AALBORG UNIVERSITY

MAY 2017

INDUSTRIAL DESIGN

MSc04

PROCESS REPORT

Cumu

JEPPE BORCHERS JENSEN
& MATILDE EILERSEN

TITLE PAGE

Aalborg University
Architecture and Design
Industrial Design
2017

Project Title: Cumu
Project Group: MaID4-12
Project Period: 01/02-2017 - 18/05-2017
Main Supervisor: Nis Ovesen
Technical Supervisor: Jørgen Kepler
Pages: 18

ABSTRACT

This project seeks to innovate the way classical musicians bring their music stands and accessories, that until now, have been clipped onto various unrelated music stands.

The design is based on pinpointed problematic consequences commonly seen in the current solutions, including unmanageable folding mechanisms, crude fastening methods, and general lack of coherence between music stand and instrument specific needs.

The project investigates the seeming disconnection between ultra compact designs, and the user scenario aspired. The very compact music stands have a valid place in the market, however a common practice in the market is to simply scale the very same structure in order to make a more stable stand.

The project focuses on identifying the needs of various musicians and creating a music stand that can be customized to these user's needs, without having to attach additional products that look alien to the music stand.

Cumu is bought as a standalone product, with the possibility of buying modules specially designed for specific user scenarios. The music stand takes form as a complete music station e.g. the trumpeter that needs somewhere to hang a mute for quick mute changes, or for the flute player that needs somewhere to place a secondary flute.

The product seeks to look at a range of classical musicians in a holistic light, creating a platform for neat customizability.

TABLE OF CONTENT

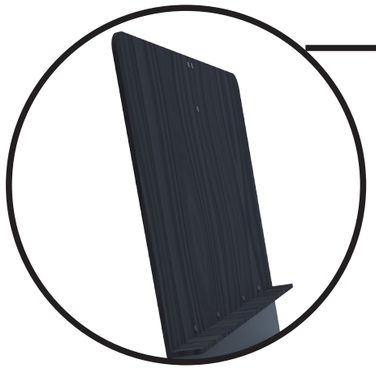
MEET Cumu

Introducing the new way of bringing music with you. Cumu can be customized to your needs, whether you are are a trumpet player in the need of a mute holder, or a flute player that needs quick access to your secondary flute.

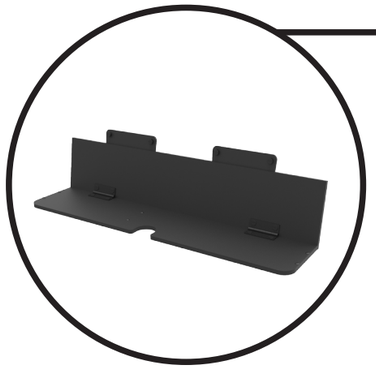
With Cumu, the modules stay on the music stand, no need to unclip, unscrew or otherwise dismantle your entire setup. They can simply be folded in before packing up the stand.

Gone are the days of squished fingers and over-tightened screws at the joints. Cumu reinvents how you set up your stand, making setup as straightforward as ever before.

WHY CHOOSE Cumu



Bring the comfort of having a firm backplate for your music, and make notes in your sheets with ease.



Customize yur music stand to your needs, while preserving a neat expression and easy setup.

No more struggles trying to tighten the joints properly. The joints are just as easy to unlock with the flick of a lever.

The profile of the telescopic tube ensures that it only follows the motion it is intended for, up or down.

TRUMPET 01

FLUTE

TRUMPET 02

BOTTLE

SETTING UP Cumu

1

Hold Cumu by the top

2

Fold the foot down until the lock snaps in place

3

Unlock the first joint, extend it, and lock it

4

Repeat for the second joint

5

Repeat again for third joint, if needed

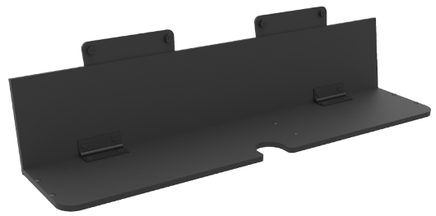
6

Fold the module down

DIFFERENT MODULES AVAILABLE

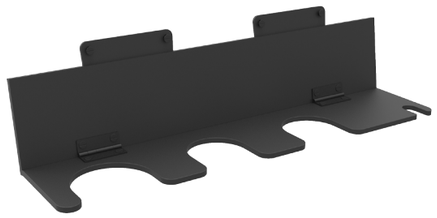
Buy Cumu, and create the music stand that caters for your needs. The flexible coating of the module protects your mutes, your flute or any other object from scratches, and avoids any unwanted sounds when placing objects on the tray.

Need somewhere to place your phone while practicing? Or your pencil, tuner, reeds or resin? With this module you have plenty of space for smaller objects.



Do you ever have long practice sessions, and need to have a drink at hand? This module lets you hang a standard water bottle, right where you need it.

Have your straight or practice mute readily available, right on your music stand. The open ended holder, makes picking up and placing the mute a breeze.



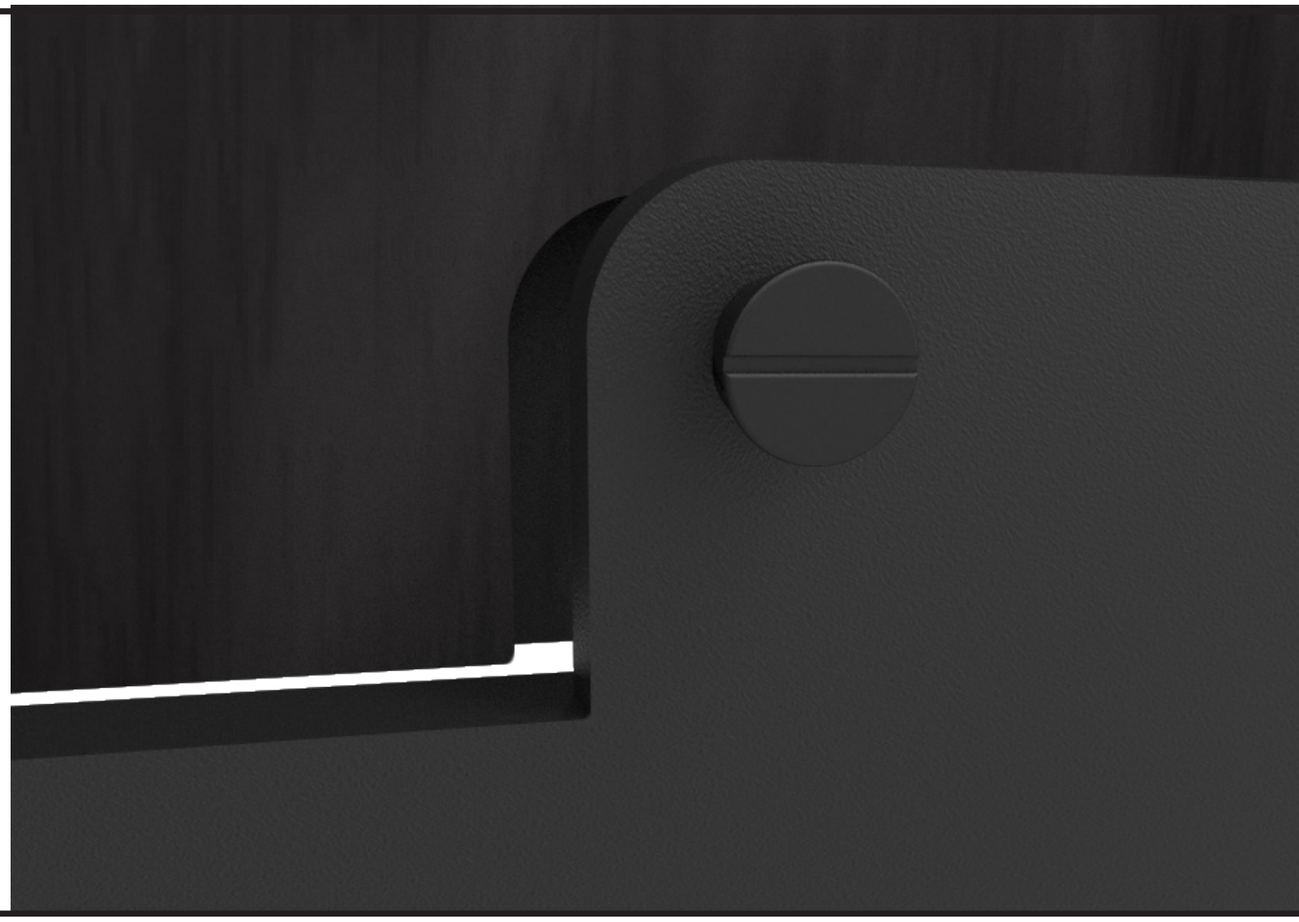
Now you can fit up to four mutes right on your music stand, while still keeping an orderly appearance.

COLOURS

Choose the surface finish that suits you.

MOUNTING OF MODULES

The module is simply aligned with the matching cut outs, and fixed with four screws.



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ill. 1 Group members.

Jeppe Borchers Jensen

Matilde Eilersen

PREFACE

This report contains the Master Thesis Project which describes the process of designing the product CuMu - a customizable music stand.

In addition to this process report, a product report, appendix and technical drawings have been developed.
This process report is accompanied by physical copies of:
A product report and technical drawings. Appendix and worksheets can be accessed on the attached USB-drive.

ACKNOWLEDGEMENTS

A special thank you goes to Mette Marie Matthiesen for providing us generously with information through several interviews, and helping us gain contacts in the symphony.

Thanks go to staff at Aalborg Symphony in general, for being available for interviews and giving us insight into their everyday lives at the symphony.

Thanks to everyone at MGK Aalborg, Vester Hassing Tamburkorps, the big bands Swingtime and Birdland, for being so open and willing to help during the project.

READING GUIDE

A collection of worksheets that contain additional content have been added to the appendix. The remainder has been left out. These worksheets are not targeted towards the reader, they merely serve to add transparency to the project, giving the curious reader the opportunity to further investigate the process and gathered data.

Tests and tasks in the detailing phase are not all in chronological order, unless it highly influences the understanding of the process. Related development is gathered in batches throughout the report, granting the reader a better overview of each strand of development.

01

The report is divided into six sections; alignment-, research-, concept development-, product development-, market-, and the finalizing-phase. From 01 Research to 06 Finalizing. The corner markers indicate the current phases throughout the report.

The red triangles shows when a criteria for the product has been stated.

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INTRODUCTION

The group has been developing a music stand. The group members have no prior experience playing music what so ever, but were introduced to the theme through another intended project for this master thesis. The theme of music was found interesting, and a great challenge due to the lack of insight in the area, but also advantageous, since the group members could give the area a fresh take.

Several problem areas were found in relation to the use of the products already on the market, and a great potential was seen.

The focus in the project concerns customizability and easy setup. Customizability is generally not something considered by other products in the area, and is therefore a unique selling point. The setup scenario has been seen as one of the mayor problems in the existing products which could greatly benefit from being reinvented.

As to the customizability, several musicians have been interviewed in order to pinpoint particular needs concerning each individual instrument. The focus has been delimited to classical instruments.

The music stand is designed for the mobile musician, whose scenarios include bringing the music stand to various location to practice or play concerts.

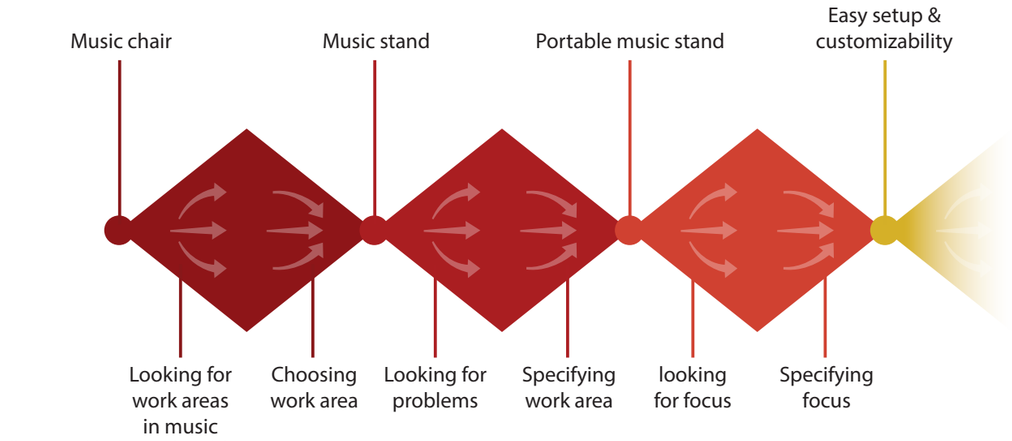
TABLE OF CONTENT

Phase 01
Alignment

METHODOLOGY

Method	Purpose	Page	Reference
Semi-structured interview	Collecting qualitative data from users, by bringing a structure for the interview that helps guide the flow of the interview. This helps collect qualitative data within a predetermined area, while the structure is loose enough to let unforeseen results emerge.	9, 12, 29, 30	
Interpreted Customer Needs (Eppinger)	Finding the user's underlying wishes for the product, by analysing e.g. data from interviews. The statements noted are interpreted and converted into needs. These can then be compared, paired and selected from the vast amounts of data.	18, General approach	[Eppinger, S.D. 1995]
Striim's model for idéudvikling	Idea generation through five steps. Step 01: identifying the focus area. Step 02: Idea generation for the focus area. Forced relations can be used. Step 03: Sketches are evaluated and combined. Step 04: Sketches are further developed upon. Step 05: Ideas are evaluated.	19, 22, 37	[Striim, O. 2000]
Forced Relations	When ideating, choosing objects that are more or less related to the ideation's focus. The found object or picture is then forced upon the idea, in order to break usual thinking patterns, and therefore opening up the creative thinking.	19, 22, 24, 28	
Stimuli	When sketching, more or less relevant stimuli can be used to help the creative process, e.g. looking at inspirational pictures, or getting inspiration from each others sketches during ideation.	General approach	[Eppinger, S.D. 1995]
Act It Out	Acting out various situations, putting oneself into the situation. Props can be used, such as mock ups, to get an understanding of various interactions. It can also be used as a communication tool. It is a phenomenological approach, revolving around experiences and feelings.	21,25, 27, 31, 32, 38, 39, 41, 42, 44, General approach	
Ghosting	To observe people, without interacting with them or disturbing their natural procedures, to gather information about behavior.	11,12	

PROJECT SCOPE



ill. 2 Double diamond model

The project started with the task of designing a **music chair**, unfortunately unforeseen problems regarding a collaboration with a company, a chair was no longer an option, and therefore a new area had to be sought out. Contacts with people within the music industry had already been settled, and the area of music had piqued the group's interest. An interview had already been held with musicians regarding the chair (p. 9), and the recordings of the interview were the basis for finding problem areas.

Aalborg Symphony and MGK Aalborg were visited to further search for problems (p 11). The **music stand** was chosen, since several problems were identified in this area (ill. 7). Further research led to focusing on **portable music stands**, due to more potential seen in this area in comparison to stationary music stands. Several iterations were gone through to find the focus area of the project (p. 22 and 27), and finally focusing on **easy setup and customizability**.

Phase 02
Research

INTERVIEW PIA AND METTE

Pia and Mette were interviewed. Pia is a music teacher at MGK in Aalborg, teaching piano and singing. Mette is a violinist in Aalborg Symphony Orchestra.

Purpose
The interview was set up in relation to the first project about a music chair (p. 7), and the structure of the interview was therefore not related to the theme of a music stand.
The interview which was recorded was therefore to be listened through, after the scope had been changed, to find relevant themes to work with.

Process:
The information gathered was listened through, looking for problem areas, and five themes were found.

Output
From processing the interview, five areas arose, creating a background for further research:
- Music stands
- Teaching children
- Placing of objects
- Violin "on the go"
- Standing while playing violin

"You can end up in some uncomfortable postures when teaching children. You need to get down at eye level with the children when teaching". Pia

"As a violinist student, you stand up while playing. You get a better posture". Mette

"We got new music stands - but they broke pretty quickly and were sent back". Mette

"The woodwinds have a stand to place their instrument on. The flutes have a small tray on the music stand." Mette

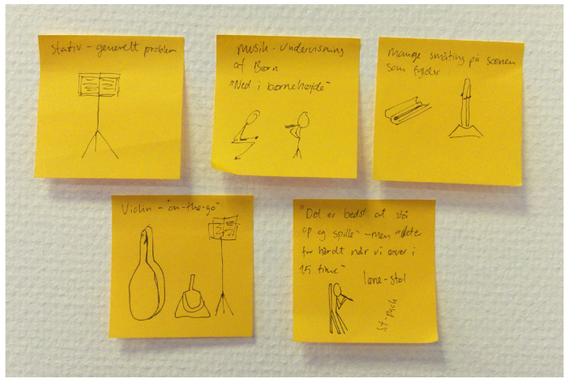
Statements from the interview are freely translated from Danish

PROBLEM MAPPING

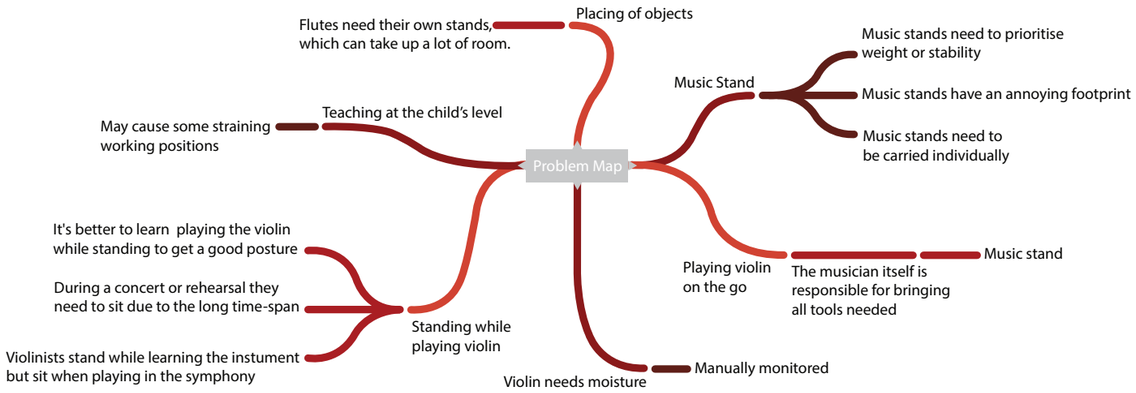
Purpose
The five areas (ill. 3) had to be further researched, to get a deeper understanding of the problems, getting background for choosing a direction.

Process
Research was conducted, and the problems further expanded.

