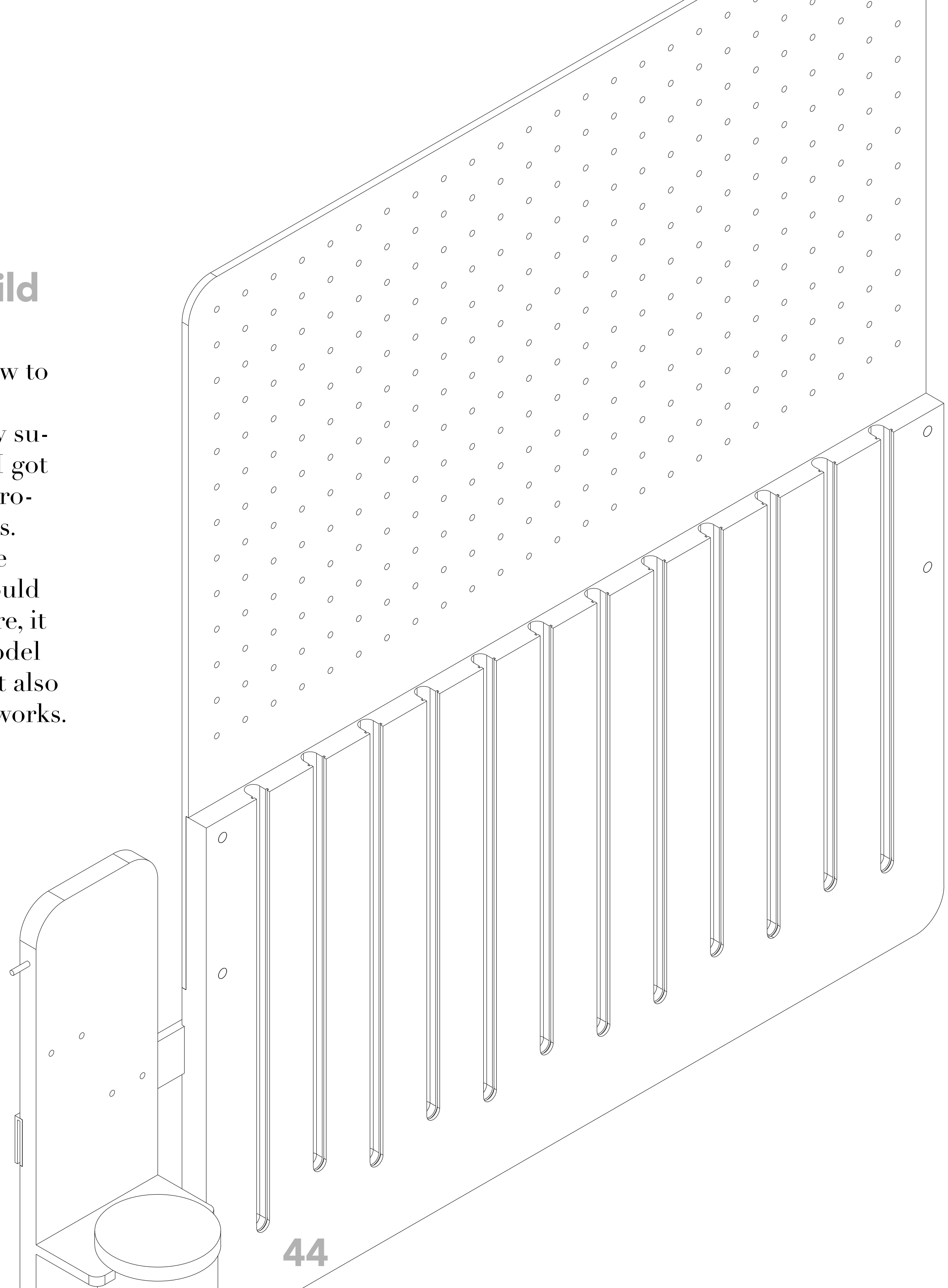
FINAL BUILD

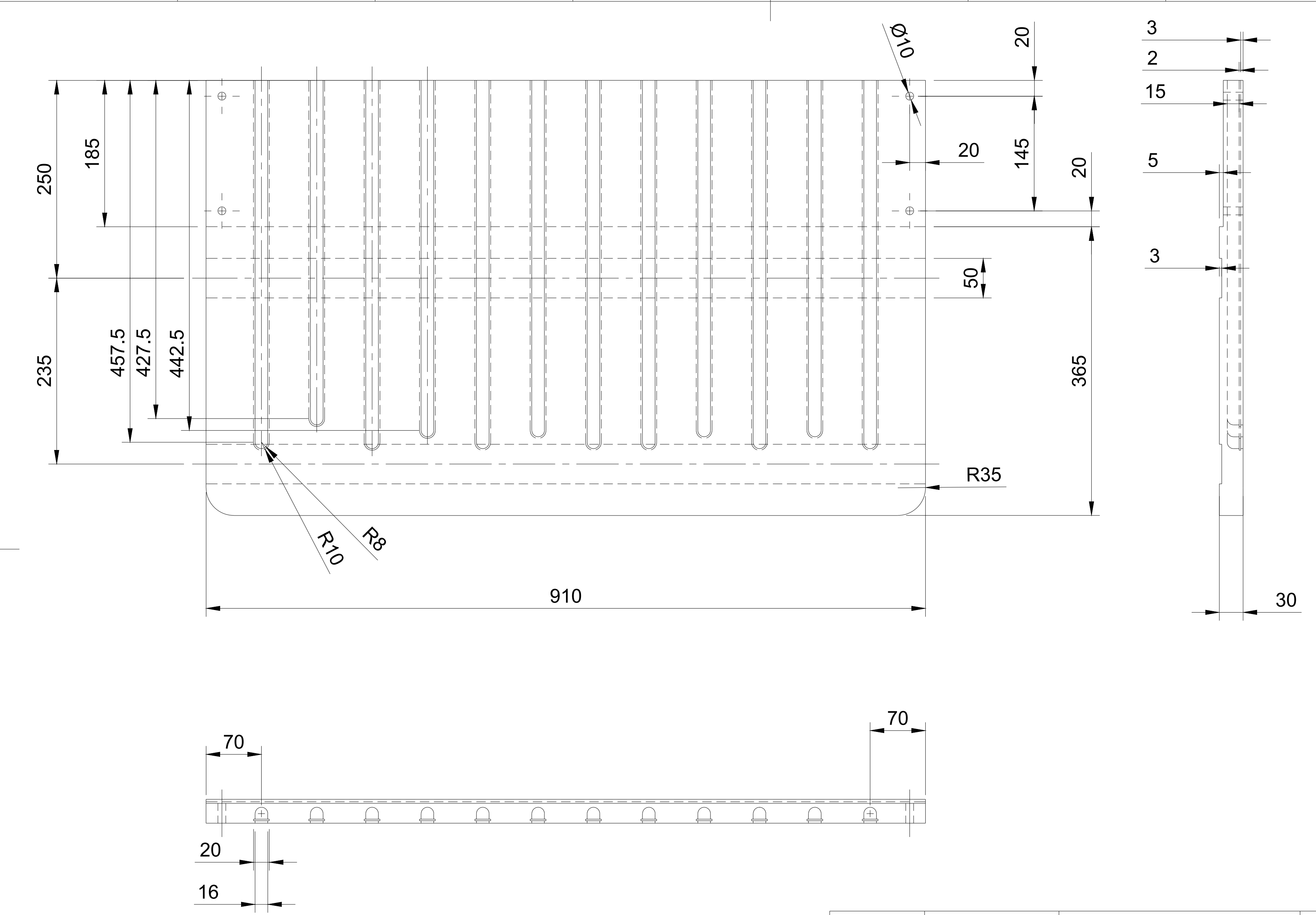


Planning ahead

Trying to structure the build

With the design set, I made a plan for how to build a physical model of the calendar. Consulting the staff in the workshops, my supervisors and other professors at IKDC, I got superb guidance in how to think about production techniques, CMF and dimensions.
I wanted to create a physical model of the calendar so that it in a dream scenario could be tested in a real classroom. Furthermore, it is often important to create a physical model to really display not only the product, but also the impact it gives in a room and how it works.





