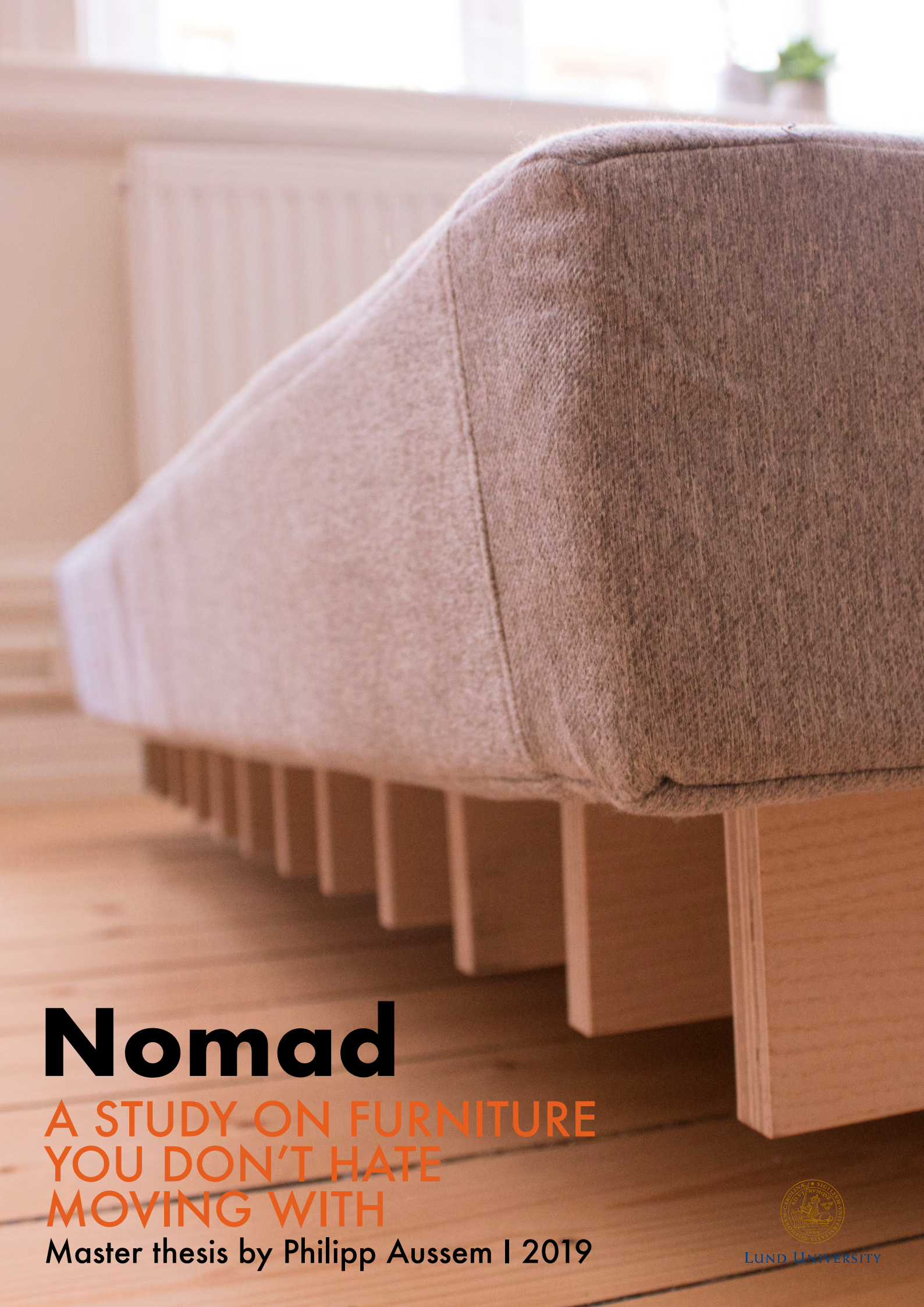

Nomad

A STUDY ON FURNITURE YOU DON'T HATE MOVING WITH

Master thesis by Philipp Aussem I 2019

LUND UNIVERSITY

Master Thesis

Nomad
A study on furniture you don't hate moving with
By Philipp Aussem

Degree Project for Master of Fine Arts in Design

Main Field of Study:	Industrial Design
Instutution:	School of Industrial Design Department of Design Sciences Lund University
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Abstract

We live in a world where people move in-between countries every day, every month, every year. Family, work, education, those are only some of the motivators for getting out of the comfort zone and starting a new adventure, sometimes even abroad.

This dissertation investigates students and how they handle the furniture of their private living spaces during their time in academic mobility.

Academic mobility generalizes the state of moving for an academic purpose, for example starting a bachelor's programme and therefore having to move to a new city or country. For many students, this leads to a decision that has to be made:

Will - and can - they transport the already possessed furniture to the new environment, given that it is not or only partially furnished, or do they organize new furniture once they arrive?

To get more detailed information on how the situation used to be and still is, a survey was created to investigate students moving behaviour and how they dealt with the furniture situation.

Furthermore, the most important interior objects were bed, desk and closet, which are needed for living and working. Leisure items like a couch or a side table were rated way less important.

In general, the research shows that there is an issue with furniture in the life of a mobile student. Moreover, the target audience has problems with handling the situation to a level where they are 100 % satisfied and that creating alternatives needs to be investigated further.

Foreword

The subject of moving is a loyal companion along my academic education since I lived in seven different flats since 2011. This fits well with my new passion for multi-functional furniture as I hadn't found any good solutions for easy to move furniture.

Fortunately, we could choose our master thesis subject ourselves and here I am with an 87 pages dissertation about furniture that is easy to take apart and move during one's academic education.

For, in my opinion, the success of this project I want to thank many different people, first and foremost Per and Anna as my supervisor and examiner.

Tack så mycket, Per, for encouraging me to think bigger, connecting me with Smålands production industry to produce the complicated parts of my prototype and staying calm while knowing how students think and work.

Tack så mycket, Anna, for your always good and critical feedback, your guidance throughout the whole process and for sometimes taking me a step back to see the bigger picture.

Furthermore, thanks also to my parents for always sharing your opinion and making it possible for me to live and study abroad.

Last but not least, tack så mycket to Vapenkroken Nation and Drottningtorget for always having an open ear, a helping hand or an extra portion at dinner.

Contents

Fig. 1: Bent sheet metal

KICKOFF

Starting point

During their academic education, European students move multiple times between cities, countries and even continents. For my academic education, I moved multiple times between 7 apartments, 6 cities and 2 countries. Besides usual items like clothing and books, a big issue often is how to deal with furniture. Is the place they are moving to furnished? What do they have to bring or buy once they arrive? In several of those cases a trip to a thrift store, IKEA or similar shops is inevitable. This is neither economic nor practical.

Once you possess big or heavy items like a desk or a wardrobe and want to take them with you at some point you have to either get rid of them or, given the case you don't coincidently own a van, need to rent a truck.

Fortunately, the world of affordable furniture for adolescents hungry for education is accommodating. IKEA products, for instance, are affordable, mostly easy to bring home and to assemble. Unfortunately, from that point on they are rather difficult to disassemble or transport as a whole.

Heavy or bulky furniture, then, becomes the archenemy when it comes down to transportation and asking friends for help might be socially acceptable but no one enjoys to carrying a 2 x 1.40 m bed down four floors on a Sunday morning.

Fig. 2: Moving map

Think back.

Have you ever moved or helped someone moving without professional help such as a moving company?

Problem hypothesis

During their studies, many academics move multiple times in-between cities, countries or continents. While heading for the next place, heavy or bulky furniture becomes the archenemy when it comes down to transportation.

INITIAL RESEARCH

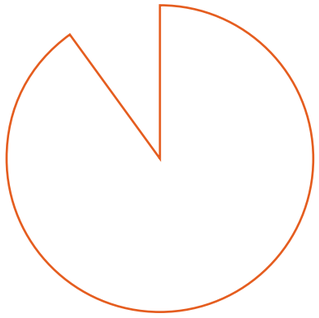
Academic mobility

In the western world numbers of young high school graduates seeking higher secondary education are increasing (OECD, 2011) due to the growth and diversification of the job market. Every year more and more specific study programmes pop leading to a constant flow of adolescents migrating from their childhood home to a new and probably unknown city to start studying at a university. This phenomenon is called academic mobility.

For starting a graduate-level education, academic mobility conditions inside the European Higher Education Area (EHEA, Shields, 2016), such as an increasing number of programmes taught in English, even simplify moving abroad to follow an education.

Additionally, going abroad on exchange, mostly organised by student exchange programmes such as ERASMUS, is consequently on the rise.

Ultimately, if the individual does not decide to stay in the area for the first job after graduation, at least three changes of personal living space in a minimum of four years happen.



90 % of academic mobility of EHEA is intra EU

Fig. 3: European academic mobility
Source: Academia Europæa, 2015

26 Y

Average nest leaving age on EU average: 26 years

Fig. 4: European nest leaving age
Source: Eurostat, 2017

Student accomodation

The most common types of student accommodation besides staying with one's parents are university organized residencies and privately rented spaces. Most universities try to accommodate students within their own buildings or at least support finding a home, but due to the shier high amount of degree-seeking nomads housing offices struggle to organize living space for every new youngster in need. The advantage of school provided living spaces is them being furnished so that tenants do, in fact, not have to bring or buy essential interior.

Much more common in Europe are private rentals such as shared apartments or houses and as the graph shows, they cover more than half of the housing situations of current students. The downside of agreements like this is in many cases a lack of interior.

In fact, new moving in students oftentimes have to bring or buy larger essential items such as a bed, desk or wardrobe.

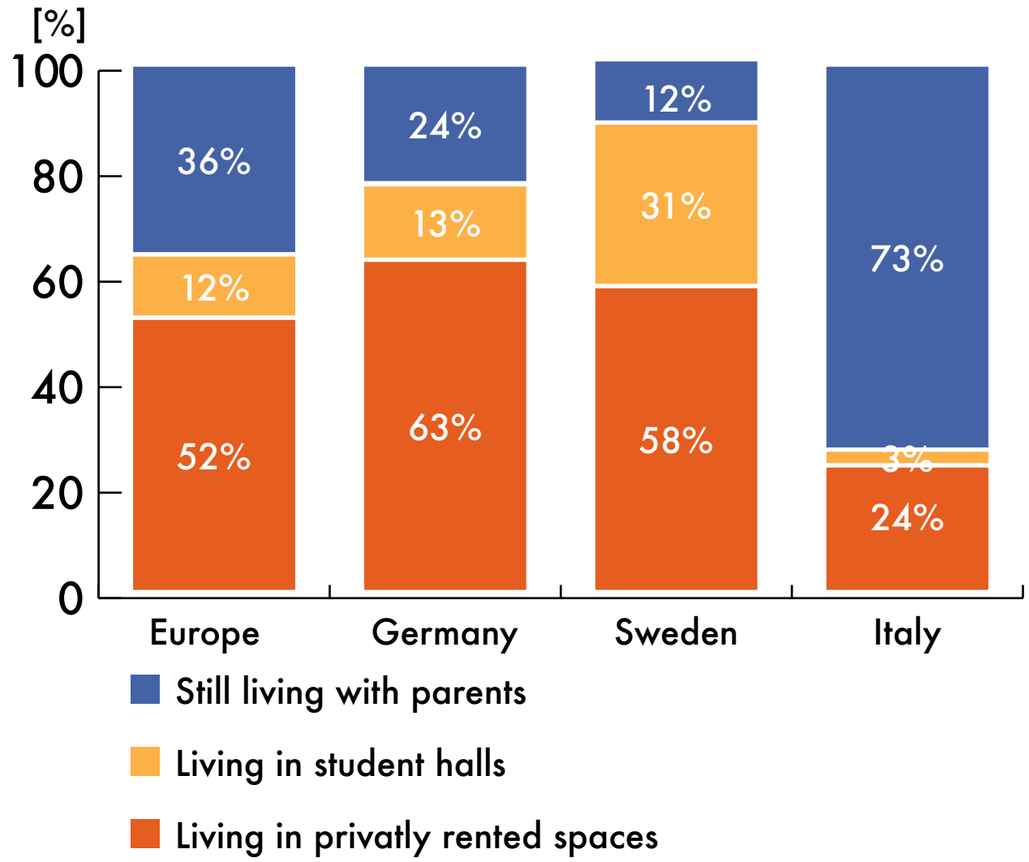


Fig. 5: Common student accomodation types
Source: Savills.co.uk, 2013

Survey

The existing research showed a lack of concrete quantified evidence of European academic mobility. To find proof for an existing issue and to get a more applied impression of the target audience, a survey (Kraemer, 1991) revealed first-hand information and potential trends of moving inside the target group. It should, furthermore, investigate the attitude and behaviour of both national and international students towards furnishings for their private living spaces, for instance, the interior of their bedrooms.