Output
A map of problems was created (ill. 4). The map shows all the assumptions that have emerged, and will serve as a tool for collecting further assumptions during the coming field research. Furthermore, the research should help test the validity of each branch, in order to either prune the map, or mark the branch as trustworthy.



ill. 3 The five areas



ill. 4 Problem map, edition 01

OBSERVATIONS, PROBLEMS

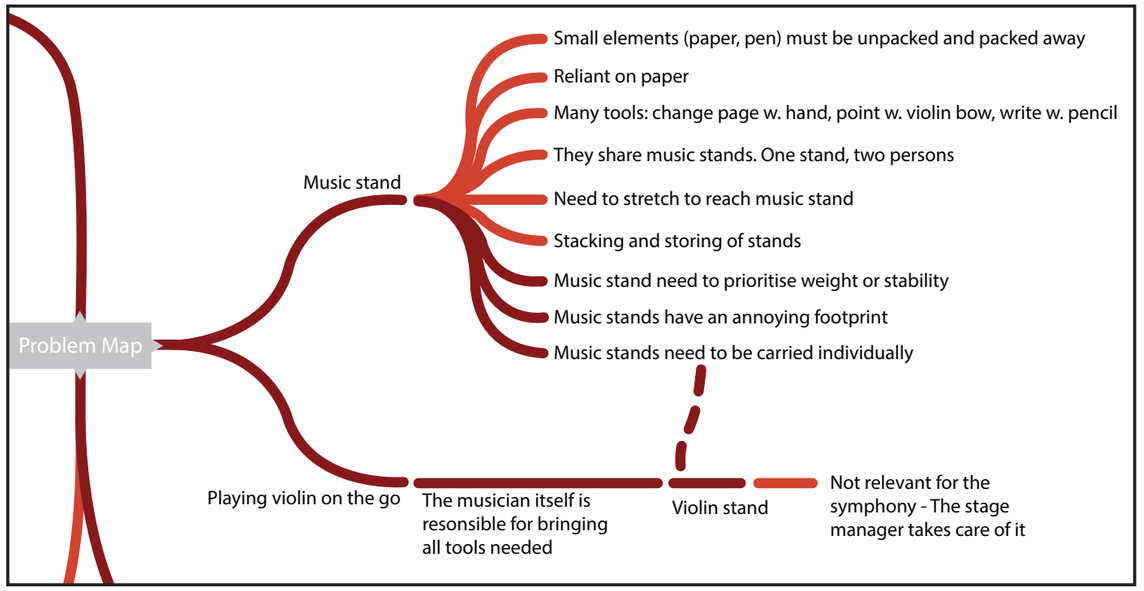
Purpose
The symphony and MGK were visited to observe problems and opportunities for a project. The scope was intentionally wide, looking for emerging problems. Meanwhile, a few work areas have been prepared that need their validity evaluated.

Process
While sitting among the audience, watching the musicians practice for four hours at the symphony, most observations were related to the use of music stands. The initial problem map was brought, and expanded afterwards with new details observed. At MGK, observations were also related to the music stand, and in general the interactions with the elements in the room. Besides from the observations, a short interview with two violinists in the symphony was arranged.

Output
When looking at the expanded problem map after the observations and the interview, it was chosen to work with either the problems of the music stand, or the theme of "playing violin on the go". The two areas were then, after elaborate consideration, brought together as one, where the focus would be looking at the action of getting ready to play music.

ill. 5 Visit at Aalborg Symphony Orchestra.

ill. 6 Visit at MGK Aalborg.



ill. 7 Problem map, edition 01

The map has been pruned, showing the area chosen to work with. The dark lines are from the original map, the bright lines are from observations in the symphony and MGK.

SETTING UP A MUSIC STAND

Purpose
After deciding on the direction, two areas had to be looked further into: The stage managers interaction with the music stand, and the musicians interaction with the music stand. The purpose of the meeting with the stage managers was to observe how they in the symphony set up the music stands, and to find where there is most potential, in two different scenarios: Setting up at Musikkens hus, and packing a truck when playing at another location.

ill. 8 Setting up at the stage.

ill. 9 Packing the truck.

Process
The stage managers set up as usual, while ghosting (p. 6) was made in relation to their interaction with the music stand. First, they set up on the scene, getting ready for the musicians to practise, and after practise they packed the truck for a concert out of the house.

Output
The stage setup is already very simple, so it must not be made more complex for them. As for the truck scenario, they already need to bring the truck due to the numerous other elements they bring, so a foldable version would not add much value.

Therefore, it was assumed that there is more potential to add for the individual musician.

Purpose
The purpose of this meeting was to document how a violinist from the symphony uses a mobile music stand, and to see if some further problems would emerge.

Process
A meeting was set up with Mette, a violinist from Aalborg Symphony Orchestra. It was documented by video (ill. 10), how she unfolded the music stand, unpacked her violin and got ready to play. Afterwards an unstructured interview was held, where Mettes music stands and music stands in general was discussed. Note sheets were inspected as well, which were all either A3 or oversized A3.

Mette mentioned in the interview that: "*If the top is not solid, it is difficult to write on, and light can shine through*". and "*We have music stands to bring with us, but they are pretty unhandy*".

ill. 10 Mette setting up music stand.

Output
Two mayor problems with the music stand were identified, seen in the statement, and transfered into needs (p. 16). After this meeting, **it was decided to focus on the scenario where the individual musician herself needs to transport her music stand to a location, and set it up, i.e. a portable music stand.**

The unhandyness that Mette mentions needs to be examined. What makes a music stand unhandy? (p. 14).

The music stand must have a uniform surface.
The top of the music stand must accommodate an A3 sheet (appriximately 30*40 cm).

DELIMITATION

It was the decided, that the product must be portable (p. 12). But what is portable? Seeing as many of the instruments are of a size that warrants transportation in the boot of a car, this project will aim at creating something to scale with instrument cases. Therefore, the portability will revolve around creating a convenient way to carry the music stand along with the instrument, instead of creating something as miniscule as possible.

When deciding on the direction, a digital solution was considered. Several scenarios were considered though. First, when watching a concert, it was found that it is not only about listening to the music, the scenography is as big a part of the experience. The whole setup around the symphony orchestra is very traditional, and there is something about changing to a digital solution (e.g. using a tablet) that could simply disturb the whole experience by e.g. removing the expressive flipping of pages.

Another thing to consider is the fact that mistakes might occur, and that more problems might actually be added to the current product. For example, with a digital solution, someone would have to make sure that there would always be power available, to avoid the scenario where the note sheets would run out of power in the middle of a concert.

This does not mean that there is no market for a digital solution, moreso that it is believed that there still will be a market for a traditional music stand in the near future.

As mentioned above, this explains why this particular project does not focus on a digital direction, and instead aims at nurturing the current act of musical performance.

TARGET GROUP

To delimit to a more manageable target group, it was chosen to target musicians playing classical instruments. Amongst the classical instruments, it has been further delimited from the very large instruments such as contrabass, drums and harp, since the instrument itself is not very portable, and therefore will not benefit directly from the scope.
People who follow the pattern of bringing their instruments in the trunk of their car, on the bus, or walk shorter distances with it can be: String instruments (Violin, Viola, Cello), woodwinds (Flute, Oboe, Clarinet, Bassoon, English horn), or brass instruments (Trumpet, French horn, Trombone).

As to the users, the violinist has been used as initial target group (P. 12), and a range of other classical musicians, such as students and amateur musicians have been involved later (p. 31).

FDF Vester Hassing Tamburkorps has been visited to get insight in relation to which elements they bring to practise/ concerts, and which kind of transport they use (WS 39), but their user scenarios deviate greatly from the main target group. Therefore, scenarios such as generally playing ourside in various weather conditions, marching while playing, etc. has not been further processed. They are not a part of the main target group, but has been investigated as individuals playing an instrument.

Scenario
The music stand would be used in several different scenarios, e.g. soloists playing at churches where the musician is expected to bring its own stand. This means the music stand will have to be packed up and bought and set up at the church prior to the performance.

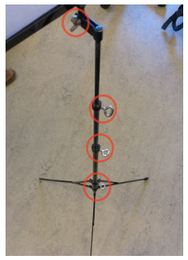
A different scenario is musicians having practice meetups, situated at locations that do not regularly facilitate musicians, or facilities where music stands are not available, and the musicians therefore need to bring their own.

ISSUES WITH CURRENT SETUP

Purpose
Looking at the type of music stand that many musicians use when transporting their music stand to another location, the foldable version (ill. 16), this sections seeks to illustrate the issues found in the interaction with the music stand when setting up (WS 41).

Process
The music stand was unfolded, and critical points were noted.

Amount of steps
Rotating the top Extending one part of telescopic rod Extending other part of telescopic rod Unfolding the foot Unfolding the top



ill. 11 Music stand.

ill. 16 Music stand

No natural resting point
The foot has no natural resting point, meaning the user has to hold the stand at an approximately appropriate angle while tightening the screw.

ill. 12 Foot.

No feedback
Neither of the joints have any feedback as to when it is tight enough to hold. This can lead to overtightened screws that take strain to release, or too loose joints, leading to the music stand collapsing when subject to a load.

ill. 14 Lock.

Rotarion of top
The circular profile makes it possible to rotate the joints, making it difficult when folding the top back down. i.e. they have to be turned in a specific direction to make the folding possible.

ill. 13 Top.

Special order of actions
When the cross bars are folded down, the top of the stand is locked in place. I.e. it has to be opened in a specific order, otherwise it will jam. There is no visual indication of this, and is something that needs to be learned in order to unfold it correct.

ill. 15 Cross bars jamming.

Output
Four criteria are found, that would ease the scenario of setup. If these four can be accomplished, it is estimated that the setup would be much easier. The four criteria are:

- **Locks provide feedback**
- **Having a resting point in the foot joint**
- **No folding mechanism that can jam if folded in wrong order.**
- **Removing a degree of freedom by not making a circular profile in the telescopic part.**

Reducing the amount of steps will not be a criteria, since **reducing the amount of steps might not in itself make the setup easier** In the current setup, it is not the amount of steps that make the scenario annoying, but the nuisance of the steps that are present.

MARKET

Purpose
The purpose is to see what is already on the market, and thereby differentiate from these, and to get inspiration and see which features must be incorporated.

Process
Several music stands on the market has been looked into. Four types that differ a lot are illustrated below (ill. 17). (For full analyse, see WS 9).

Mobile music stand

Very compact

Can be folded into a square (the size of the top)

The legs can be folded.

This stand can only be adjusted in height.

Stationary music stand

FEATURES	Stagg	RATstands	Supreme s.	Falk Magnussen
Weight (kg)	1	2,8	3,6	8
Price (kr.)	195,-	885,-	299,-	1927,-
Foldable	YES	YES		NO
Stackable	NO	YES	NO	YES
Height adjust	YES	YES	YES	YES
Tiltable tray	YES	YES	YES	YES
Tiltable rod	NO	YES	NO	NO

ill. 17 Competitor analysis.

The research showed that there are mainly two different types of music stands, the mobile music stand (Here represented by Stagg), and the stationary music stand (Falk Magnussen), and then there are some music stands in between.

The compactness decreases from left to right, and it is assumed that the stability likewise decreases from right to left. It hasn't been possible to test all four models, but it can be seen in the scheme that the weight increases, which could be an indication of the stability as well.

Output
It is desired to create a product which lays somewhere in between the two poles of a mobile music stand and a stationary one.
The focus lies in having an acceptable stability, like the stationary stand, while focusing on the mobile scenario.

It is also desired to create a music stand that offers something different for the users, that accommodates their needs more than the current music stands.

PROBLEM PINPOINTING

Purpose
It was made clear that it didn't seem like the problems and their consequences had been concretisized. This task seeks to get an overview, pinpoint each exact sub-problem, specify in what scenarios these problems exist, and get an overview of how they could potentially be documented and tested.

Process
It was noted in the problem-pinpointing matrix (WS 13), for whom each problem was relevant, and in which scenario. In the worksheet it is furthermore noted how the different criteria will be further tested.

Then the matrix was printed and each problem was cut out. The problems were sorted into three categories (WS 14):

The core needs, the elements that must be there when making a music stand.
The needs that are user/scenario specific (to the scenario of this project).
The wishes. The functions that could be nice to incorporate, but are not necessary.

A section of the scheme can be seen below. The full scheme can be found in appendix A.

Output
The output was the three categories shown in the scheme. The scope was later changed (P. 22), since some of the needs had no basis.

	Problem	Scenario	For whom?	Criteria	Source
CORE NEEDS	If the top is not homogeneous, it is difficult to write on.	If writing on top of a hole, the pencil has no support.	The musician when practicing.	There must be a uniform surface for the notes to be placed on.	Interview Mette p. 12
	If the top is not homogeneous, light can shine through.	Not having a full backplate means that light shines through from the back, making notes hard to read.	The musician.	There must be a uniform surface for the notes to be placed on.	Interview Mette p. 12
		Regular music note sheets are A4, but often part of a book, so A3 when folded out.	The musician.	The top must be at least x*x cm (bigger than A3).	Interview Mette p. 12
	Music stand is unstable	When having a stack of notes on the stand, it needs to hold the weight of it, while also being stable enough to have someone write notes on it without supporting in	The musician	Must be stable enough to be able to write on the notes when placed on the music stand.	Desktop reseach, own experience
			The musician.	The height must vary between x and x.	
SCENARIO SPECIFIC	Fingers can get stuck while setting up stand.	If positioned fingers incorrect, the user can be surprised that elements move in different directions, and the fingers might get stuck.	The mobile musician.	The product must show optimal interaction points.	Own use of fully foldable music stand.
	Stand is difficult to set up.	The tested stand has a certain order in which it needs to be unfolded, and it can be folded in the wrong way, jamming it.	The mobile musician.	There must not be a specific order in which you set up, unless this is very clearly indicated by the product.	Own use of music stand p. 16
	Music stand is heavy.	When carried a long distance, it can be unpleasant if the music stand is too heavy.	The mobile musician.	The music stand must have a weight below x.	Desktop research.
	For the height adjustment the user needs to use both hands.	This is problematic when holding an instrument.	The musician.	It must be possible to adjust the height with one hand free.	Own experience.
	Music stand needs to be carried individually	When going somewhere, the musician will typically carry their instrument in one hand, and the music stand in the other.	The mobile musician.	There is a need for the product to be carried along with instrument.	Desktop research
	Small elements have nowhere to be put while playing	Pencil, eraser and notes.	The musician when practicing	Small elements need somewhere to be placed	Observation symphony
W			T usician.	The product be able to tilt bet deg	

ill. 18 Section of scheme.

Phase 03
Concept development

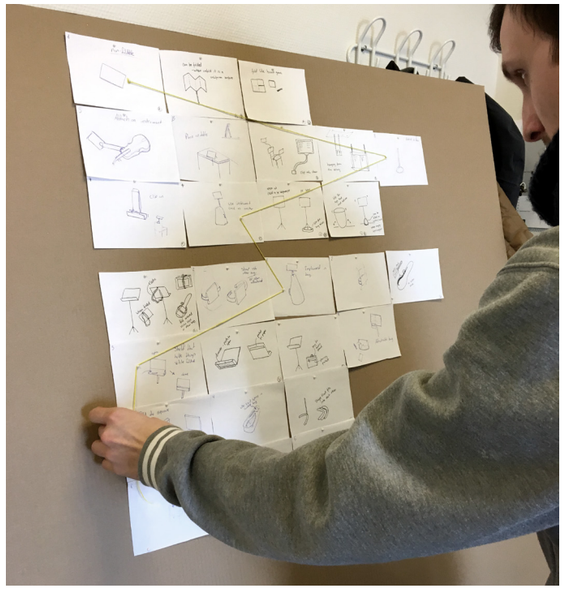
IDEATION 01

Purpose
To open up the idea generation, and to get three initial concepts ready for the first status seminar, this ideation was initiated.

Process
A list of problems were stated (P. 16 - but at this point a bit shorter). The problems were interpreted, using Ulrich and Eppinger's Interpreted needs [Eppinger, S.D. 1995].

First round
A sketching round was made where two of the needs had to be solved per sketch, picking the needs randomly. It showed that by using this approach, the result would be concepts that were too narrow and specific, since they did only consider some of the problems, and it was decided to start over.

Second round
Instead of full concepts, principles would be sketched for each need, at least two principles from each participant, resulting in 4+ principles for each need. Apart from the needs, core functions for a music stand were stated, and principles were sketched too. All of the principles were set up in a matrix, giving an overview, and then four different concepts were created by mapping principles together, that seemed like they would be a great match (ill. 19).



ill. 19 Mapping out concepts.

Output
Four concepts were created, where the three of them were brought to status. It was made clear that the concepts were too shallow to use further on, and **a new ideation had to be set up**, this time structured differently (P. 19).

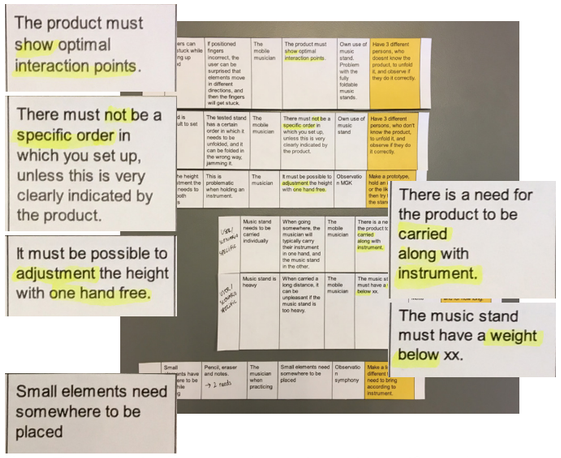
PRODUCT CRITERIA

Purpose
From the current project scope, it was considered how to structure the following idea generation.

Process
When getting ready for ideation, it was made clear that the massive amount of criteria would be too broad to idea generate from. If choosing only the user/scenario-specific needs, it showed that they could be divided into three categories: (ill. 20).

- Easy setup
- Convenient transportation
- Storing of small elements.

There was no clear indication to choose either one of the directions, and therefore it was decided to focus on the core needs initially, and then get back to the other needs afterwards.



ill. 20 The emphasized notes are the user/scenario-specific needs

Output
To set a common ground, all concepts in the following idea-generation should therefore meet the core needs:

- There must be a uniform surface for the notes to be placed on.
- The top must be at least 30*40 cm (approximate A3).
- The music stand must be stable enough to be able to write on the notes when placed on the music stand.

Since construction was something that had to be considered for any music stand, and an area that could be improved in existing music stands, it was decided, to get a more structured process, to **generate ideas upon the construction in relation to different ways to compact and de-compact the music stand**.

IDEATION 02

Purpose
The first ideation was quite limited, and therefore this ideation seeks to cover a more satisfying solution space.

Process
This ideation follows a structure inspired by Ole Striim's "Model for idéudvikling" [Striim, O. 2000].

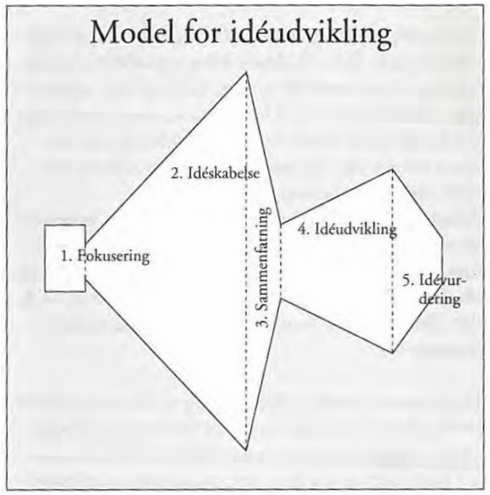
In the **first step**, the focus of the ideation is found. This describes what area, in which ideas are sought out. The ones used are the following:

"How can the top of the music stand be compacted and de-compacted?"
"How can the bottom part of the music stand be compacted and de-compacted?"
This focus was chosen, as this seemed like an area, in which current products have quite varying results, while the core needs of the music stand should be addressed in every case.

