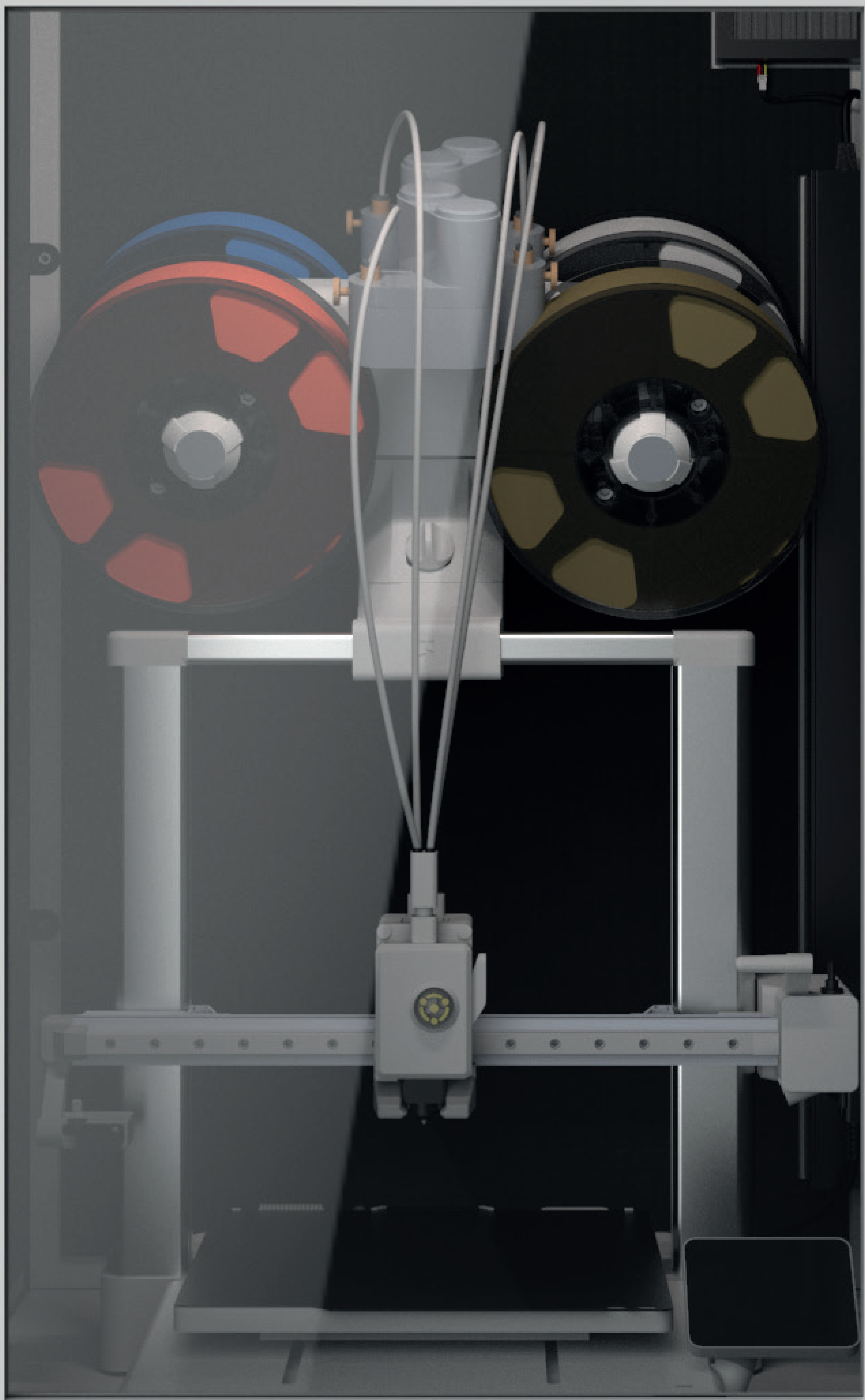
Print Pod



May 2025

Product Report

MA4-ID6

Daniel Hjort Jacobsen

Lawrence de Krijger

TITLE PAGE

Project title:	**Print Pod**
Project theme:	**Furniture for additive manufacturing**
Project:	**Master Thesis - 04 semester**
Project Team:	**MSc04-ID6** **Inddustrial Design** **Institute of Architecture and Design** **Aalborg University**
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Main supervisor:	**Linda Nhu Laursen**
Technical supervisor:	**Benny Endelt**
Number of pages:	**24**

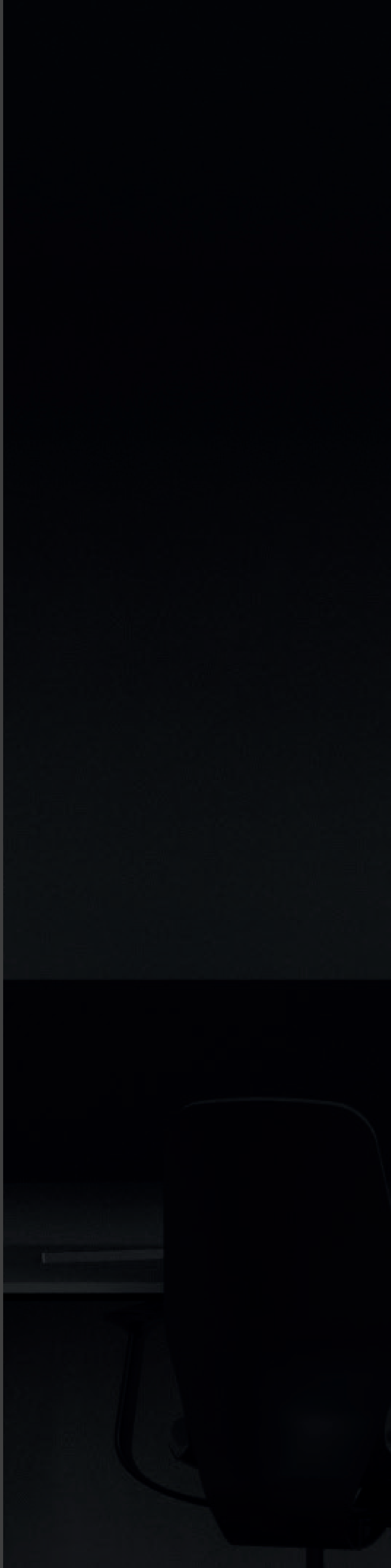
ABSTRACT

As 3D printing continues to move into private homes, users are increasingly faced with practical challenges such as noise, odor and spatial constraints. Print Pod is a response to these issues, a modular 3D printer enclosure system, developed through extensive user research and iterative design.

Rather than altering the printers themselves, Print Pod improves how they integrate into everyday environments. The design is based on insights from surveys, interviews, home visits, and observational studies, with a clear focus on the needs of hobbyists, the most engaged user group. These users often rely on improvised setups to manage the disruptive side effects of 3D-printing.

Print Pod addresses these problems through a scalable, two-part system: A main enclosure that reduces noise and odors, and an optional storage module for tools and materials. Together, they form a clean, functional, and adaptable solution designed to fit a wide range of FDM printers, enhancing the home printing experience without compromise.

CONTENT



PRINT POD

This Product Report presents the final design outcome of Print Pod, a modular 3D printer enclosure system developed to address key environmental challenges faced by home users. Rooted in extensive user research, the design offers solutions to common issues such as noise, odor, and spatial constraints, while enhancing usability and integration within modern living spaces.

Unlike the Process Report, which details the journey from research to design decisions, this report provides a concise and visual overview of the finished product. It showcases the features, functionality, and modular nature of Print Pod, emphasizing how it supports both current user needs and future expandability.

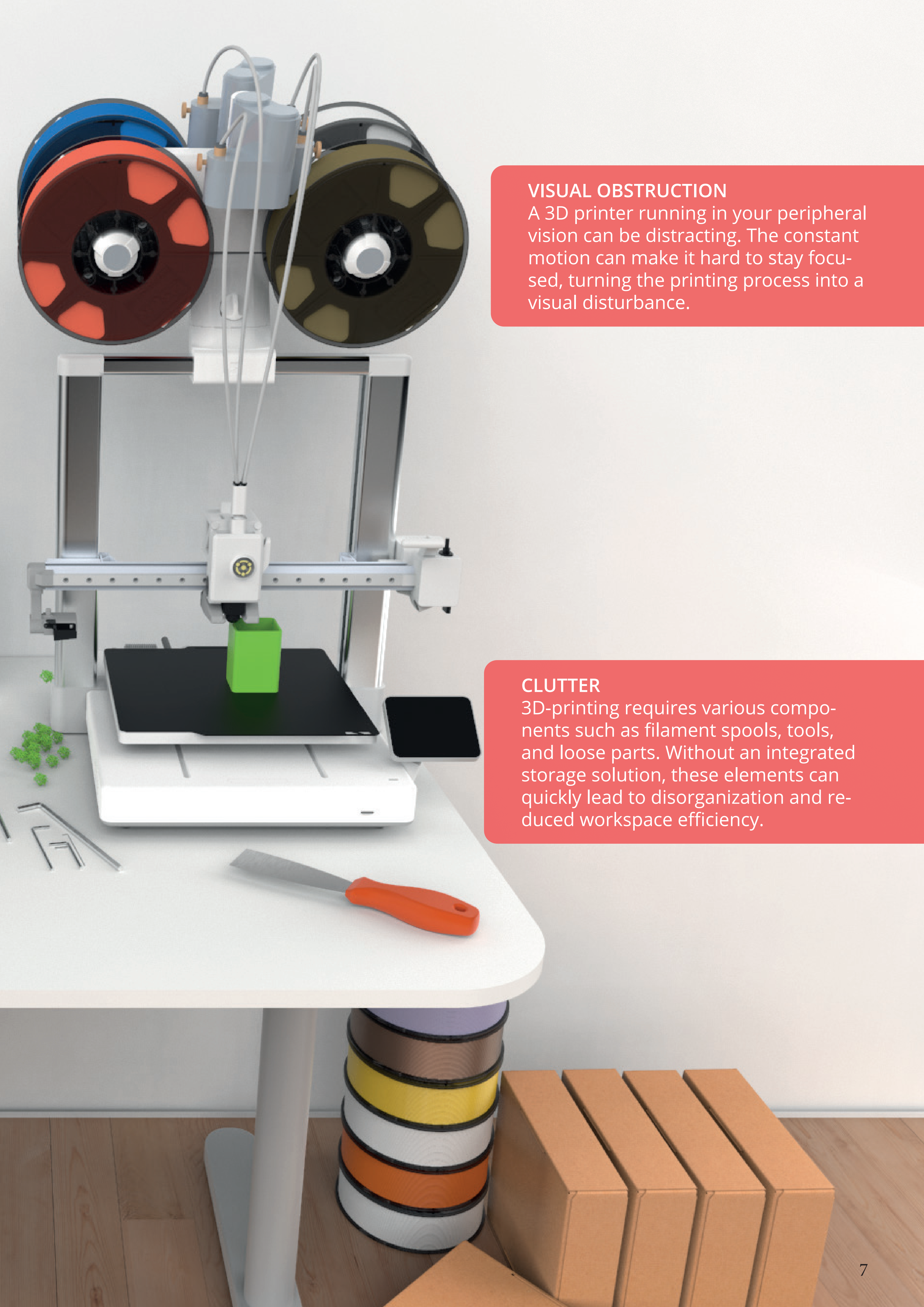
Designed with hobbyists in mind, yet flexible enough for professional and educational settings, Print Pod is a practical response to the growing demand for accessible, home-friendly 3D-printing solutions.

THE PROBLEM

SPACE DEMANDS
Despite being labeled as “desktop” machines, most 3D printers take up a substantial amount of space. Their wide base, moving parts, and open frames require a clear area larger than the printer itself. This footprint can dominate a desk, limiting available workspace and crowding out other tools or devices.

NOISE
3D printers produce sound through mechanical movement, stepper motors, fan operation, and vibrations. This cumulative noise level can be persistent and distracting over extended print times.

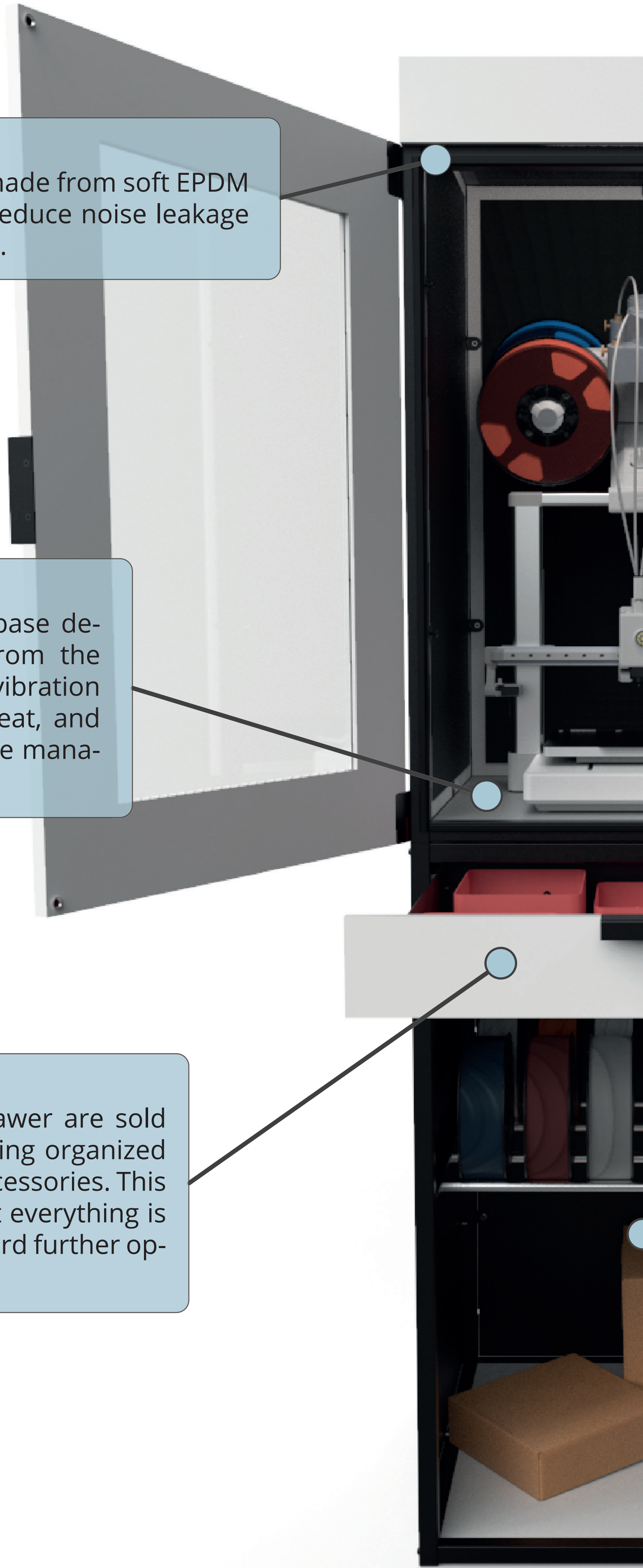
SMELL
The printing process releases odors from melting the filament, particularly materials like ASA, PETG and ABS. These emissions can be unpleasant and may linger depending on the material and duration of the print.



VISUAL OBSTRUCTION
A 3D printer running in your peripheral vision can be distracting. The constant motion can make it hard to stay focused, turning the printing process into a visual disturbance.

CLUTTER
3D-printing requires various components such as filament spools, tools, and loose parts. Without an integrated storage solution, these elements can quickly lead to disorganization and reduced workspace efficiency.

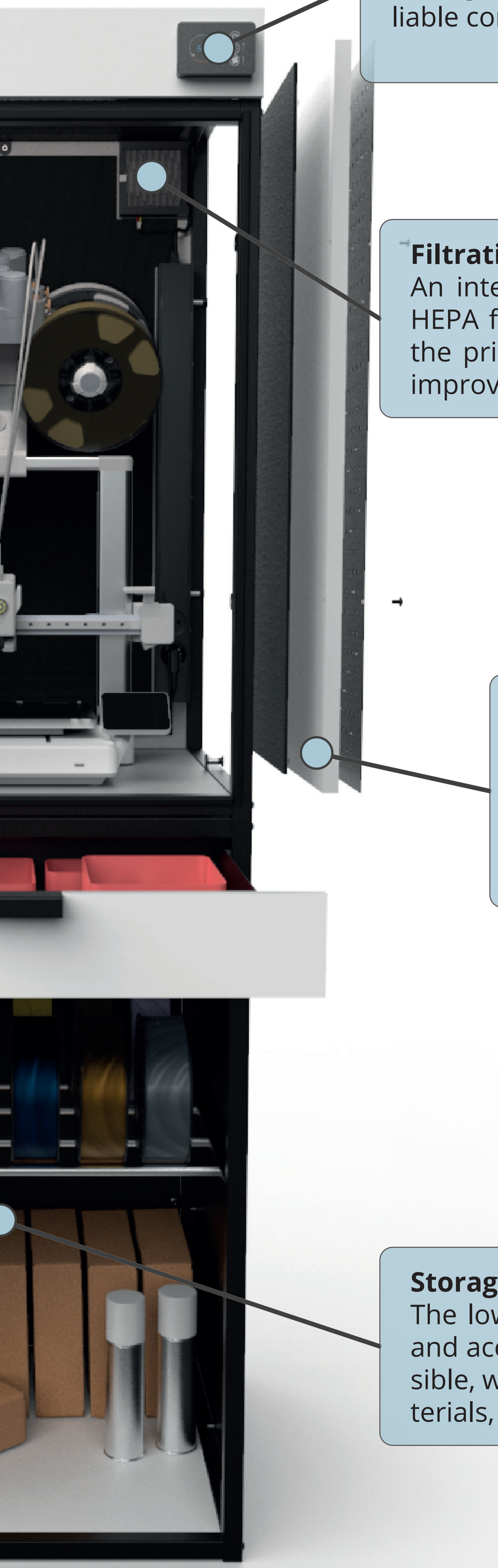
THE SOLUTION



Seal
The door uses a self-adhesive D-profile seal made from soft EPDM rubber. It creates a tight closure that helps reduce noise leakage by absorbing vibrations and blocking air gaps.

Suspended base
The enclosure uses a suspended base design that separates the printer from the enclosure floor. This reduces vibration transfer, protects surfaces from heat, and provides space for airflow and cable management underneath the printer.

Tool storage
A storage module and integrated tool drawer are sold alongside Print Pod main enclosure, allowing organized placement of filament spools, tools, and accessories. This reduces workspace mess and ensures that everything is within easy reach. The tool wall and pegboard further optimizes storage.



Control Panel
The control panel manages the main power, ventilation fan, and LED lighting. With clearly labeled switches, it offers direct and reliable control over the enclosure’s key functions

Filtration
An integrated ventilation system with replaceable carbon and HEPA filter helps capture and neutralize odors released during the printing process. The sealed design minimizes air leakage, improving the effectiveness of odor control.

Acoustic layer
The Print Pod enclosure features sound-dampening panels and a sealed structure that significantly reduces noise generated by motors, fans, and vibrations during printing. This helps create a quieter and more controlled printing environment.

Storage
The lower area of the storage module is designed for filament and accessories. Built-in racks keep spools organized and accessible, while additional space allows for neatly storing related materials, keeping the setup tidy and efficient.

BUILD TO EVOLVE

Two Modules
Print Pod consists of two primary modules: the Enclosure Module and the Storage Module. The enclosure is designed to fit the most popular 3D printers, with added space to house an AMS (Automatic Material System). A hardened glass panel in the door ensures clear visibility during prints while providing a sleek, durable finish. The Storage Module features integrated filament racks and compartments for organizing tools and accessories. It can be stacked beneath the enclosure or placed beside it to create an extended work surface. Used together or separately, the modules form a flexible, expandable system adaptable to different printing setups.

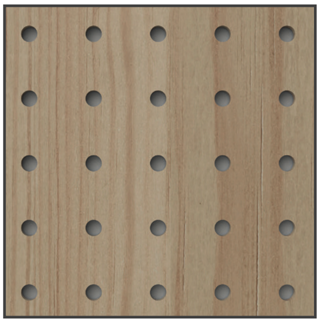
2100 dkk

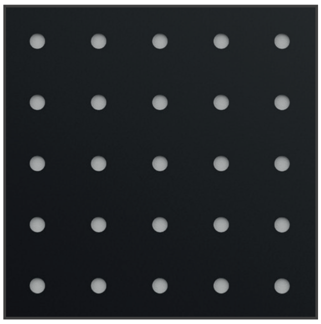
3300 dkk

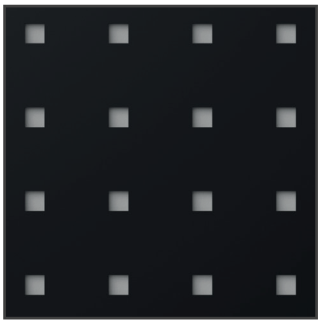
5400 dkk

CUSTOMIZE

SIDE PANELS


Pine pegboard


Plast pegboard


Metal tool wall


Metal

FRONTS

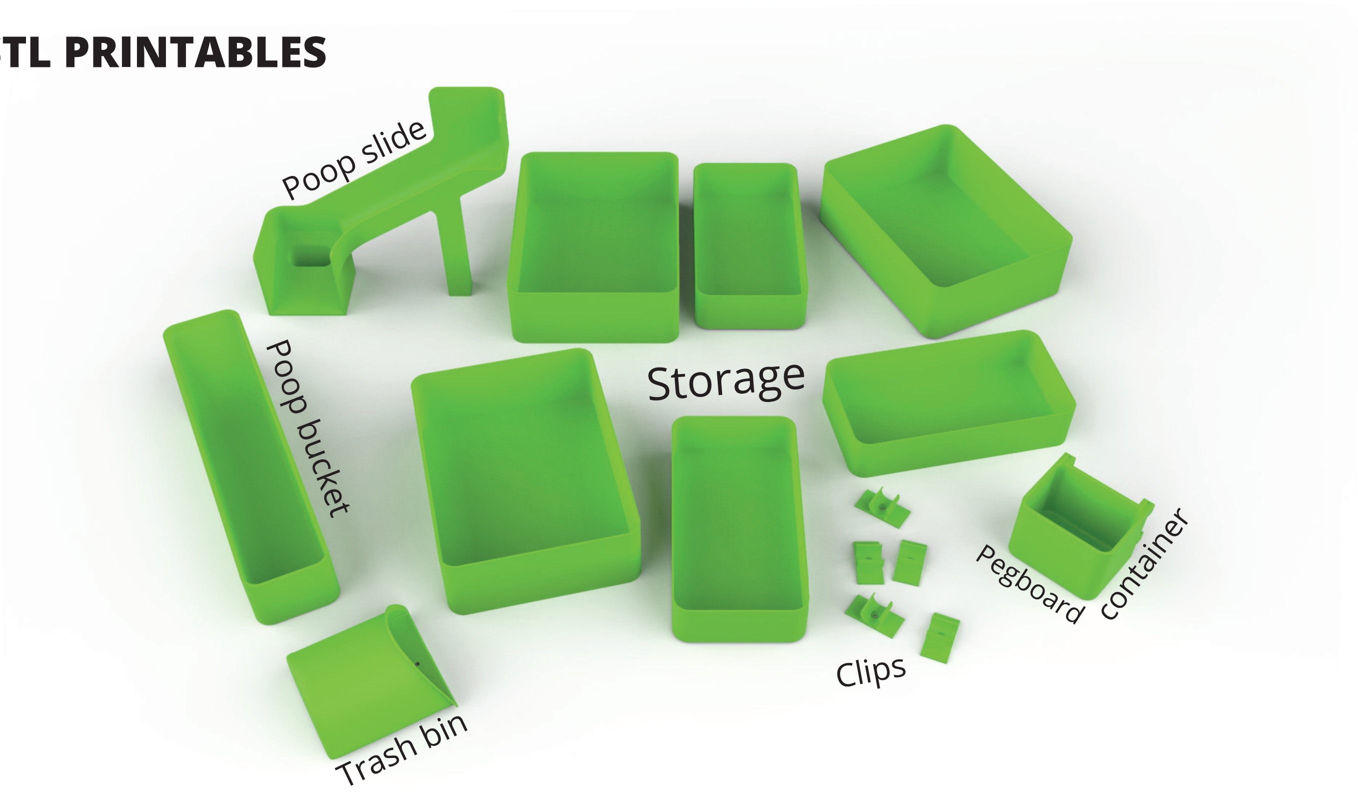

Light pine laminate


Dark pine laminate


Black laminate


White laminate

STL PRINTABLES

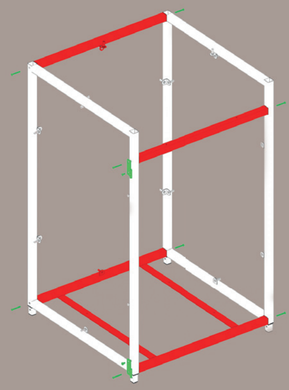


The STL Library is a collection of 3D-printable files developed to support customization and expandability within the Print Pod system. It allows users to adapt and modify their setup through additional components that integrate seamlessly with the core modules. The library is designed to evolve over time, offering ongoing flexibility to meet diverse user needs.

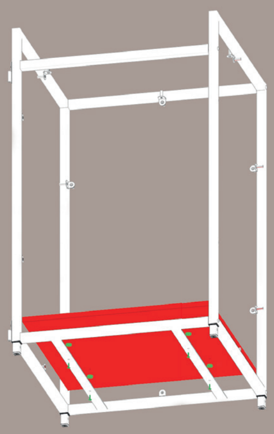
PRINT ANYWHERE

THE HOBBYIST

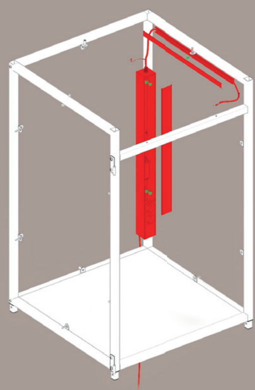
ASSEMBLY
ENCLOSURE



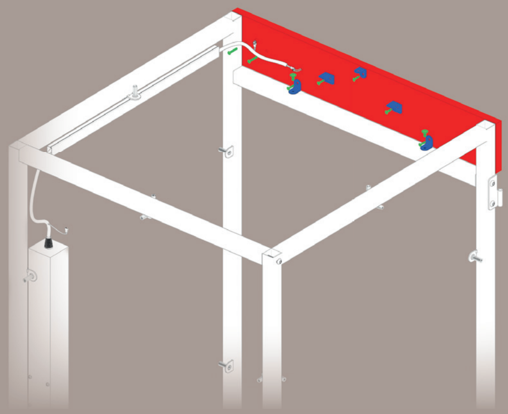
1) Connect the two side frames using the two loose profiles and the bed frame, as shown. Before tightening the bolts, place the bottom half of the hinges in the indicated positions.



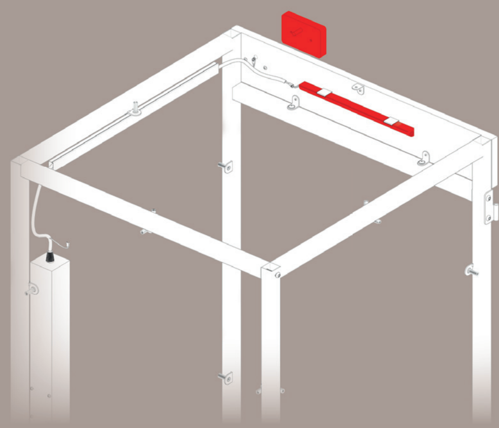
2) Fasten the suspended bed using wood screws and rubber spacers.



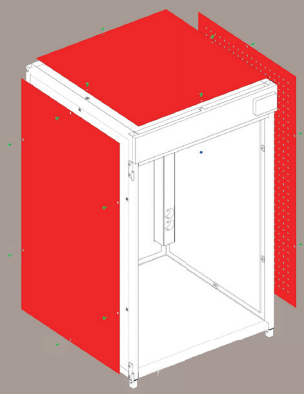
3) Install the cable box and fix the wires in place as shown.



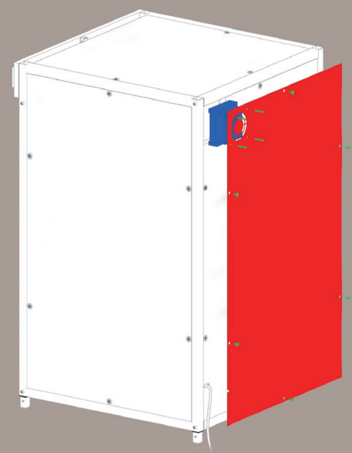
4) Mount the top front panel along with the fixtures for the LED light and top panel.



