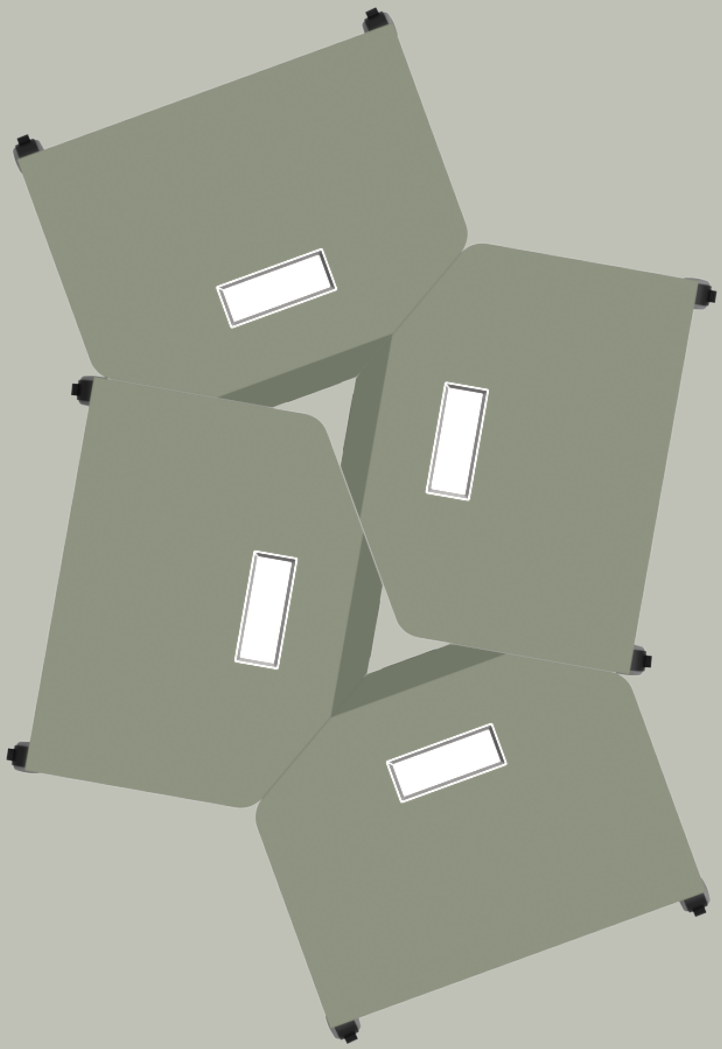
RE:FORM



JUNE 2024 PRODUCT REPORT MA4-ID3

SIMON SKAANING JACOB MADSEN-ØSTERBYE MARCUS VETCHE JENSEN

TITLE PAGE

Project title:	**Re:Form**
Project theme:	**Furniture for the Elementary school**
Project:	**Master Thesis**
Project Team:	**MSc04-ID3** **Industrial Design** **Institute of Architecture and Design** **Aalborg University**
Report type:	**Product Report**
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Supervisor:	**Christian Tollestrup**
Technical supervisor:	**Lars Rosgaard Jensen**
Number of pages:	**24**

CONTENT

RE:FORM

Reform *(verb)*
make changes in (something, especially an institution or practice) in order to improve it.

Re-form *(verb)*
to form again

Form *(verb)*
bring together parts or combine to create.

ABSTRACT

Re:Form is a master thesis about a pupil table that enhances the activities in the classroom and creates an active learning environment for the teacher and the pupils. This is obtained through collaboration with four different schools and a school furniture design company. Through this collaboration it is discovered that the market is selling a dream to the schools that has little to do with the reality in the classrooms.

With this knowledge the concept is developed to improve the flexibility in the classroom and give the option of clearing the floor of tables and give room to educational activities. Further geometrical studies make sure that pupils can be grouped efficiently together in groups of up to 6 or more. Additionally, the table is stackable and through multiple iteration it is made sure that the table behaves like a normal table any other time.

Re:Form is a proposal that gives the teacher the power to create a learning environment that suits their needs for the education material, and give the pupils an interesting school day that does not become mundane and repetitive.

RE:FORM

FAST. EFFICIENT. FLEXIBLE.

A table that allows teachers to retake their classroom back into use. Instead of being static structures that need to be maneuvered around, Re:Form tables are flexible and transforms the classroom into any room that is needed at a moment's notice.

Their stacking allows them to take up less than 30% space of other tables. Whether it is group or solo work, Re:Form will adapt fast. No need to wait for recess or the end of the day, anyone can change the layout at any time efficiently. The tabletop' form allows pupils to have a lot of freedom when forming groups.

PROBLEM

49% of education time in lessons is spent in pairs or groups. This highlights the importance of a flexible classroom for the pupils today, as different constellations are needed.

Reform allows you to make the classroom fit the curriculum, instead of the other way around. Freeing up the classroom for all activities, from solo writing through group work, to playing in the classroom. The classroom is no longer bound to a single layout all activities must conform to; it can now be changed on a whim. Whether planned or not, the layout change can happen as the teacher finds it necessary.

When sitting in groups some pupils might need some space from their classmates to focus, Re:Form enables an easy move if the need arises. No need for multiple trips to bring everything that is on the table as the workstation moves with you. Whether reading, playing or during a presentation, the tables can be stacked out of the way for maximum usage of the classroom. There is no need for the entire teaching team to agree to a single layout, as that can't possibly fit all subjects. The class teacher can set the default but if the math or P.E. teacher needs something else, there is no worry, they can both teach how they prefer, with minimum setup time.

LAYOUTS

The shape of Re:Form allows it the freedom to use space in a fitting and creative manner. This is an opportunity to experiment with the layout and determine what is best for each class, pupil, teacher, and subject. Re:Form allows transformation of what was previously static, as the children are developing and changing so should their environment.

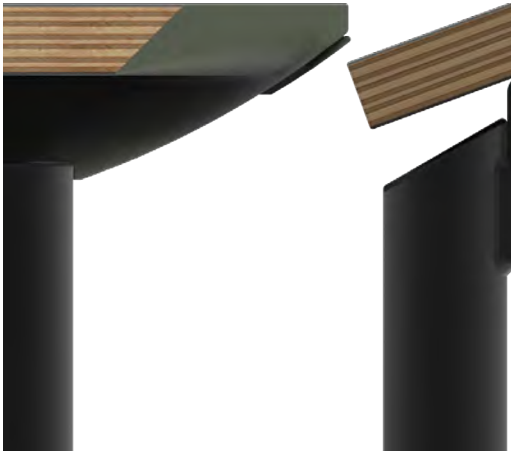
FLEXIBILITY

Change layout in under 2 minutes and transition the classroom to fit the lesson, without taking too much time. Either changing the entire classroom layout, or just part of it, does not disturb anyone. No more dragging heavy and static tables across the floor so the entire school can hear it.

STACKING

Re:Form can transform a class, by making 24 tables take up less space than 7 competitor's tables. Freeing the classroom for play, activities, and the teacher's creativity. Stacking can be done by the pupils, by just pushing tables together, no lifting required.

A custom-made hinge limits the tabletop to lift to 25 degrees, which is enough to secures a safe interaction and insertion of the teacher key.



TEACHER KEY

A Re:Form stack is started by this as it creates the stacking angle in the first table. Pupils can do this, by lifting the tabletop, and then placing the key.

It fits into the slot in the plastic in the front of the tabletop and a similar slot in the frame. While not in use it is stored on its wall mount, so it doesn't get lost.

WORKTOP

Re:Form fits everything the pupils need comfortably on the worktop. Whether the lesson is digitally minded, analog or a combination of both.

The tray functions as a temporary storage place for loose items so the pencil case can be removed from the worktop during lessons. It isn't deep enough to hinder laying a book across it and a laptop can comfortably stand over it.

LOCKED

The worktop is locked to the frame when the table isn't stacked, making it behave like a regular table unless released.

CASTORS

Half of the castors are lockable, ensuring that the table is movable and stationary when needed.

DURABILITY

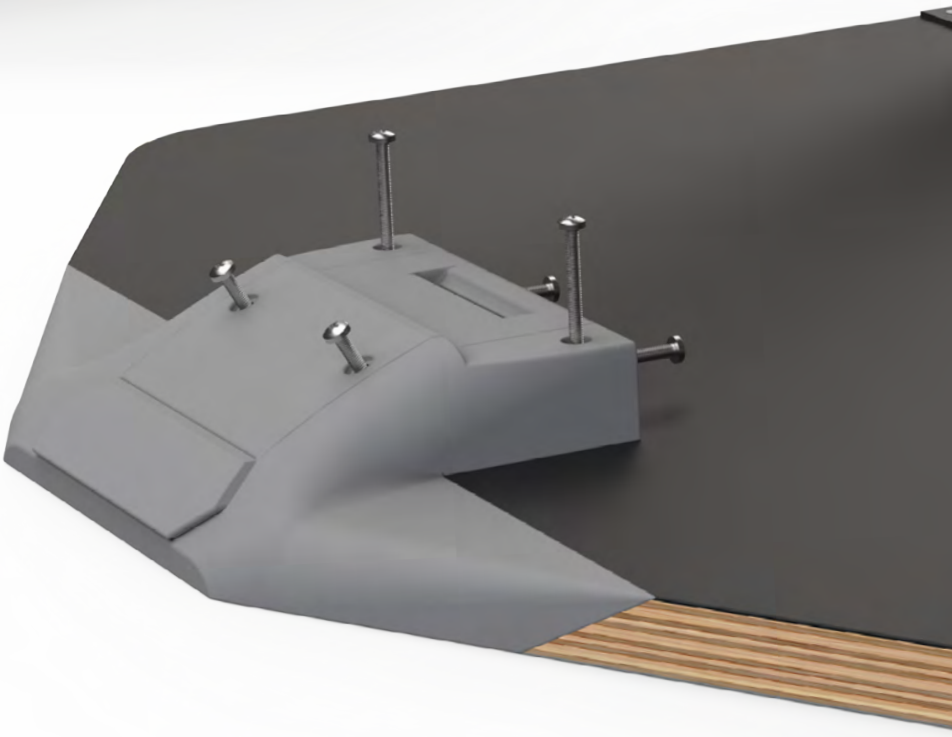
Re:Form is made to be compliant with current industry requirements. The construction is durable, even with limited material used. This is accomplished by optimizing the leg placements and dimensions of the frame.

CLEANING

Re:Form is easy to maintain, the tray has soft open corners so no dirt or waste gets trapped. The laminate is a durable material schools are familiar with, and the nylon front can withstand the same alkaline cleaning agents. The castors also allow the floor to be cleaned easily, as the tables can be pushed out of the way making it possible to use machines to clean the classrooms. This makes the classrooms more sanitary.

REPAIR

As Re:Form will be put in a harsh environment most components can be replaced if repairs are necessary. The castors and the underside of the front are expected to be the areas with the most wear, both can be replaced with either a screwdriver or a spanner. The entire worktop can also be replaced with the same tools, should it be necessary.



THE FRONT

The front is the concentration of all Re:Form' features and is pointing the table forward. It allows stacking by seating the teacher key, allowing sliding up other tables, and locking the tabletop when not stacked.

Inside is the locking mechanism securing the tabletop to the frame. This lock is actuated by a button on the front, by hand or another table, releasing the eye welded to the frame. The lock is held closed by a spring to ensure no additional action is necessary, just dropping the tabletop will lock it in place.

INSTALL

Re:Form will be sold as a set of six tables, a teacher key and a hanger. The tables will be fully assembled as part of the production, so the only on-site installation is the key hanger. This consists of a single screw to secure the hanger to the wall in the classroom. Re:Form is now ready to make the classroom flexible and efficient.

DISSASSEMBLY

After Re:Form's lifetime has taken it's course, the table can be disassembled into its materials. The table can therefore be disposed responsibly into steel, wood, and plastic. This gives an opportunity for the materials to be recycled and used again.

COLORS

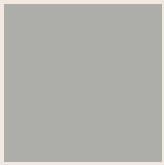
Tabletop - Laminate


Beech

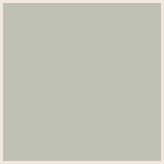
White


Black

Light gray


Dark gray


Leaf green


Ocean gray

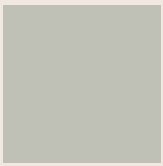

Denim


Paprika

Nose - PA


Black


Gray


Ocean gray

Frame - Powder coated steel


Black

SIZE

Tabletop - Dimensions

W: 70 cm
D: 55 cm

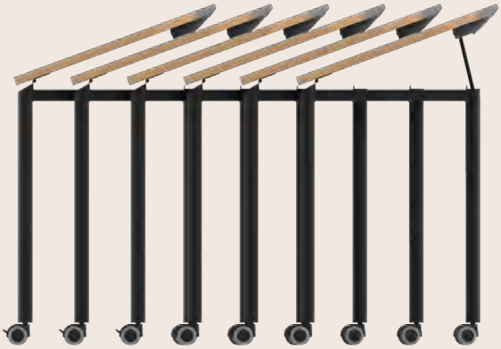
Frame - Dimension

5. - 9. Grade
H: 72 cm

2. - 5. Grade
H: 66 cm

0. - 2. Grade
H: 60 cm

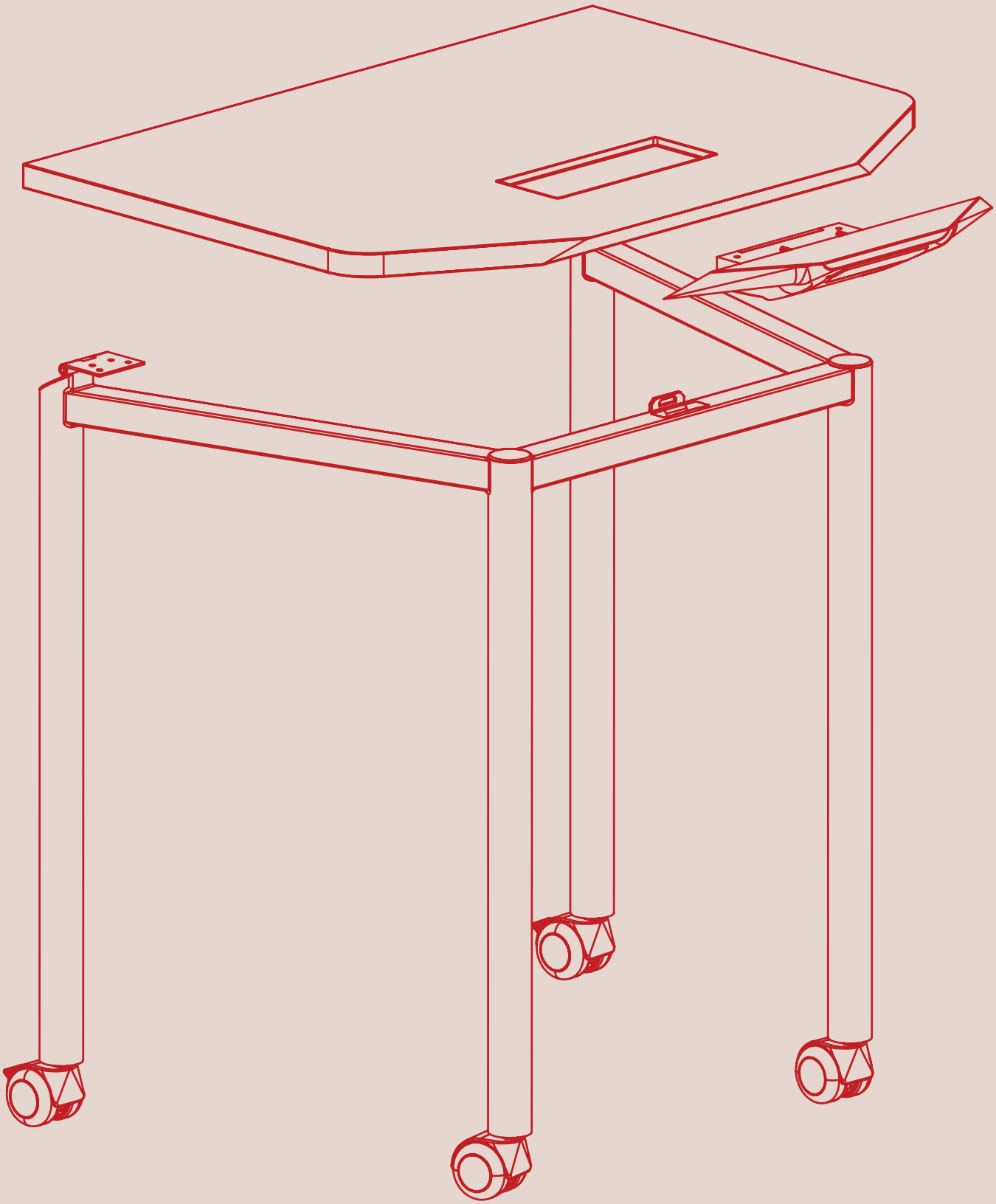
Stacked - Dimension



D: 126 cm - 6 stacked
+ 15 cm per added

FAST. EFFICIENT.
FLEXIBLE.

RE:FORM



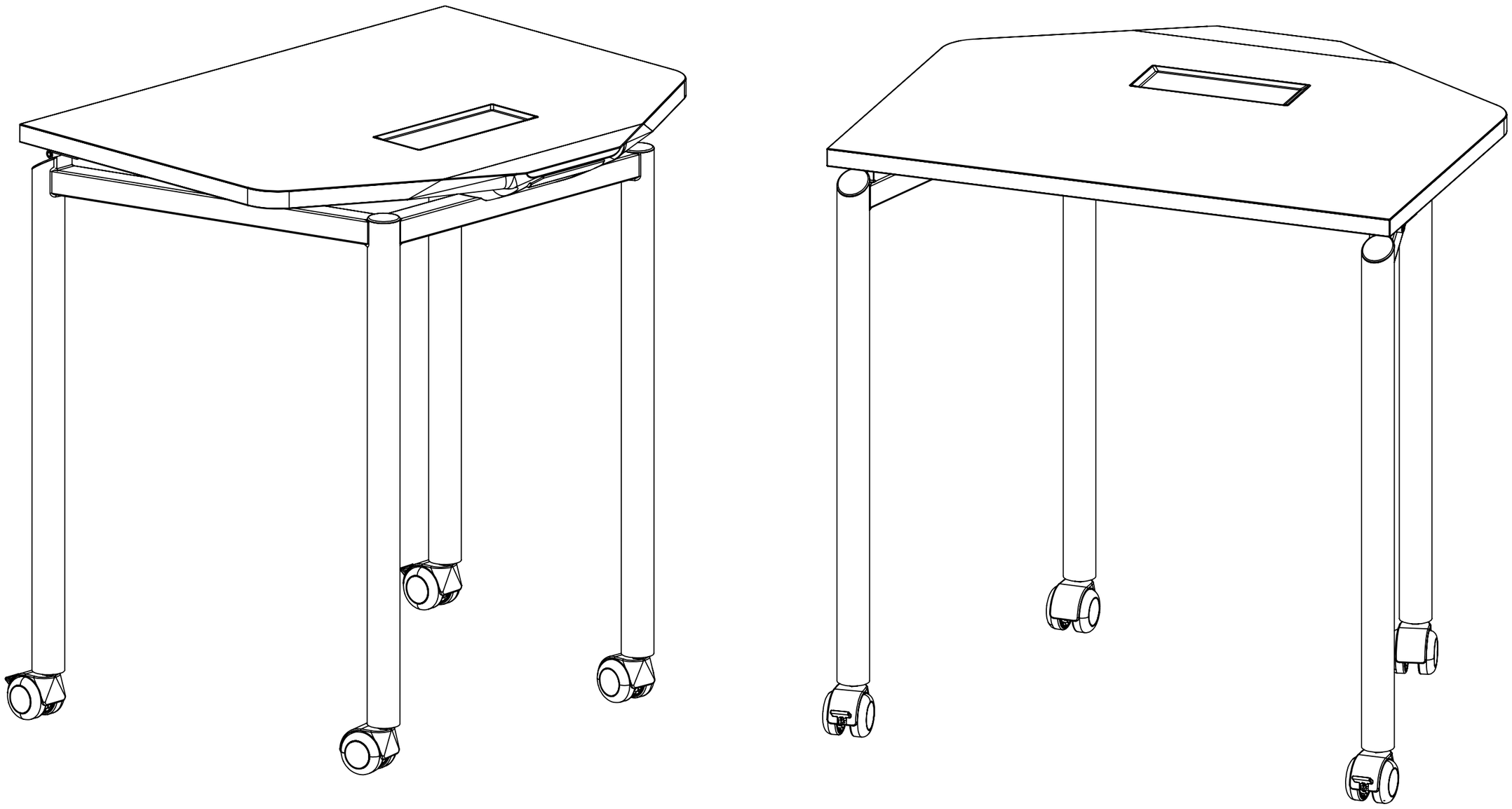
TECHNICAL DRAWINGS

RE:FORM - MSc04-ID3 - June 2024

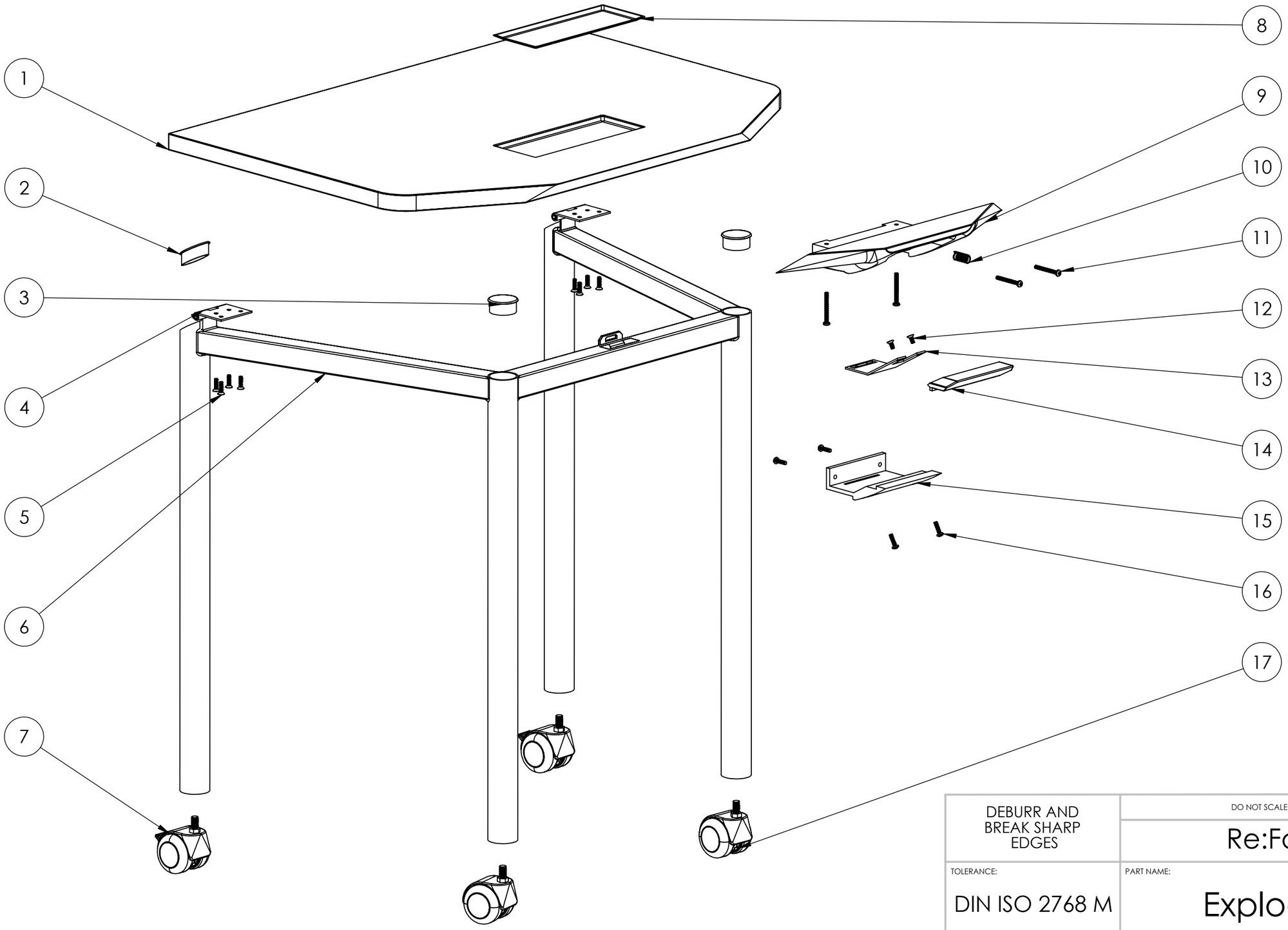
Jacob Madsen-Østerbye

Marcus Vechte Jensen

Simon Skaaning



DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING
	Re:Form
TOLERANCE: DIN ISO 2768 M	PART NAME: Perspective
OVERALL DIMENSIONS: W: 700 mm H: 720 mm D: 560 mm	PART NO. A3
	SCALE:1:5 ALL MEASUREMENTS ARE IN MM SHEET 1 OF 14



DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING
	Re:Form
TOLERANCE: DIN ISO 2768 M	PART NAME: Exploded
MATERIAL:	PART NO. A3
	SCALE:1:5 ALL MEASUREMENTS ARE IN MM SHEET 2 OF 14

PART NO.	PART	MATERIAL	QTY.	SHEET NO.
1	Tabletop	Plywood, laminate	1	4
2	Ø38 angled Plug	PE	2	5
3	Ø38 Plug	Standard Component	2	
4	Custom Hinge	Steel	2	6
5	5x20 - Woodscrew	Standard Component	8	
6	The Frame - 720	Steel	1	7
7	Castor w. Breaks	Standard Component	2	
8	Tray	Steel	1	8
9	Nose Body	PA	1	9
10	Spring	Standard Component	1	
11	5x40 - Woodscrew	Standard Component	4	
12	M4x10 - Screw	Standard Component	2	
13	Nose Plate	Steel	1	10
14	Nose Button	PA	1	11
15	Nose Shield	PA	1	12
16	ISO 7045 - M4 x 16 - Z - 16S	Standard Component	4	
17	Castor	Standard Component	2	

DEBURR AND BREAK SHARP EDGES

DO NOT SCALE DRAWING

Re:Form

TOLERANCE: DIN ISO 2768 M

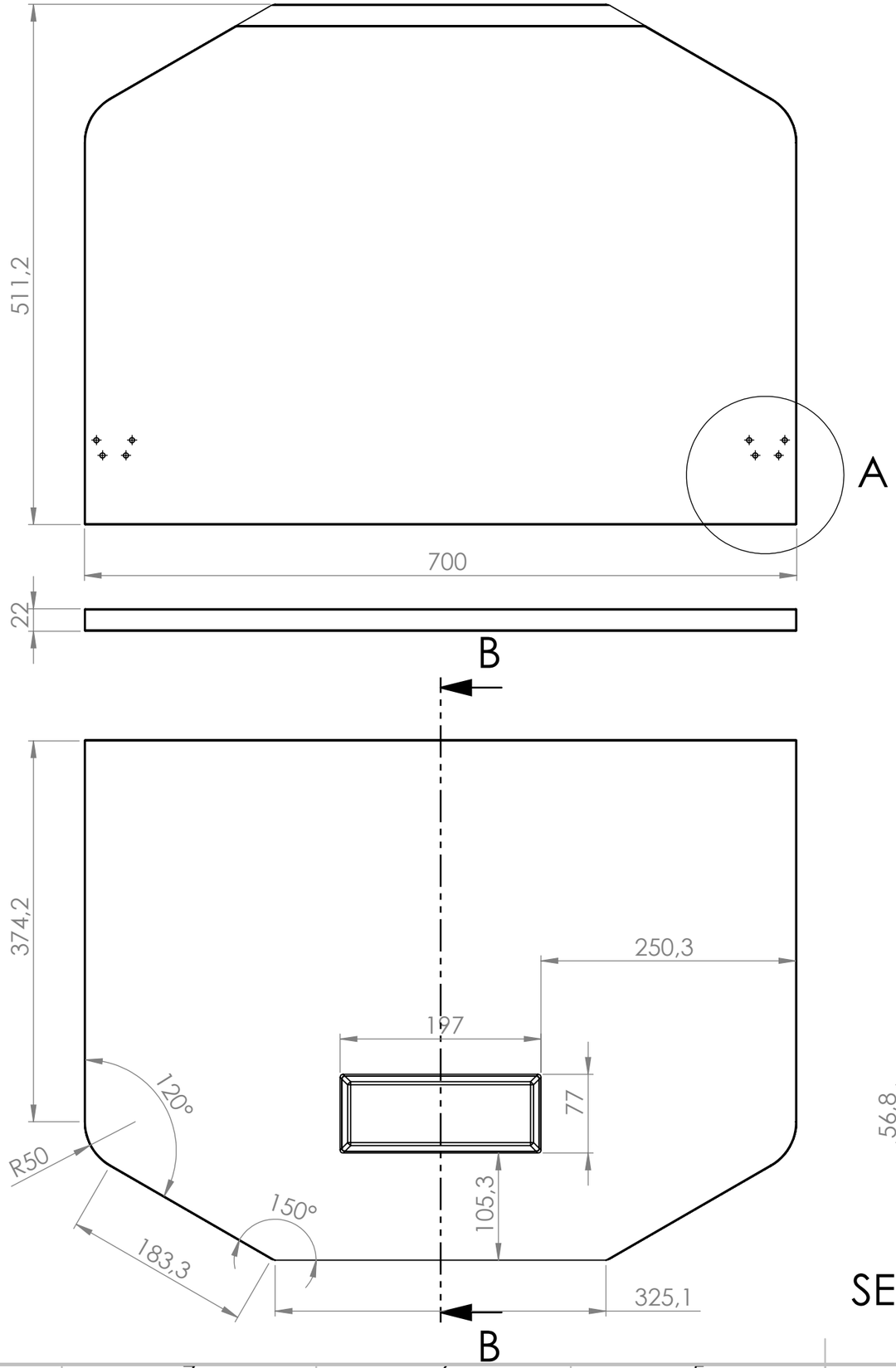
PART NAME: BOM

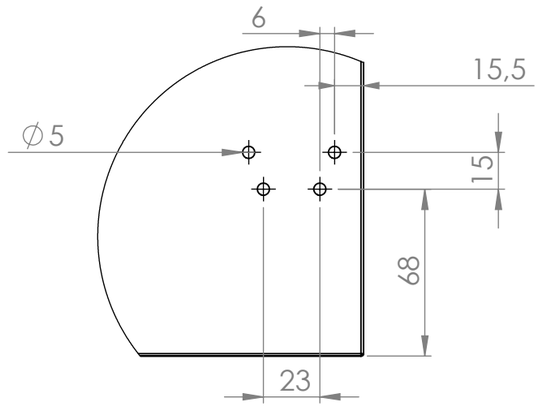
MATERIAL:

PART NO. A3

SCALE: ALL MEASUREMENTS ARE IN MM SHEET 3 OF 14

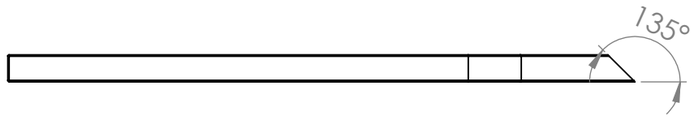
ALL MEASUREMENTS ARE IN MM

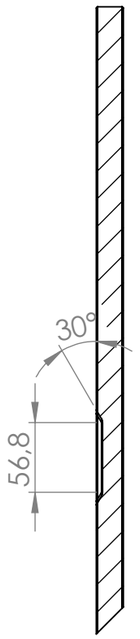




DETAIL A

SCALE 2 : 5



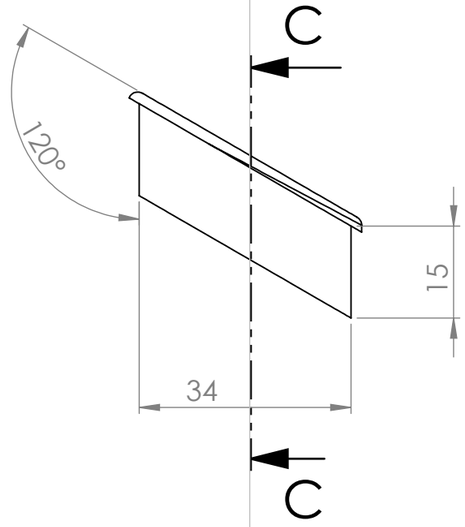


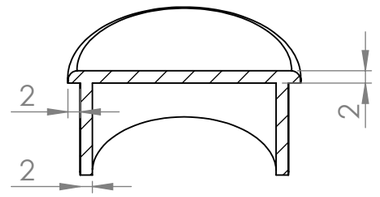
SECTION B-B

SCALE 1 : 5

DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING
	Re:Form
TOLERANCE: DIN ISO 2768 M	PART NAME: Tabletop
MATERIAL: Plywood, Laminate	PART NO. 1 — A3
SCALE:1:5 — ALL MEASUREMENTS ARE IN MM — SHEET 4 OF 14	

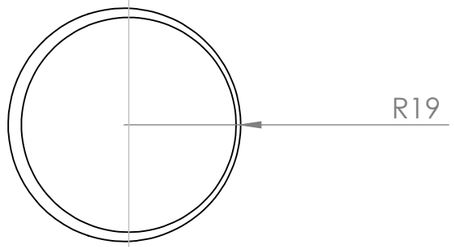
ALL MEASUREMENTS ARE IN MM





SECTION C-C

SCALE 1 : 1



DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING
	Re:Form
TOLERANCE: DIN ISO 2768 M	PART NAME: Ø38 angled plug
MATERIAL: PE	PART NO. 2 — A3
	SCALE:1:1 — ALL MEASUREMENTS ARE IN MM — SHEET 5 OF 14

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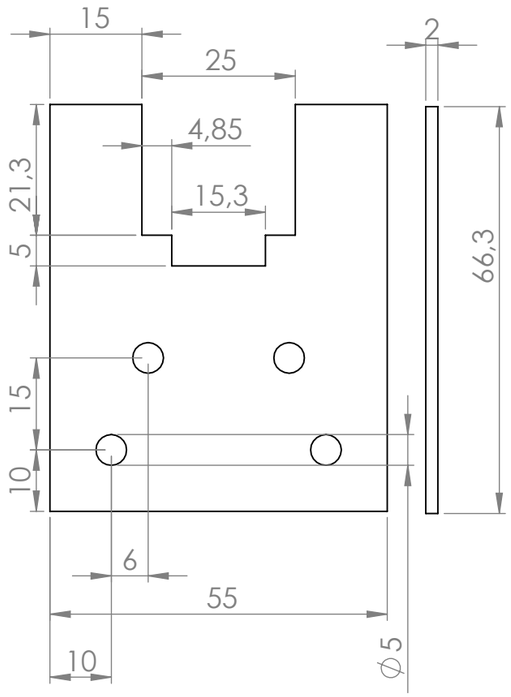

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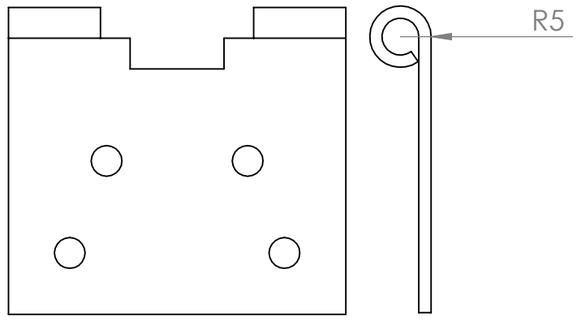

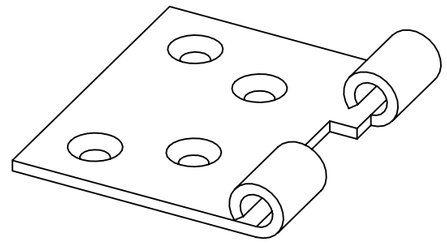

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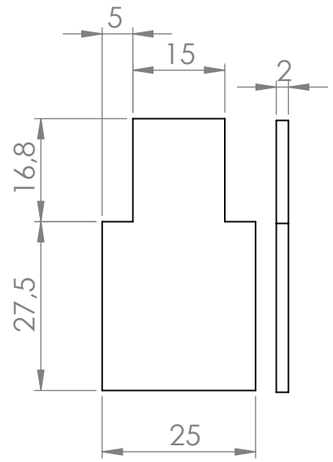

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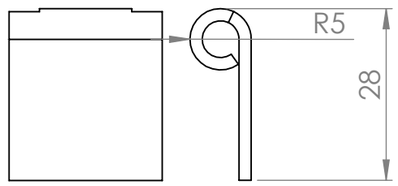
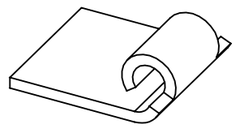
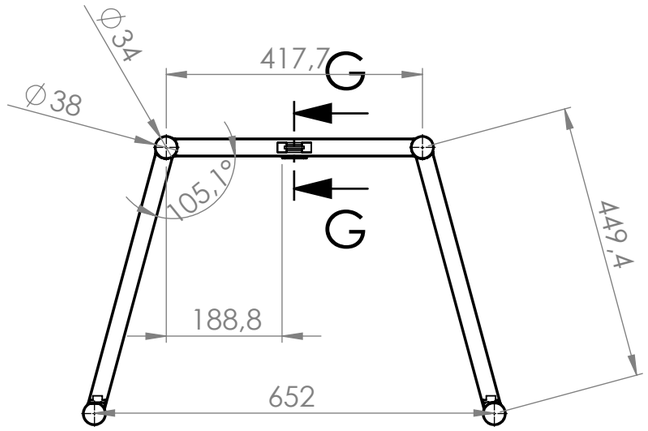
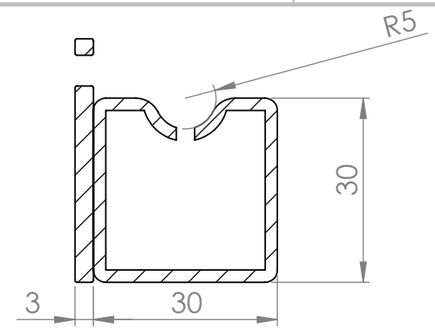




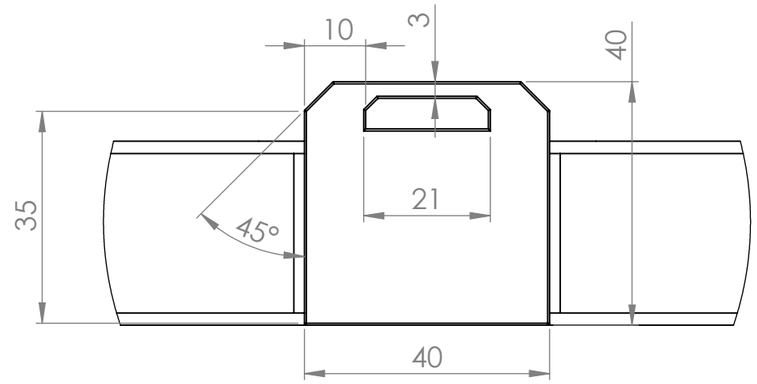
DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING
	Re:Form
TOLERANCE: DIN ISO 2768 M	PART NAME: Custom Hinge
MATERIAL: Steel	PART NO. 4 — A3
	SCALE:1:1 — ALL MEASUREMENTS ARE IN MM — SHEET 6 OF 14