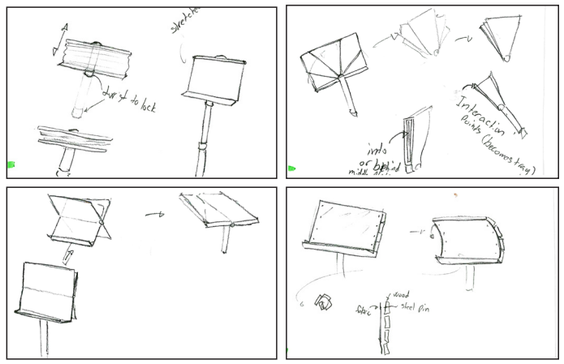
The **second step**, is where a wide range of ideas are generated. This step follows the mentality, that the more ideas that are created, the more likely it is that ideas with potential emerge. In order to help break the usual thinking patterns, pictures of a range of different compacting products were found. This amounted to 28 pictures, and forced relation was performed for each. For all sketches, see WS 15.

In the **third step**, the ideas are quickly sifted through for potential. The two categories of sketches were given colors depending on how much potential was seen in each sketch. Red: No potential, Yellow: Some potential, Green: Great potential. Then the sketches were pinned up, to get an overview.

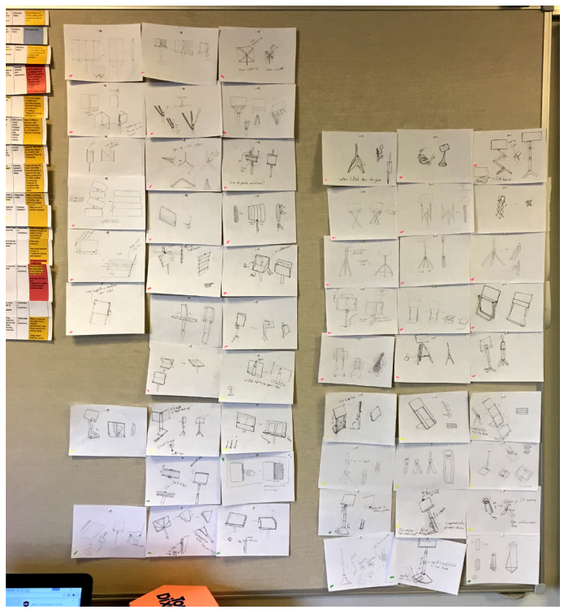
Five combinations of top/bottom were picked out and combined, to get a full idea of a music stand.



ill. 21 Stiims model



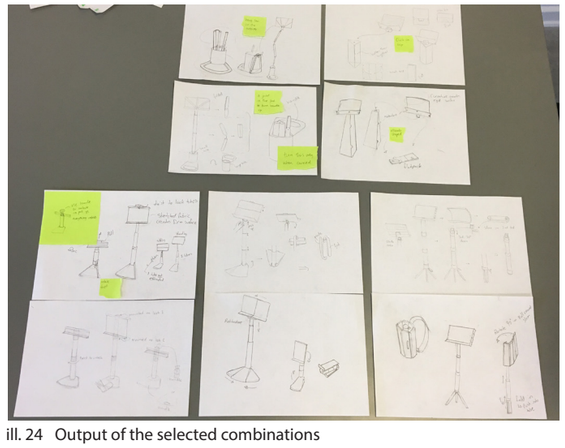
ill. 22 A selection of ideas for the top.



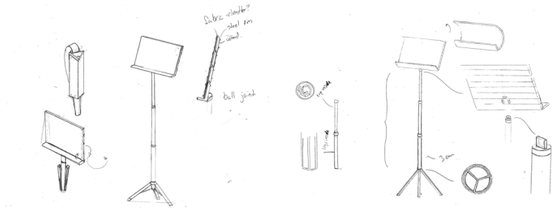
ill. 23 Overview of ideas.

The selected combinations were then created by both participants, and compared afterwards, noting decisions made or new ideas that emerged (ill. 24).
Three of the five ideas were chosen for further development in the next phase.
The three concepts were analyzed for uncertainties, that need to be specified in the next phase, in order to get more tangible concepts that have more background for being evaluated.

The chosen ideas needed to be developed, so they could get to such a tangible stage, that they could be evaluated based on the current criteria in the next phase.
One of the three concepts chosen in the previous stage turned out to be two different concepts when developed, leading to four concepts (ill. 25, ill. 26 and ill. 27).



ill. 24 Output of the selected combinations



ill. 25 Two of the four concepts

When holding the concepts up against the criteria, it became apparent that the core needs had been considered by a majority of the concepts, and that the main focus lied somewhere else.
Since the ideation focused on compacting, it turned out having two major directions within the concepts; being as compact as possible, or compacting as easily as possible.

Output

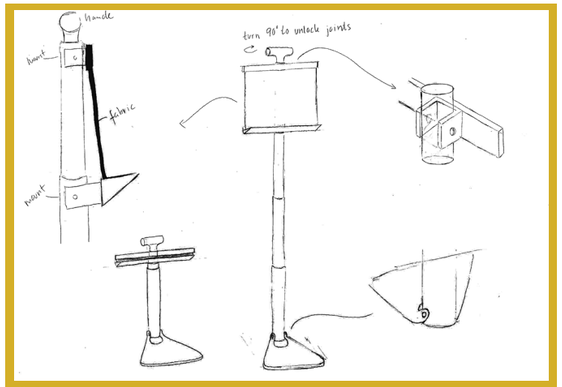
Two concepts were chosen for further development, the two which focus on easy setup (ill. 26 and ill. 27).

Concept 01: A piece of fabric is mounted onto the telescopic part, stretching the fabric when the telescopic rod is extended. The telescopic parts are controlled by having a handle in the top, that must be turned for unlocking mechanism.

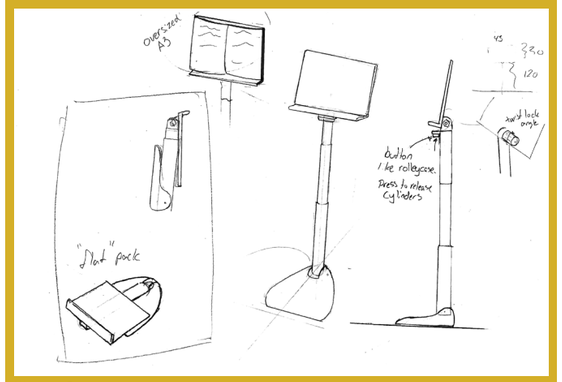
Concept 02: This concept can be flat packet. The telescopic part is controlled by a mechanism as on a suitcase (p. 29).

This was the area where most potential was seen, as it is one of the key flaws seen in the current scenario (p. 14), that has not been addressed appropriately by the products from the market analyses (p. 15).

Therefore the main focus is: **How can the setup of the music stand be as straight forward as possible. How the chosen two concepts relate to this, is to be discovered through mock ups and act it out.**



ill. 26 Concept 01



ill. 27 Concept 02

TESTING

Purpose

- To test how well the folding principles of the two concepts work, and compare.
- To get an understanding of the scale of these concepts, to see whether this is acceptable.
- Find out if one of the concepts are appropriate for further development, and whether one stands out from another. The chosen concept will work as a platform for further development.

Process

Building simplified models of the two concepts of wood.
Testing the use of the two concepts by acting-it-out, following steps will be gone through (WS 18):

- Have the stand fully folded, and act like the stand needs to be set up.
- Unfold to working position.
- Place two pieces of paper on it, and write.
- Fold into compact again.

Concept 01: It can be carried "like a bag". This was reconsidered later (P. 37).
The fabric is too flexible to write precisely on it.
Further research was done, looking into other materials for concept 01, to solve the problems of the fabric being too flexible. An alternative to the fabric is folding different firm materials. It showed that it would take up a lot of joints and space to create a believable solution, losing the effect of a compact top, and therefore it was chosen to discard this folding-solution.

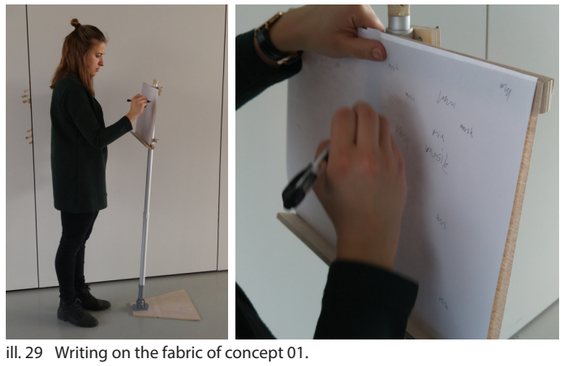
Concept 02: The joint between rod and top rotates sideways when writing on the top. (Can be fixed with a rod that is not completely round). The music stand is much more stable when foot is turned backwards.

ill. 28 Act it out with model, concept 01.

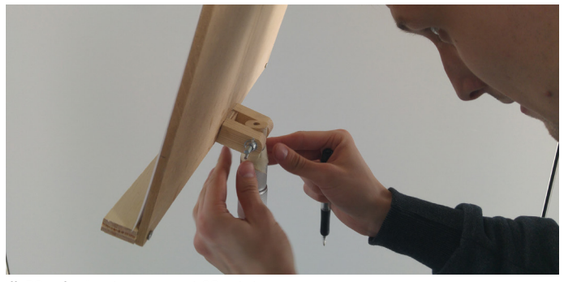
Output

The two concepts have approximately the same contour, so **having a smaller top, while the foot is large, doesn't add much value**.
Concept 01 has a larger area to hold around the rod though.
The rod for concept 02 can be about 30 cm shorter in total than for concept 01, because the top is above the rod, meaning that the full length when folded is shorter.
Only the top-part of concept 01 is discarded, so the handle and the extending mechanism is still to be further investigated.

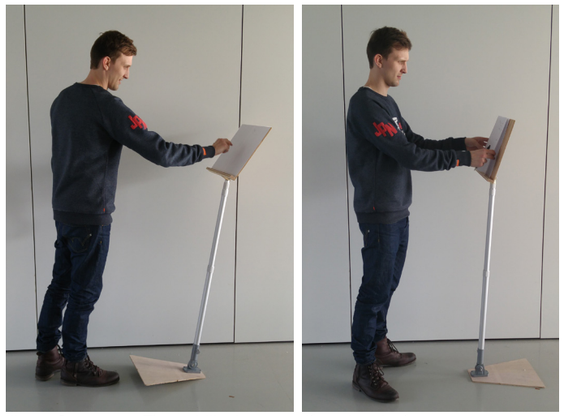
- The demand from p. 14 is confirmed: The telescopic rod must not be round.
- The foot extends away from the user, creating stability towards the user."



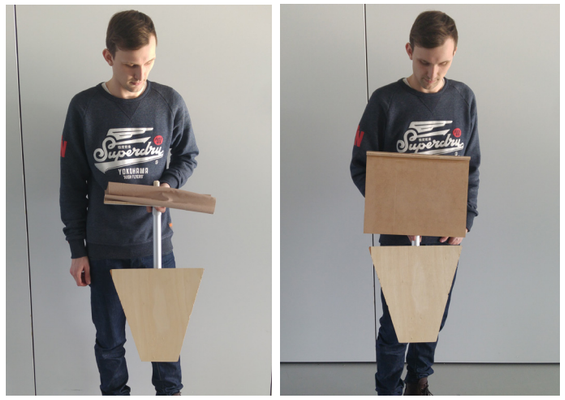
ill. 29 Writing on the fabric of concept 01.



ill. 30 The joint in concept 02 rotates.



ill. 31 Concept 02: The stability increases if turning the foot.



ill. 32 The contour of the two concepts when folded.

FOCUS

Purpose
Looking at the criteria (P. 18), the focus of the project does still not seem solid enough, so two or three solid focuses were sught after.
Where can focus be put to differ this product from the others on the market?

Process
Looking at the criteria and focus again. Reconsider what needs are not drivers for the project. Which ones are solid as they are, and which ones can become solid drivers with more work? The problem pinpointing and focus have gone through several reconsideration to get to this point (see WS 13 and 31).

It was realized that the ideal way to add new value, was to focus on the wishes, instead of only solving the core needs.

Output
Two main focus were found:
Easy setup, as mentioned P. 20, and customizablility.

Wish	1-3	Problem	Scenario
The product must be **customizable** (different instruments, different needs) - (modularity)	3		
Must be easy to setup	3		Too many steps, and can be complex.

ill. 33 Section of problem pinpointing sceme (WS 31).

IDEATION 03 - FUNCTIONS

Purpose
To expand the functionality of the product, since only the setup has been of major consideration.

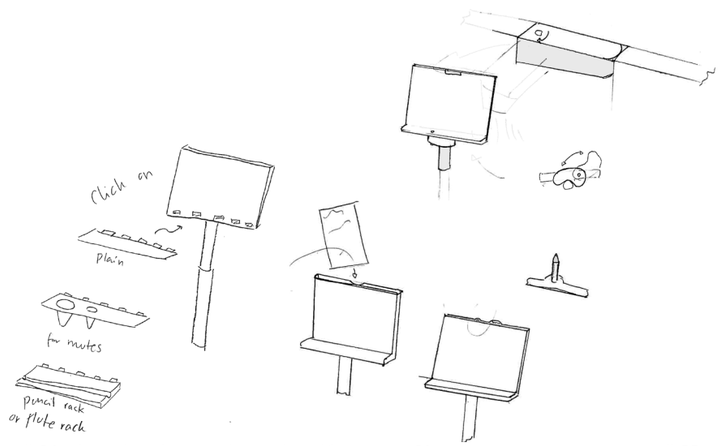
Process
A list of elements needed when using the music stand were noted, based on previous observations, and divided into three categories: The essentials, the "need sometimes" and the elements that are dependent on instrument. In the ideation only the two first categories were considered. The list was later expanded on, when interviewing users to find what they need (P. 31).

The essentials	The need sometimes
Music notes	Light
Pencil and eraser	Clock
	Phone holder

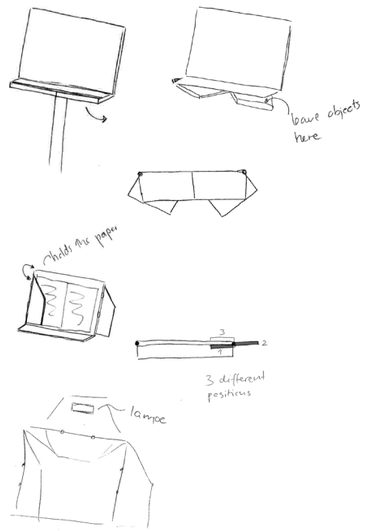
As in ideation 02, the ideation follows a structure inspired by Ole Striim [Striim, O. 2000].

First step
How can a music stand be created with space for the elements?

Second step
Inspiration photos were found, and forced relations (P. 6) used to ideate upon. Five ideas were chosen to ideate further upon, grouped for two concepts (ill. 34 and ill. 35)



ill. 34 Three ideas that must be combined for concept 01.

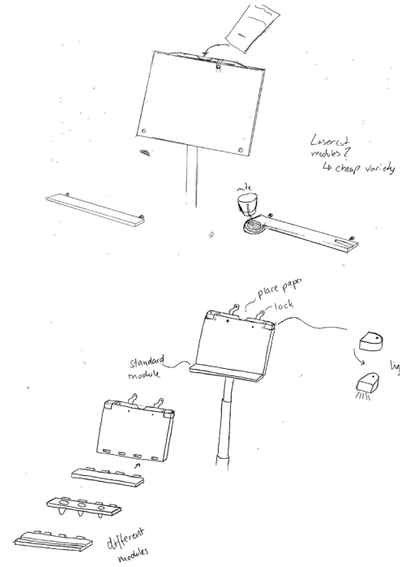


ill. 35 Two ideas that must be combined for concept 02.

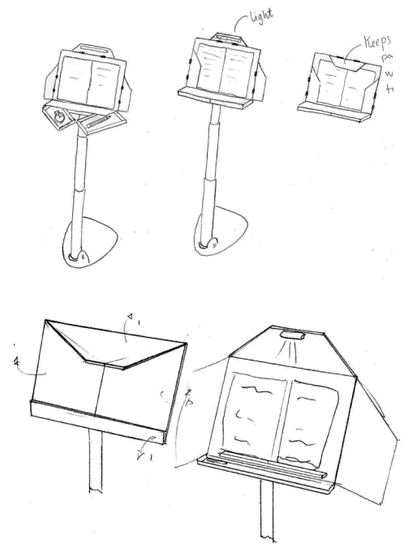
Third step
The two groups on the previous page were further developed.

Concept 01: A modular solution where paper is kept in the back of the top, and different shelves/ trays can be mounted, according to the needs of the user and which instrument they play. Light is incorporated in the top.

Concept 01: Folding sides and top down to hold the paper and a tray (drawer) either under the top or as part of the top. They handle the storage of notes in a way where the setup process could potentially be even easier, having the notes more readily available.

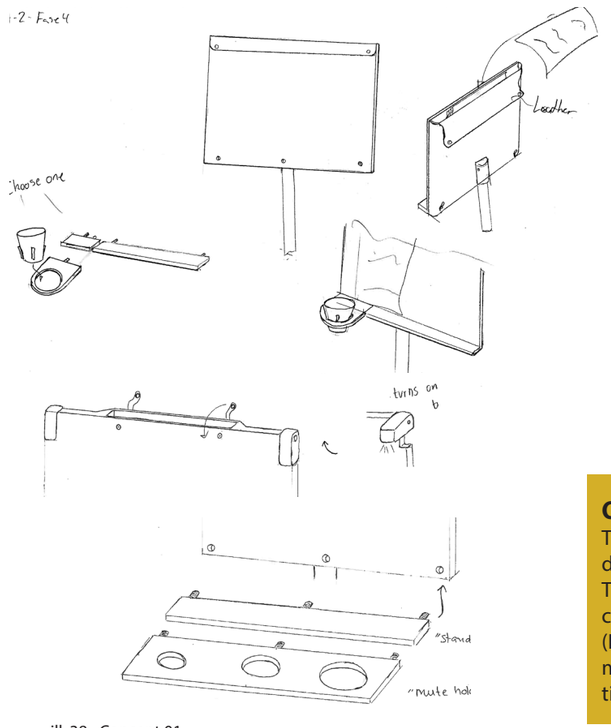


ill. 36 Concept 01.

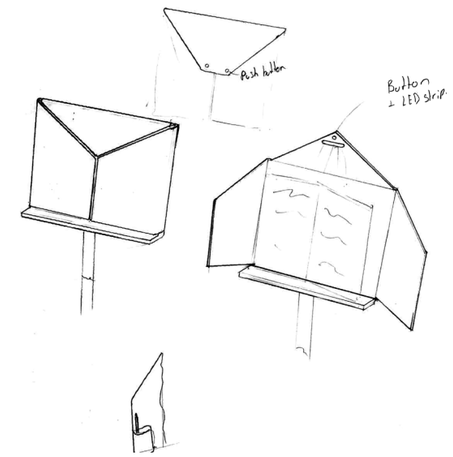


ill. 37 Concept 02.

Fourth step
The two concepts were further developed.



ill. 38 Concept 01.



ill. 39 Concept 02.

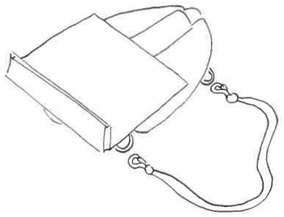
Output
The "paper in back" solution had to be tested (P. 25), and so did the concept of folding the sides and top (P. 25).
This ideation opened up for the idea of making a customizable product, which must be looked further into (P. 28). For the customization, a more clear overview of the musicians needs must be obtained. Do the needs vary from time to time or from musician to musician?