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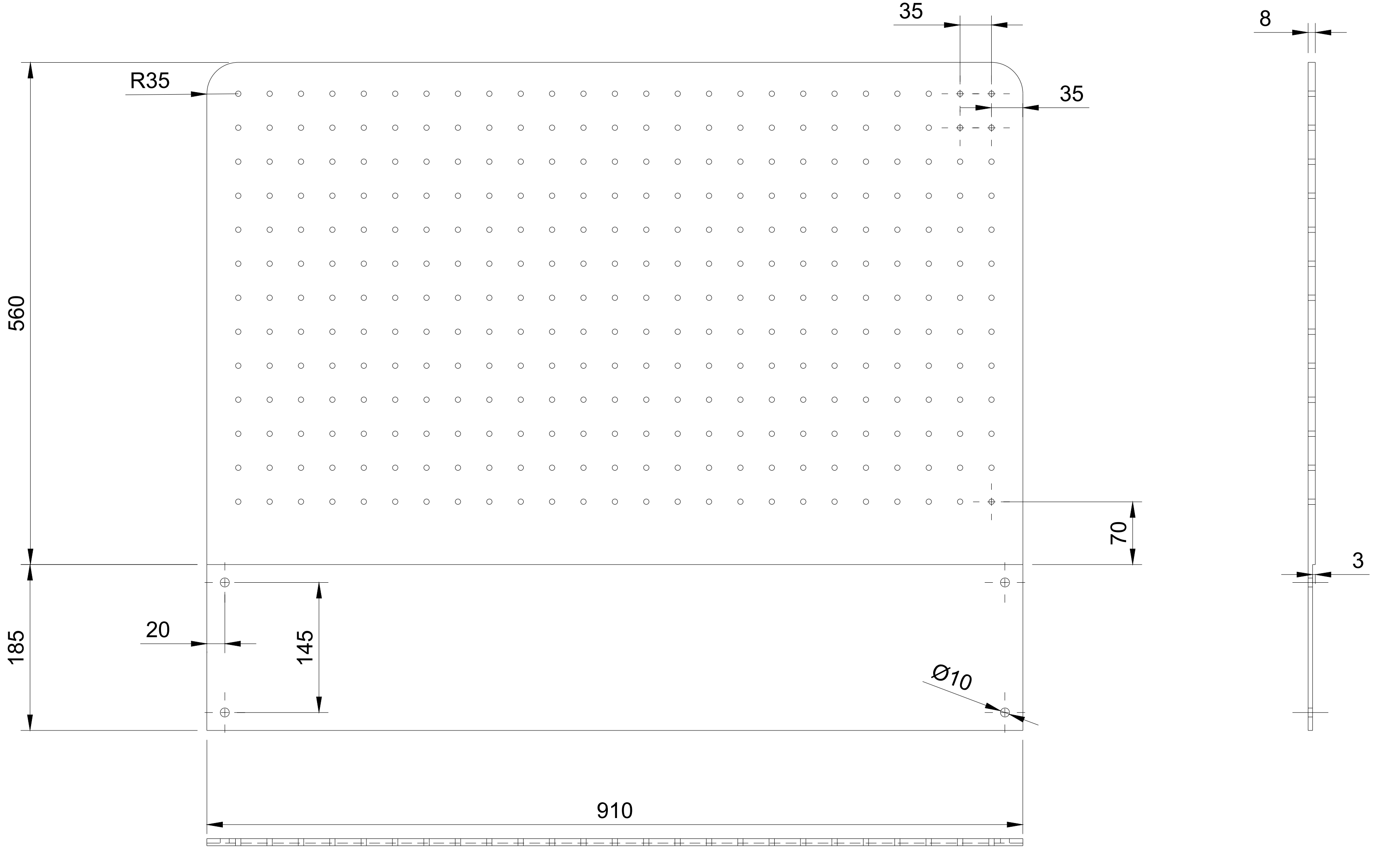

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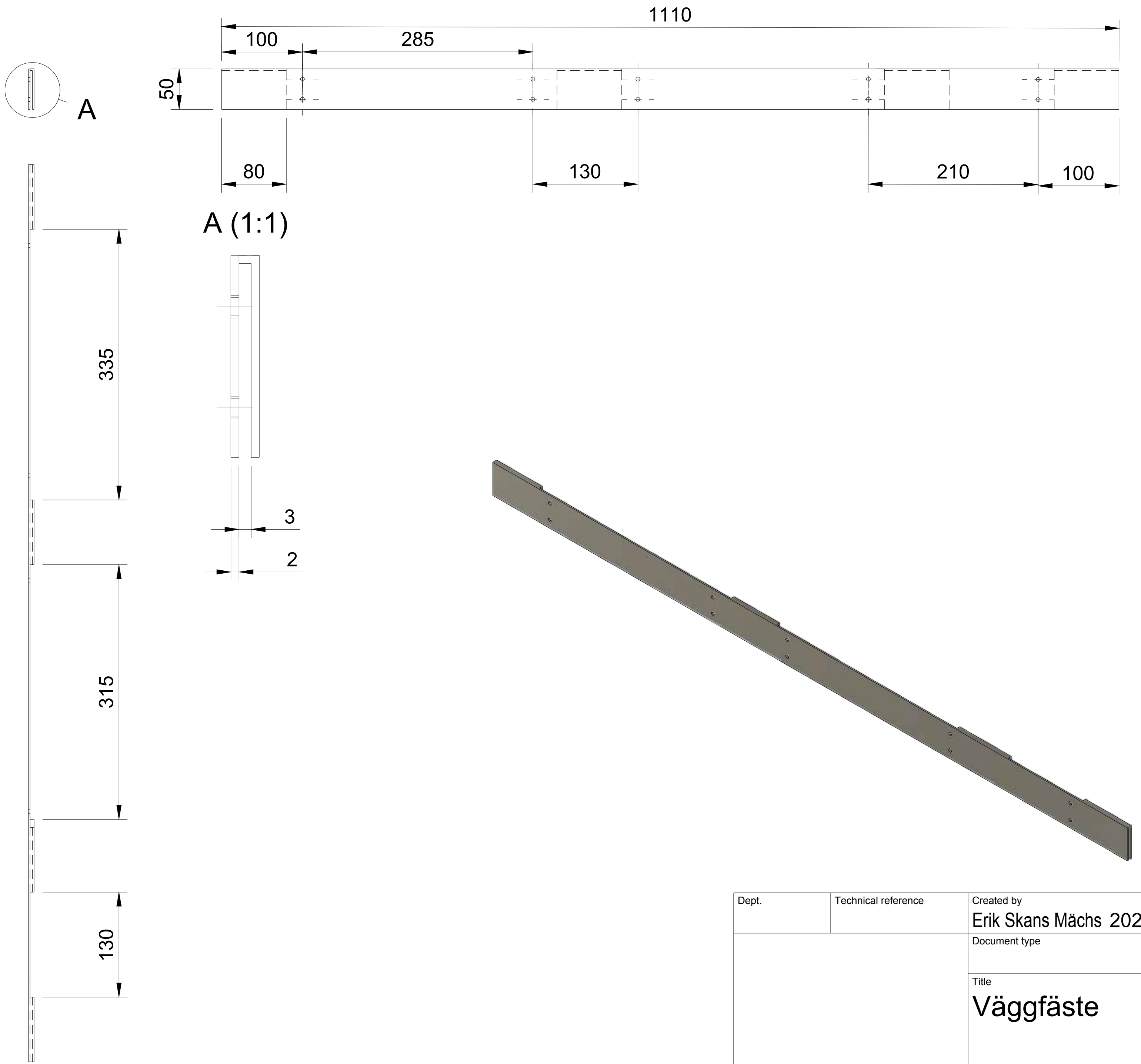