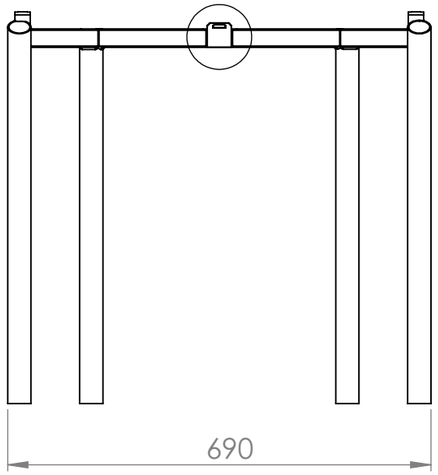


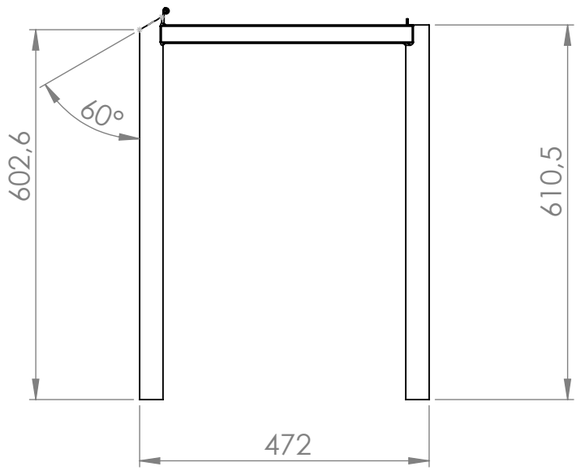


SECTION G-G

SCALE 1 : 1



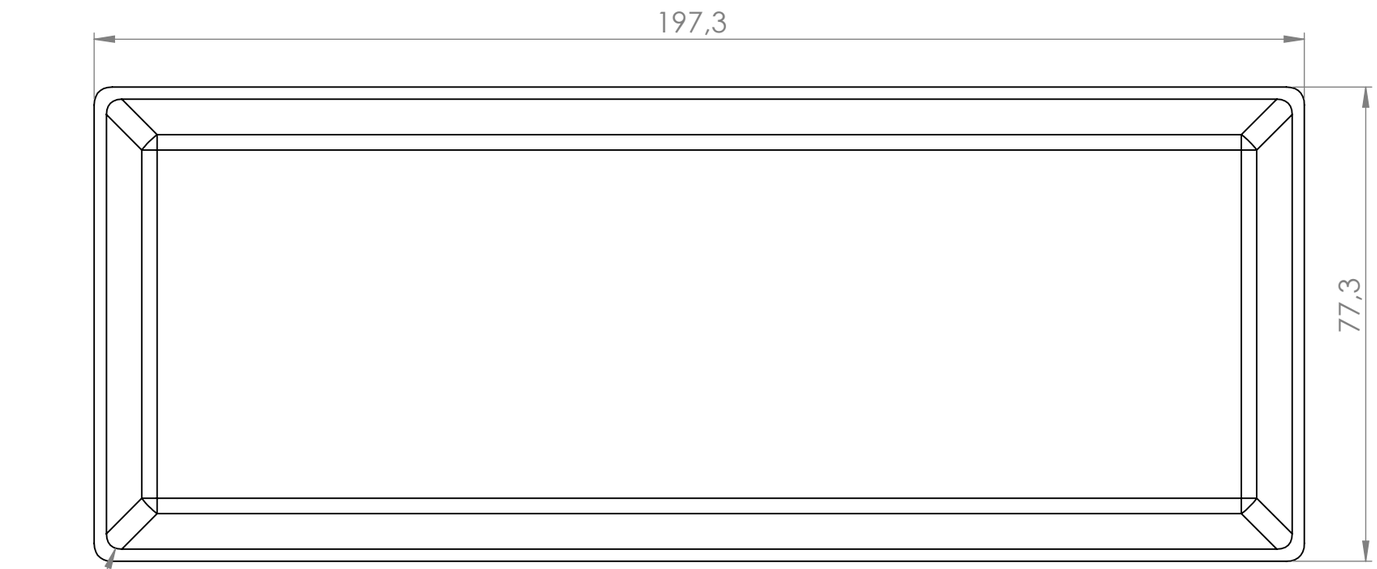


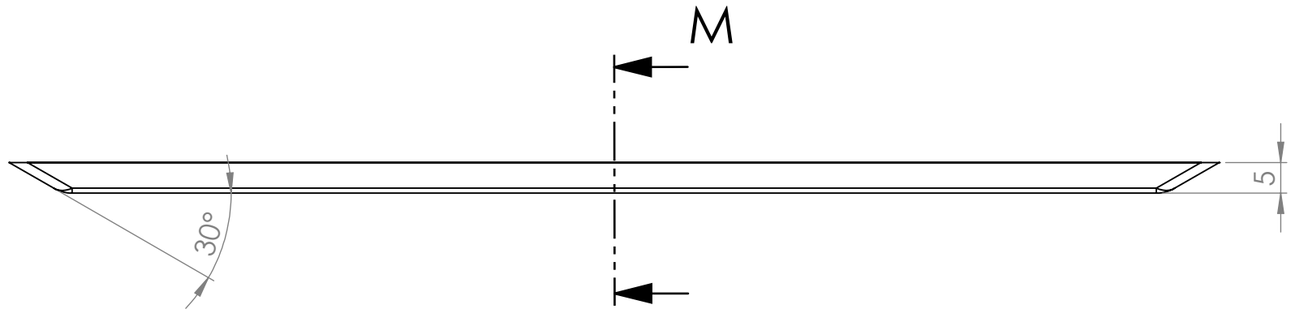


DETAIL H

SCALE 1 : 1

DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING
	Re:Form
TOLERANCE: DIN ISO 2768 M	PART NAME: Frame - 720
MATERIAL: Steel	PART NO. 6 — A3
	SCALE:1:10 — ALL MEASUREMENTS ARE IN MM — SHEET 7 OF 14

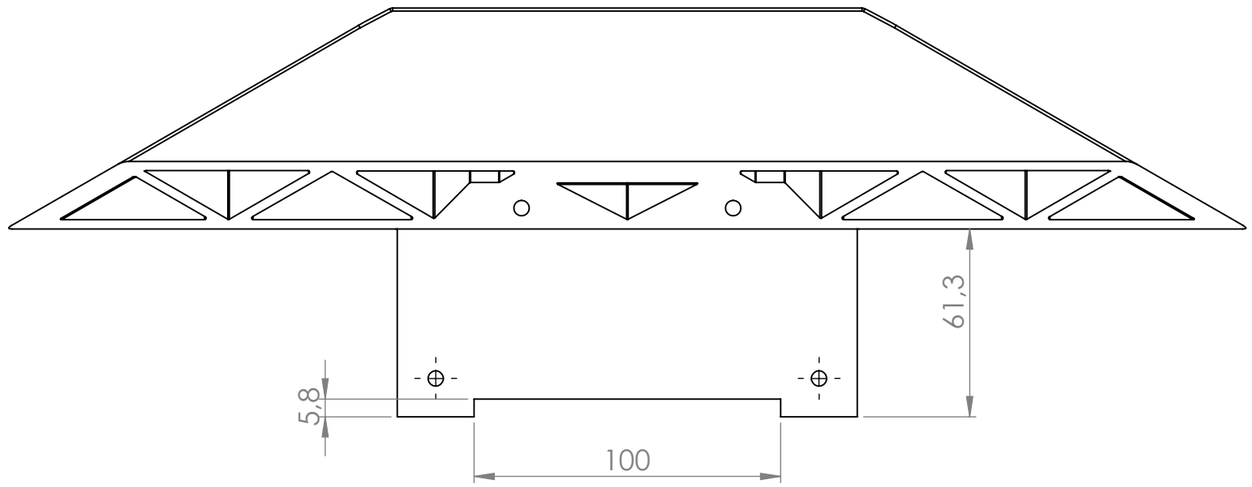


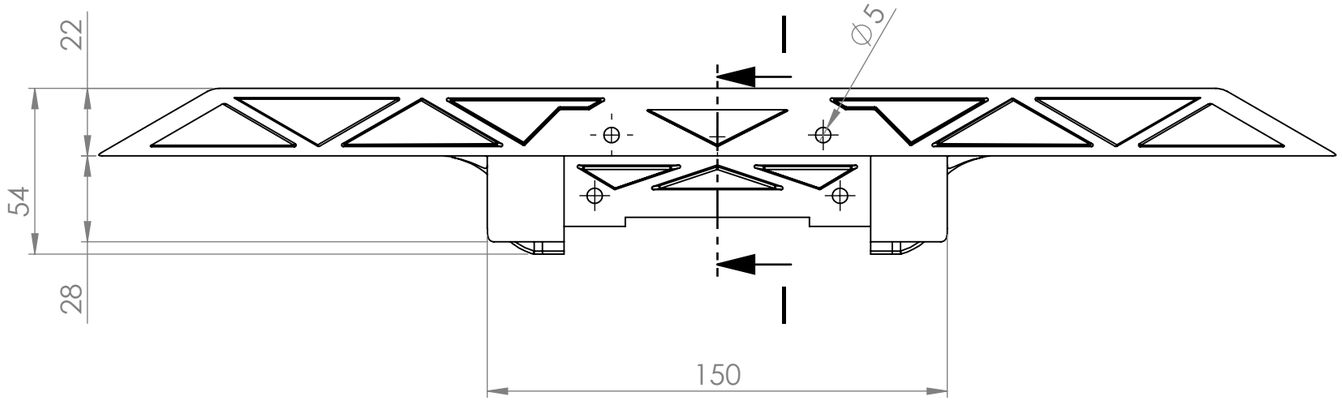


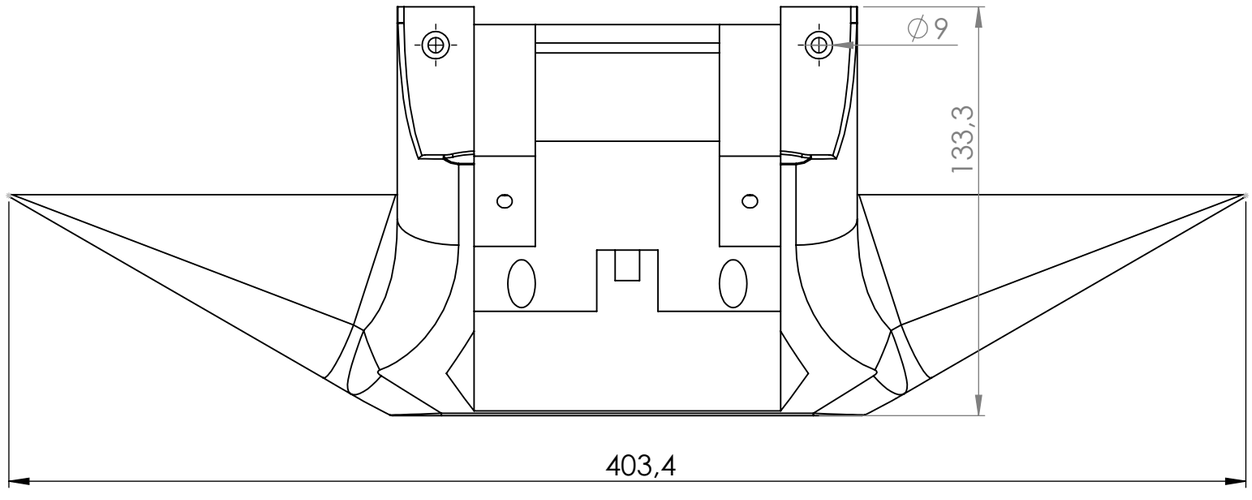
SECTION M-M

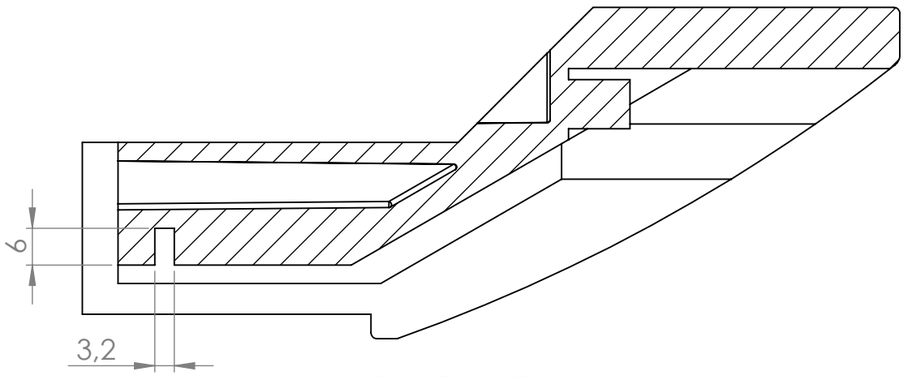
SCALE 1 : 1

DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING
	Re:Form
TOLERANCE: DIN ISO 2768 M	PART NAME: Tray
MATERIAL: Brushed Steel	PART NO. 8 — A3
	SCALE:1:1 — ALL MEASUREMENTS ARE IN MM — SHEET 8 OF 14





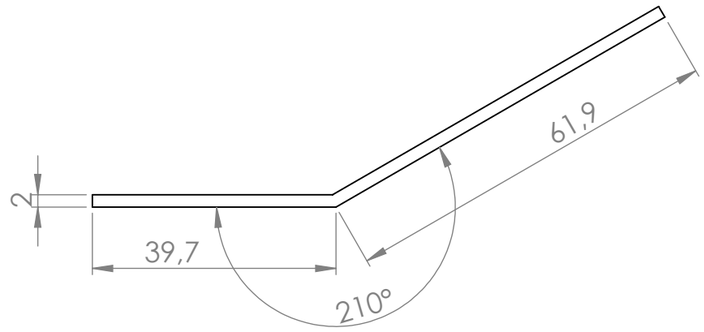


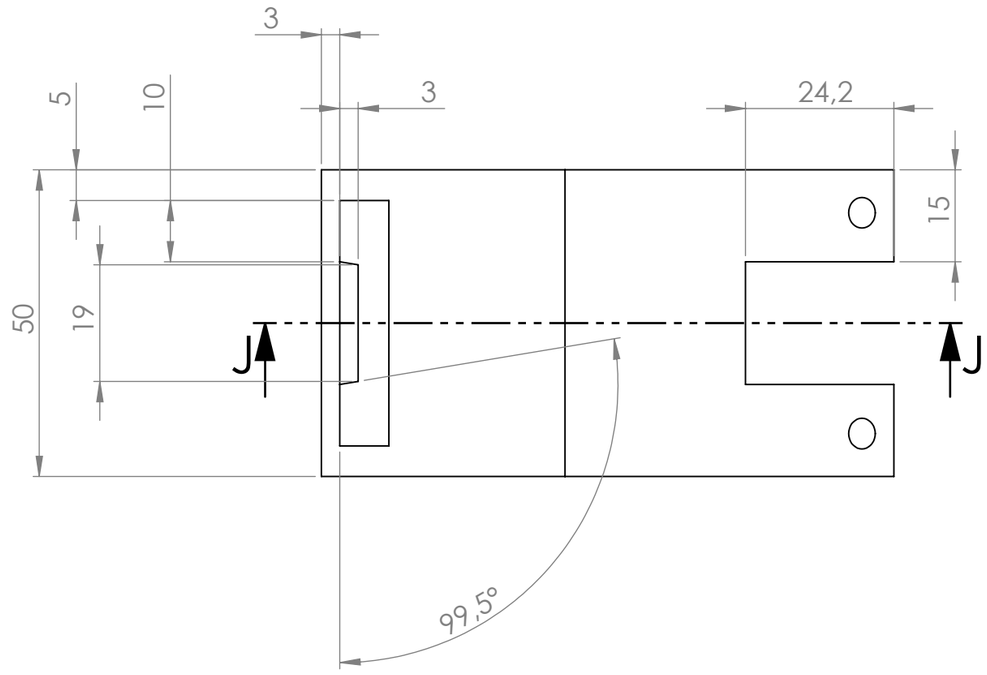


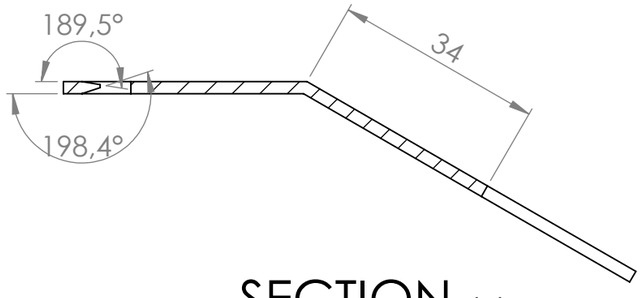
SECTION I-I

SCALE 1 : 1

DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING
	Re:Form
TOLERANCE: DIN ISO 2768 M	PART NAME: Nose Body
MATERIAL: PA	PART NO. 9 — A3
	SCALE:1:2 — ALL MEASUREMENTS ARE IN MM — SHEET 9 OF 14

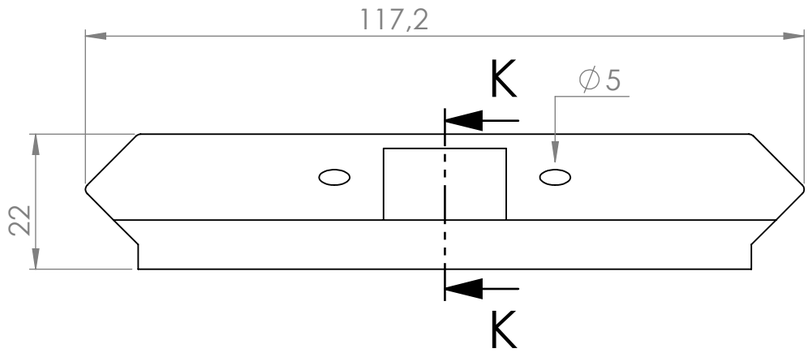


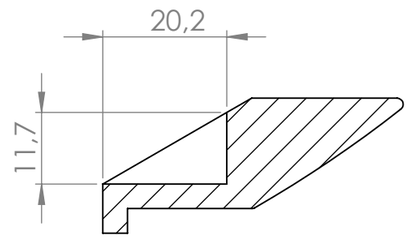




SECTION J-J

DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING
	Re:Form
TOLERANCE: DIN ISO 2768 M	PART NAME: Nose Plate
MATERIAL: Steel	PART NO. 13
	A3
	SCALE:1:1 ALL MEASUREMENTS ARE IN MM SHEET 10 OF 14





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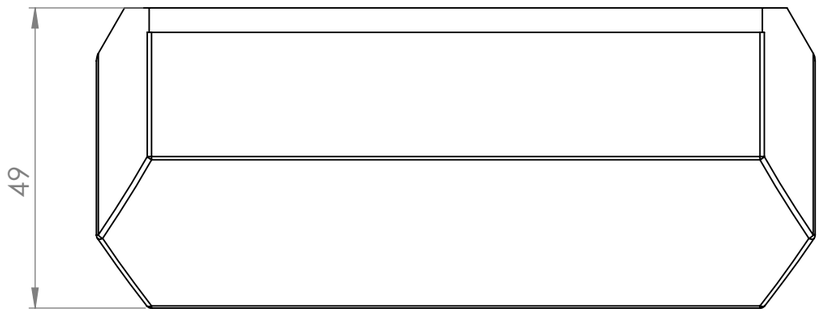

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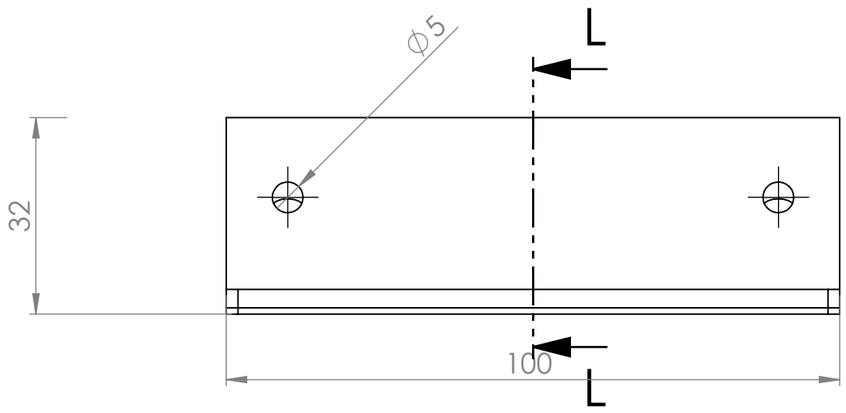

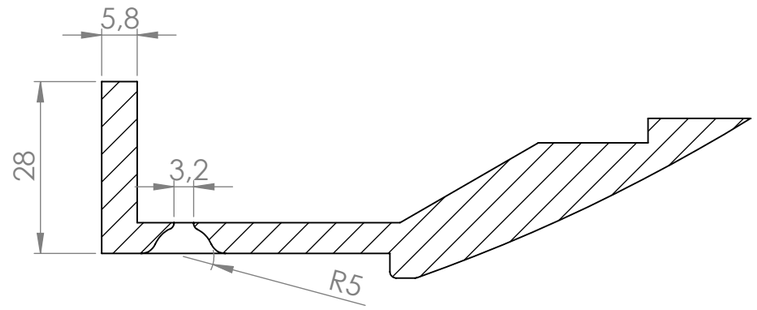

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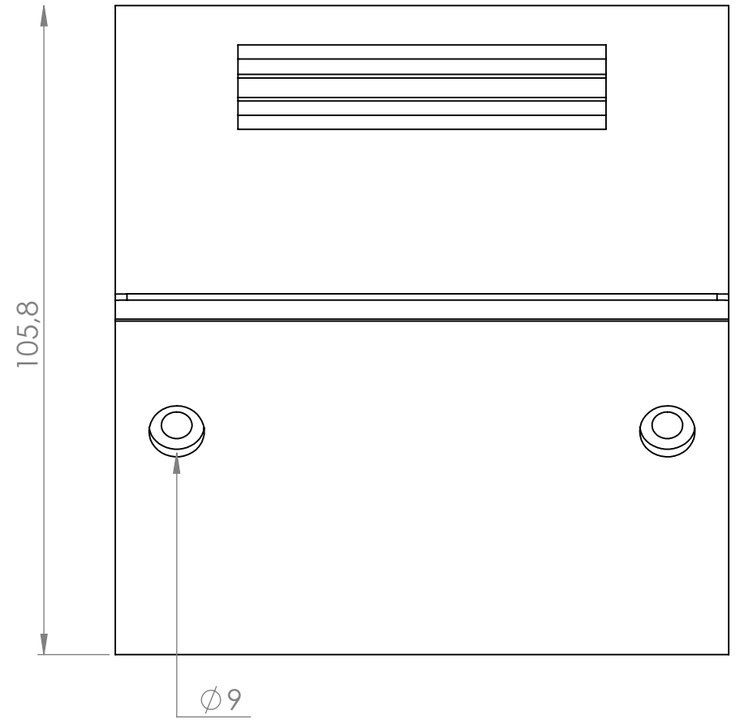

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PART NO.	PART	MATERIAL	QTY.	SHEET NO.
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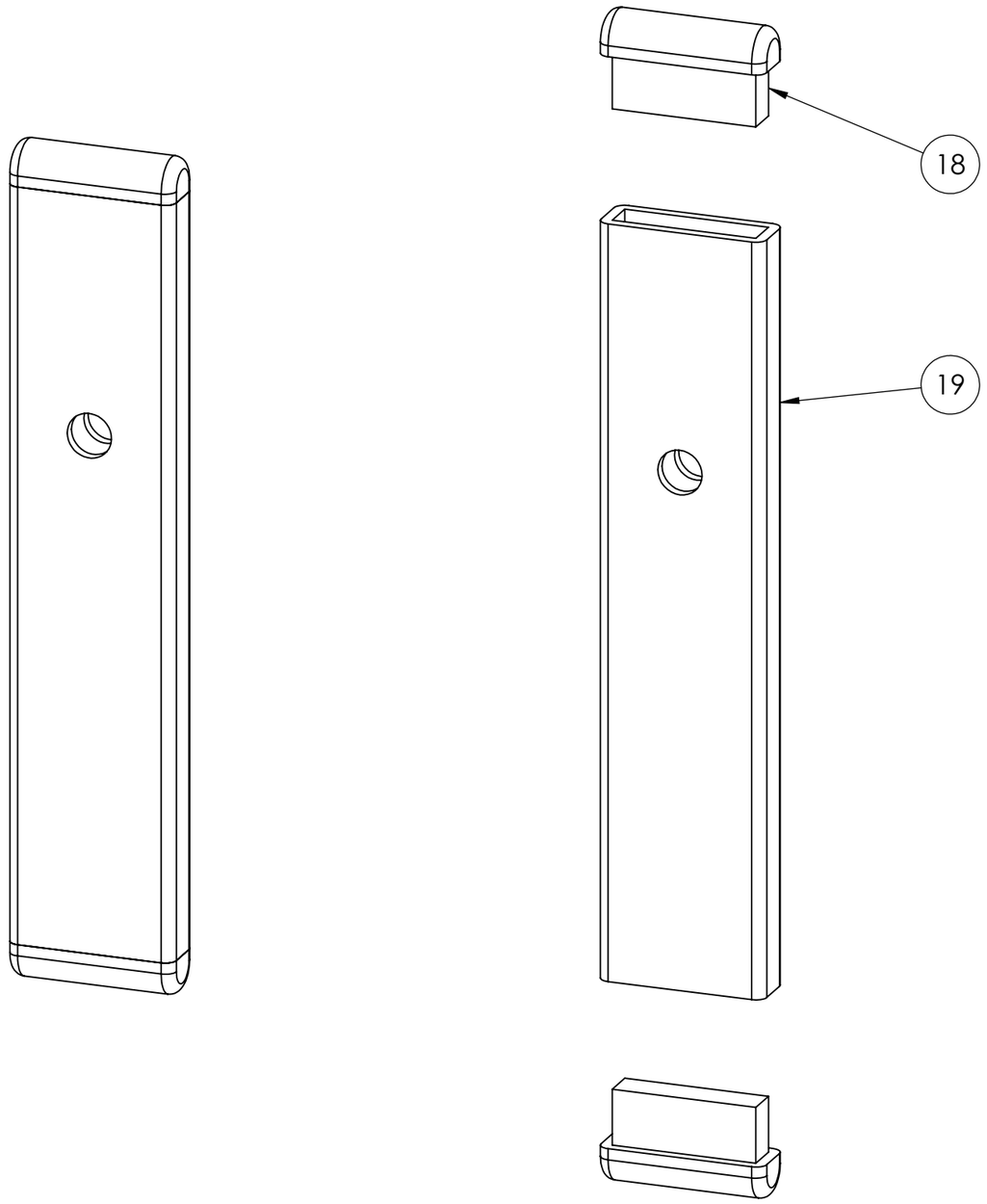
19	Rectangular tube	Steel	1	14



DEBURR AND BREAK SHARP EDGES

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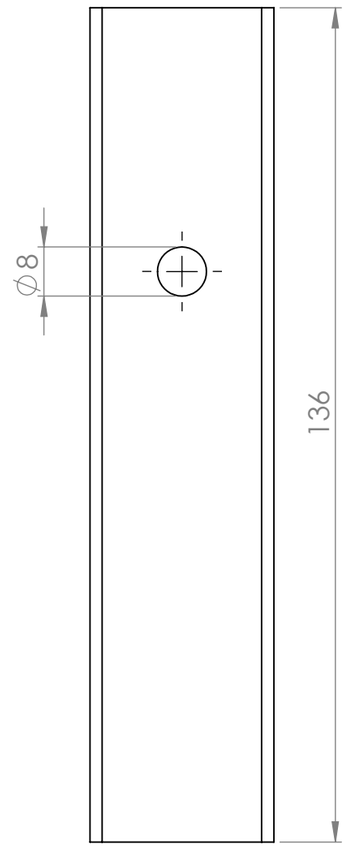

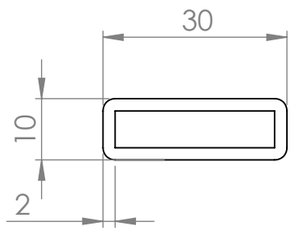

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RE:FORM

Process Report - MSc04-ID3 - June 2024

Jacob Madsen-Østerbye

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Simon Skaaning

Titelsheet

Project titel
Re:Form

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Christian Tollestrup

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Lars Rosgaard Jensen

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Appendix
48

Abstract

Re:Form is a master thesis about a pupil table that enhances the activities in the classroom and creates an active learning environment for the teacher and the pupils. This is obtained through collaboration with four different schools and a school furniture design company. Through this collaboration it is discovered that the market is selling a dream to the schools that has little to do with the reality in the classrooms.

With this knowledge the concept is developed to improve the flexibility in the classroom and give the option of clearing the floor of tables and give room to educational activities. Further geometrical studies make sure that pupils can be grouped efficiently together in groups of up to 6 or more. Additionally, the table is stackable and through multiple iteration it is made sure that the table behaves like a normal table any other time.

Re:Form is a proposal that gives the teacher the power to create a learning environment that suits their needs for the education material, and give the pupils an interesting school day that does not become mundane and repetitive

Jacob Madsen-Østerbye

Marcus Vechte Jensen

Simon Skaaning

Introduction

Today's school furniture is focusing more and more on creating activities inside the classroom and making it possible for the pupils to be physically active during the day, however there are some discrepancies surrounding the market and the reality in the classroom.

If pupils are active during the lessons, research shows that the learning ability is heightened, furthermore other aspects of the pupil's health are improved, both mentally and physically. If activity is implemented, studies show that the pupils in the class feel a sense of more inclusivity and the chances of smaller cliques inside the classroom are lessened, as the classroom gain more dynamism and makes sure that all the pupils are interacting with each other. (Blue, 2022) (Mehrbach & Beingessner, 2018)

Designing a possible solution for this, demands that the interaction and the functionality of the product is intuitive and failsafe. Moreover, is the economy a huge aspect as the schools throughout Denmark has a limited budget, and the market is controlled by the tender act.

Through an iterative design process, the aim is to create a solution for the schools that account for the school principals', the janitors', the teachers', and the pupils' needs, improving the normal day to day life of all four.

Reading guide

This project is made up of four different parts: a product report, technical drawings, a process report, and an appendix that includes additional information.

The process report includes nine chapters documenting the design process, each chapter is divided by 'chapter pages' where a short summary of the chapters can be found.

References are made using the Harvard method.

Symbol Explanation

This symbol is used to indicate that the project has chosen a direction between two or more things.

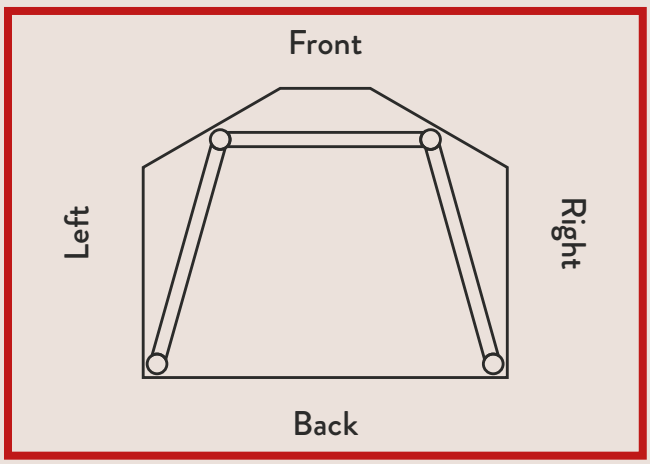
The green color indicates a conclusion or an addition to demands

The orange color indicates multiple direction are being presented or a direction is chosen

Word Explanation

Elementary school: describes the school system that teaches kids from the age of 5 to 16 and consists of a preschool grade which is labeled as 0. Grade and then 1. Grade all the way up to 9. Grade.

Lesson: describes a timeframe that one subject is taught, typically 45 minutes or an hour and a half.



Illu. 1: Orientation around the table

Motivation

Illu. 2: Picture of the project participants

As almost industrial designs with a master's degree, we feel the need to design products that can make a difference in the world and not just create 'another' chair or table. Through this belief of making a difference, we have responsibility of making products that improve the everyday life of the users designed for, and not just create and alternative that have the same functions. Moreover we believe that for a design to be great the timeframe of the product must be included in the design process, as the choices must be with respect to the longevity aspect, thereby prolonging the lifetime and making it repairable is essential in our opinion.

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Concept Development

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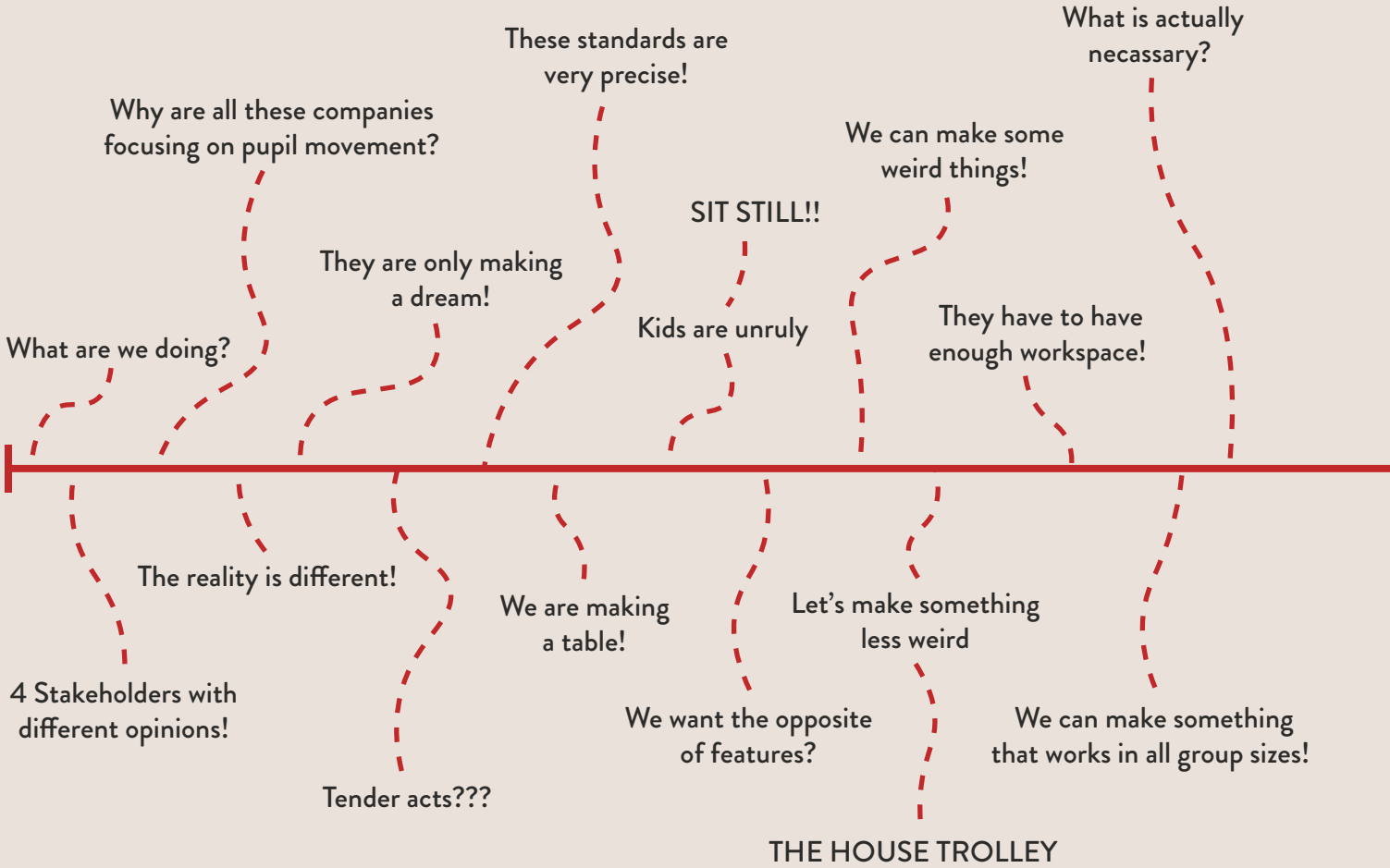
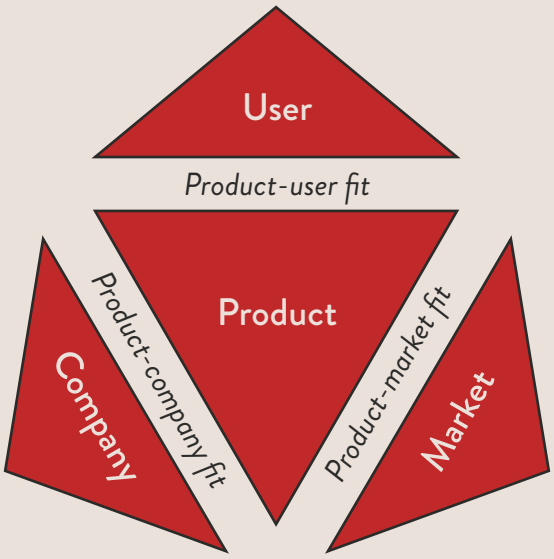


Illu. 3: Process timeline illustration

Strategic Durability

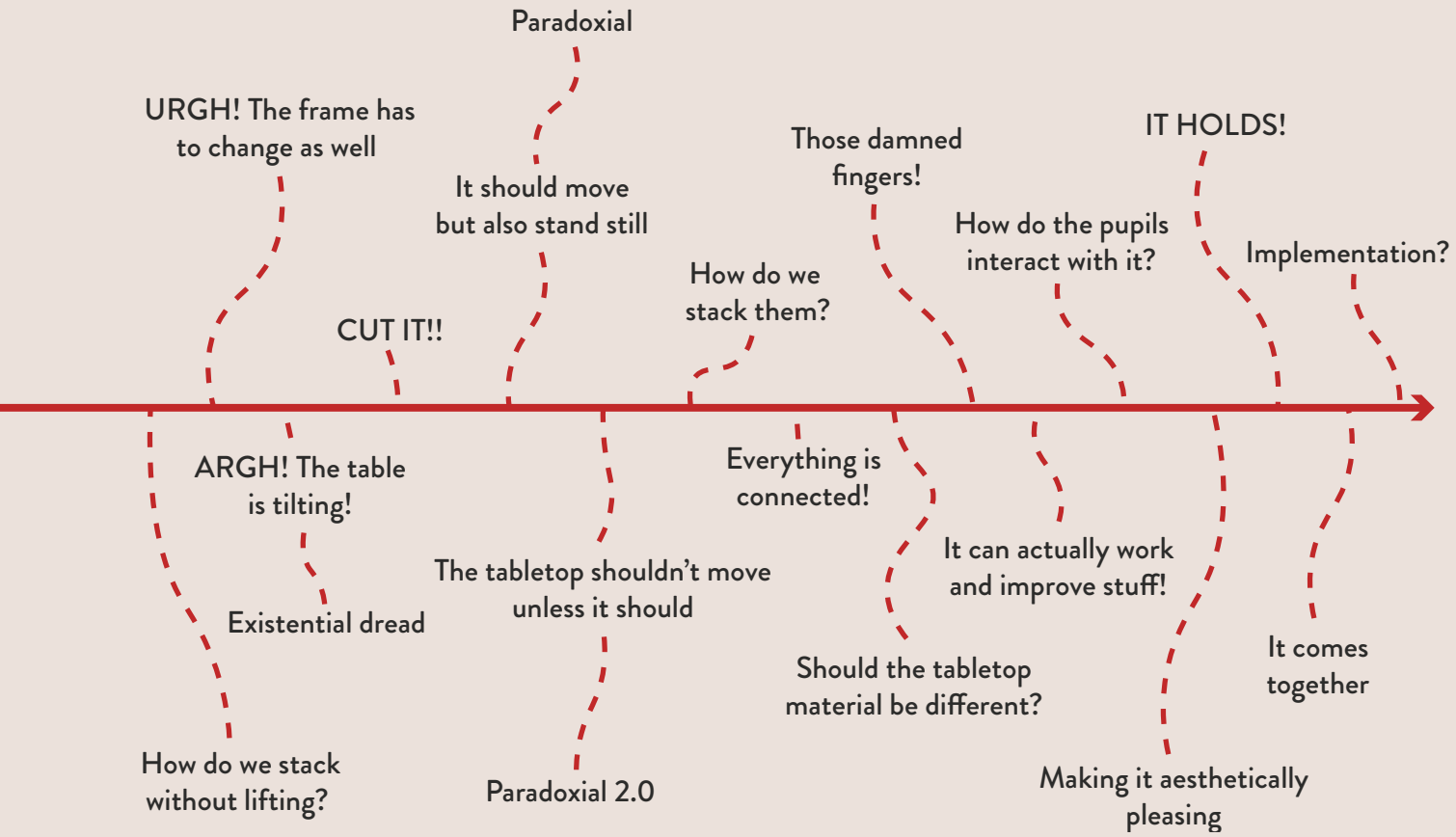


Illu. 4: Strategic durability illustration

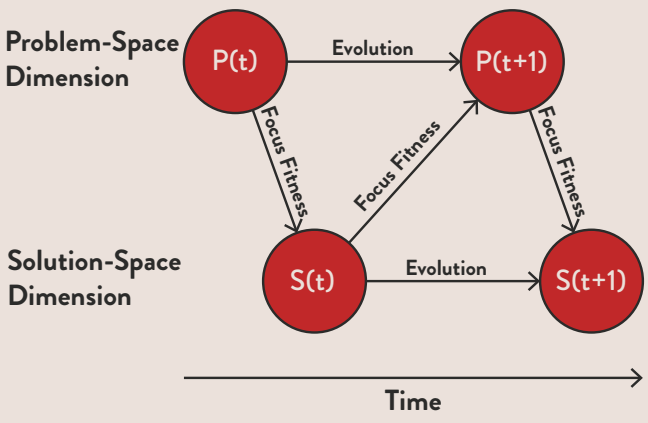
The strategic durability model (illu. 4) focuses on how to create products that can achieve a long useful lifetime. The model introduces 3 different aspects to focus on when trying to create a long-lasting product: Product-user fit, Product-market fit, and Product-company fit. (Laursen & Haase, 2023)

Product-user fit:
Focuses on long-term problems and trying to fulfill the users needs, wishes, and aspirations.
Product-market fit:
Focuses on creating a long-term competitive advantage in the market and the company's credibility in that market
Product-company fit:
Focuses on utilizing the company's advantages and prolonging the company's purpose and values they want to project outwards.