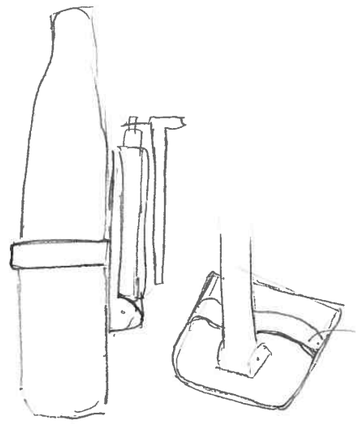
IDEATION 03 - HANDLE

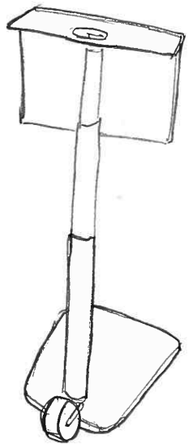
Purpose
To find a reasonable way to carry the music stand (WS 20).

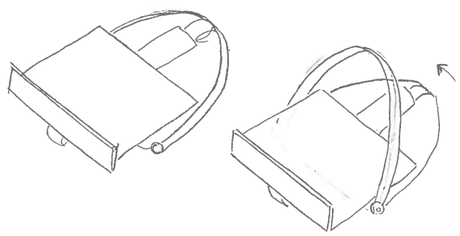
Process
Inspiration photos were found, and will be used for forced relations (P. 6). Three different scenarios should be considered: :

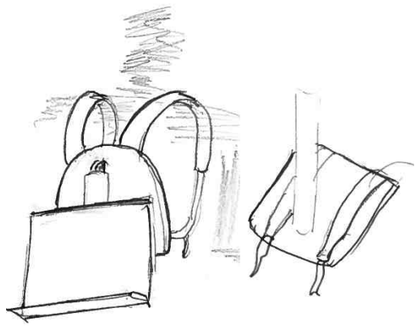
- Walk with it
- Lay it on the floor
- Put it in your car











ill. 40 Sketches from first round.

Output
After ideas were made for the handle, it was made clear, that it didn't make sense to go further with this, choosing ideas, before having a tangible concept, since the location of the handle would depend on the way the music stand is folded. Therefore, mock-ups should be made, and by acting it out, it can be seen where it would feel more suitable to place the handle. Also the user needs need to be examined to get an idea of how they will need to transport the product (P. 34).

TESTING

Purpose
To test whether the concepts work as expected, or unexpected problems would occur (WS 21 and 22).

Process
Models were built and act it out used to test the two scenarios:
01: Folding and unfolding the music stand to see the interaction (ill. 41)
02: Unpacking note sheets from two different music stands. One with firm sheet-pocket, and one with leather back.

ill. 41 Act it out scenario 01

ill. 42 Act it out scenario 02

Output
For the flaps to be able to cover the entire notes when folded, they needed a certain length. This also meant that the stand became quite large, covering most of the person behind the stand. The concept of folding turned out suboptimal, due to the sheer size. There could potentially be another way to fold the parts out of the way, however further complicating the folding action, voids the entire concept.

Both of the solutions in scenario 02 seemed fine, but it was found that there was no background for why this direction should take a key role, so it needs to be reevaluated. It also leads to other problems, such as the mounting of the rod on the backside of the music stand. A better solution for storing of notes was later found (P. 36)

Purpose
To find out how the music stand would be folded with the current concept.

Process
Building a foldable mock-up, that has two joints, and acting out how this could be folded.

ill. 43 Folding test 01

With the current setup, having notes in the back, turning it upside down felt unnatural.

A better solution needed to be found, creating a placement of joints that eases the folding process, leading to the next test, where existing models were used to try another folding principle:

ill. 44 Folding test 02

Output
One step of folding can be removed from the scenario by attaching the telescopic part at the top of the note tray, leading to only one folding action, followed by one pull to extend the stand.
This however leads to new issues, such as how this avoid obstructing the concept of having notes in the back, and that the telescopic rod needs to extend even further.

REFOCUS

Purpose
The priorities still didn't seem clear enough.
Therefore, this exercise seeks to find out where this product is better than its competitors.

Process
The music stand is compared with the portable music stand (ill. 45). On which parameters can the music stand compete with them, what does it do better, and which areas should be prioritized? For better understanding, the portable music stand will be called P and the new stand X.

Easy setup
X will have feedback when interacting with joints, which P lacks. (P. 14).
X will have controlled actions (e.g. resting points in foot and joints), which P lacks.
X will remove several degrees of freedom, e.g. in the rod
P has a certain order of actions, which P will remove.

Transportation
X will not be made as minuscule as possible. This is not where the focus will be laid. The transportation will be considered, making it easy to take with you, but will not be as compact as P.

Customizability
X can be customized to the specific users needs. P can be customized more freely, by adding add-ons, but the result is messy, and requires individual setup for each add-on.
For X, the modules are made to fit the product. The products come together as a whole, and the way the main product and the modules work together is predetermined. Different scenarios are taken into account, such as when folding and unfolding the stand.

Stability
X will strive to be more stable than P, but not as stable as a stationary music stand, since the weight must still be acceptable when carrying the music stand.

Expression
X will seek to fit better to the users need, not only in functions, but also in aesthetics. The context will be taken into account, e.g. when choosing material (P. 46).

ill. 45 Music stand (P).

Output
There must be a firm backplate, and it must still be easy to setup. Solutions with something flat that could turn into firm, added new problems, such as a not total firm backplate (P. 21), this resulting in a rather large product when folded.

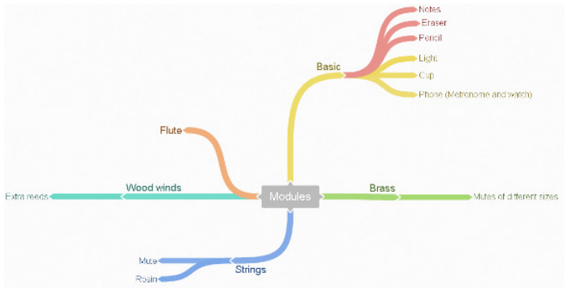
It must be considered how the music stand will be carried, in order to not make it unreasonably large.

X can be better in easy setup and customizability, and it can have a better expression, e.g. by not looking messy, by the use of add-ons (P. 28).

ELEMENTS NEEDED 01

Purpose
An investigation was set up, to find out what are the needs of people playing different instruments (WS 24). Which elements do they need when playing and rehearsing?

Process
Desktop research was conducted, and concerts on Youtube watched, to pinpoint which elements the musicians bring with them on stage.
Furthermore, an act it out was conducted, where the different elements found were represented by objects or cardboard pieces representing the elements (WS 27). The objects were then placed on and around a model representing the top of a music stand (ill. 47).



ill. 46 Output of investigation

Output
The output was a good overview, showing a list of elements (ill. 46), but it was clear that **a more thorough research was needed to get in depth with the needs of the different musicians.** This task made it more clear what needed to be sought after in the next assignment (P. 31).
Also, it was estimated, that every musician, regardless of the instrument being played, needs a pencil and rubber to correct notes, and therefore the idea of a permanent piece to place these elements on was born (ill. 53). This needs to be confirmed though. (P. 31).

Cupholder | Phoneholder | Mutes for brass | Violin: Rosin and mute | Reed

ill. 47 Elements placed on model

Purpose
Since the modules mentioned before are based on observed needs, it was found nessesary to find inspiration in current solution to see where additional modules could create value, and to see how these needs are met with e.g. clip on solutions (WS 28).

Process
A search on Amazon was chosen, searching only for popular products, i.e. products with high star rating and many pieces sold, and looking at the reviews to see whether these products have flaws or forces to keep in mind.

ill. 48 Add-ons.

Meanwhile it was questioned why modularity seems like a good solution to the customizability wish. An investigation was made, looking at existing add-ons (WS 32). What are the consequences of these add-on solutions? What do they do well, and what do they do poorly?

ill. 49 Current mute holder

While the trumpet mute holder manages to hold the mutes, it also looks quite busy and untidy. The screw mount makes it visually clear that it is an attachment to the music stand, deviating from a uniform expression. Additionally, the change in geometry and tube thickness, makes the add-on look alien to the stand.
The untidy aesthetics are enforced by the lack of structure. Each individual mute holder can rotate to various positions, meaning there is no guidance to align them against anything. The disorderly placed mutes surely adds to this.

Output
The selection of customizing products for music stands, shows a disconnection between the elegance and tidiness of classical performers, and a range of the solutions available on the market.
Therefore, **the modular approach could provide a platform for a more uniform and tidy look by:**

- Having attachments that follow the same geometry and material thickness as note tray.
- Aligning the directional lines of attachments with the overall product e.g. parallel lines

Additionally, if modules can stay on the stand when transported, it can remove extra steps from the setup process.

MEASUREMENTS OF ELEMENTS

Purpose
As mentioned, the music stand must have space for different elements - but is it also realistic to place mutes on it?
This investigation was made to get an understanding of the different sizes of mutes, and how current solutions accommodate the need to hold these various sizes, and thereby to find out, if there is background for having mutes on the music stand as well as smaller objects.

Process
Looking at the mutes available (trumpet mute), and looking at pictures of mutes taken at the symphony from a previous visit (P. 11). Additionally, doing desktop research looking for various sizes. For full analysis, see WS 33.
Only three mutes have been available for measurements at this point, so only those mutes will be taken into account in the further ideation.

ill. 50 Testing the sizes of mutes.

ill. 51 Mutes at the symphony.

Output
Since the mute needed at hand is dependent on the piece of music being played, **creating a module where it is easy to swap between mutes at concerts or training sessions would be preferable.**
They do take up a fair amount of room, so it couples nicely with the idea of them being modular, so they only need to take up space when they are needed, and can leave room for something else when not.

A module that can either hold a straight mute and a practice mute, or plunger mute, can fit within a 15x12 cm rectangle (ill. 50).

Harmon and bucket mutes seem quite different, so they probably would need different modules, however the mutes need to be inspected to decide this.

HEIGHT OF STAND

Purpose
Get an idea of what range of height the stand needs.

Process
Measures of other music stands were found (WS 29), showing a span of maximum height between 1200 and 1470 cm.

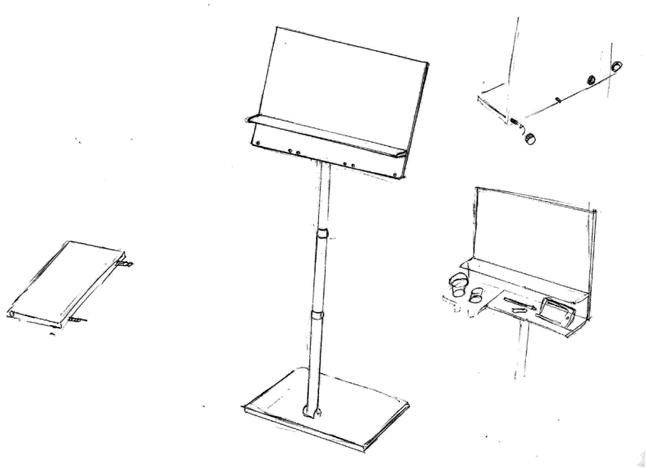
Output
The music stand must be able to elevate up to at least 1200 cm.

03

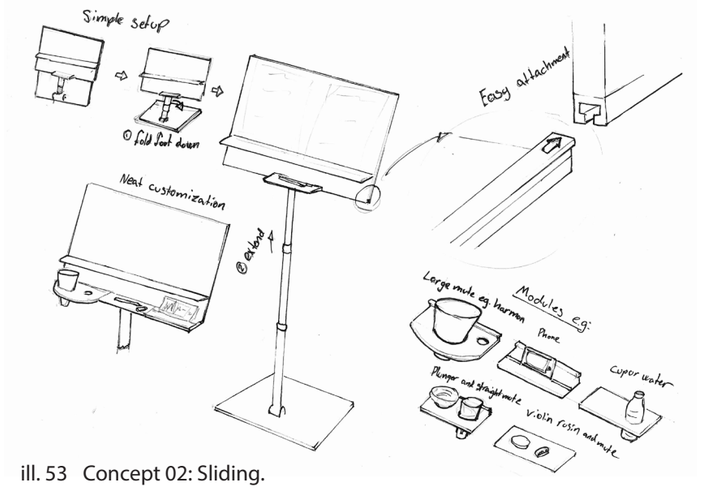
IDEATION 04

Purpose
To seek out various ways of achieving the modularity sought.
To find how the modules can be attached to the music stand.

Process
Again, Stiims was used (P. 6), and forced relations (P. 6).
01: How can different modules be attached to the music stand? (WS 34)



ill. 52 Concept 01: Nuts and bolts



ill. 53 Concept 02: Sliding.

Two ideas were picked out for further development.

01: Nuts and bolts.
This modularity allows full freedom to pick x amount of modules. It is presumably sturdy. Changing these modules might be a tedious process, and the nuts need to be managed while changing. Does it go against the easy setup, as it makes it hard to change modules? Or are they rarely changed, making it less of an issue?

02: Sliding.
Is it limited to two modules, due to the rail only having two entry points? It can have an immobile module in the middle, for general storage. It is a very easy way of switching, making changes between various modules regularly a possibility.

Output
To be able to choose between the two, the needs of the users must be further investigated, to find how often they would need to change modules (WS 39).

ELEMENTS NEEDED 02

Purpose
It was clear that it was needed to go in depth with the users needs, and several interviews were set up. This page shows a selection of users, the ones that differ the most, the rest can be seen in WS 39.

Process
A semi-structured interview (P. 6) was conducted, where the users were asked which elements they need to bring for practice and for concerts. Musicians from Aalborg symphony Orchestra, MGK Aalborg, Swingtime Big Band and Vester Hassing Tamburkorps were interviewed.

ill. 54 Violin.

Mette
Plays violin in Aalborg symphony orchestra.

- Often she brings a little box with earplugs.
- " Often we put the bow away if we don't need it, then we put it on the tray of the music stand, or on the floor."
- She has a pencil case with pencil and eraser with her when they practice.
- She often brings an extra lamp.

Additional information
Mette had bought an extra tray to mount on her portable music stand, but she doesn't use it, since it is an additional thing she needs to bring.

ill. 55 Mettes extra tray.

Output
For Mettes music stand she needs somewhere to place her violin bow and a tray for smaller objects.

ill. 56 Flute.

Marianne
Plays flute and teaches at MGK Aalborg.

- "When i place water on the floor, there is a large risk to kick it over, and if it is placed on the tray of the music stand, it can fall over as well".
- She also brings pencil and eraser for practice.
- If the light is bad, she uses an extra lamp.
- She uses her phone for metronome and tuner.
- When I play at a concert, i have a tray close to me, so that i can change between my flutes".

Additional information
Marianne has situation where she changes between four different flutes. "It is most common to change between the standard flute and the piccolo".

ill. 57 Mariannes flutes.

Output Marianne
For Marianne's music stand she needs somewhere to place her flute, somewhere to place water and small elements. She has four flutes, but rarely uses them all at the same time. Also the space needed for four flutes, would not make sense around the music stand, so the module will only have space for one flute, making switching between two flutes convenient

ill. 58 Trumpet.

Keld
Plays trumpet in a jazz big-band.

- "I need to bring a pencil, so that i can take notes when i practise."
- Keld uses five different mutes.
- "I don't always use all my mutes in the same piece. Typically two different, but then maybe another one in the next piece."
- ".. If i could have the bucket mute close to me, i would rather have that". (It doesn't fit on the mute holder he has.)

Additional information
"It is important that it doesn't make a lot of noise when hanging up the mutes".

ill. 59 Keld's mutes.

Output Keld
For Kelds music stand he needs somewhere to place his five mutes. He doesn't always use them in the same track, but he would prefer to have them all at hand.

ill. 60 Trumpet and flute.

Pia
Plays trumpet and flute in Vesterhassing Tamburkorps.

- Sometimes brings an extra lamp.
- "It would be nice to have somewhere to place the practice mute when we practice".
- When i play in the corps, i play alto flute and soprano flute. Then i need to change between the two...", "I cant just put it in the box, because then i need to take it apart".
- She brings pencil and eraser for practice.

Additional information
Pia plays both flute and trumpet.

ill. 61 Pias trumpet.

Output Pia
For Pia's music stand she needs somewhere to place her mute when playing the trumpet, and when playing her flute somewhere to place it, and also somewhere for small objects.

Output

Lamp
Many of the musicians mention that they use an add-on lamp once in a while. The need was noted, however the needs that were more consistent were prioritized.
Designing the lamp properly brought many sub-problems, that could become time consuming. The musicians only need it sometimes, and the amount of light needed seemed to vary a lot, since they play at different locations with different lighting environments. Therefore it was chosen to spend the effort on the needs that were actually observed, and not merely based on anecdotes.

Modules
It has been chosen to only develop modules for the types of instruments that has been interviewed, since the needs mentioned for other instruments haven't been investigated thoroughly. It became apparent that there are other needs, but they would need to be investigated further to make a fitting module.

As to the changing of modules, it was clear from the interviews, that the users scenarios at practice and concerts are so similar, that **it is appropriate to mount the modules securely like on concept 01 (P. 30), instead of making them quickly interchangeable.**

MODULARITY

Purpose
After the users needs had been investigated thoroughly (P. 31-32, WS 39 and 39-01 - 39-10), the modules could again be ideated upon (WS 56).

Process
A list was conducted from the users tests, creating an overview and a basis for the ideation.

Flutes (Marianne, Selma, Ida Katrine)	Flute holder Water Small elements Phone
Violin (Mette)	Bow holder Small elements
Alto horn (Astrid)	1 mute Phone
Trumpet (Keld)	5 mutes
Bassoon (Justin)	Small elements Phone

Bettina and Pia had not been interviewed at this point, and are therefore not part of this ideation. Some of the musicians needs have been merged into groups, where the needs were overlapping.

First, the flute module was ideated upon (ill. 62). The ideation resulted in a concept of using two modules, and this structure would then be tested, if it would make sense with the other users.

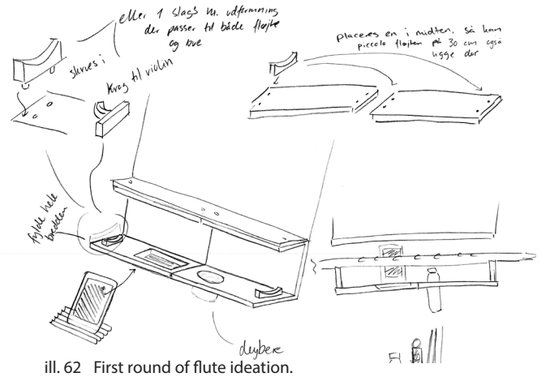
Next was the violinist (ill. 63). A hook was considered for the bow (ill. 64), but act it out showed that if the music stand is set too low, the bow would hit the floor, making short persons unable to use this function. It was decided to use the same mount as for the flute.

Then the Jazz trumpet and the bassoon were sketched upon (ill. 65 and ill. 66).