The results of the survey, filled out by 85 participants, shows that almost half of them (combined 47 %) moved three or more times for academic purposes and that a third (33 %) moved at least twice for the same purpose with a total sum of minimum 224 cases of moving.

The survey, moreover, revealed that a combined 68 % of the participants moved at least at one point in their lives into a new space which was not at all or only partly furnished. In those cases, at least some additional furniture had to be organized.

Furthermore, more than half of the participants (57 %) used a plane at least once for moving, whereas the majority of 71 % moved with a private car.

In comparison, only 17 % rented a moving truck to transport their belongings to the new place. This insight has a significant influence on the product development since using commonly sized cars varying in interior size limits the scope of transportation.

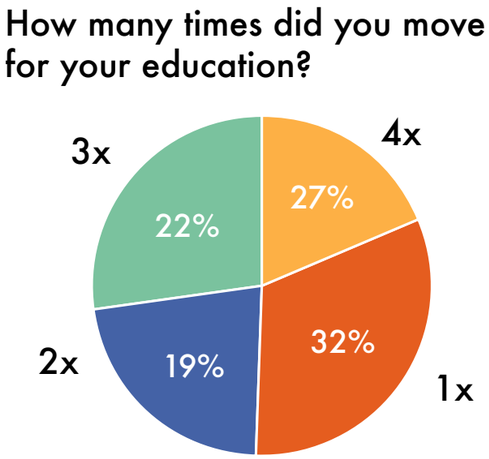


Fig. 6: Amount of moving

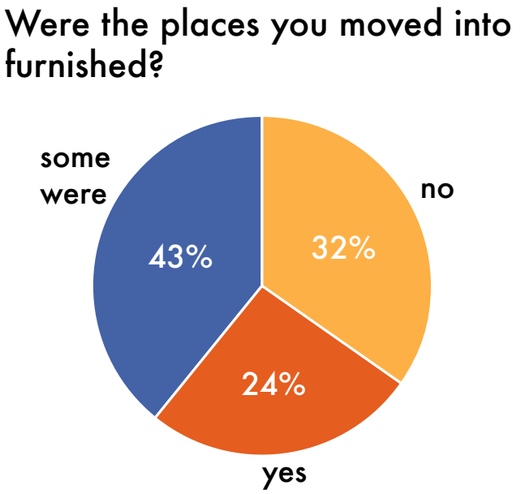


Fig. 7: Moving destination

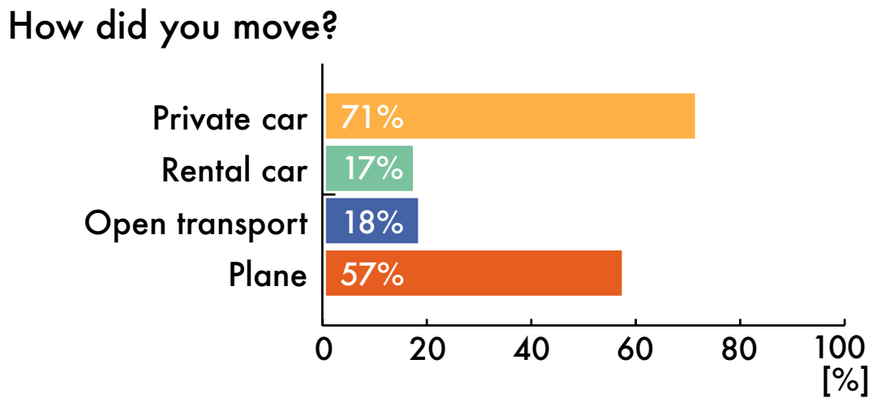


Fig. 8: Methods of moving

SCOPE

Who?

The primary focus group are young students in degree mobility. High-School graduates who are about to start a university programme are facing a major change in their life concerning time, workload and living space. When moving to a new and first apartment a set of furniture is needed that reflects a more mature and maybe nomadic lifestyle for the future.

The secondary target audience consists of more advanced academics such as master and PhD students who already completed a study programme and want to continue their education in a new environment.

Fig. 9: Student moving

Personas

Name:	Jasper
Age:	27
Relationship status:	Single
City and country of origin:	Reykjavik, Iceland
Current situation:	Lives in a shared flat, has an income
Current academic status	Master graduate
Major:	Physics
Upcoming life change:	Accepted for PhD. in Stockholm, Sweden
Next step:	Moving to a new country, moving to an apartment, for more than three years

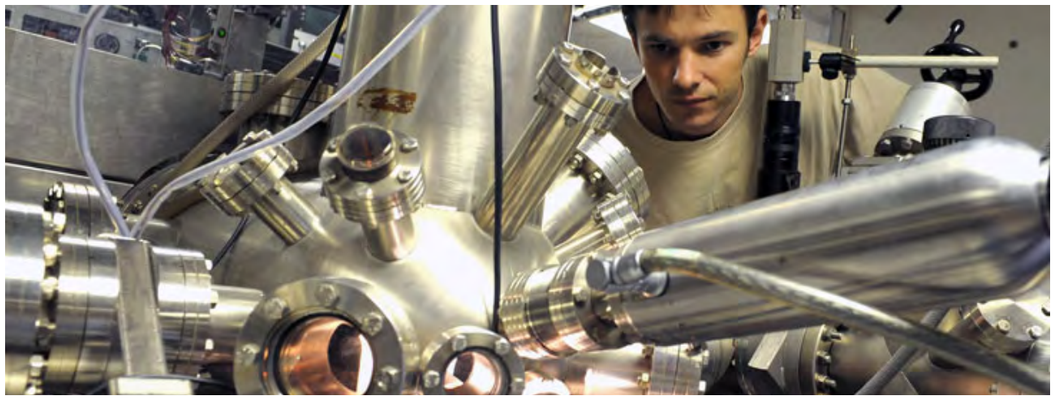


Fig. 10: Persona 1: Jasper

Name:	Lea
Age:	25
Relationship status:	In a relationship
City and country of origin:	Zürich, Switzerland
Current situation:	Lives in a student housing, gets governmental/ scholarship
Current academic status:	Master student
Major:	Architecture
Upcoming life change:	Moving in with partner
Next step:	Moving inside current city, moving to an apartment, for one to two years

Fig. 11: Persona 2: Lea

What?

Both, basic and applied research showed a hierarchy in interior objects students desperately need. These objects are divided into two groups.

Nice to have

The Nice-To-Have-Item like rugs or nightstands are mostly atmospheric and luxurious pieces. They transform the room into a space that is more than studying and sleeping and create space for leisure activities.

Essential items

However, the most important items as the graphs communicate are lamp, chair, bed, desk and shelf/wardrobe. For instance, without a bed for a good night's sleep or a desk for studying, the academic career is seriously endangered. That being said, those are also the hardest to move.

The bed takes a special role in one's furniture collection since it represents a very intimate interaction with the user. It, moreover, needs to fulfil a certain amount of stability to stand the weight of up to two persons. The survey revealed concrete numbers on what participants brought and bought once they arrived. The percentages are calculated on the sum of moves, for instance, more than half (51 %) of the participants brought at least once a bed with them to a new place.

Hence, having a bed that is easy to move but at the same time brings a rigid construction and saves energy, nerves and money.

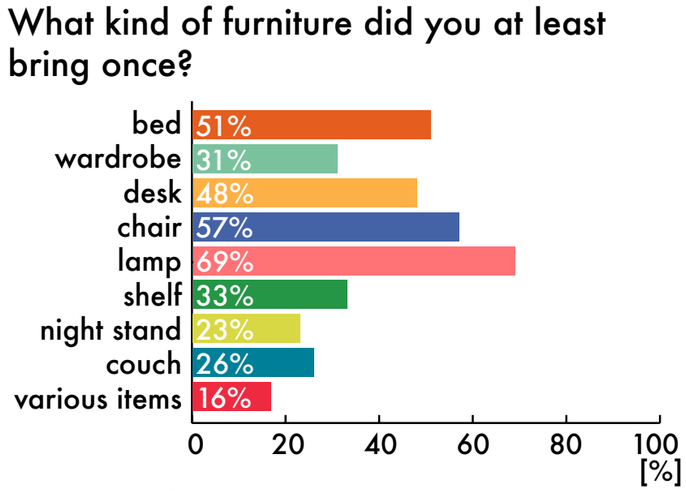


Fig. 12: Brought furniture data

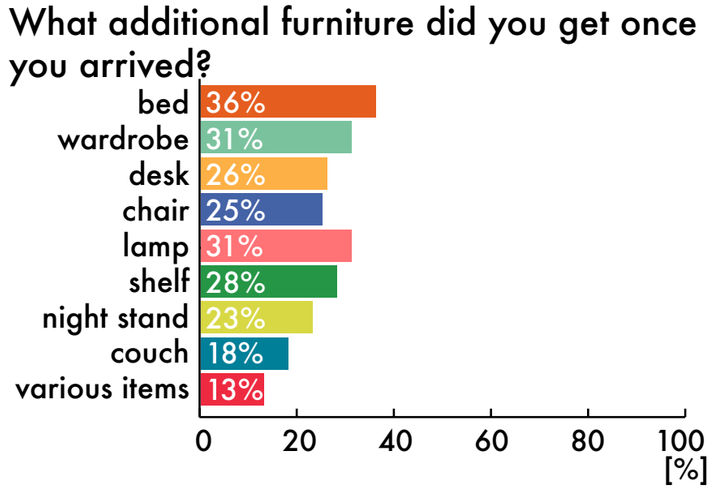


Fig. 13: Organized furniture data

How?

The preferred scenario of furniture usage for those cases should be cyclic. Instead of hustling with moving heavy or bulky furniture or having to sell or trash it, a flexible solution can facilitate bringing those possessions.

A flexible solution, hence, does not only lead to simplification for the consumer but also to severe sustainable advantages in the product life cycle. The perceived value of the product is higher due to long-time possession and quality materials. This results in better handling and ultimately longer endurance of the product, making it unnecessary for selling or throwing away the old and new cheap furniture to be purchased after every move.