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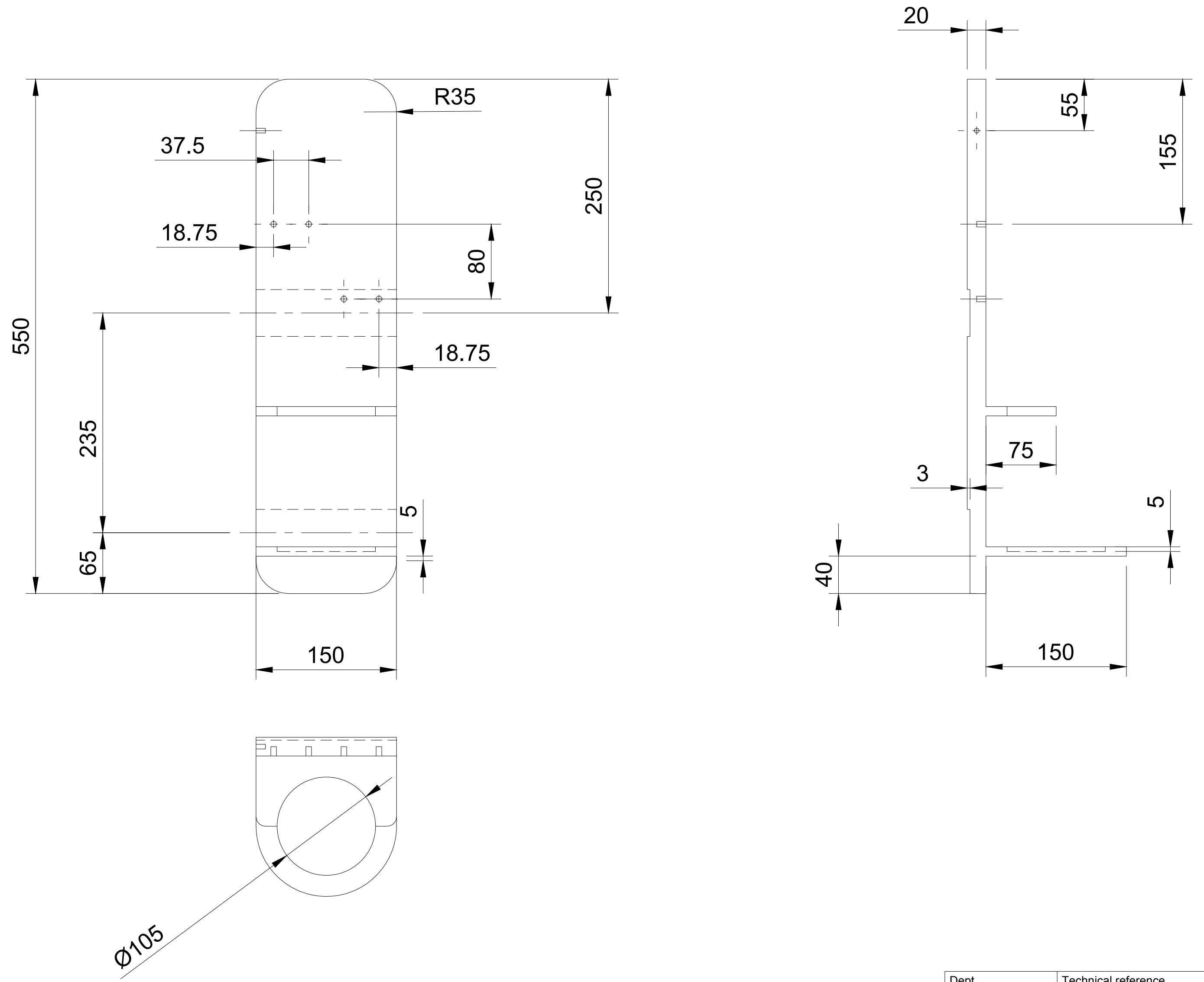

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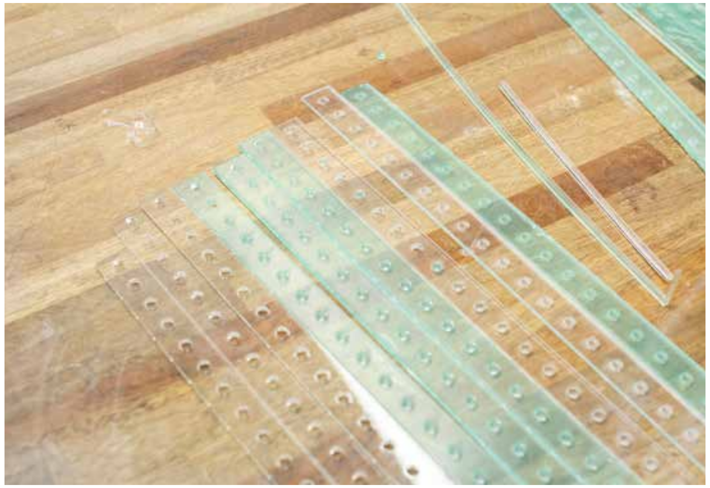
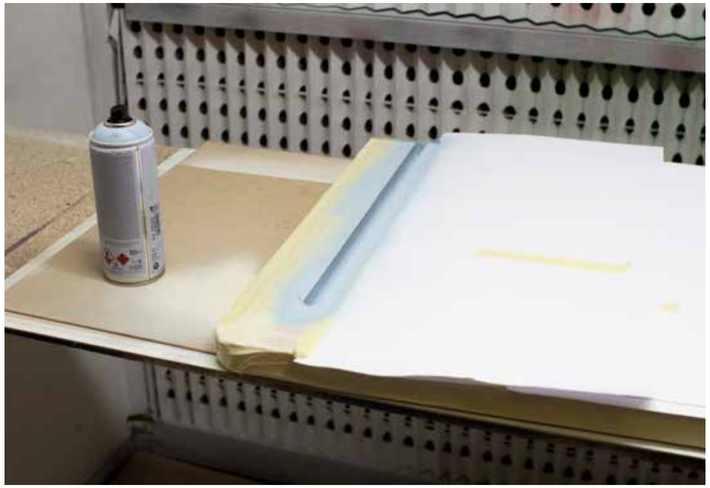
Assembly of the Base Plate

To create a as straight as possible base plate for the calendar I made a glue line joint from beech wood boards.



The Slots

Utilizing CNC-milling the slots for the marbles could be cut out with high precision. First a track with a radius in the bottom was cut out and then slot was cut 2mm below the surface to fit the acrylic screens.