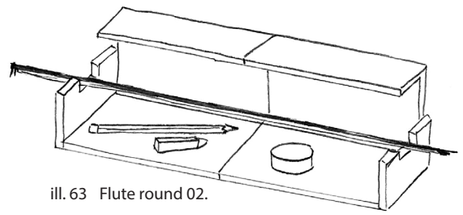
The alto horn was during the ideation chosen not to ideate upon anyway, since it had not yet been possible to get measurements on her mutes, and it was prioritized to spend time on the other four user scenarios instead of going out to do more user tests.

Output
- 2 modules on each music stand. (This was later on changed to one module (P. 47)).
- 4 different modules in total that you can combine.
- 3 extra mounts for the sides (maybe bow and flute can be combined).
- Approximately 10 cm high modules.

For the mounting of the modules, the material had to be decided first (P. 46).

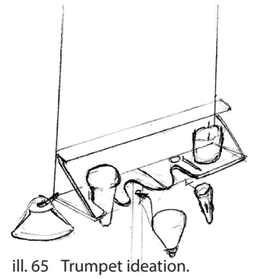


ill. 62 First round of flute ideation.

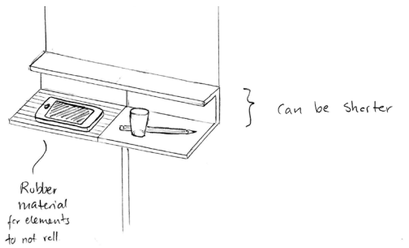


ill. 63 Flute round 02.

ill. 64 Violin ideation.



ill. 65 Trumpet ideation.



ill. 66 Bassoon ideation.

TRANSPORTATION - EXTREME SCENARIO

Purpose
At a meeting with Mette concerning elements needed (WS 39-02), the talk fell upon transportation, where Mette stated "I have been riding my bike to practise previously, and would like to do it again". she also stated: "Many of my colleagues ride their bike when going to rehearsals".

Process
The transportation on a bike might be the extreme scenario. Therefore, if the product can fit on a bike, it can be used by most musicians, for other means of transportation. Conversation with musicians showed that several of them uses their bike for transportation (WS 39-01- 39-10). The stated transportation is when they bring their music stand as well as instrument.

Who	Main transportation
Ida Katrine	Bike and walk
Mette	Bike and car
Marianne	Bike and car
Selma	Bike and walk
Keld	Car
Astrid	Bike
Justin	Car
Matthias	Bike or car
Pia	Car
Bettina	Car

Output
It was previously assumed that most users would drive in their car, since the instruments are quite large. This investigation shows that 6/10 rides their bike with instrument and music stand.
The sample size is very small, at only ten people, but the variety of different people make it more nuanced: two from the symphony, two from a marching band, one from a jazz big band, four students from MGK and one teacher from MGK.

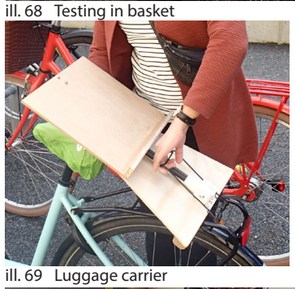
The music stand needs to be suitable for bringing on a bike.

If it can be carried on a bike, it can also be transported in a car.

ill. 67 Mettes transportation scenario.

Mocking it up and testing
A model representing the size of the music stand was used for act it out on and around a bike, to find out where and how it can be placed while transporting it (WS 42).

ill. 68 Testing in basket



ill. 69 Luggage carrier

ill. 70 Basket

ill. 71 Test of music stand on bike, luggage carrier.

The bicycle basket was considered, but many would be too small (ill. 68 and ill. 70), and would require the musician to acquire a specific basket. The luggage carrier was considered as well (ill. 69 and ill. 71). Using the mechanism of the carrier to attach the music stand was a rather complicated action, and another solution came to mind: Attaching the music stand onto the carrier with a buckle clip. (ill. 72)

ill. 72 Bucle clip act it out.

Additionally it must be considered, that the music stand must not be wider than the distance between the handles, when placed on the back of the bike, making sure that the person riding won't hit anything with the music stand. (ill. 73)

ill. 73 Width of music stand.

Output
The bag of the music stand will be mounted onto the luggage carrier by the use of buckle clips.

BAG FOR MUSIC STAND

Purpose
Finding a reasonable way to carry the music stand.

Process
At the interview with Ida Katrine, an overview of the elements she brings with her, and her way of transporting them, led to a new idea.

ill. 74 All of the elements Ida Katrine brings with her for rehearsal or concert.

She either transports the elements above (ill. 74) in a tote bag or a backpack. She uses the backpack especially when it rains, to make sure that the notes don't get wet.

What if the music stand had its own bag, where there would also be space for notes and other small elements? Then she wouldn't need to bring an additional bag.

ill. 75 Ida Katrines transportation scenarios.

Additionally, Mette also stated (WS 39-02):
"My current music stand came with a bag. I have used plastic bags before, but the music stands tear them apart".

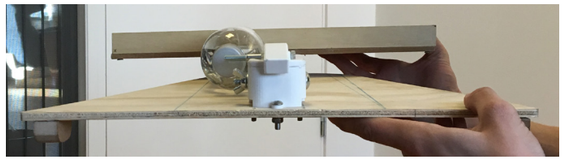
Output
The music stand must have a bag, with an extra compartment for notes, that can be closed, to make sure the notes won't get wet in the case of rain.

This solution can furthermore replace the earlier concept of having notes in the back of the music stand (P. 25).

Purpose
Considering what additional objects a bag for the music stand can hold.

Process
The bag will not be made specific for each kind of instrument. But looking at some of the smaller instruments, e.g. a piccolo flute, is it possible to fit everything they need to bring in this bag, so they don't need to bring another bag for the instrument and accessories? Or will this take up too much space and bother people with other instruments?

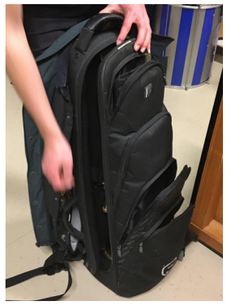
Taking Ida Katrine for example (WS 39-01). She brings a flute, notes, water bottle, pencil and eraser and clip-on lamp (ill. 74).
Everyone brings notes. There could easily be an extra compartment for notes. Her flute can fit in the note-sheet compartment, since it is only 33 cm long. The water bottle can be placed in the compartment for the music stand (ill. 76). Other elements such as pencil, eraser, clip on lamp are rather small, and could have a small compartment for themselves.



ill. 76 The width of the bottle can fit on top of the music stand.

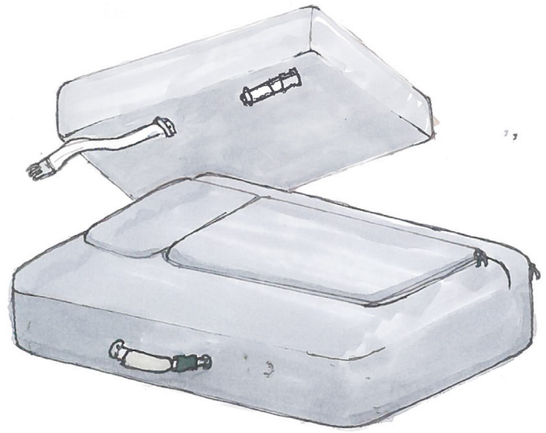
This solution with mounting the music stand onto the bike with a buckle clip could be combined with the solution of having a bag for the music stand - having the buckle clip on the bag for easy attachment.

Taking inspiration in their instrument bags (ill. 77), most of the user's' bags are fabric. They have multiple compartments for small elements, and either shoulder strap, straps to carry it as a backpack or a handle. The four fabric bags can be carried in two different ways. They all open all the way up, making it easier when putting the instrument in.



ill. 77 Mettes, Matthias and Astrids instrument bag.

When finding the measurements for the bag, it was decided, that the module tray would need to be folded up, for the music stand to be small enough when folded. Besides from making the music stand thinner when folded, folding the tray up also ensures that it is less fragile when moving it around when setting up or packing down, making the risk of hitting something with the tray less likely. The exact solution was considered later on (P. 45).



ill. 78 Bag for music stand.

Output
The result was this bag, that opens all the way around, making it easier to place the music stand. The bag has an extra room for notes, and a small room for small elements. The bag hasn't been thoroughly been ideated on as to the shape and expression. This is something that should be further developed.

It was decided, that the module tray would be folded up, creating a thinner package.

Purpose
It was further considered, that there is not an indicated area as to carry the music stand. Looking at the scenario when lifting the music stand when folded, to put it into the bag, could benefit from having an intended way to carry the music stand. Would it make sense to have a small handle on the music stand?

Process
A leather handle was mounted on the music stand to see the interaction (ill. 79). The music stand with leather handle was used for act it out (ill. 80), and the interaction turned out to be very pleasing.

ill. 79 Leather handle on music stand.

ill. 80 Act it out with handle.

It was decided, that the music stand must have a handle.
It never reached a developed state though.

AESTHETIC GROUND RULES

Purpose
An interview was set up with five musicians, to find out what they like when it comes to aesthetics, and what aesthetic values they prefer.

Process
Six different music stands were printed out on a sheet of paper each. The products were paired two-and-two, in combinations where they show contrasting aesthetics.
The users were then asked which of the two they prefer, and asked to elaborate why.
Afterwards, the interviews were listened through, to find connections in what they like. Images of all six music stands shown to the users can be seen in WS 39.

ill. 81 RATstand.

ill. 82 Wooden stand.

Output
The users liked that the joints suited the rest of the shape of the music stand. They must be simple, while still looking strong. Ida Katrine and Mette liked a structural design, but it must still look stable.

Most of them expressed that they care more about the functionalities that the aesthetics. Especially Mette and Bettina, where most of their answers towards questions about aesthetics ended up being about the use of the music stand.

All five of them prefer the wooden music stand (ill. 82), because of the material and the organic shapes.
Pia: "It would look fine at home, almost like a decoration".
Bettina: "That one is special, it is aesthetic and i like that".
Ida Katrine: "It fits nicely to the instruments, to the music".

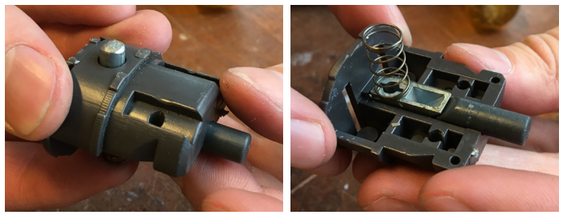
All five also agreed that they like RATstand the least (ill. 81). Two of them mentioned that it looks too angular, and four of them doesn't trust on the stability. Pia: "It is too angular, that's not pretty". Bettina: "I don't like that one, not at all". Marianne: "It looks clumsy, there is something with the balance".
For full analysis, see WS 39.

Phase 04
Product development

TELESCOPE TYPE

Purpose
During ideation 02 (P. 19), the idea of using the mechanism as used in a suitcase came up, and therefore had to be examined, to get an understanding of how the locking mechanism of a suitcase handle works.

Process
The cylinder was taken apart, to find the components that perform the locking motion (WS 17).



ill. 83 Disassembly of suitcase mechanism.

Output
The mechanism turned out to be quite simple, but doesn't seem that durable, since the mechanism often breaks on suitcases (Based on own experience).

Purpose
To get an understanding of what options are available for creating the height of the stand. The research is limited to mechanical/manual principles.

Process
- Looking at the different types that are available already, analyzing why these do not fulfill the criteria of this project.
- Look at how other music stands do it differently
- Find solutions in other types of products

Each mechanism was commented on and evaluated (WS 30).

ill. 84 Lever lock

ill. 85 Screw 01

ill. 86 Vacuum cleaner tube.

Output
From the investigation it was chosen to continue with the Lever lock (ill. 84), since this seems like the best working solution, mainly due to its easier and controlled locking, and inherent rigidity.
It was also decided to avoid fully circular profile for telescopic rod, to avoid twisting, and therefore always keeping the right orientation.

Purpose
To narrow down what the lock should look like.

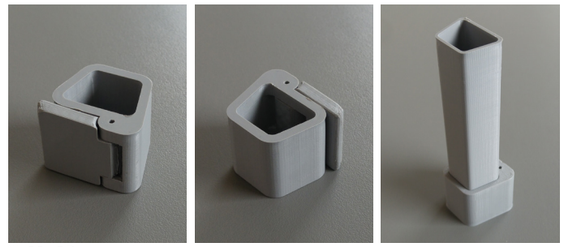
Process
Finding inspiration in other locks - choosing the one that would fit best to the wished aesthetic of the music stand (WS 49), and modeling up a lock with inspiration in the chosen lock.

ill. 87 The selected locks for inspiration.

The shapes and expression of the locks chosen were not used directly, but opened up for a discussion about the shape. The idea of making the lock simple and making it fit to the shape of the rod were used.

Meanwhile 3D-printed models of the rod was created to find the optimal shape and size of the rod. The grey model (ill. 88) was chosen.

ill. 88 3D-printed rods.



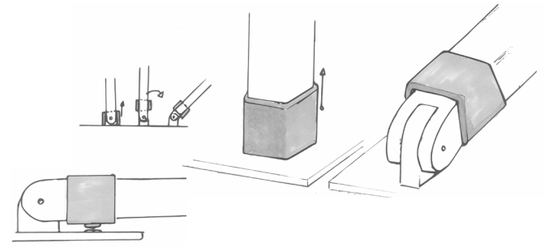
ill. 89 3D-printed lock

Output
The result is seen in ill. 89. The lock has the same shape as the rod for making it simpler, aesthetically.

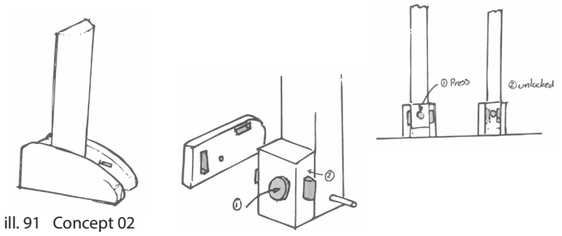
LOCK AT FOOT

Purpose
To concretize how the foot is held in place when set up and folded down, considering the current structure.

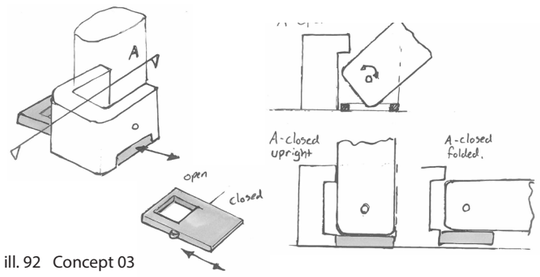
Process
Considering what mechanism is reasonable for the concept, considering overall structure, and the things found to avoid. Inspiration is taken from the former mechanisms in the project, and new ones were sought after. Striims ideation was used in this ideation as well [Striim, O. 2000]. For a more thorough explanation of the procedure see WS 38.



ill. 90 Concept 01



ill. 91 Concept 02



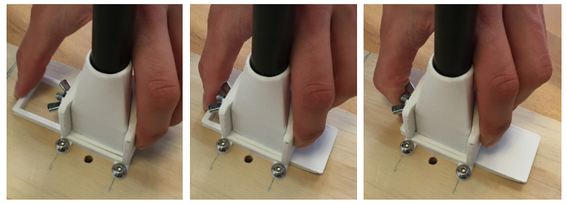
ill. 92 Concept 03

Output
It was considered which of the concepts would be more stable, and estimated that they could all be approximately equally stable by dimensioning or by choosing the right tolerances.

Concept 02 seemed more complex than the other two solutions, and it doesn't seemingly add more value in different areas. Concept 01 had a more simple aesthetic expression when the music stand is unfolded.

Concept 03 was chosen since it only needs one lock for up and down, whereas concept 01 needs an additional lock when folded. The concept needs to be tested though.

Purpose
After thorough consideration, and 3D printing of a model to test the principle, it wasn't very convincing. Therefore, it was needed to look further into standard solutions.

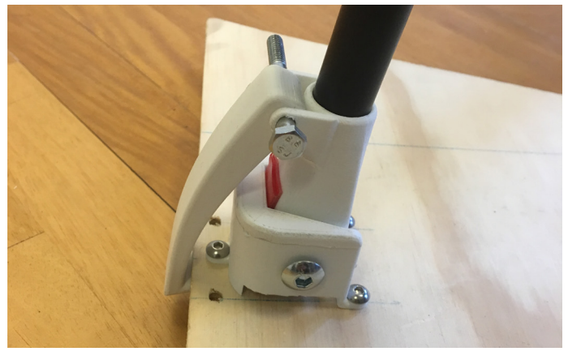


ill. 93 3D printed model

Process
Two solutions were considered at first: Bayonet lock and sun-chair principle.

ill. 94 Inspiration for foot-lock

With the Bayonet solution the music stand would be taken apart in, resulting in two pieces when folded, which is not preferable.
Looking at the model, a question arose: What if the sun-chair solution is used, but put on the opposite side, so it pulls instead of being pushed.
This led to the final solution, having a hook to lock the music stand (ill. 95), taking advantage of the slanted structure, hooking the structure into a resting position. This lock only works in upright position, so another lock must be used when the music stand is folded (see p 44).



ill. 95 Solution for foot-lock

Output
Unfornutately no standard solution was found applicable, so a new principle was developed. The model in ill. 95 was chosen. Later, a spring was added to the solution, for making the interaction easier (P. 41).

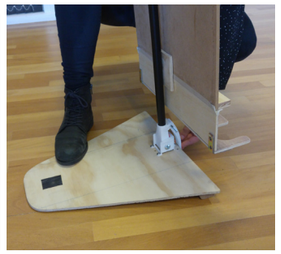
Purpose
Refining the lock at the foot, creating a better user experience.

Process
Acting out with the mock up, it was found that the interaction was suboptimal. Having to hook it into place, while holding the telescopic rod was possible, however when applying pressure on the hook, to get it in place, the foot would start lifting (ill. 96). This led to a scenario where either a foot had to be placed on the music stand's foot (ill. 97), to hold it in place, or the user had to grip both the hook and foot with the same hand (ill. 98). Both these scenarios were quite awkward.

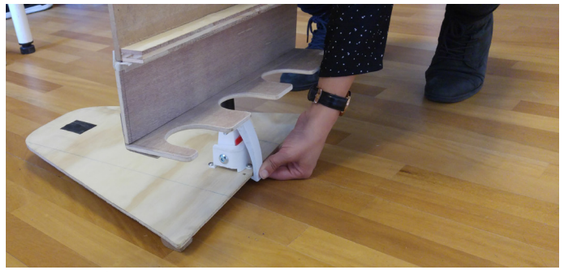
By acting it out, it was found that spring-loading the hook would remove the need of an extra hand, creating a scenario where the user simply has to unfold the foot, by grabbing the foot and tray, unfolding until it snaps in place.

A handle was added to the other end of the hook, making the user able to simply push the lever while holding the stand, in order to unlock and fold it.

ill. 96 Foot lifts



ill. 97 Holding it in place with foot

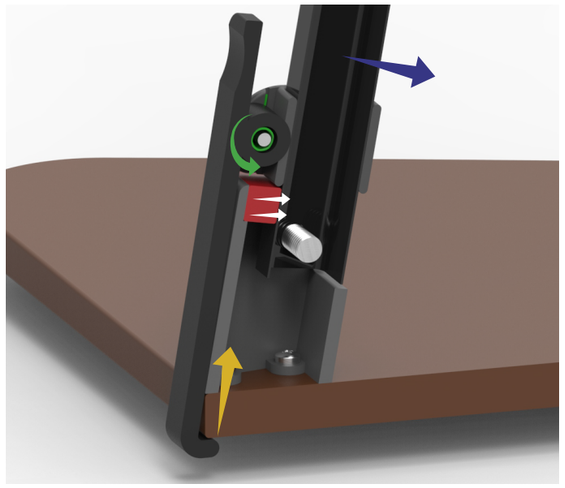


ill. 98 Hook forced with one hand

Output
A new unfolding scenario has been created.