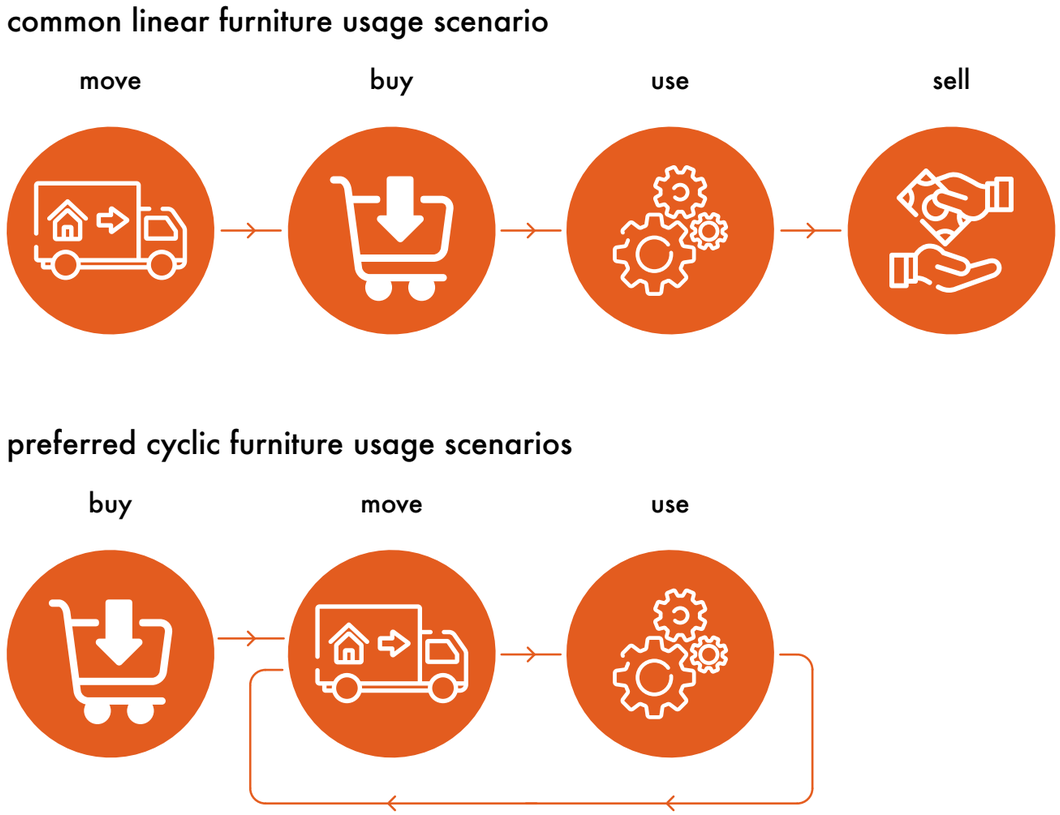
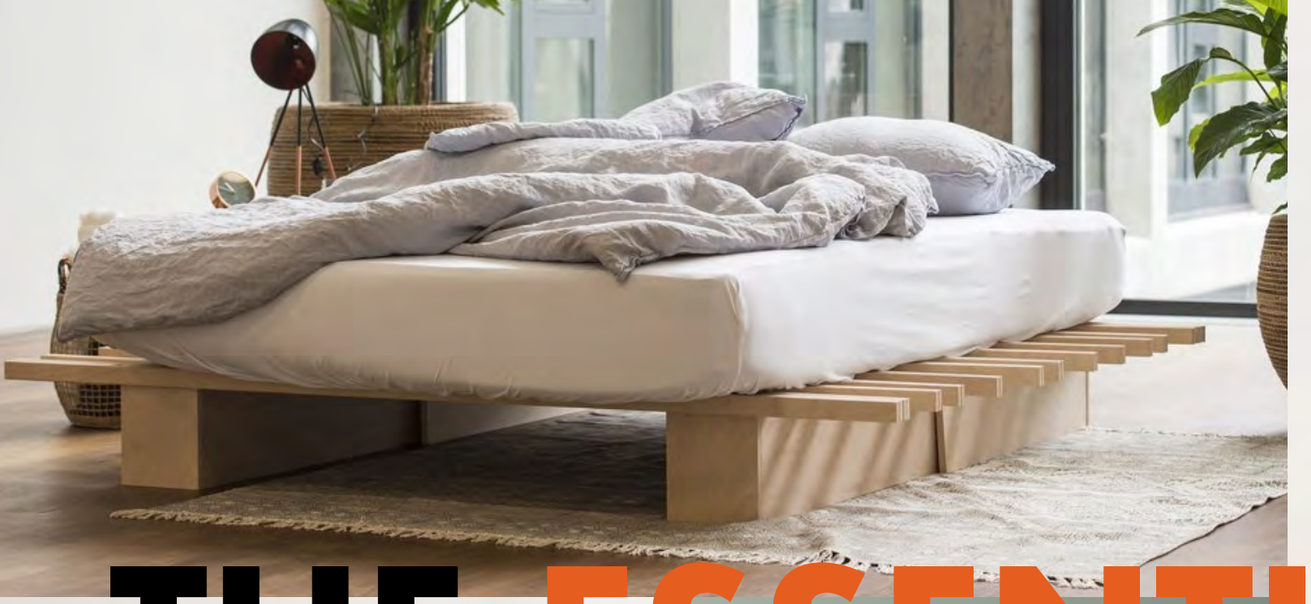


Fig. 14: Usage scenarios

Brief

During one's studies, many academics move multiple times between cities, countries or continents. While heading for the next place, furniture becomes the archenemy when it comes to transportation. Hence, having a set of furniture that is easy to move saves energy, nerves and money.

Develop a piece/ set of furniture that is easy to move and saves energy, nerves and money.



THE ESSENTIALS

Where?

Fig. 15: Quadrant chart

Fig. 16: Wardrobe *Out of Neccesity*
by Martin Gschwandtl

Fig. 17: Modular furniture *Crisscross*
by Crisscross Furniture

Fig. 18: Bed *Tojo V*
by Tojo

Fig. 19: Shelf *String Pocket*
by String

Fig. 20: Table *Tebur*
by NM Bello

Fig. 21: Table *Instant Table*
by Why the Friday

IDEATION

Fig. 22: Ideation sketching

Direction-finding

The essentials were the mostly covered objects throughout the ideation process. Especially for a bed, the combination of being both easy to carry and rigid construction seemed challenging so I started investing more time into portable bed solutions.

Even in the case of low widths, beds always come with a length of 2 m which complicates the moving process even if it is made to be taken apart. There are always some components which are hard to manoeuvre through, for example, narrow staircases or complicate transportation in a car.

In addition to that, the use of slats is essential since the mattress needs to be ventilated from underneath to make sure the humidity the human body releases can evaporate.

A solution where the longest parts are collapsible came into my mind. Separated or moving parts, on the one hand, are useful since they facilitate transport but require, on the other hand, an application to secure them to be rigid during use The most promising idea appeared to be a demountable bed where for the transport all components can be rearranged into a package.

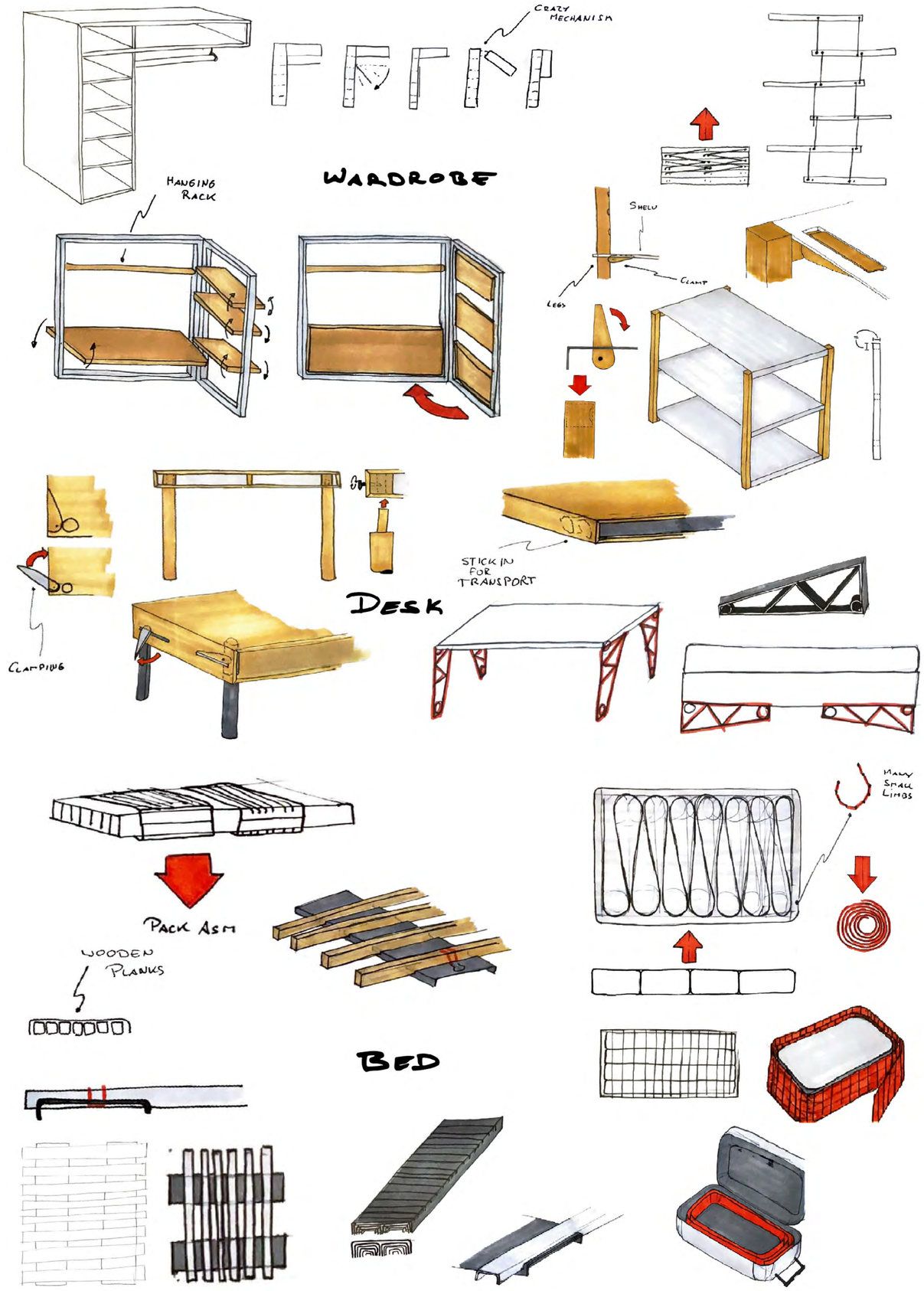


Fig. 23: Direction finding

Concept development

Detailing

Developing the flatpack idea further, I had to find the triple point at which weight, size and number of components even each other out. I wanted to create a system in which all parts are essential for both states, the sleeping configuration as well as the package, to not lose any parts, for example during transportation.

Sheet metal appeared to come in handy for its stable properties with even thickness of only a few millimetres. It could be used for a frame to secure a solid base but should be kept limited due to the metals natural weight. Furthermore, bent sheet metal parts could work as a container to wrap the other parts up.

The slats, however, need to be quite stable to support the full size of a mattress but still light enough to be portable. I decided to use wooden planks lengthwise making them the 2 m components. Splitting these planks would solve the manoeuvring problem but makes the construction less rigid and increases the number of components. This lead to the problem of how to reconnect the slat parts after transport.

Looking into traditional Chinese or Scandinavian joinery, solutions from only wood seemed too fragile. In order to avoid additional metal parts that needed to be included in the transport package. I decided to use fixed metal hinges to guarantee sturdy conjunction, make the slats collapsible and decrease the ultimate number of components the user has to deal with.