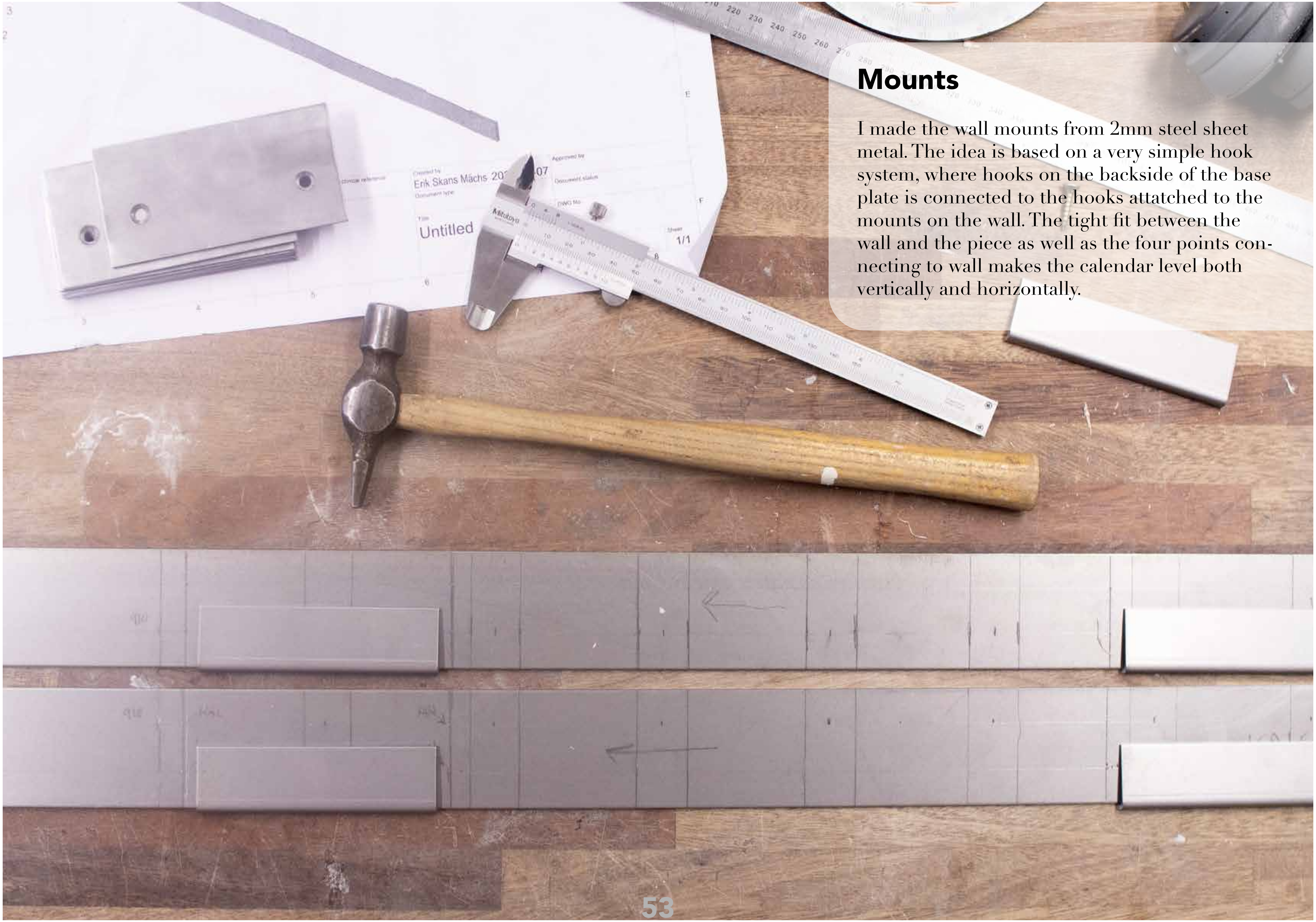


The Slots

Each slot could after beeing cut out be painted with spray paint. I choose to this before engraving the dates since the date engraving was the most time consuming operation.

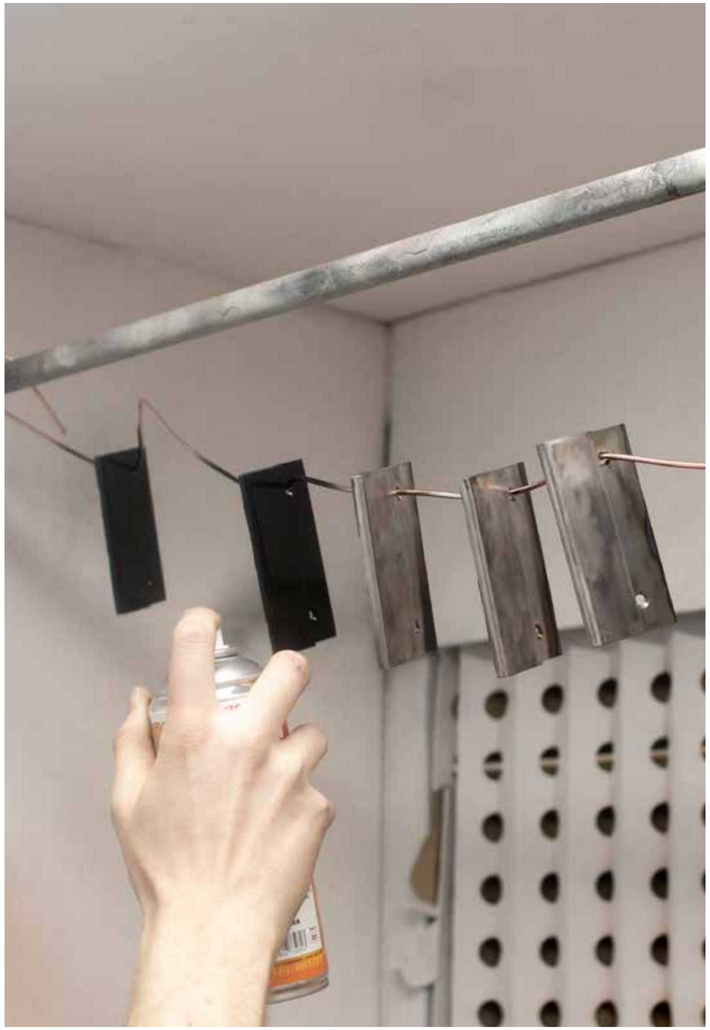
Engraving

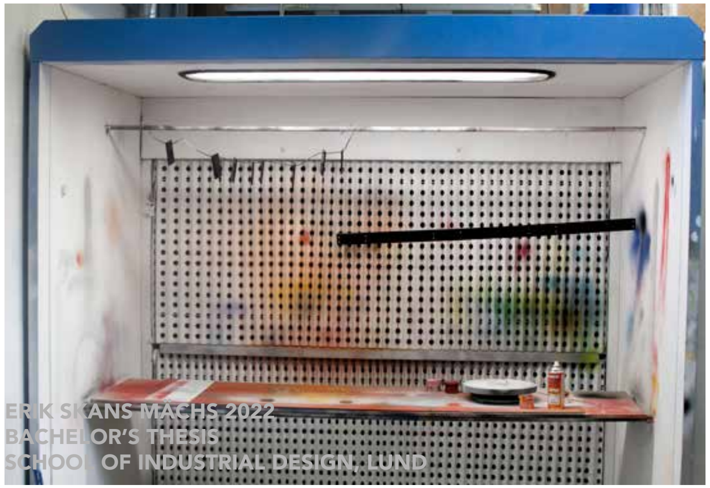
The engraving of he dates into the board was made with a lasercutter. First I calibrated the laser with a test piece that matched the base plate, then I could engrave in the actual plate. With a light sanding of the top surface all soot marks could be easily removed.