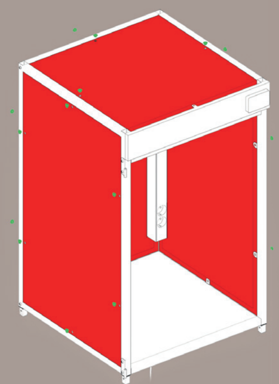
5) Install the electronics and plug in the cables connected in step 3.



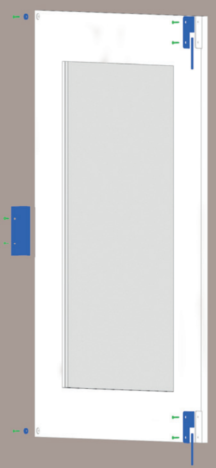
6) Install the acoustic panels one at a time, using a nylon spacer to temporarily hold each panel in place.



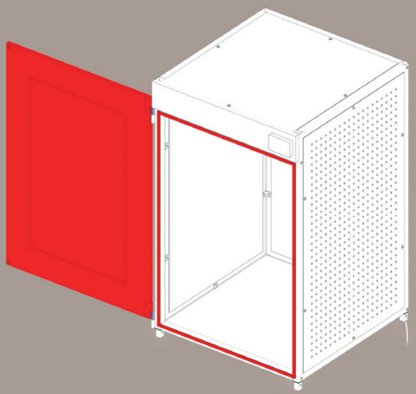
7) Mount the back panel, with the fan and filters pre-installed.



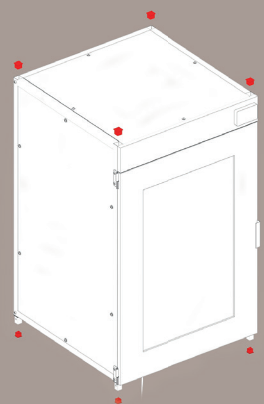
8) Mount the right, left, and top panels and secure them using M5 bolts.



9) Mount the hinges, magnets, and door handle using the provided wood screws, as shown.

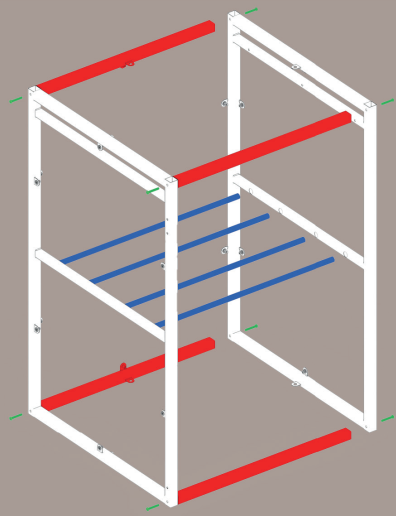


10) Hang the door on the hinges and adjust the friction to your preference.
Peel off the protective film from the sealant, then mount it to the metal frame around the enclosure opening.

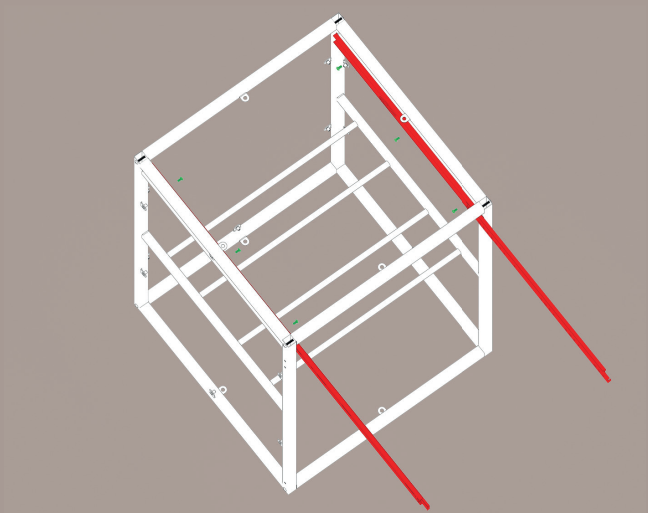


11) Install the end caps and feet onto the top and bottom profiles of the enclosure.

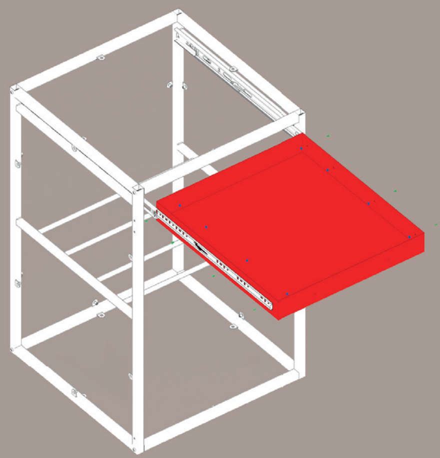
ASSEMBLY
STORAGE MODULE



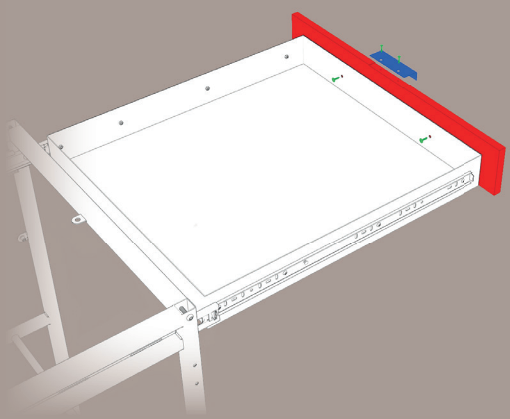
1) Connect the two side frames using the four lower profiles and four loose rods, as shown.



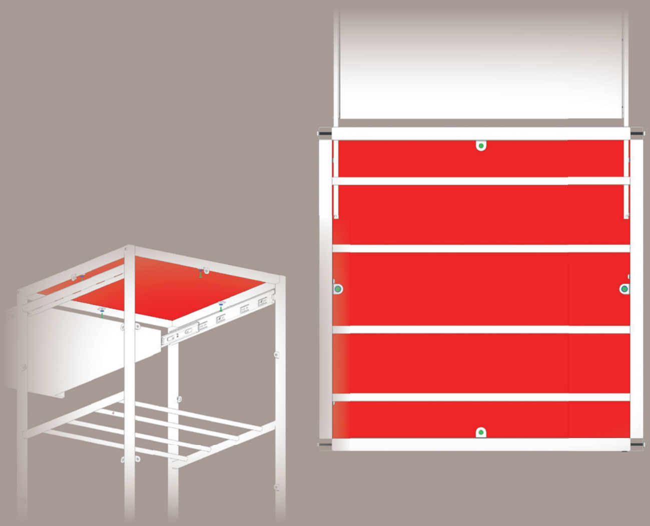
2) Install the two drawer carriers by pulling them all the way out and bolting them to the frame through the holes.



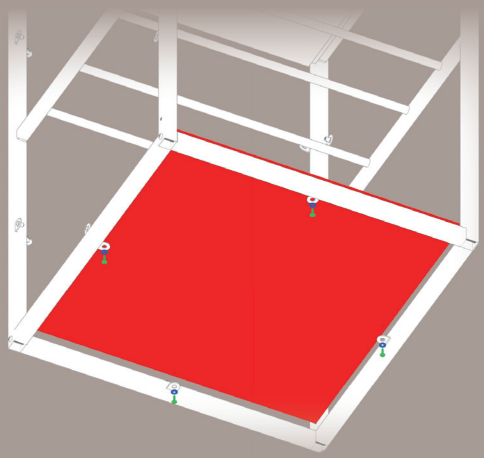
3) Insert the drawer in the same way.



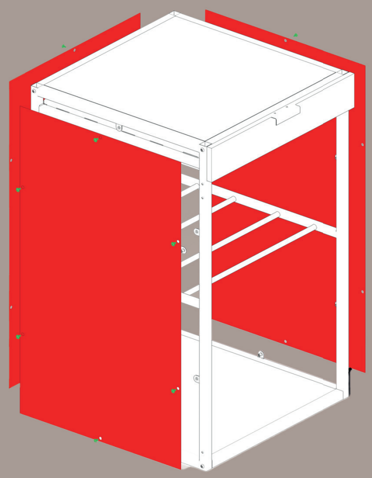
4) Attach the wooden drawer front and secure the drawer handle.



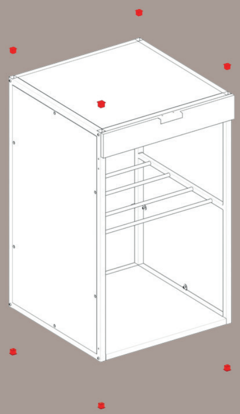
5) Align the top plate with the holes and secure it using the provided wooden screws.



6) Use the same method to fasten the bottom plate.



7) Mount the side panels to the frame using M5 bolts.



8) Install end caps on the top and bottom of the profiles.

SPECIFICATIONS

Enclosure:	
Internal size H,L,W:	890, 550, 550 mm
External size H,L,W:	990, 600, 618 mm
Box dimensions H,L,W:	1025, 675,180 mm
Weight	37 kg
Power input	220 volt
Power out	2 x EU 220 volt
Ventilation unit	80 mm quiet fan
Filtration	HEPA, active carbon
Supported materials	PLA, PETG, ASA, TPU, ABS, PC, HIPS, Nylon, PP, Carbon,
Light source	LED
On/Off	3” LCD screen with buttons
Friction hinges	Torque adjustable 3N - 8N
Latch mechanism	Magnetic
Noise reduction level	≈15 dB
Airflow rate	15 m^3/h, 25 m^3/h, 50 m^3/h
Color options	White, Black, Walnut
Assembly type	Bolt-together construction

Storage Module:	
External size HxLxW:	950, 600, 616
Box dimensions H,L,W:	1050, 650,140 mm
Weight	35 kg
Drawer size H,L,W:	70, 557, 522 mm
Drawer load capacity	30 kg
Color options	White, Black, Walnut
Assembly type	Bolt-together construction

HOW IT WORKS

The Print Pod's quiet performance is inspired by materials commonly used in acoustic paneling, specifically felt and glass wool. These materials are known for their ability to absorb and dampen sound by reducing vibrations and trapping noise within their fibrous structure. By integrating them into the enclosure's walls, the design minimizes the mechanical sounds of 3D printing, creating a calmer and more comfortable environment without compromising functionality or access.

The Print Pod features a dual-stage air filtration system designed to improve air quality during printing. A HEPA filter captures fine particles released by the printer, while an activated charcoal filter absorbs odors and volatile compounds. This combination helps maintain a cleaner, safer environment, especially during long prints or when using materials that emit noticeable fumes.

Print Pod includes two built-in power outlets inside the enclosure, allowing easy connection of your 3D printer and accessories. This reduces cable clutter and keeps everything neatly contained within the system, while maintaining quick access to power where it's needed most.

GET STARTED

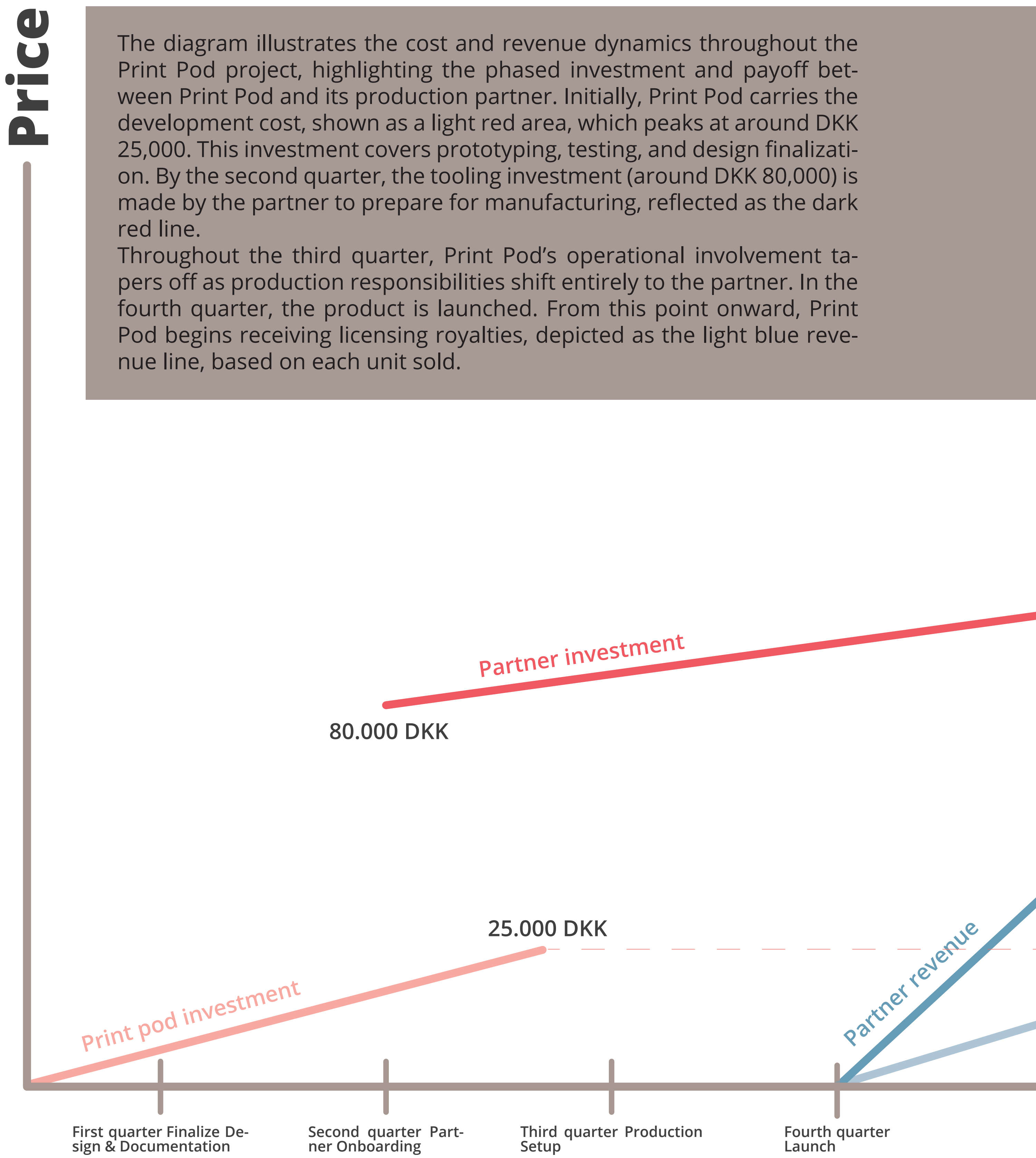
Place your 3D printer on the platform, ensuring all moving parts have enough clearance to operate freely. Connect the printer to one of the two available power outlets. Before doing so, make sure the Print Pod itself is already plugged into a wall outlet.

With your setup complete, connect the printer to Wi-Fi or transfer your file via USB, whichever you prefer. Power it on, load your model, and you're ready to print. The Print Pod keeps things quiet, clean, and organized so you can focus on bringing your ideas to life.

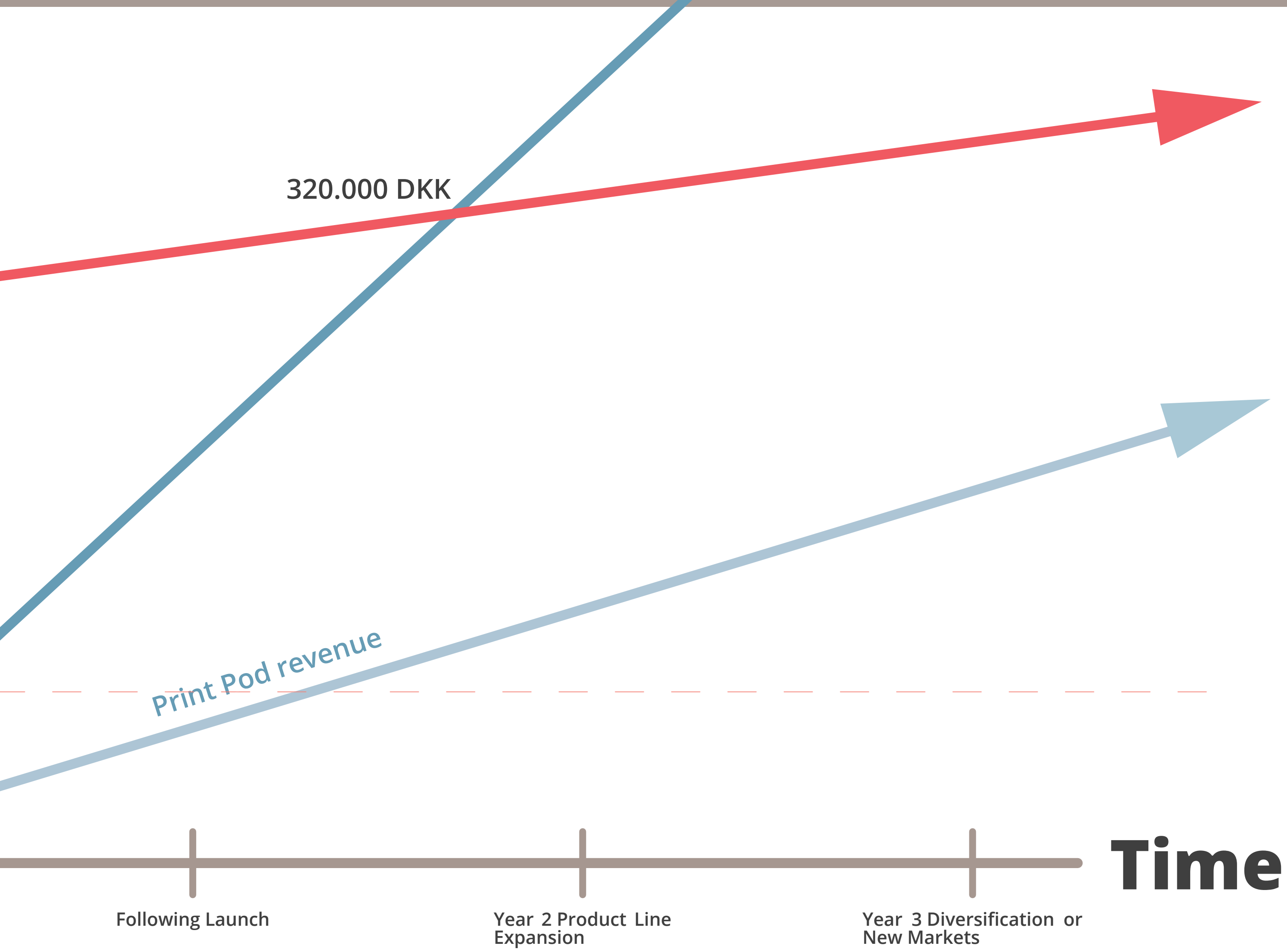
Stay in control throughout the print without opening the enclosure. The external control panel lets you adjust the fan, toggle the LED light, or power the system as needed, all from the outside. Meanwhile, the hardened glass panel allows you to monitor progress without interrupting the process.

IMPLEMENTATION

The diagram illustrates the cost and revenue dynamics throughout the Print Pod project, highlighting the phased investment and payoff between Print Pod and its production partner. Initially, Print Pod carries the development cost, shown as a light red area, which peaks at around DKK 25,000. This investment covers prototyping, testing, and design finalization. By the second quarter, the tooling investment (around DKK 80,000) is made by the partner to prepare for manufacturing, reflected as the dark red line.
Throughout the third quarter, Print Pod's operational involvement tapers off as production responsibilities shift entirely to the partner. In the fourth quarter, the product is launched. From this point onward, Print Pod begins receiving licensing royalties, depicted as the light blue revenue line, based on each unit sold.



The partner's revenue, shown as the dark blue line, begins at product launch in the fourth quarter. At around 170 units sold, the partner's total revenue exceeds their investment, marking the break-even point. Print Pod, on the other hand, surpasses its initial development investment earlier, at approximately 120 units sold, through accumulated licensing royalties. This highlights the efficiency of the model: Print Pod recoups its upfront investment relatively quickly and continues to generate revenue without ongoing production responsibilities, while the partner benefits from growing profitability as sales scale up.



FUTURE VISION

As customers start using Print Pod in their daily setups, their feedback will help guide the next steps in its development. Real-world insights will shape improvements and new features, ke-eping the system responsive to what users actually need. Looking ahead, a flagship version is in the works, finished in a bold, signature color that makes it instantly recognizable as Print Pod. This edition will represent the product's identity.

CREDITS

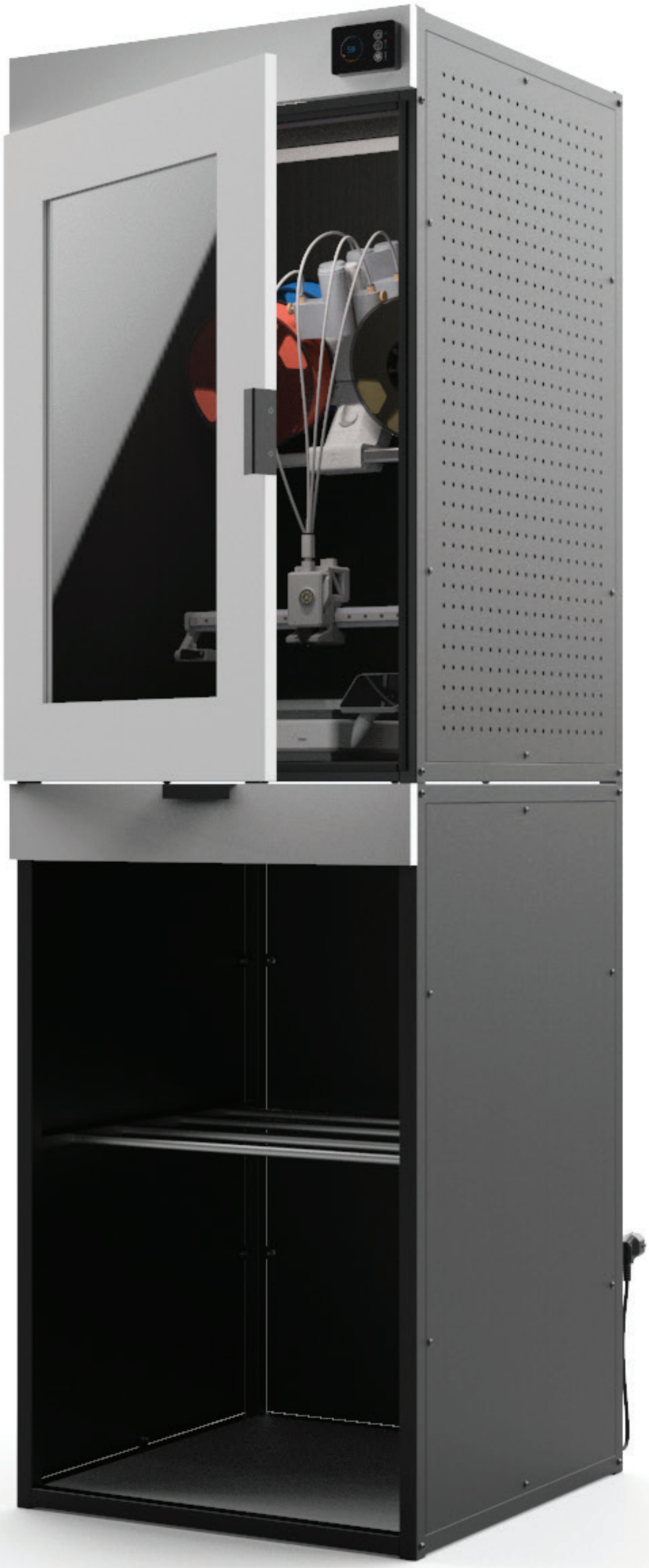
This product report was developed by Daniel Hjort Jacobsen and Lawrence de Krijger as part of their final Master's thesis in Industrial Design at Aalborg University. The project was carried out under the theme Furniture for Additive Manufacturing during the spring semester of 2025. The team would like to extend their sincere thanks to Linda Nhu Laursen for her supervision, guidance, and support throughout the project, and to Benny Endelt for his technical expertise and valuable feedback during the development process. Appreciation is also given to all those who contributed through interviews, testing, and user research—your insights played a key role in shaping the final outcome.

Artificial Intelligence

Assistance was provided by AI language models like Chatgpt and Otter ai, for drafting, transcribing and refining content. These text portions were then subsequently reviewed and edited by the author. Visual assistance was provided through Photoshop ai, Vizcom and Adobe stock to enhance the story telling of the images.


AALBORG
UNIVERSITY

Print Pod



May 2025 **Process Report** **MA4-ID6**

Daniel Hjort Jacobsen
Lawrence de Krijger

Title Page

Project title:	Print Pod
Project:	Master Thesis - 04 semester
Report type:	Process Report
Project period:	03.02.2025 - 28.05.2025
Main supervisor:	Linda Nhu Laursen
Technical supervisor:	Benny Endelt
Number of pages:	92
Appendix Pages	158

Daniel Hjort Jacobsen

Lawrence de Krijger

Design team and motivation

This project was developed by Daniel Hjort Jacobsen and Lawrence de Krijger, master's students in Industrial Design at Aalborg University. Over the course of our studies, 3D-printing, particularly FDM technology, has become an integral part of our workflow. What started as an occasional tool has gradually evolved into a regular part of our design process where printers has become a permanent tool in our homes.

With this growing presence came a set of recurring challenges. Coordinating when to print in relation to daily routines, managing noise during late hours, remembering to ventilate rooms after printing, all of these small interruptions accumulated over time. These frustrations were not only inconvenient but also served as a reminder that 3D printers, as they exist today, are not fully suited for domestic life.

Our motivation for this project stems directly from that experience. Having personally felt the limitations of existing solutions on the market, ranging from noisy enclosures to makeshift storage hacks, we saw a clear opportunity to develop something more fitting. A solution designed specifically for the modern home, one that respects both the technical needs of the printer and the everyday needs of the user.

00 Prologue

0.1 Abstract

I takt med at 3D-printning bliver mere udbredt i hjemmet, oplever brugere fortsat udfordringer relateret til støj, lugt og pladsmangel. Denne rapport undersøger, hvordan brugercentreret design kan forbedre integrationen af 3D printere i hjemlige omgivelser, uden at redesigne selve printeren. Gennem en metodekombination af spørgeskemaundersøgelse blandt 302 brugere, dybdegående interviews, hjemmebesøg og observationsstudier blev centrale brugergrupper og behov identificeret, hvor hobbybrugere viste sig at være den primære fokus gruppe.

Projektet viste, at brugerne ofte er stærkt engagerede i deres printere, men må ty til midlertidige løsninger for at håndtere de miljømæssige gener. Med udgangspunkt i disse indsigter blev der udviklet et todelt modulært kabinet, der adresserer støj og lugtgener og samtidig muliggør senere udbygning med en tilhørende opbevaringsenhed. Kabinettet er designet til at rumme en bred vifte af FDM-printere og tilbyder en skalerbar løsning, der understøtter både nuværende og fremtidige behov.

0.2 Acknowledgement

The project team would like to express sincere gratitude to all those who contributed to the successful development and completion of this work.

Special thanks are extended to Linda Nhu Laursen for her dedicated supervision, insightful guidance, and continuous support throughout the design process. Her contributions were instrumental in shaping both the conceptual direction and overall coherence of the project.

Appreciation is also given to Benny Endelt for his role as technical supervisor. His expertise and constructive feedback played a key role in addressing engineering challenges and ensuring the technical feasibility of the solution.

Further thanks go to the individuals who participated in user research, interviews, and testing sessions. Their input provided valuable perspectives that helped align the design with user needs and expectations.

0.3 Reading guide

This Process Report documents the development of Print Pod, from early research to final design decisions. It focuses on the methods, insights, and reflections behind the concept.
The report is part of a larger submission, which also includes:

- ***Product Report*** - A visual overview of the final design and its features.
- ***Appendix*** - Supporting material such as survey data and interview notes.
- ***Technical Drawing Folder*** - CAD drawings and specifications for production.

The Process Report is best read in sequence, but each section can also be consulted individually for specific insights.

Throughout the report, two icons are used to highlight key findings:

Insight
Used when an investigation or analysis leads to a relevant, new understanding that informs the next steps in the process.

Requirement
Used when findings can be directly translated into specific product requirements that guide the final design proposal.

Contents

0.4 Methodology

This timeline illustrates how the focus of the project started out as a strongly design-driven approach to increasingly becoming more business-oriented. In the early phases (Sections 1–3), the process was guided by user-centered methods such as surveys, interviews, and contextual analysis. The goal was to understand user challenges and define a design direction based on real-world needs.