This model is used throughout the project, to secure a strong strategic fit, and is used as a guideline of areas that the process should focus on.



Co-evolution



Illu. 5: Co-evolution illustration

The Co-evolution model (illu. 5) surrounds how the problem space, and the solution space evolves when having a creative design process. The model specifies that designing is not about having a problem and coming up with a solution, but how the designers move back and forth between the problem and the solution spaces throughout the process then ending up with a new problem space and solution space by the end as the result of trying to solve the initial problem.

The problem space and the solution space therefore co-evolve, and move away from the initial starting point, but progress to find the real reason behind the problem and a better solution. (Dorst & Cross, 2001)

This model is used throughout the project to home in on the actual problem space as well as the solution space, which can be seen through the process.

Chapter 1:
Framing

This chapter will take a deep dive into the context and market of school furniture. First the market size is presented and what trajectory the project has chosen. The context is investigated by visiting different schools and getting an understanding of what's the reality and the dream is. Lastly a design brief is presented with a problem statement, aim, stakeholders, demands and wishes.

School furniture & Why?

School furniture has a bigger impact than what is believed, as they can influence not only the learning aspect, but also pupils' physical health, inclusivity in the class, sustainability, and the dynamic in the classroom (illu. 6). (Attai, et al., 2020).

This is not trying to oversell the importance of the furniture, but rather what it influences, obvious or not. "If the student is not interested in the topic being taught and nothing is done to stimulate and build an interest then learning will not take place." (Hawthorne, 2022). There are multiple factors that influence that on a physical, social, and emotional level. (Hawthorne, 2022) First, the physical wellbeing is purely based upon the ergonomics of how the pupils are seated and how they are interacting with their tables. Ergonomics also influences the concentration level, as discomfort during lessons can affect the timespan of how long a pupil can do a task.

The inclusivity aspect can be hard to detect, as it is just some furniture, however if the furniture considers that pupils are different and some of them have special needs, then the furniture can be inclusive in the classroom, and the pupils with special needs doesn't necessarily feel left out.

The social and emotional relationship between pupils in the classroom can be influenced as well as anything else, if the furniture layout is set up in zones or groups and in some places a singular table for some concentration, this can lead to a more relaxed environment where the pupils can feel safe and relaxed. As the school furniture is some of the furniture that is produced in the largest quantities, the environmental impact of it is significant. (Tuddenham, 2023)

Conclusion

Therefore, it is the intention to design a piece of school furniture that can have an impact on the classrooms, that affects not only the pupils but the teaching environment in general.

Illu. 6: Areas school furniture impact

Market potential

64.000 Pupils per Grade

682.000 Pupils Overall

42.000 Teachers Overall

93.500 DKK per Pupil on Average

90.000 DKK per Pupil in Aalborg

To further understand the project potential the market is analyzed. Here it has been necessary to find key numbers for pupils and the elementary schools. These numbers will be used to specify the size of the market potential. The two areas will show if there is a gap for a new piece of furniture in the elementary school. (Appx. 1)

Users:
The key figures provide an overview of how many pupils are in elementary school. **On average, there are approx. 64,000 pupils at each grade from kindergarten to 9th grade**. 18% of the pupils in elementary school go to private schools. The total amount of daily users for the school furniture was in 2022/23 **682.000 pupils and an additional 42.000 teachers**. (illu. 7) (Ministry of children and education, 2023c)

The expenses for the primary school are approx. 43 billion DKK annually. This means that **a pupil costs an average of DKK 93,500 per year**, specifically **in Aalborg municipality a pupil costs DKK 90,000**. (Marthinsen, 2023) these 93,500 DKK per pupil covers the cost of furniture, teacher salary, lessons, school trips, rent, cleaning staff salary and so on. (illu. 7)

Conclusion

From these numbers it can be deduced that the potential for a product in this sector is viable. Furthermore, this type of profession is not going away in the years to come, and there is a steady flow of pupils coming into the elementary school system each year. As each pupil costs around 93.500 DKK each year there is a possibility of introducing a new piece of furniture that the schools can acquire.

Illu. 7: Key numbers of the school market

Direction

Besides the market potential based on users there are also companies in the market for school furniture. Today the main competitors are Lekolar, Højer møbler, Uniqa, Kinnaps, and Holmriis B8. The services and products they are delivering can be divided into different directions for what furniture can provide. (Appx. 2)

Easy maintenance

An example of this is the 'School table' series from 'Højer Møbler' (illu. 8) (Højer Møbler, 2024), where the materials used are steel as the legs and wood surfaced with laminate for the tabletop. The table can come with wheels, so that one person is able to move it, so that the maintenance of the classroom can be done easier.

Illu. 8: Easy maintenance example

Longevity

These companies deliver warranties between 15-25 years, meaning they believe their furniture have a long lifetime in the context. This is down to the durability of the products, and the connection between the parts to withstand daily use. (Appx. 2)

Illu. 9: Warrenty badge

Modularization

When it comes to modularization the existing companies that manufactures the furniture do not incorporate the modularization inside the product, but rather makes the entire product the module, so for example a collection of triangular tables from Uniqa Group (Uniqa Group, n.d.), can be put together to form an unusual shape, or a seating box from Friis & Moltke architects (illu. 10) can be put together to form a small and intimate amphitheater (Friis & Moltke Architects, 2020).

Illu. 10: Module boxes

Possibility for Reconfiguration

This value gives the schools more flexibility, when it comes to the classroom, by giving the necessary tools for the users to change the furniture into what is necessary. An opportunity for the school is if two pieces of furniture can be combined, and thereby avoids the purchase of a new piece of furniture.

It is not possible to find a product that is catered to the school segment, however different furniture does this, for example the category of sofa beds and toys as Modu. Modu is a "supersized lego brick" (illu. 11) where from a few standard parts, the possibility of building is almost endless. (Modu, n.d.)

Illu. 11: Modu constellations

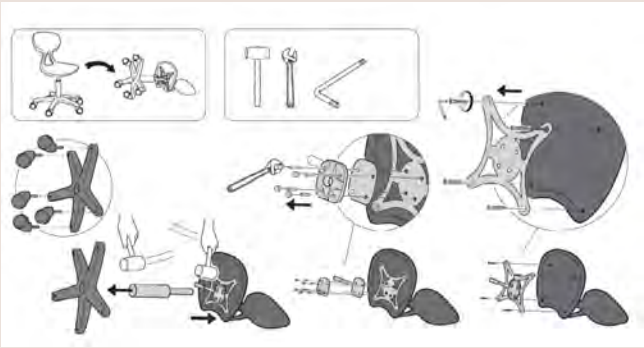
Use less Storage Space

This value is primarily for the technical service employee, as items like the table or chair rarely stores efficiently, however by using a product that are build using modules can be disassembled into smaller parts and stored more efficiently. The Modu reduces the storage to smaller buildings blocks (illu. 12) that's taking less space compared to have multiple products stored.

Illu. 12: Modu dissassembled

Responsible disposal of product

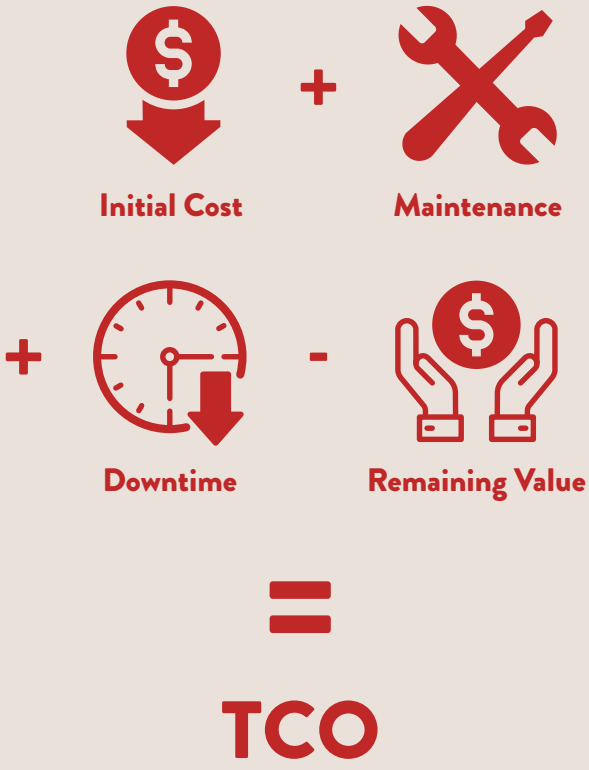
An example of this is the "Karoline" chair from Lekolar (illu. 13), where the chair is designed to be disassembled into the different materials it consist of, and thereby making both the disposal, reuse and repair easier for the users. (Lekolar, n.d.c)



Illu. 13: How to dissassemble the Karoline chair

Lower TCO

The Lower TCO (Total Cost of Ownership) is so that the schools save money and have the means to spend it on other important aspects of education. TCO can be calculated in various ways, however when not complicating things it is done simple by this calculation (illu. 14)



Illu. 14: TCO Breakdown

Conclusion

Through looking at the companies and what values they deliver, it became clear that in some respects these are direct competitors to the developing product. Maintenance, longevity and responsible disposal are key values that such a product should fulfill, however in other areas such as modularization and saving storage space there is a gap on the market to adapt into.

When it comes to TCO calculation, it is evident that it is not the upfront price tag that is the driving factor, as the cost of maintenance and downtime have a huge impact of the cost over time, here is an area to compete within.

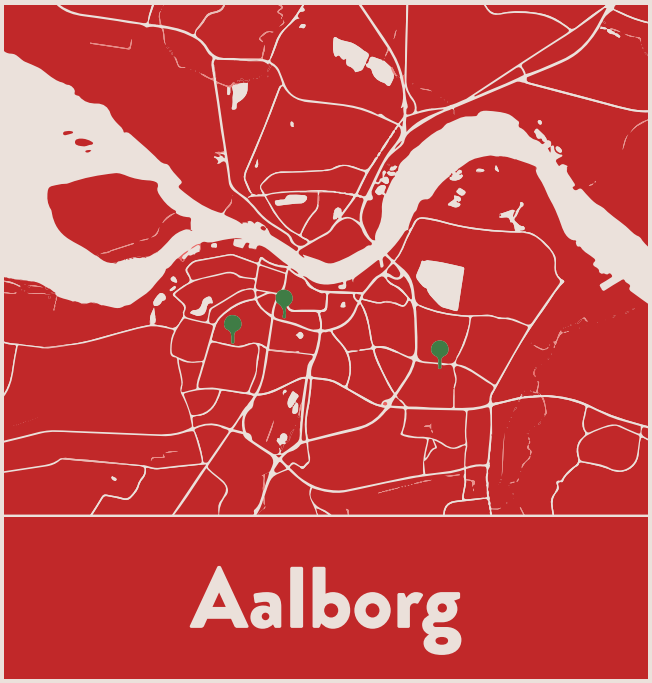
Demands

- One person must be able to move it
- Must be able to withstand daily use
- Must be able to be disassembled into the different materials

Context Reality

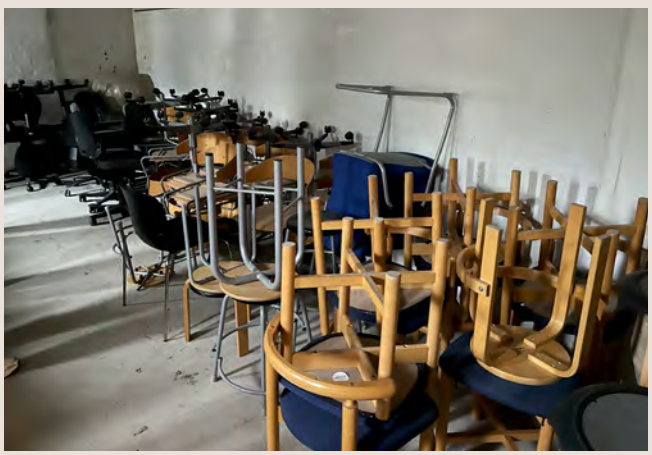
To gain insights into the use of school furniture three different schools in the Aalborg area was visited. First, a guided tour of the school and simultaneously a situated interview was conducted with the janitor or principal at the schools. (illu. 16, 17, 18, 19, & 20) (Appx. 3,4 & 5)

The first school was skipper Clements private school in centrum where a principal was interviewed, the second was Herningvej public school with the janitor in the eastern part of Aalborg and lastly Stolpedal public school with the janitor. (illu. 15)



Illu. 15: Map over aalborg with three schools pinpointed

A summarizing and comparison of insights from the three school visits have been separated between:



Illu. 16: Furniture stored in a school basement

Illu. 17: Classroom with triangle tables

Commonalities

- School budgets are tight.
- Not a lot of backup furniture is stored because it's too expensive and takes up a lot of space.
- The table should not change height, but the chair should.
- The attitude towards furniture is different when talking to a newly educated teacher compared with a very experienced teacher of 20+ years.
- The suppliers of furniture are bound by tender act and the cheapest offer.
  - These agreements supply furniture that is not even useful.
- In a Janitors opinion today' furniture' lifetime is way shorter than before when furniture was used for up to 20 years.
- - The most important feature when buying new furniture is lifetime.
- There are commonly between 22-25 pupil in each class.
- The janitor oversees procuring furniture.
- The single table is more expensive than the two-person table per seat.
- The classrooms aren't that big – build after standards in 1960-70

Dissimilarities

- Private schools can haggle over price.
- A classroom filled with new furniture cost 42.000 DKK at one school and up to 100.000 DKK at another school.
  - A chair and table per pupil are around 2.500 DKK.
- Single tables are preferred as it gives more flexibility.
  - But today it's a mix of both single and two-person tables.
- One janitor liked wheels on tables because of easy movement for the cleaning crew and himself.
  - and another janitor doesn't find it practical.

Illu. 18: Classroom with rectangular tables

Illu. 19: Furniture stored in a room

Illu. 20: Physics classroom with alternative furniture

Conclusion

From the perspective of the janitor and principal the budget and the possibilities of getting specific furniture are the most challenging aspects. The janitors' common values in relation to the tight budget are lifetime, maintenance, and durability when talking school furniture design.

There are different opinions about the furniture and what they must be able to do in areas such as movement and adjustment of furniture. These are especially time consuming for the janitors. Another perspective is from the daily users as their requirements could give other insight into what a piece of furniture can provide to them.

Demands

- Must have a long lifetime
- Must take up less space than the current solution
- Must be in the "normal" prize range
- Must minimize time spend on repairs and maintenance
- Must fit into already existing classrooms

Wishes

- The Teacher wants to adjust the furniture as little as possible

School Summary
Reality

A summary and understanding of the different activities the pupils go through a day is gained from school visits, observing their lessons. These has resulted in an assumption of how their daily schedule looks like and that each lesson is 45 minutes. Following that, a list of activities can be made for what the piece of furniture must accommodate. (Appx. 6)

School day	
8.00 - 8.45	Danish
8.45 - 9.00	Break
9.00- 9.45	Danish
9.45- 10.15	Break
10.15 - 11.00	English
11.00 - 11.15	Break
11.15- 12.00	Math
12.00- 12.30	Lunch Break
12.30- 13.15	P.E.

Illu. 21: Breakdown of a normal school day

Activities during lessons

- Playing around
- Board education
- Solo work at table
- Larger group 5-6 pupils working
- Smaller group 2-4 pupils working
- Lunch break, where they eat at their table
- Outdoor breaks

Demands

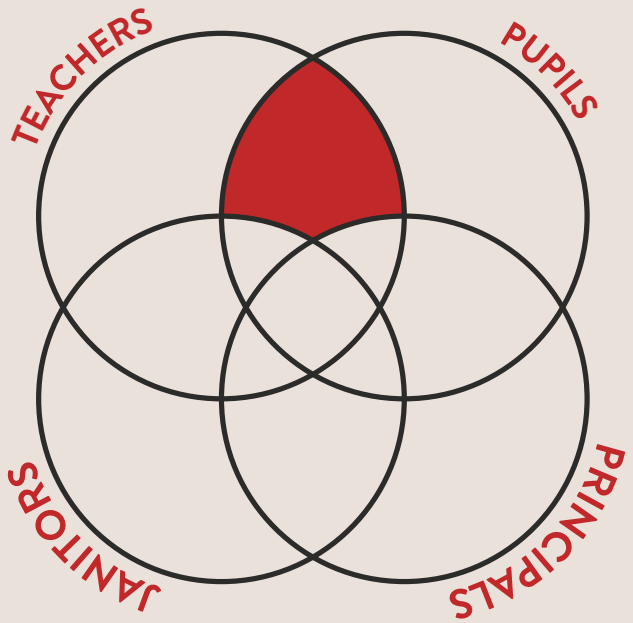
- The furniture must be able to function in board education, individual work, and groups.

Stakeholders

From the gathered insights at the school visits, it has been shown that there are some discrepancies as the buyer and the users aren't the same. This poses a challenge for the development of the project, because these two groups will inevitably have conflicting demands.

User VS Buyer

The buyers are, from the insights gathered, the principals and the janitors, and the users are the teachers and pupils. This could foster some contradicting demands, where the demands must be prioritized. However, this can lead the project down to different lanes where in the beginning of the project the insights were gathered from the buyers, as those are the one interviewed. From this perspective was a realization that the focus should be on the teacher and pupil as they are the daily users. These are more important as they are interacting with the furniture every day and thereby give better insights into how the furniture is supposed to be used.



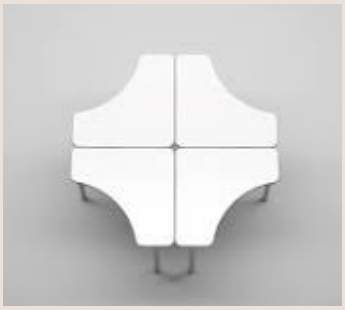
Illu. 22: Venn diagram of the four stackholders and where the focus is

When the demands from the user's perspective for the furniture are met the users' perspective, then the buyers demands are going to be taking into consideration as they have control over the purchase of the proposed end product.

Product Direction

Tables



Illu. 23: Different school table catagories on the market

To understand the context better research into flexible furniture is done, because of the lack of these in the visited school classrooms. The categories chairs, tables, and other alternative furniture is investigated, as it was the three main things that is used in the classrooms. (Appx. 7)

It shows that tables with different geometry and wheels can give the teacher a lot of opportunities to experiment with the classroom. The other aspect is the opportunities for the pupils to sit upon alternative furniture that can engage their motor skills and keep up their concentration because it fits their mood and concentration level. (Gibbs, 2022) There is both a market directly for school furniture in the classroom, but also different furniture outside the classroom has been researched to find inspiration for the project. (illu. 23 & 24)

Chairs




Illu. 24: Different pupil chair catagories on the market

Conclusion

The research upon flexible furniture and visiting the context has given insight into different product directions to challenge today's classrooms. These directions are;

Tables	Chairs
Movable	Inflatable
Geometry	Stools
Standard sizes	XX in one
The future classroom	Cushion

Further insights into the decision-making process and the opportunities for schools to choose furniture themselves are necessary to understand, and thereby learn why they don't have all these alternatives furniture that can helps the pupils through their school day. It has been obvious to see that the context and market doesn't match, and the big question is why?

On behalf of this research an assumption is made that it is a difficult job to design another chair that influences the context significantly compared to the table, furthermore, the chair market seems like a red ocean, where the table market is bluer. (Mauborgne & Kim, 2004)

Main Competitors Dream

Illu. 25: The dream setup

After researching the market and seeing a mismatch, visiting one of the manufacturers was expected to provide some clarity. Therefore, a situated interview with the designers combined with a tour around the facilities at Højer Møbler was conducted to gain insight from people who design school furniture for a living. (appx. 8)

During this interview there were some recurring insights from the schools, which underpins the insights that were gathered in the context. However, some new ones came to light:

- Teachers are often the barrier to incorporating the nontraditional classroom.
- The EN/DA Standards can be a hurtle when trying to challenge the traditional classroom, especially the chair. The standards are very specific.
- The upfront price is the most important factor when schools purchase furniture through tender agreements, compared to TCO.
- Sustainability is more of a market strategy than a selling point.
- There is a market for innovative and progressive classroom furniture.
  - They are specialist in the flexible learning environment.

A dive into Højer Møbler underlines their focus on the flexible learning environment (illu. 25), and the seven advantages this brings. (Højer Møbler, 2023)

1. Creates room for all pupil types.
2. Gives the pupils responsibility and participation in their own learning.
3. Creates new perspectives and room for creativity.
4. Enhances the pupil's physical wellbeing.
5. Gives the teacher the possibility for quick scene chances and varying activities.
6. Gives the teacher the opportunity to include special needs pupils.
7. An enhancement to the soundscape, which improves concentration and peace to learn.

Conclusion

The insights gained from Højer Møbler highlight gaps in areas of knowledge which need further research. These are standards, tender agreements, and the understanding of the effect of flexible and stimulating learning environment.

Dream VS Reality

After visiting both the context and Højer Møbler a significant insight has been gained. The reality at schools is different to the dream that Højer Møbler sells and shows. The school's classrooms do not have the required space in the classroom for zone dividing with static furniture (dream).

The reality is that in small classrooms the layout is chosen to suit the class best in relation to how the teacher likes the lesson. It is the classic solution such as rows, clustered 2-4 pupils, groups of 5-6 pupils, or alternative layout such as a U-form created by the tables.

In comparison the dream has a zone divided classroom with different furniture, where the pupil has free choice of where to sit depending on tasks and mood for the day, and further down to the specific lesson.

Reality

1. Octopus
   - Combination of solo tables and group constellation
2. Classic table settings
   - U-shape, rows individually, rows 2-4 people
3. Group with 4-6 pupils
4. Solo and board focus layouts

Dream

1. Zone divided classroom with different furniture

There is an assumption of a scale between reality and dream, where a golden mean can be found (illu. 26), rather than a solution that only favors one option, thus damaging the dynamics in the classroom between teacher and pupils.

Considerations

- There is a range in the complexity of the product from single function to multifunctional. It must be possible to easily change the room without noise, but at the same time it must be possible to do it quickly (motivation for doing it under lessons)
- The reality ensures that the teacher has control and the focus of the pupils as opposed to zone divided classrooms which makes it more difficult to have the overview of the classroom.
- The two opposites favor different teaching methods, where they do not accommodate each other - so there is no room for both (Where is the compromise)

Illu. 26: The golden mean between dream and reality

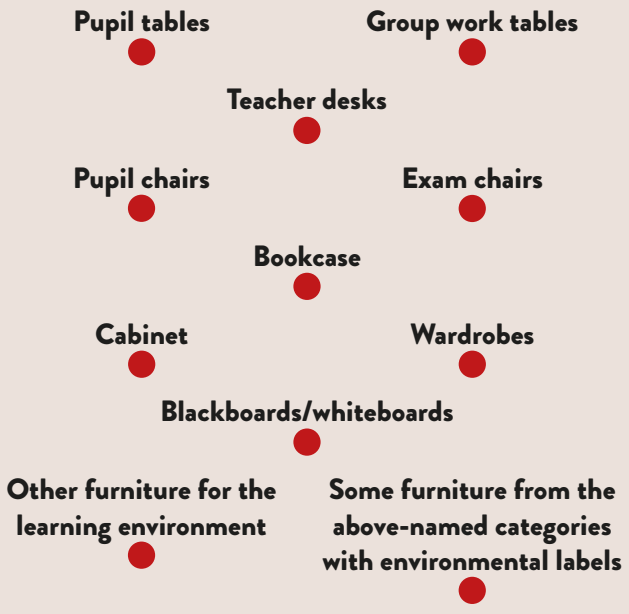
Tender Act & Ecomony Structure

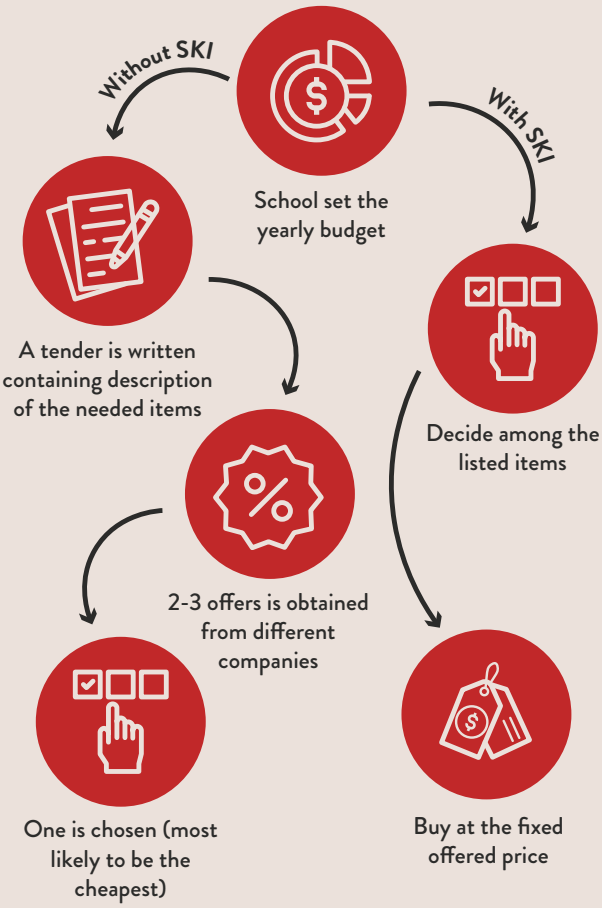
Knowing that the schools can only buy furniture through tender agreement, a further dive into the process and economics was necessary to better understand the buyer's decision making (illu. 27). A dive into the Tender Acts, Staten og kommunernes indkøbsservice A/S (SKI), and a telephone interview with tender/procurement consultant Kell Christensen, Ringkøbing-Skjern municipality was done to clarifying the process. (appx. 9)

SKI operates as a collaborative venture, jointly owned by the Danish state (55%) and Local Government Denmark (45%). One of the agency's primary functions is to streamline the often complex and time-consuming purchasing procedures. Each year, the agency oversees **approximately 3% of the total purchases made by the public sector**, amounting to a significant **12 billion DKK.** These purchases are facilitated through typical agreements that span a **duration of one to four years**, ensuring some stability and continuity in procurement processes.

A fundamental requirement for suppliers is that **tenders must demonstrate a minimum turnover of 2.5 million DKK in the latest available financial year**. This criterion ensures that suppliers possess the necessary financial capacity and stability to fulfill their obligations, both when they make the agreement and at the end of it.

SKI catagories for institution furniture





Illu. 27: Breakdown of how schools purchase furniture

Conclusion

The tender agreements are restrictive and allow little opportunity for a school to choose freely. SKI should give all schools equal purchasing power, but in practice this comes at the expense of broad choice.
The most critical aspect for a new product/supplier in the agreements is the requirement of a minimum turnover of 2.5 million DKK in the latest available financial year.

This means that if our product must be available for schools an agreement with an already existing company must be made to secure that.

Demands

- Must fall under one of the SKI Categories

DS/EN Standards

The purpose of this section is to research regulations and laws surrounding furniture for institutions, and get some specific demands surrounding the furniture after visiting Højer Møbler. This is done by reading and gathering information from the DS standard DS/EN 1729-2:2023 (Danish Standards Association, 2023).

The set of demands formed, that the product must abide by, will be represented by the highlighted demand. More was discovered but is not included as they were found nonrelevant due to their obvious nature such as “cannot have sharp edges”.

Demands

- Edges that are in contact with the user must be chamfered or rounded.
- No gap between 8-25 mm between to moving objects.
- Adjustable parts must not move on their own.
- Every tubular profile must be capped or otherwise closed.
- Holes must not have a diameter between 8-18 mm, unless the depth of presentation is less than 10 mm.
- Parts shall not be detachable without the use of appropriate tool.
- **Must comply with the current industry standards (DS/EN 1729)**

Learning Environment Dream

After visiting different schools and Højer Møbler, a phrase popped up again and again ‘the stimulating learning environment’ and ‘the flexible learning environment’, which had to be investigated to figure out what they were talking about.

Stimulating Learning Environment

The stimulating learning environment is about activating as many senses as possible when teaching and trying to avoid boredom. The pupils are urged to actively engage in the class by asking questions, experiment and explore the content that is being taught. This can be done in various ways; however, it can be summed up to trying to engage physical, visual, and audio stimulation for the pupils through the learning material. (Blue, 2022)

Illu. 28: What the stimulating learning environment influences

Flexible Learning Environment

The flexible learning environment is mainly the physical space in the classroom, where the teachers can change and remodel the layout of the classroom. This is not to say that the traditional setup of classrooms is not used, there are just possibilities to do much more.

The core idea of this is to create rooms within the classroom, and not be restricted to the four walls that a normal classroom has. Here the teachers can fit the lesson to the curriculum and fit that in the classroom. Some data shows that pupils that are exposed to this flexible learning environment are more likely to find connection between different subjects, and they are more likely to use their reasoning to figure out a problem than their rote learning. (Mehrbach & Beingessner, 2018)

Conclusion

However, after seeing what furniture that are being offered to the schools and what is being used in the classrooms, there is a mismatch of what the dream of a lesson should be and what the reality is, therefore it seems to be possible to design a product that can bridge the gap between the dream and reality.

Demands

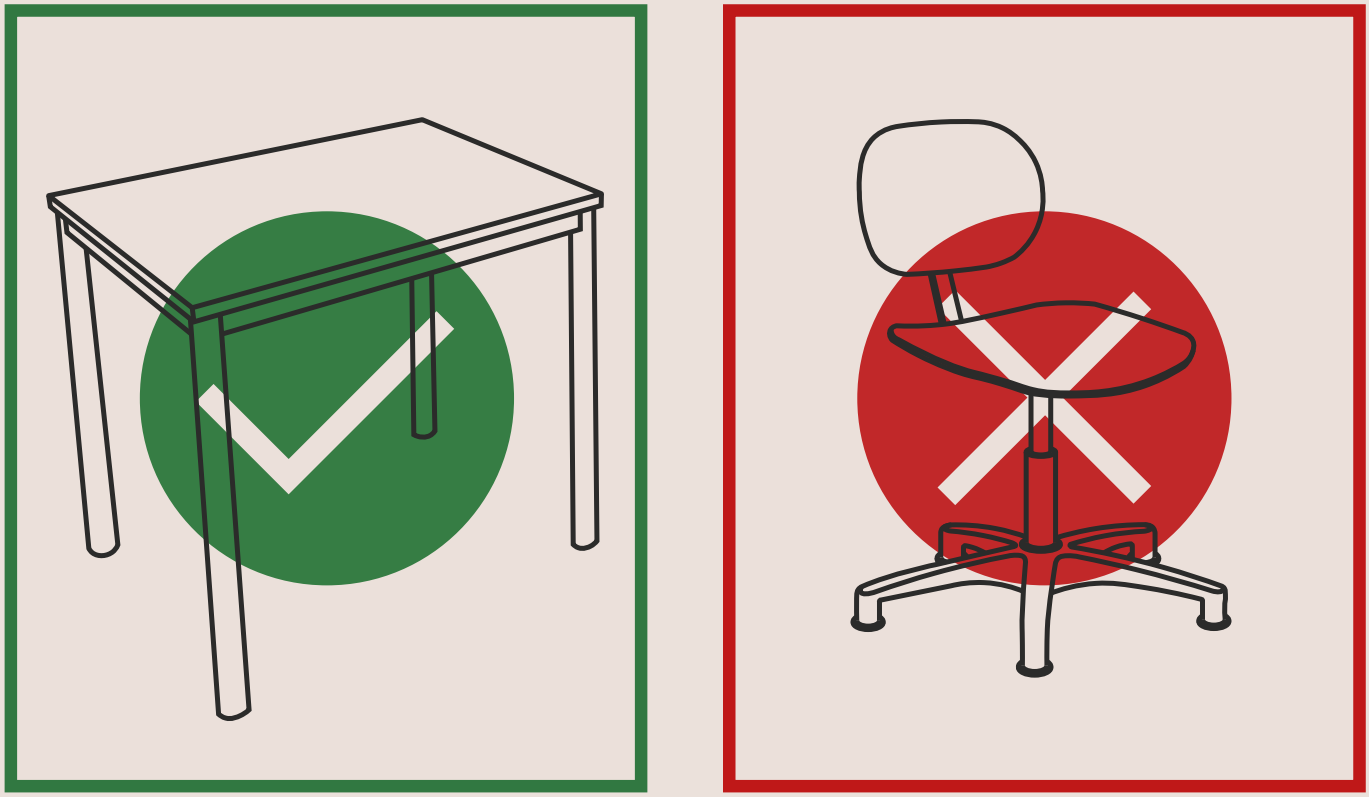
- The furniture must be able to change constellation though a lesson
  - The change must be quickly
- The pupil must feel comfortable when using the furniture

Table or Chair?

Through the chapter no clear product category has been determined but especially the chair and the table have been mentioned a lot. The chosen product category is the pupil table as it both has the greatest capacity to change its environment and a great opportunity to be innovated (illu. 29). Some of the tables “Helle” seen still in use at skipper (appx. 3) are the same exact model that where in use in the elementary school 20 years ago, when we started. The table hasn’t changed a lot over the last couple of decades, and the classroom dynamic suggests that it is time.

Chair varieties are explored significantly more than tables and can be seen in many classrooms. There is a lot of different expressions of the same basic chair as according to Højer Møbler the Danish Standards heavily restrict the physical form of what can be called a chair. This contributes to the chair market being a red ocean, where the table market is a bluer ocean (Mauborgne & Kim, 2004). This is especially true when looking at less standard or static tables.

The tables function also dictates a lot of the layout around it, therefore challenging the tables function in the classroom can greatly influence how the classroom is used in the lessons



Illu. 29: Which direction of product category to go

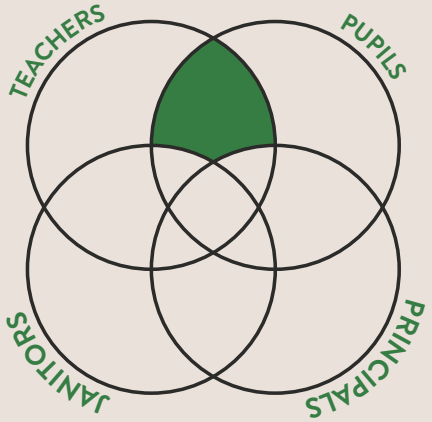
Design Brief 1.0

Problem Statement

How can we design classroom that challenges traditional setups, promotes flexibility, and allows for seamless transformation of the learning environment during lessons, fostering collaborative and dynamic teaching methods for school children?

Aim

The aim is to create a product that focuses on the teachers and the pupils, that can create a cultivating environment for learning and growth.