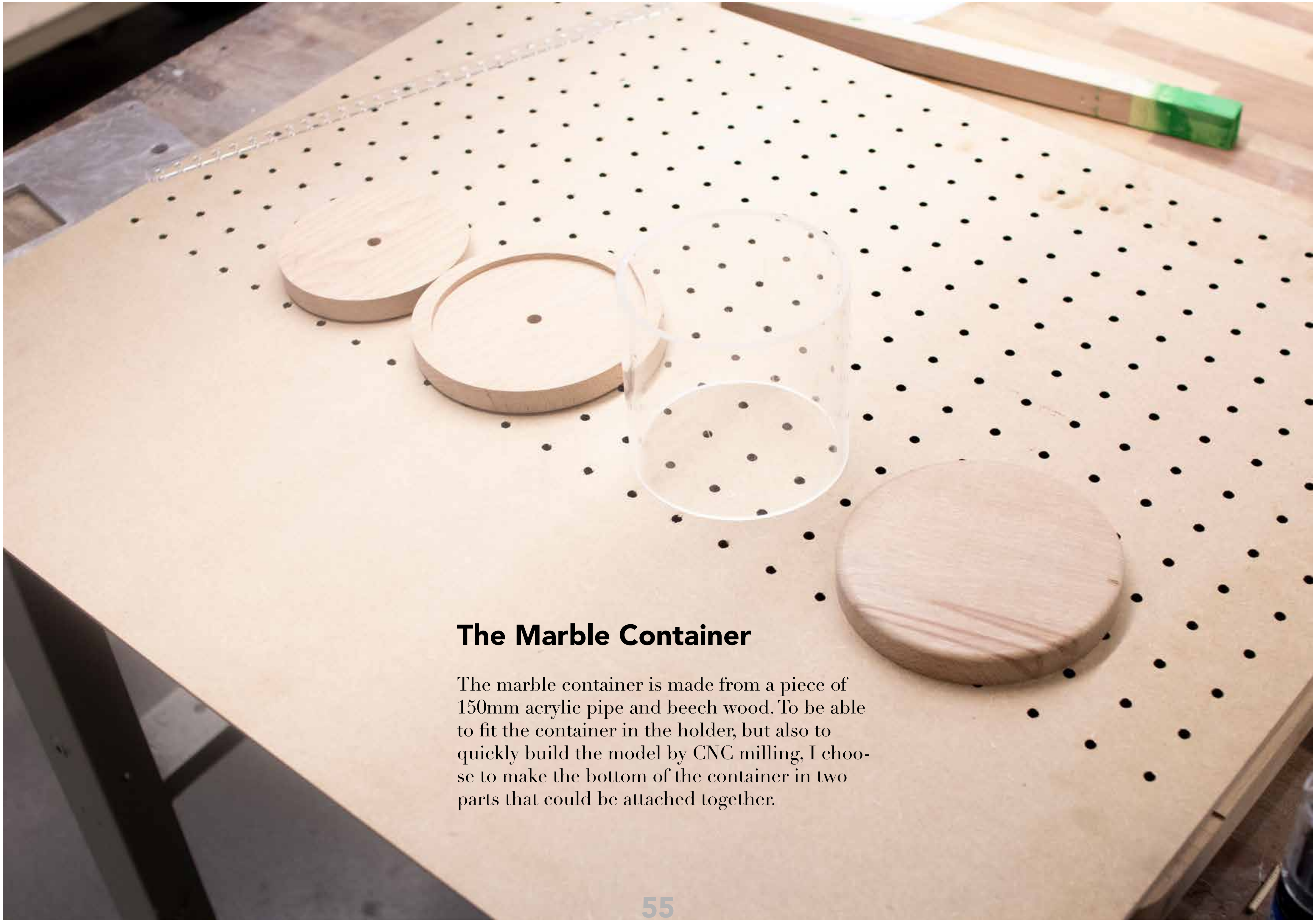


Mounts

I made the wall mounts from 2mm steel sheet metal. The idea is based on a very simple hook system, where hooks on the backside of the base plate is connected to the hooks attatched to the mounts on the wall. The tight fit between the wall and the piece as well as the four points connecting to wall makes the calendar level both vertically and horizontally.

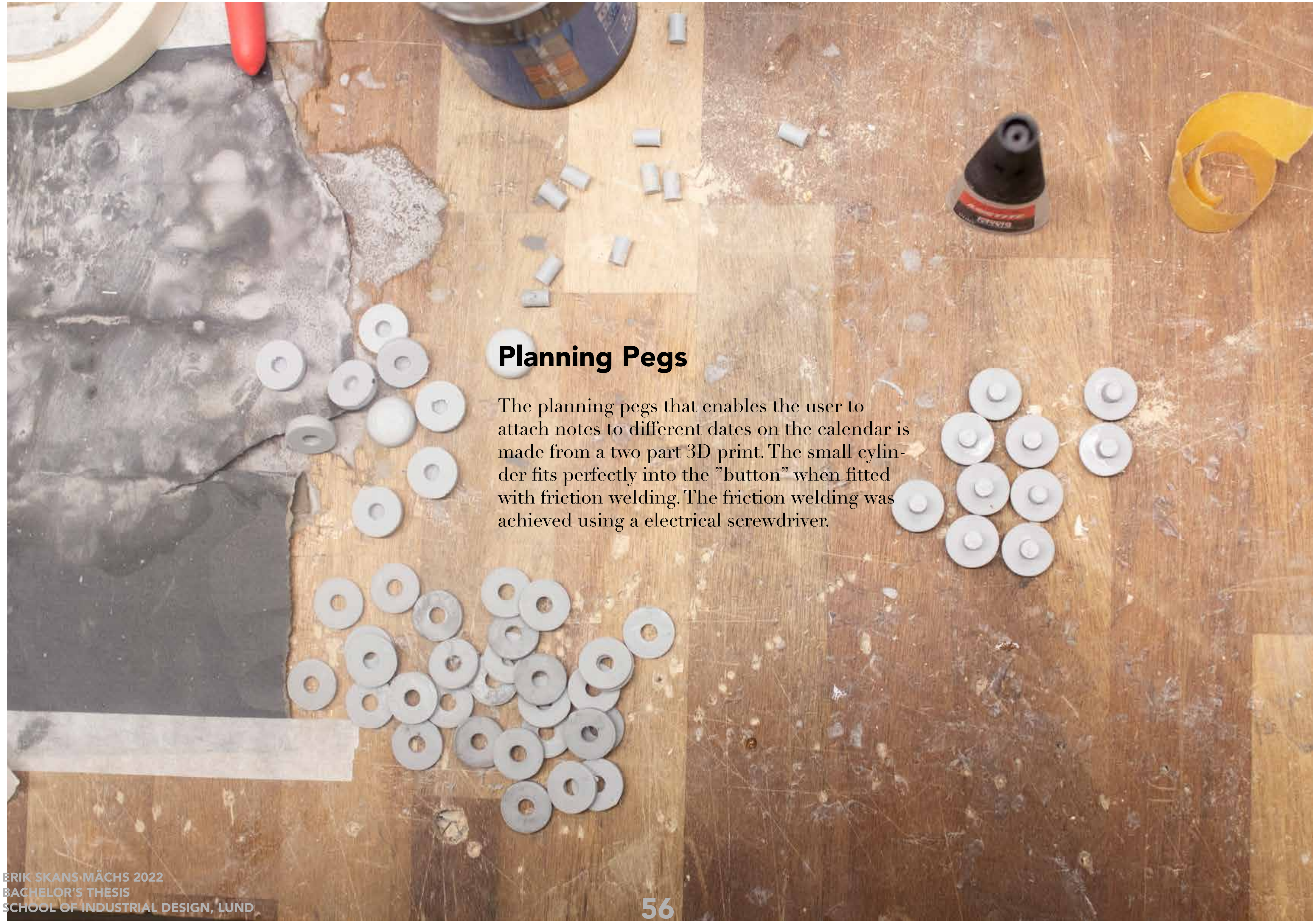






The Marble Container

The marble container is made from a piece of 150mm acrylic pipe and beech wood. To be able to fit the container in the holder, but also to quickly build the model by CNC milling, I choose to make the bottom of the container in two parts that could be attached together.