From Section 4 and onward, business thinking began to play a larger role. As concepts were developed and evaluated, considerations such as feasibility, production methods, scalability and market alignment started influencing decision-making. This shift continued into Sections 5 and 6, where practical detailing, manufacturing decisions and strategic reflections became more important.

	Section 1: Identifying the Problem	Section 2: Context & User Analysis	Section 3: Reframing the Project
Design Thinking	• Focus on noise, smell, and space issues • Mapping how printers affect the home environment • Survey with 302 users • Insight into daily use and placement • Framing the problem from a user perspective • Recognizing unmet needs in existing setups • Understanding printing as both a tool and a disruption in the home	• Home visits and interviews • Shadowing users during printing • Mapping workflows and printer placements • Identifying patterns in user behavior • Categorizing user types and environments • Focus on daily routines and practical challenges • Building understanding through observation • Learning how different home types affect printer placement • Realizing emotional attachment users have to their setup	• Shifting focus from printer to environment • Reframing the problem as integration, not redesign • Selecting hobbyists as primary target group • Emphasizing modularity and adaptability • Defining key needs across user types • Creating a clear design direction • From fixing problems to designing around them • Shaping the project to support adaptability, not perfection
Business Thinking	• 3D-printing seen as a growing consumer trend • Early awareness of market potential • Early signs of a market gap in domestic 3D printer integration	• Noting diversity in user setups • Potential to target specific user segments later • Indication of different user "segments" based on behavior and space	• Recognizing potential in focusing on hobbyists • Early alignment between user needs and market gaps • Beginning to align user needs with product categories • Seeing hobbyists as a scalable user group

Illu 01: Methodology model

The model is divided into six sections, aligned with the structure of the report. Above the red line are key actions and mindsets driven by design thinking. Below the line are those influenced by business and entrepreneurial thinking. The point at which the two areas intersect, marked as the “crossover point”, highlights the moment where both perspectives held equal weight in shaping the final outcome.

This dual focus reflects the project’s broader ambition to not only design a meaningful and usable product, but to ensure that it could realistically be produced, launched, and sustained in the real world.

Section 4:
Concept Development

- Ideation based on user needs
- Exploring different integration scenarios
- Evaluating concepts through functionality and context
- Prioritizing usability and home fit
- Introducing modularity as a user-centered feature
- Keeping the concept grounded in actual user context
- Designing for flexibility across homes and printer types

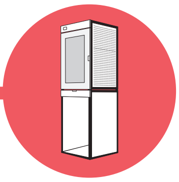
Section 5:
IDetailing & Feasibility

- Ensuring easy access and maintenance
- Adjusting tolerances for consistent fit
- Focus on user interaction and assembly experience
- Balancing technical function with user interaction
- Prioritizing simple solutions over complex mechanisms

Section 6:
Business Case & Strategy

- Evaluating user research impact
- Reflecting on design decisions and trade-offs
- Considering future improvements in form and usability
- Acknowledging what could have improved user testing

Cross over point



Section 4 (below the line):

- Starting to assess production feasibility
- Considering cost-effective manufacturing
- Aligning concept with 3D Eksperten’s product strategy
- Thinking in product phases (enclosure first, storage later)
- Judging concepts by scalability and market fit
- Testing ideas that could be manufactured in phases

Section 5 (below the line):

- Decision to use welded frame for simplicity
- Adapting design to known manufacturing methods
- Preparing for scalable production
- Working within 3D Eksperten’s logistics and resources
- Addressing CO_2 impact of overseas manufacturing
- Adjusting design to avoid manufacturing risks
- Real-world constraints shaping final decisions

Section 6 (below the line):

- Assessing dependency on 3D Eksperten
- Highlighting risks in scalability and ownership
- Reflecting on production challenges and material choices
- Questioning long-term feasibility and sustainability
- Recognizing need for broader market strategy
- Understanding how much of the product's future depends on external actors
- Questioning how sustainable and scalable the business model is

01 IDENTIFYING THE PROBLEM

1.1 From industrial machine to home appliance

3D-printing, also known as additive manufacturing, began in the early 1980s as a niche industrial technology. The first significant breakthrough occurred when Dr. Hideo Kodama developed a system in 1981 using ultraviolet light to harden polymer layers. Shortly after, in 1986, Charles Hull patented stereolithography (SLA) and subsequently released the first commercial 3D printer, SLA-1, through his company *3D Systems Corporation* (Ultimaker, 2023). During this initial phase, 3D-printing was predominantly used for industrial prototyping due to its high cost and complexity.

The turning point towards consumer adoption came with the RepRap Project in 2005, which popularized open-source 3D-printing and significantly lowered entry barriers. This movement made it possible for hobbyists and small businesses to experiment with affordable desktop 3D printers, transforming 3D-printing from an industrial exclusive into a home appliance (Ultimaker, 2023).

Today, the market for 3D printers continues to expand, driven by advances in hybrid manufacturing and the adoption of large-scale additive techniques in sectors such as construction and automotive industries. The global market value is projected to reach approximately $105 billion by the end of 2025, reflecting the technology's widespread adoption and future potential (Uptive Manufacturing, 2025). As such, 3D-printing is set to become further embedded within everyday manufacturing and home-use scenarios, continuing its evolution from industrial machinery to household essential.

1.2 Defining the problem

This section presents initial findings from a survey within the 3D-printing community. It focuses on demographic characteristics, usage patterns, equipment preferences, and common challenges, laying the groundwork for deeper analysis.

Respondents were mainly adults aged 21 to 50 years, indicating strong appeal among active hobbyists and professionals. The group was overwhelmingly hobby-oriented, emphasizing recreational usage as a primary driver.
The survey highlights the widespread use of 3D-printing technology, particularly for hobby purposes, and identifies key areas such as equipment choices, user engagement frequency, and practical challenges, informing future strategies to enhance user experience.

Early Insights into 3D-printing Community Practices

The survey gathered insights from 302 participants regarding their experiences and use patterns related to 3D-printing, emphasizing both the challenges and practical aspects of this technology.
The demographic data indicates that the community is largely made up of individuals aged between 21 and 50 years, they make up 84.4% of the respondents. This suggests that 3D-printing primarily appeals to adults in their active professional and hobbyist years. A striking 93.4% identified as hobby users, clearly marking hobbyists as the predominant segment within this community. Of the 93,4% there were 16,9% who also ticked off that they worked with 3D-printing professionally and 11,9% identified themselves as students who 3D prints because of their choice of education.

Regarding printer types, an overwhelming majority of 99.3% own FDM (Fused Deposition Modelling) printers, making this the clear favourite among enthusiasts. Resin printers, while significantly less common at 10.6%, typically serve as supplementary devices alongside FDM printers, illustrating that hobbyists are diversifying their equipment.

Experience among users varied considerably, with the largest group (30.8%) having between 3 and 5 years of experience. Another substantial group, 24.2%, reported between 6 and 10 years, highlighting a stable core of experienced users. Conversely, users with shorter experience spans (ranging from less than half a year to two years) made up 39.1%, indicating the ongoing growth and attraction of new users to 3D-printing. Veterans with over a decade of experience constitute a small but important group, representing about 6% of the total.
The frequency of printer use demonstrates high engagement levels within the community: 23.5% of respondents print daily, and 37.1% print multiple times per week. Users printing less frequently or only as needed collectively represent approximately 29.8%, while very infrequent or non-users form a minimal segment.

The purpose for engaging with 3D-printing predominantly revolves around hobby-related activities, cited by 84.1% of respondents. Functional applications, including creating functional parts and repair or spare parts, are widely popular at 68.5% and 65.9%, respectively. This underscores the significant practical utility and everyday relevance of 3D-printing technology. Additionally, prototyping remains an important application for nearly half of respondents (44.4%). Educational (13.2%) and research purposes (6.3%) are less prevalent but reflect important specialized uses.

In conclusion, the survey paints a clear picture of a vibrant, predominantly hobbyist-driven 3D-printing community actively engaged in both recreational and functional applications, primarily utilizing FDM-based printing technology. The full survay results can be found in Appendix 1

Core age group: 84.4% are aged 21–50, showing strong appeal among working-age adults.

Pro users overlap: 16.9% of hobbyists also use 3D-printing professionally.

Hobbyist majority: 93.4% use 3D-printing as a hobby, making them the dominant group.

Student users: 11.9% are students using 3D-printing through their education.

Common Challenges in 3D-printing

A critical area of the survey was understanding the challenges that users face. The chart below illustrates the most frequently mentioned issues among respondents:
In total, 402 individual challenge mentions were recorded across all participants. The most common issue, reported 102 times, was noise, making it the top concern. This was followed by smell and air quality (59 mentions), which includes concerns around resin and filament fumes, VOCs, and ventilation. Storage and space constraints were mentioned 43 times, highlighting practical limitations in setting up printing environments.

Noise	Smell	Storage and space constraints
102	59	43

Most Used 3D Printers

Survey participants reported a wide range of 3D printer brands in use, with a clear concentration around a few key names. The most frequently mentioned brand was Bambu Lab, cited 101 times, followed by Creality with 76 mentions and Prusa with 36.
Other brands that received 10 or more mentions include

Bambu Lab	Creality	Prusa	Anycubic	Flashforge	Elegoo
101	76	36	18	17	16

These seven brands represent the majority of printers used within the community and reflect current trends in user preference and market presence.

Printer Placement Preferences

Survey responses revealed a wide range of printer placement choices, reflecting how users adapt their environments to fit 3D-printing into their daily lives. The most common location was the home office, with 106 mentions, showing a strong preference for integrating printers into existing work or computer spaces.
Other frequently chosen locations include

Office room	Dedicated rooms	Living room	Basement	Bedroom	Workshop or hobby room	Garage
40	40	39	33	28	27	19

Overall, these placements highlight how users balance accessibility, space limitations, and the need to manage noise and fumes—often repurposing existing rooms or carving out dedicated spaces to accommodate their printing setups.

Combined Workarounds for Noise, Smell, and Space Issues in 3D-printing

Effectively managing noise, odor, and spatial constraints seamed crucial for users of 3D printers. The following categories summarize common strategies identified from survey responses, highlighting diverse approaches that participants have implemented to enhance their printing environments:

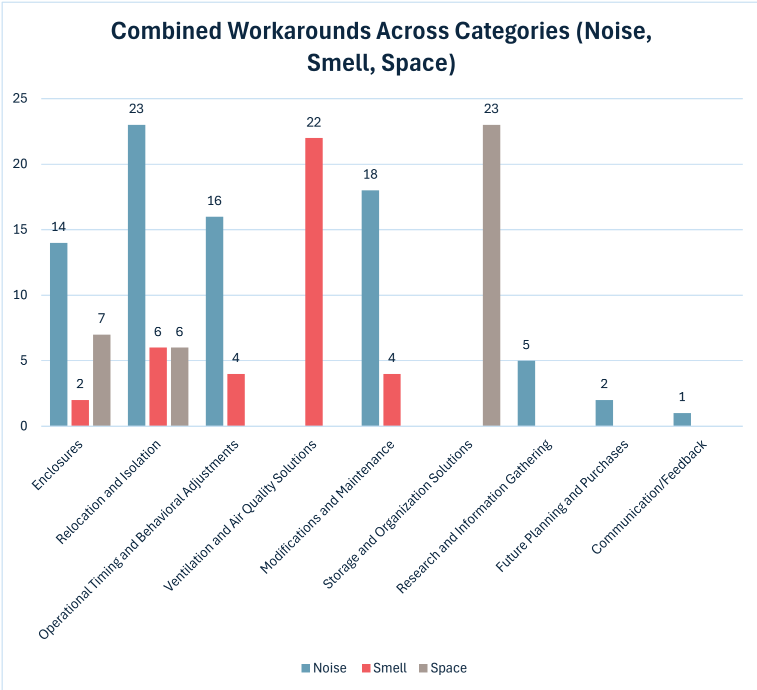
Common challenges: Out of 402 total mentions, noise was the top concern (102), followed by smell/air quality issues (59) and storage/space constraints (43), reflecting key practical and environmental hurdles in 3D-printing setups.

Printer placement: Home office is the top spot (106 mentions), showing a preference for work-integrated setups.

Space-efficient setups (e.g., for home offices, bedrooms, or shared spaces)

Accessible storage for printers, tools, and filament.

Enclosures. Use of dedicated chambers, boxes, or custom enclosures to mitigate noise, control odors, and manage printer space efficiently.
Relocation and Isolation. Moving or isolating printers in separate areas (e.g., basements, attics, or dedicated rooms) to minimize disturbance and optimize space.
Operational Timing and Behavioural Adjustments. Scheduling print jobs at specific times, altering user behaviour, or limiting presence around printers to reduce noise and exposure to smells.
Ventilation and Air Quality Solutions. Implementing external ventilation, air purifiers, filters, or natural ventilation methods to improve air quality and reduce smells.
Printer Modifications and Maintenance. Hardware changes or regular maintenance (e.g., silent mainboards, vibration dampeners, squash balls, soft mounts) aimed at reducing noise and odors.
Storage and Organization Solutions. Employing storage methods (e.g., shelving, humidity-controlled storage, dedicated rooms, or DIY solutions) to address filament organization, tool accessibility, and optimal use of limited space.
Research and Information Seeking. Actively researching solutions through articles, tutorials, forums, and online videos to address noise-related issues.
Future Planning and Purchases. Planning future acquisitions or additional space to resolve existing printing concerns, primarily related to noise.
Communication and Feedback. Contacting manufacturers or suppliers for solutions or improvements specifically targeting noise reduction.



Illu 02: Combined workarounds

The survey data indicate several effective strategies users employ to address common issues with noise, smell and space when operating 3D printers. Enclosures emerge as a highly versatile and popular solution, frequently addressing multiple concerns simultaneously reducing noise, containing odors, and optimizing spatial organization. Similarly, relocating or isolating printers in dedicated or remote spaces is widely utilized, effectively minimizing acoustic disturbances and improving air quality by physically distancing the printer from primary living or working areas.
Operational timing adjustments and behavioural changes, such as scheduling prints strategically or avoiding proximity during printing, represent initial, low-investment approaches favoured by many users. However, more permanent measures, including hardware modifications, maintenance routines, and installation of dedicated ventilation and air purification systems, are also common, demonstrating the willingness of users to invest in long-term solutions.
For space management, dedicated rooms or specifically designed accessible storage solutions, such as shelving units, DIY custom arrangements, and vertical storage solutions, are frequently adopted . These solutions effectively manage both filament and accessory organization, significantly improving user satisfaction.
In conclusion, combining enclosures, printer relocation, hardware modifications, and organized storage provides comprehensive solutions, effectively addressing noise, odor, and spatial constraints inherent in 3D-printing activities.

Acoustic and air quality control (to handle printer noise and Odors)

Mobile solution that can work across multiple living spaces.

1.3 Design Brief 1

Problem Statement

3D-printing users frequently encounter three key environmental challenges: excessive noise, poor air quality due to fumes, and limited space. These issues are particularly disruptive in-home environments, where printers are commonly placed in offices, living rooms, bedrooms, and basements. Survey data shows that noise is the most reported problem (102 mentions), followed by smell and air quality (59 mentions) and space/storage limitations (43 mentions). Addressing these concerns is essential for improving comfort, safety, and usability in personal and semi-professional printing setups.

Target Group

- Hobbyists
- Small business operators
- Students and educators working at home, school or workshop environments.

Context

- Home office
- Separate or dedicated room
- Living room

Mission

To improve the 3D-printing experience by developing user-centred solutions that:

- Reduce operational noise
- Manage air quality and fumes
- Maximize storage efficiency and spatial organization

Vision

To create a quieter, safer and more space-efficient 3D-printing experience - one that integrates seamlessly into home offices, hobby rooms, schools and creative workspaces, with minimal disruption or health risk.

Key Requirements

Acoustic and air quality control (to handle printer noise and Odors)	Space-efficient setups (e.g., for home offices, bedrooms, or shared spaces)
Accessible storage for printers, tools, and filament.	Mobile solution that can work across multiple living spaces.

Key User Insights

Student users: 11.9% are students using 3D-printing through their education.	Core age group: 84.4% are aged 21–50, showing strong appeal among working-age adults.
Hobbyist majority: 93.4% use 3D-printing as a hobby, making them the dominant group.	Pro users overlap: 16.9% of hobbyists also use 3D-printing professionally.
Printer placement: Home office is the top spot (106 mentions), showing a preference for work-integrated setups.	Common challenges: Out of 402 total mentions, noise was the top concern (102), followed by smell/air quality issues (59) and storage/space constraints (43), reflecting key practical and environmental hurdles in 3D-printing setups.

02

UNDERSTANDING 3D-printing IN HOME ENVIRONMENTS

As 3D-printing becomes increasingly accessible, its integration into home environments presents unique challenges and adaptations. This chapter explores how users incorporate 3D printers into their living spaces, examining the practical, spatial, and behavioural implications of home-based printing. Through a combination of observational studies, interviews, and user analysis, key factors such as workflow efficiency, environmental impact, and user preferences are investigated.

2.1 Research in context

Understanding how 3D-printing is integrated into home environments requires examining its use within real-life settings. To contextualize user behaviours and challenges, visits were conducted to participants' homes, allowing for direct observation of their setups, routines, and interactions with their 3D printers.

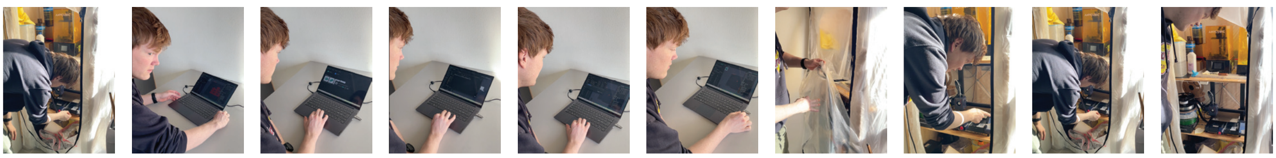
Interviews

To explore user experiences and challenges related to home-based 3D-printing, a series of semi-structured interviews was conducted with six participants. These interviews aimed to gather insights into individual printing habits, workflow adaptations, and environmental considerations. Participants included both experienced and novice users, providing a range of perspectives on printer integration within domestic spaces.
Discussions focused on printer setup, print preparation, file transfer methods, monitoring behaviours, and environmental factors such as noise and spatial constraints. A recurring challenge identified was the impact of noise levels, particularly for users who placed their printers in shared living spaces. Some participants described workarounds, such as relocating the printer to a separate room or limiting usage to specific hours. Others emphasized the role of connectivity features, noting that Wi-Fi-enabled printers significantly streamlined the printing process by eliminating manual file transfers.
Additionally, differences in slicing software preferences influenced user experiences, with some participants expressing frustration over software-printer compatibility issues. Several users also reported modifying their workflows by incorporating pre-print maintenance routines, such as cleaning the build plate or recalibrating the printer before each job. These insights provided a foundational understanding of user needs and informed the subsequent observational study.
While the primary focus of interviews was on direct users, it is worth noting that cohabitants, such as partners, roommates, or family members, are indirectly impacted by the placement and operation of 3D printers. Their sensitivity to noise, odors, and shared-space disruption plays a role in how and where printers are placed. Future design considerations should account for these secondary stakeholders, especially in shared or multi-use living environments. All interviews have been transscribes and can be found in Appendix 2

Observational studies

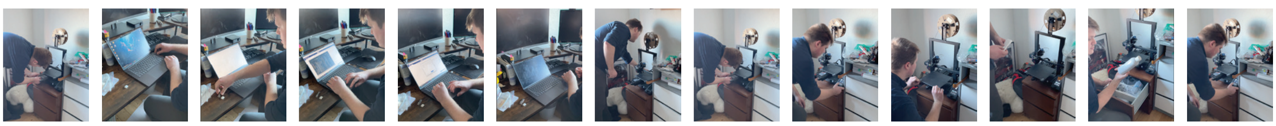
Building upon the findings from the interviews, an observational study was conducted using a shadowing approach. This method facilitated the collection of real-time insights into user behaviours, workflows, and challenges without reliance on self-reported data.
Each participant was provided with a 10mm x 10mm x 10mm cube file to print, and their process, from file preparation to print initiation, was observed. This approach highlighted variations in workflow, including differences in file transfer methods, printer setup, and monitoring habits. The following section details key observations regarding file transfer methods, printer preparation routines, and user interactions with their machines.

Asger Participant 1



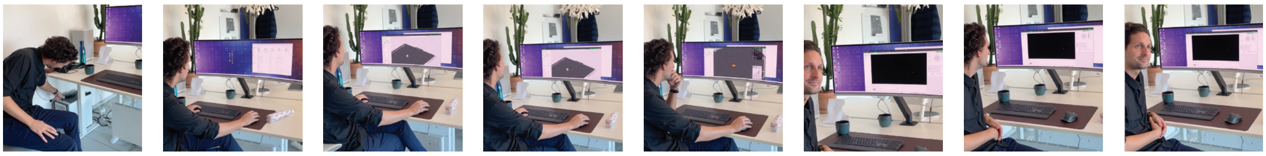
1. Takes the SD-card from the printer and turns on machine
2. Plugs in USB we gave him with the cube.stl file. Plugs in the SD-card from the printer
3. Opens up slicer program "orca slicer"
4. Drags file from USB to Orca slicer
5. Uses a preset to slice the file Saves as G-code to SD-card
6. Removes the SD-card
7. Folds the enclosure front away to gain better access to the printer
8. Plugs in SD-card to the printer
9. Hits "print" on the cube. stl file.
10. Watches the first layer print

Mikkel Participant 2



1. Takes the SD-card from the printer.
2. Plugs in USB with the cube. stl file. Plugs in the SD-card from the printer
3. Drags file from USB to desktop
4. Opens up file from desktop in the slicer program "CURA"
5. Uses a preset to slice the file. Saves as G-code to SD-card
6. Removes the SD-card
7. Turns on printer
8. Plugs in SD-card to the printer
9. select the file cube. stl on the screen.
10. Noticed that the build plate was dusty
11. went up to get a piece of paper
12. Wipes the dust off the build plate
13. Hits "print" on the cube.stl file.

Mikkel Huse Participant 3

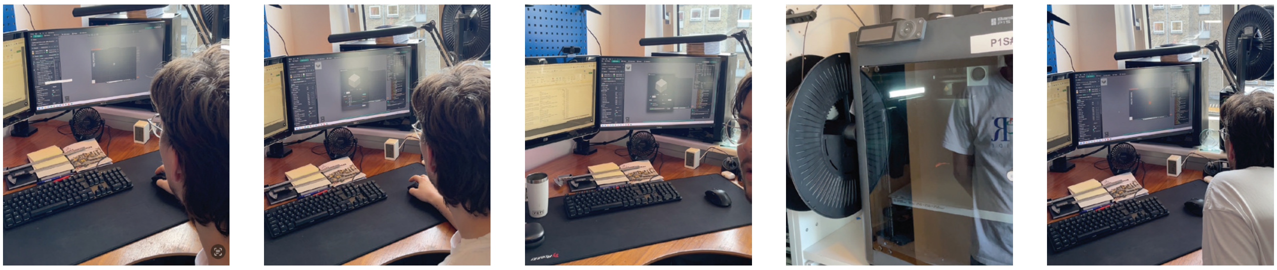


1. Plugs in USB we gave him with the cube.stl file into pc.
2. Drags file from USB to desktop
3. Opens up file from desktop in the slicer program "bambu studio"
4. Uses previous settings from a solid print.
5. inspects part in slicer
6. Looks at his printer to decide with ones are free and have loaded filament.
7. Sends the sliced part to 3d printer - wirelessly
8. Observes if the printer starts printing.

Christoffer Participant 4

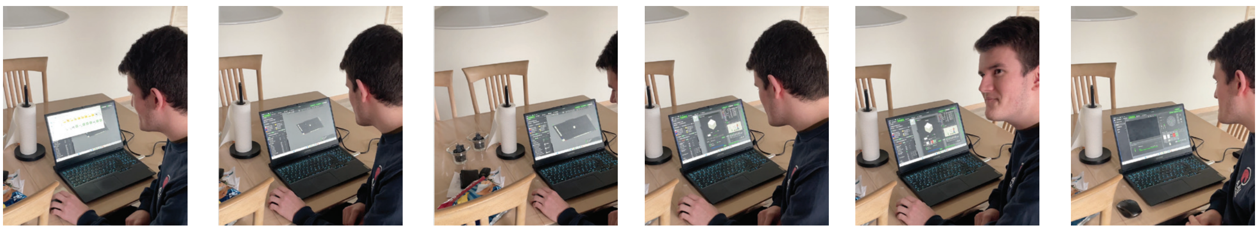
1. Plugs in USB we gave him with the cube. stl file into pc.
2. Drags CAD file into the slicer.
3. Checks the settings in "prusa slicer".
4. unplugs the usb stick with the sliced file on there.
5. inspects the build plate and scratches off left over filament.
6. places the build plate onto the heated bed.
7. Connects the usb stick.
8. presses "print"
9. closes the door for the enclosure.

Toke Participant 5



1. Drags CAD file into the slicer.
2. Checks the settings in "orca slicer".
3. Looks at his printer to decide with ones are free and have loaded filament.
4. Sends print to printer wirelessly.
5. Checks printing time.

Mikkel F Participant 6



1. Drags CAD file into the bambu slicer.
2. Checks the settings in "bambu slicer".
3. Sets printing speed
4. Inspects part
5. Chooses color of the to be printed part.
6. Sends print and monitort it on the build in camera.

Following the shadowing study, notable differences were observed in 3D-printing workflows. Users with Wi-Fi enabled printers, such as those owning Bambu Lab models, effortlessly sent g-code directly to their printers via Wi-Fi. In contrast, participants without Wi-Fi-enabled printers had to manually transfer their g-code files onto an SD card or USB stick, walk to their printers, power them on, and manually select the appropriate g-code file to initiate printing.

Notably, participants did not actively monitor the printing process. When they did, it was only to confirm that

the print had started. However, half of the participants, specifically those without Wi-Fi-enabled printers, took additional preparatory steps, such as cleaning the build plate of dust and/or older print purges prior to printing. Additionally, one participant (Interview 5) faced challenges due to both the lack of Wi-Fi connectivity on one of his printers and the use of a different slicing software. This combination complicated his workflow, resulting in the printer being used infrequently.
These observations suggest that convenience features such as wireless connectivity and compatibility between slicing software and printer setups significantly streamline the user experience. Consequently, users with integrated setups reported greater ease and potentially higher satisfaction. Ensuring seamless integration and connectivity could foster more frequent use and a more positive overall user experience.

User	Noise workarounds	Average dB	Peak dB	Min dB	Printer	Enclosure type
1	No	64	82	61	Anicubic cubra 2	
2	No	67	77	63	Ender 3 v2 neo	
3	Yes	45	52	38	Bambulab a1	Two layered windows
4	Partially	59	72	48	Prusa mini +	Cabinet open back
5	No	64	76	60	Bambulab P1 + ams	Comes with printer
6	No	63	71	49	Bambulab P1 + ams	Comes with printer
Avrage noise, no workarounds		64,5	76,5	58,25		

Illu 03: Avrage noise test

As part of the shadowing study, sound levels were measured to assess the acoustic environment of 3D-printing. Each participant printed the same provided STL-file while sound levels were recorded. The average noise level measured from printers without noise-reducing measures was approximately 64.5 dB.
Measurements were conducted using a phone application rather than professional equipment, which may have influenced accuracy. According to the World Health Organization (WHO, 2018), indoor noise levels ideally should not exceed 30 dB(A) at night for bedrooms and should generally remain below 40 dB(A) in living areas for optimal comfort and health. The recorded average noise level of 64.5 dB significantly exceeds these recommended values, indicating potential discomfort during prolonged exposure. This finding highlights the importance of integrating sound-dampening solutions or selecting quieter 3D-printing equipment to enhance acoustic comfort and overall quality of life for regular users.

Context photos

As part of the six user interviews, photographs were taken to document how 3D printers are positioned within home and work environments. The images reveal real-life spatial arrangements, highlighting factors such as accessibility, available surface area, surrounding equipment, and integration with furniture. This visual data provides contextual support for understanding user behaviour and spatial constraints related to 3D printer use.