The foot is unfolded while holding the rest of the stand with the other hand. The joint is rotated until the flexible block (red on ill. 99) is slightly compacted, and the hook is pushed into place by the spring (green arrow ill. 99). The flexible block serves to limit the tight tolerance needed, and to keep the telescopic part interlocked by the hook and compressed block.

This way, the music stand always leans away from the user (blue arrow ill. 99), and the forces applied by the user in many scenarios pushes this same direction, meaning the hook should stay tightly locked (yellow arrow ill. 99). The flexible block is there to absorb minor forces applied from the opposite direction, e.g. if the structure slightly flexes back towards to user (white arrows ill. 99).



ill. 99 Section view of foot lock.

ill. 100 Lock at foot before push.

ill. 101 Lock at foot when pushed.

ill. 102 Rod tilting.

SHAPE OF FOOT

Purpose
To find an appropriate layout of the foot.
How can the foot support the structure most efficiently, in regards to the various forces it can be subject to. Moreover, how can the flat structure be modified to create stability?

Process
Acting out with the folding model, seeing how the model reacts, and applying general knowledge.

Several musicians interviewed have mentioned that they occasionally play concerts in churches. Older churches can have uneven floors, which needs to be considered when designing the foot. The music stand must not wobble when standing on the expected surfaces.

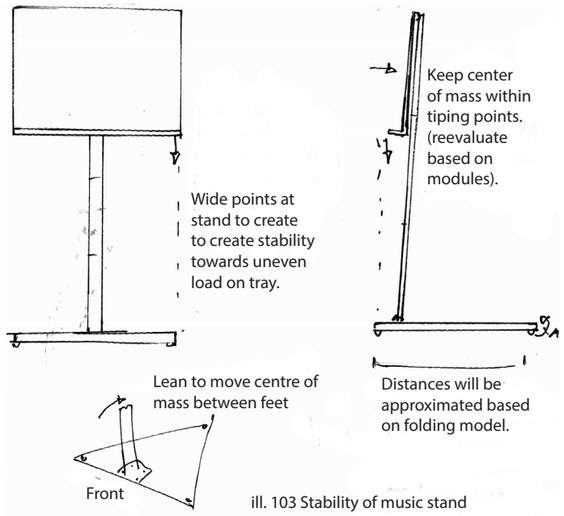
Three points on a surface is the minimum needed for resting an object on a surface, and while adding an additional point can move the tipping point of the structure further out, it is also subject to rocking on even a slightly uneven surface.

Therefore, the goal is to find three optimal points, at which the foot should touch the floor. The exact type and size of these feet is yet to be considered.

Output
The width of the foot will be based upon the overall size the current folding pattern allows, making the foot as wide as the note tray. In this way, they two shapes will relate to each other, also when folded, and making it more unlikely that the music stand will tip. For calculations on the structure see p 51.

The two wide points are kept at the front, to accommodate for the wide tray, while the single point is moved as far back, as the folding principle allows, i.e. the foot should not extend past the note tray unless absolutely needed. The distances will be approximated during the model building process.

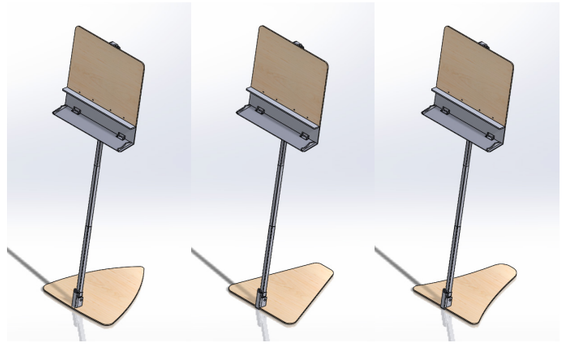
This only serves as guidelines for the initial testing, and as the various components concretize regarding sizes and weight, and as the modules take shape.

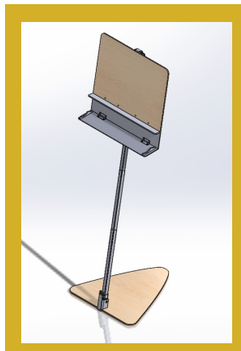


ill. 103 Stability of music stand

Purpose
To find the best looking foot within the rules set in the previous exercise.

Process
Different shapes were drawn in SolidWorks, adding them to the assembly for context, and picking an aesthetically pleasing variation. ill. 104 shows a selection of shapes, for more variation see worksheet 60.


ill. 104 Different shapes of the foot.


ill. 105 The chosen shape of the foot

Output
The straight front was chosen, since it relates to the shape of the top of the music stand, while the rest of the shape was deemed most pleasant to look at.

LOCK AT TOP

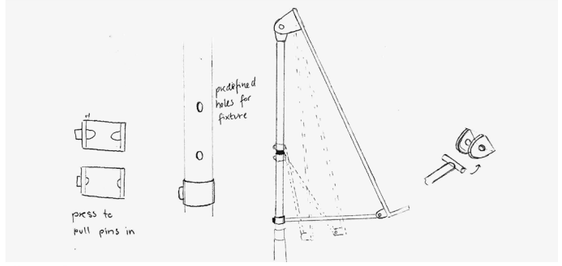
Purpose
To find the best possible solution for the lock at the top.

Process
Two different solutions were considered. 01: The mechanism from a sun-chair, and 02: Using the mechanism already on the model, but adding a different lock. Only having it fastened in the top.


ill. 106 Sun chair.

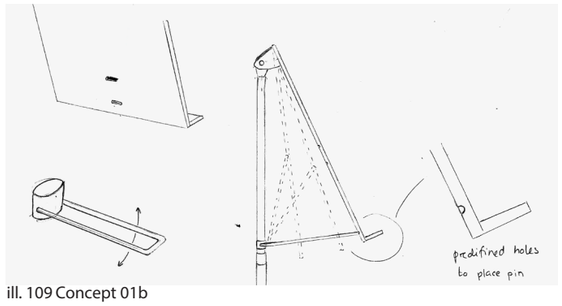

ill. 107 Own model.

01: Use the mechanism from this chair for the adjustment of the top. Having an "arm", that can fall into 3-5 holes, creating different angles. This concept has two different solutions:



ill. 108 Concept 01a.

Suitcase mechanism + sun-chair mechanism.
The button is pushed, releasing the mechanism, pulling the mechanism up or down, until it falls into the next hole.



ill. 109 Concept 01b

The other solution uses the sun-chair mechanism more directly, simply lifting the "arm" of the mechanism, placing it in a hole in the back of the music stand.

Output
Before choosing any direction, tests had to be made to find out which forces are applied onto the music stand.
Is it even possible to use concept 02, the mechanism on the model? The model seems quite unstable, but it is unknown whether it is the joint or the top.

Purpose
To get an understanding of what makes the current model instable, and to get an understanding of scale between the various factors, such as the joint and flexibility of the plate.

Process
Testing by applying different forces and seeing how the model reacts. The full data can be found in WS 47.
Four tests were performed:

Test 01: Testing the influence from the weight of modules/mutes/etc. The test showed that before the structure moves, it must be applied with a force of above 2 kg. This force is unrealistic, since the heaviest scenario would be five mutes, having a weight of around 1 kg, so the static force would never be above 2 kg.


ill. 110 Test 01, pulling down.


ill. 111 Test 02, pulling in the corner

Test 02-03: Pulling on the corner of the top. The top is mounted in two different ways. Comparing the results from test 02 and 03 shows that very little of the deviation is in the top. If pulling with 300g the deviation is 6 mm, three in the top and three in the joint/rod. **The test is very imprecise, but gives an understanding of where the structure is supported poorly.**
Test 04: Finding how much force you write with. This test showed, that **the weight you pressure with when writing lays somewhere between 200-350.**


ill. 112 Writing on weight.

Output
The tests showed that a pin added to the middle, as in concept 01 (ill. 108 and ill. 109), will not be of great help, since it is the corners that are critical. The concept would only be helpful if one pin was to reach out to each of the two bottom corners. This solution was not chosen due to aesthetic reasons.

Therefore, we will focus on making a joint only attached in the top of the music stand (concept 02). The joint on the tested model will be used as inspiration, but scaled up in the areas needed, for greater strength.

INTERACTION BETWEEN PLATES

Purpose
To find a way the top and the bottom of the music stand meet when folded. How can it be avoided that fingers easily get squished?

Process
When folded, the plates must be fixated in relation to each other, in order to avoid rattling sounds, which the user might associate with cheap products rather than a quality product. If you ride your bike with the product on the luggage carrier multiple times, riding on uneven roads, and the plates are not fixed, there will be added more force to the joints, which will exhaust them in the long run.

Therefore, it is sought to fixate the two plates in a way where sideways movements can be avoided. Act it out was used.


ill. 113 First considered solution.

ill. 114 Fingers quished

Several different solutions were considered. The first one (ill. 113), where plates are mounted on the back of the top, where the shape of the foot will fit into. This led to another problem though, that the fingers could get squished (ill. 114).

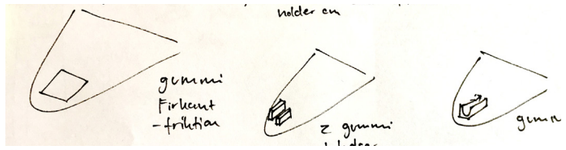
Other places were considered, where fingers would not get squished, and a solution was found (ill. 115). Here blocks are placed on the foot, that the rod falls into.


ill. 115 Solution for fixating the two plates.

It was also considered whether the rod should also be fixated to the top plate, to avoid stress put on the joint in the top. (ill. 117)

ill. 117 Fixation in the top.

The two latter solutions were chosen. The next step was to decide how they should be mounted.



ill. 116 Three solution for fixating tie rod on the foot plate

Three solutions were considered. With all of them, a magnet would be added to hold the rod on the foot.
1: A flat piece of rubber. The magnet would keep the rod on the plate and the rubber would create some friction, that would keep the rod from sliding sideways on the plate. Rubber is also a ductile material, dampening the rattles.
2: Two rubber blocks, keeping the rod in place.
3: A rubber profile, that could grab around the rod.

It was doubted if solution 1 would actually work, but found that this was presumably the simplest and cheapest solution, and also the most aesthetically pleasant solution, so it had to be tested.


ill. 118 Testing the rubber-magnet solution

A strong magnet was placed inside a rubber tube.
The rubber was held onto the plate, and the rod tipped down. A baggage weight was used to find how much force should be applied, to pull the rod off from the magnet/rubber tube.

The result: Pull up: 300 g, pull sideways 450 g.

ill. 119 Fixation in the top.

Output
The rod tested on is round, which would in reality be trapeze-shaped, giving the magnet a bigger surface to attach to. Therefore, the magnet-test was made on a flat steel surface as well, where the force applied before the magnet was pulled off, was 1 kg.
Also, the magnet used is very small, which could easily be scaled up, giving it an even bigger surface to attach to.
I.e. scale the magnet up, and this solution would work.

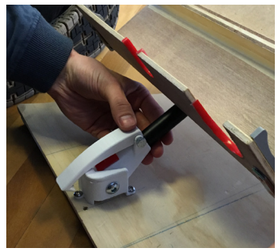
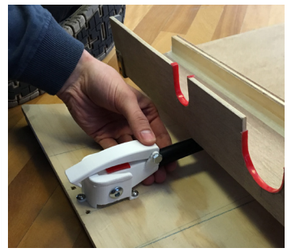
Purpose
To make sure that there are no other places on the music stand, where fingers could get squished.

Process
The model was used for act it out, folding and unfolding the music stand, to check if there is somewhere where the user would interact with the product, where fingers can get squished.

ill. 120 Fingers between two plates.

ill. 121 Fingers between rod and plate.

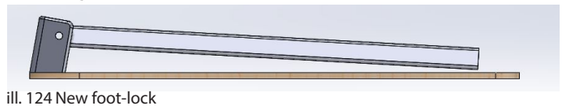
Fingers will not get squished between the two plates when folded, since they have a distance determined by the rod (ill. 120). You can also not get your fingers all the way in under the rod, while having a reasonable interaction with the music stand (ill. 121).

ill. 122 Fingers can get squished under foot-lock.

Fingers can get squished in the bottom part when folding the music stand. There needs to be a gap between the footplate and the rod at the gripping point. According to "The measures of man and woman" [Henry, D.A. 2002, p. 75], a large man's fingers are 19mm wide at the fingertips. Therefore, we will make sure that the gap is at least 19 mm.

ill. 123 Original foot-lock



ill. 124 New foot-lock

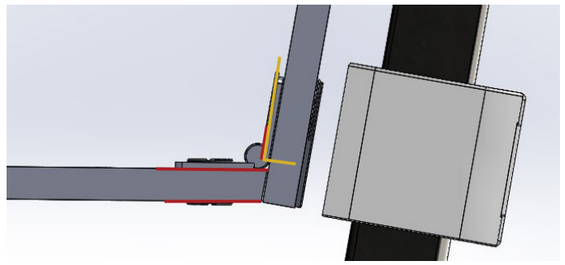
Output
The SolidWorks model was changed, resulting in a lock where fingers would not get squished (ill. 124).

MOUNTING

Friction hinge

Purpose
It was decided earlier (P. 36), that the module tray should fold up. This exercise aims to find a hinge that can be used for the modules.

Process
The piano hinge was considered, and after a brief Google search, friction hinges were chosen to use.

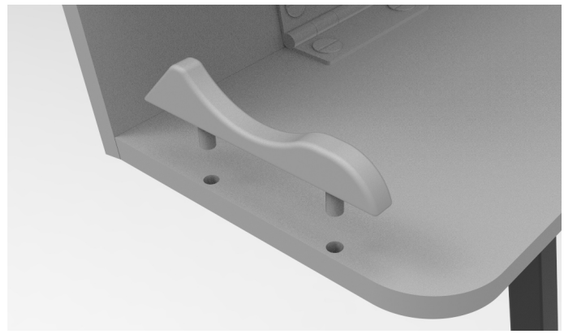


ill. 125 Friction hinge at module

Output
In the selected solution, the module shelf itself stops the friction hinge from being able to rotate the shelf down to more than the intended 100 degrees.

Flute and bow holder

The mounting of flute and bow holders have been considered as well. This ideation have been brief though, selecting the first principle considered, and then deciding the location and size.



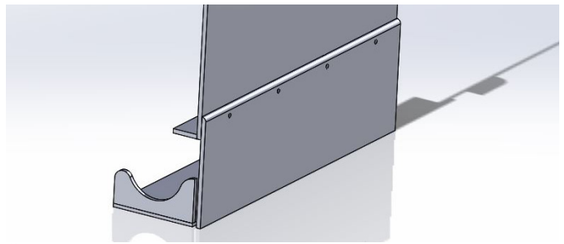
ill. 126 Mounting of flute and bow holders.

The flute and bow holders have two pins for mounting them onto the plate. The flexible material allows for a friction fit.

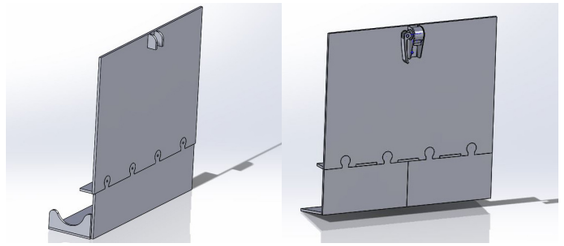
MOUNTING OF MODULES

Purpose
to find out how the modules can be mounted.

Process
Different solutions were considered, but it was found that the material had to be chosen before the mounting of the modules could be considered thoroughly.
ill. 127 was considered first, but it would depend a lot on the material, how the final result would look like. If it was to be thin metal sheets, maybe it would be alright, but for a wood construction, it would leave a rather thick plate in the assembly area.

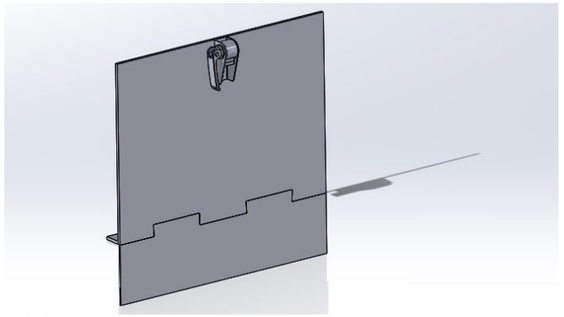


ill. 127 Connecting module and top plate.



ill. 128 Carvings in wood plates.

When the material had been chosen (P. 47), different carvings were considered, for the plate to keep the same thickness at the mounting area as for the rest of the plate. The two solutions in ill. 128 were some of the first considered solutions, but a more simple looking solution was sought.



ill. 129 Carvings in wood plates.

The solution in ill. 129 was chosen, since it was more low-key compared to the previous solutions (ill. 128). The squares are slightly trapeze shaped, with the broad side upwards, for better strength.

MATERIAL SOUND TEST

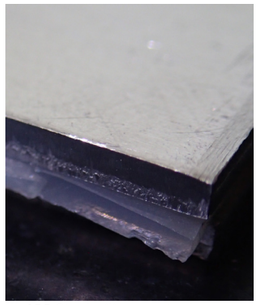
Purpose
To get an understanding of material's dampening properties.

Process
Knocking on material, listening to the sound it makes, recording it, examining the sound files (WS 48).

ill. 130 Testing material sounds

ill. 131 Different materials

The metals (1 + 2) are very rigid materials, they have a high pitch and a long reverberation, which can be problematic if accidentally hitting the plate in a concert.
To accommodate for this, you can either increase the mass, which was tried by testing two sheets of steel, or combine with a ductile material, which was tried by combining steel with rubber.
Veneer and Acrylic have some of the shortest reverberations and the lowest pitches.
The experiment showed that combining hard shells (steel) with a soft core (silicone tape), the result is an anechoic material, so a new test was to be setup with veneer.



ill. 132 Steel, silicone, steel.

ill. 133 1: Birch veneer + pine core. 2: Plywood (unknown sort). 3: Pine wood.

Output
Of the three tested materials, the pure pine had the best sound, but since pine wood is very soft, it needs to be combined with something harder, in order to be used for construction. The next best sound was the birch + pine combination.

We assume that using pine plywood for the core will have a similar effect as pure pine, despite the added structure, but give more strength to the construction. Therefore, a plywood with a pine core, and hardwood outer layers will be used.

MATERIAL

Purpose
Finding the best suitable material for top and foot.

Process
Setting up some different materials, measuring them against criteria, and additionally commenting on pros/cons for the different materials. For full analysis see WS 46.

The materials considered were: Steel, aluminum, plywood, fiberglass, polycarbonate (thermoforming).
Plywood was the material that fulfills the listed criteria for the material best. It can be light, we know from the aesthetic investigation (p. 37), that the users are fond of wood. Using plywood allows for various aesthetics by using various kinds of wood veneers, and various types of lacquer.
By keeping the structure in the wood while painting it, this wish for a wooden surface can partly be met, still keeping the music stand more aesthetically neutral.