Illu. 30: Venn diagram of where to aim when it comes to stakeholders

Stakeholders

Primary
Teacher & Pupil

Secondary
Janitor

Tertiary
School Principal

Demands

1. One person must be able to move it (Direction)
2. Must be able to withstand daily use (Direction)
3. Must be able to be disassembled into the different materials (Direction)
4. Must have a long lifetime (Context)
5. Must take up less space than current solution (Context)
6. Must be in the “normal” prize range (Context)
7. Must minimize time on repair and maintenance (Context)
8. Must fit into already existing classrooms (Context)
9. Must be able to function in board education, individual work and groups (School Summary)
10. Must fall under one of the SKI categories (Tender Acts & Economy Structure)
11. Must comply with the current industry standards – DS/EN-1729 (DS/EN Standards)
12. Must be able to change layouts through a lesson (Learning Environment)
    a. The change must be done quickly (School Summary)
13. Pupil must be comfortable when using the furniture (Learning Environment)

Wishes

1. The teacher wants to adjust the furniture as little as possible (Context)

Illu. 31: Golden mean between dream and reality

Chapter 2:
Sketching

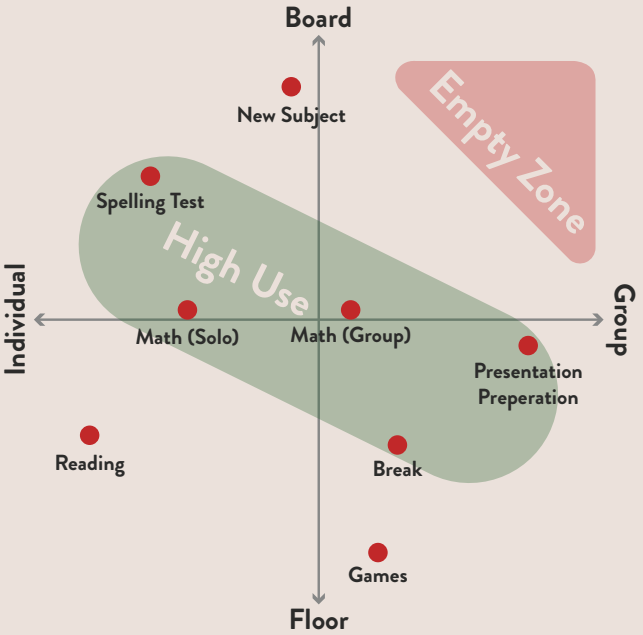
This chapter opens the solution space by understanding the behavior of pupils, what the product should and shouldn't be able to do and defining them as Features and Non-Features. From this, sketching of solutions is begun in two rounds, which leads into a geometry study, what features are on the market, and what features should be in the product to successfully fulfill the demands. Lastly an updated design brief is presented.

School Visits

As the users are specified to the teachers and the pupils it is necessary to understand how they behave and interact with the furniture in today's classroom. This has been observed through shadowing of five different classes: one 1st grade, two 3rd Grades, one 4th Grade, and one 6th Grade. These different classes were observed at two different schools, Stolpedal public school in Aalborg and another in a smaller city called Kjellerup in Central Jutland. The classes were observed through different lessons.

From the shadowing of the two 3. grades at Stolpedal public school, some insights into how the pupils behave during lessons and how the teachers interact with the pupils were gained (appx. 10). The shadowing of the other grades was necessary to understand the entirety of the spectrum of age in the schools of Denmark. Therefore, an appointment with "Trekløverskolen" public school in Kjellerup was made, where the rest of the grades were shadowed (appx. 11).

From shadowing a map over the activities has been made (illu. 32).



Illu. 32: Map over what different activities are focused on

Insights

- Four activities throughout the day.
  - Board, individual, group and floor.
- No activities are the same back-to-back across lessons.
- The height of the tables is fixed.
- A consequence of rows is that the pupils walk around in the classroom during the lessons.
- Group tables create a better dynamic between pupils.
- 6 activity switches throughout the whole day.
- The chairs have a gas cylinder to adjust the height.
- Work is done alone or 2:2.
- No matter what, they talk together.
- None of the pupils are standing up while working.
- Noise-cancelling walls make pupils feel different (Visual Isolation).
- Headsets are used to retain focus (Audio Isolation).
- Tall pupils have a hard time being comfortable.
- Tall pupils could experience no suspension.
- Teachers can experience discomfort throughoutt the day, as they need to squat down.
- The table moves forward, and not the chairs because there are no castors.
  - At the other school they have chairs with castors and doesn't see the table move.
- Castors is fun for a short period of time before it gets mundane.
- Teachers adjust the position of tables every day after school in some classes.

As expected, many issues observed both at Stolpedal and Trekløverskolen public school. Both teachers and pupils are individuals, so some range in the behavior was noted. A wider age range is observed to ensure that any problem isn't a localized one. Differences were observed in part due to educational material or behavior. As the younger pupils work less with a computer, they need space for the books and booklets they use, where the older ones focus significantly more on the computer. The younger pupils are more curious and playful, and the older pupils get more self-conscious as images begin to determine the social hierarchy.

Demands

- The height of the tables must be fixed.
- Must be able to adapt to the four activities used by the teachers.
  - Board, individual, group and floor.
- The workspace must have the opportunity to have both books and pc at the same time.
- Must deliver the same opportunity to every pupil.
- Must be able to be moved by a 1st grader.
- Must be able to work in 1st to 6th grade.

Wishes

- Give the opportunity to focus individually by limiting the visual peripheral.
- The furniture must be able to cancel out noise for the pupil.

Non-Features & Behaviors

As observed the pupils are walking around in the classroom despite been supposed to sit down. Certain behaviors aren't necessarily possible to dictate, as the social hierarchy affects the behaviors in the classroom. Therefore, behaviors and scenarios are divided into categories to understand which situations the product can influence and minimize the chances of happening and which it cannot influence, a table can't determine all kinds of behavior.

Non-features are situations with the table it must try to minimize.

Features are situations with the table it must be able to fulfill.

Non-avoidable behavior is controlled by the pupils and cannot necessarily be influenced by furniture.

Non-Features

- Fast-moving furniture
- Time spent preparing for activities
- Minimize play in changing the furniture
- "Crawling" furniture

Features

- 3 Activities (Board, Individual, Group)
- Clear the floor for tables
- Transforming or change the room
- One primary function
- A feature must be out of reach, but also within reach

Non-Avoidable Behavior

- Throwing and playing with Small items, such as pencils or erasers
- Noise level
- Pupils tinker
- Executing tasks
- Concentration and focus time
- Pupils need to move around in the class
- Bags are left on the floor
- Distinction between boys and girls
- Use of space for books, PC, etc.

Conclusion

Some **non-avoidable behaviors** from the pupils seem to be **possible to influence positively** by designing a new table for the classrooms. These situations or behaviors are:

Non-Avoidable to influence

- Noise level
- Concentration and focus time
- Pupils need to move around in the class
- Use of space for books, PC, etc.
- Bags are left on the floor

From the non-features, three concept directions are defined and is the starting point for a sketching round that will explore the opportunities for the product in the context. The directions must also try to incorporate solutions that can influence the Non-avoidable behaviors or situations positively.

Demands

- The transformation between constellations cannot take more then XX seconds to executed from delivering the message to the pupils sitting down in the new formation.

Direction 1

Three Activities: Board, Solo & Group

This concept direction means that a concept must work in all these three activities and must give better options for these activities to succeed.

Direction 2

Room full of Tables VS Room Full of Free Space

This concept direction is self-explanatory; however, the concept must work in both situations, and it must be done swiftly.

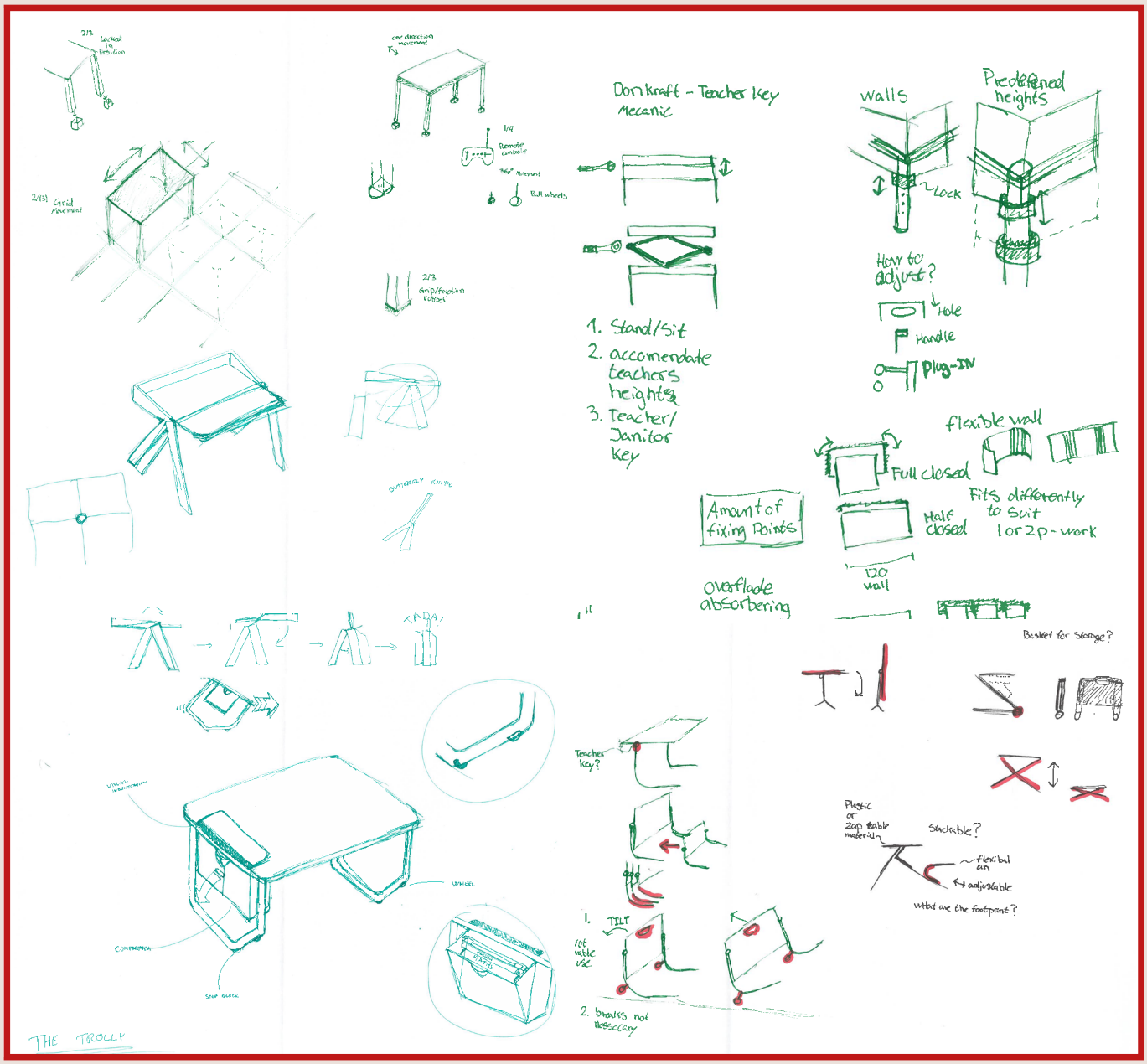
Direction 3

Reduce and Minimize the Non-Features

This concept direction must avoid the non-features for the concept to succeed.

Sketching Round 1

This sketching round is done by using the three concept directions defined by features and behavior from the classrooms, where the sketching will have focus on the users of the product. (appx. 12) (illu. 33)



Illu. 33: Overview of the first sketching round

Conclusion

From this sketching round, it can be concluded there are three different concept directions with hidden solution principles: visual indication, mechanical, and non-mechanical, Therefore, a dive into these is done to help with ideas from already existing products.

Solution Principles Analysis

Deeper research on the three concept directions has been done to uncover different solution principles to understand the different opportunities before solving the problems in the concepts. The findings will provide insight into different products, than the furniture category, where these solutions potentially can be translated and used in the concepts. (appx.13)

Visual indication solution

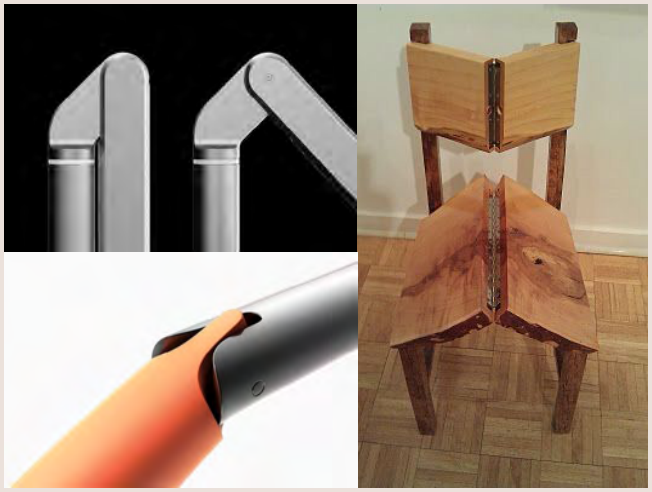
Illu. 34: Different Visual indication solutions

A visual indication solution concerns the signals the design should give to the users. This can be a way for the user to get feedforward or feedback by “saying” or showing whether something is assembled correctly or not. (illu. 34)

Mechanical solution

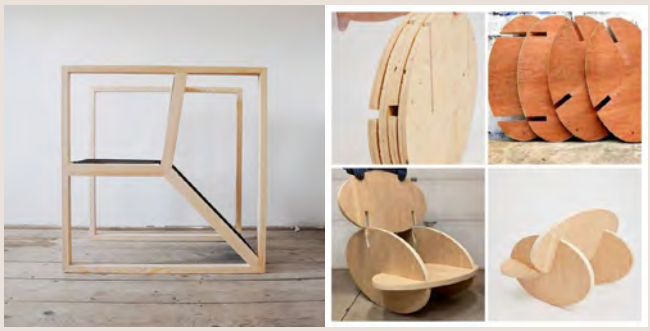
A mechanical solution is movements the design does internally, so that it accomplishes a new assignment that it needs to fulfill. (illu. 35)
The spectrum of complexity in this solution space is huge, on the simpler side, a wheel’s mechanism can be a hole with a stick through it. The other side of the spectrum can be infinitely complex as a simple mechanism can be a part of a chain reaction, and therefore continue into infinity.

The solution space must therefore favor the simpler solutions as fewer mechanisms can fail less often, and the users have a sense of understanding the design



Illu. 35: Different mechanical solutions

Non-mechanical solution



Illu. 36: Different non-mechanical solutions

The non-mechanical solution is as simple as possible and has no internal movements within the design. The only thing that can change the design is outside forces. Such as a rectangular box can be used as a stool and by turning it around it can then be used as a bench.

Conclusion

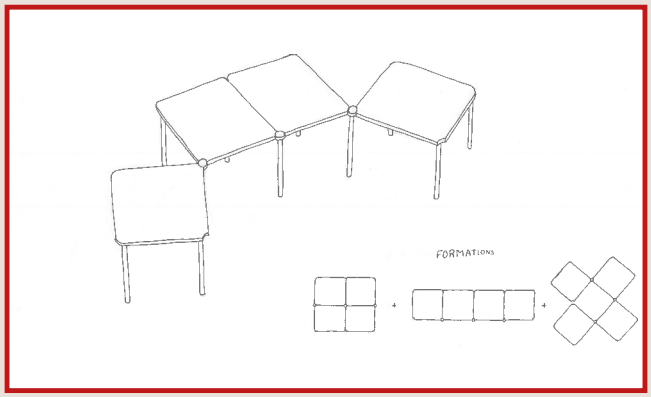
It seems to be almost impossible not to use a mechanical solution if the product must be moved, stacked, or folded to save space. It will be most affordable to make the mechanical solution as simple as possible, also making it fit the environment of the classroom. The non-mechanical solution seems to be very limited, as the geometry decides the possibilities. The visual indicators have different levels of impact on a product, such as color is a simple solution to incorporate compared to an object that shows it isn’t assembled correctly.

Sketching Round 2

A new sketching round is put into action, as the analysis of solution principles has generated new ideas to develop the different concepts. After using the principles as inspiration in the concept development a round of feedback from the users is necessary to better understand what each of the concepts can contribute. (appx. 14)

The feedback is given by a teacher that is primarily teaching the 3. grade pupils in mathematics, biology, and creative subjects, but are also secondary teacher in other subjects. (appx. 14)

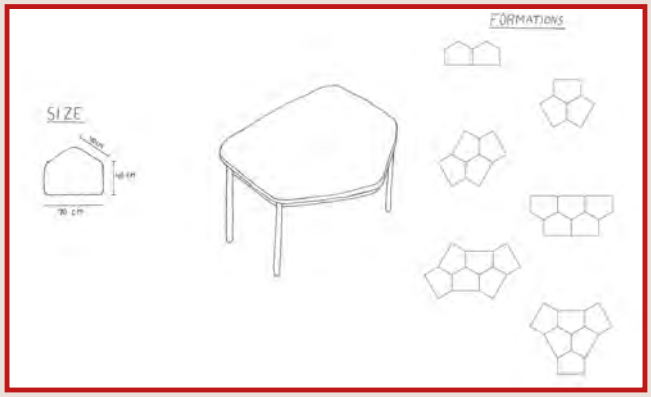
The Chain



Illu. 37: The Chain concept

"Gives the teacher room in the middle, and the opportunity to help more pupils at once."
"Like the rotation option, allows a lot of different shapes."

The House



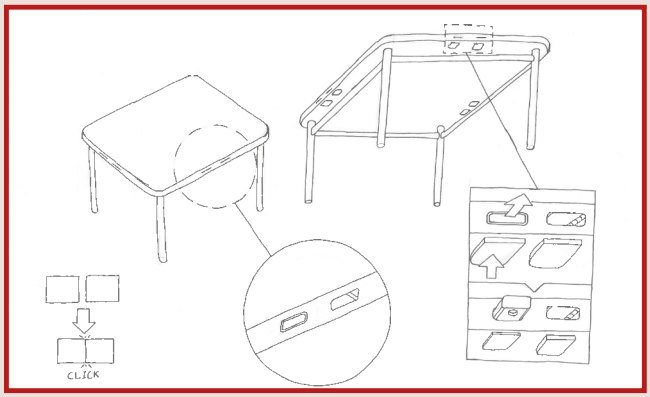
Illu. 38: The House concept

"They come closer to each other."
"I'm worried about the amount of table space for the pupils."

"There is of course a lower limit to how much space they actually need, but if they get more, then they use it."

"The pencil case fits in the apex."

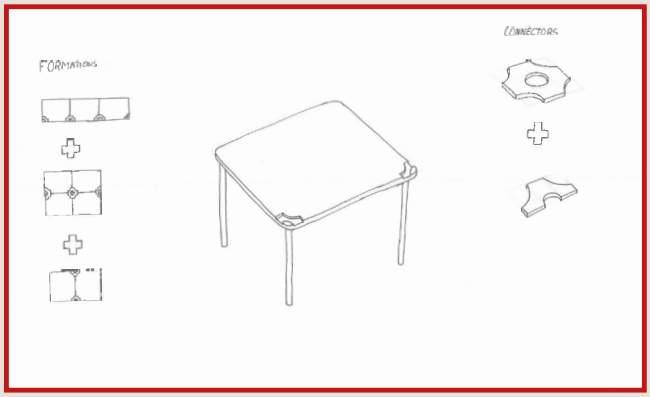
The Connector



Illu. 38: The Connector concept

"I like that the tables are linked together."

The Puzzle



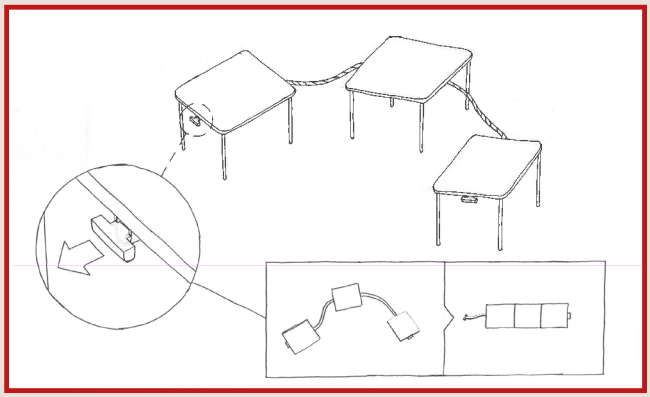
Illu. 39: The Puzzle concept

"Awesome idea... Seems to be the best concept surrounding table formations."

"Things in the classroom that have a designated place, is a help to secure that the pupils always return the things to the right place when they are to not be used."

"It would be necessary with extra puzzle pieces, if they should disappear or depending on what formation that must be used."

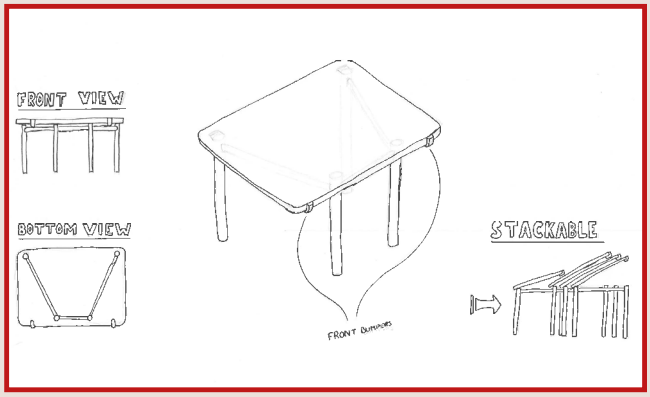
The Jumping Jack



Illu. 40: The Jumping Jack concept

"The rope would not work in the classroom, because **one or two meters isn't enough for them to stop talking to each other**."

The Trolley



Illu. 41: The Trolley concept

"Stuff on the table is inconvenient when the tabletop is tilting."
"It will be the delivering of the message to the pupils that takes time, not the movement of the tables themselves."

Overall feedback

"The kids aren't moving the tables around today and the tables aren't moved every month."
"The tables are clumsy and make a lot of noise, because the pupils aren't strong enough to lift them around, therefore if they move them, the pupils push or pull them."
"There are conflicts between pupils surrounding the 2-person tables space... a consequence of this is that a line is drawn in the middle of the table, either by a pencil or tape."
"The pupil fills out the table space they have no matter the size."
"The noise can be heard at the other end of the school if we begin moving the tables around today."

Conclusion

This feedback gave some insight into which ones of the shown concept could work, where a combination of The Trolley, The House, and The Puzzle would be a viable concept to go forth with.

Supporting Insights

- The teacher is interested in using the classroom as an asset to the lessons instead of seeing it as a limitation.
- The teacher is very hesitant about the physical capabilities of the pupils, as they can't lift the tables.
- The teacher is interested in a table that has multiple layout opportunities in a simple system.
- "There are conflicts between pupils surrounding the 2-person tables."
- The time it takes to "move tables" is mostly spent on delivering a message and then getting the pupils to be silent again. Little time is spent on physically moving the tables.

However, there are still a lot of different unknown variables that need to be known, where especially one of them being the classroom sizes to understand how much space there is for the different formations, and thereby what different geometries can do when put together as 'The House'.

Demands

- The pupil must have their own table.
- The tables should move quietly.
- The tables must have multiple layout opportunities.

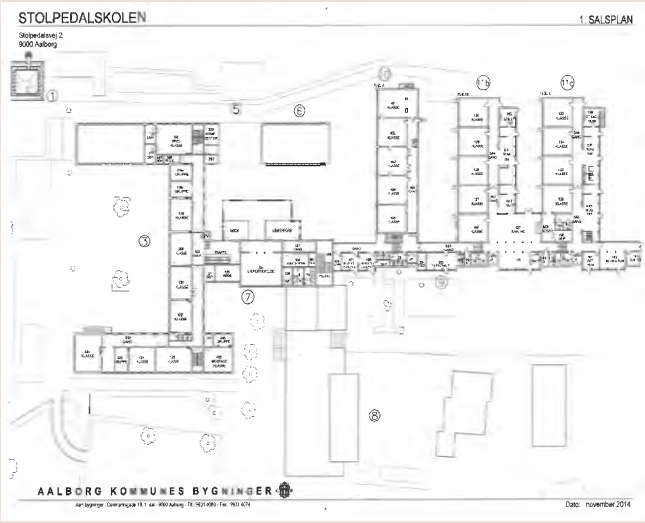
Classroom Size & Table Arrangement

Only a couple of new schools are built in Denmark each year (Stanek, 2023), and must adapt to the new standards and ways of designing an interesting classroom and common rooms. The rest of the schools are built before 2000, where 50% of the schools are built in 1960-70 (Center for Indeklima og Energi, 2016, p. 3). These schools are built after old standards and are still in use. Here it will be important to dive into the sizes of the schools and especially the classrooms where our solution must adapt into. Furthermore, how the tables that are used today can be arranged inside them.

Classrooms sized between 60-65 square meters fall under the category of reasonable-sized classrooms for the ordinary class of 22 pupils, however, this size is seen as insufficient when more pupils are introduced in the classes, where the 70-75 square meters would be more appropriate. (Danish Union of Teachers, 2017). Further the law specific that a class cannot exceed 28 pupils (Skole og Forældre, 2020).

Classroom sizes

The following numbers are calculated or noted from the floor plans of different schools. (illu. 42)

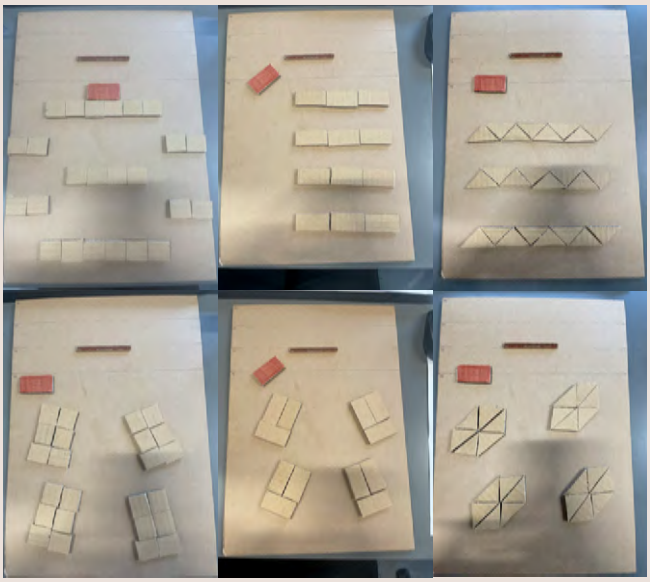


Illu. 42: Floor plan of the Stolpedal puplic school

- Kjellerup public school
  - 50 square meters in the oldest building from 1901
  - 75 square meters in a newly renovated part done in 2006.
  - 60 square meters in a new building from 2020
- Stolpedal public school
  - 67 square meters in classrooms from 1941
- Ulfborg public school
  - Classrooms from 40-60 square meters in building from the nineteenth century

Table Arrangement

Further the table arrangements are modelled to understand what the limitations of space does to the tables seen in the contexts at the three schools: square 1-person tables, rectangular 2-person tables, and triangular 1-person tables (illu. 43). This is done to figure out what each of the table limitations are in the schools today, and what the inventory prioritizes. (Appx. 15)



Illu. 43: Table arrangements with a square, rectangular and triangular tables

Conclusion

The overall conclusion is that the triangle gives a lot of opportunities for different layouts, but the downside is the lack of space for items and all the dead zones it provides. And opposite is the squared table where there is a lot of work surface but lacks the opportunity for more interesting layouts than larger squares. Single tables give more freedom with different layout opportunities but are a bit larger per person than 2-person tables. Tables placed along the wall or in a U-shape leave a lot of space for other activities in the middle of the room. This must be used to create a tabletop geometry that better fulfills the necessary layout opportunities for the teacher to use it actively in their lessons.

Demands

- Must not take up more space than the solutions today.

Geometry Study & Workspace

This section aims to understand what the geometry of a tabletop can provide to guide and give opportunities when changing between activities, where working groups can change from single up to 6 pupils. The study is based upon tables seen at the school and research online on alternative shapes for a table. By the end of this section a definition of the tabletop's geometric expression is decided. (appx. 16)

The parameter for a good geometry is:

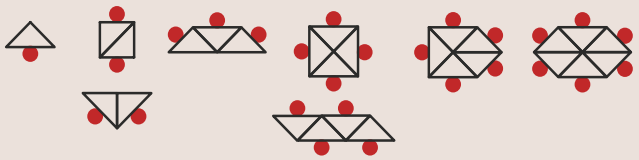
- Does the geometry fill out the space when placed together or does the geometry create dead zones in the classroom?
- There is room for the one pupil's stationery.

The tables included in this study are square, triangular (isosceles and equilateral), 3.4.5-tables (IA France, 2024), trapeze, and circular-square (illu. 44 & 45). See appx. 16, for specific insights for each table type

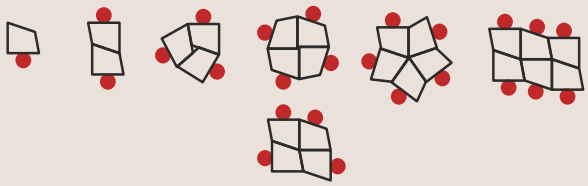
1-Person Table

Rectangular

Isoceles Triangle

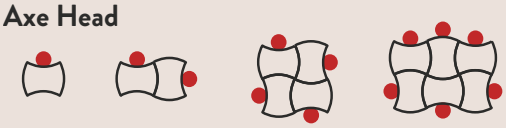


3-4-5 Table



Equalateral Triangle

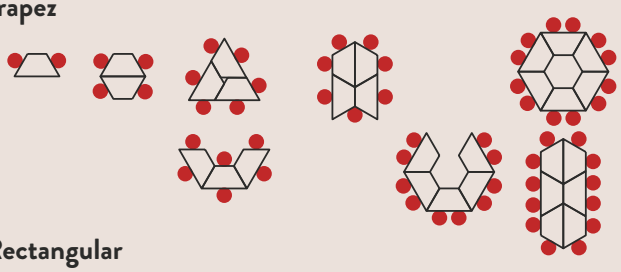
Axe Head



Illu. 44: Different group constellations with different 1-person table types

2-Person Table

Trapez

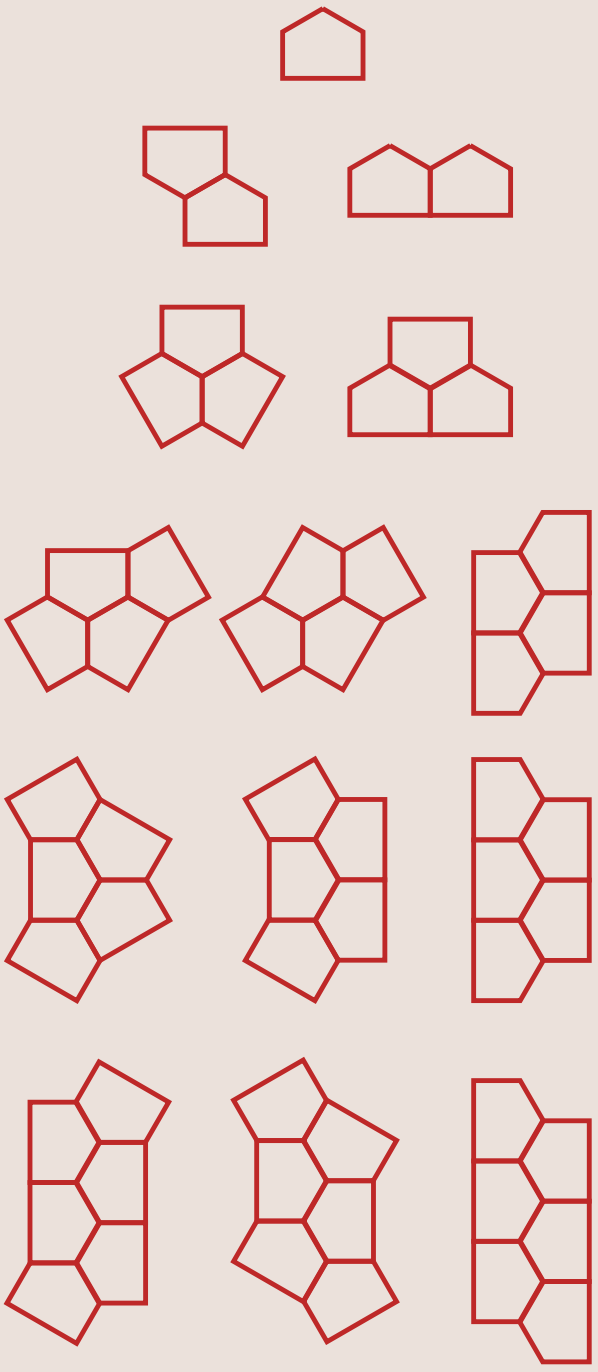


Rectangular

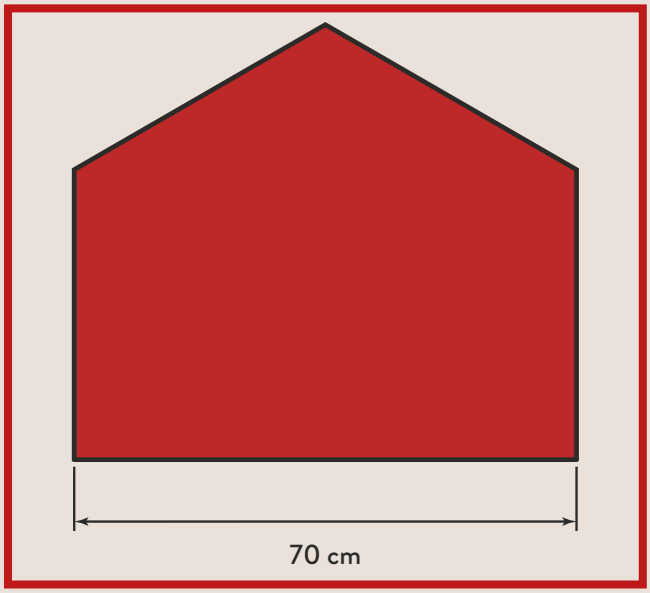
Illu. 45: Different group constellations with different 2-person table types

- Dead zones have been observed being used as placement for the schoolbag in the context.
- None of the geometries have a primary side when standing alone.
- Triangles are wider than a normal square table because they need to have the same amount of workspace as a square.
  - The problem is the work surface is thus poorly utilized.
  - And they will take up space from each other when clustered, because multiple triangles result in a slightly larger regular square table.
- Isosceles triangles are more efficient in a classroom compared to equilateral.
- Triangular tables can bring the pupils closer to each other in group work.
- A triangle end can give an orientation to guide the different setups.
- 1-person tables provide better opportunities for layouts than 2-persons tables.
  - Fit for solo and even group sizes.
  - Fit in a class with both even and uneven numbers of pupils.
  - Each pupil has a relation to a table

From the before-mentioned pros and cons of the existing table geometries on the market, a tabletop geometry has been created that suits the criteria (illu. 46 & 47):



Illu. 46: Constellations with the chosen tabletop geometry



Illu. 47: The chosen geometry for the tabletop

Conclusion

The gained insight from the study has resulted in a new geometry that combines the best opportunities from especially the triangle and squared table. The table geometry will then fulfill.

- High Working Surface: The workspace is utilized by keeping most of the tabletop as a square.
- Angled Side: Introducing an angle deviating from the conventional 90 degrees enhancing the table's layout opportunities.
- Symmetrical Geometry: A meticulous balance like the Isosceles triangles and squares ensures a uniform geometry that eases the layouts.
- Uniform Side Lengths: Consistency in the side lengths across all four front sides minimizes confusion during table arrangement, fostering seamless integration into various layouts.
- Directional: Incorporating a triangular end serves as a clear directional indicator, guiding users to place the tables correctly.

Demands

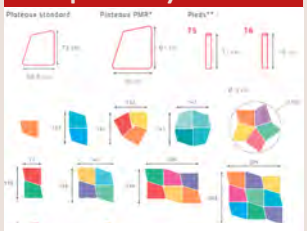
- Must fit into one 1 to 6-person groups.
- Must follow the 1-person tables width of 70 cm

Choosing the Right Features

Stackable

Mobility

Adaptability



Footrest

Connectors

Height Change

Visual Screen

Bag hook

Extra Storage

Color

Noise Cancel

Wheels

2-in-1

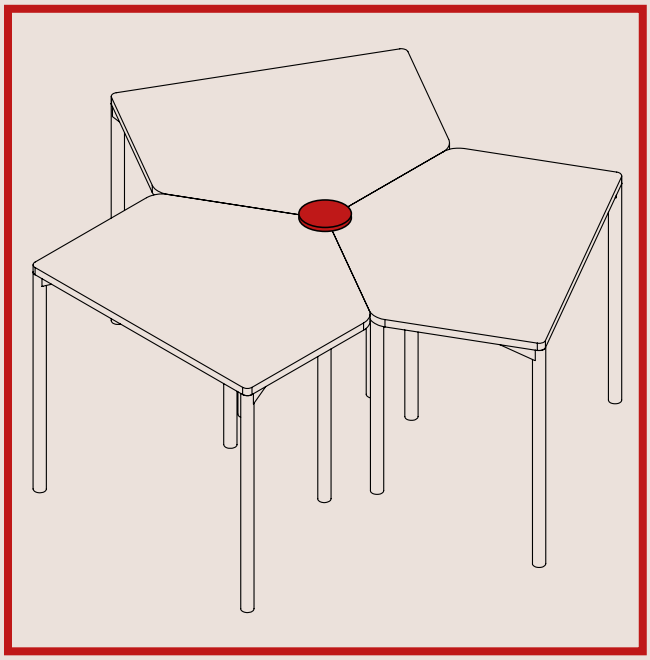
Angular surface

Illu. 48: Different products with specific features on the market

From the features seen on the market (illu. 48) and what the empirical data from the school visit suggests, there is no need for 15 different features in one table as this would be “the dream” that is not actually useful. Therefore, based on a combination of the three concepts, a list of what features are needed and what are nice to have, is made to specify the most relevant features for the project going forward. (appx. 17)

How to Combine?

From this chapter the solution space has been narrowed down to a table that can be stacked without being lifted, can be put together in groups of one to six, and thereby be connected to form a bigger coherent table. The table must conform to the features specified in the earlier section and try to maneuver around and thereby minimize the chances of the non-features happening, furthermore, the table must try to influence some non-avoidables positively during the school's day (illu. 49). By combining all these aspects into one design, the concept detailing can now begin.



Illu. 49: Combined concept

Features

Need to have

- Stackable
- Mobility
- Stationary (new)
- Adaptability
- Pupils can do it (new)
- Connectors

Two new features are being added, as it is not explicit on the market, and these two new features are deemed essential for the final concept to work.

Nice to have

- Color
- Height Change

Add-on Products

- Visual Screen
- Bag hook
- Noise cancel
- Footrest
- Wheels
- Extra Storage

Deemed Unnecessary

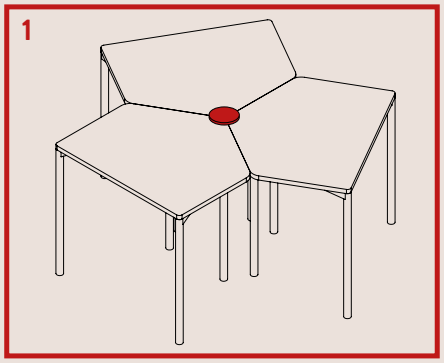
- Angular Surface

The nice to have features are cosmetics and add-ons that can potential be implemented later in the process, if they are deemed to provide an addiction layer for the user experience without overcomplicate the table.