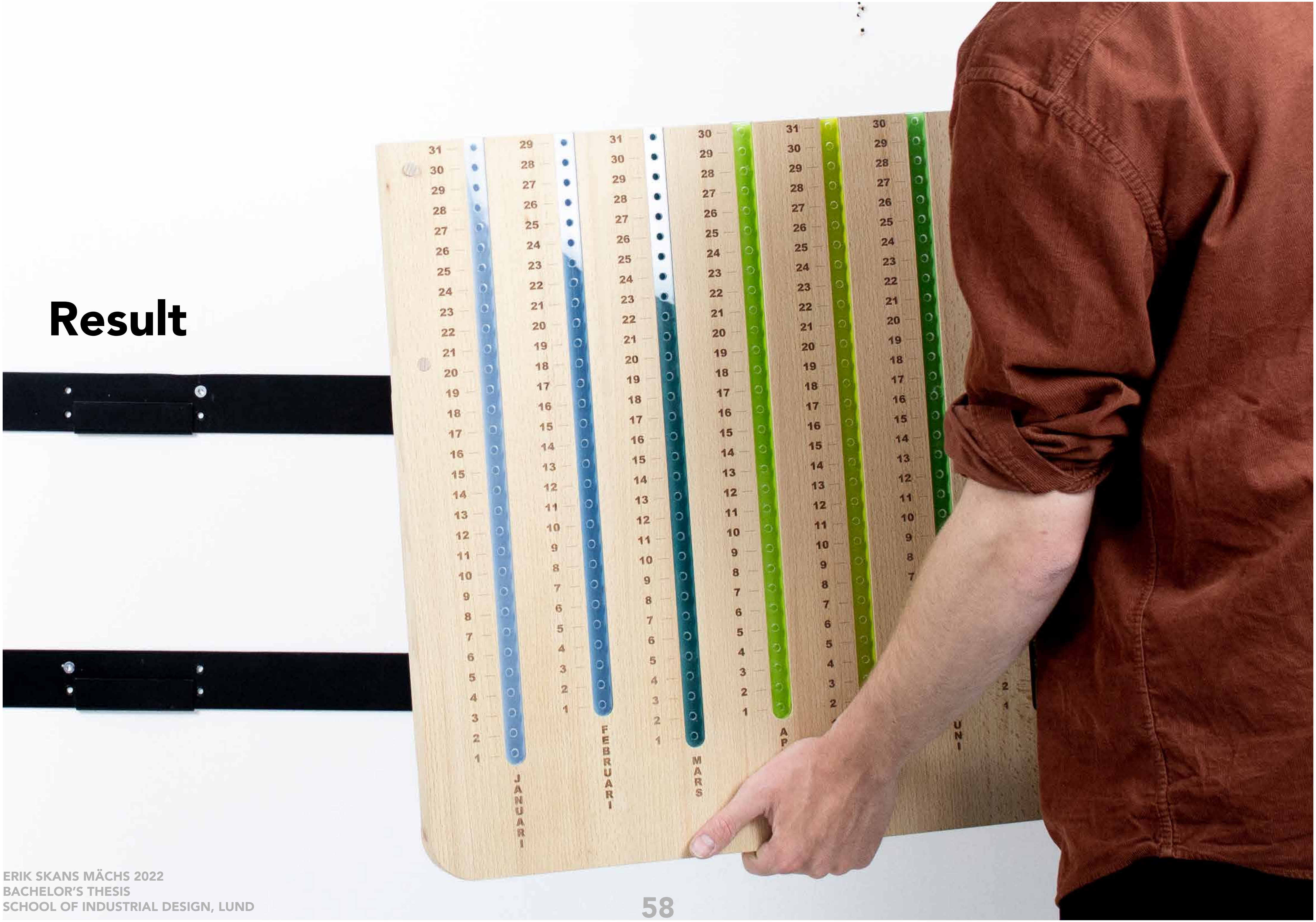
Planning Pegs

The planning pegs that enables the user to attach notes to different dates on the calendar is made from a two part 3D print. The small cylinder fits perfectly into the ”button” when fitted with friction welding. The friction welding was achieved using a electrical screwdriver.

Marble Path Segments

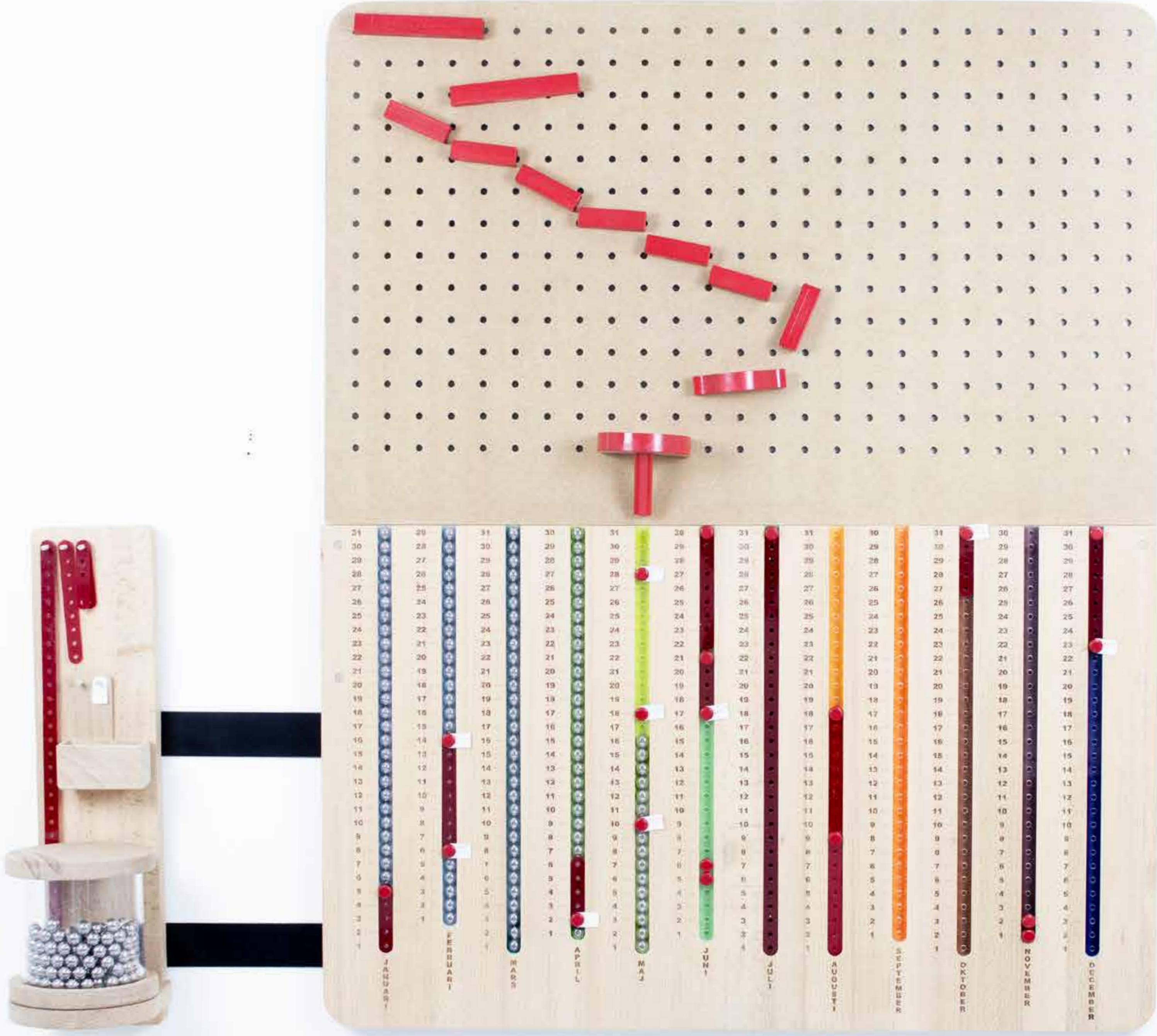
This part was probably the most straight forward one to make, just CNC milling and then drilling a hole for a dowel, but yet it was one of the more time consuming ones. When finally finnished, they where spray painted red.