Interview 1: Asger

Placement: Dining room corner

Printer(e):
1 - Resin
1 - FDM-bedslinger

Interview 2: Mikkel

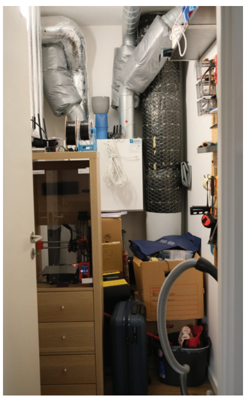
Placement: Bedroom corner

Printer(e):
1 - FDM-bedslinger

Interview 3 Mikkel Huse

Placement: Rented office

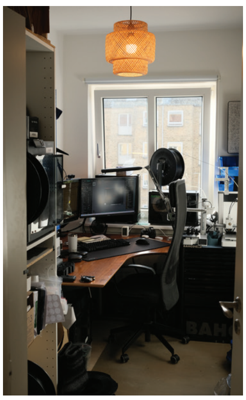
Printer(e):
2 - Resin
9 - FDM-bedslinger
1 - FDM-CoreXY



Interview 4: Christopher

Placement: Utility room

Printer(e):
1 - FDM-bedslinger



Interview 5: Toke

Placement: office

Printer(e):
2 - FDM-bedslinger
4 - FDM-CoreXY

Interview 6: Mikkel F.

Placement: Shed

Printer(e):
1 - FDM-CoreXY

Odor concerns are common, especially in shared or poorly ventilated areas.

Wi-Fi-enabled printers streamline workflows and reduce friction during setup and printing.

Closet or isolated placement helps reduce disruption but hinders monitoring and accessibility.

Aesthetic integration is important for users placing printers in visible living areas.

Users adjust routines, such as avoiding nighttime prints or lowering speeds, to manage noise.

Follow up survey

Following our initial survey, we conducted a follow-up survey to gather more detailed information from participants. We reached out via email addresses provided during the initial interview, asking users to submit pictures of their 3D printer setups witch can be located in Appendix 3.

user	print nr.	days since printed	print time hours	interview nr.	User type	printer	Summed print time	Print period	Hours a day on avrage
1	1	1	4	107	hobby	Bambu lab A1 mini	25	2	12,50
	2	1	4			Bambu lab A1 mini			
	3	1	2			Bambu lab A1 mini			
	4	2	15			Bambu lab A1 mini			
2	1	3	2	280	hobby	Prusa MK4	30	30	1,00
	2	10	3			Prusa MK4			
	3	30	25			Prusa MK4			
3	1	2	4	73	hobby	Bambu lab P1s + AMS	56	12	4,67
	2	5	4			Bambu lab P1s + AMS			
	3	12	48			Bambu lab P1s + AMS			
4	1	3	1,5	274	hobby	Flashforge Adventure 5M	4,5	17	0,26
	2	17	3			Flashforge Adventure 5M			
5	1	3	0,5	263	hobby / student	Creality K1 MX	11,75	11	1,07
	2	3	0,25			Creality K1 MX			
	3	11	11			Creality K1 MX			
6	1	1	0,75	187	hobby/professional	Creality K1 MX	12,25	12	1,02
	2	5	10			Magneto X			
	3	12	1,5			Idea Former			
7	1	3	11	285	hobby	Prusa MK4	13,5	3	4,50
	2	1	0,5			Prusa MK4			
	3	1	2			Prusa MK4			
8	1	7	1,65	268	hobby/researcher	Bambu lab A1+AMS	4,95	7	0,71
	2	7	1,65			Bambu lab A1+AMS			
	3	7	1,65			Bambu lab A1+AMS			
9	1	1	2	140	hobby	Bambu lab A1	6	8	0,75
	2	4	2			Bambu lab A1			
	3	8	2			Bambu lab A1			
10	1	2	6	123	hobby/researcher/Industrial	Bambu lab X1 Carbon	6,5	2	3,25
	2	2	0,5			5 axis old ender rebuild			
11	1	5	12	31	hobby/professional	Bambu lab P1s + AMS	102	27	3,78
	2	15	70			Bambu lab P1s + AMS			
	3	27	20			Bambu lab P1s + AMS			
Average daily print time for followed-up interview participants.								3,05	Hours

Illu 04: Follow up survey - results

The results from this follow-up indicated that the average daily print time among respondents was approximately 3 hours and 3 minutes. Additionally, the average duration for individual print jobs was about 8 hours and 31 minutes. Participants typically waited around 2.8 days between print jobs. These findings provide valuable insights into user habits and printer utilization, contributing to a deeper understanding of how participants engage with their 3D-printing activities.

Other avrages		
Average daily print time.	3,05	hours
Avrage print time for individual jobs	8,51	hours
Avrage days between print jobs	2,80	days

Illu 05: Avrages from folllow up survey

Understanding VOC emission

Understanding how 3D-printing affects indoor air quality requires examining the VOCs (Volatile Organic Compounds) emitted by various materials. Although users place their printers in diverse spaces, our earlier survey (Section 1.2.4) showed that the most common location is the home office. For this reason, and because converting emission rates from mg/min to ppb (parts per billion) requires a known room volume, therefore we used the typical Danish home office as a reference setting. While this context is used for consistency in calculations, the values can be adapted to any room with known dimensions and ventilation rates.

VOC Emissions from 3D-printing Materials
This section provides an overview of the types and quantities of VOCs emitted during FDM 3D-printing. These emissions contribute to indoor air pollution and may pose health risks depending on material type, exposure duration and ventilation. PLA, a commonly used filament, is generally safer for indoor use due to its lower emissions of compounds like lactide and acetaldehyde, which may irritate the eyes and lungs (Kim et al., 2015). In contrast, ABS and ASA printing produce significantly higher emissions of styrene, ethylbenzene, and acrylonitrile—linked to respiratory irritation and identified as possible or probable carcinogens (substances that may increase your risk of developing cancer) (Azimi et al., 2016; Deng et al., 2016). Even more natural-looking filaments like wood- or metal-filled PLA can emit harmful VOCs: DEHP and naphthalene from metal-filled PLA, and caprolactam from wood-filled PLA (Potter et al., 2021; Vance et al., 2017). Nylon also emits caprolactam—a strong respiratory irritant (Steinle, 2016), while TPU may release sensitizers depending on its chemical makeup (Potter et al., 2021).

VOC Concentration from FDM 3D-printing
To evaluate whether emissions from 3D-printing materials pose a risk to indoor air quality, it is necessary to convert the emission rates—typically measured in milligrams per minute (mg/min)—into a unit compatible with indoor air quality guidelines, such as parts per billion (ppb). This allows for direct comparison with threshold values recommended by health authorities, such as those set by the World Health Organization (WHO).

Room Dimensions
Based on housing data from Denmark, a typical home office measures approximately 10 m^2 in area with a minimum ceiling height of 2.5 m (Eurostat, 2023; Nørgaard et al., 2021; Schulze et al., 2021; MDPI, 2021). This results in a total room volume of:
Volume = 10 m^2 x 2.5 m = 25 m^3

Residential Ventilation Rate
The ASHRAE 62.2-2019 standard recommends a minimum ventilation rate of 0.35 air changes per hour (ACH) in residential settings (ASHRAE, 2019). This corresponds to an airflow rate:
Q = (0.35 ACH x 25 m^3) / 60 min = 0.1458 m^3/min

Emissions from ABS Filament (Styrene)
According to Azimi et al. (2016), ABS emits approximately 0.5 mg/min of styrene during printing. The molecular weight (MW) of styrene is 104.15 g/mol.
Using the formula:
ppb = (mg/min x 24.45) / (MW x Q)
Substituting values:
ppb = (0.5 x 24.45) / (104.15 x 0.1458) = 12.225 / 15.18 ≈ 805 ppb

ABS: The estimated 805 ppb of styrene significantly exceeds the 100-ppb reference level often associated with mucosal (nose, throat, eyes and lungs) irritation, as identified in health-based literature and summarized in WHO (2010) and other sources.”

Emissions from PLA Filament (Acetaldehyde)
According to Azimi et al. (2016), PLA emits approximately 0.02–0.04 mg/min of acetaldehyde. Using the upper-bound emission rate of 0.04 mg/min, and the molecular weight (MW) of acetaldehyde being 44.05 g/mol, we can estimate the concentration using the same method.
Substituting values:
ppb = (0.04 x 24.45) / (44.05 x 0.1458) = 0.978 / 6.418 ≈ 152 ppb

PLA: Emitting ~152 ppb of acetaldehyde, PLA exceeds the 100-ppb reference level used for irritants like formaldehyde. However, due to the relatively low toxicity and short exposure window during printing, PLA remains the safest among the filaments considered.

Emissions from ASA Filament (Styrene)
ASA, a common alternative to ABS, emits lower but still significant levels of styrene. Based on emission data, a rate of 0.35 mg/min is used, and the MW of styrene remains 104.15 g/mol.
Substituting values:
ppb = (0.35 x 24.45) / (104.15 x 0.1458) = 8.5575 / 15.18 ≈ 563 ppb

ASA: At ~563 ppb of styrene, ASA also exceeds the WHO limit, though it emits less than ABS. Health concerns remain similar but somewhat less intense.

Emissions from PETG Filament (Formaldehyde)
PETG emits aldehydes like formaldehyde during printing. Based on Vance et al. (2017), an upper-bound emission rate of 0.05 mg/min is assumed. The MW of formaldehyde is 30.03 g/mol.
Substituting values:
ppb = (0.05 x 24.45) / (30.03 x 0.1458) = 1.2225 / 4.379 ≈ 279 ppb

PETG: The estimated 279 ppb of formaldehyde is nearly three times the WHO recommended short-term limit of 100 ppb. This level can cause eye, nose, and throat irritation, with long-term risks if exposure is chronic.

Emissions from TPU Filament (Varied Compounds)
TPU, or thermoplastic polyurethane, emits various VOCs depending on formulation. Some studies have identified emissions such as caprolactam and isocyanates, both of which can be respiratory irritants or sensitizers. Based on Potter et al. (2021), an upper estimate of total VOC emission is 0.03 mg/min. Assuming a molecular weight of 113.16 g/mol for caprolactam as a representative compound:
Substituting values:
ppb = (0.03 x 24.45) / (113.16 x 0.1458) = 0.7335 / 16.51 ≈ 44 ppb

TPU: With an estimated concentration of ~44 ppb for caprolactam (as a representative compound), TPU emissions are below most short-term exposure limits. However, due to the variability of chemical additives in TPU, some formulations may still pose risks for chemically sensitive individuals or in poorly ventilated environments.

The data clearly show that VOC emissions from 3D-printing vary significantly depending on the filament material, with ABS, ASA, and PETG producing concentrations that exceed common short-term health reference levels, such as the 100-ppb threshold associated with mucosal irritation. While PLA and TPU are comparatively safer, they can still emit compounds that may impact indoor air quality—especially in poorly ventilated environments. These findings underscore the importance of material choice, proper ventilation, and the potential value of enclosures with air filtration to minimize health risks during home 3D-printing.

Ventilation: Effective odor management and air filtration

2.1 User analysis and mapping

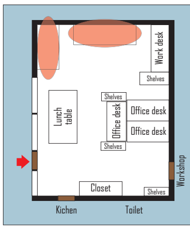
To better understand how users integrate 3D-printing into their home environments, this section examines user behaviours, spatial organization, and printing habits. By analysing floorplans, clustering behavioural patterns, and defining user types, this study identifies key factors influencing printer placement, workflow efficiency, and overall user experience.
Through a combination of floorplan studies, behavioural spectrums, and user categorization, different approaches to 3D-printing in home settings are explored, ranging from dedicated workspaces to more improvised setups in shared living areas.

Floorplan studies

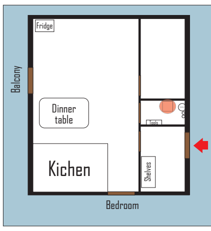
The placement of 3D printers in home environments affects usability, noise and accessibility. This section examines how users allocate space, comparing dedicated rooms with shared living areas while separate rooms reduce noise, but limit real-time monitoring. In contrast, shared spaces require compromises on sound, ventilation and workspace organization. Mapping these setups reveals key trade-offs in home 3D-printing integration.

Users with a separate room often isolate their 3D printer to minimize disruptions, placing it in storage closets, enclosed workspaces or even separate buildings. While this setup helps manage noise and environmental factors, it also makes real-time monitoring difficult, posing challenges for rapid prototyping and adjustments during the printing process. Some users see the printer as an industrial tool best kept out of living areas, while others create dedicated spaces that balance noise reduction with accessibility.

With a seprate room



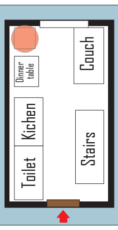
Interview 3:
-Removes the printer from his living space entirely because he sees it as an industrial tool. If he where to use one at home, it would be in the garage.



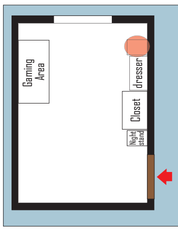
Interview 4:
-Isolates it within his home but still keeps it accessible, using a dedicated space to balance noise, practicality, and aesthetics.

Illu 06: Plan drawings of users with seprate rooms

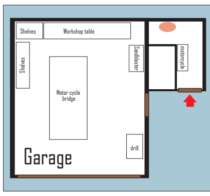
Without a seprate room



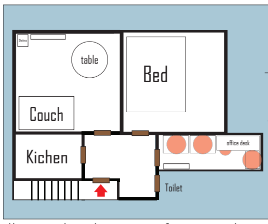
Interview 1:
-Keeps it in his living room but moves it upstairs to his bedroom to Balance Accessibility & noise Management.



Interview 2:
-Keeps it in his bedroom. Avoids running prints at night because of the noise. He sets longer prints aside until his roommate goes on vacation and then he moves the printer to the living room.



Interview 6:
-Moved the 3d printer to the shed at his parents house due to his family getting tired of the noise, and he also found it disruptive. He did not put it into the garage because other tools might damage the printer in combination with dust and debris.



Interview 5:
-Keeps it in his office space. Turns down the printer speed before going to bed but he can still hear it. He admits that it sometimes disrupts his own sleep and sometimes his girlfriend Aswell.

Illu 07: Plan drawings of users without seprate rooms

For those without a separate room, compromises are necessary. Users adapt their setups to manage noise, smell and space limitations, often relocating their printer based on convenience. Some keep their printer in a living room but move it to a bedroom for quieter operation, while others avoid running prints at night to minimize disruptions . Office setups provide a balance between accessibility and noise control, though some users still experience disturbances, even reducing print speeds at night to lessen the impact.

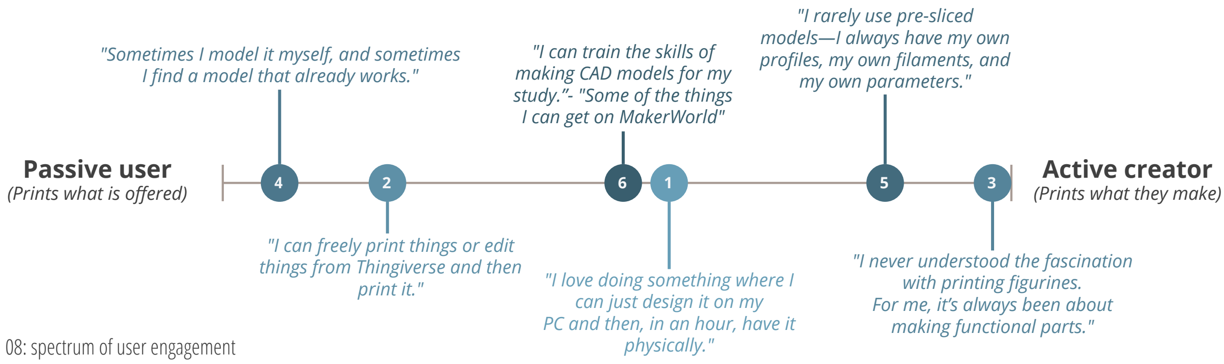
These findings highlight how users adapt their environments to accommodate 3D-printing, with choices driven by space availability, noise sensitivity, and workflow needs. Whether isolating the printer or integrating it into shared spaces, each approach comes with trade-offs that influence the overall user experience.

Quiet Operation: Acoustic comfort, especially in shared or nighttime settings.

User Behaviour Clustering

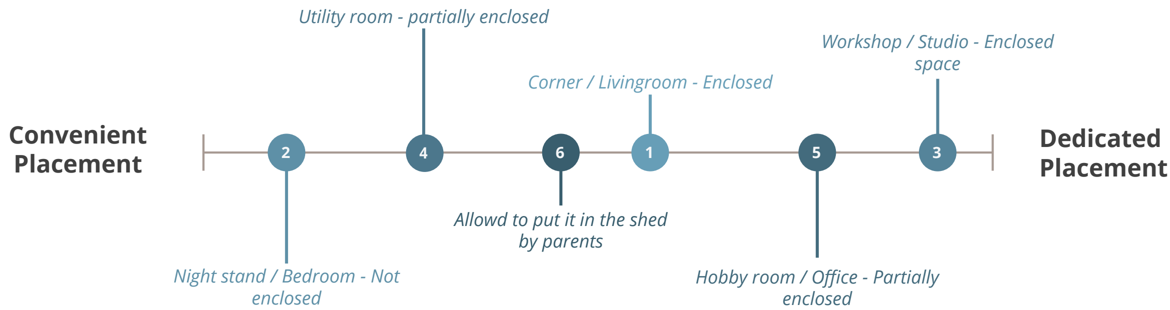
To better understand the different ways users relate to their 3D printers, the insights from the interviews with 3D printer owners were mapped onto four distinct spectrums. Each spectrum captures a key dimension that differentiates user experiences, attitudes and behaviours surrounding their 3D-printing practices.

User engagement
This spectrum describes the extent of a user's creative involvement with their printer. At one end are "passive users," who primarily print pre-made designs and engage minimally in customization. At the opposite end are "active creators", who regularly design, customize and print their original creations, viewing the printer as a tool for creativity and innovation.



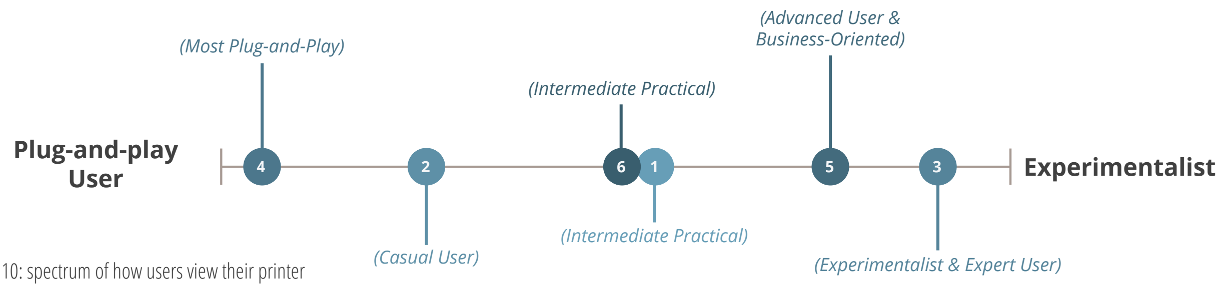
Illu 08: spectrum of user engagement

Placement
This spectrum addresses how users integrate their 3D printer into their physical space. "Convenient placement" users position their printer in accessible yet unobtrusive areas, prioritizing practicality and ease of use. Conversely, "dedicated placement" users allocate specific, intentionally arranged spaces for their printer, highlighting its importance and making it a central part of their environment.



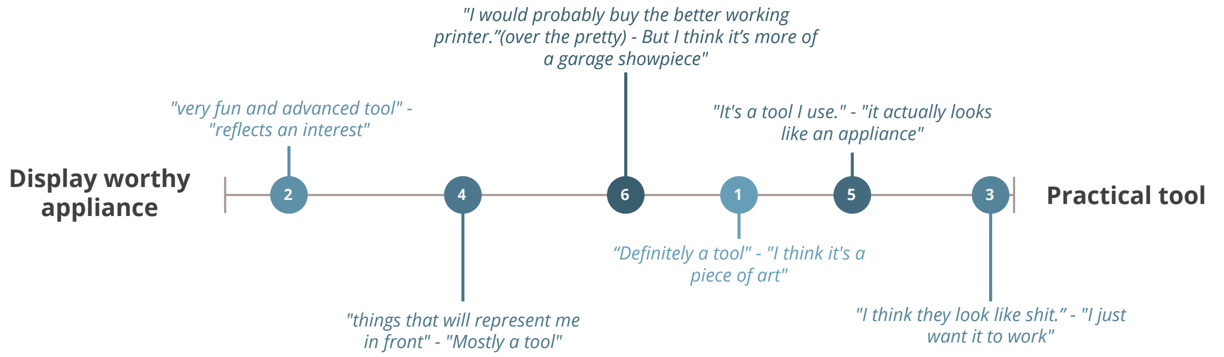
Illu 09: Spectrum of 3D printer placement

Function
Users on this spectrum vary in how they approach the complexity and capabilities of their printers. "Plug-and-play users" prefer simplicity, ease of use, and reliability, typically avoiding experimentation or adjustments beyond basic operation. "Experimentalists" in contrast, embrace complexity and actively modify, calibrate and explore advanced features, using their printers as experimental platforms.



Illu 10: spectrum of how users view their printer

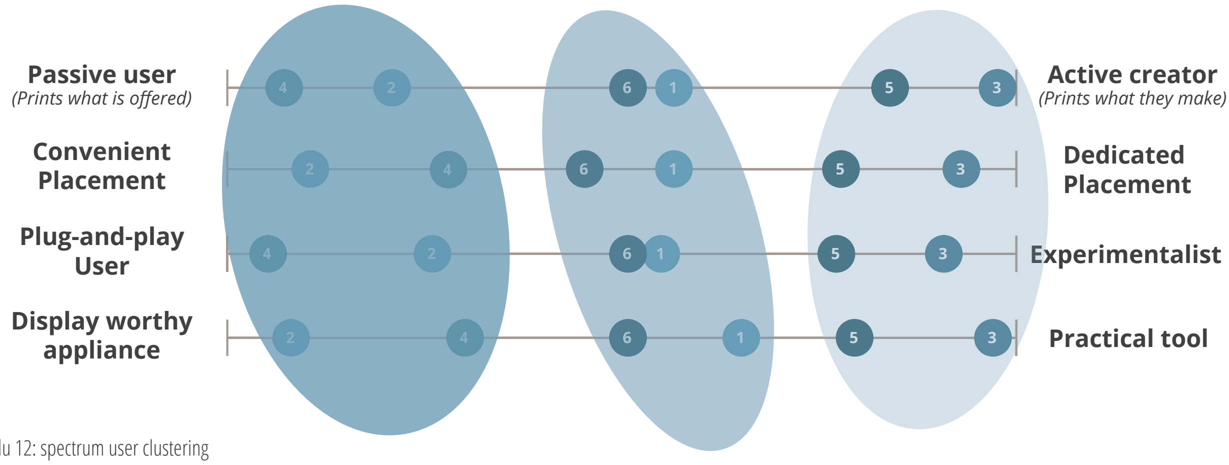
Printer identity (Consumer Perception)
This spectrum reflects users' perceptions of their printer's role and value. On one end, users treat the printer as a "display-worthy appliance", valuing aesthetic appeal and often placing the printer prominently as a showpiece. At the other end, users view their printer strictly as a "practical tool", prioritizing functionality, output quality and efficiency over aesthetics or visibility.



Illu 11: spectrum of how users view their printers identity

Defining user types

Based on the mapped spectrums a clear pattern emerged among the six interview participants, revealing three distinct user groups. Two participants consistently positioned on the left side of the spectrums, indicating a "hobbyist" profile. These users primarily engage in 3D-printing as a casual interest, favouring ease of use, pre-made models and a plug-and-play approach.
In contrast, two participants were positioned in the middle of the spectrums, representing "practical users" or students. This group demonstrates a balanced approach, engaging in both pre-made and custom prints while maintaining a functional yet flexible placement and operation of their printers. Their usage is driven by a mix of utility and learning rather than purely creative or professional ambitions.
Finally, the two participants on the right side of the spectrums form the "professional user" group. These individuals are highly engaged creators who dedicate specific spaces for their printers, frequently experiment with settings and modifications, and view their 3D printer as a practical tool essential to their work or advanced projects.

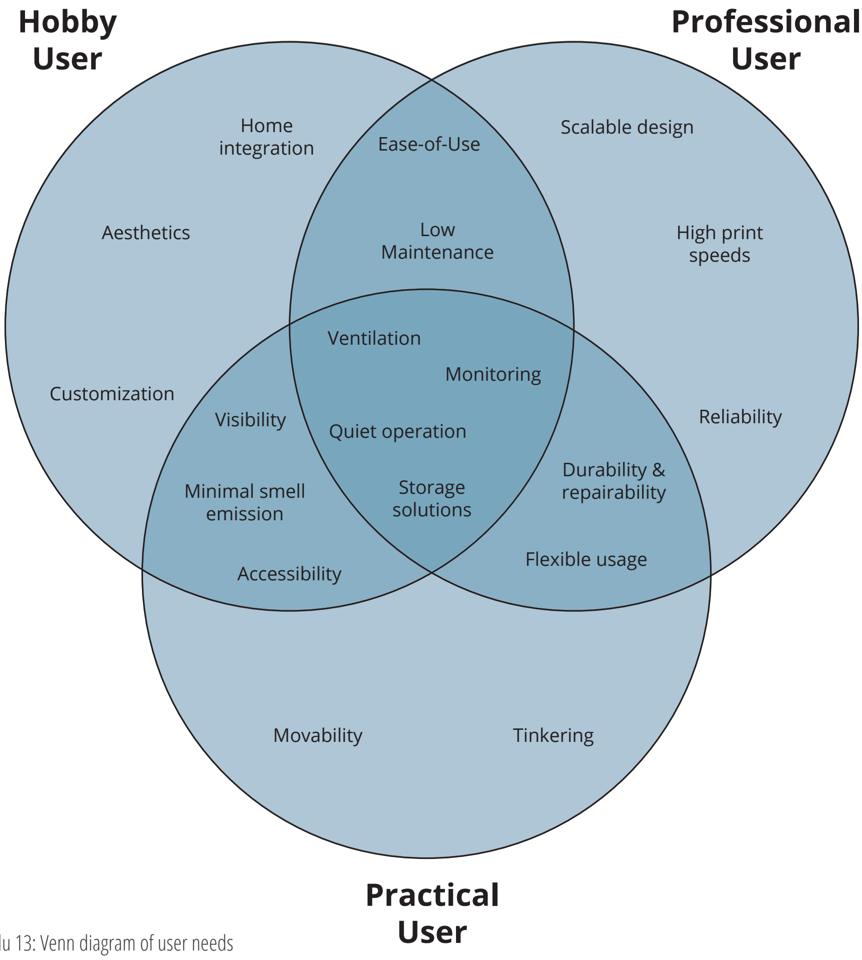


Illu 12: spectrum user clustering

By analysing user placement across these four spectrums, the study effectively differentiates key user types, illustrating how 3D-printing is integrated into different lifestyles and work processes. These insights help categorize the diverse ways in which users perceive and interact with their printers, ranging from hobbyist enthusiasm to professional application.

Venn Diagram of Different User Needs

The Venn diagram effectively maps the diverse needs of 3D printer users, illustrating both common priorities and user-specific requirements. By analysing the overlap between different groups—hobbyists, practical/student users, and business/professional users—we can see distinct patterns in how different users interact with their printers.



Illu 13: Venn diagram of user needs

At the core, all user groups share the need for ventilation, monitoring, quiet operation and storage solutions, indicating that regardless of their level of engagement all users value an organized, controlled and efficient printing environment.
Beyond this universal core, certain needs are shared between two user groups. Ease of use and low maintenance are priorities for both hobbyists and professional users, suggesting a preference for straightforward, hassle-free operation. Meanwhile, minimal smell, visibility and accessibility are important for both hobbyists and practical users, reflecting a focus on integrating the printer seamlessly into their living or working spaces. On the other hand, durability, repairability and flexible usage are key factors for both practical users and professionals, emphasizing the need for a printer that can withstand frequent use and adapt to different projects.
Outside these shared needs, each user group has distinct preferences. Hobbyists prioritize home integration, aesthetics and customization, underscoring their desire to incorporate 3D-printing into their personal spaces in a visually pleasing and creative way. Practical users emphasize movability and tinkering, valuing flexibility and hands-on experimentation. Meanwhile, business and professional users mainly focus on scalable design, high print speeds and reliability, aligning with their need for performance, efficiency and consistent output.
While some aspects are universally valued, each group brings unique priorities that influence how they use and perceive their printers.