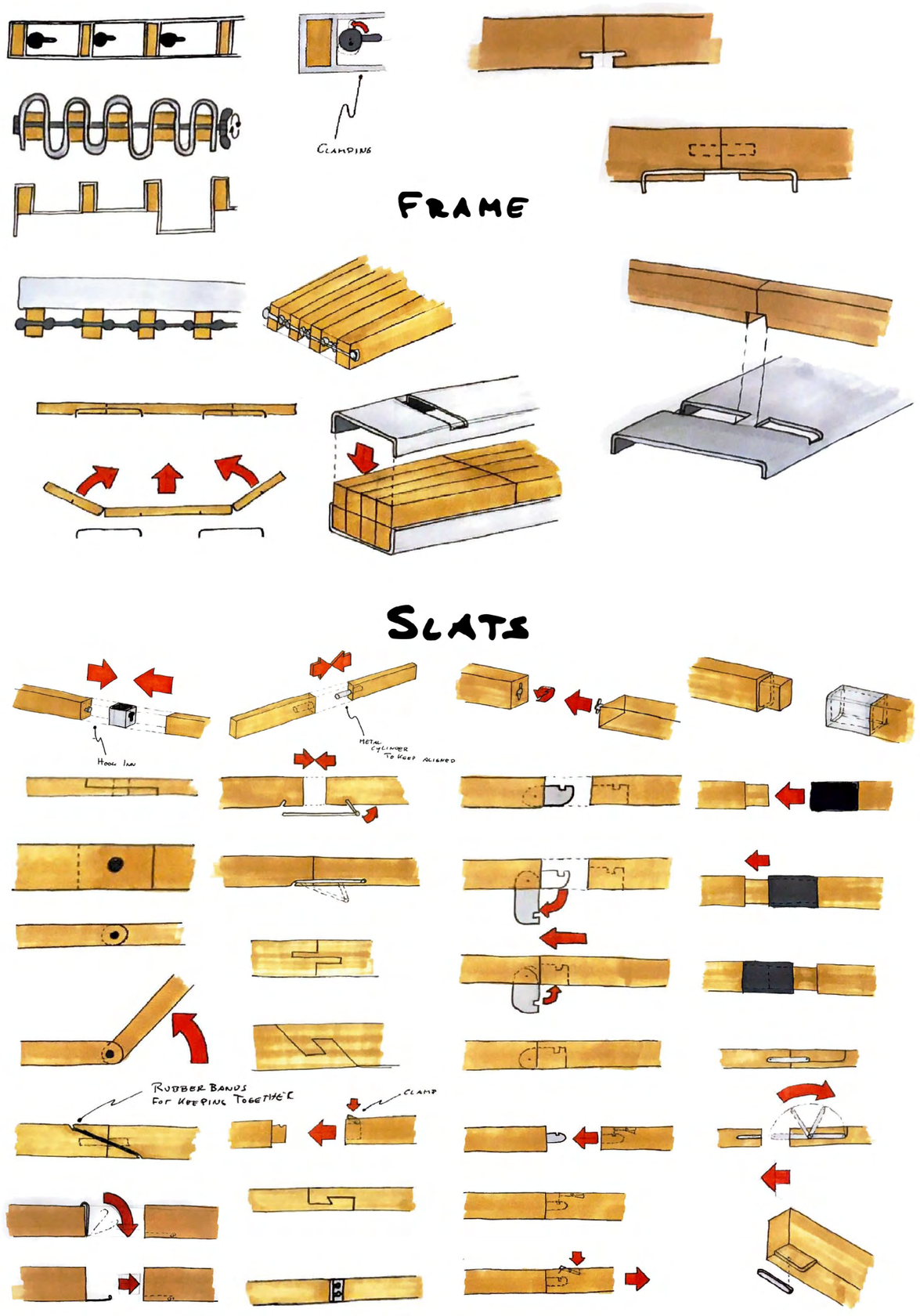
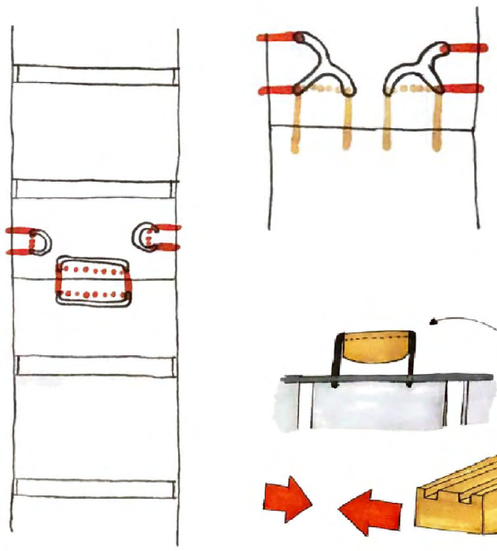
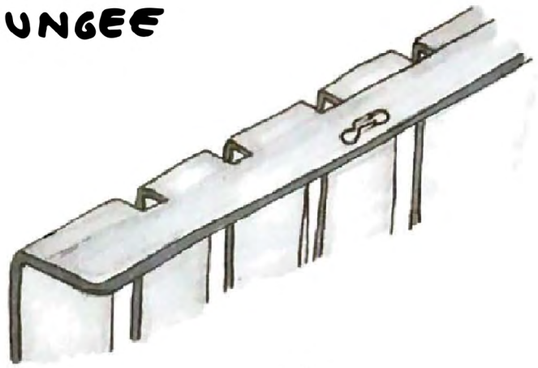


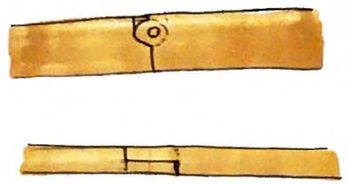
Fig. 24: Detailing

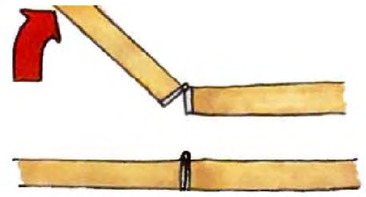


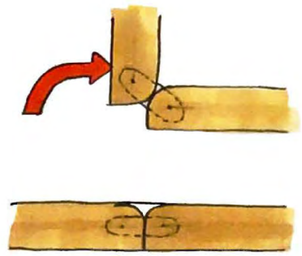
BUNGEE



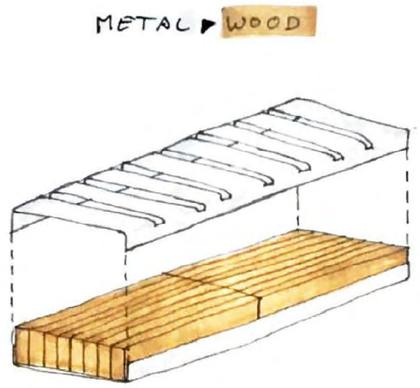
HINGES

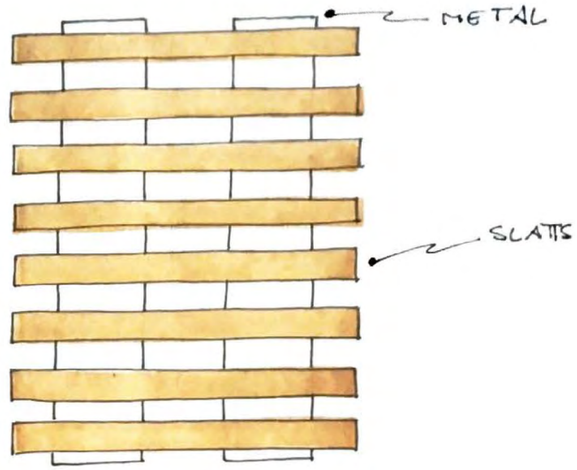




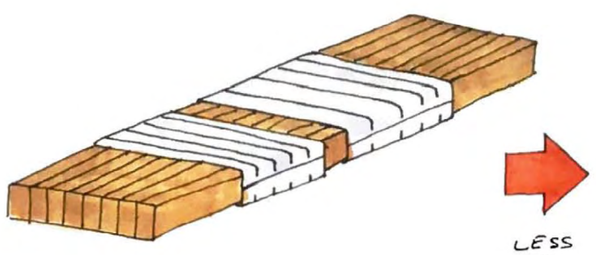


COMPOSITION

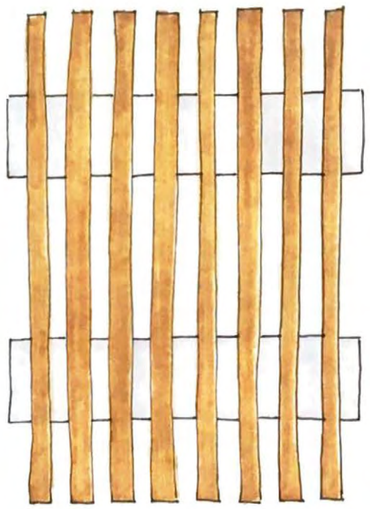


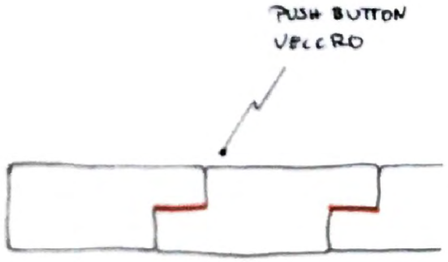


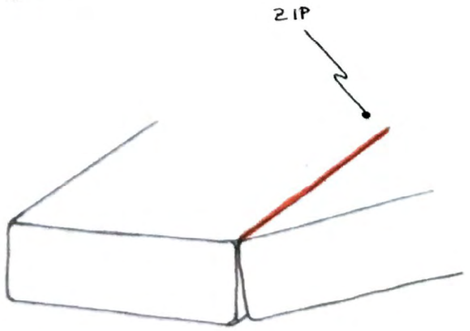
TOO MUCH
METAL
⇨ HEAVY



LESS
METAL

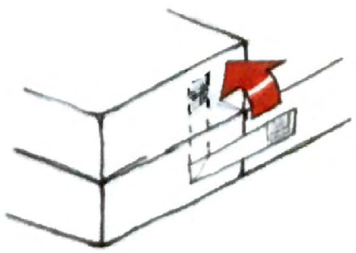


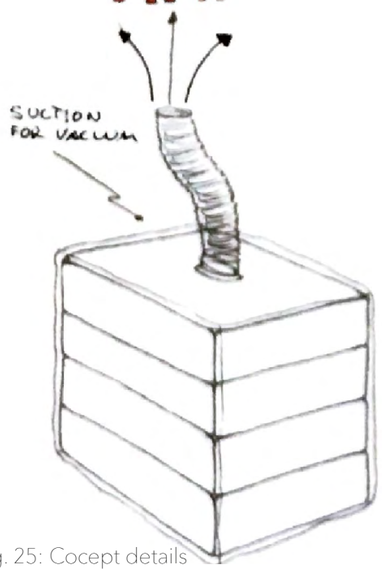




AIR

MATTRESS





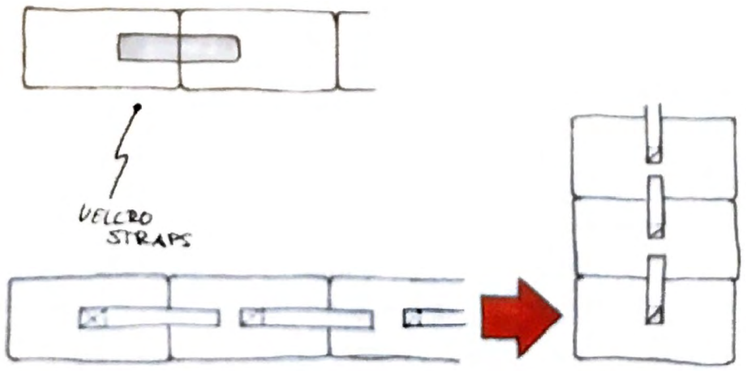


Fig. 25: Cocept details

Miniature mock-up

To quickly evaluate the idea I built a small scale wooden mock-up. It provides a clearer understanding of the concept in terms of the assembly of parts, how the slats are folded and laid into the U-profiles while in transportation mode.