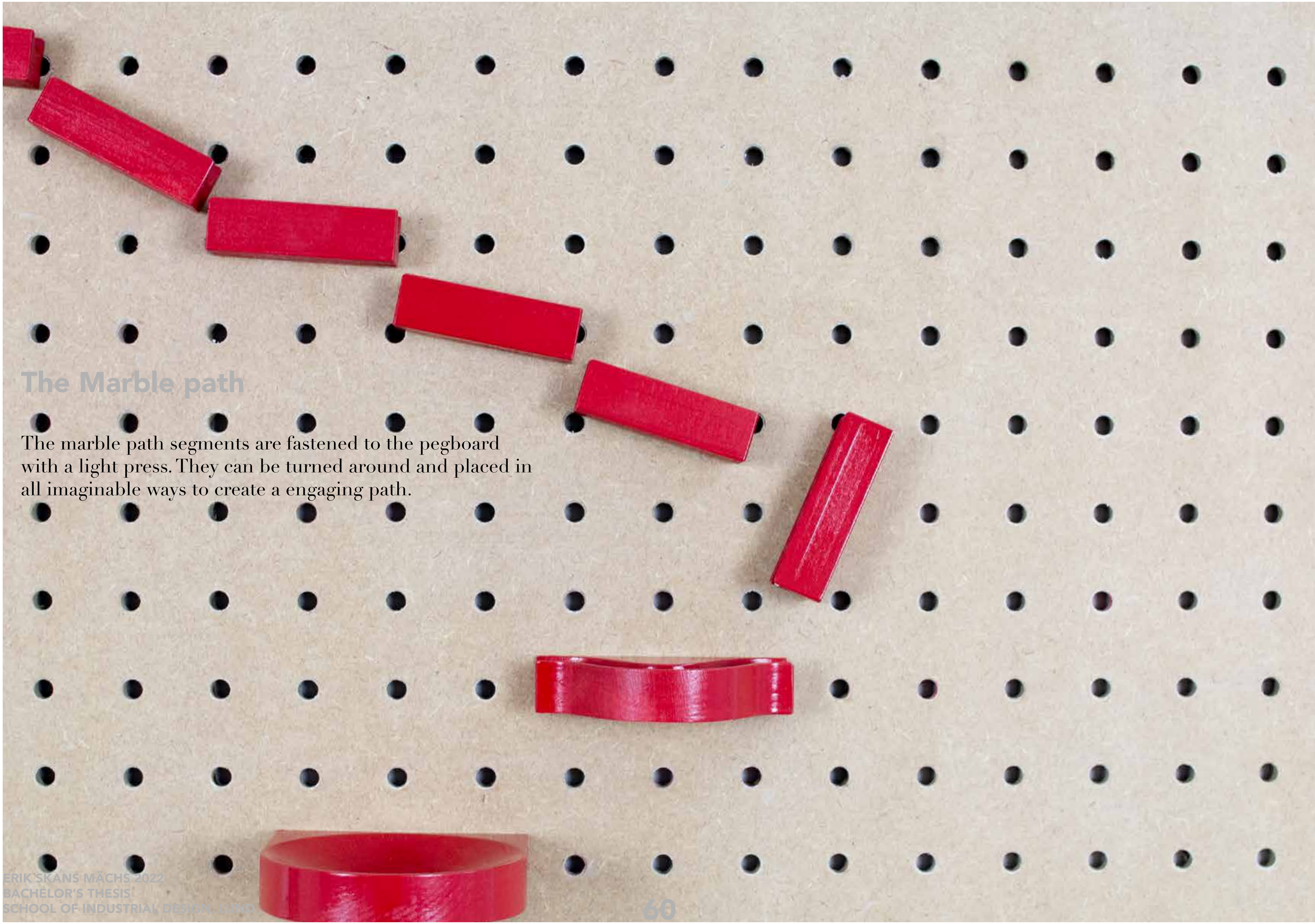
Result



The Calendar

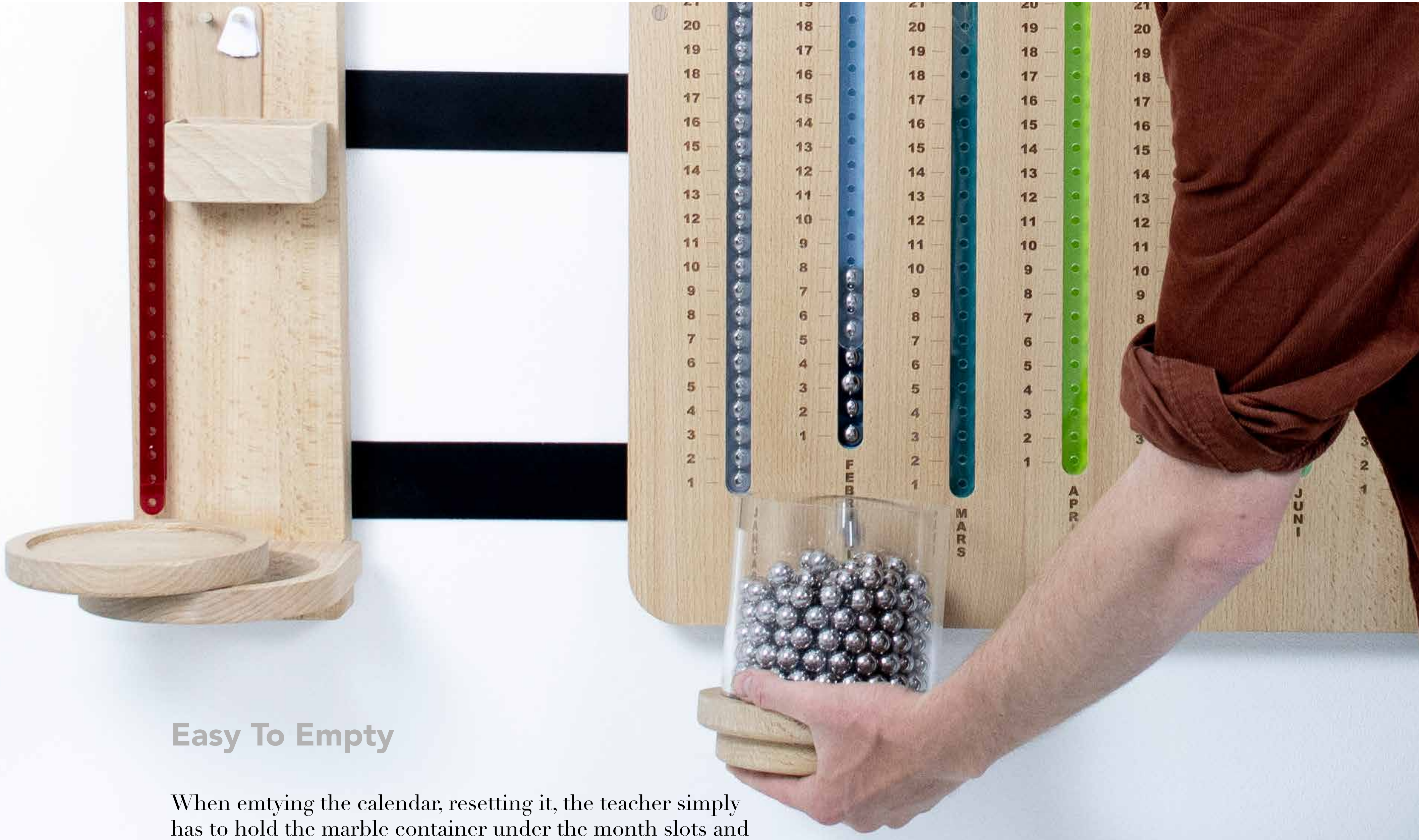
Mounted on a wall, the calendar is ready to be used. On the acrylic screens covering the month slots, notes can be attached to enable planning. The red strips that cover several days are there to show when there's a break or longer holiday.
The board to the left holds the marble container, the red strips as well as the notes and the planning pegs.
The marble path segments are fastened to the pegboard with a light press. They can be turned around and placed in all imaginable ways to create an engaging path.
When emptying the calendar, resetting it, the teacher simply has to hold the marble container under the month slots and lift up the acrylic screen covering it.