Monitoring: Easy access or visibility to supervise prints

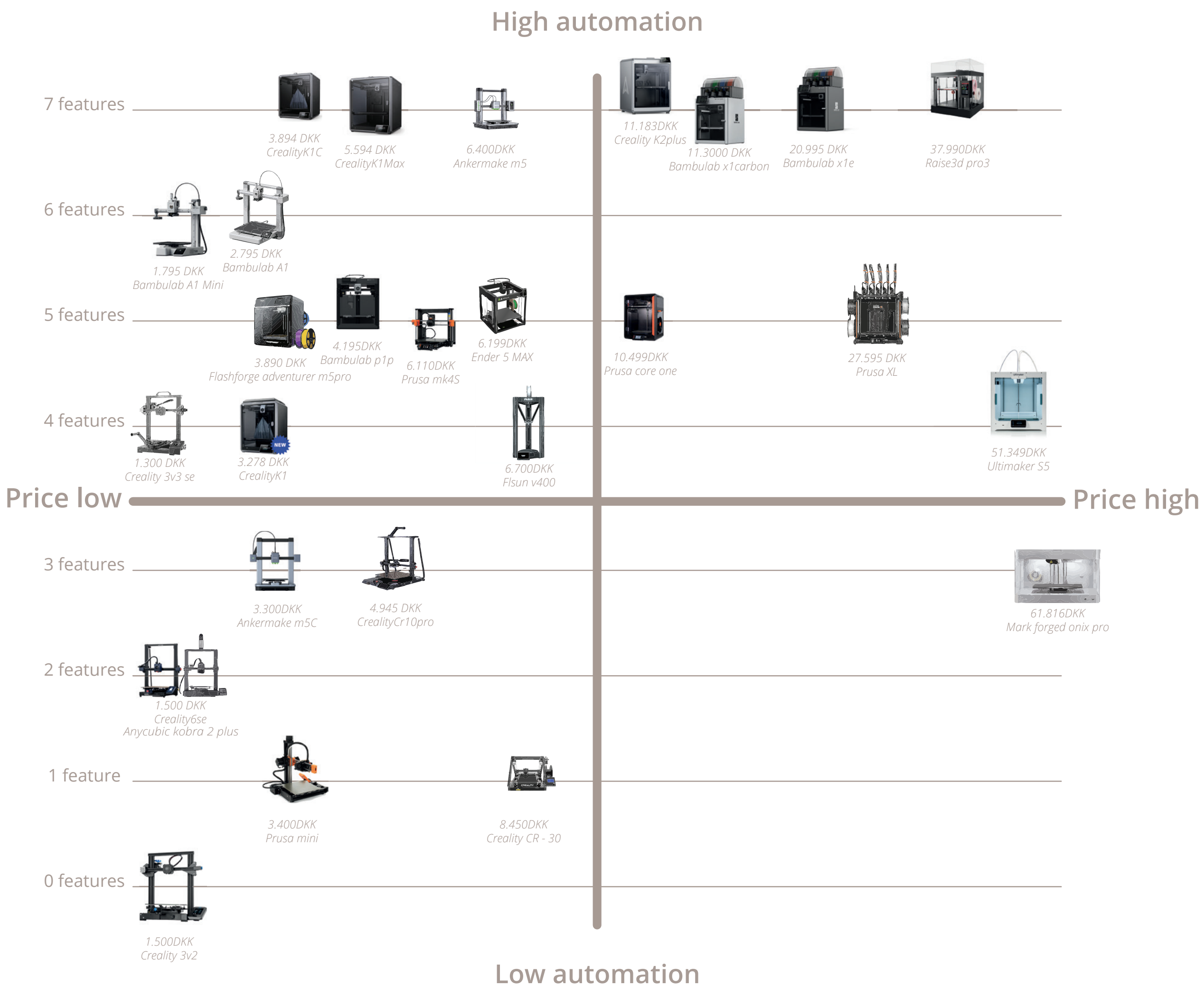
Storage Solutions: organized and controlled printing environment

2.3 Market Analysis

The Market Research section provides an in-depth analysis of the 3D-printing market, emphasizing the industry's shift from niche industrial applications to general consumer adoption. Through examining key market segments, pricing dynamics and levels of automation, this section outlines how various user groups, particularly hobbyists, practical users and professional users, engage with 3d printers. Utilizing insights derived from surveys, observational studies and comparative analysis of competing products, this research identifies current trends and user preferences, addressing challenges such as noise management, odor control and space optimization.

Segmentation of the 3D printer Market: Price vs. Automation

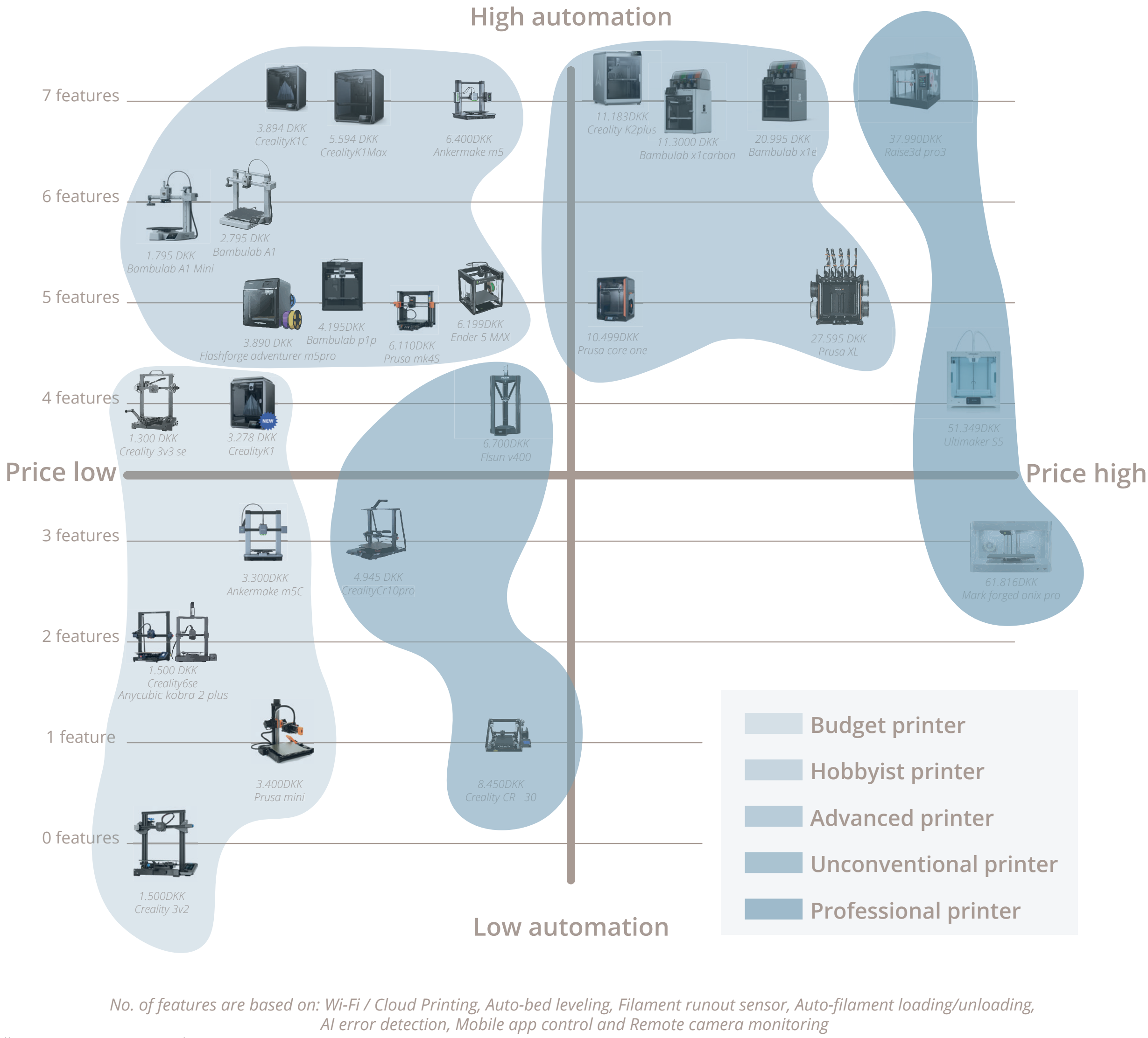
The 3D printer market is shaped by a wide range of products that vary in cost, functionality, and user experience. Among the most influential factors in this landscape are price and automation—two elements that define accessibility, ease of use, and the level of expertise required. While some 3D printers offer affordability at the expense of manual setup and fine-tuning, others prioritize automation, streamlining the printing process for greater efficiency and consistency.
This section examines how these factors influence different segments within the 3D printer market.
By looking at how price and automation are connected, we can see trends in product choices and who uses them. This helps us understand the different needs of 3D printer users, from hobbyists to professionals, and how the industry is changing.



No. of features are based on: Wi-Fi / Cloud Printing, Auto-bed leveling, Filament runout sensor, Auto-filament loading/unloading, AI error detection, Mobile app control and Remote camera monitoring

Illu 14: 3D printer market, price vs automation

As we analyse the connection between price and automation, it becomes clear that these factors do not always align in predictable ways. A higher price does not necessarily mean a higher level of automation and budget-friendly printers are not always the most beginner-friendly. Industrial 3D printers, despite their professional-grade status, often require significant manual setup and operation. Meanwhile, newer consumer models are becoming more affordable while offering more advanced features than older counterparts.
By examining these relationships, we can identify five key segments within the 3D-printing market:



Illu 15: Price vs automation clustering

Budget Printers – Low-cost entry-level models that attract hobbyists and tinkers looking for an affordable way to start 3D-printing. While they provide accessible options, they often require more manual setup and troubleshooting.
Hobbyist Printers – A step up from budget models, offering improved reliability and features while remaining within a reasonable price range. These printers appeal to enthusiasts who are willing to invest in better quality and performance.
Unconventional Printers – Specialized machines designed for unique applications, such as belt printers and large format printers. These cater to users with specific needs beyond standard printing.
Advanced Printers – Targeted at professionals who require high precision, reliability, and automation. These models enhance efficiency and streamline workflows, making them suitable for serious creators and businesses.
Professional Printers – High-end, industrial-grade machines built for durability and large-scale production. While they offer superior build quality and consistency, they do not always provide higher levels of automation compared to lower-tier models.

Understanding these market segments helps clarify the trade-offs between cost, automation, and usability, guiding users in selecting a 3D printer that best fits their needs. As technology advances, the line between these categories continues to shift, making 3D-printing more accessible and adaptable for a growing range of users.

Categorization on E-commerce platforms

Different retailers highlight how each retailer strategically aligns product placement with the preferences and expectations of their unique target audiences.

Company	Category	Target Gruop	View on 3D Printers
Conrad Electronics	Computer & Office	Tech Professionals	Office Equipment
Walmart	Industrial & Scientific	Businesses & Manufacturers	Industrial Tool
Micro Center	Maker/STEM	Makers & STEM Enthusiasts	STEM & Learning Tool
Bilka	Electronics	General Consumers	Consumer Electronics
Proshop	3D Printers	3D Printing Enthusiasts	Dedicated 3D Printing Product
Geekbuying	Computer Electronics	Tech Enthusiasts	Tech Accessory
Amazon	Industrial & Scientific	Businesses & Manufacturers	Industrial Tool
eBay	Electronics	General Consumers	Consumer Electronics
The Home Depot	Tools	DIY & Hobbyists	DIY Tool
Best Buy	Computers & Tablets	Tech Professionals	Tech Gadget
Newegg	Toys, Drones & Maker	Hobbyists & Experimenters	Creative & DIY Tool
BOL	Computer & Electronics	Tech Enthusiasts	Tech Accessory

Illu 16: E- commerce 3D printer categorisation

Best Buy and Newegg position the product within Computers & Tech, resonating with consumers who view it as an accessory to their technological devices or gadgets. Walmart and Amazon categorize it under Industrial & Scientific, broadening its appeal to business professionals, educational settings and specialized applications. Home Depot's classification as a Tool distinctly targets do-it-yourself enthusiasts and makers, emphasizing practicality and hands-on usage. Lastly, Micro Center and Proshop focus on Maker/STEM & 3D-printing categories, directly engaging hobbyists, innovators, and tech enthusiasts passionate about creative projects and emerging technologies.

Market Trend: From Bedslinger to Enclosed CoreXY 3D Printers

In the earlier phases of consumer 3D-printing, bedslinger-style printers—such as the widely popular Creality Ender series—dominated the market due to their low cost, simple mechanics and accessible learning curve. These printers, which move the print bed along one axis (typically the Y-axis), became the go-to option for hobbyists and makers entering the field (Fabbaloo, 2024a).
However, as the market matured, user demands shifted toward higher print speeds, improved accuracy and the ability to work with a broader range of materials. This demand resulted in a growing preference for CoreXY motion systems with enclosed designs. CoreXY printers move the print head via coordinated belts while keeping the print bed stationary, resulting in greater stability and speed. Enclosures further enhance performance by improving temperature regulation, reducing warping and providing safety and noise insulation, especially important in home or shared environments (Fabbaloo, 2024b).

This shift is clearly reflected in product offerings from major manufacturers:

- **Bambu Lab** has surged in popularity, achieving a 336% growth in shipments and capturing 26% of the global entry-level market. Its enclosed CoreXY printers, like the Bambu Lab X1 and P1 series, are praised for their speed, quiet operation, and out-of-the-box reliability (3D-printing Industry, 2024).
- **Creality**, previously known for its bedslinger Ender series, has pivoted with the K1 series, which features a fully enclosed CoreXY architecture tailored to meet modern user expectations (Fabbaloo, 2024b).
- **Prusa** Research has introduced the Prusa CoreXY ONE, a fully enclosed printer with active temperature control, reflecting the company's entrance into the high-performance enclosure market (Prusa3D, 2024).
- **Anycubic**, another leading manufacturer, recently launched the Kobra 2 Pro and Kobra 2 Max, both featuring CoreXY architecture with optional enclosures, aligning with user needs for quality and convenience (Laotian Times, 2025).

Market data supports this trend. In Q2 2024, global shipments of entry-level 3D printers grew by 65% year-over-year with brands like Bambu Lab, Creality, Anycubic and Elegoo accounting for 94% of all consumer-grade shipments under $2,500 (3D-printing Industry, 2024). Additionally, early in 2025 the enclosed-CoreXY printers accounted for more than 50% of Amazon's 3D printer sales, a significant increase from just 14% in early 2024 (Laotian Times, 2025).

Looking ahead, the market appears poised to continue its movement toward enclosed, high-speed CoreXY systems, driven by three key factors:

- **Performance Expectations** – Users increasingly demand faster, more precise prints with minimal manual calibration.
- **Material Compatibility** – Enclosed environments allow safe use of advanced filaments like ABS, ASA, and carbon-fiber blends.
- **Usability and Safety** – Consumers value out-of-the-box reliability, noise reduction, and environmental safety—especially in home offices and shared spaces.

In summary, while bedslingers like the Ender 3 were once the industry standard, the new norm is shifting toward enclosed-CoreXY printers that prioritize speed, safety, and seamless integration into the home environment.

Despite this shift toward CoreXY systems, bedslinger printers continue to play a vital role in the ecosystem as explored in the next section.

The Continued Role of Entry-Level Bedslinger Printers

While the 3D-printing industry is rapidly shifting toward enclosed-CoreXY systems, entry-level bedslinger printers continue to occupy a stable, albeit more niche, segment of the market. Once the standard for hobbyists and beginners, models such as the Creality Ender 3 became popular for their affordability, open design, and wide community support (Fabbaloo, 2024a). Today, their appeal endures, particularly among budget-conscious users and educational settings.

For those seeking a low-cost entry point into 3D-printing, bedslinger-style printers offer simplicity, visibility, and ease of modification. Their open mechanics make them ideal for tinkering, upgrades, and learning environments, where hands-on interaction is part of the experience. In emerging markets and lower-income regions, bedslingers remain a vital gateway to digital fabrication due to their lower cost and accessibility (3D-printing Industry, 2024).

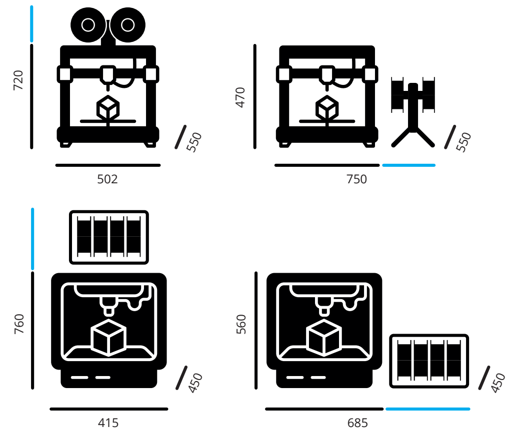
However, the mainstream consumer market has clearly shifted. With the rise of smart, enclosed-CoreXY printers from brands like Bambu Lab, Creality, Prusa, and Anycubic, users now expect higher printing speeds, reliability, and safer operation. According to recent industry reports, over 50% of 3D printers sold on Amazon by early 2025 were enclosed-CoreXY systems, reflecting evolving consumer preferences (Laotian Times, 2025).

In summary, although no longer at the forefront of innovation, bedslinger printers remain relevant. Their simplicity, modifiability, and low barrier to entry ensure their continued presence in the global 3D-printing ecosystem—even as the industry increasingly favours enclosed, high-performance CoreXY models.

To better support both printer types in real-world environments, especially when using accessories like Automatic Material Systems (AMS), the next section compares their spatial requirements and setup considerations.

Should target core xy 3d printers but can allow for bedslingers if possible

Comparing 3D Printer Sizes: Bedslinger vs. Enclosed CoreXY with AMS Placement



Illu 17: size study

This diagram presents a comparison of the space requirements for four common 3D printer configurations, contrasting bedslinger-style printers with enclosed CoreXY systems, each paired with an Automatic Material System (AMS). The dimensions shown (in millimetres) represent the minimum recommended operating space, accounting for both the printer and the AMS placement.

The measurements are based on the most popular FDM printers currently sold by Danish retailer 3D Eksperten (Appendix 4) , using their "most popular" filter. This ensures the comparison reflects realistic layouts and user preferences in Denmark's consumer 3D-printing market.
In the top row, two bedslinger configurations are shown. With the AMS mounted on top, the required footprint is 720 mm in height, 502 mm in width, and 550 mm in depth. This setup maintains a compact horizontal footprint but demands significant vertical clearance. When the AMS is mounted to the side, height is reduced to 470 mm, but width increases considerably to 750 mm, which may present challenges in narrow or multi-use environments.

The bottom row shows two enclosed-CoreXY printers. The model with a top-mounted AMS measures 760 mm in height, 415 mm in width, and 450 mm in depth, making it the tallest overall but also the most space-efficient in terms of width and depth. When the AMS is placed on the side, the dimensions shift to 560 mm in height and 685 mm in width, with the depth remaining at 450 mm. This setup offers a more balanced form factor but requires additional lateral space.

From this comparison, it's clear that top-mounted AMS configurations are the more enclosure-friendly option. Although they increase height, they allow for a significantly narrower footprint, making them ideal for shelves, compact furniture, or shared workspaces where width is limited. They also help centralize cable management and improve the visual integration of the printer and AMS unit.

To accommodate both popular bedslinger and CoreXY models with AMS mounted on top, a shared enclosure should be designed with minimum internal dimensions of 760 mm in height, and 502 mm in width, 550 mm in depth. This setup ensures compatibility with the most common user scenarios in 2024 while allowing flexibility for future upgrades or printer swaps.

2.4 Reframing the Project: From Challenges to Home Integration

Through user analysis, the focus has shifted from mitigating 3D-printing challenges, such as noise, odors, and space constraints, to integrate printers seamlessly into home environments. While professionals and practical users have specific functional needs, hobbyists have emerged as the primary target group due to their emphasis on home integration, aesthetics, and customization.

How can 3D printers be seamlessly integrated into home environments for hobbyists without disrupting daily life?

This reframing moves beyond problem-solving to proactive design solutions that enhance usability, convenience, and aesthetic appeal. Hobbyists require a lifestyle-oriented approach that prioritizes quiet operation, minimal smell emission, and effective storage solutions. Unlike professionals focused on performance or students seeking flexibility, hobbyists value seamless integration into their personal spaces.
The approach now prioritizes making 3D-printing an accessible and natural part of hobbyists' living environments through improved placement strategies, air filtration, noise reduction, and better spatial integration.

Design Direction

After thorough analysis of research findings and user insights, two potential pathways emerged for addressing home-based 3D-printing integration: creating a new, visually appealing printer or developing solutions to better integrate existing printers into home environments. The collected data distinctly supports the last option.

The hobbyist, who is the primary user group, places significant value on aesthetics, customisation, and seamless integration within their living spaces. This group demonstrates a clear preference for solutions that address key challenges such as noise reduction, odor management, and space optimization. Given the existing investment hobbyists have in FDM printers and their established workarounds, products like innovative furniture or adaptable enclosures that enhance usability and comfort align best with user needs and expectations.

Consequently, design efforts will focus on practical integration solutions rather than entirely new printer hardware, enabling hobbyists to optimize their existing setups while significantly enhancing their home printing experience.

Why Not Redesign the Printer?

Although redesigning the printer itself was considered during the early stages of development, this approach was ultimately set aside. Research indicated that hobbyists are often deeply invested in their existing 3D printers, both financially and emotionally, and frequently customize them to suit individual workflows. The primary challenge was not the visual design of the printer, but rather its lack of a natural and integrated place within the home environment. As a result, the design focus shifted toward shaping the surrounding environment instead of altering the machine itself.

Moreover, workarounds observed during interviews and observational studies were rarely cosmetic. Users consistently prioritized functional solutions, such as noise insulation, odor control, and improved accessibility, over purely aesthetic considerations. This reinforced the conclusion that the core challenge lies not in how the printer looks but in how effectively it fits and functions within a domestic setting.

2.5 Concept sketching 01

With key insights from the research phase, the focus now shifts to potential design solutions. These concepts address challenges such as space efficiency, noise reduction, air quality, and seamless home integration. Each proposal explores ways to make additive manufacturing more accessible, organized, and better suited for home environments, moving beyond problem-solving toward proactive design strategies.

Collapsible enclosure

Building on the research findings, many hobbyists face challenges with space limitations, noise, and air quality when integrating 3D printers into their homes. To address this, this concept introduces a collapsible enclosure that provides temporary containment and filtration while remaining easy to store when not in use.

Key features include:

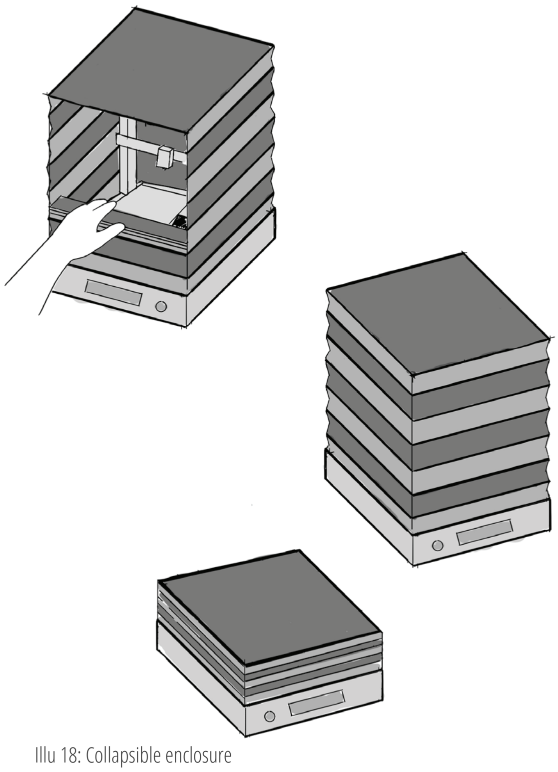
Curtain-Like Enclosure: A foldable, retractable cover that unfolds to enclose the printer, reducing noise and containing emissions.

Integrated Air Filtration: Built-in ventilation to minimize odors.

Collapsible Design: Easily folds down into a compact form for storage when not in use.

Portable & Adaptable: Can be set up in various locations, allowing users to print where convenient without a permanent setup.

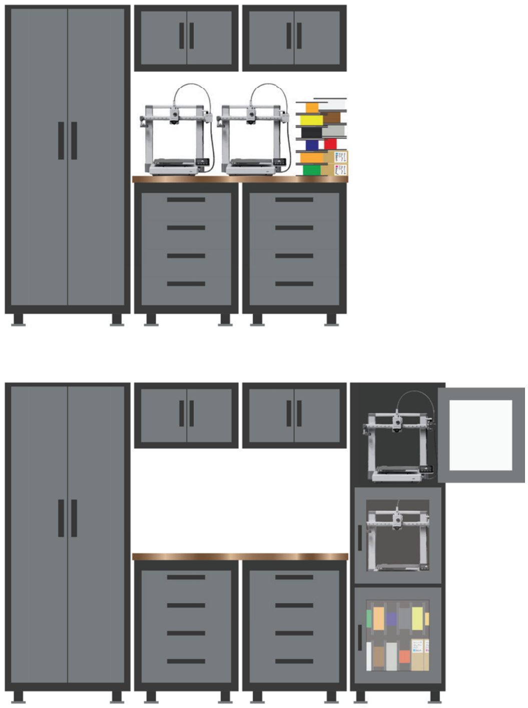
This space-saving solution offers hobbyists a way to control their printing environment without dedicating a fixed area, making 3D-printing more adaptable, convenient, and home-friendly.



Illu 18: Collapsible enclosure

Additive manufacturing furniture

Based on the research findings, hobbyists struggle to integrate 3D printers into their living spaces due to noise, odors, and lack of dedicated storage. This concept introduces additive manufacturing furniture designed to seamlessly fit into the home while enhancing usability and minimising clutter.



Illu 19: Additive manufacturing furniture

Key features include:

Noise Reduction: Enclosed design with sound-dampening materials.

Air Filtration: Built-in ventilation to minimize odors.

Home Integration: Aesthetic design that blends with interior of the workshop, garage and hobby room.

Optimized Storage: Dedicated compartments for filament and tools.

By addressing real user challenges, this furniture solution makes 3D-printing more accessible, organized, and home-friendly for hobbyists.

2.5 Design brief 02

Problem Statement

How can 3D printers be seamlessly integrated into home and work environments without disrupting daily routines, comfort, or productivity?

Target Group

3D-printing hobbyists, ranging from casual makers to highly engaged enthusiasts, who use FDM printers in domestic spaces.

Context:

- Living areas
- Home offices
- Hobby rooms
- Workshops

Mission

To improve the home-based 3D-printing experience for hobbyists by creating integration-focused solutions that minimize noise, manage air quality, and support compact, flexible storage—allowing users to print freely without disrupting their environment or daily life.

Vision

To make 3D-printing a natural, seamless part of home life by designing solutions that blend functionality with lifestyle. Through quieter operation, smarter placement, and better environmental control, we aim to support creativity and convenience without compromise.

Key Requirements

- Ventilation: Effective odor management and air filtration
- Quiet Operation: Acoustic comfort, especially in shared or night-time settings.
- Monitoring: Easy access or visibility to supervise prints
- Storage Solutions: organized and controlled printing environment
- Should target core xy 3d printers but can allow for bedslingers if possible

Key User Insights

- Odor concerns are common, especially in shared or poorly ventilated areas.
- Closet or isolated placement helps reduce disruption but hinders monitoring and accessibility.
- Users adjust routines, such as avoiding nighttime prints or lowering speeds, to manage noise.
- Wi-Fi-enabled printers streamline workflows and reduce friction during setup and printing.
- Aesthetic integration is important for users placing printers in visible living areas.

03
LEARNING FROM OTHER APPLIANCES

Household appliances are designed to make daily life easier but not all of them fit seamlessly into our homes. Some are used regularly and have a designated place, while others are moved around, stored away or feel out of place. How a product is designed, used and integrated into a space affects its practicality and appeal.

This chapter explores what we can learn from other appliances by looking at how they are designed, adopted, and improved over time. By understanding these patterns we can gain insights into making products more functional and better suited for everyday life.

3.1 Comparative Analysis

Designing household products requires an understanding of how they fit into daily life. While some find a natural place, others remain in-between places, moved, stored, or lacking a designated place. Over time, certain product categories have evolved from niche or impractical to essential solutions. This section explores how design innovation has transformed products, improving functionality and integration.

The Concept of "Homeless" Products

Many household products lack a designated place, often stored away or moved frequently. These "homeless" products result from infrequent use, multifunctionality, or impractical form factors.

To better understand this issue, various homeless products were mapped, analysing why they lack a fixed place and how users manage them. This process identified common patterns, such as products being too large to integrate, too small to justify a spot, or designed for flexibility across multiple rooms. Appendix 5 provides a detailed overview of the mapped products, their characteristics, and how they are typically used or stored.