To assemble the bed, the slats are simply taken out of the hollow feet profiles, unfolded and stuck onto the feet.

Problems that already occurred were that the slats not stayed straight naturally and the question of how to connect the two metal feet standing next to each other. During the further development, this has to be investigated.

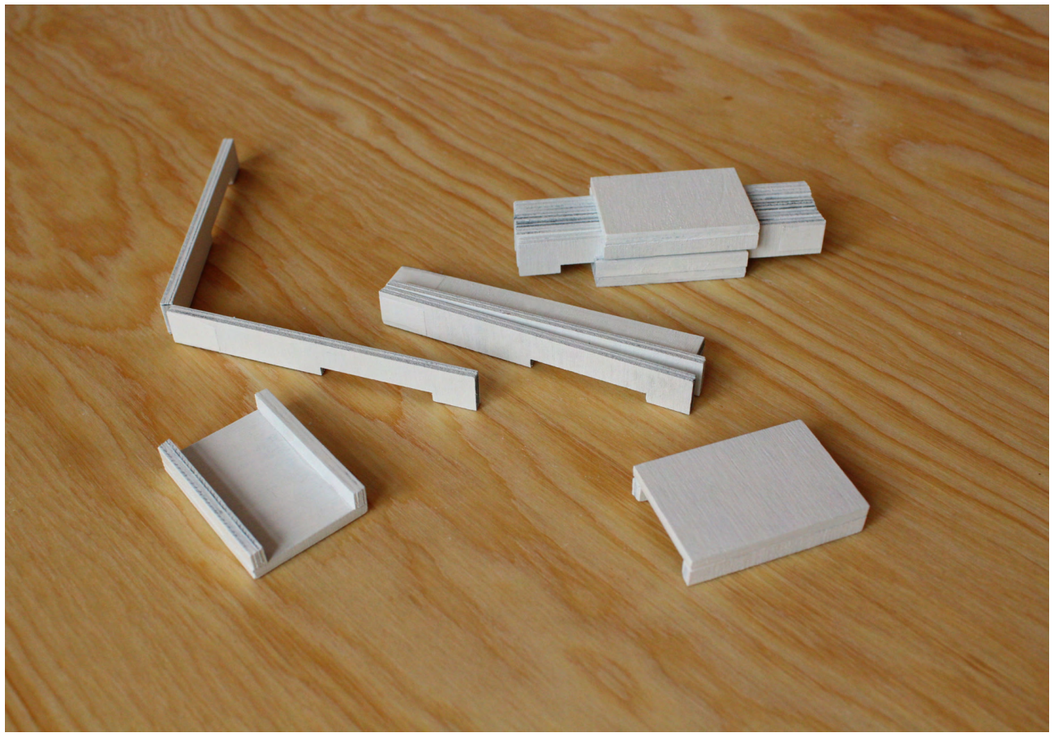


Fig. 26: Miniature mock-up taken apart

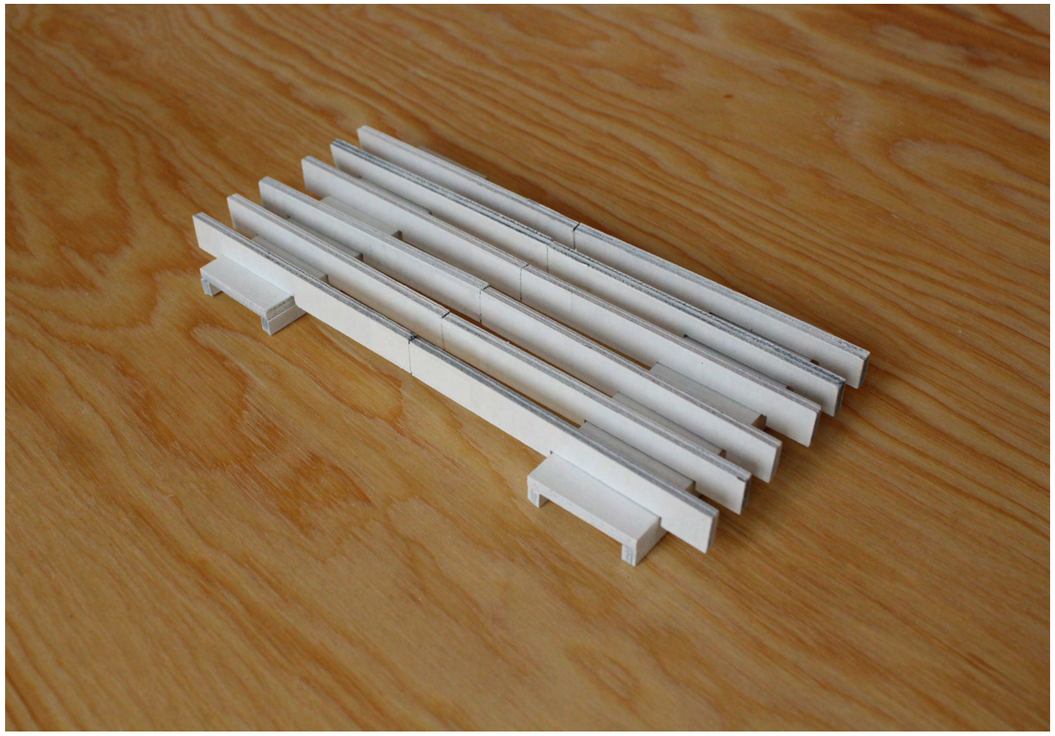


Fig. 27: Miniature mock-up built up

Preliminary concept

The bed consists of a to be determined number of slats that support the mattress lengthwise during usage. These slats, as well as the sheet metal feet, will be slotted and stuck together for a rigid composition. Each foot consists of two identical metal components that will be connected via bungee chords. For transportation, the slats will be collapsed via hinges and laid into the feet where they will be secured from both sides. The bungee chords keep the package together.

Fig. 28: Concept rendering

DEVELOPMENT

LIGHT

WOOD

BASIC

SHAPES

LIGHTWEIGHT

COMPOSITION

SIMPLE

CONNECTIONS

Fig. 29: Design moodboard

Testing

Slats

In order to determine how many slats are needed for a comfortable sleep, I built a real scale MDF mock-up with modular exchangeable slats. In addition to influencing the comfort, the amount has a serious effect on the weight of bed and packages. Starting with six slats I added two every day spending a night on each configuration of the mock-up for real user experience. The testing showed that for a comfortable laying experience 10 wooden planks are enough to not feel the gaps in between. Getting out of as well as kneeling on the bed turned out to be a problem. After adding two more slats to the sum of 12 appeared to be the right amount since the discomfort was eliminated.

Mattress

The core of this project was to develop a portable bed suitable for students that moving around. The mattress is part of the whole concept but left out during detailed development. Although it is, as the rest of the bed, hard to transport, due to its flexibility it ended up not being the main focus throughout the progress of the development.

Nonetheless, I want to continue with the studies and include a fully ripened design for the mattress as well.

In its actual state, it consists of four via stitching connected rectangles which can be folded together. the parts contain Velcro straps to secure the package for transport.

Fig. 30: MDF mock-up

Fig. 31: Mattress segments

Having Phil's bed prototype in the studio was such a treat, the perfect spot for a sweet powernap after lunch, bummed that we had only one!!

- Riccardo Lajolo, Industrial Design Master Student 2019

Fig. 32: Classmate napping on prototype in studio

Simulations

To determine the thickness of the metal feet, the rigidity of the construction had to be tested, first digitally via FEM analysis (Finite Element Analysis, a digital force simulation) in SolidWorks. The upper picture shows the plastic deformation with a force of 120 kgf (kilogram-force) on the 3 mm regular sheet metal. The red areas indicate the maximum deformation of roundabout 2.3 mm.

The lower picture shows the same simulation but with 2 mm sheet metal and bent strengthening flanges inside the slots and on the outside edges. The plastic deformation appears to be 0.4 mm (3.562 e-001 = 3.562 * 10-1 = 0.352 mm) which is considered acceptable since it is less than a millimeter.

The FEM analysis showed that without any strengthening actions the feet had to be manufactured from at least 3.5 mm steel to withstand a weight of 120 kg. A similar impression resulted from the mock-up.

To save material and weight the sheet metal thickness could be decreased down to 1 mm but to not make the bed too flimsy 2 mm was chosen for the final concept. To reach sufficient stability, 90 ° flanges will be added at the naked edges as the lower picture shows.

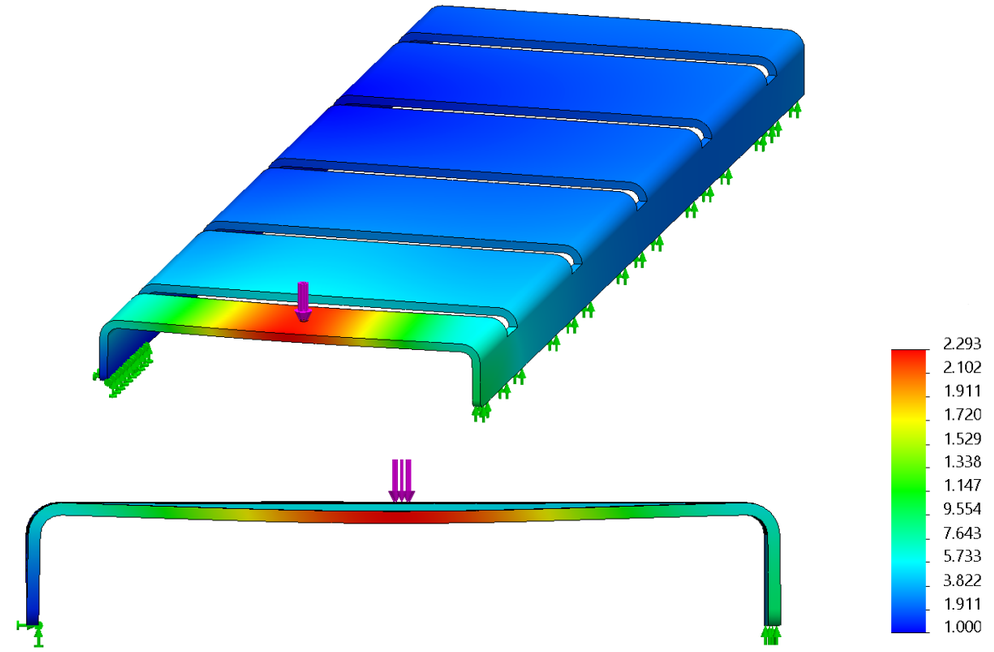


Fig. 33: Deformation analysis in SolidWorks with 3 mm sheet metal

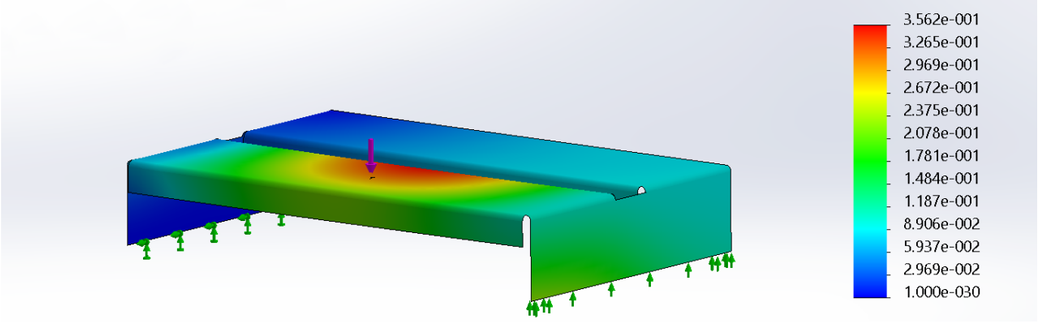


Fig. 34: Deformation analysis in SolidWorks with 2 mm sheet metal with flanges

Real scale mock-ups

Car boot mock-up

Every car has different interior dimensioning which makes it difficult to transport bulky items that are big in two dimensions. As the picture shows, the inside of a small car - based on a VW Polo - with with folded down back seat depth of 60 cm, a boot depth of 70 cm, and a width of 110 cm can easily fit items with a length of 130 cm. It's only getting complicated when the width and height both increase.