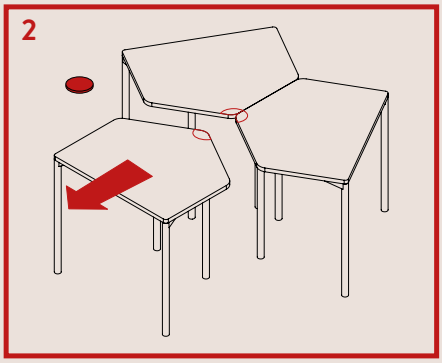
Demands

- Must be stackable
- Must be stationary when the pupils sit at the table
- Must have a physical or visual connection

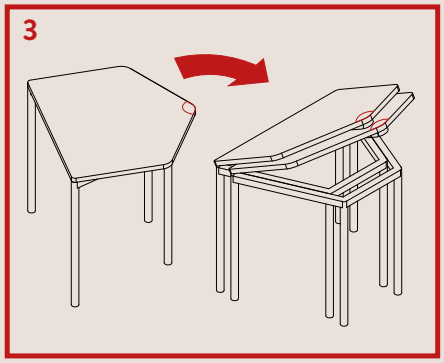
Dream Scenario



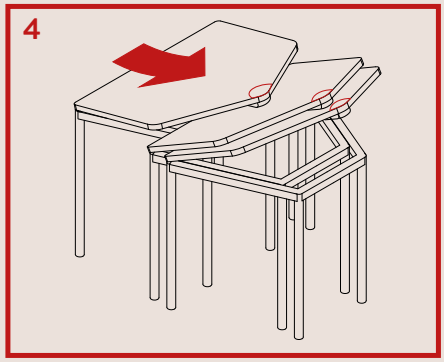
Tables are connected together.



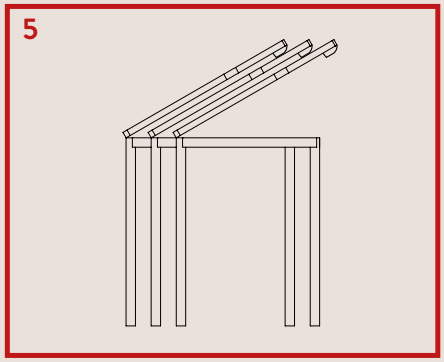
The connector is removed, and the tables are moved.



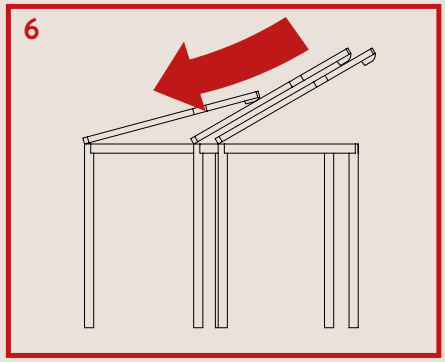
A table is pushed over to get ready to stack.



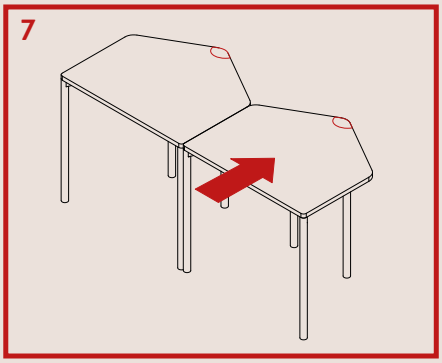
The tables are stacked.



The tables are stacked to make room for floor activity in the classroom.



The tables are taken out to get ready for board education.



The tables are put together in a new formation.

Illu. 50: Storyboard with the combined concept

Design Brief 2.0

Problem Statement

How can a classroom furniture be designed to promote flexibility and allow for a smooth transition between different learning environments, fostering dynamic teaching methods for pupils?

The learning environments is defined as board, solo and group work. Lastly also free space in the classroom is the fourth option to solve.

Features

- Stackable
- Mobility
- Stationary
- Adaptability
- Pupils can do it
- Connectors

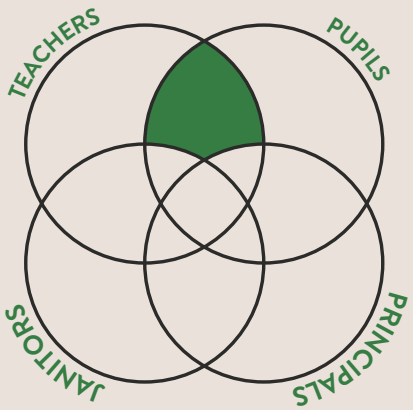
Non-Avoidables to Influence

- Noise Level
- Concentration and Focus Time
- Pupils Need to Move Around in the Class
- Use of space for Books, PC, etc.
- Bags are Left On the Floor

Aim

The aim is to create a product that focuses on the teachers and the pupils, that can create a cultivating environment for learning and growth and bridge the gap between the dream and the reality. Additionally, the table seeks towards creating Non-Features that minimizes unattractive situations that appear in today's classroom and focuses on features that can evolve the way teachers and pupils interact within the classroom.

Target Group



Illu. 51: Venn diagram of where the project is aimed

Non-Features:

- Fast Moving Furniture
- Time Spent Preparing for Activities
- Minimizing Play in Changing the Furniture
- "Crawling" Furniture

Illu. 52: The golden mean between dream and reality

Demands

1. One person must be able to move it (Direction) ->
   a. must be able to be moved by a 1.grader (School Visits)
   b. must be able to work in 1. To 6. Grade (School Visits)
2. Must be able to withstand daily use (Direction)
3. Must be able to be disassembled into the different materials (Direction)
4. Must have a long lifetime (Context)
5. Must take up less space than current solution (Context)
6. Must be in the “normal” prize range (Context)
7. Must minimize time on repair and maintenance (Context)
8. Must fit into already existing classrooms (Context)
9. Must be able to function in board education, individual work and groups (School Summary) -> Must be able to adapt to the four activities used by the teacher; Board, individual, group and floor education (School visits)
10. Tabel must fit into 1 to 6-person groups (Geometry Study & Workspace)
11. Must fall under one of the SKI categories (Tender Acts & Economy Structure)
12. Must comply with the current industry standards – DS/EN-1729 (DS/EN Standards)
13. Must be able to change layouts through a lesson (Learning Environment)
    a. The change must be done quickly (School Summary)
    b. The table should move quietly (Sketching Round 2)
14. Pupil must be comfortable when using the furniture (Learning Environment)
15. The teacher wants to adjust the furniture as little as possible (Context) -> The height of the table must be fixed (School Visits)
16. The furniture should have a set of predefined opportunities when switching between the activities (School Visits) -> The table must have multiple layout opportunities (Sketching Round 2)
17. The workspace must have the opportunity to have both books and PC at the same time (School Visits)
18. Must deliver the same opportunity to every pupil (School visits) -> The pupil must have their own table -> Must follow the 1-persons tables width of 70 cm (Geometry Study & Workspace)
19. The transformation between constellations cannot take more than XX minutes to executed from delivering the message to the pupils sitting down in the new formation (Non-Features & Behaviors)
20. Must not take up more space than the solutions today (Classroom Size & Table Arrangement)
21. Must be stackable (What Features do we provide?)
22. Must be stationary when a pupil sits at the table (What Features do we provide?)
23. Must have a physical or visual connection (What Features do we provide?)

Wishes

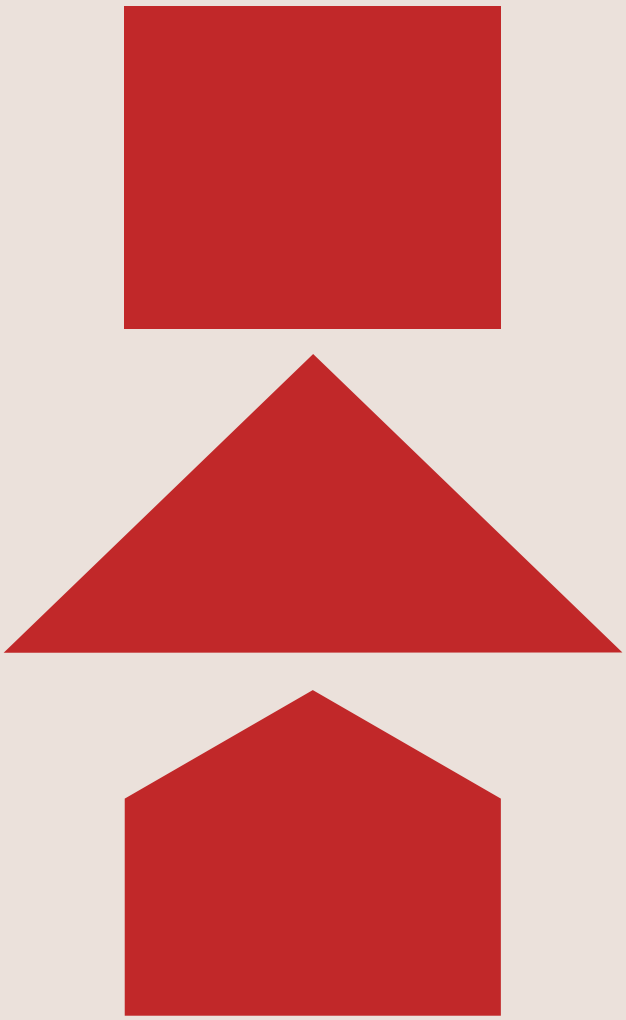
1. Give the pupil the opportunity to focus individually by limiting the visual peripheral (School visits)
2. The furniture must be able to cancel out noise for the pupil (School visits)

Chapter 3:
Concept Development

This chapter is maturing the concept presented in the earlier chapter, this is done by examining each aspect in the concept i.e. stacking, workspace and tilting, and figuring out how it can be obtained. Lastly an updated design brief is presented.

Available Workspace

The chosen pentatonic geometry, that makes it possible to challenge the layout opportunities in today's classrooms, must be tested upon the available working area for the pupils' utilities. A study is made upon the original geometries that have been seen at the schools; the square and the triangle table, to compare the available space against the pentatonic geometry (illu. 53). (appx. 17)



Illu. 53: Different tabletops that are being tested on

Models of pupil utilities (appx. 17) has been made to understand how much space each item takes on a table, the following items will be used in this study; an 11,6 inches PC, an A4 book and a pencil case (2 different sizes). And in the higher classes a notebook is also seen.

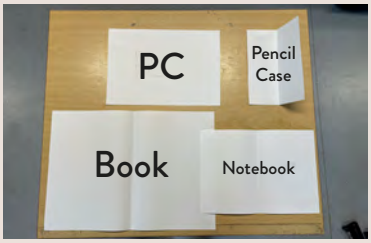
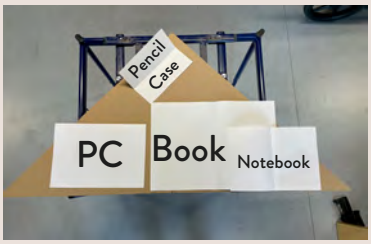
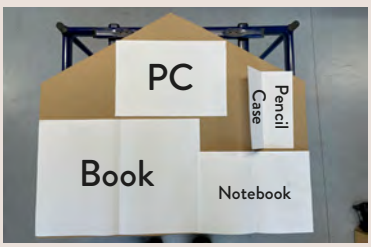
Open items
3. grade & up




Table 1: Overview of open items on the three tabletops

The study shows that the squared table has space for all items, where its opposite for the triangle table. The triangle table is especially challenged in groups because the pupils cannot let their stuff hang off the table (table 1).

The Pentatonic geometry, even when having a triangle front, can have all items by rearranging them at bit. It's possible because the overlap between the tables is smaller than the triangles and there are 40 cm before the triangle starts. The chosen angle also makes it possible to have a book in front of you and a smaller pc behind that, as observed in the context.

Conclusion

As seen, the pentatonic geometry meets the requirements to have the pupils' items on their own table and thereby validates it to be used as a geometry for the tabletop. The tabletop will then have both the ability to give many different layout opportunities and still doesn't compromise the workspace.

How to Stack

Tables are currently stored by pushing the tables aside in the classrooms. And because the classroom sizes today aren't that big, it takes up a lot of floor space from the main activity in the classroom. Different stacking approaches were investigated to achieve efficient staking and thereby reduce the table's footprint in the classroom.

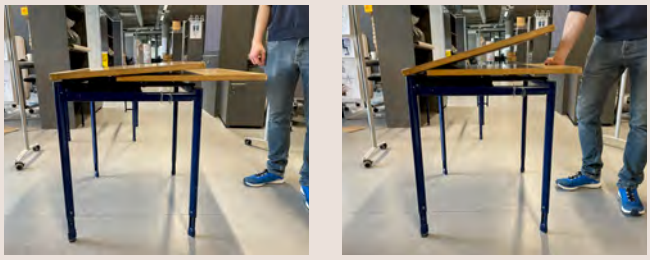
The most efficient method was found to include a rigid trapeze frame with a tiltable surface.
This design enables users to stack the tables without having to raise them. (appx. 18)

A test is conducted to verify the feasibility of the chosen approach of stacking the tables. This test will define where the tilting point must be located to ease the interaction for the user and reduce the wear on the tables (illu. 54).

illu. 54: Different stacking solutions

Stacking from the front

This means that the tables that are already stacked are raised, instead of the ones being pushed into the stack, when the user is stacking the next table. The tabletop is thereby raised closer to the hinges, creating a significant amount of counteracting momentum. It makes stacking the tables very challenging because every table in the stack must be raised by the table being pushed. An additional finding is that the wear is most noticeable on the front edges of the table (illu. 55).



illu. 55: Test of stacking from the front

Stacking from the back

When stacking from the back, the user only interacts with the ones they are supposed to elevate because the others are already lifted in the stack. The lifting point is now in the front of the table far away from the hinges making the counteracting force weaker.

This makes stacking the next table much easier than using the first method. Another observation is that the tabletops must have a locked stacking angle if they are to be stacked correctly and not overload the table in front with unnecessary weight from the tabletop. If there is a locked stacking angel a need for a locked working angle, as one of the pupils' non-avoidable behaviors is that they tinker, and thereby minimizing what they can tinker with. (illu. 56)

Also observed in the test, the frames can't come close enough to each other so that the tabletops have the same angel. To make sure the angles are the same a spacer under the tabletop must be added to lift the tabletop enough to lock it in the desired stacking angle. The spacer must also be utilized to reduce friction on the tabletop, allowing for easier stacking and decrease wear. (illu. 56)

illu. 56: Test of stacking from the back

Conclusion

It is decided that the method is stacking from the backside, because it seems to ease the stacking of the tables, without complicating the process. This is because the principal ensures that all tables are stacked the same way every time and not based on how much the pupils are pushing from the front. At the same time the pupils will interact at the side they already are sitting at. Further, must a spacer be developed to make the stacking principle possible.

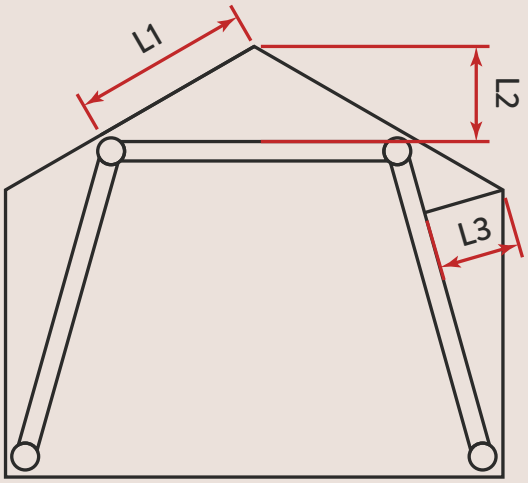
Demands

- The tilting point must be placed at the backside of the table
- A group of 6 tables must be stacked within the space of 2 60x70 cm tables
- The tabletop must be locked in an angel when stacked and when pupils are using it.
- A spacer must secure a distance between the tabletops when stacked

Frame Study

After deciding to use a trapeze frame structure, the overall expression must be defined with the function of stacking a large number of tables as the focal point. The study will focus on trapeze leg positioning, with the back legs placed in corners of the table for optimal support. So, in the study, the front legs will change position while still following the table's contours, as would the back legs; the position will then be adjusted at a 50mm interval. All legs are placed 5mm in from the edge of the tabletop. (illu. 57)

The assumption is that the most stable frame structure is if there is the same amount of overhang in the three corners This means that none of the corners will be more exposed for tilting than other corners.



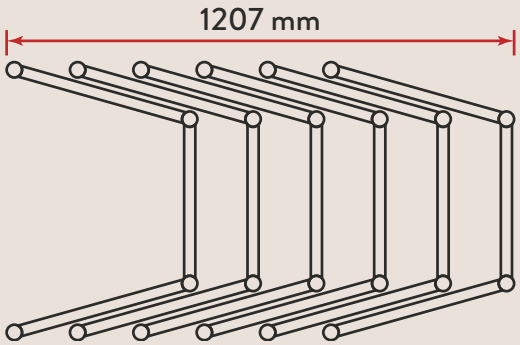
L1	L2	L3
100 mm	50 mm	167 mm
150 mm	76 mm	150 mm
200 mm	100 mm	128 mm
250 mm	126 mm	103 mm
300 mm	150 mm	72 mm

illu. 57: Overview of what is changed doing the test and numbers accordingly

As seen in the illustration (Illu. 57) the distances to the front (L2) move by approximately 25mm when adjusting the legs position (L1) with the 50mm interval. The best distance from the front to secure the equal distance between the three front corners will therefore be between distance 200mm and 250mm from the leg to front (L1). The distance for both L2 and L3 to the corners will then be 115mm if the legs are placed with 227,5mm from the front corner (L1).

With the desired placement of the front legs the table can almost be stacked within the two tables that is demanded. However, it has not been considered that the tabletops are tilted up when they are stacked, which will mean that they take less space than shown here (illu. 58).

Also, the fact that the tables are stacked perfectly with the exact same space between them. This will not necessarily happen in the context. Therefore, a need to guide or protect the frames against each other could be investigated. Because it's a tight fit with only 6mm between each of table frames.



illu. 58: Stacking depth with this frame dimension

Conclusion

The overall frame size is specified to comply with the demand 21B of stacking distance, but there are still dimensions that haven't been decided that influence the stability and strength of the table. The dimensions are meant to follow already existing tables from the competitors on the market

The assumption for equal spacing must be tested to clarify if it can comply with Demand 12 (DS/EN standards). And thereby finalizing the frame structure's overall dimensions before making the aesthetic choices.

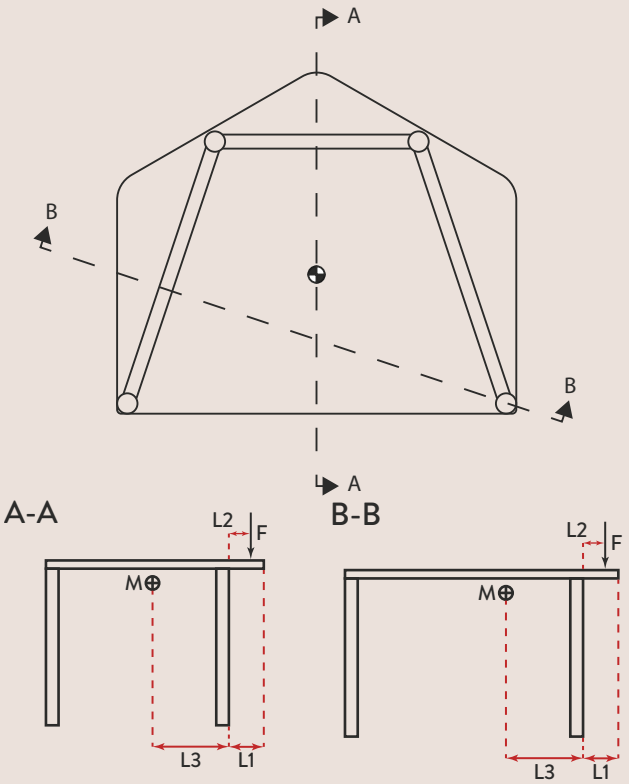
Another aspect of the leg profiles is if they can help to guide the stacking as seen with the prototype, that are made by repurposing some old Helle-tables from Stolpedal public school. They help because they have rectangular table legs angled inwards, and thereby guide the table in place.

Tilting Study

The three corners at the front of the table are equally exposed when in use, because they all have the same overhang. It is therefore necessary to clarify if all three corners can comply with demand 12 (DS/EN standards) and more specific;

The crucial aspect is *"All tables shall be tested in accordance with EN 1730:2012, 7.2, with a distance of 50 mm from the edge to the loading point and a vertical force of 600 N"* - section 7.1.2 in DS/EN 1729. The data put forth beneath is calculated by using Equilibrium equations from static mathematics. (appx. 19)

Equal spacing



	L1	L2	M	L3	F
A-A	117 mm	67 mm	123 N	223 mm	408 N
B-B	117 mm	67 mm	123 N	252 mm	460 N
The scenario is not up to par with the Standards					

illu. 59: Diagrams and calculations over equal spacing

The pentatonic geometry' overhang is too large for it to become approved by the standards. (illu. 59)

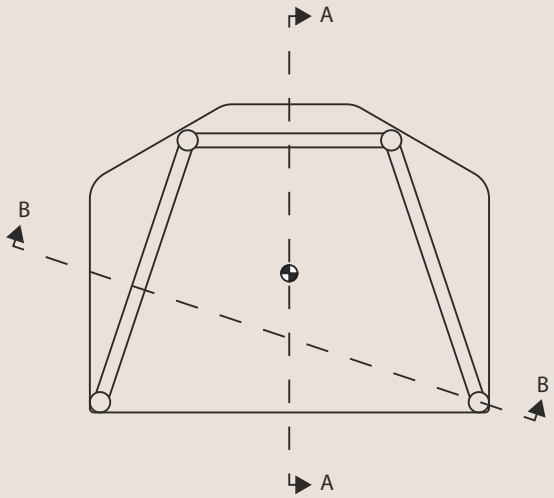
What If...

The Legs are moved?

By moving the legs and thereby the overhang, there is no scenario where this would make a shape up to par with the standards, as one of the two directions would become weaker, and therefore never move above the 600 N threshold.

Therefore, a new shape of tabletop must be thought up, as the project can't continue with this shape.

The Front is cut?

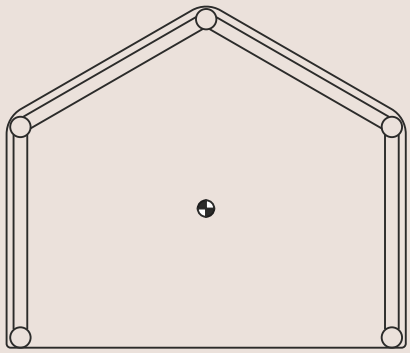


	L1	L2	M	L3	F
A-A	66 mm	16 mm	123 N	217 mm	1706 N
B-B	102 mm	52 mm	123 N	267 mm	627 N
The scenario is up to par with the Standards					

illu. 60: Diagram and calculations where the front is cut

By cutting the front corner away, the overhang is significantly limited, and thus a tabletop shape makes the table live up to the standards, however it is not yet known if this shape is desirable for use (illu. 60).

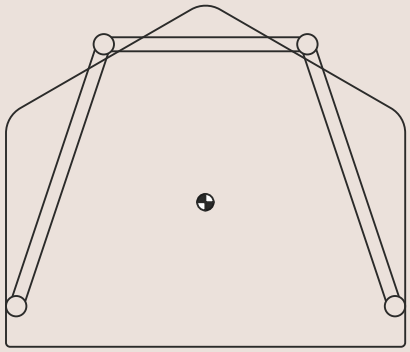
An extra leg is added?



illu. 61: diagram of adding an extra leg

As the load is being applied 50 mm from the edge of tabletop (from DS/EN standard), then if the loading point is inside the frame, it is not a question of tilting but a question of strength, and therefore it would pass the test of stability. A disadvantage with this solution is losing stacking, as the legs would collide. (illu. 61)

The tabletop is moved backwards?



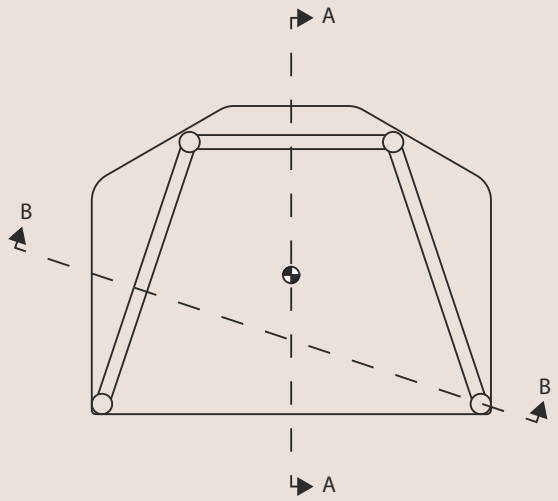
illu. 62: diagram of moving the tabletop backwards

This solution isn't viable for the concept to work, as the frame goes beyond the tabletop, and makes it impossible for the needed formations to take place (illu. 62).

Conclusion

After considering different opportunities and different tabletop shapes (appx. 20), the result is to use the second option, cutting the front end.

Further, the optimal length to the corners is then calculated, so regardless of which corner is affected, no corner is more exposed than the others.



	L1	L2	M	L3	F
A-A	94	44	123 N	217 mm	603 N
B-B	102 mm	52 mm	123 N	267 mm	627 N
The scenario is up to par with the Standards					

illu. 63: Diagram and calculation over the final solution

Here the two overhangs are adjusted to fit comply with the standard, so that the table can pass the tests. This means that the overhang in the front should be 94 mm and 102 mm at the sides. The table depth is then reduced by 2 cm compared to the pointed edge. There will still be space for the school items, because the tables aren't reduced significantly. When working further with the new geometry it must be confirmed if this shape is desirable by the users. Secondly, when the four sides aren't equal anymore if it is still understandable how to make the different layouts. (illu. 63)

Mobility & Stationary

The movability is a key to changing the layout during a lesson, and because the users are children down to the age of 6, it cannot be too complicated and heavy to move. Therefore, an investigation into moveable solutions to ease interaction for the children is made. The solution must fit into the legs because that is what contacts the floor. (Appx. 21)

With insight from the earlier school visits, it determined that the solution must solve the following issues when changing the layout:

- The floor gets scratches.
- It is very loud in the classroom.
- The tables are heavy to move.
- They cannot lift the table by themselves

This study is done to find a solution that can obtain the desired results that demand 1A, 13, and 22 need.

Possible solutions

Office wheels

illu. 64: Office Caster

- External castors can easily be changed if damaged and are generally larger, so dust, dirt, and other things from the floor isn't a big issue.
- If brakes are installed, access to them will be outside the leg and the interaction must be within reach
- The table will be stationary with only two castors with brakes, meaning they cannot rotate in any direction.
- With the use of 360-degree wheels there is full movability when the tables must be stacked or create a new layout.

Inside wheels or ball bearing wheels

- The main problem with internal wheels is that they collect dirt, dust, and other debris from the floor, which results in the wheel becoming clogged and losing the ability to move. It will therefore require that they are cleaned to maintain their functionality.
- The get pushed up into the leg if overloaded, making them useless.

illu. 65: Ball bearing wheel and a wheel inside the tube

Sliders shoes/nails or vibration absorber

illu. 66: Slider shoe and a vibration absorber

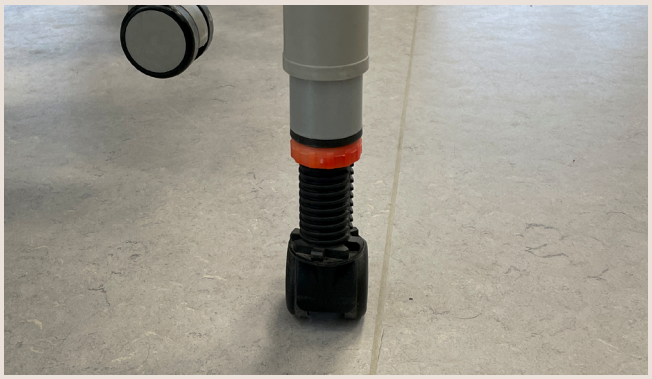
- The different types of materials reduce friction between the legs and the floor. This influences how much noise and how easy the movement is and the wear on the sliding shoes.
- The main problem is that there is still friction, meaning the leg is always slightly behind causing vibrations is tries to catch up and thereby noise.
- A test has shown that even if the material has low enough friction, it easily collects dirt and dust, increasing friction, resulting in damaging the floor and making noise.

Conclusion

The best solution to use is the 360-degree office castors that make the movement very easy for the pupils. And by adding brakes to two of the castors the tables can be secured to not move when they are used as stationary tables. The brakes will be attached to the castors placed on the back of the table as these are closer to the user for the best interaction opportunity. The castors will be attached as a removable part to the leg.

Height Adjustments

Demand 15 determines that the height must be fixed, because it has been observed that tables in classrooms look like ocean waves. This happens as the table legs have individual height settings resulting in an uneven tabletop (illu. 67). At the same time, the janitor wants to have one height of tables in a classroom, where pupils can't change the height by themselves, but just adapt to the table's height with adjustable chairs (appx. 22). Along with the option to make different layouts in the classrooms, all tables must be the same height, so it always will be possible to stack them.



illu. 67: Images for the solution to height adjustment today

How to decide the heights

Another aspect is that the height must be comfortable for the pupil, as mentioned before the pupil can adjust their chair to fit the table perfectly. So, when looking at the DS/EN sizemarks for pupil tables, the final solution must fall under one of the 6 sizemarks.

The sizemark 3-5 (illu. 68) is within the ages of school pupils in the project scope. Additionally, the intervals have a tolerance of +/-20mm that can expand their range. The solution therefore could be multiple heights that jump 5-6cm.

Competitors takes on heights

When looking at the competitors on the market their tables are overall in the sizemarks ranges, but there is a difference in how many heights and which they offer for one table. Højer is in the high end of the range and only give the opportunities 72-74-76cm (Højer Møbler, 2024). Opposite is Lekolar with the entire sizemarks range, 55-60-65-72cm as fixed height or the opportunity to adjust it from 50-72cm as they must see the option to adjust your height with the chair a necessity (Lekolar, 2024).

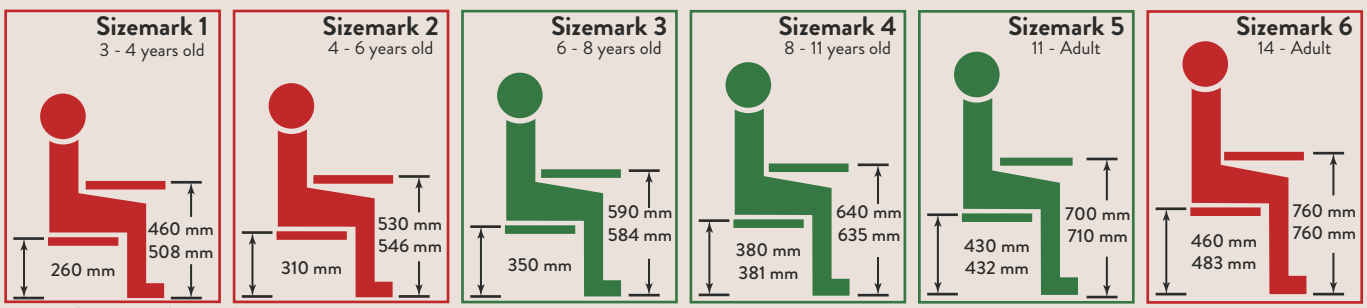
Conclusion

The chosen solution is the fixed heights of 60-66-72cm that follows both the sizemarks and especially Lekolar' span of opportunities, because Højer Møbler' table heights are seen too high when designing for children in grades from 1.-6. grade.

To ease the job for the janitor any mechanism to adjust table's height is not included.
The table will come in 3 different frame heights that are fixed, where the pupils then can adjust to the tables with their chairs.
This also ensures that all tables in a class will be the same height and thereby allowing them to stack.

Demands

- Must have 3 different fixed heights of 60, 66 and 72 cm



illu. 68: Overview of the different sizemarks

Visual Aid for Direction

After cutting the front of the tabletop there is an uncertainty if the sense of direction the table had has been lost, therefore a study upon implementing a visual indicator to help the pupils understand the orientation of the table. This is done by creating different versions of the tabletop with a color indicator. (illu. 69)

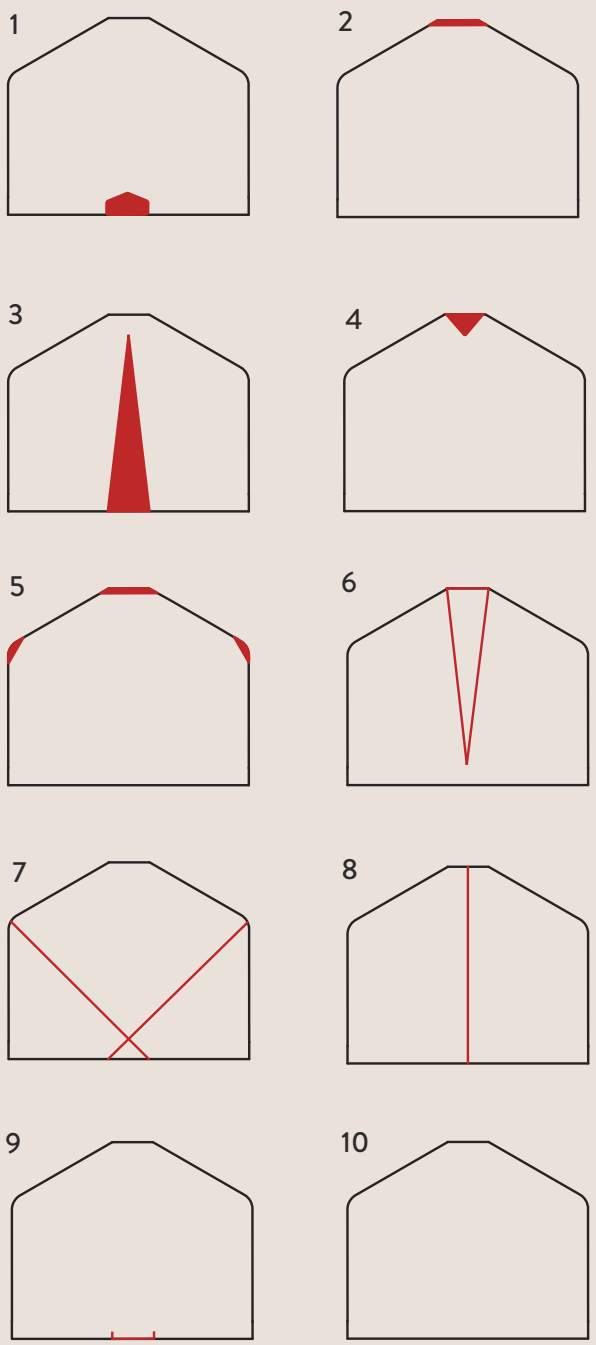
Thoughts

- If there must be a visual guidance its most important on the back end, where the front geometry will fit to the visual area of the stacked table.
- A combination of no. 1 and 4 will give a total guide for hitting the stacking correctly as both front and back of the tabletop will be marked by color and geometry that fits together.
- The thin lines on no. 6-8 don't disturb as much compared to larger painted geometries.
- A smaller visual indication is more subtle, and thereby not rob focus, such as no. 2 and 9
- As there is a need for a lock to secure the work surface, there is an opportunity to give some feedforwards, as it cannot be lifted before you hit the table in front correctly.
- And lastly, if the table is coming from an angle, the trapeze frame will guide the table, straightening it out.

Conclusion

It will not be necessary to incorporate a visual indicator as it will disturb more than guide the pupils, and as the tabletop shape has only been cut by 2 cm, it can be assessed that the shape still has direction incorporated. At the same time, it will be seen as a nice to have feature on the tables. Therefore, it's concluded that the combination of the trapeze frame and the tabletop shape provides all the direction the table needs.

If meant to be implemented as guideline, a study on the aesthetic part has also been made in appx. 23.



illu. 69: Different visual aid solutions

Design Brief 3.0

Preliminary Conclusion

Through this chapter enough knowledge about the concept has been obtained and that it is possible to challenge the school table to this degree. Furthermore, the stacking aspect of the concept and its consequences for the construction of the frame, is possible to incorporate into the final design proposal as it lives up to the DS/EN standards. Moreover, the different areas of concern such as if there is enough working space available on the tabletop and ensuring that stacking is possible in all classrooms has been addressed.

Problem Statement

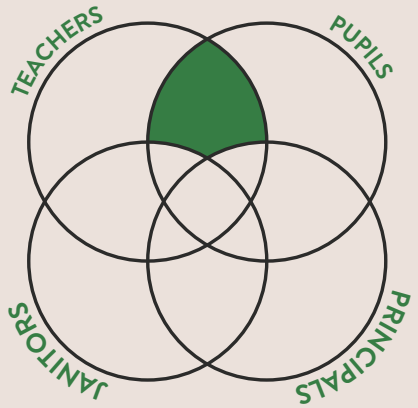
How can a classroom furniture be designed to promote flexibility and allow for a smooth transition between different learning environments, fostering dynamic teaching methods for pupils?

The learning environments is defined as board, solo and group work. Lastly also free space in the classroom is the fourth option to solve.

Aim

The aim is to create a product that focuses on the teachers and the pupils, that can create a cultivating environment for learning and growth and bridge the gap between the dream and the reality. Additionally, the table seeks towards creating Non-Features that minimizes unattractive situations that appear in today's classroom and focuses on features that can evolve the way teachers and pupils interact within the classroom.

Target Group



illu. 70: Venn diagram of where the project aims

Features

- Stackable
- Mobility
- Stationary
- Adaptability
- Pupils can do it
- Connectors

Non-Features

- Fast Moving Furniture
- Time Spent Preparing for Activities
- Minimizing Play in Changing the Furniture
- "Crawling" Furniture

illu. 71: Golden mean between the dream and reality

Demands

1a. Must be able to be moved by a 1. grader (School Visits)
1b. Must be able to work in 1. To 6. grade (School Visits)
2. Must be able to withstand daily use (Direction)
3. Must be able to be disassembled into the different materials (Direction)
4. Must have a long lifetime (Context)
5. Must take up less space than current solution (Context)
6. Must be in the "normal" prize range (Context)
7. Must minimize time on repair and maintenance (Context)
8. Must fit into already existing classrooms (Context)
9. Must be able to adapt to the four activities used by the teacher; Board, individual, group and floor education (School Visits)
10. Must fit into 1 to 6-person groups (Geometry Study & Workspace)
11. Must fall under one of the SKI categories (Tender Acts & Economy Structure)
12. Must comply with the current industry standards – DS/EN-1729 (DS/EN Standards)
13. Must be able to change layouts through a lesson (Learning Environments)
  a. The change must be done quickly (School Summary)
  b. The table should move quietly (Sketching Round 2)
14. Pupil must be comfortable when using the furniture (Learning Environment)
15. The height of the table must be fixed (School Visits) -> Must have 3 different fixed heights of 60, 66 and 72 cm (Height Adjustment)
16. The table must have multiple layout opportunities (Sketching Round 2)
17. The workspace must have the opportunity to have both books and PC at the same time (School Visits)
18. Must follow the 1-persons tables width of 70 cm (Geometry Study & Workspace)
19. The transformation between constellations cannot take more than XX minutes to executed from delivering the message to the pupils sitting down in the new formation (Non-Features & Behaviors)
20. Must not take up more space than the solutions today (Classroom Size & Table Arrangement)
21. Must be stackable (What Feartures do we Provide?)
  a. The tilting point must be placed at the backside of the table (How to Stack)
  b. A group of 6 tables must be stacked within the space of 2 60x70 cm tables (How to Stack)
  c. The tabletop must be locked in an angle when stacked and when pupil are using it. (How to Stack)
  d. A spacer must secure a distance between the tabletops when stacked (How to Stack)
22. Must be stationary when a pupil sits at the table (What Features do we provide?)
23. Must have a physical or visual connection (What Features do we provide?)