The advantages and disadvantages of homeless products were analysed and mapped as benefits with negative impacts. On the positive side, they offer flexibility, adaptability and efficient use of space by being movable when needed. However, their lack of a fixed place can lead to clutter, inconvenience, and difficulty in storage or retrieval. Understanding these pros and cons helps in identifying design strategies that enhance their usability while minimizing drawbacks.

Homeless devices		
Benefits		**Negatives**
Portability & flexibilty	→	Clutter & disorganization
Multi room use	→	Hard to acces when needed
Space efficiency	→	Not designed for permanent spot
Easy to replace	→	Discarted before technological obsolescence
Seasonal adaptability	→	Less aesthetic integration

Illu 20: Homeless benefits and their negative side

"Homeless" products share common traits. Some, like air fryers, if used infrequently are only brought out when necessary. Others, such as heaters and ventilators, function as additions to existing systems rather than standalone essentials.

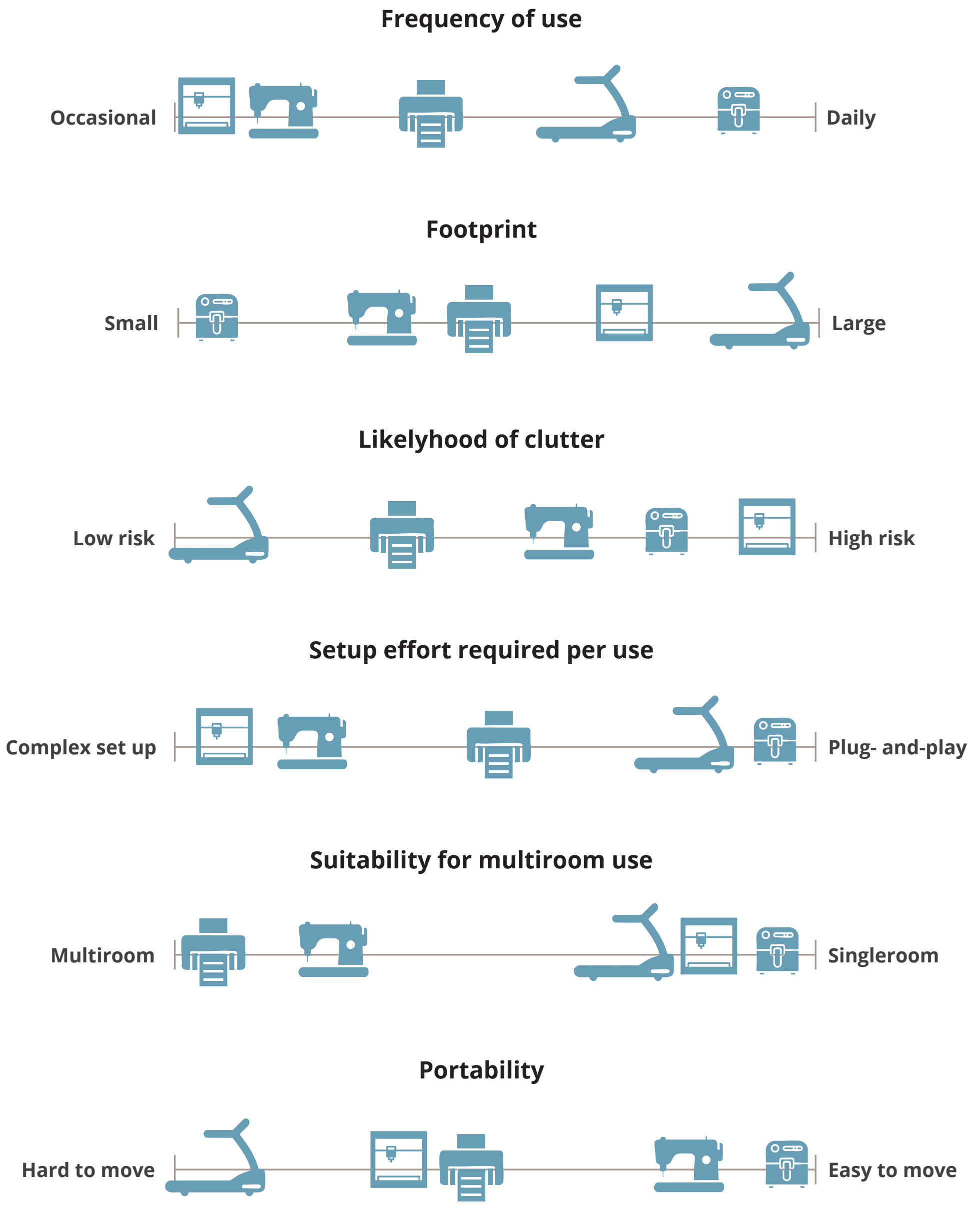
Flexibility also plays a key role, devices like Google Home speakers and Dyson vacuums are designed to work across multiple rooms. However, a lack of thoughtful design features, like handles or docking solutions, can make them feel misplaced.

Additionally, some products struggle to fit into home spaces due to their form factor, being either small and easy to place at random or big but not big enough for a designated spot.

3D printers are often "homeless appliances"-used regularly but without a clear spatial identity, contributing to clutter and disruption

Spectrum Analysis: Evaluating the Placement of "Homeless" Appliances

Understanding why certain household products become "homeless" involves analysing their characteristics and how these influence their integration within domestic spaces. To delve deeper into this issue, we conducted a spectrum analysis evaluating five representative household appliances: the treadmill, air fryer, sewing machine, 3D printer, and inkjet printer. These five representatives were assessed across six key dimensions: Frequency of Use, Footprint, Likelihood of Clutter, Setup Effort Required per use, Suitability for Multi-room Use, and Portability.



Illu 21: Homeless spectum placement analysis

The analysis revealed clear patterns affecting product placement and storage decisions. Products with frequent or daily use, like air fryers and treadmills, typically command a fixed spot despite their differing footprints. Conversely, appliances such as 3D printers and sewing machines, used occasionally and requiring moderate to complex set-ups, often contribute to clutter or remain stored away until specifically needed.
Additionally, portability and multi-room functionality emerged as critical design considerations eg. easily movable devices like air fryers can effortlessly adapt to changing domestic needs, while larger or less portable items, including treadmills and 3D printers, struggle to integrate seamlessly due to size constraints or setup complexity.
This analysis highlights the potential for targeted design improvements, particularly for appliances currently identified as "homeless." Specifically, addressing the unique challenges of the 3D printer can transform it from an occasionally cluttered appliance into one seamlessly integrated into everyday home environments.

Placement often involves trade-offs between visibility, noise, and accessibility

Defined Placement: A fixed, integrated spot that prevents the printer from becoming a cluttered or displaced object

Case Studies: How Other Product Categories Were Reinvented.

Product reinvention plays a crucial role in adapting everyday items to modern needs. Many products that were once impractical or disruptive have been redesigned to enhance usability, efficiency, and integration into daily life. This case study explores how different products have elevated their product category, identifying key strategies that have transformed them into more functional and widely accepted solutions.

Vacuums reimagined by Dyson

- "In 1978, James Dyson became frustrated with his vacuum cleaner's diminishing performance. Taking it apart, he discovered that its bag was clogging with dust, causing suction to drop. He'd recently built an industrial cyclone tower for his factory that separated paint particles from the air using centrifugal force. But could the same principle work in a vacuum cleaner? He set to work. Five years and 5,127 prototypes later, he had invented the world's first bagless vacuum cleaner (Dyson n.d.)."

Speakers reimagined by Bang & Olufson

- "The A9 is a very flexible design. Most people know it standing on the three wooden legs, but you can also hang it on the wall where it can blend in if you take a fabric with the same colour as a background to the wall or you can make it stand out by giving it another maybe contrasting colour on the front fabric and the cool thing is they can always later on change their entire appearance of the design by changing the colour of the front fabric. In this way, the appearance will change but the circle will always stay a circle and the A9 always stay an A9 (Bang & Olufson n.d.)."

Air filtration reimagined by IKEA

- "Home air filters have been popular for many years now, particularly as people learn more about how many of us are living with poor indoor air quality and the negative impact it can have. But while they have long been effective at reducing allergens and contaminants, there haven't always been effective yet stylish air cleaners available. IKEA proves that a powerful home air cleaner can have beauty and brains, with styles that fit effortlessly into almost any home aesthetic (IKEA n.d.)."

Re-invented products succeed because they directly address consumer pain points, offering smarter, more efficient solutions where traditional designs fall short. By simplifying functionality, they remove complexity and enhance usability, making everyday tasks more intuitive. These innovations don't just solve problems—they improve productivity, allowing users to focus on what matters. Additionally, they break barriers by integrating technology seamlessly into daily life, setting new standards for convenience, sustainability, and efficiency.

Inspired by successful reinventions of household appliances (e.g., Dyson, IKEA, Bang & Olufson), 3D printers could benefit from a distinct yet integrated form factor that communicates their creative function while blending into domestic environments

Users want their setup to reflect their creative practice - Product design can elevate the experience beyond pure functionality

3.2Mapping 3D Printers Against Other Appliances

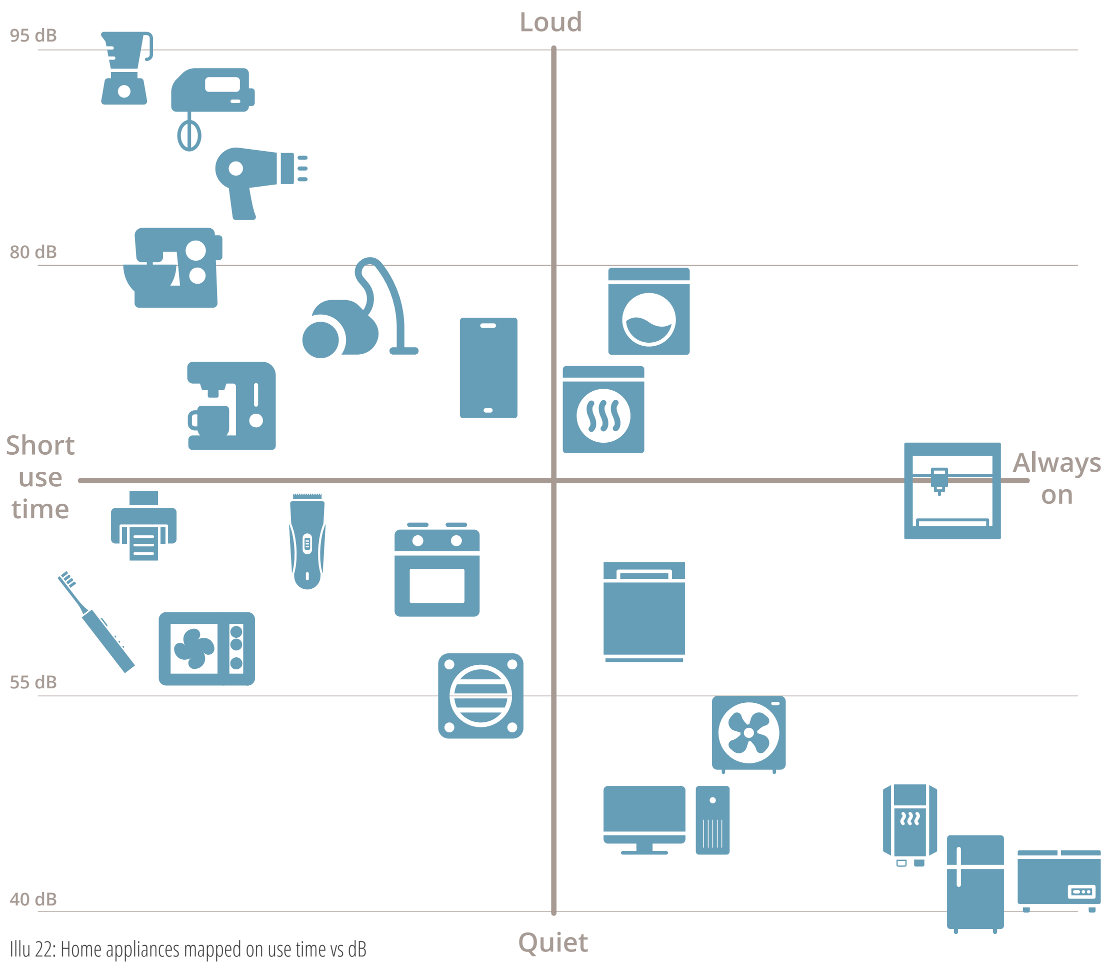
It's useful to look at appliance categories we have lived with for a long time to better understand where 3D printers fit in. By comparing them to familiar devices, we can see patterns in how products are categorized, marketed, and used. This helps us learn from existing appliances when thinking about where 3D printers belong and how they impact daily life.

Use time vs. Noise

Maintaining appropriate noise levels in our homes is essential for overall health, comfort, and quality of life. Excessive noise exposure has been linked to a range of health issues, including sleep disturbances, elevated stress levels, anxiety, and even cardiovascular problems (WHO, 2018). According to the World Health Organization, indoor noise in bedrooms should not exceed 30 dB(A) at night to ensure restful sleep. In living areas and home offices, recommended levels generally fall between 30 and 40 dB(A) to support comfortable communication, focus, and relaxation (Archtoolbox, 2023).

In a broader regulatory context, the European Union's Environmental Noise Directive (END) recommends maximum residential exposure levels of 55 dB(A) (day-evening-night average) and 50 dB(A) at night to reduce long-term health risks (EEA, 2023).

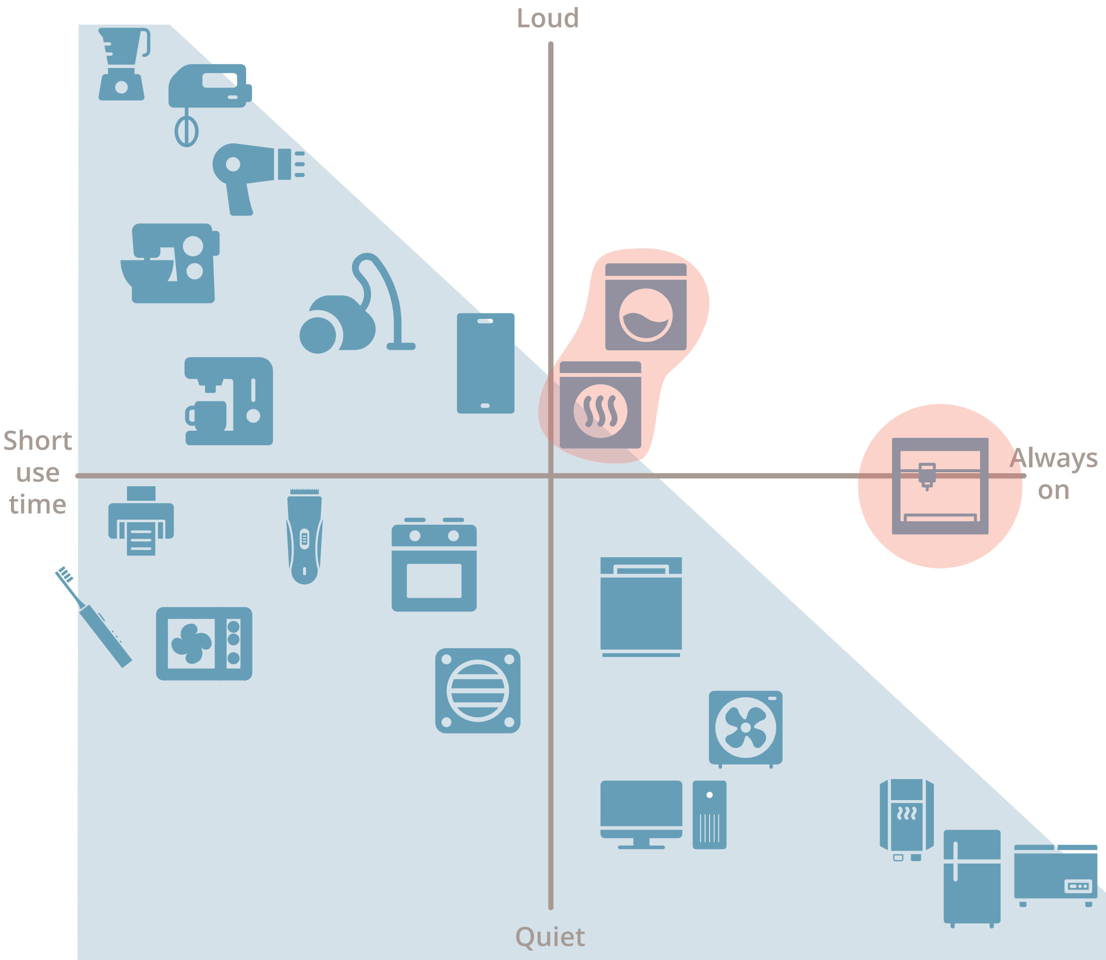
However, when compared to these guidelines, the average measured noise level of a 3D printer at 64.5 dB, measured via phone apps, significantly exceeds both WHO recommendations and EU targets. This puts 3D printers well outside the comfort threshold, especially considering their typical placement in home offices, bedrooms, and living rooms, as revealed by our survey, interviews and participants that we followed up with.



Illu 22: Home appliances mapped on use time vs dB

As shown in the illustration above, 3D printers sit in a relatively loud and long-use-time category compared to other home devices.

Further analysis shows that while other noisy appliances like washing machines and dryers also operate in the 60–70 dB range, they are usually located in isolated areas like garages, basements, or laundry rooms. In contrast, 3D printers are often placed in shared living spaces and are used for extended periods—on average, around 8 hours and 30 minutes per session. This prolonged exposure amplifies the impact of noise, making it a chronic disruption rather than a short-term inconvenience.



Illu 23: Mapped appliances compared to 3D printers

This is further illustrated in the following visual analysis, where the unique noise profile and use behavior of 3D printers stand out.

These findings highlight the pressing need for noise mitigation solutions, whether through quieter printer models, acoustic enclosures, or environmental adaptations, to better align the 3D-printing experience with established health and comfort standards.

Acoustic Comfort: Reduce operational noise to <50 dB to meet WHO guidelines for daytime and shared environments

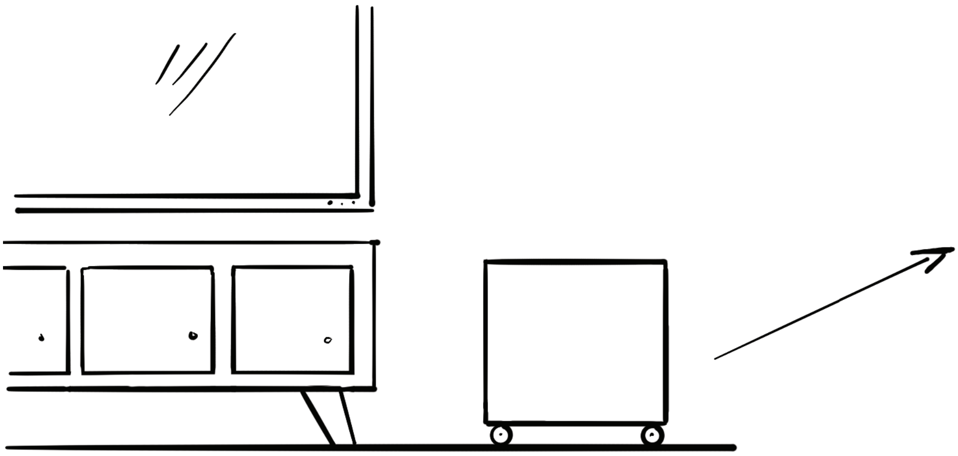
3.3 Concept sketching 02

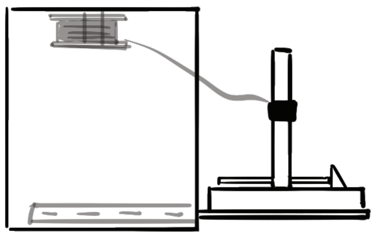
Building upon insights drawn from analysing successful household appliances, this concept sketching round explores integration strategies specifically tailored to distinct home environments. By organizing design explorations around the actual rooms where 3D printers are placed, bedroom, office, living room, and workshop, the proposed concepts directly respond to unique spatial characteristics and user behaviours inherent in each setting. These sketches focus on intuitive usability, quiet operation, aesthetic compatibility, and practical convenience, aiming to harmoniously embed 3D-printing within everyday domestic activities and lifestyles.

Living room

Living room appliances should be quiet, compact, and aesthetically unobtrusive, supporting comfort, air quality, and seamless entertainment. They must fit effortlessly into shared, often sleep-adjacent spaces.

Key devices include smart TVs, sound systems, and streaming devices with voice control and wireless connectivity. Air purifiers, humidifiers, and climate control units ensure comfort, while smart lighting and home assistants enhance ambience and automation. Mini fridges and beverage coolers round out a space designed for both relaxation and functionality.





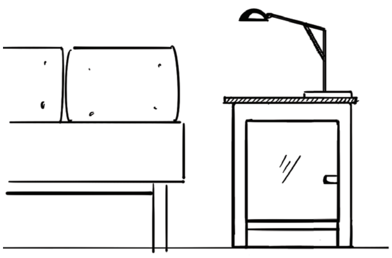
Illu 25: Vertical spool holder

Illu 24: 3D printer trolly

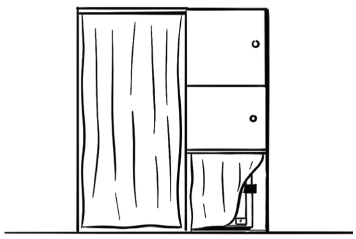
Bedroom

Bedroom-friendly appliances prioritize comfort, quiet operation, and aesthetic harmony. They should support entertainment, multi-user needs, and offer seamless media connectivity while blending naturally into the room's decor.

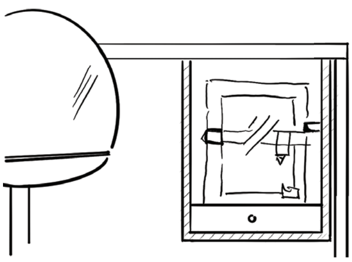
Ideal examples include air purifiers, humidifiers, and fans or heaters with silent, smart features. Smart alarm clocks, mini fridges, and adjustable lighting enhance relaxation, while aromatherapy diffusers add a calming, sensory touch, all contributing to a restful and tech-integrated bedroom environment.



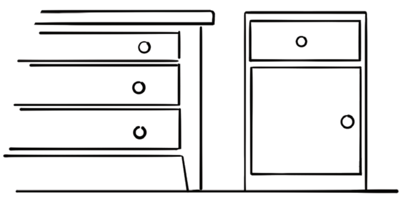
Illu 26: Side stand enclosure



Illu 27: Heavy curtain style sound dampening



Illu 28: Mountage under desktop enclosure

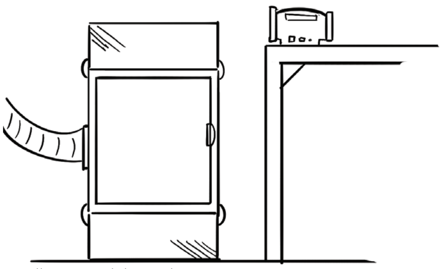


Illu 29: Furniture inspired enclosure

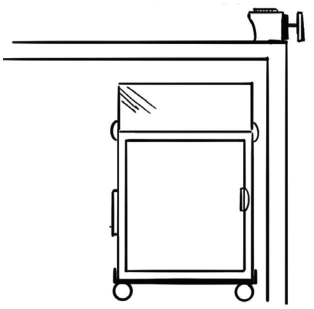
Workshop

A well-integrated workshop demands durable, high-power tools built for safety, noise and vibration control, and resistance to dust and debris. Mobility, accessibility, and temperature tolerance are also key to maintaining an efficient and safe environment.

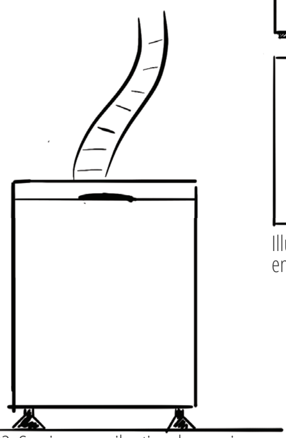
Essential tools include drills, saws, and grinders designed for precision and protection, air compressors and welding machines with reliable output and compact builds, and dust collectors with HEPA filtration to manage debris. Smart tool storage systems, impact-resistant work lights, and climate control appliances round out a space optimized for productivity, adaptability, and user well-being.



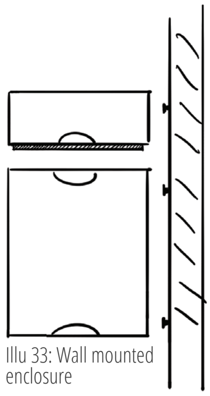
Illu 30: Modular enclosure



Illu 31: Movable enclosure



Illu 32: Succion cup vibration dampening

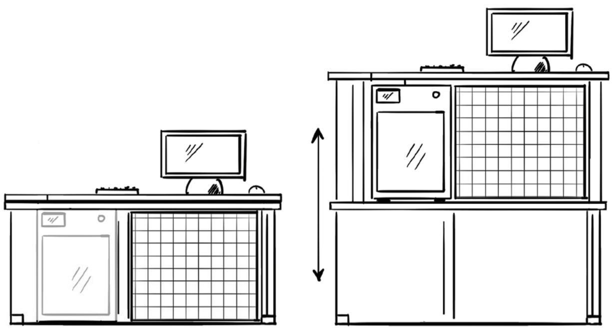


Illu 33: Wall mounted enclosure

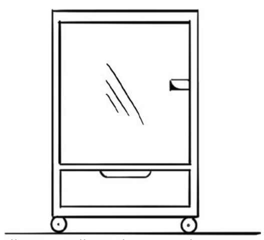
Office

Effective integration within a home office or workshop requires appliances that are ergonomic, quiet, and efficient, with smart automation, clean cable management, and support for multi-user use.
Key examples include printers and scanners with wireless and duplex capabilities, coffee machines that brew quickly and cleanly, and air purifiers that quietly improve air quality. Mini fridges, paper shredders, and smart lighting all contribute to a productive and comfortable space, while heaters, fans, and charging stations ensure year-round comfort and device readiness.

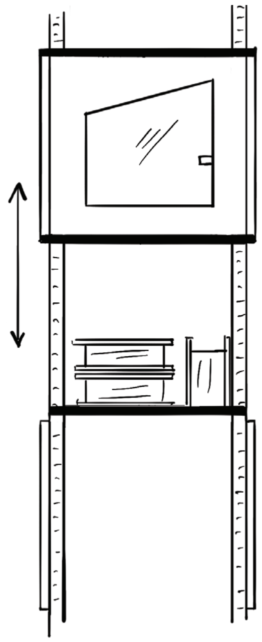
Together, these appliances reflect the balance of functionality and liveability essential for a well-integrated home workspace.



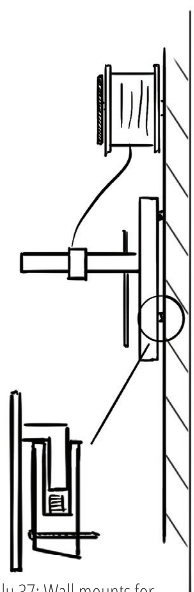
Illu 34: Rasing desk with hidden enclosure



Illu 35: Trolly enclosure with storage



Illu 36: Floor to cealing rail system with enclosure



Illu 37: Wall mounts for 3D printers

3.4 Concept Exploration and puzzle analogy

Puzzle analogy

To guide our design development, we established a set of five puzzle-based strategies that frame the relationship between the 3D printer and the home environment. In this metaphor, the home environment is viewed as a complete puzzle, and the 3D printer is a single piece that must be integrated. These strategies helped us explore various directions for achieving seamless coexistence between the functional needs of the 3D printer and the spatial, aesthetical, and user needs of the home office.