Fig. 35: Car boot mock up

Stability mock-up

To choose the right type of hinge I bought a variety to compare them in terms of sturdiness, attachment method but also price and look.

The so-called invisible hinges are as figure 33 shows to be screwed into the head sides of the slats with in total 4 screws per hinge. Screwing parallel to the direction of the veneered layers, however, is the least stable connection, since the screws may force the glued layers apart.

The most stable way to attach objects to plywood is by screwing perpendicularly through the veneer layers, as seen in figure 34.

Furthermore, the hinges in figure 34 appeared to be the most sturdy ones due to the amount of screws, the smallest tolerance at the axis pin and the material choice of stainless steel which made me choose them for the prototype.

To avoid the hinges, the slats weakest points, being in the middle of the bed affected by the highest momentum, the wooden planks are divided in one middle half and two outer quarters. Ultimately, the weakest points are now right above where the slats are being stuck into the feet.

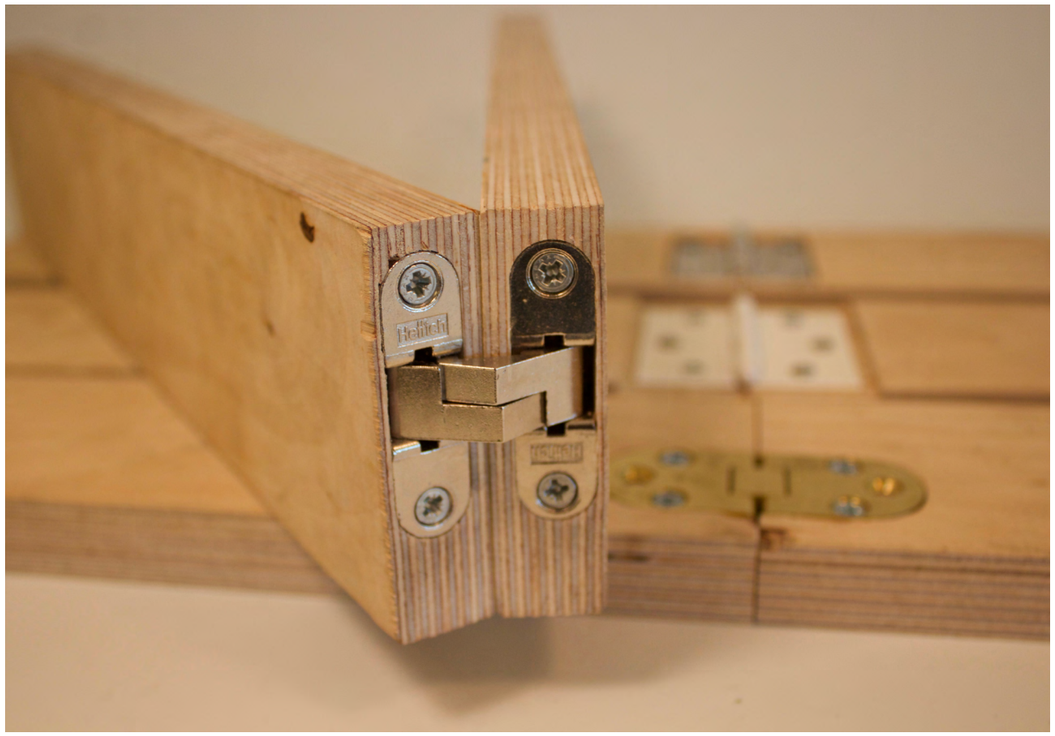


Fig. 36: Car boot mock up

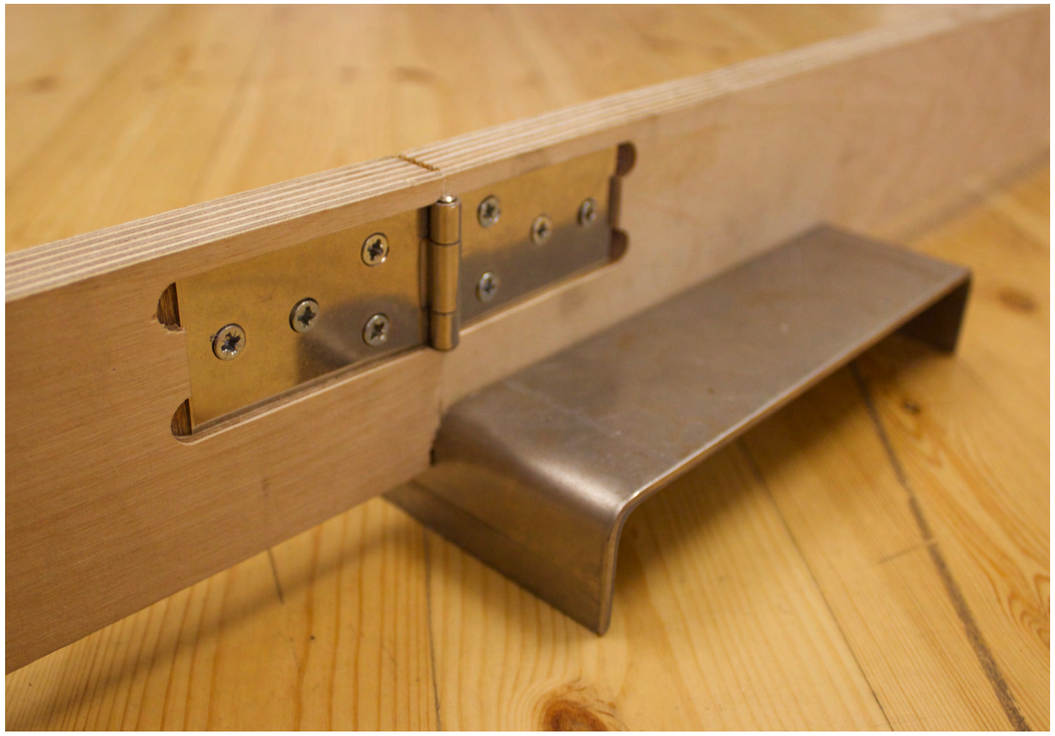


Fig. 37: Car boot mock up

FINAL CONCEPT

Fig. 38: Final Concept

Concept description

In its sleeping state, Nomad is a full-sized bed that will guarantee a good night's sleep on its 1.20 x 2 m mattress. For transportation, the mattress will be folded up and secured with Velcro. The frame's slats collapse in half and are then stored inside the hollow metal feet. Bungee cords hold the packages together while moving and keep the feet connected during usage. One bed folds into two portable packages of only 13.5 kg and 1 m length each and includes shoulder straps for comfortable carrying.

Due to the small number of individual parts and its easy detachable connection methods, Nomad is a system in which all parts are essential for both states, decreasing the chance of losing parts during transportation. Additionally, the almost screwless assembly facilitates quick exchanging of parts for easy maintenance and, ultimately, recycling.