Output
Choosing from a selection of hard woods, **oak was chosen due to the structure in the wood. Pine plywood will be used as the soft core.**
The two tests on this page were made parallel, so the choice relates to both.

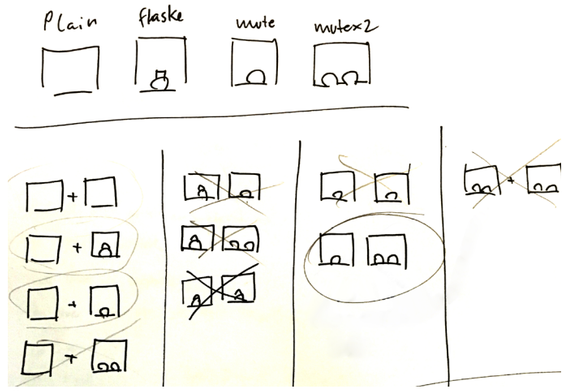
ill. 134 Oak veneer surfaces

ill. 135 Black stained oak veneer.

ONE OR TWO PLATES

Purpose
To find out whether the modules should exist of one plate or two separate plates.

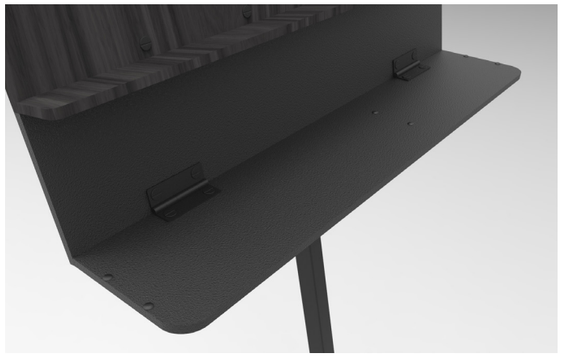
Process
Listing pros and cons for both. See full list in WS 54.
Considering one instead of two, the different modules had to be considered. Trying to map out all of the different combinations that could be made from having two modules, to see whether all of the same combination should be made with just one plate.
The ones that there was no user for (according to the user tests (WS 39)) were ignored for the moment.
This left four base models, keeping the amount of models just as low as before, but with less decisions up to the user.



ill. 136 Deciding one or two plates.

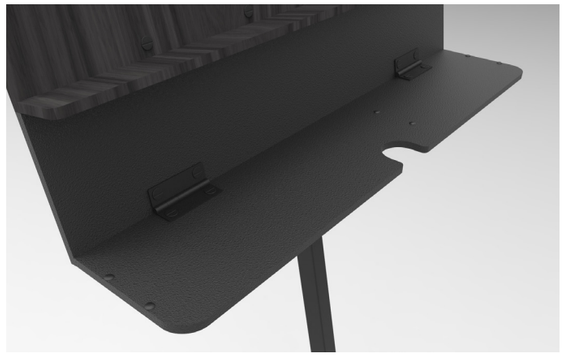
Output
It became apparent that there might be other needs, but since the user research is limited to 10 people, the modules are only based on what is known that these people need, and therefore there is no background for the additional complexity that two individual modules brings.
Another problem would be the structure in the veneer, when surfaces meet. A solution could be using a different surface finish (P. 52).

MODULES



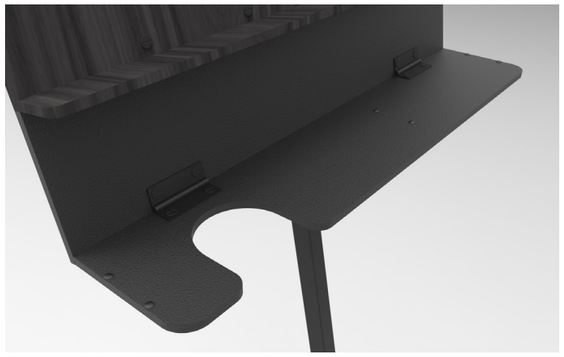
ill. 137 Plain module

The plain module acts as a shelf for general storage of items, such as pen and eraser, tuner, reeds etc. The non slip surface (P. 52) allows the user to e.g. place a phone at an angle, without it slipping.



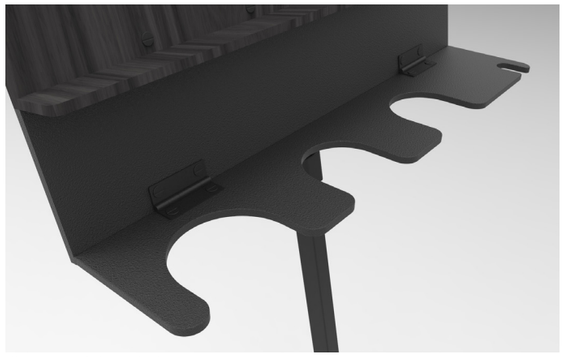
ill. 138 bottle module.

This module has an added slot, designed for holding generic waters bottles. The bottle is centered, for optimal balance.



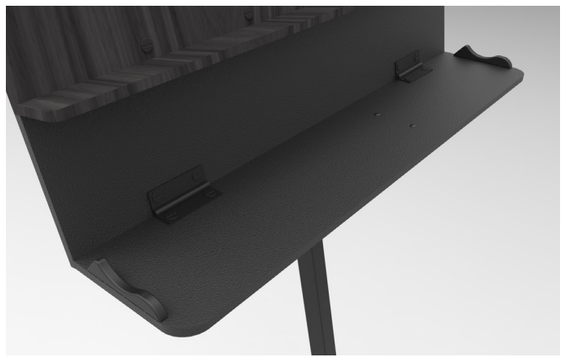
ill. 139 Module with one mute.

The cutout of this module holds a single mute, letting the trumpeter store the straight mute for quick and easy switching during tunes. In a practicing scenario, it may hold the practice mute while not in use.



ill. 140 Module with three mutes.

This module is meant for the trumpeter that wants the full range of mutes at hand. At the moment it holds a straight mute, cup mute, harmon mute and plunger mute comfortably.



ill. 141 Flute and bow holders.

The flute and bow holders can be attached on the modules, and hold violin bows or regular or alto flues, while preventing them from rolling onto the fragile keys.

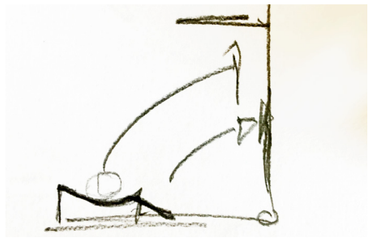
TESTING MODULARITY

Purpose

A question arose, that had not been considered in the ideation of modules. What if the user uses a flute of 30 cm? The module created so far was for a 70 cm flute.
The plunger (mute) needed a solution, that could be tested as well.

Process

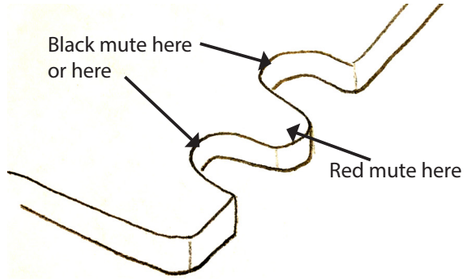
In the original idea, the bow and flute holder would be mounted into the sides. If an additional mount was needed for a 30 cm flute, how could the module shelf still be flipped up, without the mounts being in the way.
Multiple solutions were considered (For all solutions, see WS 53). The ideation resulted in a mount that would be short enough for the module to fold up, but not all the way up (ill. 142).



ill. 142 Solution for flute/violin mount

As for the plunger mute, desktop research showed that plunger mutes have two different designs of the part they would hang in (ill. 143). A solution was found, in which they could both be used (ill. 144).

ill. 143 Two types of plungers.



ill. 144 Principle of mount for plungers

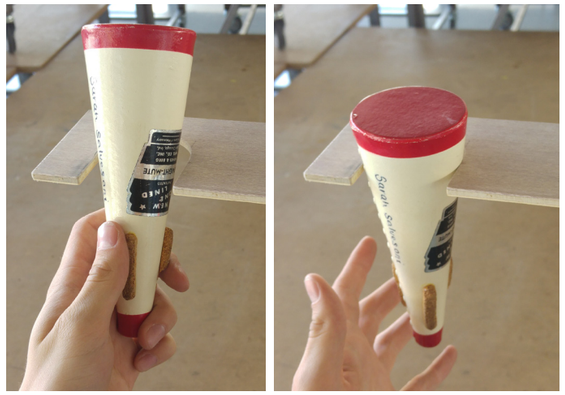
Output
The flute mounts had to be 3D printed for testing (P. 50), and the plunger solution needed testing as well (P. 50).

Purpose

The principles for modules created earlier (P. 33) had to be tested with elements, to see if they work as expected, and to get an understandig of scale (WS 52).

Process

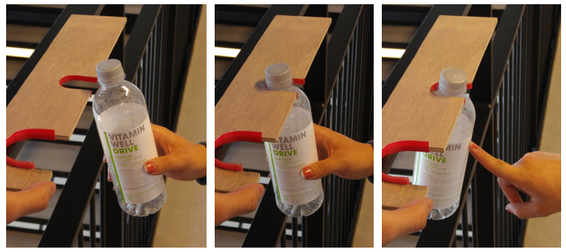
Principles tested were: Mute holder, flute holder, phone holder and bottle holder.
Models were built, placing objects on them, and making decisions upon the models, as to how objects should be mounted.



ill. 145 Testing straight mute

The mute holder proved to work very well for a straight mute, even prior to adding rubber for extra grip. However the rubber edge will still be used to protect the mute from scratches, while having the extra benefit of dampening the sound when placed.

How well the other mutes fit is still to be answered (P. 50).



ill. 146 Testing bottle holder

The bottle sits nicely in the holder, as long as the bottle has a neck similar to the ones tried in this test. The bottle sits tightly, even shaking the stand, and giving the bottle a slight push.
It has been tested with three different types of bottles.

Output
The mute holder needs to be tested with multiple types of mutes. The bottle holder works with 3/3 bottles tested.

Purpose
The principle of the mounts from p. 33 were 3D printed for test. When mounting them on the model, it was found that they place the flute in a way that it is in the way for the bottle holder (ill. 147).
This exercise seeks to find a shape of the mounts that ensures space for both flute and water bottle. The module must still be able to fold up.


ill. 147 Flute and bottle will collide if bottle is pushed to the back of the carving.

Process
First cutting out cardboard pieces and act it out with the model and elements and then 3D printing.
Different solutions were tried out: Lifting the flute up, but resulting in the module tray not being able to tilt up (ill. 148), and finally finding a solution where the flute mount is moved to the back, and the bottle moved further to the front, creating space for both (ill. 149). For all solutions see WS 59.


ill. 148 Lifting the flute up.


ill. 149 Bringing the flute to the back and the bottle to the front.

The mounts were 3D printed in the sizes that presumably would fit, mounted onto the model, and tested with a flute (ill. 150 and ill. 151).


ill. 150 Module tray can tilt while flute sits neatly in place


ill. 151 Testing with a flute.

Output
The test showed that **the mounts had a suitable shape for the flute,** however it needed minor adjustments to make sure the down facing key has enough leeway, especially when a water bottle is hung as well.

As for the violin bow, it is assumed, that it will also fit. The bow doesn't have the same demands as the flute, e.g. not rolling on keys.

Purpose
Testing the mute holder to find out if it works with multiple mutes at the same time (WS 62).

Process
Visiting the big band "Birdland", testing whether the module designed for a full set of trumpet mutes, actually holds the mutes as intended.


ill. 152 Testing bucket mute.


ill. 153 Testing mutes on music stand.

The straight and cup mute sit nicely in place, and are easy to take from the music stand and place on the music stand (ill. 153).The bucket mute turned out being more problematic than intended (ill. 152). It does sit on its intended shelf, however the height of the mute, including its metal clamps, interfere with the note tray, and is in the way of page turning.


ill. 154 Testing harmon mute.


ill. 155 Testing plunger mute.

The harmon mute needs a slightly larger cut out, to get into place (ill. 154), sitting comfortably under the note tray like the straight and cup mute (ill. 153). With the help of calipers, the harmon mute was held at the right height, and the appropriate diameter of the cutout was found to be 70mm, instead of the 55mm that suited the straight and cup mute. The plunger sits neatly on the hook (ill. 155). Hooking it from the front, similar to the other mutes, could potentially create a better user scenario, avoiding having different interactions when taking different mutes.

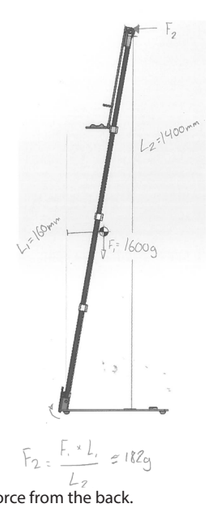
Output
Slight alterations will allow every mute, except the bucket mute. The bucket mute proved more difficult to account for than intended, due to its sheer size, and lack of ways to hook it. The bucket mute can balance on the stand in a pinch, however this is by no means a satisfying solution. This will need an additional iteration.

The cut out for the harmon mute is slightly increased, and the cut out for the plunger mute is moved to the front. A future iteration could show whether this solution clashes with the bucket mute, and will then be adapted.

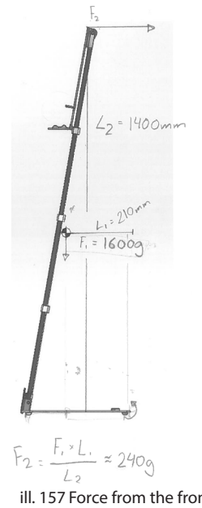
STABILITY

Purpose
To get an understanding of how stable the stand is during various scenarios.

Process
The mass and centre of mass were found in solidWorks, and the distances were measured from centre of mass to the scenarios tilting point. A simple calculation of equilibrium was then performed to approximate the force needed to tilt the stand.



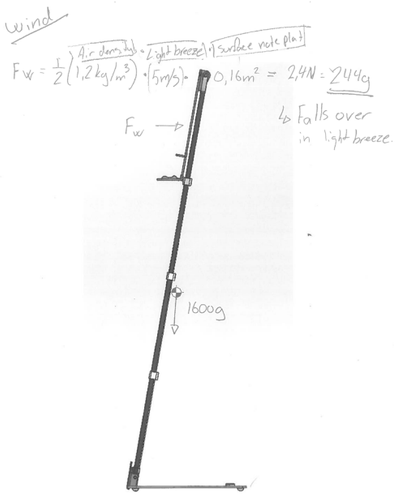
ill. 156 Force from the back.



ill. 157 Force from the front.

The calculation showed that when pushing from the back, the music stand starts tilting when pushed with a force of 182 g., and from the front with 240 g.

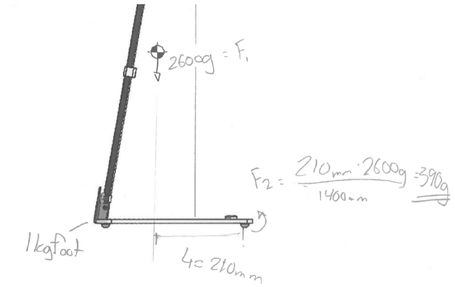
The force when pushed on the side of the tray and the force from the front when one kg mutes are on the module, is calculated as well (WS 61). The result shows that when more weight is in the tray, the more force is needed to tilt the music stand.



ill. 158 5m/s wind onto the top.

Due to the quite low force needed to reach equilibrium, a scenario is set up, where a slight breeze is acting on the flat surface of the music stand (ill. 158). It shows that the acting force on the stand at 5m/s wind, is enough to set the stand in motion. This is not the intended use, however, having a music stand that is unstable even in the slightest breeze seem inadequate.

Adding additional weight to the foot greatly improves the stability, as seen by the increase of F2 from 240g (ill. 157) to 390g (ill. 159), while the centre of gravity also has been lowered, making it less prone to falling over.



ill. 159 Adding weight to the foot.

Output
Since the music stand is designed for bringing, the lightness wanted when carrying, is the very same that causes the stand to be receptive to tilting when various loads are applied to it. When horizontal forces are applied to the very tip of music stand when erect, quite little force is required to reach the point where the stand will start tilting.

As seen from the calculations, adding loads to the note tray, and hanging e.g. mutes from it, will make it less prone to tilting.

The calculations only provide an approximation of single force scenarios, however they do create an understanding of scale, and at which points the stand is least stable. While the foot is designed to keep vertical loads within the footprint, or very close to, creating a very tall and light structure will cause a less stable stand. While the loads added to the note tray are generally within the footprint, the music stand should be able to withstand a quite significant load, theoretically limited by the structure's integrity.

In order to achieve a more stable structure, a few things can be adjusted. Lowering the height of the music stand is not an option, which leaves elongation of the feet, or increasing the mass itself.

An option could be expanding the customizability even further, letting people choose a foot of a certain weight, depending on each individual's priority between portability and weight. This, however, would increase the amount of parts needed in stock for the company itself, yet the choice of cnc machining the foot allows for great flexibility in materials and thicknesses.

MANUFACTURING AND MATERIALS

Purpose
Explaining the intended material and manufacturing process for major parts.

01 Top plate, 02 Foot, 03 Module

Material
The material used for the two top plates will be pine plywood with oak veneer on both sides. The pinewood ensures a soft core, which makes the material more anechoic (P. 46), and the oak creates an aesthetically pleasing finish. A black staining lacquer is applied by default, in order to create a neutral expression. This process also allows various other colour schemes, e.g. at an additional cost The very same lacquer serves to add durability to the plates, especially the relatively weak edges.

Manufacturing
The plates are CNC machined, mainly because this allows great flexibility in production, and therefore allows creation of various modules without e.g. having to invest in further moulds. This allows cutting out the plates with great precision, while also being able to mill into the plates at various depths. These milled geometries help guide the assembly while decreasing stress applied on bolts.

The surface area for the modules have certain needs, considering it will at have various objects place and hung from it, e.g. the modules holding mutes need a surface that won't scratch the high polish surface, while higher grip is preferred due to the holding principle. The initial approach was to glue a rubber profile along the edge of the modules, however this might not have the preferred aesthetics.

This led to looking into whether an elastomeric paint could take the hard lacquer, reducing the amounts of steps needed. Variations of these paints are also targeted wooden products [www.cbrproducts.com], meaning it should be possible to find a type that is applicable and could have the added benefit of creating a very uniform surface that still provides grip and damping when objects are placed on the module.