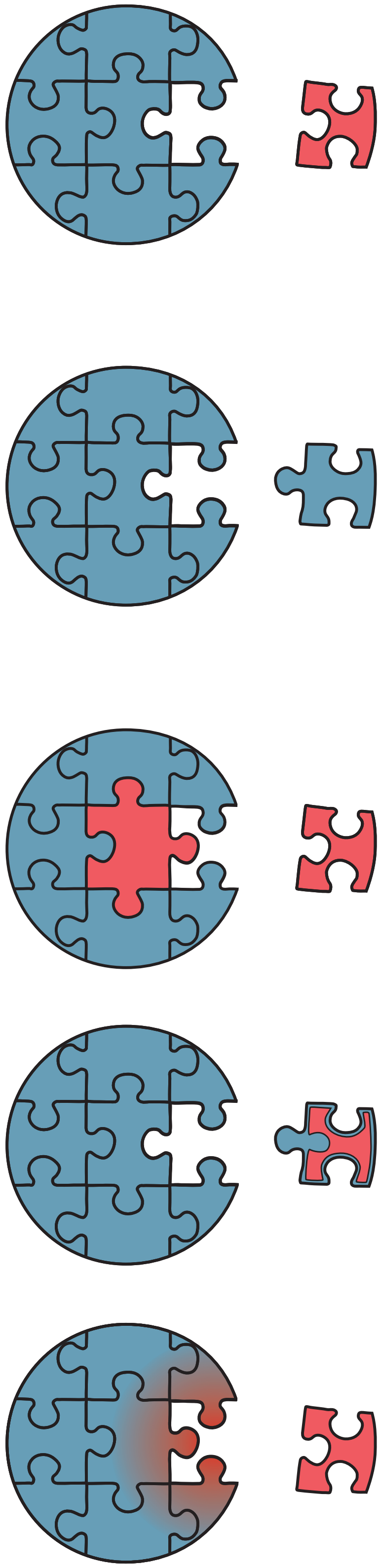
Each strategy posed a different design challenge, whether it was about changing the puzzle piece to fit the whole, reshaping the environment, or blending identities. Below is an overview of each scenario, along with our design reflections.

Adapt an Existing 3D Printer
This scenario explored the possibility of making targeted adjustments to existing printer models, such as adding modular components or custom accessories that improve domestic integration. While redesigning the printer from the ground up was initially considered, it was quickly ruled out due to technical complexity, market fragmentation, and user loyalty. User interviews revealed that many hobbyists are emotionally and financially invested in their current printers — often customizing them heavily. As a result, the design direction shifted toward augmenting these existing setups rather than replacing them. This approach supports compatibility, minimizes disruption, and respects the strong personal attachment users have to their machines.

Change the Environment to Fit the Printer
This scenario flipped the focus: instead of changing the printer, we explored reshaping or designing the surrounding environment to accommodate it. This includes creating dedicated spaces that respect and reflect the printer's industrial identity. Potential solutions include maker spaces, workshops, or custom furniture modules. This strategy acknowledges the printer as a tool with presence and weight and aims to give it a meaningful place rather than hiding it away.

Camouflage the Printer to Fit the Room
The approach was to add the identity of the environment to the printer, essentially camouflaging it to better align with the surrounding interior. This method treats the printer as a "guest" in the room, it borrows aesthetic cues, colours, and forms to minimize its visual disruption. While this can improve integration, it raises questions about accessibility and loss of identity, which became focal points in our evaluations.

Identity-Driven Integration
This final strategy became the leading approach. It centres around merging the identity of the 3D printer with that of the environment, allowing the printer to remain visible and at the same time a deliberate and celebrated part of the space. This strategy recognizes that many users view their printer as more than just a tool, it represents creativity, autonomy, and self-expression. Rather than hiding the printer, we looked for ways to honour its functional and emotional identity, while aligning it with domestic expectations around aesthetics, comfort, and liveability.



Illu 38: Puzzle pieces - Design direction

By structuring our design process around these five puzzle-based strategies, we were able to evaluate not just what could be done to integrate 3D printers into homes, but how and why certain strategies resonated more with user needs. This framework helped us move beyond isolated design fixes and toward holistic solutions that balance utility, comfort, and identity.

Concept 1: Curtain Enclosure Platform

This concept features a platform slightly larger than the 3D printer footprint. It incorporates a retractable curtain that can be lifted from the platform base and drawn upwards, fully enclosing the printer. The platform itself includes vibration-dampening materials to minimize operational noise. An Additional Member System (AMS) has been integrated into the base, capable of holding an additional 3-4 filament spools, significantly reducing the overall footprint of the combined AMS and printer setup.

Illu 39: Curtain enclosure renders

Concept 2: Transformative Raising Desk

This concept involves a multifunctional desk that transitions from a standard workspace to a dedicated 3D-printing workstation. When the desk surface is raised, it reveals a secondary workspace below designed to house a 3D printer, filament storage, and additional tools. The raising of the desk surface simultaneously lifts a concealed back wall, uncovering a pegboard equipped with tools and accessories. When the top surface is lowered, the printer remains hidden within an enclosed compartment that effectively contains noise and odors. This concept was designed to seamlessly integrate into office spaces, maintaining aesthetic harmony while providing practical functionality.

Illu 40: Transformative desk renders

Usability: Easy access for monitoring prints, material swapping, and post-processing.

Concept 3: Minimalistic Free-standing Furniture

The third concept introduces a free-standing, cylindrical furniture piece designed specifically for housing a 3D printer and filament storage. Its rounded shape provides an elegant and minimalistic aesthetic, seamlessly blending into various home or office interiors. The enclosed design efficiently blocks out operational noise and fumes, enhancing user comfort and maintaining environmental quality. Its form factor offers a discreet yet accessible solution to printer storage and operation.

Illu 41: Minimalistic floor furniture rennders

Concept 4: Workstation optimised for additive manufacturing Print pod.

The Print Pod is a free-standing cabinet designed to house a 3D printer while keeping it visible, accessible, and integrated into the home office. This concept addresses key hobbyist needs without hiding the machine away. It features a waste collection system for AMS-generated print debris, a HEPA filter to reduce VOC fumes, and an optional charcoal filter for additional odor control. Filtered warm air is redirected into the filament storage below, helping keep materials dry and print-ready. With its clean design and functional upgrades, Print Pod redefines how 3D-printing fits into the modern home offices.

Illu 42: Workstation optimised cabinet - Print Pod renders

Aesthetic Integration: A design language that complements home office or studio aesthetics, while also reflecting the creative, maker-oriented identity of 3D-printing.

3.5 Concept evaluation

Evaluating the concepts through scale models and spatial simulations reinforced what had already become apparent in earlier phases of research: successful design for 3D-printing in the home requires integration, not isolation. This was reflected in both user placement preferences (Section 1.2) and observed workarounds, where users consistently carved out space in existing environments, most notably the home office, as a practical and creative hub for printing.

Our user interviews and observational studies (Section 2.1) showed that noise, smell, and accessibility were persistent issues. These findings were further supported by follow-up surveys revealing long print durations and frequent usage (Section 2.1).

The idea of fully redesigning the 3D printer does not align with the target group, as users are deeply invested in their current machines, both practically and emotionally (Section 2.4). Rather than seeking aesthetic reinvention, users prioritize functional improvements like noise reduction, odor control, and spatial efficiency (Section 1.2, 2.1). This insight redirected the focus toward adapting existing printers and enhancing their surrounding environments, instead of replacing or radically altering the machines themselves (Section 3.4, 2.2). Camouflaging the printer conflicts with the desire to express interest in this hobby and observability. Users like Mikkel noting that they explicitly enjoy showcasing their printer or Asger appreciating the ease of access for practical reasons.

The third direction to change the environment to fit the printer, while being attractive for functionality, its practically challenging due to space and cost concerns. This fits some practical needs but fails on spatial practicality. For example, Asger's tent-like enclosure that creates a dedicated space is appealing for noise/smell mitigation, however it risks becoming a large investment in limited floorspace.

Merging the printer and environment identities is the strongest fit as it directly addresses expressed concerns about functionality (noise/smell management) and matches their desire to keep printer visible as part of their hobbyist identity. Users have clear functional frustrations, notably noise/smell (Christopher, Asger) and would value an integration solution without losing visual identity (Mikkel).

Taken together, these insights suggested that a permanent, optimized spot within the home, particularly the home office, offered the most promise. It balanced workflow needs with domestic liveability, especially when paired with solutions for sound dampening and VOC control.

The concepts that stood out,such as the Print Pod and Transformative Desk, did not attempt to hide or minimize the printer but instead gave it a defined role within the home. This thinking aligns directly with the identity-driven integration strategy explored in our puzzle analogy (Section 3.4), where the goal was to merge the printer's creative, functional, and emotional identity with the values of the surrounding space. These concepts responded to a clear user desire: not to treat the printer as a temporary nuisance, but to celebrate it as a tool of autonomy and expression (Section 2.2).

Additionally, interviews and floorplan studies (Section 2.2) revealed that users, particularly hobbyists, often modify their routines to manage noise or smells, relocate their printers for convenience, or even reduce print speeds at night. This behaviour further validated our decision to prioritize furniture and environmental adaptations over redesigning the printer itself (Section 2.4).

In conclusion, the most successful concepts reflect a reframing of the design challenge: not how to fit a machine into a home, but how to support a maker identity within domestic life. By prioritizing defined placement, functional expression, and aesthetic compatibility, these solutions respond directly to real user needs, resulting in spaces that feel coherent, empowering, and truly integrated.

Illu 43: Scaled models in size 1:10

3.6 Design brief 03

Problem Statement

How can an environment be designed for 3D printers, in the home, that establishes a clear functional identity, while minimizing disruption to daily life and maintaining aesthetic coherence with modern interiors?

Target Group

Home-based hobbyists and enthusiasts who use FDM 3D printers regularly, often in multi-functional spaces such as home offices or hobby rooms.

Context:

- Home offices

Mission

To transform the 3D printer from a disruptive or temporary device into a respected and permanent creative appliance in the home. By defining its identity through spatial integration, environmental control, and expressive design, we aim to support both technical performance and lifestyle compatibility.

Vision

To design a new category of domestic furniture for 3D-printing, one that functions like a mini workshop yet feels at home in modern interiors. This furniture will provide structure, reduce noise and odors, and visually represent the creativity of its user. In doing so, 3D-printing can evolve from a “homeless” activity into a central and celebrated part of everyday home life.

Key Requirements

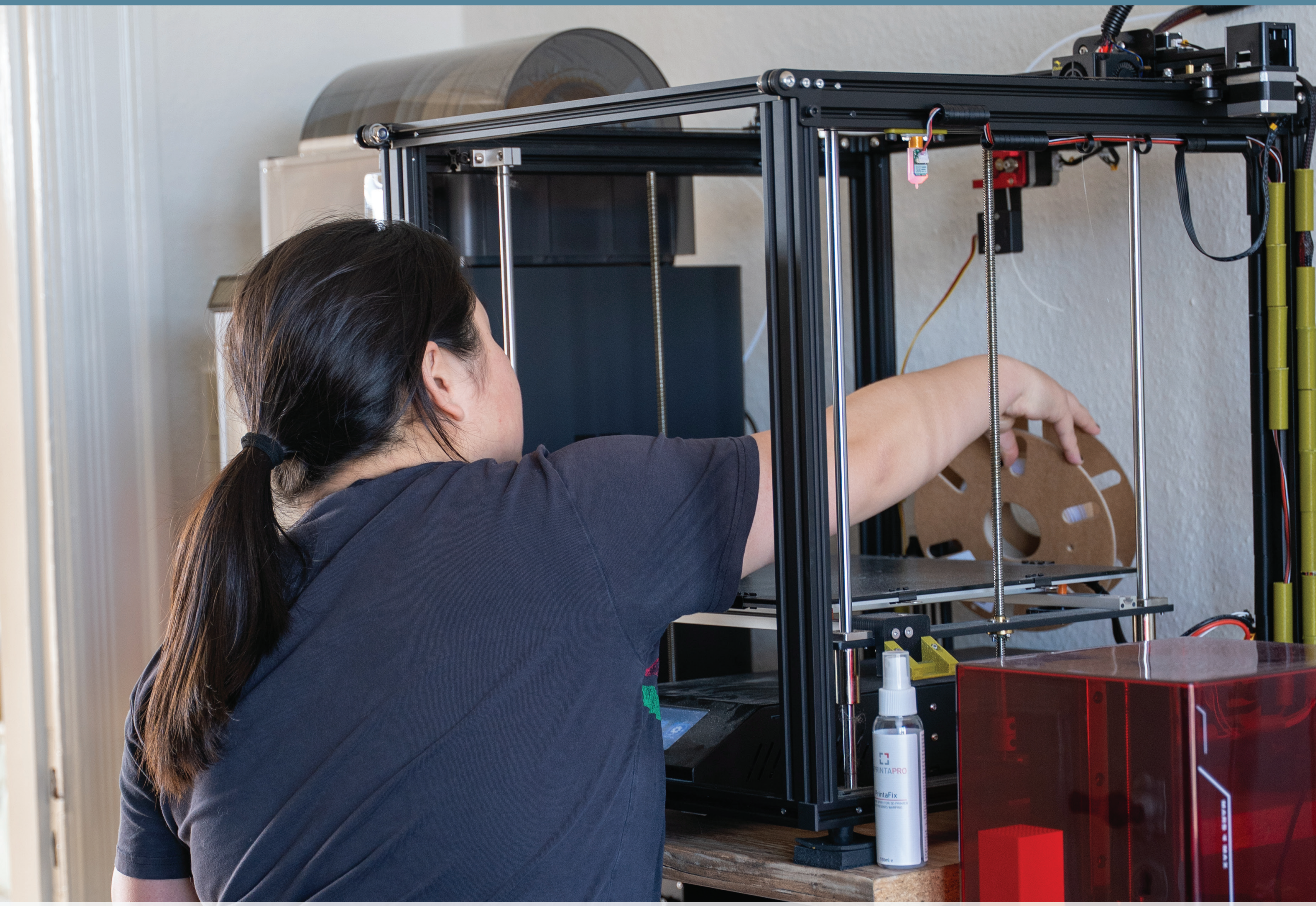
- Acoustic Comfort: Reduce operational noise to <50 dB to meet WHO guidelines for daytime and shared environments
- Defined Placement: A fixed, integrated spot that prevents the printer from becoming a cluttered or displaced object
- Aesthetic Integration: A design language that complements home office or studio aesthetics, while also reflecting the creative, maker-oriented identity of 3D-printing.
- Odor and Fume Control: Enclosed design with filtration to manage VOCs from advanced materials.
- Organized Storage: Built-in storage for filaments, tools, AMS, and accessories to promote tidiness
- Usability: Easy access for monitoring prints, material swapping, and post-processing.

Key Insights

- 3D printers are often “homeless appliances”-used regularly but without a clear spatial identity, contributing to clutter and disruption
- Inspired by successful reinventions of household appliances (e.g., Dyson, IKEA, Bang & Olufsen), 3D printers could benefit from a distinct yet integrated form factor that communicates their creative function while blending into domestic environments
- Placement often involves trade-offs between visibility, noise, and accessibility
- Users want their setup to reflect their creative practice - Product design can elevate the experience beyond pure functionality

04

COEXISTING IDENTITIES: A HOME FOR THE 3D PRINTER.



Following the research and evaluation of early concept directions, this chapter marks the transition from understanding challenges to refining opportunities. Building on the insights gathered around user behavior, environmental friction, and emotional connection to 3D printers, the design process moves into a focused development phase where integration becomes the primary objective.

Rather than proposing isolated technical fixes, the aim is to create a solution that supports both the functional demands and the expressive identity of the 3D printer within domestic spaces. It is not enough to contain the printer's noise or control its odor; the solution must also recognize the printer's role as a symbol of creativity, autonomy, and personal craftsmanship.

This chapter outlines the emergence of the Print Pod concept, an approach that frames the 3D printer within the home rather than hiding it. Through iterative sketching, material exploration, and spatial studies, the Print Pod is tested in multiple forms to balance visibility, workflow, and environmental management.

In parallel, a deeper analysis of user interaction patterns is conducted, studying the physical behaviors, tool use, and time-based routines of hobbyist users to inform the design's practical details. These investigations culminate in the development of a full-scale 1:1 functional model, allowing key interaction points to be evaluated and refined before transitioning into final technical detailing.

Ultimately, this chapter represents a critical design bridge: from broad opportunities to a single, purpose-built solution, preparing the Print Pod to move from concept into a fully realized domestic product.

4.1 From Challenge to Design Opportunity

The early stages of research uncovered a persistent set of challenges faced by hobbyist 3D printer users working in domestic environments: noise, odor, spatial constraints, and visual dissonance with existing home aesthetics. While technical solutions like soundproofing and air filtration exist, they often treat symptoms rather than addressing the deeper issue: the 3D printer's uneasy fit within the rhythms of home life.

Despite creative workarounds, remote placement, DIY enclosures, restricted print times, users expressed ongoing friction between their desire for creative autonomy and the limitations of their living spaces. In interviews and surveys, it became clear that users did not want to hide their printers, nor accept them as disruptive intrusions. Instead, they sought ways to integrate the printer into their lives, both functionally and emotionally.

This reframing revealed a deeper design opportunity. Rather than focusing only on reducing friction, the project could celebrate the 3D printer's presence, giving it a dedicated, dignified place in the home. This shift opened the path toward solutions that balance technical performance with emotional value: managing noise and smell while supporting visibility, pride of ownership, and everyday usability.

The design opportunity thus became clear:

- Create a home for the 3D printer that manages its environmental impact while elevating its identity, integrating it into domestic life without compromising creativity, functionality, or space.
- This ambition guided the exploration of new design directions, aiming to merge the worlds of technical making and home living in a seamless, empowering way.

4.2 Insights from Concept Exploration

Building on the identified opportunity to integrate the 3D printer meaningfully within the home, a series of early concept explorations were developed to test different approaches to achieving this goal.
These initial directions included flexible curtain enclosures, transformative furniture solutions, and minimalist storage units. Each concept attempted to balance the technical needs of noise and smell reduction with the emotional need for visibility, workflow support, and a proud display of the printer's creative role.
Through sketching, functional mapping, and comparative evaluation, several key insights emerged:
Visibility is critical. Users consistently expressed a desire to monitor and celebrate their prints. Fully concealing the printer compromised the emotional satisfaction and creative engagement that defined the hobby for many.
Workflow must be intuitive. Hobbyists interact with their printers frequently during print jobs, checking layers, swapping filament, adjusting settings. Designs that made access complicated or disruptive risked undermining daily use.
Environmental control must be unobtrusive. Noise and smell management are essential, but must not dominate the user experience or the aesthetic integration of the object within domestic space.
Aesthetic presence matters. The 3D printer should not feel like an out-of-place industrial device. Its enclosure must complement the textures, materials, and atmosphere of the modern home, respecting both personal and shared spaces.
Rather than suggesting a single universal solution, these findings clarified the contours of a successful design:
A product that supports active use, protects domestic comfort, and elevates the 3D printer's identity within the home environment.
These insights sharpened the design direction and prepared the ground for the emergence and refinement of the Print Pod, a solution that seeks not to hide the printer, but to frame it meaningfully within everyday life.

Illu 44: Print pod

4.3 Converging Toward the Print Pod

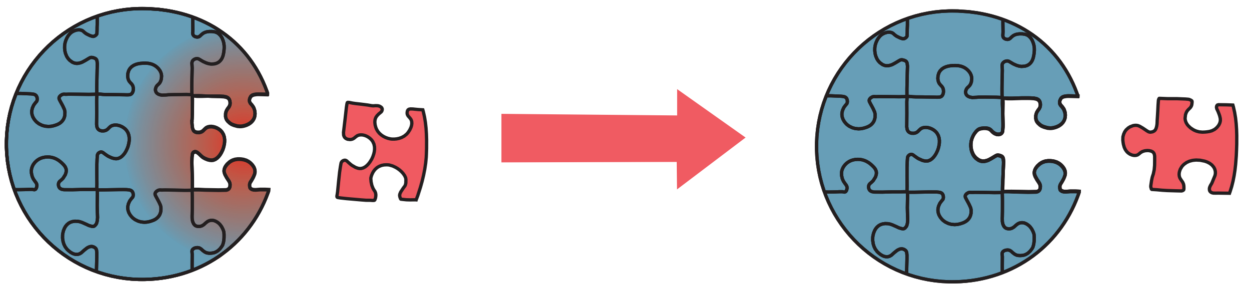
The insights gathered from early concept exploration revealed a central challenge: users didn't just want to hide or display their 3D printers, they needed a solution that acknowledged the printer's identity while offering structure, functionality, and harmony within the home environment.

Initial ideas explored how to merge the identity of the 3D printer with its surroundings, what we called identity-driven integration. However, as concepts evolved, it became clear that integration alone wasn't enough. The printer didn't need to blend in or take over an existing zone, it needed its own zone.

This realization led to a refined approach: reframing the 3D printer's place in the home as a clearly defined "contained zone integration." Rather than asking the user to adapt their environment around the printer, or asking the printer to disappear into the furniture, the Print Pod establishes a purpose-built spatial anchor, a hybrid of furniture and workspace that recognizes the unique needs of additive manufacturing.

The Print Pod becomes more than a modular cabinet. It frames the printer through a proud, visible enclosure; integrates tool and filament storage; manages waste and airflow; and sets clear spatial boundaries. By doing so, it empowers users to dedicate a space to their creative practice, without sacrificing order, aesthetics, or domestic comfort.

This convergence marks a turning point: from broad ideation around blending identities, to a focused, spatially grounded strategy, the Print Pod as a platform that gives the printer a place, not just a form.



Illu 45: Updated puzzle piece - problem fit

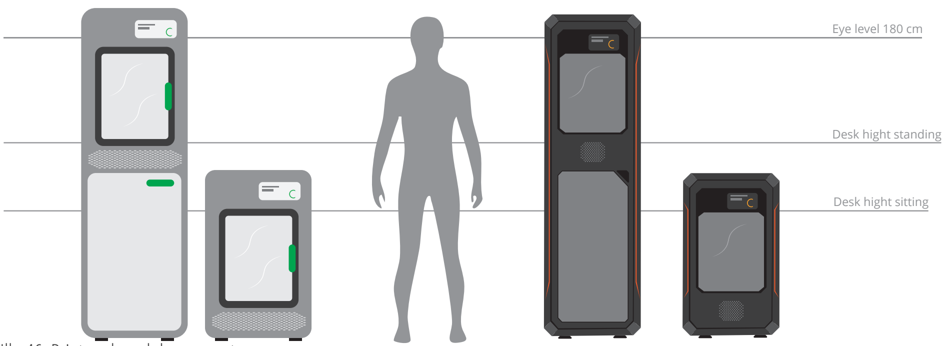
4.4 Exploring Print Pod Identity

With the Print Pod concept established as the preferred design direction, further exploration was undertaken to examine how its identity could be expressed through different material, spatial, and functional strategies. Rather than treating the Print Pod as a fixed product, this phase treated it as a flexible platform, capable of adapting to different user needs, home environments, and creative preferences.
Six distinct identity directions were developed and visualized, each prioritizing different aspects of the user experience, visual presence, and home integration.

Direction 1 – Tower Cabinet with Modular Storage

The first exploration positioned the Print Pod as a vertically-oriented tower cabinet. Drawing visual inspiration from existing 3D printer brands, two aesthetic directions were proposed:

A light, modern version inspired by Bambu Lab's design language, featuring clean gray surfaces and green accent handles.



Illu 46: Print pod modular concept

A darker, more technical version inspired by Prusa's industrial styling, with orange detailing and a robust presence.

Internally, the design emphasized modularity, allowing users to adjust shelf positions, cable management, and accessory storage to suit different setups and evolving needs. The cabinet form provided a compact footprint while maintaining easy visual access to the printer at ergonomic heights.

Direction 2 – Translucent Layered Enclosure

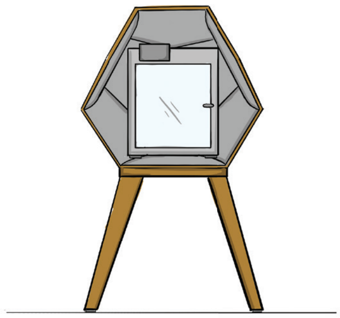
The second direction experimented with visual softening through the use of translucent polycarbonate panels. Clear thermoformed sheets allow light and color from inside the Print Pod to diffuse outward, creating a layered visual effect reminiscent of the layered nature of 3D-printing itself.

This approach maintained a strong sense of presence
while muting visual noise, helping the printer blend more subtly into domestic environments without fully hiding its dynamic character.

Illu 47: Print pod translucent concept

Direction 3 – Furniture-Inspired Sculptural Pod

The third exploration leaned toward a furniture-first expression, framing the Print Pod as a crafted object rather than a machine enclosure. Built from angled pentagonal panels (five-sided geometries), the design used textile surfaces to absorb sound while also giving the enclosure a warm, inviting presence.
The faceted geometry elevated the printer as a centerpiece within the room, transforming it into an artifact of creativity rather than an industrial device.

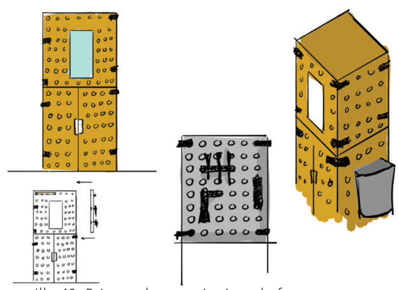


Illu 48: Print pod Sculptural enclosure concept

Direction 4 – Customization Platform for User Creativity

The fourth direction embraced the maker mindset at the core of the 3D-printing community. Rather than designing every attachment, the Print Pod itself became a modular platform, allowing users to 3D print and attach custom accessories as needed.

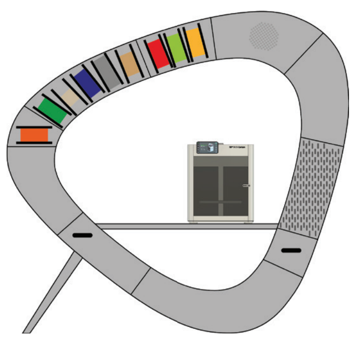
This approach extended the printer's creative ethos to the enclosure itself, allowing users to co-design their own home integration while still benefiting from core features like sound dampening, fume extraction, and baseline storage.



Illu 49: Print pod customization platform conceept

Direction 5 – Expressive Furniture Sculpture

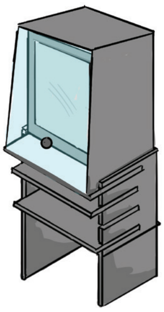
The fifth exploration exaggerated the idea of the 3D printer as a sculptural presence within the home. Taking cues from large, statement furniture pieces, this concept featured bold, looping forms with integrated filament storage along its curves.
While visually striking and playful, the design was ultimately considered too dominant for most domestic environments, and less aligned with the goal of subtle integration.



Illu 50: Print pod expressive concept

Direction 6 – DIY Construction Kit

The sixth and final direction imagined the Print Pod as an accessible DIY project. Made from simple plywood panels and basic fittings, this version allowed hobbyists to build their own enclosure, offering an affordable and customizable option.
Although less refined in appearance, this concept highlighted an important dimension of the maker culture: the willingness and desire to modify, adapt, and personalize tools and environments. While not prioritized for further development, elements from this exploration, such as flat-pack assembly and user-driven construction, remained influential in informing the overall modularity strategy.



Illu 51: Print pod DIY concept

4.5 Deeper Behavioral Analysis

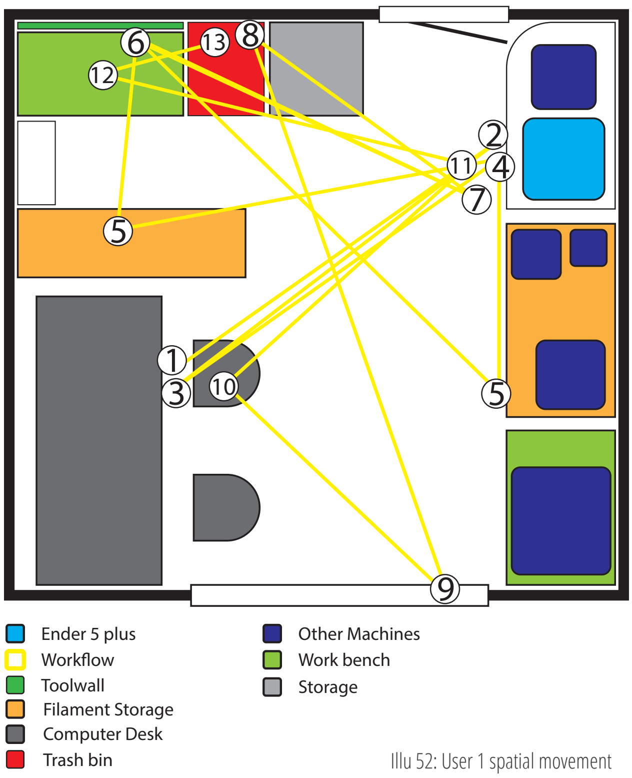
While developing the Print Pod, it was critical to move beyond functional assumptions and study the actual behaviors, environments, and workflows of hobbyist 3D printer users. This deeper behavioral investigation was structured around four key lenses: spatial movement, tool storage, tool interaction, and user engagement timelines. These together provided a grounded foundation for refining the Print Pod to match real user needs and routines.