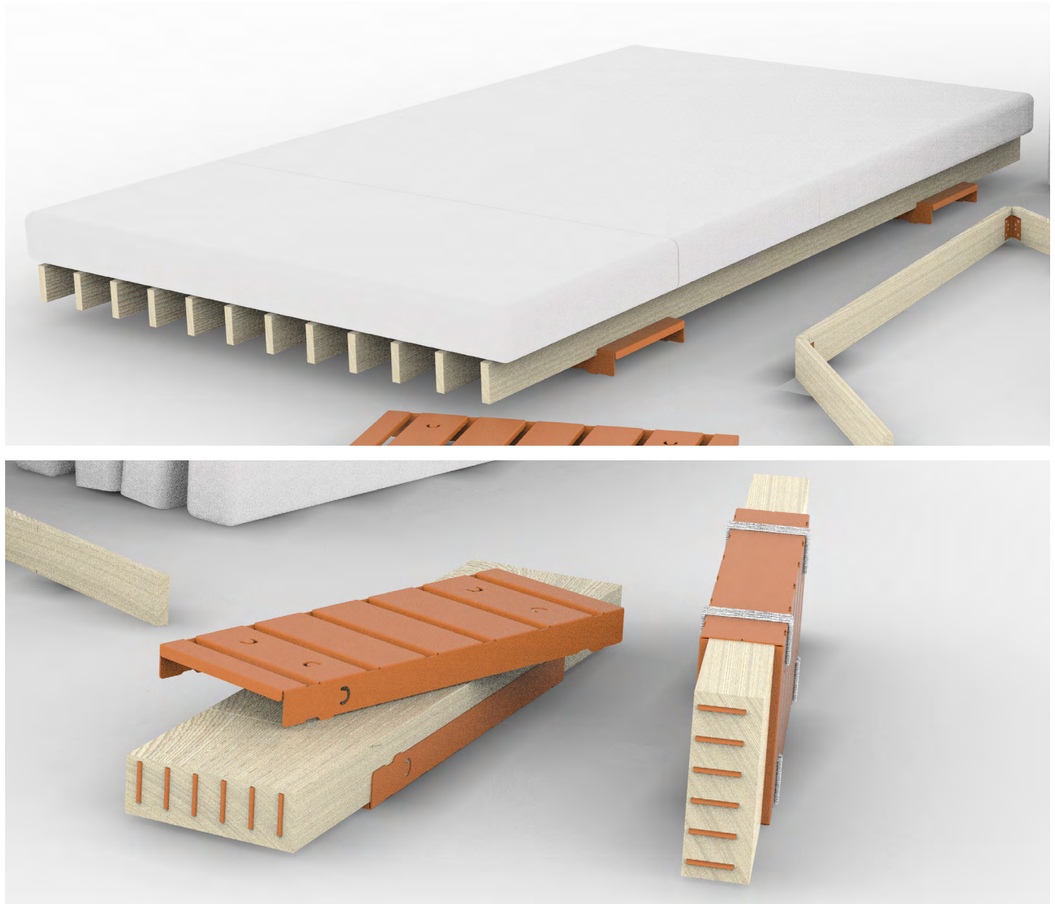


Fig. 39: Final concept stages

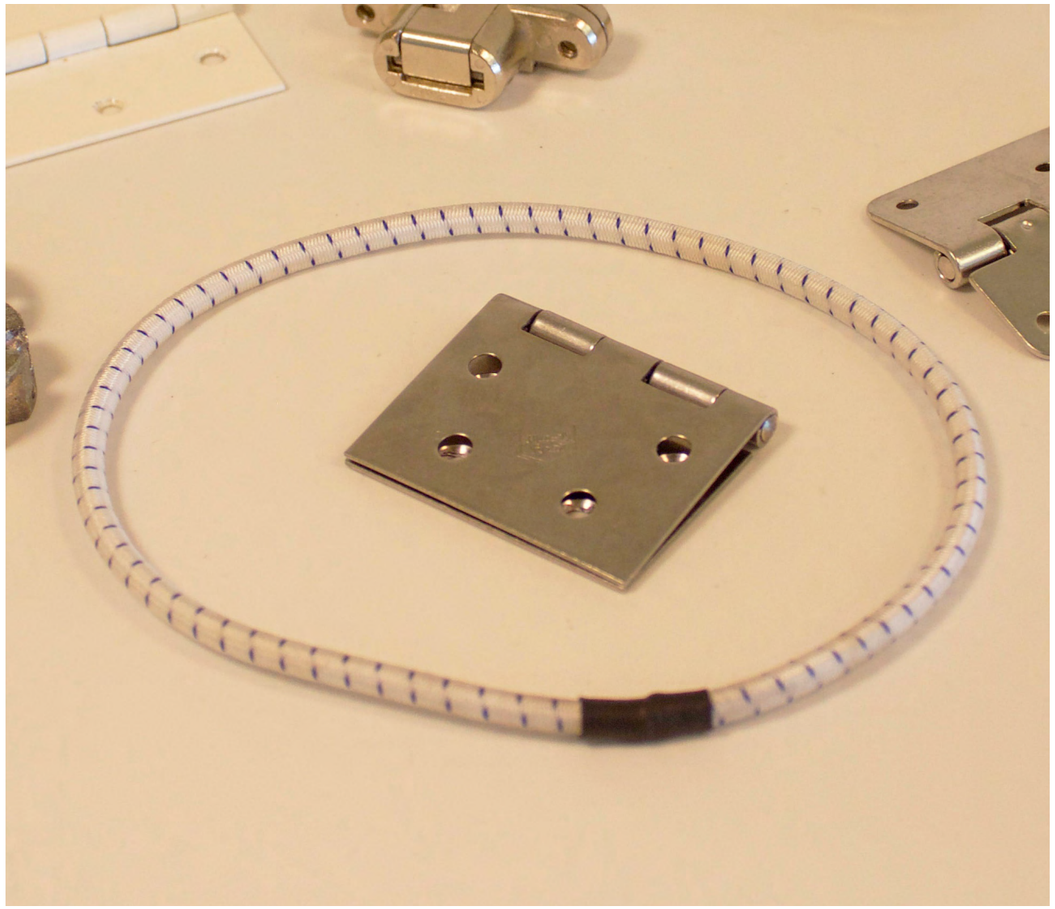


Fig. 34: Final connection methods

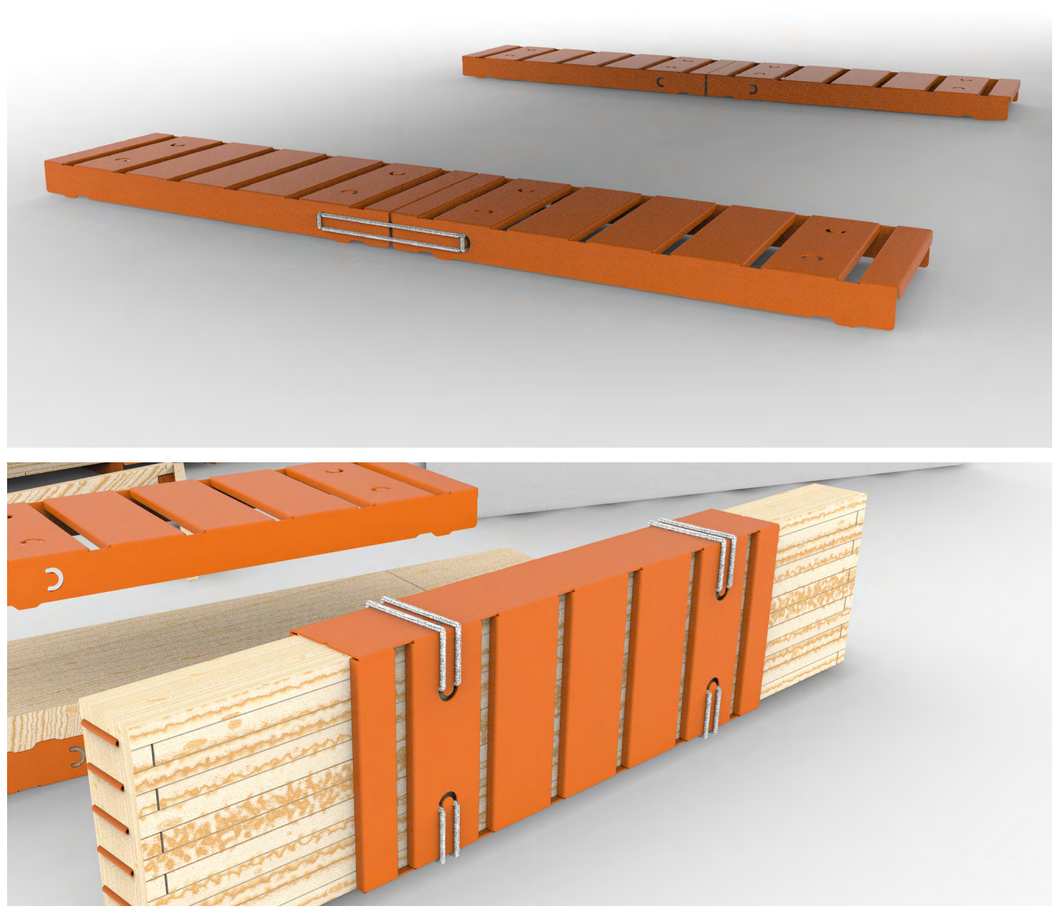


Fig. 41: Bungee cord loop connection

CMF roadmap

Colours

The compilation of materials and colours need to work with many kinds of interior objects since young academics often possess a wide range of items with different styles which should not stand in too much contrast with each other.

The colours should reflect a young and dynamic lifestyle but must not be too obvious. Since the moving process can damage the furniture or get it dirty and black is chosen as a neutral version to also harmonise with further interior objects.

Material

For a form stable construction, the slats are milled from a laminate of spruce planks covered with light ash veneer. The spruce core provides dimensional stability and absorbs humidity released by the mattress. To ensure sufficient humidity absorption, the 12 vertically arranged slats are untreated the grey ash layer gives a light and neutral texture to harmonize with other interior objects.

To secure enough rigidity in construction, the powder-coated metal feet are manufactured from 2 mm sheet metal and strengthened with flanges inside the slots and on the outside edges to withstand 120 kgf.

The connecting bands will be bungee chord loops covered with textile to preserve the rubber core and prevent them from tearing.

The mattress will be built up from 4 pieces of polyurethane foam inside cotton covers.

Finish

A powder coating will be covering the sheet metal parts for a shockproof surface. The slats will not be treated to ensure sufficient humidity absorption.

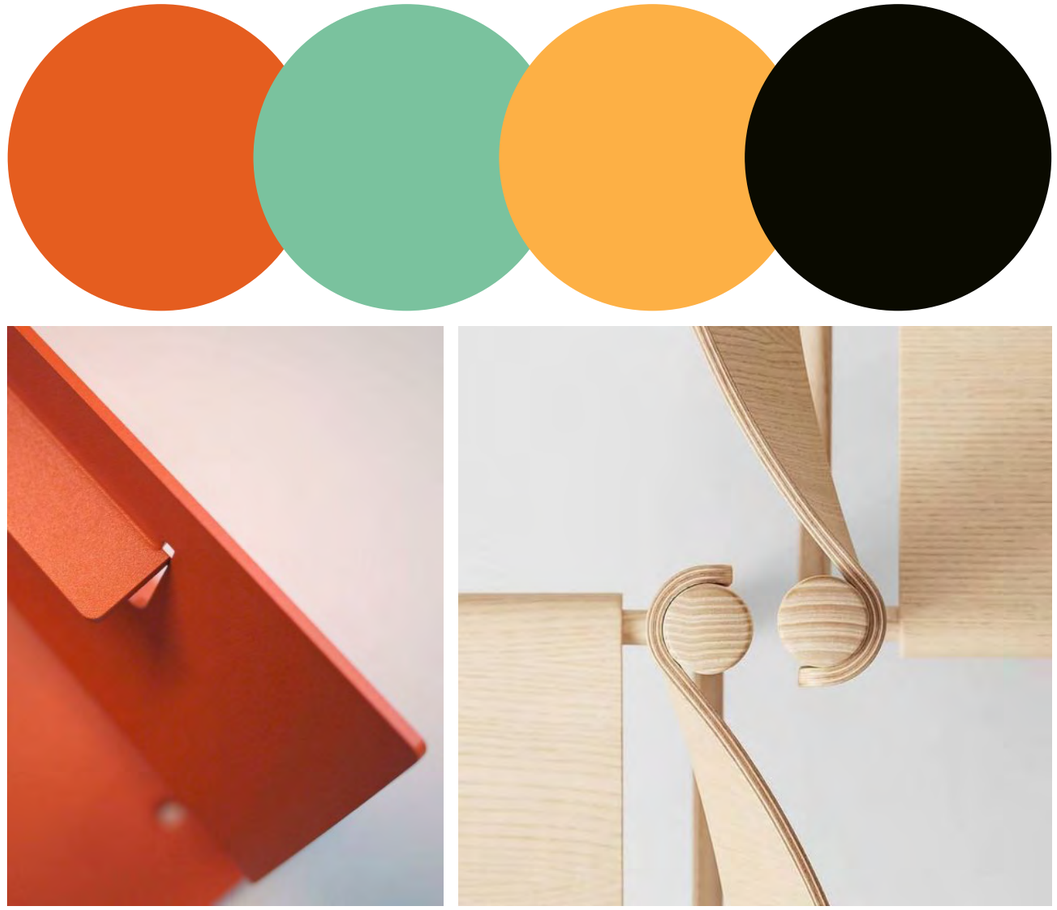


Fig. 42: CMF roadmap

PROTOTYPING

To archive highest possible precision in dimensions and cavities to sink in the hinges in slats were CNC milled from ash plywood. Afterwards, fillets were added to the edges to avoid damaging the mattress due to sharp edges. After colouring the hinges, the slats were assembled.

To achieve more precision and more complex bends, the metal feet were, thanks to Per's board connection to Swedish manufacturing companies, outsourced to TechnikCentrum AB and Gnosjö Plåtindustri in Småland. Both companies were very helpful and easy to work with.

Stitching the mattress covers was the last step and once the metal feet would arrive from Småland all parts were ready for assembly.

Fig. 43: Milling the slats

Fig. 44: Chamfering the slat edges

One night in Småland

Due to problems the bending process, the sheet metal feet arrived two weeks late and a week before the deadline. Unfortunately, the slots for the slats were to tight so that an assembly was impossible.

During a quick but effective crisis management meeting that same day, Per convinced the heads of TechnikCentrum, a colleague of him, and the head of Gnosjö Plåtindustry, a man he had never talked to before, to laser cut and bend the parts again the next morning.

This deal also included me driving to Småland, picking up the lasered pieces and bringing them to the bending company.

Ultimately, I packed a small overnight kit and drove with my van to Småland where I arrived at 2 am. After 3 hours of sleep in the van on a parking lot of the National Park Store Mosse, I arrived at the TechnikCentrum, picked up the laser cut metal parts and went to Gnosjö Plåtindustry to get them bent.