Wishes

1. Give the pupil the opportunity to focus individually by limiting the visual peripheral (School Visits)
2. The furniture must be able to cancel out noise for the pupil (School Visits)

Chapter 4:
Funtional Detailing

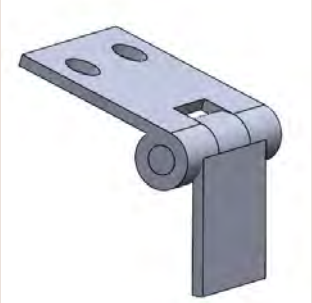
This chapter dives into the functions of the table by investigating different solutions to each of the functions. A school visit is done again to understand what benchmark values the table aims to improve. The prototypes are presented to teachers and Højer Møbler, lastly a storyboard is presented to visualize what the table is going to do.

Elevating the Tabletop

As the table is going to be stacked the tabletop must move out of the way as the frames overlap. To elevate it a mechanism must be added between the frame and the tabletop. This section therefore aims to define what type of hinge this is going to be used and how it is integrated. (Appx. 24 & 25)

Hinge type

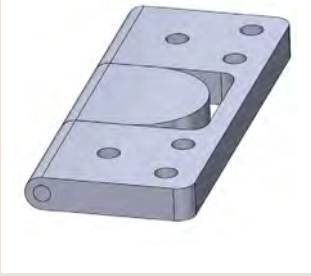
Butt Hinge



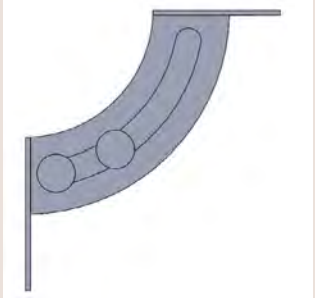
Deck Hinge

Pipe Hinge

Flush Hinge



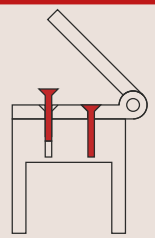
Limited Slider Hinge



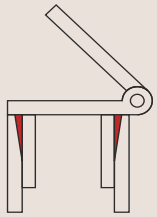
illu. 72: Different hinge types

Mounting Type

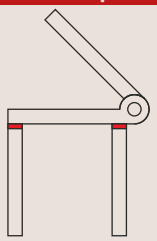
Machine Screw



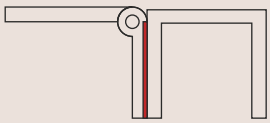
Interference Fit



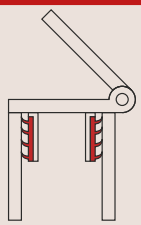
Welded on top



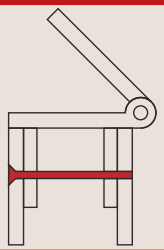
Welded on side



Plug



Set screw



illu. 73: Different mounting types

Conclusion

The solution that is chosen is the butt hinge with the hinge welded on the frontside of the legs (Illu. 72 & 73).

As the rotation point is moved forward, the back edge is lowered for easier stacking, however it must not be so low it clashes with the apron on the other tables.

The hinge is welded on as there are fewer parts that pupils break loose, and the cost would be cheaper than the other solutions.

Stacking angle and spacer

The table must have a stacking angle that eases stacking for the pupils. This is tested to define the stacking angle that best suits the table. This is first done in relation to the stacking distance that must comply with demand 21B. This means that two tables have 12 cm between the same point on each table in the stack. (Appx. 26) This will decide the thickness of the spacer between the stacked tabletops.

Test of Stacking angle in SolidWorks

Here the tabletop is connected at the back of the legs – as far back as possible, so numbers can change when the actual placement of the hinge is decided.

Stacking Angle	Distance between tabletops in mm
5	Not possible
10	4,3
15	16,2
20	**27,9**
25	39,2
30	50
35	60,3
40	70
45	79

Table 2: Overview of correlation between stacking angle and stacking depth

Sub Conclusion

It seems reasonable to have a 15 degree stacking angle to have enough space between the tabletops. But to comply with the standards from DS/EN 1729-2 – there must not be gaps between 8-25mm which means the angle must be approximately 20 degrees meaning there is a distance of 28mm between the tabletops (table 2). Therefore, the spacer must also have this thickness to lay correctly on top of the frame to ensure a horizontal tabletop.

Mock-up Test

The stacking angle is verified using the prototypes. Support pieces are made to ensure the right angles when pushing and pulling the tables together in the test. (illu. 74)

illu. 74: Test done upon stacking angle

Conclusion

As shown with the mock-up a 20 degree angle can be used because the frame doesn't tilt when pulled as with the higher degrees. While the 28mm between the tabletops lowers the risk of squeezing your fingers. This also decides the thickness of the spacer to secure a horizontal tabletop.

The 20-degree angle also lowers the force that is required for stacking and lowers the risk of damaging the tables at the same time. It is reasonable to include a backstop in the hinge, so the tabletop is not able to tilt beyond what is necessary.

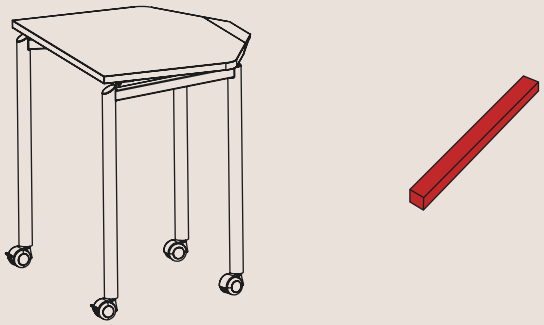
Demands

- The tabletop must be locked in a 20-degree stacking angle and a horizontal angle.
- A spacer must be 28 mm thick.

Support for the First Table

When exploring how the tables can stack multiple options were considered (appx. 27). Two solution spaces are available with three implementations, a support arm that is fixed to the table, or a separate arm that could be used on any table. *The teacher key* is a loose support arm. The *incorporated* is a permanently mounted support arm on every table. And lastly, the *Lead tables* use the same solution but only on some of the tables. (appx. 28)

Teacher Key

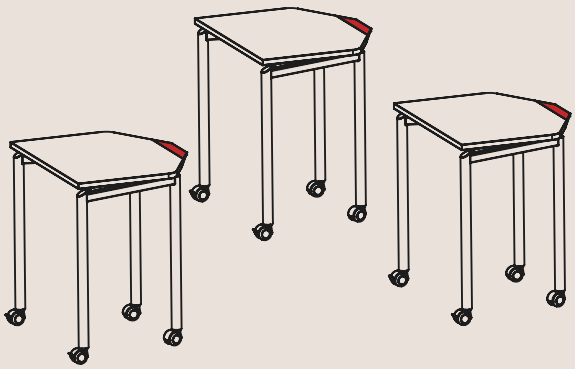


illu. 75: Teacher Key principle

The major benefit of this is economical as it simplifies the tables, also minimizing misuse during lessons. As there is no mechanism mounted on the tabletop, the pupils can't use it as a distraction, neither for themselves nor for the rest of the class. (illu. 75)

The teacher key poses two challenges, firstly by having a separate support arm, there is potential for them to get misplaced, lost, or hidden. They need a "home" in the classroom, so everyone knows where to find/return them. Secondly if a support arm can't be found or a new user doesn't know it's needed the tables could be stacked incorrectly and cause harm to the table.

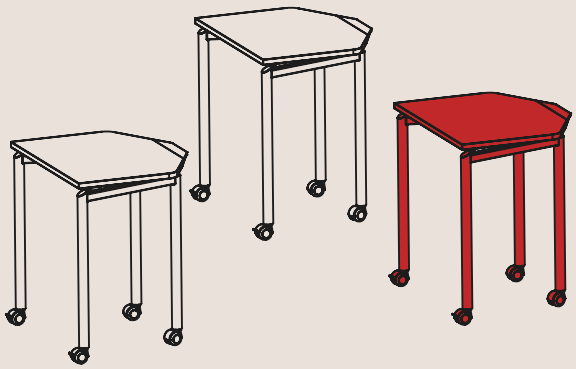
Incorporated



illu. 76: Incorporated principle

If the support arm is built into all tables, it eases the use in class. There is no searching, and any pupil can start the stack. It could shorten the time of stacking, as it is installed on every table. Whether it is needed or not, means that a classroom set will be pricier than a set with the teacher key. (illu. 76)

Lead Table



illu. 77: Lead Table principle

This combines some of the benefits of the other solutions while creating other challenges. It isn't as pricy as the incorporated and doesn't result in any loose objects, like the teacher key. This solution introduces two types of tables in the classroom, and it becomes necessary to tell them apart to locate lead tables. A simple visual solution is to color the lead tables differently. As seen with some of the tools the pupils can get, depending on age and grade they might feel differentially treated if there are lead tables. (illu. 77)

Conclusion

Economically, functionally and with the current understanding of the dynamic in the classroom, the teacher key has been chosen to lock the stacking angle.

Because, with lead tables, differential treatment, and discussions of whose turn it is, can happen. The teacher key could have the same challenge, but it isn't expected because it isn't "permanently" placed with the pupils. Here it is a bigger worry of losing the teacher keys, but as a teacher at Stolpedal public school has commented, "They know these things have a spot here and aren't toys."

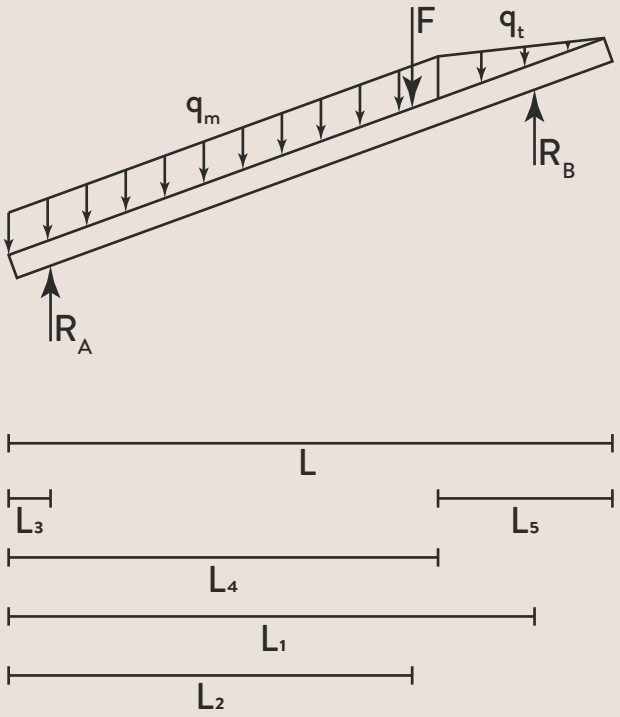
Stacking Calculation

To determine if it feasible for the teacher key to support a stack of 28 tables, it is necessary to understand how the loads are distributed through the table and among them, and how much weight a teacher key must carry (appx. 29). As expected, at some point the load that is transferred to the first table of the stack is negligible when adding tables. This point should occur as early as possible, as this means that the least amount of load is transferred forward.

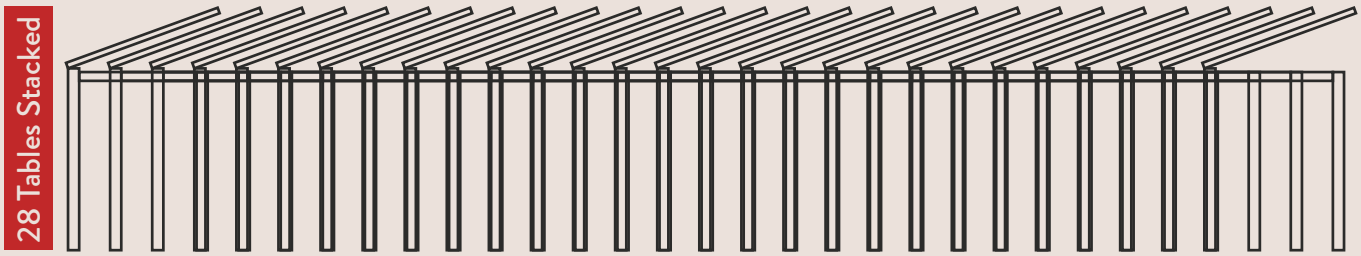
Conclusion

With 28 tables the load on the teacher key is 10,3 kg, and a single table puts 3 kg on its teacher key. The curve flattens at the 8th table as the load is within 0,5 kg of the maximum load. After this only a small load is added as more tables are added and after 15 the load is negligible (below 0,02 kg).

This also allows storage of large amounts of tables without worry of overloading. The biggest factor influencing this load is the possibility of misuse, if a chair or bag is placed on top of stacked tables. This would most likely be inevitable in the classroom so the arm should handle this.



illu. 78: Free body diagram of stacking loads



illu. 79: 28 tables stacked together

Slider

As the table needs to be stacked by a 1. grader, it is necessary for the stacking principle to work without anything being lifted by them. Therefore, a slider needs to be added to the design, as it would make it possible to push the tables together. If a slider is added to the front, it would make sense to incorporate the spacer into this slider, resulting in a combined nose for the table. As the table must work in formations, the slider must not be on the outside of the tabletop, therefore, it must be integrated into the tabletop shape itself. (Appx. 30).

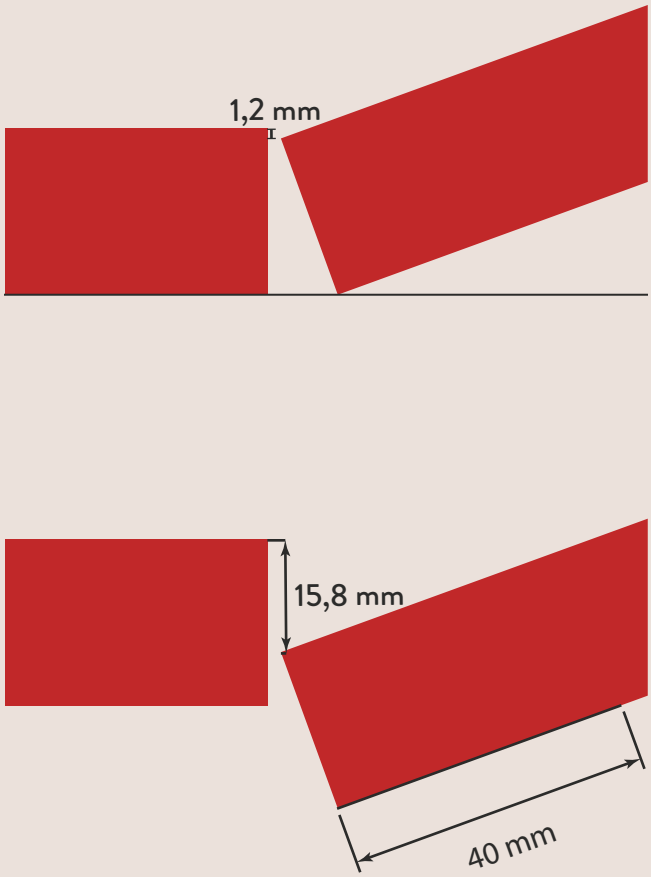
Therefore, an investigation upon helping the tabletop up on another tabletop has been done by looking into the placement of the hinges, and the geometry and placement of the integrated slider is made. See other alternatives in appx. 31

The Placement of the hinges

In an earlier section it is chosen to have the hinges welded to the frontside of the back legs (pp. 56), therefore, a study into how much the backend of the tabletop will drop if it suffices. This is done by testing different length of spaces from table edge to the hinge, and then measured the drop (illu. 80). The placement test goes to 40mm, as it is seen to be the common choice of circular leg-profile from the competitors (Højer Møbler, 2024). (tabel 3) (Appx. 32)

Placement (mm)	Overlap (mm)
0	1,2
10	4,8
20	8,5
30	12,1
40	**15,8**

Tabel 3: Overview of placement of hinge and the overlap it creates



illu. 80: Examples of Overlap with different hinge placements

Sub Conclusion

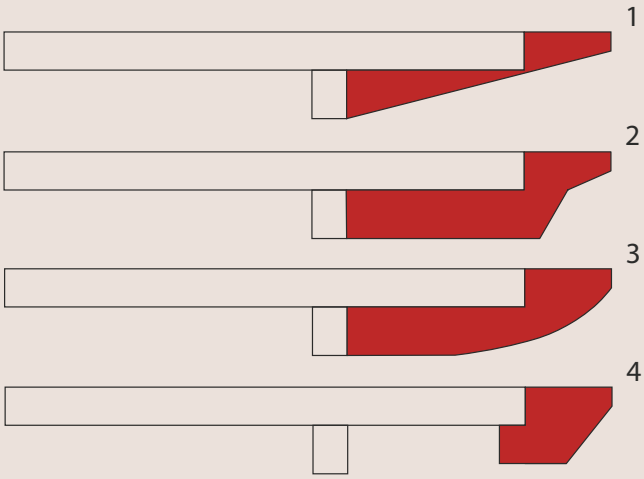
The hinges are placed around 40 mm from the edge of the tabletop to lower the tabletop as much as possible. The table will then drop 15mm under the horizontal line when tilted, because of this the aprons must be lowered as well. As the spacer has already been introduced, with a thickness of 28 mm, the spacer could be what rests on the aprons. The aprons are therefore being lowered by the thickness of the spacer to keep the top horizontal. This means that there is still a high margin of 13mm down from tabletop to the apron.

A problem occurs when the tabletop comes under the horizontal line, because it can clash with the top of the frame. Either the leg must have a cut that minimum follows the stacking angle of 20 degrees, or the hinges must be lifted over the leg.

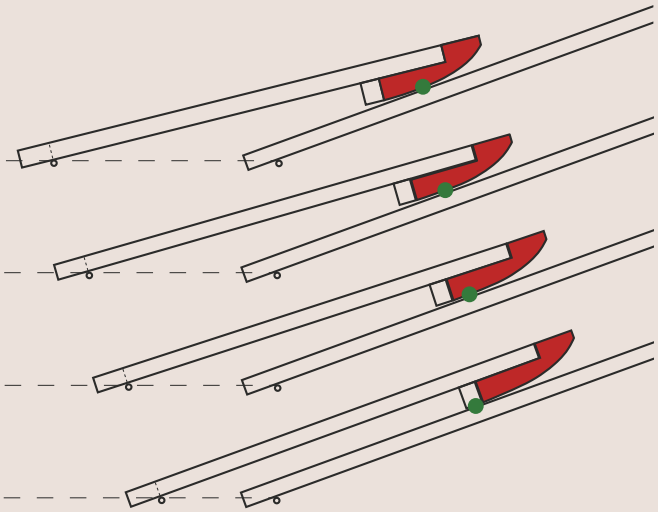
The Geometry of The Slider

The slider now has a 15mm overlapping contact area with the tabletop in front to start the stacking. Another aspect is the geometry of the slider as it should change contact point when sliding on the tabletop to secure equal wear over a larger surface. Different geometries are being discussed in appx. 32, where the convex shape is the best solution (illu. 81), because the contact point is changing all the way and then reducing the amount of bumps the slider will take on the way up (illu. 82).

For the slider to have the best opportunity to slide onto the table in front, the slider must start the curve above the underside of the tabletop, therefore a cut is made in the tabletop's front and filled out with the slider.
Different tests are done to figure out how much to cut off is necessary. (appx. 33).



illu. 81: Different slider types



illu. 82: contact point of the slider

Sub Conclusion

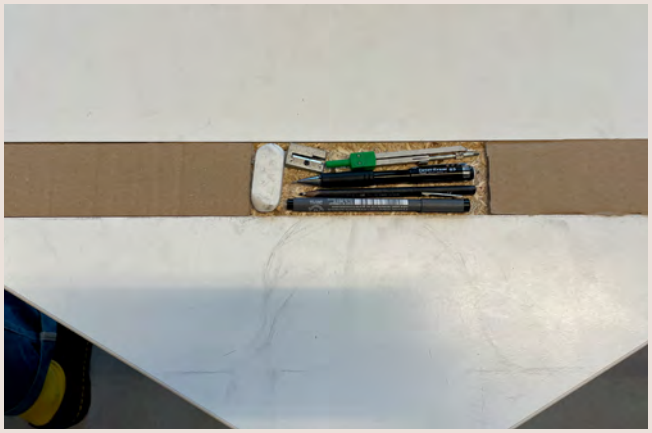
A convex-shaped slider has been incorporated with the spacer. It is important that the circular arc's radius should be high, because it will result in less resistance created along the tabletop and thus also softer impacts into the table in front.

To ensure the table still doesn't tilt, the entire overhang in the front can't exceed 94mm as was concluded on page 48 surrounding stability and therefore the tabletop's front is cut an additional 50 mm in the front and replaced by the slider.

Friction plate

As relying on materials, such as rubber (appx. 33), to hold the table in place when stacked isn't viable, because of wear over long time use and cannot secure a precise stacking over time. An alternative solution was taken into consideration, where a reference is made to the tables in DSB trains as they have a cup holder, made as an indentation (illu. 83). This solution of a tray could secure that the slider can catch it and assure that the table is stacked correctly. (Appx. 34)

illu. 83: Tabletop in a DSB train



illu. 84: Test done on a tray in the tabletop

illu. 85: Test of stacking with a tray

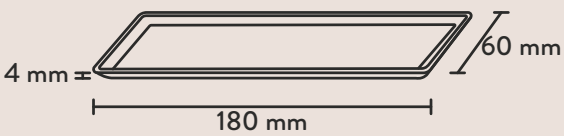
illu. 86: Stability test with one connection point

The stability test is carried out first to figure out if one fixing point or two fixing points are necessary in the spacer to accomplish a desired stability when the table is used (illu. 86). The result of this that only one fixing point in the middle is enough with the minimum dimensions of 15 cm in width (appx. 35).

Different considerations on placing the spacer in the middle have been taken into account in testing, such as different school objects in the tray, different angels of the chamfer, and the size of the tray (illu. 84 & 85) (appx. 34). Furthermore, a visit to Stolpedal public school to test the solution is done to gain feedback from the users and be taken into consideration (pp. 67).

Conclusion

From these tests and the user visit it is determined that the tray should be made of metal, should be a 4 mm indentation, to secure a clear feedforward. The items from the pupil's pencil cases has resulted in the width of the indentation should be a minimum of 180 mm, the length of the indentation should be 60 mm. (illu. 87) Lastly the chamfer around the edge of the tray should be at an angel of 30 degrees, because it gives a bump that the nose must come over when stacking, which means that the tables cannot roll away from each other easily.



illu. 87: Final internal tray dimensions

Locking mechanism

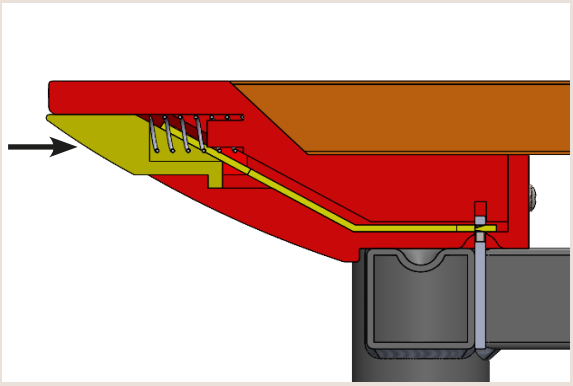
As the nose is laying on the apron, it would be logical to incorporate the locking mechanism into the area around this contact point. However, see appx. 36 to see other alternative solutions.

To comply with the allowable clearance the locking mechanism is built into the nose. This is also to reduce the number of parts and mountings on the tabletop, and as it already has contact with the frame it is obvious to incorporate into it. This also encloses the mechanism, so no moving parts are reachable.

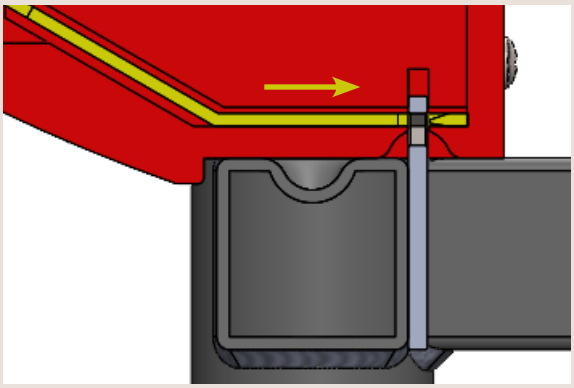
First developed as a split system with one button placed in front and two locking pins, one in each spacer. After tests indicated that the spacers could be joined into one in the center (pp. 62) the locking pins were reduced to one and centralized (illu. 88).

illu. 88: Mock-up of a locking mechanism

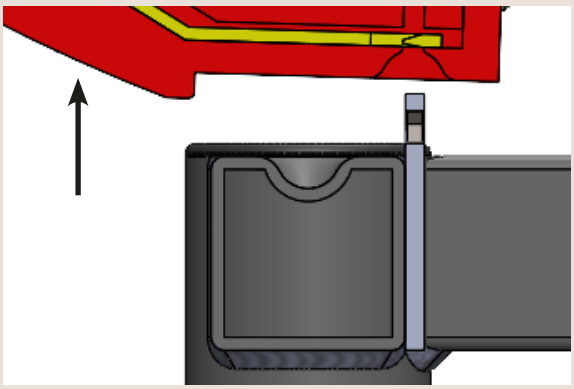
Conclusion



illu. 89: The eye which the locking mechanism is catching



illu. 90: Section view of the locking mechanism inside the nose



illu. 91: Section view of The Nose

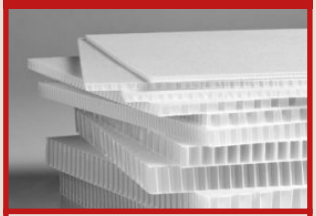
The locking mechanism is integrated into the nose, to ease production and discourage misuse that disturbs the class. To have more space for the locking mechanism, cutting the front of the tabletop at a 45-degree angle is experimented with. Visually the table looks almost the same, however it gives significantly more room for the mechanism. (illu. 89, 90 & 91)

Tabletop material

Thermoclear

180 kg/m³

Thermhex



92 kg/m³

Vikutherm

258 kg/m³

MDF

600-850 kg/m³

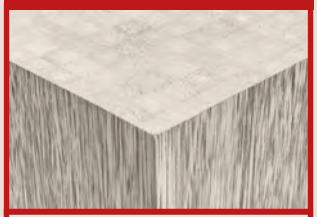
Particleboard

600-750 kg/m³

Plywood

400-700 kg/m³

Karuun



400 kg/m³

Papembood

716 kg/m³

illu. 92: Different tabletop materials

For the pupils to be able to move the table, the lighter it is the better, therefore if the tabletop can be constructed of a different type of material or a combination of materials to make it lighter, that would be advantageous. This section aims therefore to find and select materials that can do this. (illu. 92) (Appx. 37)

Each of these materials must be used differently as Thermoclear, Thermhex, and Vikutherm are materials that can be used as core material as they relatively fragile structures and pupils would easily break them over time. Therefore, would these materials be used in a sandwich structure in a tabletop. Whereas MDF, Chipboard, Plywood, Karuun, and Papembood, can be used as the tabletop material itself as they are solid materials with no open surfaces.

A sandwich construction as the tabletop sparks some production concerns, as they aren't structurally sound enough to screw directly into. This means that threaded inserts must be molded directly into the material. As there is no readily available process or company doing this, this is expected to be cumbersome and expensive if possible.

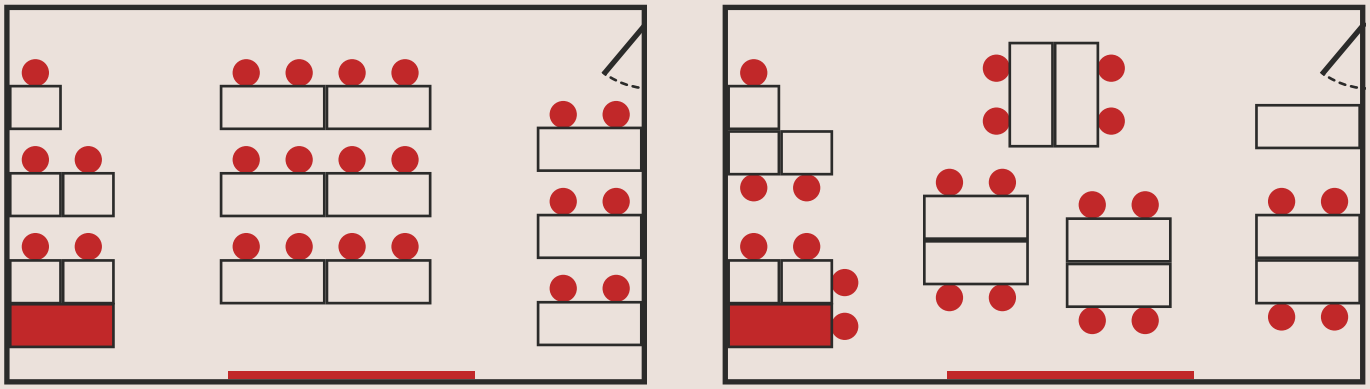
Conclusion

The core materials must be encapsulated inside two other pieces, furthermore if the tabletop with the core material was going to be screwed into different bushings or solid material is going to be incorporated into it. These things make the core materials too expensive to go forth with and therefore the materials left to choose from are the materials that can be used as the tabletop without any additional work.

The Karuun and Papembood are too expensive for the schools, so the decision falls upon Plywood, Particleboard, or MDF.

Benchmark - School Visit

To get a benchmark with the furniture in the classroom today, a traditional classroom was observed in a lesson where the teacher had the pupils move tables from rows to groups back to rows (illu. 93 & 94). Furthermore, the behavior of the pupils and teacher was observed while moving the tables around, to understand how they would react. This benchmark highlights both some of the behavior and timeframe the product should improve. (Appx. 38)



illu. 93: Before and after moving the tables around

illu. 94: Collage of pictures and notes from the observation

Today's use of time

Factors when Changing layout

Is the layout known

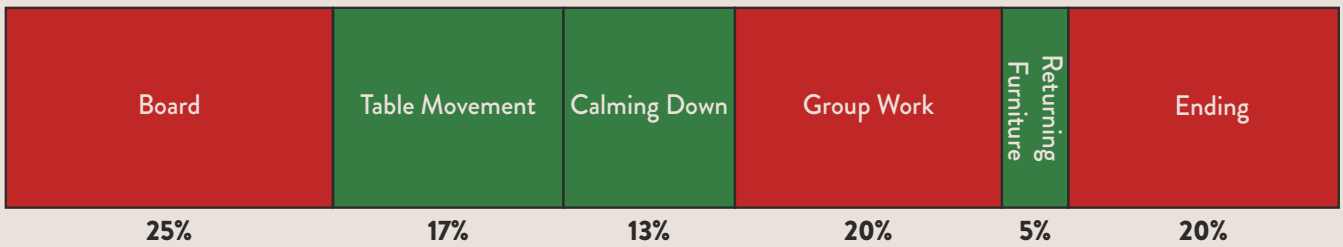
Mobility of furniture

Routine

Movement of items

In this list there are both some that are easily influenceable and some that are non-avoidable obstacles that the table doesn't address, that contribute to the problem, but are solvable in other ways. As an example, the chairs are not on castors and are thus noisy and cumbersome. The bags aren't stored in a uniform way, but nine out of ten are on the back of the chair (illu. 95) (appx. 38).

illu. 95: Picture of the pupils moving tables



illu. 96: Today's use of time made up in precentages from a 45 minute class

Conclusion

Moving to a new layout takes seven minutes and there is a lot of room for improvement. The pupils can't do this autonomously and rely heavily on the teachers' instructions. This can be improved considerably, as seen when moving back to the familiar layout, in 2 minutes. Here the pupils don't have to wait for the teacher to tell them what to do with each table, instead they can move all tables at the same time.

Currently, it is much more than just moving the tables that takes time, a significant amount of time goes to calm them down after moving the tables into an unfamiliar layout. But as the same amount of time isn't needed when moving back to a familiar layout, some of this is attributed to them not regularly changing layout.

It should be possible to get the layout change time down to under 2 minutes with a familiar layout as the difference is twice as many tables that are significantly easier to move, that all pupils now can move individually.

Demands

- Must take less then 2 minutes moving the tables between constellations.

Final test of concept

Prototypes are shown to teachers at Stolpedal public school to receive input on what works for the concept in the actual context. The inputs are gathered through an interview at the school and interactions with the prototype's functions. This provides feedback that can clarify whether they imagine themselves using the product in their lessons. (illu. 97 & 98) (Appx. 39)

Feedback

"It looks really easy to use, I will definitely use it"
- Victoria

Opportunities

"There are multiple ways for placing the table against the wall, so that the kids do not have to look straight into it."
- Victoria

It expands our opportunities in the classroom"
- Nikoline

Movement

"Can create rooms in the room, so some pupils can sit on the floor, while others sit at a table"
- Nikoline

Teacher Key

Pupils can easily learn how to use it themselves.

The teacher key must seem like it belongs to the tables, so it is not thrown away.

Tray

"There is plenty of space for what they currently have on the table."
- Victoria

It makes it harder for things to fall off the table.

illu. 97: Picture of the day the feedback from the teachers where recieved

Gaps in the layout

"It could be a problem that things can fall into the holes when sitting in groups"
- Nikoline

The solutions doesn't have to lock the table together, but only prevent things from falling between the table.

illu. 98: Picture of the day the feedback from the teachers where recieved

Conclusion

The concept has been approved by the user, as they can imagine the tables in their classrooms. It offers them opportunities they don't have today, because of the features it provides. They even wanted to have a complete class set to test with their pupils to investigate all the opportunities the tables could give them.

The main issue from the visit is the gaps in the group layouts, which require a new iteration to determine whether it is crucial to develop a puzzle piece that can plug the various holes the tables create to ensure that objects won't fall off the table.

This is done in appx. 40 where it is determined there is not to be some kind of plug addition to the final proposal as it would increase the complexity of the everyday use, not only when in use but also where they should be stored. Furthermore, the cost of the final solution would increase and maybe deem the solution too expensive for the schools to by into. Even if the holes are closed, it will only solve the problem when the pupils are sitting in groups, as when the pupils are sitting alone there is an even higher chance of things falling of the tabletop

Feedback from the industry

A visit to Højer Møbler provides new insight upon the concept; Re:Form (illu. 99) from a manufacturer with expertise in school furniture design. The situated interview's purpose is to highlight what works and what might be improved, allowing the concept to heighten its value to the market from a company perspective. Further insight into the pricing of production and materials is important to clarify. (Appx. 41)

Feedback

Price estimation for a Højer Møbler table

70x60 table cost 1.600DKK + VAT

The nose price and casting price

A mold probably costs 70,000-100,000 DKK
The nose will cost approximately 50-100 DKK

Tabletop material

The particleboard must have an edge banding – and requires an additional process in production.
Plywood does not require edge banding – but is more expensive in itself.

Movement of the table

It is almost better that the groove is locking the tables to good – could it be strong enough to make it possible to move the stack around.

More than just a table - Selling point

The table offers more than "dead" tables and may therefore cost more.
But if it is too expensive, the schools take the cheap choice anyway, even if they would like to have the extra features.

Hinges and apron

It can be cheaper for the manufacturer to make the hinges by themselves because they can optimize their production flow.
They don't trust a table without four aprons. The apron can be horizontally oriented, so it doesn't interfere with stacking.

illu. 99: Picture of the prototypes

Conclusion

"I can actually see that it could be a good product. The concept idea is good"
- Ulrik (Product and Development Chief)

The overall feedback for the concept, models and production considerations was positive. The visit provided valuable insights into the product's presence on the market and which areas require additional iteration to validate the current solutions, develop a new one, or take a final decision between different solutions or options. Especially, the decision to use only three aprons must be validated through static calculations, because that is the most critical part of the concept from their perspective.

The Use of Re:Form

Pupils are sitting in groups of three and working together.

The teacher gives the Teacher Key to a pupil.

Pupils stack the tables.

There is room for play on the available floor space.

The pupils retrieve a table and hand back the Teacher Key.

The pupils sit around the classroom and do individual work.

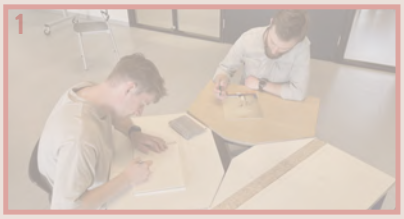
In the next lesson the pupils does group work again.

illu. 100: Storyboard with the final concept

Chapter 5:
Interaction Detailing

This chapter tackles the pitfalls of additional problems with interaction, i.e. add-ons, teacher key, and the level of complexity

Pitfalls



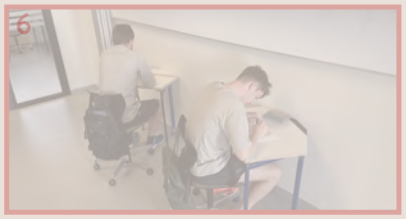
Pupils are sitting in groups of three and working together

The teacher gives the Teacher Key to a pupil

Pupils stack the tables together

There is room for a game on the available floor space

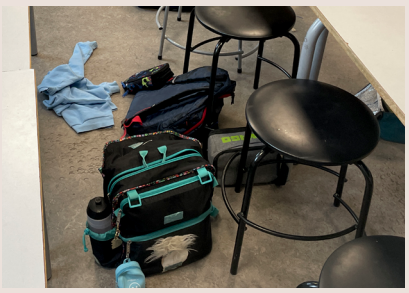
The pupils take the tables and hand back the Teacher Key



The pupils sit around the classroom and do individual work

The pupils does group work again

illu. 101: Different pitfalls pointed out



illu. 102: Observed pitfalls

By implementing Re:Form in today's classrooms there is a change in the dynamic of the school day, as the pupils are not going to have a regular seat in the classroom, as it is possible to change it around in an instant. This should make the lessons more dynamic and make the pupils more engaged in the educational material. This change can result in some pitfalls with other products as this is only the table that changes, the chairs are noisy if they don't have wheels, and they take up a lot of space as they aren't stackable. Another pitfall is the bags the pupils have, as they can't be stored and can be a hindrance to the mobility of the tables (illu. 102). (appx. 38)

The Add-on Problem

During the different school visits, different challenges on the outskirts of the core problem became clear. Specifically, the number of items that need to be moved as layout changes, was observed at all schools but was highlighted at the benchmark visit (appx. 38). Stationery on the tables, bags on the floor around the table, and lastly the chairs, everything needs to be moved. These items are not specifically tackled as there are a multitude of different solutions on the market, some more compatible with Re:Form than others.

A lot of schools already operate with as few items on the table as possible, so therefore it will depend on the users, what would be on the table. But as observed at Stolpedal public school (appx. 38) the table doesn't need to be cleared when changing layout, only when stacking the tables.

The backpacks were observed in three locations, along the classroom wall, leaning on the table, or hanging on the chair. This is highly dependent on the types of chairs, as this is the most common place to find them. The problem is not all types of bags can be hanged on the chair. A hook for the bag on the table isn't possible as it interferes with stacking and group constellations. The desired solution is that the table is sold with a chair that can hang most bags, but as pupils own a wide range of bags, a one size fits all isn't achievable.