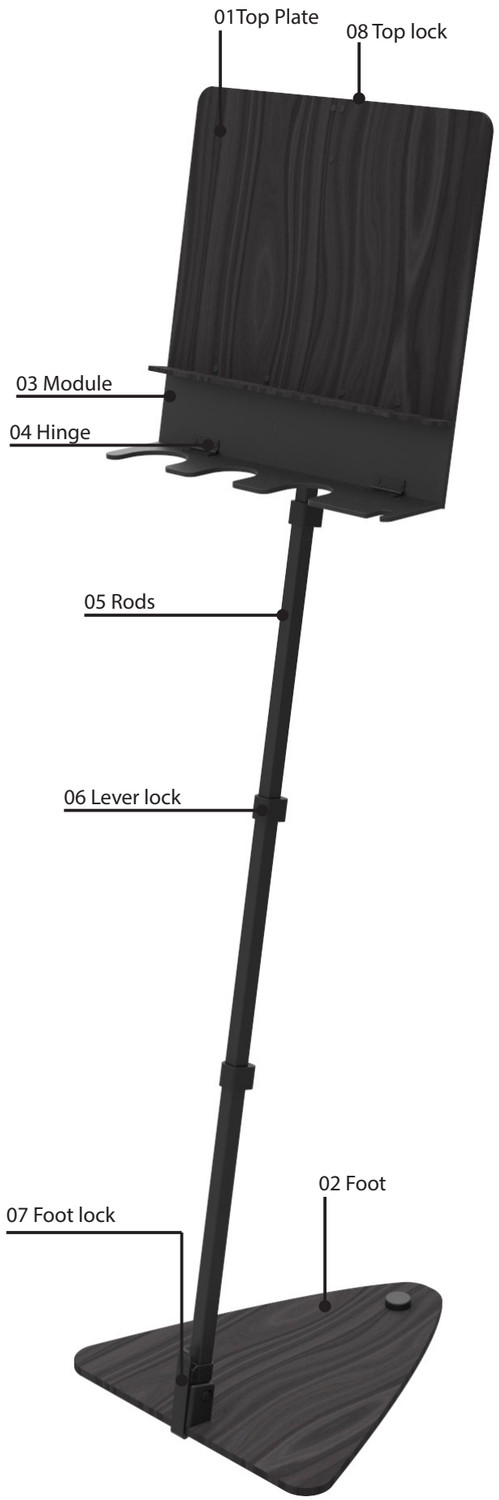
04 Hinge

Description
The hinge is bought as a standard part [www.alibaba.com]. The hinge connects the two parts of the module. For more information see p 45.

05 Rods

Material
The rods are made of steel, due to its strength and since a magnetic material is needed to fixate the music stand when folded (P. 44).

Manufacturing
The rods will be bought as a standard profile, already painted, cut to the right lengths and assembled.



ill. 160 Exploded render of music stand.

06 Lever lock

Material
ABS is chosen due to its great impact resistance and reasonable price. The joints will have to withstand various loads and impacts, and need to be able to withstand this.

Manufacturing
The parts are injection molded in order to achieve the intended geometries, while being able to produce at relatively larger scale.


ill. 161 Lever lock

ill. 162 Foot-lock.

07 Foot lock, 07a, 07b, 07c

Material
The three parts are made of ABS as well, for the same reasons as 06 lever lock.

Manufacturing
The parts are manufactured by injection molding for the same reasons as 06 Lever lock.

07d Flexible spacer

Description
Between the parts in the foot-lock, is a piece of rubber. In the backwards direction the rod is held by the hook (ill. 162), whereas in the front, the rubber insures that the rod won't wobble in its shell, and that the tolerances doesn't need to be zero.

Material
Polyurethane will be used due to: "excellent abrasion resistance and tensile strength as compared to other elastomers providing superior performance in hydraulic applications with high pressures, abrasive contamination and shock loads" [http://www.columbiaerd.com]

Manufacturing
The part is manufactured by injection molding.

08 Top lock

08a Handle

Description
The handle is bought as a standard part [www.alibaba.com].

08b Mounting plate

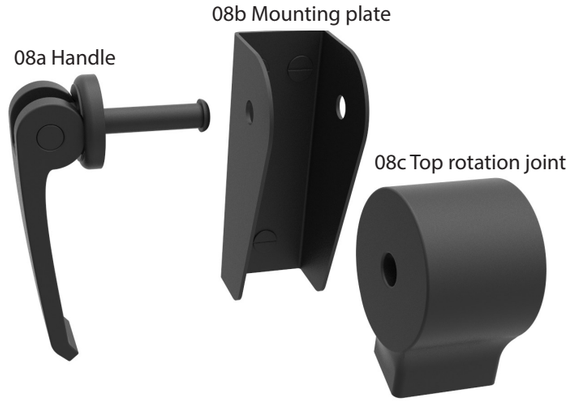
Material
The mounting plate is made of steel, due to great strength.

Manufacturing
The plate is punched out and then bend.

08c Top rotation joint

Material
The rotation joint is, as 07d, made of polyurethane.

Manufacturing
The part is manufactured by injection molding.



ill. 163 Top lock.

http://www.columbiaerd.com/materials.html#epdm

Phase 05
Market

BUSINESS

Purpose
To find out how big the market is. How many people play classical music in Denmark, and how many is estimated that would buy the product. Also, looking at competitors to set a targeted price for the product.

Process
Looking at statistics, calculating and roughly estimating how many professional musicians are present in Denmark and Germany (WS 55).

Denmark
If we only look at students from the music conservatories and MGK (only classical students) and people playing in symphony orchestras in Denmark, we have approximately 2327 persons. When mentioning people playing in the symphonies as a customer, it is not the symphony as a group, but the individuals buying the product for personal use.

Germany
If we expand to Germany, we have an additional 10.000 people playing in symphonies (WS 55). If we can assume that they have the same amount of students relative to people in the symphony, as in Denmark, they would have 32.230 students. This is a very rough estimate, since we don't know the amount of students in Germany.

	Denmark	Germany
MGK	276	(32.230)
Conservatory	1.500	
Symphony	551	10.000
Total	2.327	42.230

ill. 164 Guesstimate of professional classical musicians.

We assume that there are at least five times as many amateur musicians that could be interested in the product as well.

	Denmark	Germany
Professionals	2.327	42.230
Amateurs	11.635	211.150
Total	13.962	253.380

ill. 165 Guesstimate of customers in total.

If we take a period over three years, we assume that 5% of them would buy the product, this leaves us with a number of 698 product sold in Denmark and 12.669 in Germany.

	Denmark	Germany
Total	13.962	253.380
5%	698	12.669

ill. 166 Guesstimate of products sold in total.

Products sold in Denmark and Germany in total would be 13.367, and if we divide these over three years, numbers could be: **Year 1: 2.000, year 2: 4.000 and year 3: 7.000**.

A phonecall with a salesperson from the music store 4Sound in Odense was conducted, where the amount of music stands sold on a yearly basis, were announced. From this number, the amount sold in the four other 4Sound stores was roughly estimated by the size of the cities (ill. 167).

Odense	800
Esbjerg	800
Aalborg	900
Aarhus	1.000
København	1.100
Total	4.600

ill. 167 Guesstimate of music stands sold in 4Sound.

Output
The products sold would be:
Year 1: 2.000 **Year 2: 4.000** **Year 3: 7.000**.
Comparing these numbers with products sold in 4Sound, which is only in Denmark, where there are other music stores as well, and other music stands are sold, the numbers don't seem unrealistic.

Purpose
To set a sales price for the product.

Process
Looking at the music stands used for the market analysis (P. 15), and searching for additional music stands, prices for these products were used to estimate a price for the product.

Supreme S	Petersen	Hercules	RATstands
299,-	405,-	598,-	885,-

ill. 168 Comparison of music stands.

Output
ill. 168 is a section of the comparison, for full analysis, see WS 55. None of the products offers the customizability. RATstands does focus on easy setup, and all of them can be quite compact.
Based on the functions of the other music stands, and compared to their prices, an estimated **sales price of the product would be 995 dkk** without attached modules.

The user has the possibility to buy four different modules, where two different types of mounts can be attached to all of them. The modules vary in price of production.
An estimate of the price of a module would be around 150-300 dkk, which aligns fine with the price of e.g. a mute add-on of 183 dkk (WS 55). This price will be further validated in price estimation (P. 56). Additionally, the side mounts would be around 50-99 dkk pr. piece.

PRICE ESTIMATION

Purpose
Getting an overview of how much the various parts could cost, and what the sales price of the product can be.

Process
Plastic mould prices and wages were roughly estimated, standard parts found and prices noted. CNC-cutting time and price calculated based on an approximated travel distance. All price calculations can be found in appendix B and WS 50.

Production price music stand	327	dkk
Production price module	77	dkk
Production price stand + module	404	dkk

ill. 169 Calculated productions price.

The price of the music stand was calculated in relation to 13.000 products sold (ill. 169), which the estimation was made upon (P. 55).

The sales price estimated on p. 55, of 995 dkk for a music stand (without module) has been compared to the production price calculated.

If the retail price is at 995 dkk, then the production price must be below 223,88 dkk (ill. 170).
If the retail price is set according to the production price calculated (ill. 169), then the sales price must be 1450 dkk (ill. 171).

Retail price	%	995	dkk
Tax	75	746,25	dkk
Retailer contribution margin	50	373,12	dkk
CuMu contribution margin	60	223,88	dkk
Production price		223,88	dkk

ill. 170 Estimated sales price.

Retail price	%	1450	dkk
Tax	75	1087,5	dkk
Retailer contribution margin	50	543,75	dkk
CuMu contribution margin	60	326,25	dkk
Production price		326,25	dkk

ill. 171 Actual production price.

Output
Either the sales price can be raised to 1450 dkk from 995 dkk, or the production price must be lowered from 327 dkk to 223 dkk. The production price purely a rough estimate, showing the consideration made.

The calculations of price regarding the top, module, and foot are based on buying a single sheet of wood, resulting in a rather high price. This link could presumably be lowered significantly by buying in bulk. Other parts could potentially be bought at bulk prices as well, reducing the price.

The contribution margin has been calculated (ill. 172). This is in relation to the price of 1450 dkk.

	Year 01	Year 02	Year 03	Total
Parts sold	2.000	4.000	7.000	13.000
Sales price	544	544	544	
Product cost	326	326	326	
Turnover	1087.500	2.175.000	3.806.250	7.068.750
Variable cost	652.500	1.305.000	2.283.750	4.241.250
Contribu-tion margin	435.000	870.000	1.522.500	2.827.500

ill. 172 Budget (retail).

From the total contribution margin for three years, some going to the salary of the two designers. If we assume that there are two employees for three years in this business, then 2.160.000 dkk goes to salary. That leaves a contribution margin of 667.500 dkk, where some of it goes to overhead. This is a very rough estimate, and it must be assumed, that the two employees develop additional products as well, during these three years, reinvesting the earnings.

In relation to the price of 1450 dkk it was considered if this price would be too high. Looking into other accessories that musicians buy, it was made clear that the amount of money spent on accessories can be quite large.

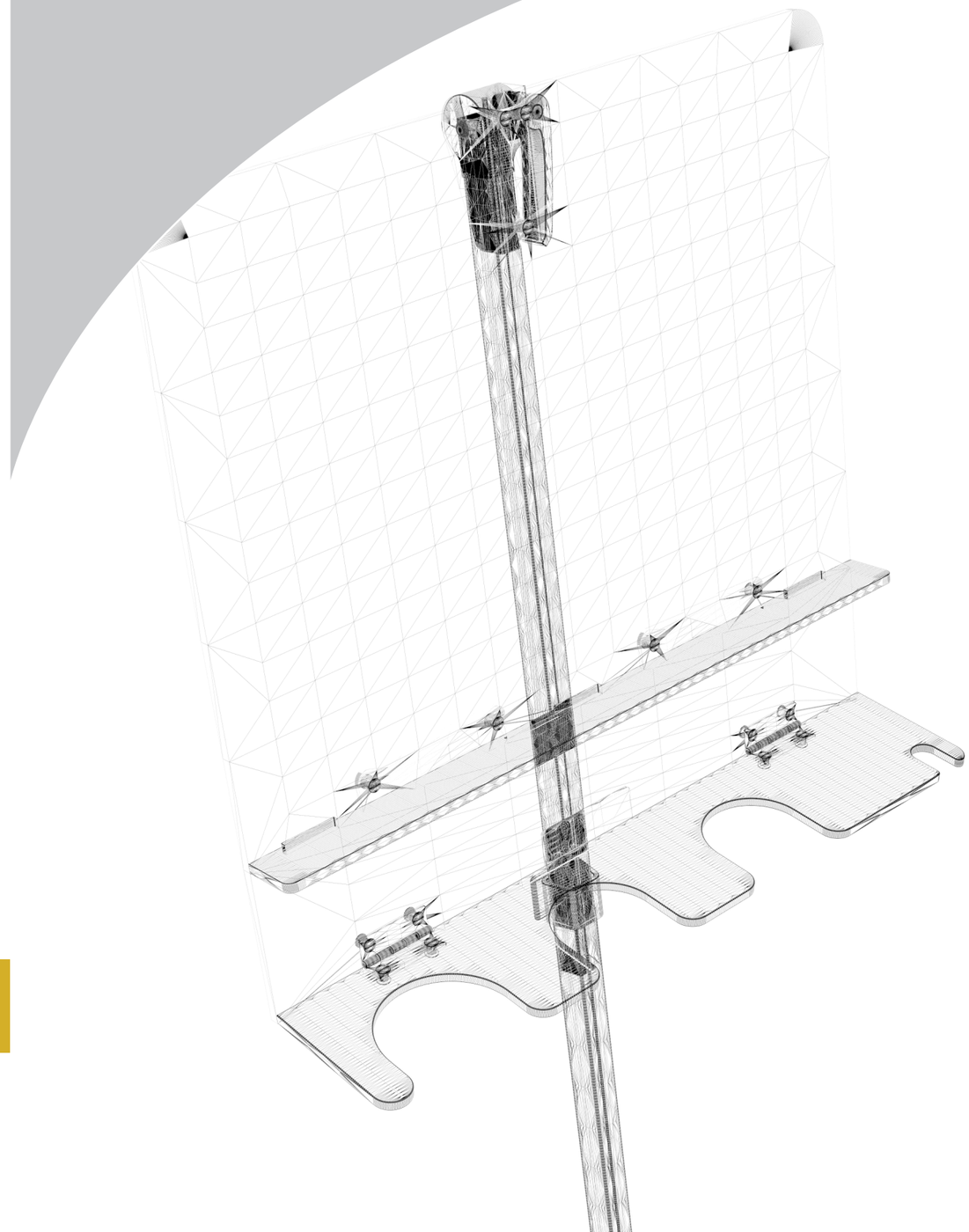
Looking at the most common mute, the straight mute, it can be bought at a price as low as 110 dkk, but goes all the way up to 825 dkk, having many products ranging between these two [www.thomann.de]. Reeds vary from 110 dkk to 974 dkk, meaning that even for an amateur musician, it is an expensive hobby, where a range of people are willing to spend significant sums, to get products that surpass low tier options.

ill. 173 Mutes.

ill. 174 Reeds

Output
It was decided, that the price of 1450 dkk would be an appropriate price for the product.

Phase 06
Finalizing



PROCESS REFLECTION

The project ended up having a very large scope early in the process due to the sudden change of direction. This meant that the initial framing process started with a very ambitious and time consuming scope, in a project that had been subject to a minor set back.

Early on, the project could have benefited from a closer and more continuous contact with the users, which would have saved a lot of time on desktop research and assumptions, where the output of the task could have been gathered in the same time span at an interview.
This was, however, realized and during the design of customizability the users were visited.

Due to the late scope involving customization towards various users, it was prioritized to get a nuanced understanding of few users, instead of getting a large and too simplified output, from e.g. questionnaires. This doesn't change the fact that only ten users were interviewed, which forms little background for creating a customizable product. Had the time been available, a much larger range of people should have been involved, also getting a range of people playing each individual instrument.
Designing based on such few users led to the customizability being very specific to these people, meaning that in reality, there might be a risk of one of the modules that has been designed, having a questionably small target group.

The approach of mocking up models, and acting out with said models, has proven to be an invaluable tool for getting an understanding of the concepts throughout the project. The consequences of various concepts were often impossible to hold against any criteria, and the communication and meaning making through models helped make the decision making conscious. The model building was a time consuming process but proved useful through countless act it outs, when questions arose regarding interactions and scale of the design.
It would have been beneficial to have all the elements at hand during the development, e.g. the full range of mutes, instead of only a few. One of the mutes ended up not fitting properly on the module, which could have been avoided, had it been available when ideating. Alternatively, models could have been mocked up representing the mutes, based on the measurements taken at the interviews.

As mentioned, the scope was found late, and too much time spent on concept development, leaving little time for detailing, which resulted in some aspects of the design not being fully developed, e.g. the handle and the bag.

PRODUCT REFLECTION

The product has many custom solutions, that each represent a potential use. Unfortunately, the detailing was initiated very late in the project, which did not leave enough time to either fully develop these, nor find standard solutions to take their place. Therefore, the major drivers of the project were prioritized, the easy setup and the customizability, while the detailing of other components remain poor. Some of the custom parts, especially the lever locks, including the telescopic tubes, could benefit from being standardized parts, bought preassembled instead.

Additionally, some of the custom solution's prices have been calculated based on standard components. E.g. the telescopic part, made as a trapeze, has alternatively been calculated as the price for a standard square rod. It is estimated, that a similar shape would be possible to find as a standard product, but it has not been prioritized to spend time on searching for this. Therefore, the price estimation consists of many rough estimations and assumptions.

Another solution would be finding a premanufactured telescopic rod, that follows usability and aesthetics of the overall design to an acceptable level. This would severely reduce the initial investment, reducing the general risk of the project, therefore making investors more likely to back the project.

Regarding price, the bag and the music stand would most likely be sold as a package, but the price has not been calculated, since the design of the bag is at a state where it is not developed enough to estimate a price upon.

The design, and its adaptability, encourages the expansion to adjacent markets. The functionality of creating an easier setup and coherent modularity is not tied to classical instruments, and therefore the same approach could be adapted to various genres.

Hence the product architecture, and choice of production methods, a potential direction could involve taking the customizability even further, making a series of different feet for the stand, depending on the user scenario. It was found, that either stability or weight would have to be prioritized. Having different variations of the foot, could give the user the possibility to choose either a heavy foot for better stability of the stand, or a lighter foot if their transportation requires a light music stand, but then giving them a less stable music stand.

The exact stability of the stand has been difficult to gauge. It is acknowledged that there is no perfect balance between weight and stability that will please every user. Therefore, the current attempt to find an acceptable balance is made within this premise, and future work would involve prototyping the way forwards.

CRITERIA SUMMARY

Purpose
Gathering the criteria throughout the report, marked with ▶
Checking that the criteria are met.

CRITERIA	SOURCE	IS THE CRITERIA MET?
"The music stand must have a uniform surface."	12	It does.
"The top of the music stand must accommodate an A3 sheet (approximately 30*40 cm)."	12	It does.
"Locks provide feedback"	14	It does. The locks can only be either open or closed.
"Having a resting point in the foot joint"	14	The foot either rests on the magnet when folded, or is automatically fixed at the correct unfolded position by the spring loaded hook.
"No folding mechanism that can jam if folded in wrong order. "	14	It doesn't jam, but the interaction is not optimal if the foot is folded up before telescopic rods are compressed.
"Removing a degree of freedom by not making a circular profile in the telescopic part. "	14, 21	The profile is trapeze-shaped, making rotations impossible.
"The foot extends away from the user, creating stability towards the user."	21	It does.
"Having attachments that follow the same geometry and material thickness as note tray."	28	They do.
"Aligning the directional lines of attachments with the overall product e.g. parallel lines."	28	They do align.
"The music stand must be able to elevate up to at least 1200 cm. "	29	It can.
"The music stand needs to be suitable for bringing on a bike. "	34	The bag for the music stand is designed for mounting on a bike.
"The music stand must have a bag, with an extra room for notes, that can be closed, to make sure the notes wont get wet in the case of rain. "	35	The bag hasn't been materialized yet , but there is potential for working further with this.
"It was decided, that the music stand must have a handle."	37	The handle hasn't been materialized yet , but there is potential for working further with this.

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ILLUSTRATION LIST

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