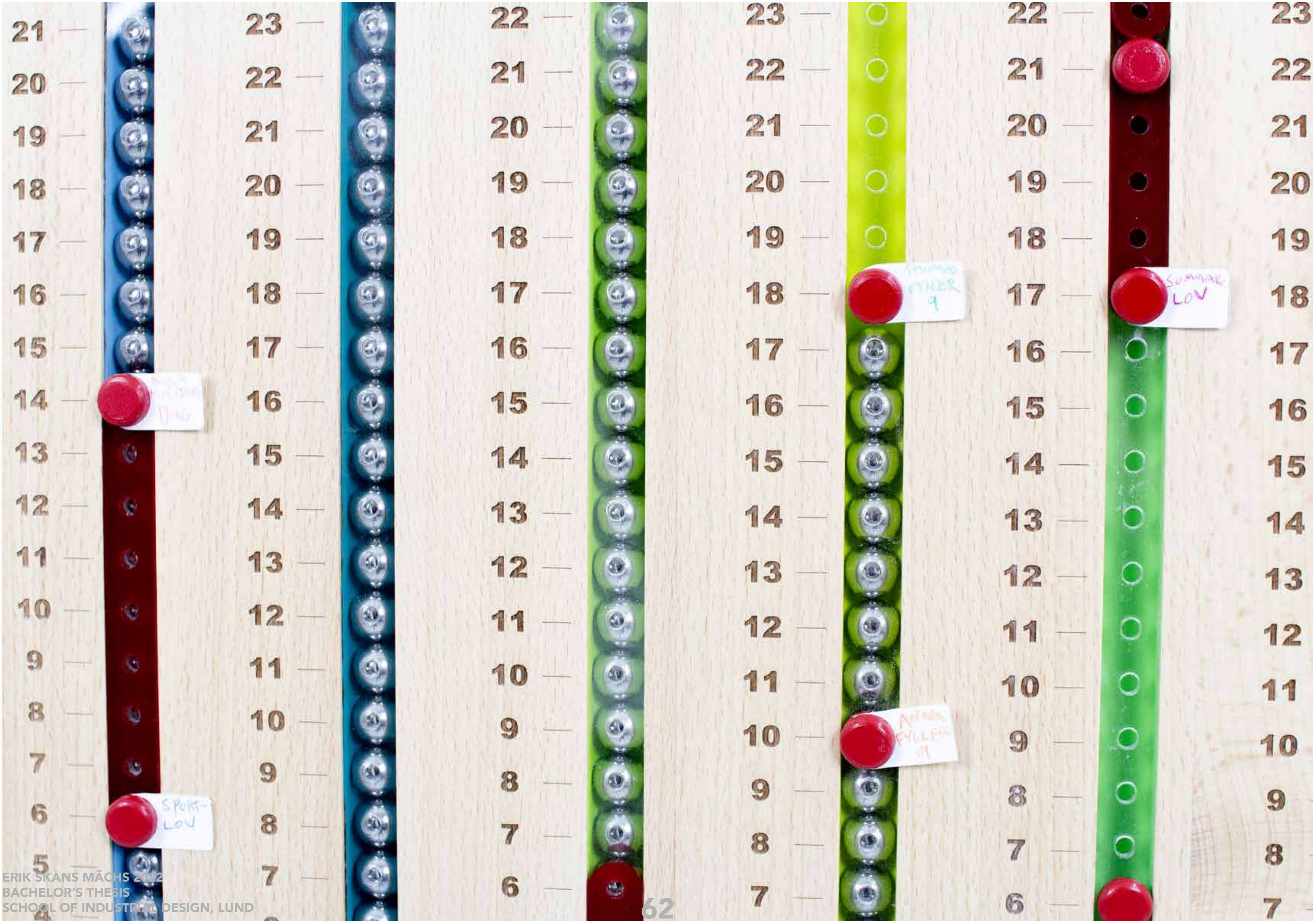
The Marble path

The marble path segments are fastened to the pegboard with a light press. They can be turned around and placed in all imaginable ways to create a engaging path.



Easy To Empty

When emtying the calendar, resetting it, the teacher simply has to hold the marble container under the month slots and lift upp the acrylic screen covering it.


SPORT-LOV
SOMMAR-LOV

Conclusion

The Calendar, as shown with the final prototype, is to be seen as a step towards a finished product. Even though I am very happy with the concept and the visuals as well as the research behind it. This is also proven by the appreciation it has received from supervisors and the people that have seen it and experts that have been involved in the project.
However, there is a lot that needs to be improved. This has also been pointed out by my supervisors and also by myself when evaluating the project. To start off, the overall layout could be rearranged. Instead of keeping the marbles, planning notes and planning pegs on a separate piece, it should be more integrated into the main board. This would also allow for the mounts to be less visible, since the two racks mounted to the wall are taking focus away from the calendar itself. While addressing the mounts, it is also worth mentioning that they should be re-designed since it is quite a challenge to mount the calendar to the wall. Not only is it a challenge to mount it level, but to get it to hook into the wall mounts is a challenge that as of this iteration is way too hard.
The planning pegs don't fasten properly into the date holes which is crucial for the calendar to function as intended. The need for spacers is also something that would need to be eliminated. Furthermore, not using steel marbles is also a very valid change to reduce cost, weight as well as enabling the use of magnets in other parts of the construction, for example the planning pegs and date markers. Even though the comfortable weight of a steel marble in your hand would disappear, the possibilities that instead are enabled outweigh that tactile sensation. Even more so when the main target group are children.
Since this product is meant to be sold to schools I would probably team up with a company like Lekolar AB to sell it. They are one of the largest resellers of educational equipment for schools in Sweden with a broad product portfolio ranging from pencils and play dough to full design interior solutions for classrooms and kindergartens.
Even though I was inspired heavily by the toy company BRIO regarding colour, material and finish, the kind of product is focused more on the element of education and not on play.
In conclusion, the final model showcases an early version of what this calendar could become. A prototype for proper testing in schools to examine how to create an even more coherent visualisation of how counting time works. As for the concept, I can confidently claim that there is a need for educating children more thoroughly in how to count time and that my calendar is a proper proposal of how to do just that.

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Learning kids to tell time

Thank You

I would like to thank the fantastic team of professors, lecturers, teachers and workshop staff that made this project possible with your expertise, knowledge and superb feedback throughout the project. With your patience and guidance I have been able to thrive with my project and complete it with pride and confidence.

With gratitude,

Erik Skans Mächs