This leaves the chairs; it is common to see chairs with wheels, and this is also what should be paired with the Re:Form. As it defeats the purpose that the table is easily movable, and the chair is clunky and noisy. The chairs aren't stackable, as rolling stackable chairs are a project in and of itself. If they are placed on top of each other, there is still more room than with current furniture. (illu. 103)

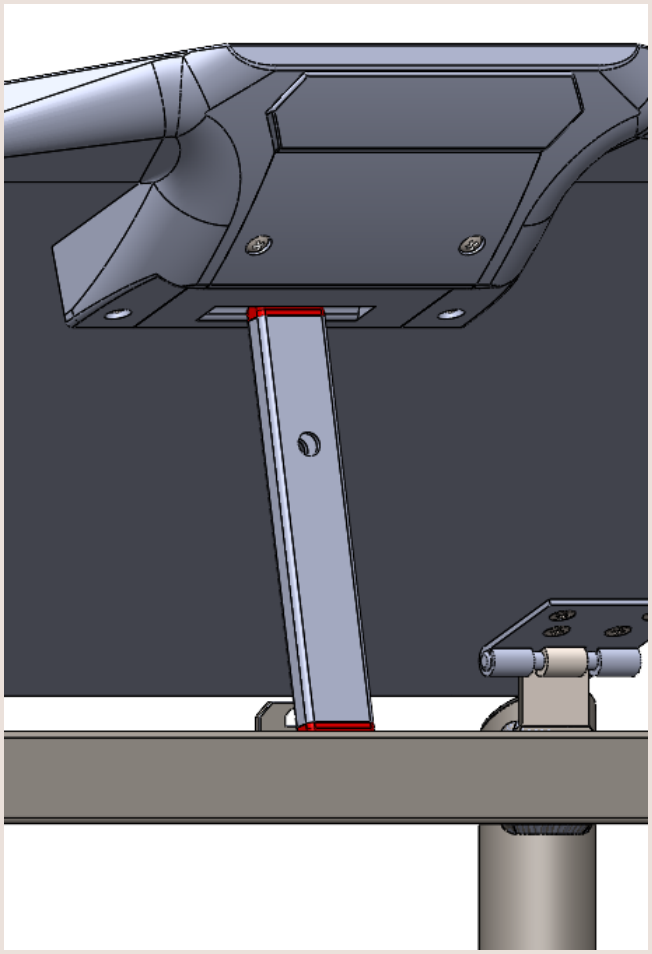
illu. 103: Different things add-ons could solve

The Teacher Key

The support arms function is determined by the form of the nose, specifically the cavity that also allows it to lock the tabletop. The arm needs to fit into the nose and rest in a similar way on the frame.

As the product will be sold under tender agreements the price is valued greatly, so the function is fulfilled by a simple arm. The arm consists of a piece of rectangle tube, two half dome end caps, and a hole in the tube for hanging storage. To link it more to the table some sort of visual design should be on its faces, this could be pictograms explaining the use or showing the table. (appx. 42)

Generally, the same expression, colors and materials should be the same, to create connections for new users who do not know how the product functions. (illu. 104)

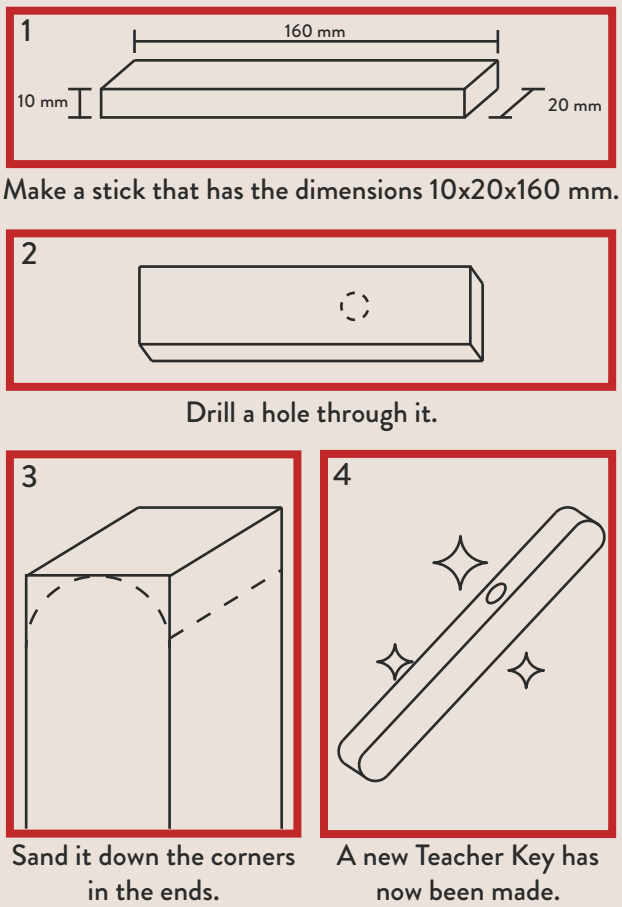


illu. 104: Aesthetic and intergration of the teacher key

Missing Teacher Key?

As the Teacher Key is a loose item, there is a chance that it is misplaced. In this scenario, what can the janitor do? As the Teacher Key has a simple geometry any janitor or shop teacher can make a replacement of wood, with basic tools (illu. 105). As it has no specialty interfaces the wood replacement would be straightforward to create, however, the biggest concern would be the strength of it. It should be created so that no wedging happens when in contact with the nose, as it could damage the plastic over time.

It is unknown whether this is something that should be encouraged as if the product fails in use with the replacement and a pupil gets hurt, someone remains with the responsibility. To what extent does the manufacturers responsibility end and the user's responsibility begin? This can't be decided only from a design perspective and must be addressed in a potential maturation process.



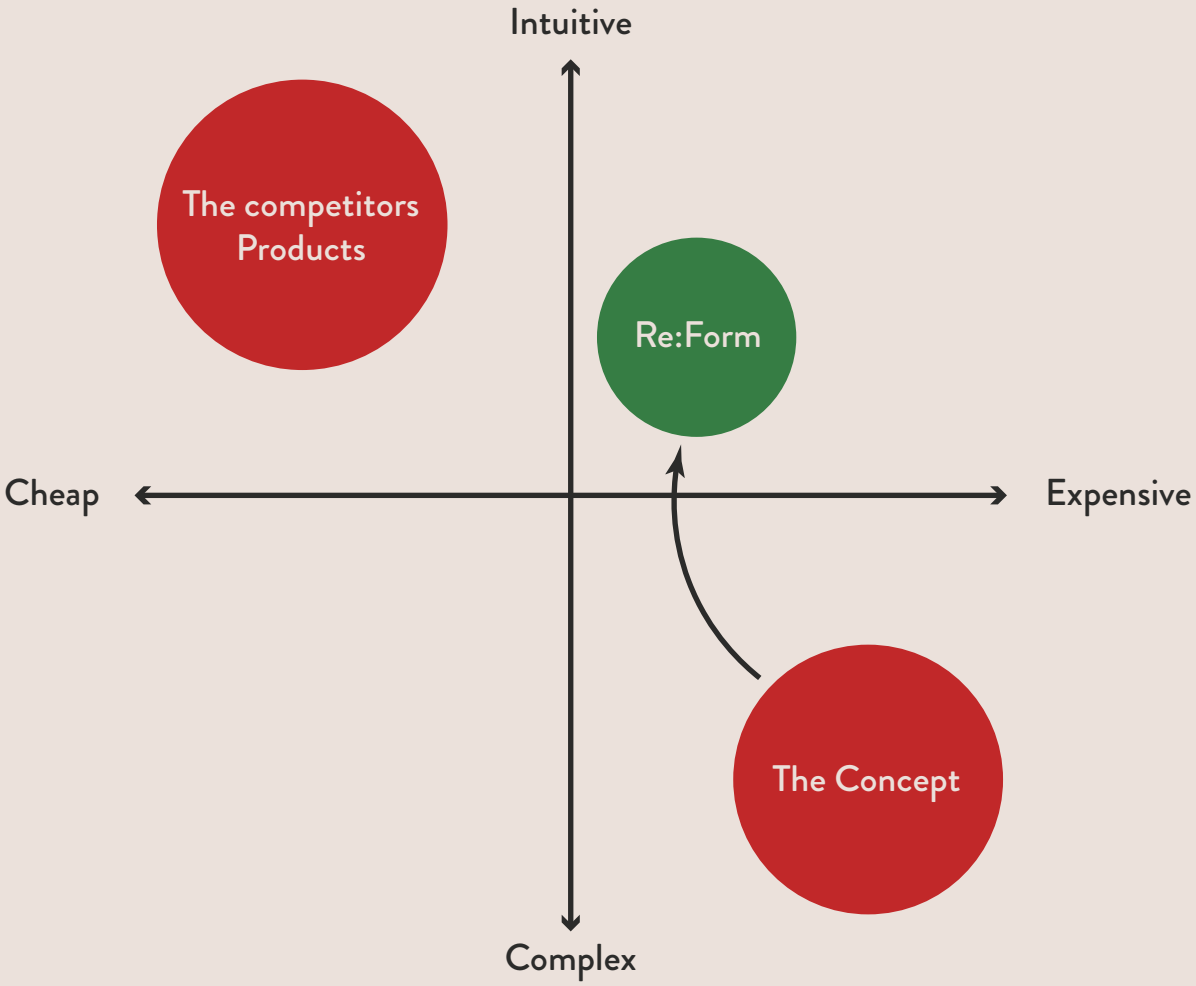
illu. 105: How to make a new Teacher Key quickly

Level of Complexity

Comparing the concept with other pupil tables, a worry of overcomplication arises. Most tables are completely static and simple with maybe one feature of changing the height. In this table, more and more complexity is introduced as features are implemented. This is a concern in relation to both the price point and the user interactions.

The concern in terms of the price point is the wider reach on the market. This is a sliding scale starting at the same low price point as the simple tables. This price point has a good opportunity for a wider adaptation but is unreachable with the extra features. The other extreme is simply that the product is too expensive, and no school will adopt it. Between these two points there is a relationship between paying for the features and being able to afford the product. The cheaper, the wider reach but the less likely it is to be a profitable product. The more expensive the less reach, but room to create the features. The context pulls towards a cheaper solution and the concept pulls towards an expensive solution.

The user interaction concern is if they can figure out how to use it, and how precise they must be in their interactions. Very few if any of the competitor's tables have interfaces the regular users interact with daily, so the users aren't used to decoding tables. The table should be simple enough that most users can figure it out without any instructions but keeping the same features. If users can decode the features, it adds value to the classroom but if they can't it is product complexity with nothing in return. When they have decoded how to use the tables, they should also be able to do so with ease. As an example, this means that when stacking Re:Form, the users aren't required to match the angles down to the degree but can do it casually. (illu. 106)



illu. 106: Where Re:Form should be placed

Chapter 6:
Aesthetic Detailing

This chapter decides the final aesthetic of the table, by looking into how it is going to fit into the context, the tabletop shape. Further what profiles are used in the frame and how the nose expression is. Lastly the color of the table is decided.

How Does It Fit Into The Context?

50% of schools today are built according to old standards from 1960-70, which means that the furniture of the future must fit in with a time that does not necessarily follow the evolution of designs and trends. Therefore must the overall aesthetic of Re:Form be a timeless table that can also be used in 20 years' time.

The following pages takes considerations and inspiration from the aesthetic expressions from the schools today. But Re:Form also wants to give a more colorful expression in the classrooms for schools in the future, because of the benefits colors can give to the learning environment (Hettiarachchi & Nayanathara, 2017) such as orange increases energy levels and a potential to highlight the functions in the table will be looked into.

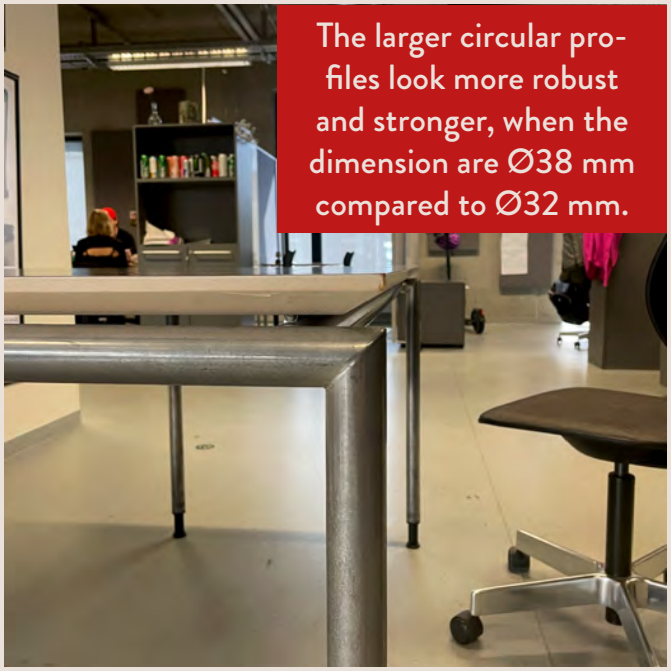
The color palette is very natural in shades of grey or with the opportunity to add wood structure on the laminate surfaces.

A bit of color has been seen in the context, but mostly it is on other furniture than the tables, such as the chair.

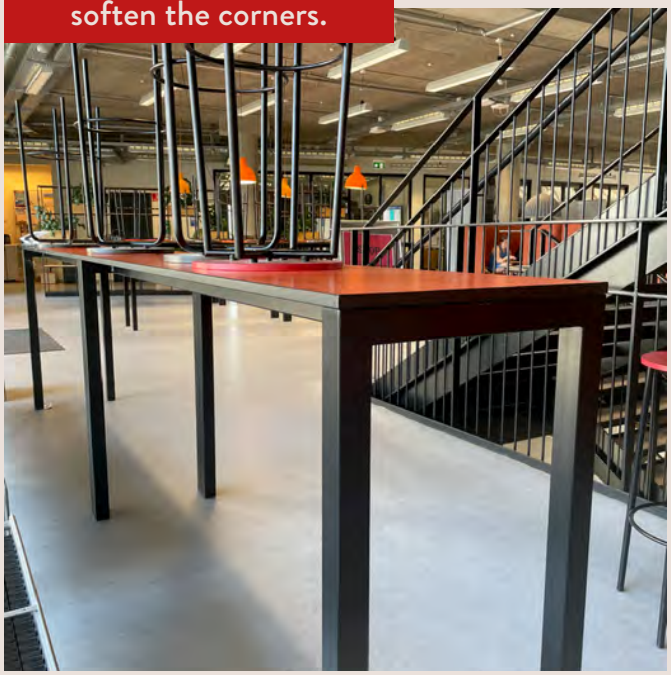
The frames look most coherent when it is a combination of round and square profiles.

illu. 107: How the context is at Herningvej puplic school, Stolpedal puplic shcool, and Skipper Clement privat school.

The tabletop has most often closed edge bands and with smaller fillet to soften the corners.



The larger circular profiles look more robust and stronger, when the dimension are Ø38 mm compared to Ø32 mm.



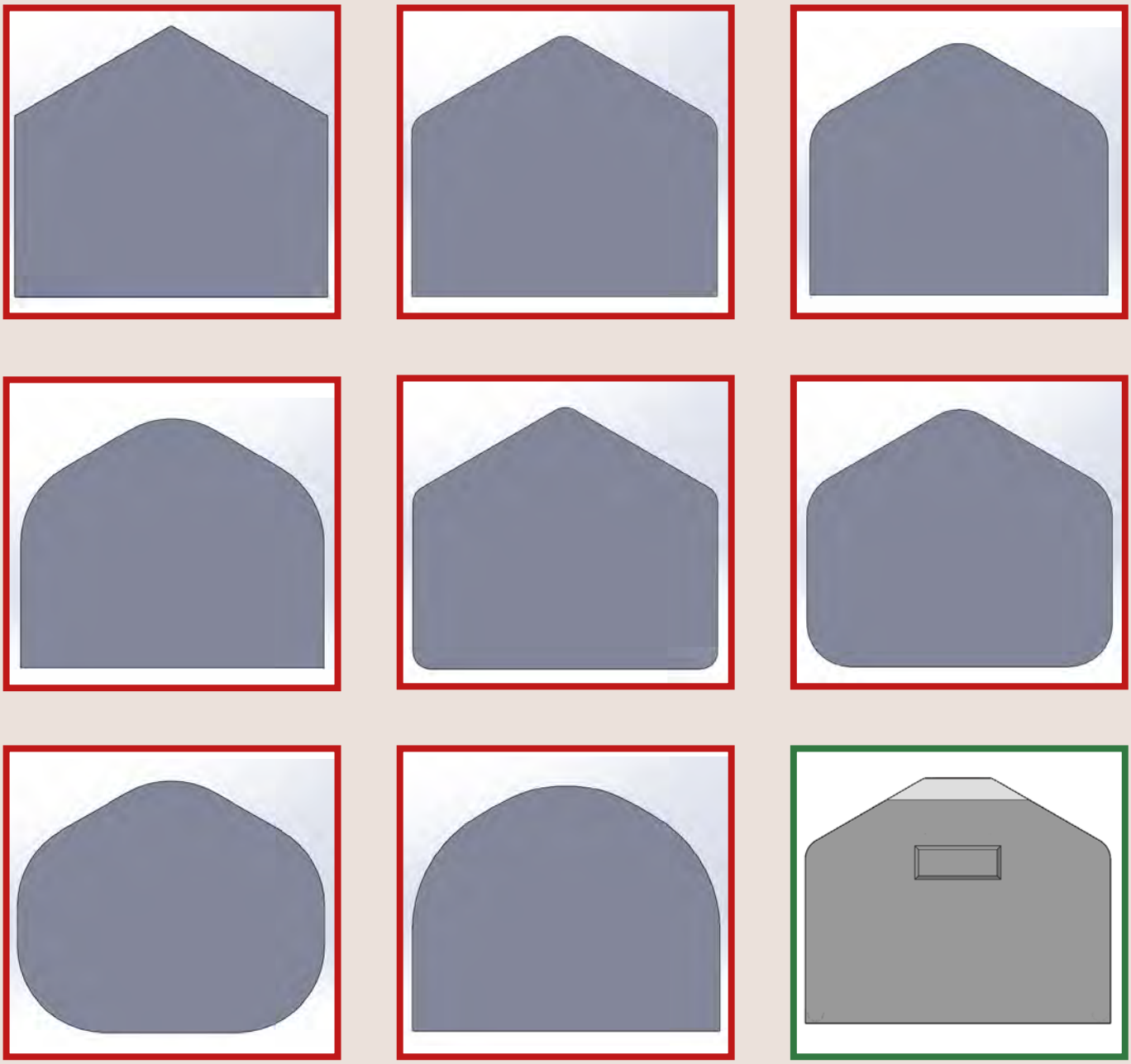
If the table only has square profiles, it looks very angular and sharp.

illu. 108: How the context is at Aalborg University

The Tabletop

Though the development phases the tabletop have changes expression multiple times. In the beginning the shape had a very clear direction due to sharp corners in the front, therefore a convergency study was made to soften the shape (appx. 43), where the result was 50mm fillets in the three front corners (illu.109).

Further into the phases the front has been cut several times and consequently it seems to have lost a bit of direction by that time with a flat front. But as the nose are replacing some of the tabletop material it makes a clear line where the front is pointing towards with the change of material. This has resulted in the final shape (illu. 109), where the corners are just rounded to secure no sharp edges, and the two sides still have a larger round over, to soften the translation between the angled sides.



illu. 109: Tabletop convergeny study

The Frame

As the environment requires that the tables can withstand hard wear and tear, because the users don't have any connection or ownership to furniture in the context, it must be robust and dimensioned with large proportions. As the table is designed more functionally driven the use of basic geometry is favored, such as cylinders and/or rectangles. Either the frame must be of the same profile or as a combination between both. The dimensions of the legs and aprons also influence the overall expression.

The visited schools and a walkthrough at Aalborg University have shown a basic rule, that tables have cylindrical legs and rectangular aprons, where the leg dimensions are larger than the apron due to strength and production.

Aesthetically, the cylinder profiles make the table appear more coherent than square profiles, which cause the table to look heavy, compact, and unfinished when legs are arranged along the edge of the tabletop. (illu. 110)

Square Frame

Round Frame

illu. 110: Square or round frame

Conclusion

As the nose is supposed to rest the weight from the tabletop upon the apron it must have a larger area to lay upon. Here is the obvious choice to use a rectangle profile, that will give a larger flat surface for the nose to rest on.

After measuring different leg profiles, the final dimension on the table will be a Ø38 mm circular leg (Appx. 44), as it was the largest in context and also used as a standard at Højer Møbler (Højer Møbler, 2024) and the apron is dimensioned to be 30x30 mm due to strength calculations (pp. 89).

The Nose

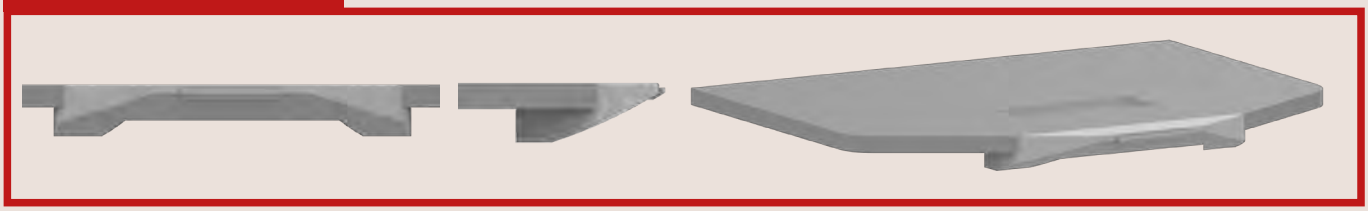
The nose is an extension of the table in the front and must look coherent with the tabletop. Through the project phases the expression of the nose has changed from having two wide support points to a single expression centered in the middle (illu.111 & 112), where all functions could be consolidated seamlessly. Here is the lock, the convex sliding form and spacer integrated as one.

Hard edges on the nose present complications if it fails to hit the front table correctly or is exposed to harm. It creates nicks and cuts, whereas softer forms can better dampen these hits without causing damage the same way (illu. 113 & 114). At the same time, the soft contours make the entire nose appear more unified, including the transition over to the tabletop itself.

From the beginning it has been important to lock the nose safely to the tabletop by both adding screws from the front (illu. 113) and underneath the tabletop to lock it in both directions. As the Button was introduced, it allowed hiding the screws. This means that the pupils do not have direct access to the screws, and since it will be rare that the janitor must have access to them, it does not have to be too easy either. It makes the overall expression of the nose look complete with hidden screws (illu.114).

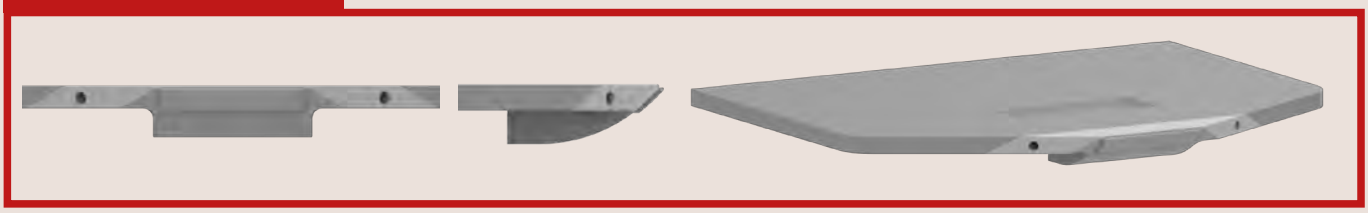
The button at the front geometry has a hexagonal shape (illu. 114), that follows the table's angular expression and ensures that no sliding tracks are required to keep the button in position because of the angled sides of the chosen form. It is designed as wide as possible because a large contact area is necessary for stacking, so you don't have to hit the table in front directly to release the button.

1st Edition



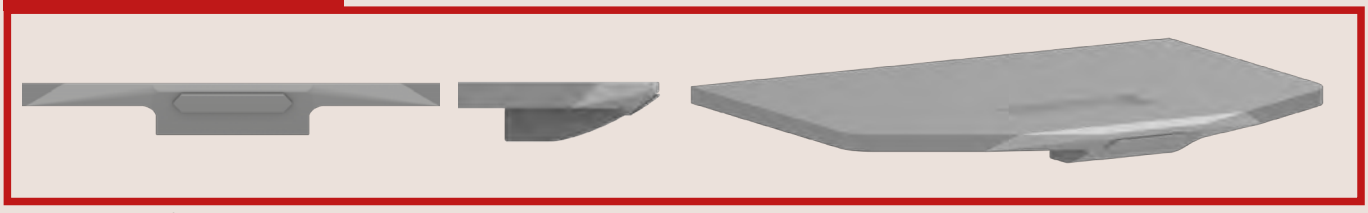
illu. 111: 1. Edition of the nose

2nd Edition



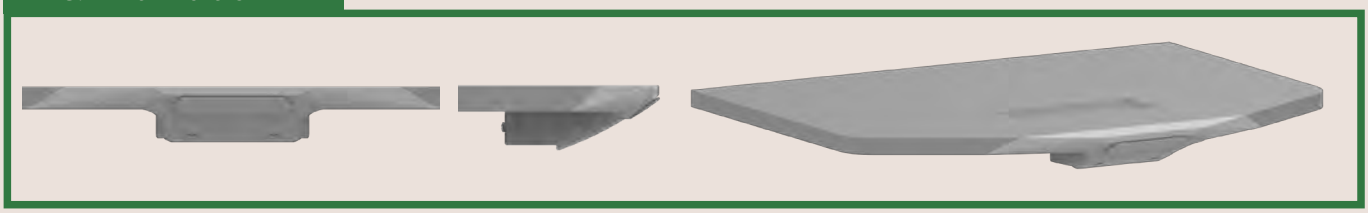
illu. 112: 2. Edition of the nose

3rd Edition



illu. 113: 3. Edition of the nose

4th & Final Edition



illu. 114: 4. Edition of the nose

Color

The table must fit into the classrooms, today the aesthetic choices are very conservative. Janitors, as the buyer and secondary users, are viewing the tables from a longevity aspect, different trends and expressions aren't an option to maintain. They seek a timeless table that can still be put in a classroom in 20 years. Here the obvious choice is neutral colors such as a tabletop in a shade of grey and a black frame.

As Re:Form already challenges the classroom dynamics the choice of accent colors could intrude and shift focus to the table, disrupting the lesson. However, it can also indicate where the main functions are and how you should interact with them. For this, it would be the nose or tabletop that differ in color from the rest.

The Tabletop

The approach of picking the tabletop color is to look towards Højer Møbler, as they could be a potential seller of the table. Højer Møbler delivers 24 different tabletop colors for their tables and can offer this as they work with a pull system and only order the tabletops when they are needed. This means that no large investment is needed to deliver a wide range of colors for their customers. (Højer Møbler, 2024). The same system is implemented in Re:Form's tabletop, where the following colors are chosen to be provided to the customers (illu.115).

Tabletop colors

illu. 115: Some of the tabletop colors available

The Tray

As the tray serves a function and is placed directly in front of the pupil the most durable option is being chosen here: Brushed steel.

The Nose

As the tabletop comes in a lot of different colors, the nose is going to have a limited option, as this wouldn't be considered a pull system but a push system, and that would mean the expense of excessive storage space. The nose will be available in three different colors: grey, black and ocean grey (illu. 116). This is done as with a few colors the nose can either be integrated in the tabletop with the correct color choice or stand out and highlight the function. As the tabletop and the nose are two different materials the colors are going to behave differently, this should be combatted somewhat with the surface finish of the plastic. (appx. 45)

As the button has a function it could be lighter or darker to highlight the contact point, however, as it isn't an emergency button it is chosen to blend in with the nose, so the pupils don't find it interesting to interact with.

Color transition: Nose & Tabletop

illu. 116: Different nose colors

Conclusion

As standard the frame will be black, as the neutral base of the table. Then the customers can match their preferred preference of color on the tabletop between a selected palette of color. It is then possible for the nose and the tabletop to be nearly identical, or that the nose can be highlighted with a color that differs. In general, the colors will have a mat structure to reduce the sense of filthy surfaces. It is expected most will acquire the table in all neutral colors as it is the easiest to maintain and taps into the longevity aspect.

Chapter 7:
Strength Detailing

This chapter examines the different critical areas of the table that must be strong enough to withstand both the use of the table and what weight the teacher key must withstand. Lastly a test of the frame is done, to make sure it can handle the wear and tear of the context.

Material Properties

The Frame

illu. 117: Steel

The frame is chosen to be made of steel, as it is one of the cheapest metals, as well as the industry standard. The steel is a good fit, as it is very strong, has versatile processing, low in cost, tough, and is recyclable (Lefteri, 2019, pp. 200-201). Some type of mild steel is used, as there is no need for the use of high strength steel.

The Tabletop

illu. 118: Plywood

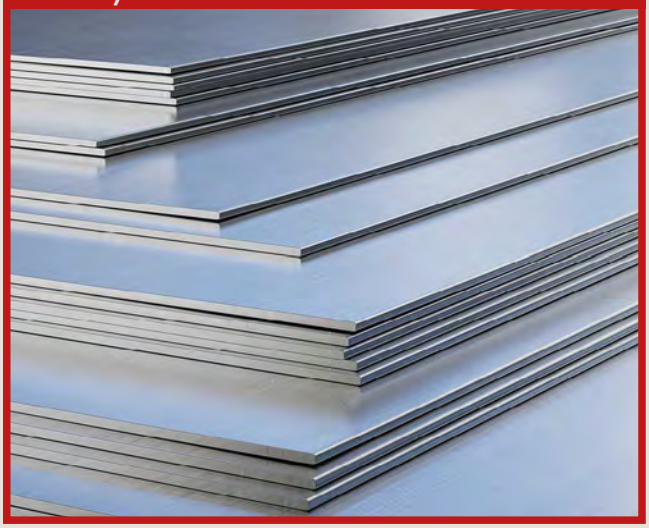
As from the before named tabletop materials (pp. 64), there is a choice between Plywood, Particleboard, and MDF, where Plywood is chosen on the background of production (pp.93). Furthermore, it is possible to reuse the plywood as a particleboard further down its lifetime.

The Nose

illu. 119: Nylon

The nose has some specific demands for the material that is used; it must have low friction as it must go up and down other tables often, the material can't leave residue on the other tabletops, and it must be able to withstand some hits from other tables when banged into each other. The choice therefore falls upon Polyamide (PA) commonly called nylon, as it has low friction, resistance to abrasion, high strength as well as being recyclable (Lefteri, 2019, pp. 112-113).

The Tray



illu. 120: Sheet steel

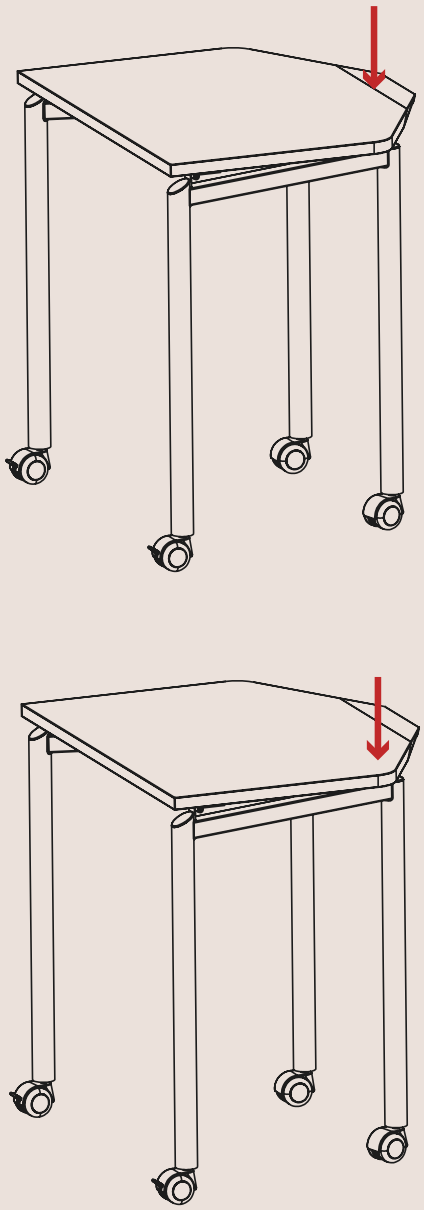
The tray material is chosen to be steel to have the same properties as the frame. This means that the pupils can't poke holes or damage the tray too easily. To hide any scratches that might come from stacking over time the steel is brushed in the same direction.

Tilting

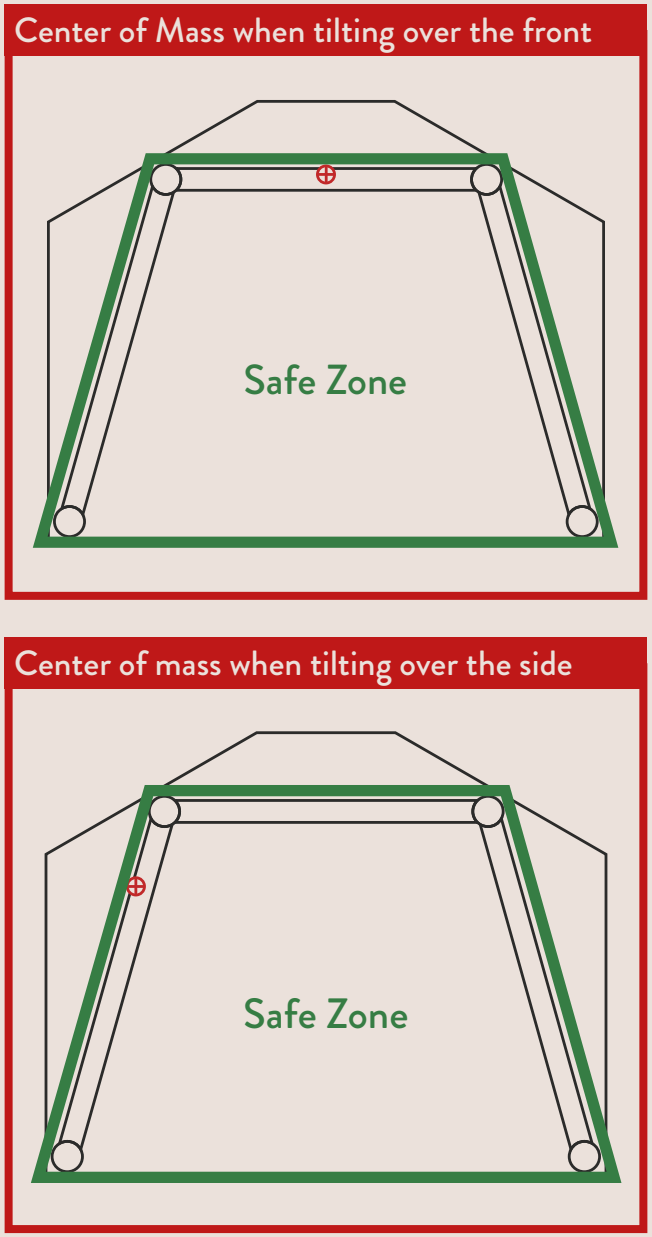
As previously one of the critical points of the design proposal is the tilting aspect (pp. 47), therefore a study is made with the final shape, dimensions, and materials to figure out if the table is tilting. If the resulting center of mass is located in the overhang the table is tilting.

The FEM study is done in SolidWorks by placing the center of a cylinder 50 mm from the edge of the table with a diameter of 10 mm with a weight of 60kg as the DS/EN standard 1729 demands. (Illu. 121)

The two critical areas are in the front and in one of the side corners (illu. 122).



illu. 121: The areas of loads to test the tilting aspect



illu. 122: The center of mass when weight is applied

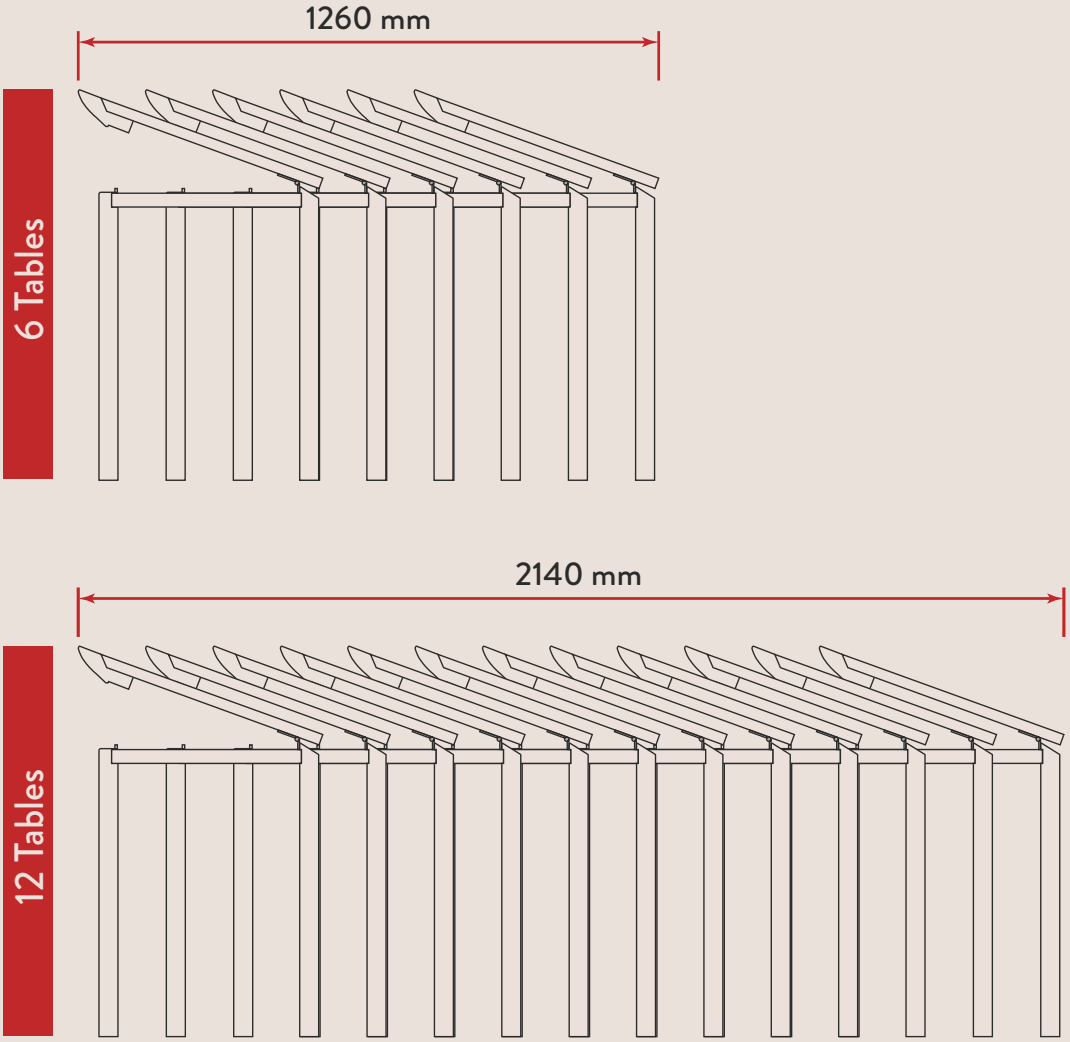
Conclusion

From the illustration 122 it can be seen that the center of mass is inside the frame, which means that the table would pass the DS/EN standard and can be approved to be a pupil table.