Håkan, the CEO of the company, gave me a small tour of their facilities and then introduced me to Matt, a 32-year-old American from Dallas, Texas, who moved to Sweden 5 years ago to marry his Swedish and pregnant girlfriend. Matt bent the sheet metal pieces while I checked the dimensions resulting in perfectly produced final pieces for my prototype.

After I contributed pastry for the factories' morning Fika break at 10 am, I drove back to Malmö, where I arrived around noon.

Within those 14 hours, I drove more than 500 km, only slept 3 hours in my car but finally got the fitting metal feet for the bed.

Fig. 45: One night in Småland

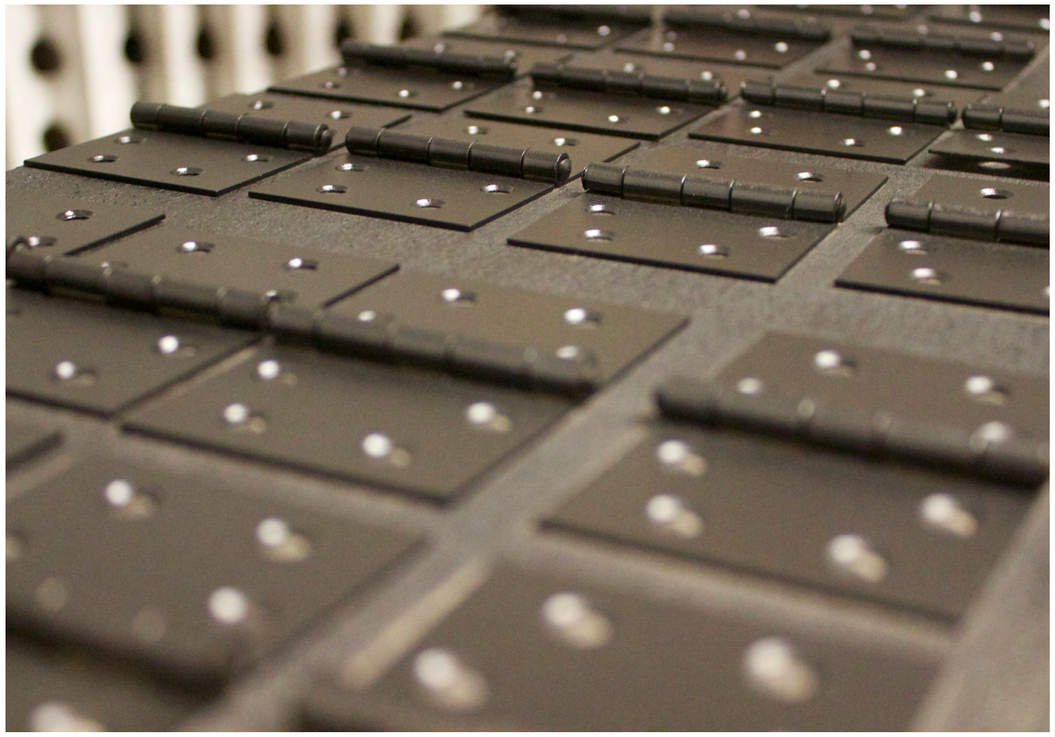


Fig. 46: Coloring the hinges

Fig. 47: Assembling the slats

Fig. 48: Bending the metal feet

Fig. 49: Stitching the mattress covers

FINAL PRODUCT

Fig. 50: Final Product

Fig. 51: Place the packages where the bed will stand.

Fig. 52: Take off the feet.

Fig. 53: Take the folded slats out.

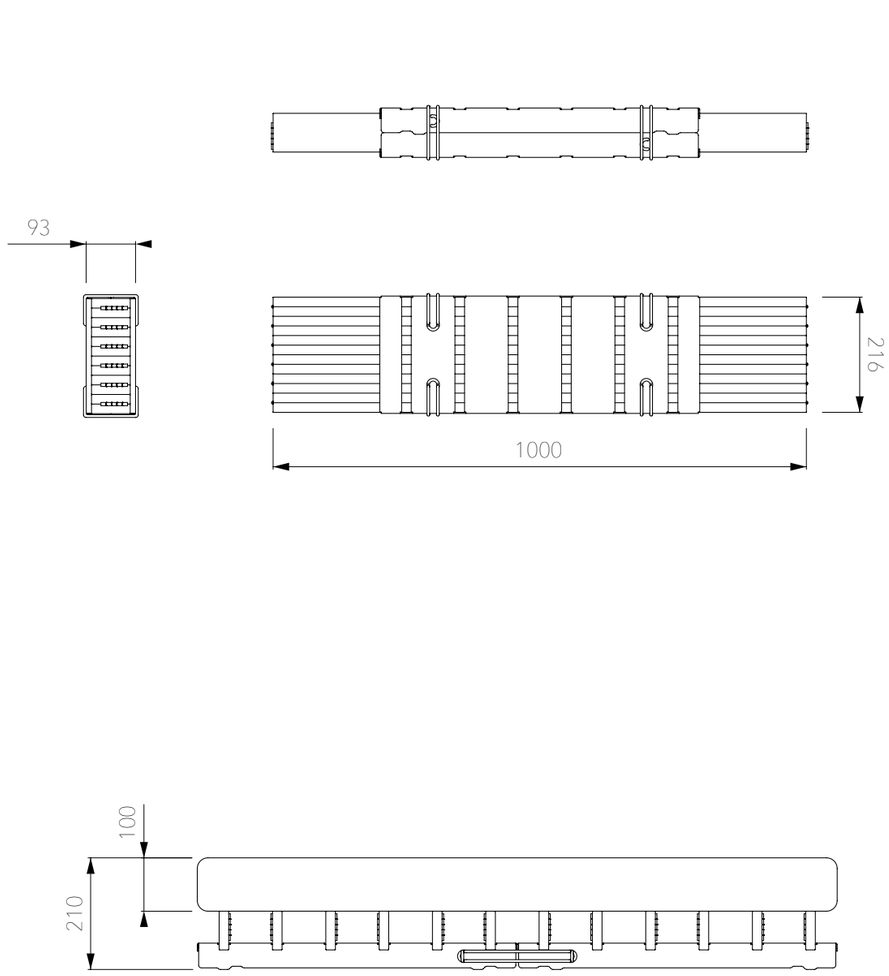
Fig. 54: Connect the feet with bungee chords.

Fig. 55: Unfold the slatts.

Fig. 56: Stick the slats into the feet's slots.

Fig. 57: Unfold the mattress onto the slats.

Fig. 58: Lay down to rest.



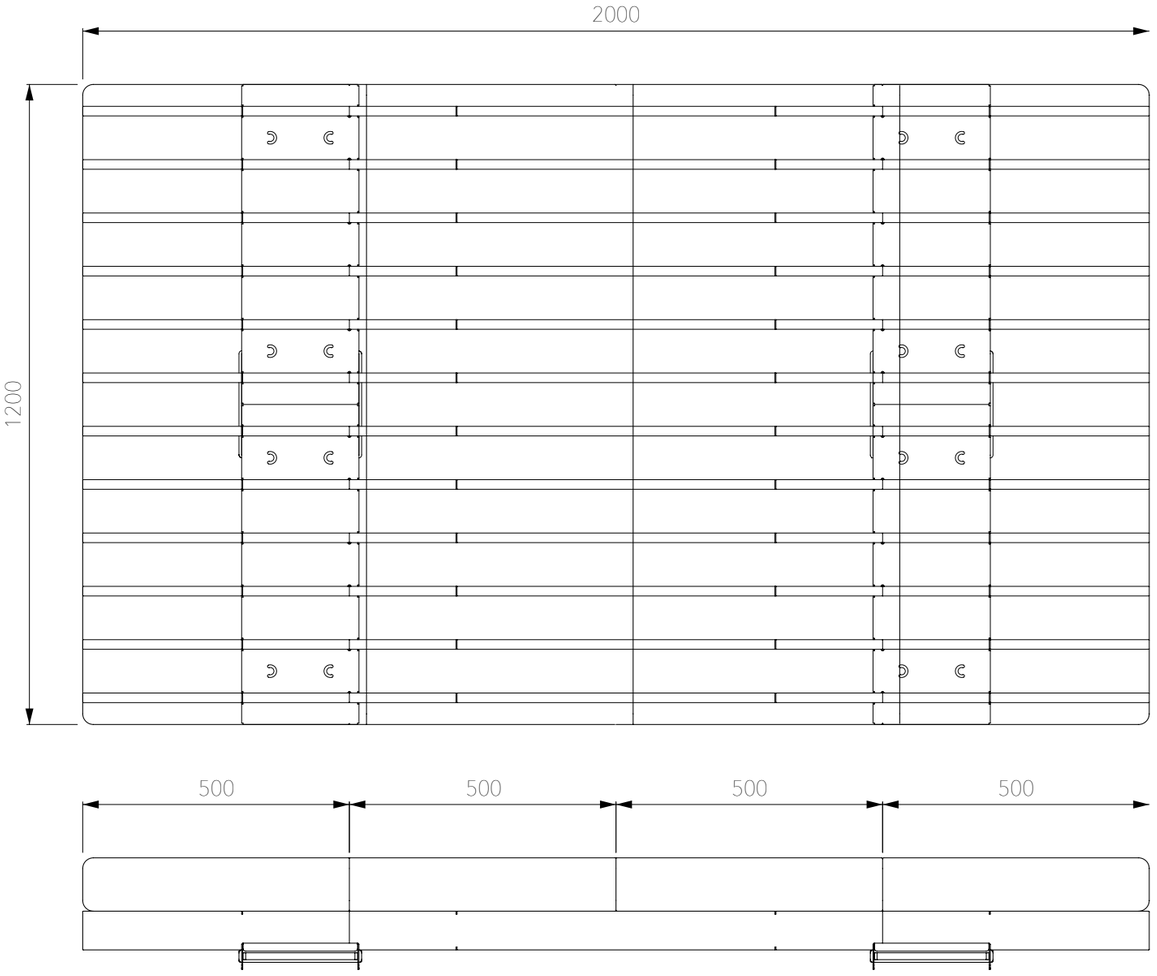


Fig. 59: Technical drawing

RETROSPECT

Conclusion

In conclusion, the developed product offers a solution to the underlying problem of furniture, especially beds, being difficult to move. Nomad improves both, the situation of getting it out of the apartment and making it transportable by a normal car. Especially the split up into three packages, two for the frame and slats and one for the mattress, facilitates a quicker and more comfortable moving process.

Having a bed, you can take everywhere is convenient and economic but this alone only reduces parts of the struggle of moving during academic mobility. More items like desks and a wardrobes need to be improved as well to make transitioning between two personal living spaces even simpler.

Furthermore, more details have to be resolved such as preventing floor scratching with the naked edge of the metal feet. Due to time issues, there had been less investigation into this issue and the solution now relies on adding felt patches underneath.

Furthermore, the hinges have to be reviewed since they and the screws have to withstand quite some force, even though the momentum on them is not critical. Moreover, the amount of screws of 192 needs to be lowered.

Reflection

Retrospectively, the project had been a lot of fun. Digging more into the furniture business I found my passion for objects that solve a problem rather than just being aesthetically appealing. Of course, a chair is for sitting and a bed is for sleeping but there are always users having problems with products on the nowadays market. For me, the most interesting part is the symbiosis between functionality and aesthetics since they can and should work together very well.

Fig. 60: Lasered sheet metal feet

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