Stacking

As demand 21b determined that six of the tables stacked should fill the space as two ‘normal’ one-person tables, it is necessary to see if six of the tables stacked would fill less than 1200x700 mm.

This is done in SolidWorks and measured.



illu. 123: 6 & 12 tables stacked together and their depths

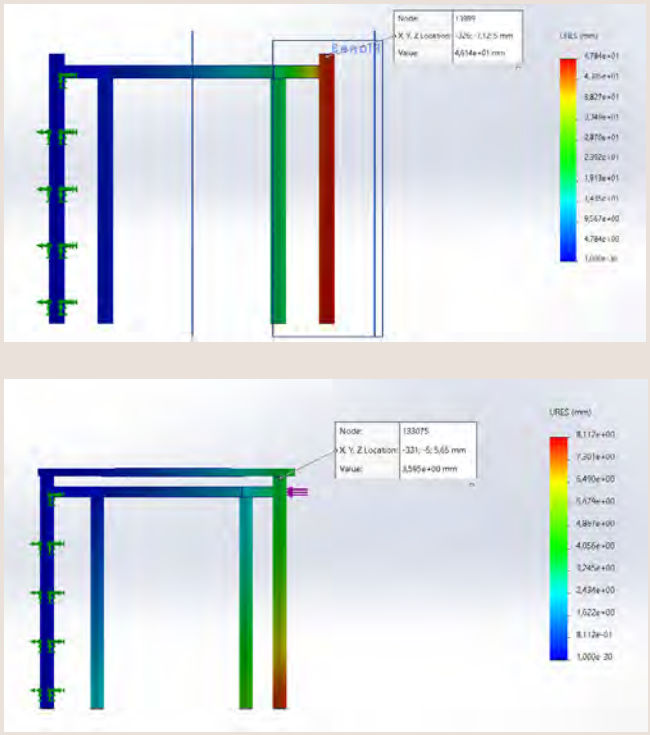
From illu. 123 it is shown that the tables actually fill 1260x700 mm, which wouldn’t be acceptable if there wasn’t a possibility to stack more tables, however with Re:Form more tables can be added to the stack which would then make 12 tables fill 2140x700 mm which is a lot less 2400x700 mm which is what four ‘normal’ tables would fill.

As the hinges cannot rotate more than 25 degrees, the frames will clash with each other when stacking before the hinges activate their backstop. Therefore, the hinges don’t get any additional forces applied to them while the tables are being stacked.

Critical Test

The two designers at Højer Møbler expressed their concern about a table without four aprons (appx. 41). So instead of just adding the apron (appx. 46) and reworking the entire concept, the task of proving the stability of the product without it begins (appx. 47). The problem is deemed to be the relationship between the two back legs, as there is no apron between them. The stability needs to be provided by the rest of the frame and the tabletop. To understand the forces and their impact it was tested on the prototype (illu 124). This is a worst-case scenario as the load on the bottom of the legs maximizes the torque force and load in the hinge.
As shown on illu 124, for a pupil to apply this force it is a case of deliberate misuse. They would have to tilt the table and sit or jump on the end of the leg. The prototype fails as the two screws in a hinge begin to get pulled from the tabletop. As shown on illu. 124 the hinges aren't dimensioned for the load but can be scaled up easily. To get a more accurate representation the load was moved in the FEA to the aprons as this would be a more likely spot for a pupil to impact. Through the FEA the deformation with the proper apron dimensions of 30x30mm (appx. 47) was determined (illu. 125). This was made both with and without the tabletop, to understand its importance for the overall stability. As the tabletop acts as the fourth apron, its effect is shown to be huge. It reduces the deformation and its direction from bending the burdened leg directly across towards the opposite, to warping the tabletop, effectively moving the loaded point downwards more than across.

illu. 124: Critical area



illu. 125: FEA of the frame

Why is this okay?

All this is deemed sufficient for Re:Form to be stable due to multiple reasons. As this is shown this scenario only happens when someone deliberately misuses the table. As the castors also have a weight limit the table should never have any load in normal use that is big enough to cause problems due to the missing apron.

This should mean that the screws are the weakest point in case there is misuse, either as they are sheared or more realistically pulled from the top. Shearing shouldn't happen as each hinge is held on by four screws, and with slightly oversized holes in the hinges, there would be a significant amount of friction to overcome before shearing starts. The screws are placed to prevent being pulled from the wood, and there are more than the two that were in a hinge during the test with the prototype. A cautious calculation shows that the force necessary to pull the screws is at least 979 N applied directly to the screws (appx.47). On top of this there is the amount of force that the frame and tabletop can absorb.

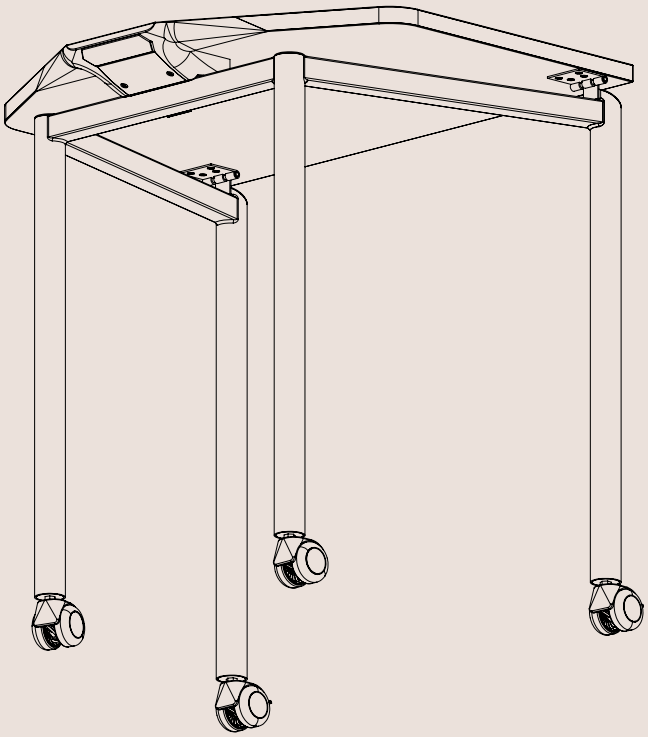
Re:Form can with these slightly larger aprons and a beefed up hinge, function without the fourth apron, while still being a durable table.

Chapter 8:
Construction Detailing

This chapter present the final product architecture and the different production methods used to create the table. Lastly a price estimation for a 0-series is made and in connection with that a comparison to the market prices.

Product Architecture

As the complexity of the parts in the product varies greatly, some of the more complex sub-assemblies will be shown in the following chapter. Much of the product is made of steel, no specific alloy is mentioned, as the manufacturing company will make the final choice based on their knowledge.



illu. 126: Re:Form wireframe

Re:Form

1x Tabletop - Plywood w. laminate
1x Tray - Steel
1x Nose body - PA
1x Nose shield - PA
1x Nose button - PA
1x Nose plate - Steel
4x Legs - cold rolled steel
3x Apron - cold rolled steel
1x Eye - Steel
2x Hinge - Steel
2x Angled end caps – PE
1x rectangular tube - cold rolled steel

Standard components

2x Domed end caps
2x End caps Ø38 mm
2x Castor
2x Castors with breaks
1x Spring
Varius screws

Production

Multiple parts of the product' production processes should be confirmed with the manufacturers, to ensure not only that it can be done but also fits their processes.

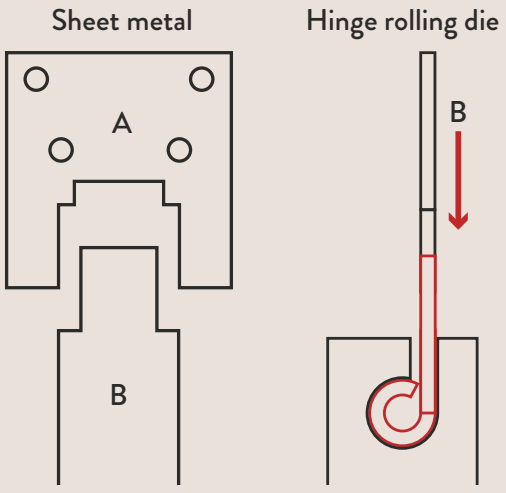
The Frame

The frame is made using cold rolled steel (Thompson, 2007, pp. 110-113) and cut and welded in the same manner as the industry uses today, on similar products. Whether they use straight cutoff methods like a bandsaw or a CNC to make the aprons hug the legs better will be up to the production and their capabilities. To achieve the cavity for the teacher key, the frame is cut and a hydraulic press deforms the tube (illu. 127). The entire thing will be powder coated afterwards

illu. 127: The two cuts available

The Hinge

As the hinge also acts as the top stop for the tabletop, it is specially made. According to Højer Møbler this isn't a problem as instead of an off the shelf hinge, the manufacturer might prefer producing the hinge. It can be cheaper for the manufacturer to make the hinges by themselves because they can optimize their production flow (appx. 41). This allows them to use a steel alloy they are comfortable welding in, and as they are cutting (Thompson, 2007, pp. 248-253, 260-275) and bending (Thompson, 2007, pp. 82-87) the hinges, creating a custom should be the same process, thus not being a large expense. (illu. 128)

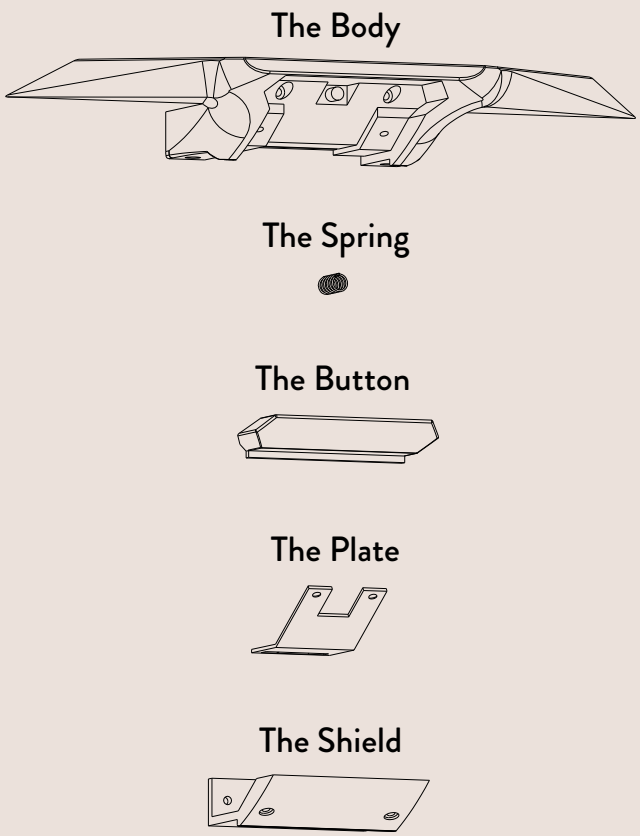


illu. 128: The way the hinge is made

The Nose

The nylon (PA), parts are injection molded (Thompson, 2007, pp. 50-51), and must be optimized with the supplier, in terms of material use and strength. The specific polymer should be chosen based on production cost, strength, and finish. The geometries are designed to be molded by a simple two-sided mold. Only the body needs a third element as it has a small cavity and two through-holes that need to be from a separate an-gle, that can possibly be combined with the ejector pins. The color change in the molding process shouldn't be a problem as a plastic process technician has stated "*If you just have to change the color it shouldn't be expen-sive as it only takes about 5-10 minutes to change*".

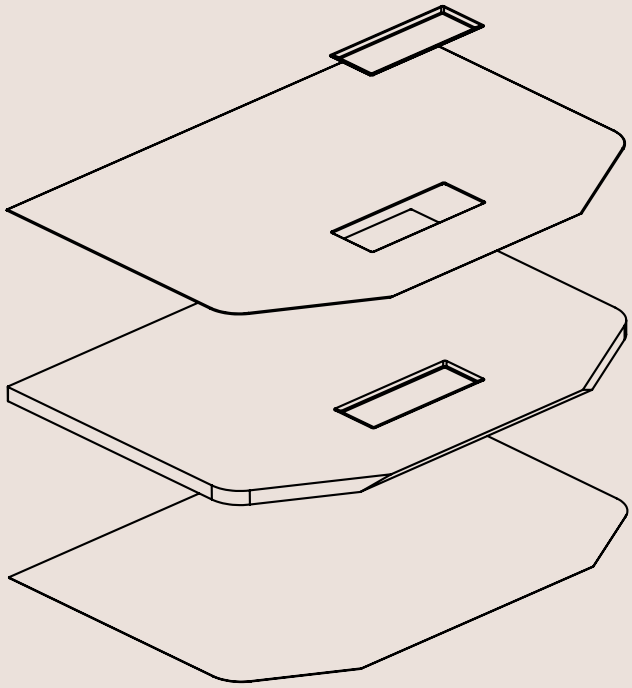
The nose is assembled onto the tabletop, starting with the four screws that hold the body to the top. The plate and button are joined with screws and are placed in the body with the spring. Lastly, everything is kept in and in place with the shield held by another four screws. (illu. 129)



illu. 129: Exploded view of The Nose

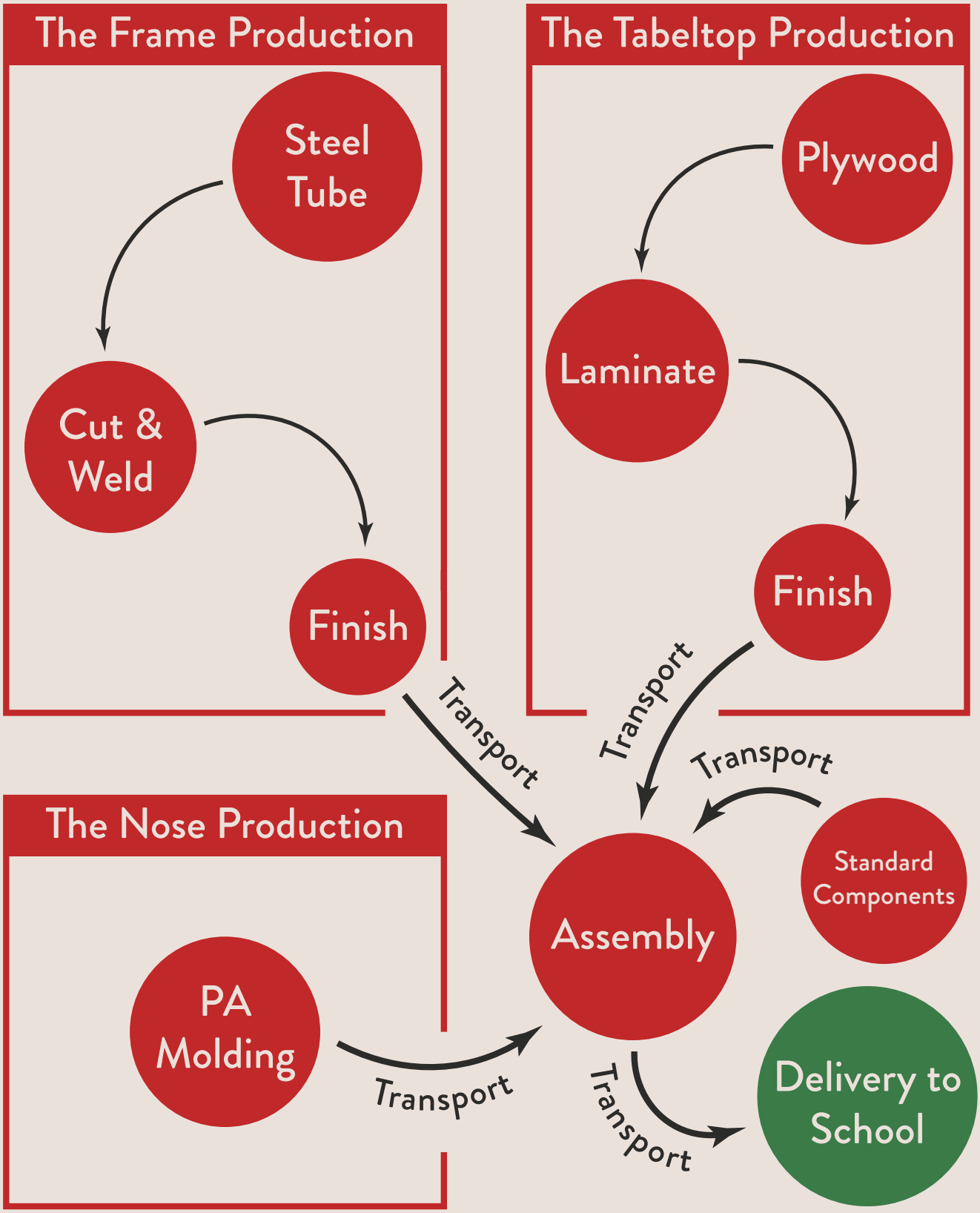
Tabletop

The plywood core (Thompson, 2007, pp. 190-193) is chosen over particleboard or MDF as it cuts down on the process in production. All materials are structurally sound, but only the plywood edges can be finished directly, but the money saved here is unfortunately spent on plywood itself as it is more expensive per board. The latest visit to Højer Møbler confirmed "In the end, both plywood and particleboard with finish cost roughly the same" (appx.41). This ensures a proper edge behind The Nose if the users should get in there. The plywood surfaces will be covered in laminate and backing paper (Thompson, 2007, pp. 206-209), to prevent warping, and lastly, a section will be routed out to glue in the tray. (illu. 130)



illu. 130: Exploded view of The Tabletop

Supply Chain



illu. 131: Supply chain

Price Estimation

The end customer price can't be specified for the product as it isn't polished regarding production, while being for a market with large volumes. The economy of scale is a clear factor for this product as tables will not be sold as individual units but as sets of around 20-30 tables per class. If the product is a success, it will be sold in thousands not hundreds, this benefits production costs as they should decrease with the larger production.

As discussed with Højer Møbler, Re:Form adds value to the classroom that a static table does not, therefore it can cost more. However, this cannot justify it being double the price, as the schools' economy still needs to keep up. So, a middle ground where the costs are covered, and the schools can afford it, needs to be reached. (appx. 41)

The price is calculated based on an initial production of 100 tables. This matters as the price per unit goes down, the larger the production (table 4). The finished price isn't calculated fully as only some of the parts are priced. This is in part due to gathering prices wasn't prioritized and at the latest conversation with Højer Møbler they agreed that the targeted price should be 2.500DKK or below and that didn't seem unrealistic (appx. 41).

The prices gathered are based on parts that can be ordered in bulk, estimates and in talks with Nytech A/S. The markup the sales price is calculated with is 4, realistically that properly isn't exactly it, but it is expected to be close. (Appx. 48)

Frame	Hinge	Nose	Wheels	Plywood	Laminate	Tray	Paint	Spring	Hardware	Assembly	Production cost	Sales price
474 DKK	Unknown	100 DKK	65 DKK	68 DKK	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	708 DKK	2830 DKK

Table 4: Overview of the costs in production of Re:Form and sales price

Comparison to The Market

As the market consists of a lot of static tables, a slightly more nuanced selection has been chosen to compare. The tables are picked from the competitors on the market based on how accessible their pricing is. Lekolar and Uniqa' pricing is from their public web shops, so it is unknown whether they are the same price in tender agreements. The one from Højer Møbler is their listing price (appx 41). All prices excluding VAT. (table 5)

Name Seller	TriTable-III Uniqa	LiteTable ST Uniqa	Helle Lekolar	Divis Lekolar	School table 70x60 Højer Møbler
					
Feature	+ Stackable + Flexible layout - Movable	+ Stackable - Flexible layout - Movable	- Stackable - Flexible layout - Movable	+ Stackable - Flexible layout + Movable	- Stackable - Flexiable layout - Movable
Price	1.095 DKK	2.236 DKK	2.150 DKK	3.985 DKK	1.600 DKK

Table 5: Overview of competitors features and pricepoint (UNIQA group, 2022) (UNIQA group, n.d.) (Lekolar, n.d.b) (Lekolar, n.d.a) (Højer Møbler, 2024)

The targeted price for Re:Form is 2.500DKK., which lands it above most of the tables, but significantly lower than Devis. The table that most closely resembles the ease of stacking a significant number of tables in a small space. All tables that are stackable need to be lifted partly or completely, so they have the feature in a lesser version. Even though a 0-series wouldn't be this affordable, it is at this price range that is realistic if there should be any chance for public schools to afford it.

Current tender agreements might not allow it, but to some extent, there could be a campaign towards using the budget from other classroom furniture here. Not that there shouldn't be other furniture in the classroom but that some of the furniture is less relevant paired with the flexibility Re:Form grants. There isn't the same need for some of the furniture such as separate group tables or static reading nooks in the back of the classroom when the layout becomes flexible.

Chapter 9:
Market Plan

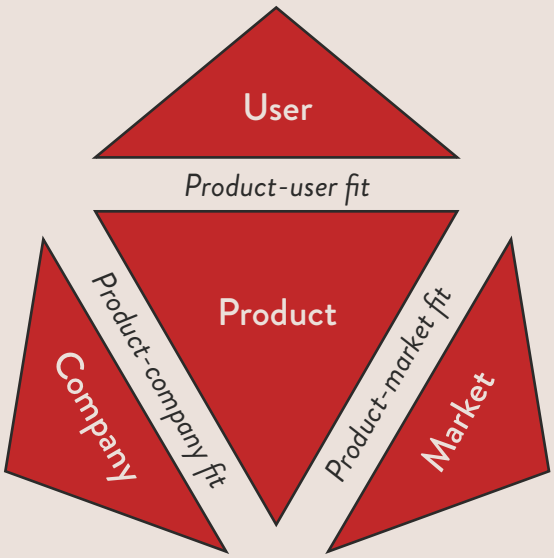
This chapter examines the strategic durability of the table and how it is going to be implemented on the market, lastly a business plan is created for Re:Form.

Strategic Durability

To accomplish a new dynamic in the classroom through the development phases different focus points have been used to strengthen the strategic fit. In the phases all three directions has been used to achieve a stronger product-user fit, product-market fit and secondary in this project product-company fit. These categories have been used to implement a long-lasting product to the market. (Laursen & Haase, 2023)

Product-user fit

The project has several different stakeholders, but the most important is the daily users that the product is aiming towards. The project is dealing with the teachers' and pupils' interactions throughout the school day to heighten the learning environment. The tables offer a new approach to teaching in the classrooms with a movable table that gives the opportunity to change the layout, by utilizing the stacking and table geometry. This table meets the user's needs, behaviors, and dreams for a new dynamic, but an even stronger product-user fit can come through in a maturation phase to heighten the interaction and simplification.



illu. 132: Strategic durability (Laursen & Haase, 2023)

Product-Company fit

Secondarily, has the product-company fit been used actively while looking into the market competitors where an established player is necessary for the product to enter the market. The product mostly adapts into Højer Møbler that are the front runners on the Danish market when looking into furnishing a classroom, especially their Zap-concept (Højer Møbler, 2023). This concept adapts into the category of alternative ways of understanding a classroom. Therefore, it seems to be a match to extend their portfolio with another solution that challenges the classroom (pp.68), as they could see potential. A stronger product-company fit can be achieved through a maturation phase, where the product can be sold to example Højer Møbler for further development.

Product-market fit

The project is aimed at defining a new way of seeing the classroom, by finding the golden mean of the flexible learning environment (dream) and the reality today. Through market research and analysis show that it can provide a new and innovative classroom dynamic for the school environment that can be worth the buyer's (Janitor or Principal) investment. The tables differ from the rest of the market with their unique features to changes through a lesson that gives the advantage of something extra to challenge the standard tables in the tender acts. The strong product market fit aims to strengthen a company's market position, but success is unknown before it reaches the market.

Market Implementation

The implementation of the product on the market must go through an already established company on the market, such as Højer Møbler. These companies already sell to schools through the tender act and SKI agreements and have products for all the different categories. It is not possible to compete with these companies through the agreements when only having one product to sell.

The product will be placed in the SKI agreements category for pupil tables alongside other competitors on the markets proposals to the schools. Therefore, the starting point will be to sell the tables and for every sixth table ordered, a teacher key will be included. (illu. 133)

After the visited schools it has been seen that a class consist of approximately 22-25 pupils. This will result in having approximately four or five teacher keys. It will give the opportunity to make clusters of five or six stacked tables, that relates to the larger layout opportunities the tables gives and it is not necessarily possible to stack all tables in one row in the classroom.

Market Implementation

Product

Re:Form

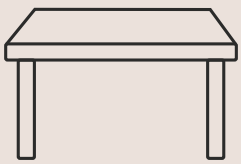
Company

Højer Møbler

HØJER

SKI Catagory

Pupil Table



What is offered

A Set

6x Re:Form
1x Teacher Key
1x Key Board

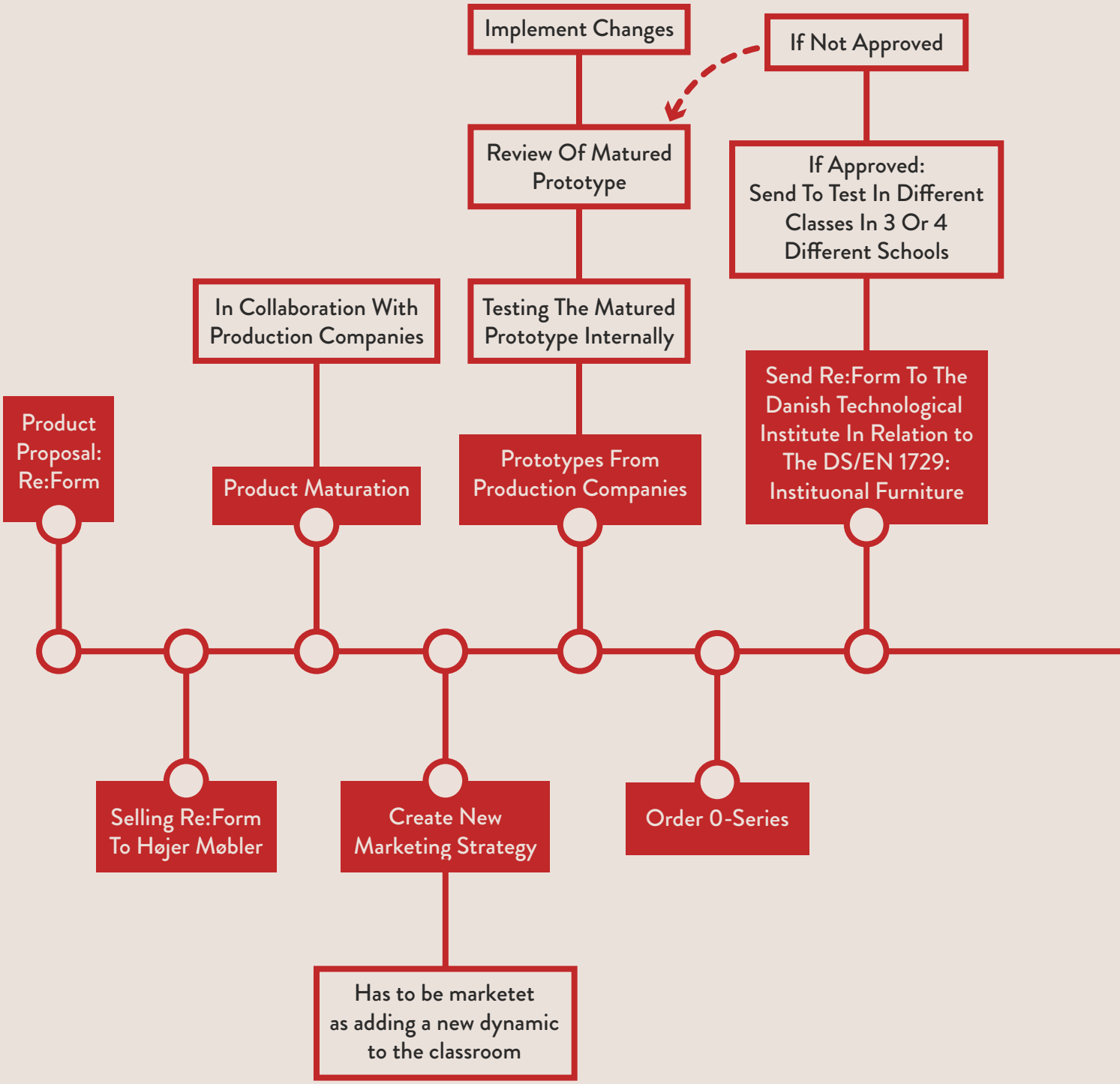
For a Class of 24 pupils

4x Re:Form Set

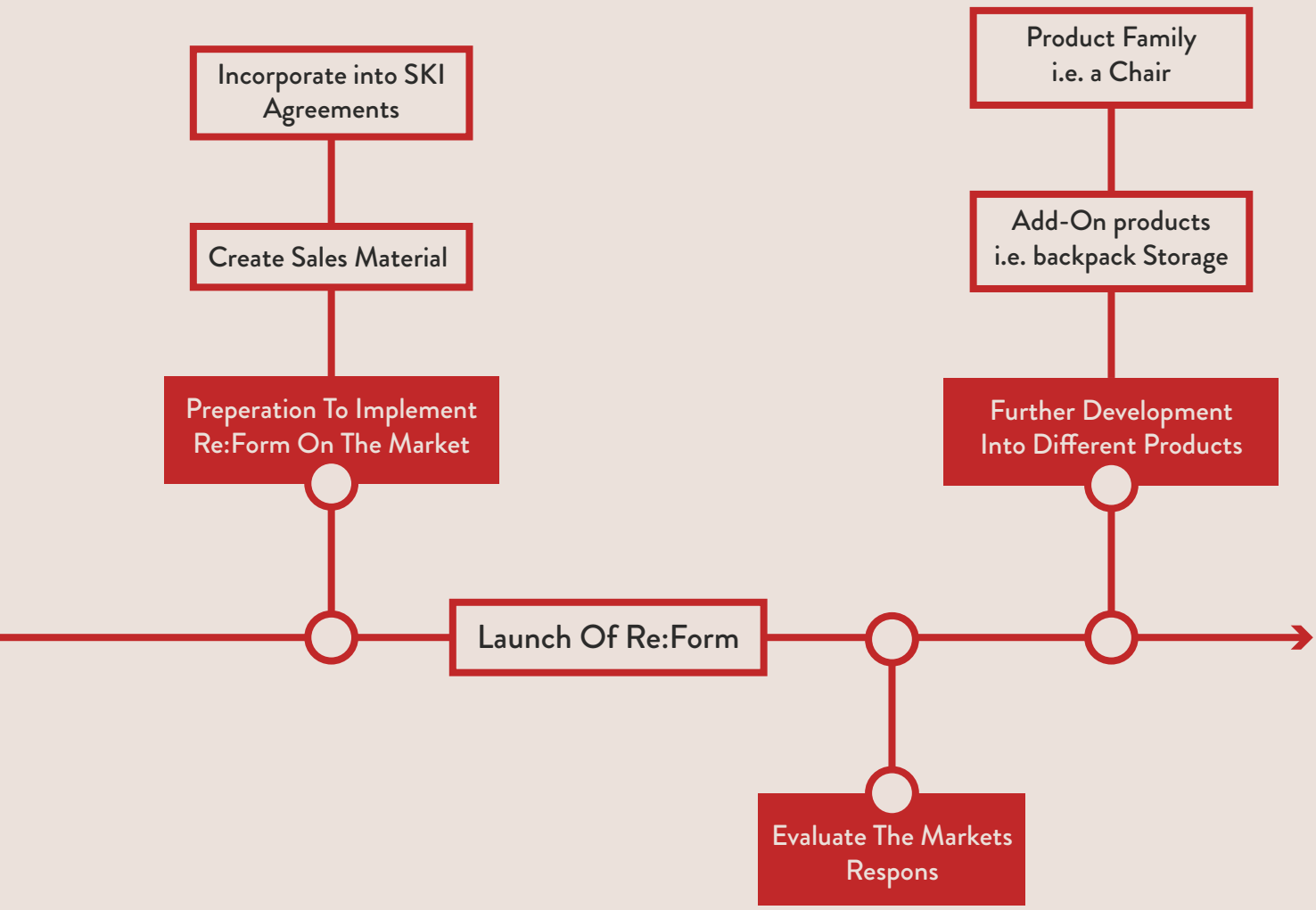
illu. 133: What the Re:Form package is

Business Plan

To implement the table on the market a business plan is made. This plan follows the idea of selling the concepts to one of the established companies on the market. In this situation, Højer Møbler has been used as a reference because they have been the company that helped the project gain insight into the market, through research and multiple visits to their office to evaluate the product. Additionally, it is based on using Højer Møbler's connections such as steel manufactory Nytech A/S. The only type of manufacturing which is unknown if they have a connection to is plastic production, so this connection would possibly need to be established.



illu. 134: Business plan


Incorporate into SKI Agreements
Create Sales Material
Preperation To Implement Re:Form On The Market
Launch Of Re:Form
Evaluate The Markets Respons
Product Family i.e. a Chair
Add-On products i.e. backpack Storage
Further Development Into Different Products

Epilogue

Product Specifications

Specified

1. Can be moved by a 1. grader (D1a)
2. Can be used in 1. To 6. grade (D1b)
3. The materials can withstand daily use and wear (D2)
4. Can be disassembled into the different materials (D3)
5. Can be maintained and repaired by the janitor (D7)
6. Is a 1-person table at W70cm x D56cm (D5+18+20)
7. Allows the teacher free choice of activities in lessons(D9)
8. Re:Form gives layout opportunities for 1 to 6-person groups (D10+16)
9. Eligible for the SKI category: pupil table (D11)
10. Complies with the current industry standards – DS/EN-1729 (D12)
11. Re:Form moves quietly as it is on castors (D13)
12. Re:Form comes in 3 fixed heights of 60, 66 and 72 cm (D15)
13. The worktop can fit the pupils school supplies (D17)
14. 6 tables can be stacked in 126cm (D21b)
15. When stacked the tabletop has a 20-degree angle (D21c+21d)
16. The tabletop is locked horizontally when not stacked (21c)
17. Castors have brakes so it is stationery (D22)
18. The pointed front of the table provides a visual connection between tables (D23)

Remains to be verified

1. Must have a long lifetime (D4)
2. Must have a price of 2.500DKK or lower (D6)
3. Pupil must be comfortable when using the furniture (D14)
4. Take less than 2 minutes moving the tables between constellations (D19+13a)

Conclusion

Re:Form is a table suitable for an active learning environment that attempts to bridge the gap between the market's dream and the school's reality. This golden mean is accomplished by making a pupil table that acts as a normal table, however, keeps some features hidden until used. Re:Form tries to reform the way that the normal school day is structured, and activates the pupils during their education, and by that makes the learning aspect of education flow easier. With Re:Form the teachers has been given a product that can suit to the teacher's specific needs for a specific task, and thereby making the lessons more interesting and enticing for the pupils.

The aim for Re:Form was to give the teachers and the pupils a table they both could see as a tool for themselves and create a new way for the traditional classroom to function. This is done by making each of the tables movable and stackable by the pupils and making sure that pupils in the 1. grade and up to 6. grade can use it. The teacher has the possibility of creating groups of pupils from one and up, and therefore making it suitable for classes with up to 28 pupils. Moreover, the teachers now have the ability to create floorspace with Re:Form, as the table is able stack away and reducing the space the tables take up significantly.

The construction of Re:Form makes it possible for the janitor at the schools to replace broken parts of the table, the nose can be disassembled, taken off, and repaired or replaced as necessary, the tabletop can be removed and replaced if broken or damaged.

Reflection

Product

The Function

What Re:Form should be able to do is fairly simple: tilting the tabletop so that it can be stacked and at the same time act as a normal table with no moving parts, is tricky. The solution that is presented is a locking mechanism that is not tested entirely, in principle this should work however, with no 1:1 prototype of this solution it is not a statement of “it works”, but a question of “How well does it work?”. If this solution doesn’t work, the consequence would be to redesign the locking mechanism.

The Hinge

As the hinges are holding and tilting the tabletop, the hinges are a critical area, not only from a construction standpoint, but also from an interaction standpoint. From the design standpoint the interface between the tabletop and the hinges are not optimum and should be reevaluated. When the tabletop is tilted, the area between the tabletop and the back legs makes it possible for fingers to be pinched, as it lives up to the standard there is some clearance so you can’t get skin caught but there is still a risk of pupils getting hurt.

The Business side

From the business side of the product, it must be incorporated into an existing company’s portfolio, and it would be very difficult to create a company ourselves, because if the product is going to be able to be inducted into the SKI agreement, the company must have a 2.5 million DKK turnover. If it isn’t possible to work with Højer Møbler an alternative route to reach the SKI agreements is to be represented by Holmris B8, as they represent a lot of companies. This would mean that the product maturation is done by us and would give us complete control over the progress made, however, a lot of financial support is needed, as all the expenses are covered by us. This would mean that before the product is on the market, there is no income.

Is it better?

From a functionality aspect Re:Form should improve the daily school day, however after a ‘honeymoon’ phase, the teacher could settle back into the routines they had beforehand, and could render the products’ functions useless. This would result in the table being used as a normal 1-person table and all the opportunities the table promises would fall to the ground. This would either be because Re:Form’s features aren’t working as we expect or because the product isn’t user-friendly enough, so looking into this would then be necessary.

Process

Testing with an entire class

To test Re:Form in a real-life scenario, 20+ tables must be manufactured, and in the timeframe of our project it wasn’t feasible. This results in a lot of theoretical assumptions for the table, and there could be some pitfalls in the day-to-day use of it that is unaccounted for. For one instance the timeframe of how quickly the layouts can be changed and be stacked hasn’t been tested. However, the potential of the table sees it doing it quicker than today’s solutions and is a feature rather than a hindrance.

The school's budget

In the beginning of the process, we were swiftly introduced to the tender act, SKI agreements and the school’s limited budget, so each time a concept was created the one thing in the back of our minds was cost. This resulted in various solutions being shut down through the process as it would be too expensive to incorporate, however, if one of these solutions were chosen, and could have been simplified and done cheap for to implement in the table. This could have turned the process in other directions, and a different outcome would have been the result.

A simple table can be complex

In the beginning of the process, all of us were quite curtain that this challenge would be based more on user behavior and aesthetics than a functional challenge, however after researching the standards, visiting the schools and Højer Møbler it quickly became a more functional problem. Through the process there has been a lot of ‘if one thing is changed, seven other problems pop up’ which normally isn’t quite as severe. The focal point of these problems came from the table tilting, as each change to the form or height or anything would result in tilting. The tilting study presented in the project doesn’t have a safety factor on top of the standards, the final design proposal is therefore on a fine line of success and failure from our perspective, as functionally this would be more comfortable.

As the “product cost” was in the back of our minds, it resulted in a lot of risk thinking and not opportunity thinking. Further the stakeholders are four different user groups which amps up the complexity, the two users (teacher and pupils) are not the ones buying the product, and the one that is buying the product (the janitor) isn’t deciding how much he can spend, and the one deciding the budget (School principal). This creates a labyrinth of opinions that can interfere with the needs and wants, that was navigated throughout the project and at best makes it confusing at times.

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Illustration List

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