Spatial Movement Mapping

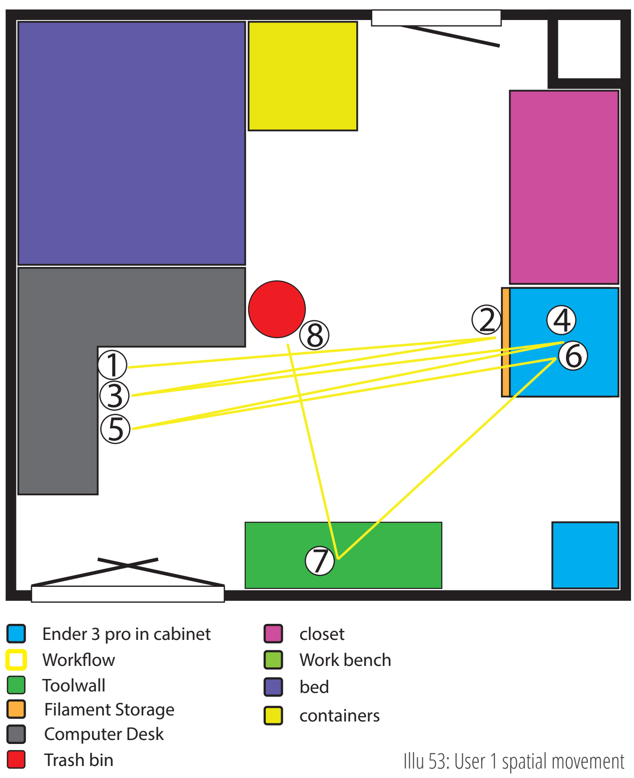
To understand broader user workflows, full print sessions were observed from two different hobbyists. For each, movements between zones were mapped across their workspace, movement forther detailed in Appendix 6

User 1 (Ender 5):
Zones included: Computer desk, two printer stations, tool wall, filament drawers, trash bins, workbench, and ventilation window.
Movement showed repeated trips between printer, tool wall, and PC.

User 2 (Ender 3 Pro):
Zones included: Computer desk, enclosed printer cabinet, tool wall, filament drawers, and workbench.Workflow was more compact but still involved crossing the room for tool use and filament handling.



Illu 52: User 1 spatial movement



Illu 53: User 1 spatial movement

These maps revealed that basic tasks such as filament loading, trimming, and print monitoring required unnecessary walking. This fragmentation suggested clear design opportunities for consolidation.

Compact Footprint optimised to the footprint of desktop 3d printers: Maintain a vertical, narrow profile suitable for home office corners or beside desks, without drastically increasing the 3d printer footprint.

Tool Storage Mapping

A detailed inventory of tools and accessories was created to understand the physical context surrounding each printer setup.

User 1:
- Three printers (FDM and resin).
- Shared maintenance tools stored in tool drawers and pegboards.
- Dedicated resin tools in separate drawers: IPA, gloves, spatulas.
- Filament in bins and drawers below printer.

User 2:
- One enclosed FDM printer.
- Tools loosely grouped near the printer and in a shared household workbench.
- Filament stored in open shelf space below printer.

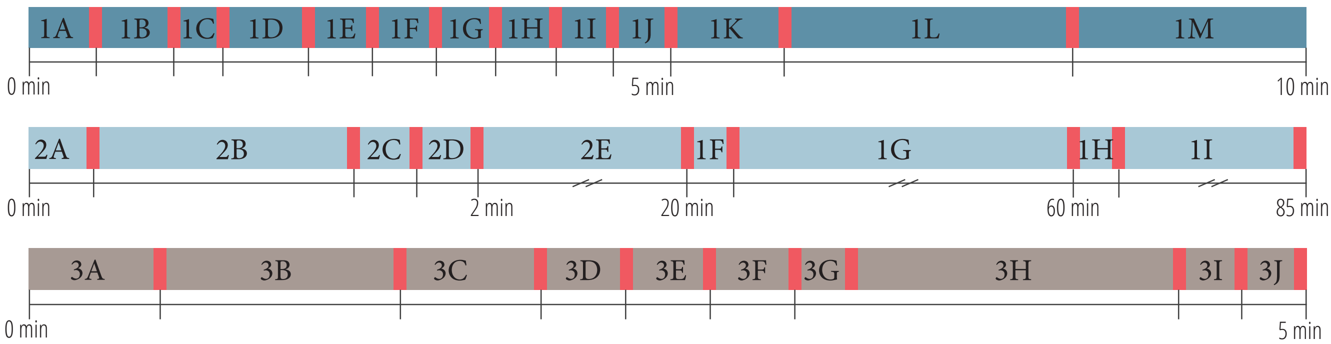

Illu 54: User 1 tool storage


Illu 55: User 2 tool storage

Micro-Interaction Timeline (User 1 & User 2)

A full breakdown of every user action was compiled into segmented micro-interaction timelines.

User 1 (Ender 5):
- 13 distinct preparation actions in 10 minutes, followed by passive printing and then 10+ post-processing steps.
- Movements between slicing, SD card transfer, printer adjustment, waste disposal, and ventilation were frequent and sequential.

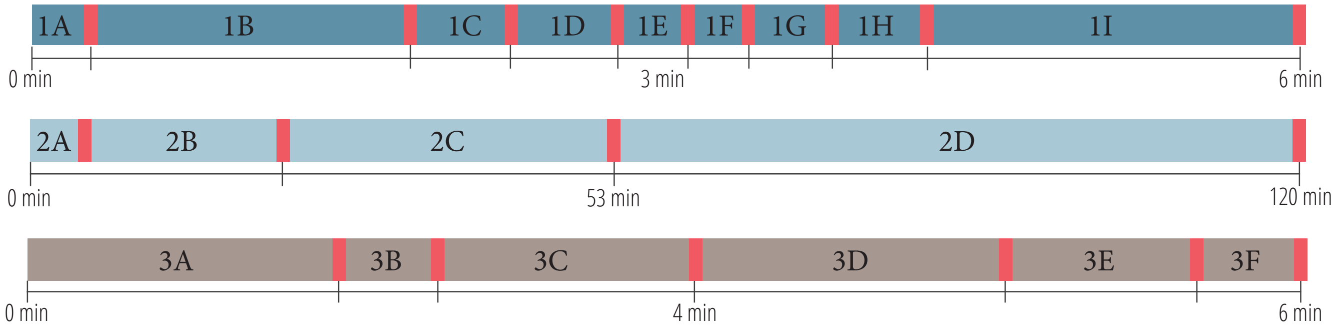


1A | 00:00 - Download STL
1B | 00:29 - Unzip and find STL (took 29 sec)
1C | 01:09 - Open in Cura (took 40 sec)
1D | 01:31 - Printer settings (took 22 sec)
1E | 02:12 - Slicing settings (took 41 sec)
1F | 03:01 - Slice + preview (took 49 sec)
1G | 03:33 - Walk to printer (get SD) (took 32 sec)
1H | 04:05 - Save file to SD (took 29 sec)
1I | 04:34 - Find filament (took 31 sec)
1J | 05:05 - find tools and trim filament (took 32 sec)
1K | 06:07 - Preheat / load filament (took 1 min 53 sec)
1L | 08:00 - Select file and wait (took 1 min 59 sec)
1M | 09:59 - Printing starts

2A | 00:00 - Peels off purge line (took 19 sec)
2B | 00:19 - Observes first lines of print (took 1 min 11 sec)
2C | 01:30 - Grabs trash and walks to bin (took 10 sec)
2D | 01:40 - Walks to window and opens it (took 11 sec)
2E | 01:51 - Walks to PC, puts on headphones (took 19 min 26 sec)
2F | 21:17 - Gets up to inspect print (took 23 sec)
2G | 21:40 - Walks back to PC (took 36 min 16 sec)
2H | 57:56 - Gets up and checks printer again (took 21 sec)
2I | 58:17 - Walks back to PC

3A | 00:00 - Gets up and walks to printer (took 5 sec)
3B | 00:05 - Peels print off bed carefully (took 32 sec)
3C | 00:37 - Inspects print for defects (took 1 min 1 sec)
3D | 01:38 - Turns off the printer (took 26 sec)
3E | 02:04 - Grabs flush cutter and tools (took 20 sec)
3F | 02:24 - Walks to workbench (took 22 sec)
3G | 02:46 - Trims supports and cleanup (took 1 min 41 sec)
3H | 04:27 - Disposes scraps in trash (took 22 sec)
3I | 04:49 - Hangs tools back on toolboard (took 17 sec)
3J | 05:06 - Final inspection of cleaned print

User 2 (Ender 3 Pro):
- Similar micro-actions were mapped across 6 minutes of preparation, 120 minutes of printing, and 7 minutes of detailed cleanup.
- The user alternated between slicing, loading filament, inspecting adhesion, and then careful post-cleaning (cutting, sanding, filing).



1A | 00:00 - Download STL (took 2 sec)
1B | 02:04 - prepare model in slicer (took 124 sec)
1C | 02:06 - choose and pick up filament (took 20 sec)
1D | 02:26 - cut filament and place in holder (took 25 sec)
1E | 02:51 - load filament in holder (took 10 sec)
1F | 03:01 - preheat 3d printer (took 5 sec)
1G | 03:26 - loadmodel on micro sd (took 20 sec)
1H | 03:51 - spray bed with 3d lack (took 25 sec)
1I | 06:00 - press start and wait for start print (took 129 sec)

2A | 00:00 - check up on print (took 15 sec)
2B | 27:00 - check up on print (took 10 sec)
2C | 53:00 - check up on print (took 10 sec)
2D | 120:00 - check up on print (took 10 sec)

3A | 00:00 - waits for print to cool down (took 180 sec)
3B | 03:00 - use spatula to remove model from build plate (took 10 sec)
3C | 03:10 - use tweezers to remove support (took 75 sec)
3D | 04:35 - use knife to cut string away (took 84 sec)
3E | 05:59 - use file to smoothen the model (took 38 sec)
3F | 06:37 - remove excess filament (took 4 sec)

Behavioural Implications for Print Pod Design

Across users, the following emerged:

Consolidation of Workflow:
Reduce physical steps by combining storage, tool access and printer interaction in one zone.

Environmental Integration:
Built-in air filtering or ventilation to eliminate the need for manual window adjustment.

Temporal Fit:
Short but frequent micro-interactions during setup and post-processing by providing immediate, intuitive access to frequently used tools, such as flush cutters, scrapers, and tweezers, while maintaining visual access during passive phases. Tool storage should be quickly accessible when needed and visually unobtrusive otherwise.

Functional Zoning:
Store essentials (tools, filament, trash) near the printer while keeping the area visually calm and uncluttered.

This behavioural foundation confirmed that the Print Pod must be more than a shell. It must become an intelligent, spatially-aware workstation aligned with the real practices of creative home users.

4.6 Functional Model Development 1:1

To validate the functional and spatial characteristics of the Print Pod concept, a 1:1 mock-up was developed and evaluated through user testing. The prototype was designed with an upper enclosure for the printer, a central tool drawer, and a lower section divided into a trash compartment (left) and filament storage (right). A removable pegboard sidewall offered the potential for tool organization or aesthetic customization.

Study Setup

Three participants familiar with 3D-printing were invited to interact with the prototype during a test session. After being introduced to the layout and purpose of each compartment, they were instructed to start a pre-loaded print file and then remove the support structures upon completion. Although the participants were experienced 3D printer users, they did not match the final target group of home office-based hobbyists. Therefore the ore the value of this test lies in observing their interactions, workflows, and ergonomic challenges, rather than their broader contextual preferences.

Key Findings

User Workflow and Interactions

Participants quickly identified the location of tools and filament, suggesting the overall layout and labelling were intuitive. However, the absence of a flat surface disrupted their workflow: users had nowhere to temporarily place tools or print remnants, forcing them to return items to the drawer immediately. This interruption negatively affected the fluidity of the post-processing phase.
A repeated frustration was the spatial conflict between compartments. Specifically, when the tool drawer was open, it blocked access to the trash compartment, making it difficult to clean up supports or failed prints while using tools, highlighting a need for more thoughtful spatial separation between functions.
The enclosure door, which provided access to the printer, had to be opened beyond 90° and lacked a "stay" mechanism. Users often had to prop it open with one arm while working, leading to discomfort and compromised access. This revealed the need for adjustable hinges or another hold-open solution.

Work Surface and Customisability

All users expressed the need for a small, accessible flat surface to support post-processing, even if temporary or collapsible. While the original design deliberately avoided flat areas to reduce clutter, this conflicted with actual workflow needs. Suggestions included fold-down trays or side-mounted surfaces.
Participants also responded positively to the idea of customisable elements, such as adjustable layouts, swappable panels, and the ability to tailor the visual appearance of the unit. While these features were occasionally described in terms of modularity, the underlying takeaway was a desire for user-driven configuration to suit different spaces, workflows and personal styles.

Aesthetic and Spatial Observations

Some personal opinions were shared regarding the appearance of the prototype, such as interest in wood finishes, dislike of powder-coated metal or integration into existing furniture systems like IKEA. While these reflect individual taste rather than the needs of the final target group, they reinforce the broader importance of visual adaptability and home integration.
Size was a general concern. Participants noted the Print Pod felt large for smaller living spaces. However, the idea of a configurable system that can adapt over time was seen as a way to balance compactness with future potential.

Functional Feature Feedback

- Tool and filament storage were seen as effective and accessible.
- The trash compartment was ergonomically placed, though the tool drawer multible times got in the way.
- The pegboard side panel was viewed positively, with users imagining it as a way to display finished prints or tools.

While personal preferences shared by the participants were not always aligned with the defined user group, their behaviours and physical interactions provided crucial guidance for the continued refinement of the Print Pod as a dedicated, ergonomic printing zone for the home office.
These insights now inform the next step: synthesizing them into a focused and actionable framework. The following section, Design Brief 04, outlines the new design direction shaped by real-world testing,clarifying requirements for form, customizability, and user-centered functionality as Print Pod enters its refinement phase.

Integrated Work Surface: Include a small surface (e.g., fold-out or slide-out tray) to support post-processing, part handling, and tool use during printing tasks.

Improved Spatial Coordination: Ensure drawers and compartments (tool, trash, filament) do not block one another. Layout should support multitasking and intuitive acces.

Aesthetic Modularity for Home Office Settings: Support customizable front/side panels using warmer, quieter materials (wood, felt, textiles) to complement office furniture.

Design the enclosure door to stay open hands-free at multiple angles ≥90°

Dedicated placement for trash needs to not be obstructed by other features like a tool drawer.

Users are more likely to invest in a system that they can grow with over time, therefore being an expandable system.

4.7 Design Brief 04

Problem Statement

Designing for 3D-printing in the home office requires establishing a clearly defined functional zone that supports the hobbyist's workflow, minimizes disruption to daily life, and remains flexible enough to accommodate personal preferences for customization and expandabilty.

Target Group

Home-based hobbyists and enthusiasts who use FDM 3D printers regularly, often in multi-functional spaces such as home offices or hobby rooms.

Context:

Home-based hobbyists and enthusiasts who use FDM 3D printers regularly.

Mission

To transform the 3D printer from a disruptive or temporary device into a respected and permanent creative appliance in the home. By defining its "workshop identity" through spatial integration, environmental control, and expressive design, we aim to support both technical performance and lifestyle compatibility.

Vision

To design a new category of domestic furniture for 3D-printing-one that functions like a mini workshop yet feels at home in modern interiors. This furniture will provide structure, reduce noise and odors, and visually represent the creativity of its user. In doing so, 3D-printing can evolve from a peripheral, "homeless" activity into a central and celebrated part of everyday home life.

Key Requirements ⚠

Acoustic Comfort: Reduce operational noise to <50 dB to meet WHO guidelines for daytime and shared environments

Odor and Fume Control: Enclosed design with filtration to manage VOCs from advanced materials.

Defined Placement: A fixed, integrated spot that prevents the printer from becoming a cluttered or displaced object

Organized Storage: Built-in storage for filaments, tools, AMS, and accessories to promote tidiness

Aesthetic Integration: A design language that complements home office or studio aesthetics, while also reflecting the creative, maker-oriented identity of 3D-printing.

Usability: Easy access for monitoring prints, material swapping, and post-processing.

Integrated Work Surface: Include a small surface (e.g., fold-out or slide-out tray) to support post-processing, part handling, and tool use during printing tasks.

Improved Spatial Coordination: Ensure drawers and compartments (tool, trash, filament) do not block one another. Layout should support multitasking and intuitive acces.

Compact Footprint optimised to the footprint of desktop 3d printers: Maintain a vertical, narrow profile suitable for home office corners or beside desks, without drastically increasing the 3d printer footprint.

Aesthetic Modularity for Home Office Settings: Support customizable front/side panels using warmer, quieter materials (wood, felt, textiles) to complement office furniture.

Key Insights

3D printers are often "homeless appliances"-used regularly but without a clear spatial identity, contributing to clutter and disruption

Placement often involves trade-offs between visibility, noise, and accessibility

Inspired by successful reinventions of household appliances (e.g., Dyson, IKEA, Bang & Olufsen), 3D printers could benefit from a distinct yet integrated form factor that communicates their creative function while blending into domestic environments

Users want their setup to reflect their creative practice-design can elevate the experience beyond pure functionality

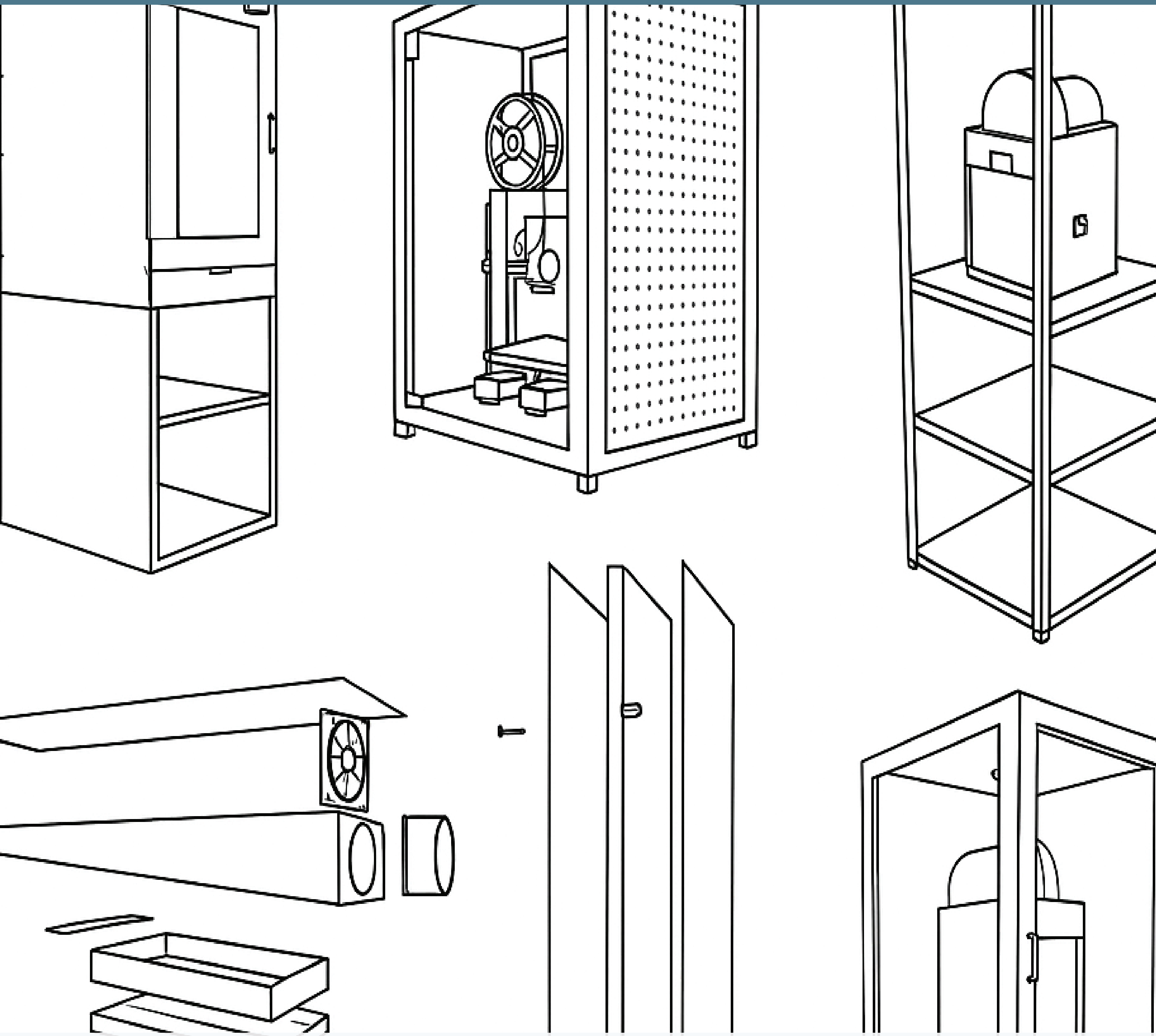
Design the enclosure door to stay open hands-free at multiple angles ≥90°

Users are more likely to invest in a system that they can grow with over time, therefore being an expandable system.

Dedicated placement for trash needs to not be obstructed by other features like a tool drawer.

05

PRINT POD – DESIGN DETAILING



With the Print Pod now clearly positioned as a dedicated 3D-printing zone for the home office, the concept has matured to a stage where detailed design becomes both relevant and necessary. The previous phases of research, prototyping, and behavioural observation helped define not just what the product should be, but how it should function, feel, and fit within everyday life.
The insights gathered have grounded the design in real-world usage and the framing established in Design Brief 04 provides a focused description through which following design decision are made.
This chapter moves from principles to precision, taking the Print Pod from a conceptual vision to a detailed, build-able, and livable product.

5.1 External Form & Aesthetic

As the Print Pod enters detailed development, one of the most critical challenges lies within its visual identity. It must strike a careful balance: it cannot resemble rugged workshop equipment, but neither should it fade completely into the background like passive office furniture. Positioned between these two extremes, the Print Pod is designed to feel creative, functional, and intentional, a product that acknowledges its technical purpose without visually overwhelming the space it occupies.

Style

The Print Pod's aesthetic strategy builds on user feedback gathered through the visual style benchmarking study, see Appendix 7. In this exercise, participants were asked to select which type of furniture best suited 3D printer placement. They were explicitly allowed to mark their choice between images if they felt the appropriate aesthetic lies inbetween two table styles. This flexibility helped capture more nuanced user preferences.

The majority of placements clustered between the middl to bottom-left regions of the matrix. These regions reflect furniture that balances functional, tool-like cues with softer visual characteristics. Participants gravitated toward styles that appeared technical but not overly industrial, highlighting a preference for visual integration into a home offices, rather than concealment or extreme expressiveness.

Illu 56: Style benchmarking

Illu 57: Style benchmarking - Office style fit

As one participant mentioned: "Looks practical, stable, and not too loud visually". Another respondant said: "This desk feels neutral enough to hide the printer, but also functional." There was clear appreciation for practicality with restraint. Several responses suggested that identity should be present, but controlled: "I liked that it didn't scream workshop but still felt tool-ready," and "It doesn't feel temporary, this is where I'd leave the printer."
This positioning was further validated by the follow-up question: "Would you place this in your home office?" Participants who chose furniture in the center or middle-lower parts of the matrix were more likely to respond affirmatively. These responses underscore that technical clarity alone is not enough, visual calm and spatial compatibility are equally critical.

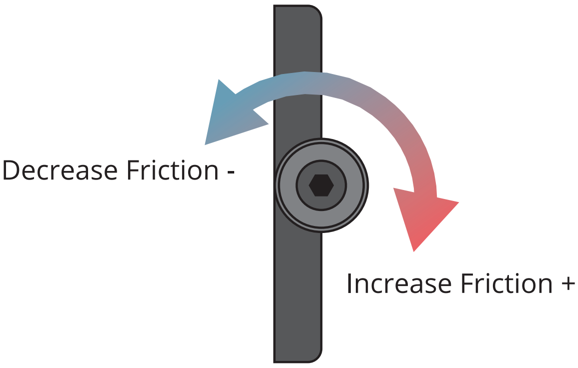
To meet these expectations, the Print Pod combines exposed technical elements, like metal framing, with carefully chosen materials that soften the raw industrial aesthetic. Contrasting finishes such as matte powder coatings, wood accents, and soft, customizable surfaces help shift the tone toward something more domestic and creatively suited for a home setting. Importantly, this study emphasizes that it is the choice and combination of materials, not their colors, that defines the aesthetic direction. Whether presented in a lighter or darker palette, the material selection communicates a deliberate balance between functionality and domestic fit.


Illu 58: Material style boards

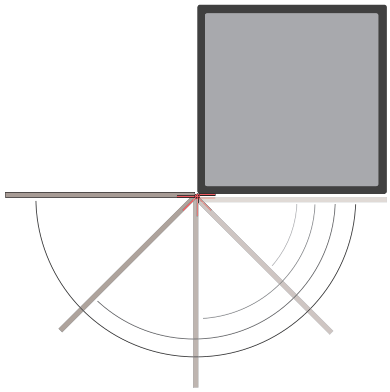
Accessibility

Providing intuitive, ergonomic access to the printer enclosure is essential for supporting smooth day-to-day interaction. During user testing (see Section 4.6), a key frustration was the enclosure door failing to remain open on its own. Participants frequently resorted to holding it open manually, which disrupted their workflow and led to physical strain, particularly when performing multi-step actions like loading filaments or removing supports.
In response, the design prioritizes a hands-free solution that enables the door to remain open securely at various angles beyond 90°. The goal is to support a wide range of user behaviors, spatial configurations, and printer maintenance tasks. The door must open fully without interfering with the drawer or the user's body movement, especially in compact office setups.
After evaluating a range of options (Appendix 8), including stay arms, multi-stage hinges, and soft-open mechanisms, the concept settled on using friction-based hinges. These provide a very minimal solution that allows the door to stay open at any angle between 0° and 180°, without relying on mechanical stops or gas springs.

Illu 59: Friction hinge



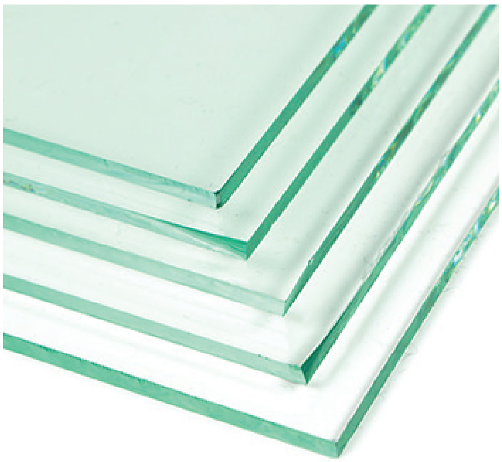
Illu 60: Friction hinge adjustability



Illu 61: Door motion

Viewing Window

The viewing window serves as the Print Pod's visual centerpiece, clearly framing the printer within a home office environment. While laminated glass was initially considered for its superior acoustic insulation, due to an interlayer that absorbs sound vibrations (Pilkington, 2020), the final design opted for 4mm tempered glass to reduce production costs and overall weight.
Though tempered glass does not offer the same level of sound dampening as laminated glass, it provides reasonable acoustic performance thanks due to its increased density and rigidity from the tempering process (Apex Tempered Glass, n.d.). It can also contribute effectively to sound reduction when combined with other noise-dampening elements in a layered enclosure system (Burton Acoustix, n.d.)
The window is sized to ensure clear visibility of key printer components, such as the full Z-axis movement, the AMS filament unit, and the control screen, allowing users to monitor prints without opening the enclosure. This decision reflects a balance between transparency, functionality, and the overall goals of cost-efficiency and manageable product weight.



Illu 62: Viewing window

Illu 63: Hardened glass panel

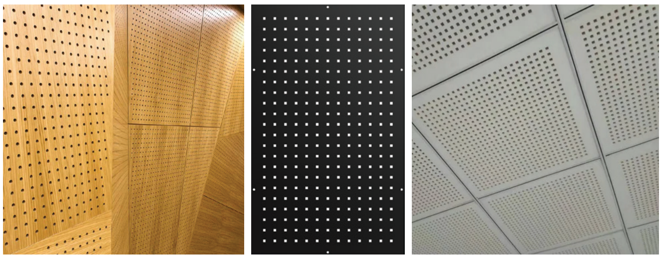
Visual expression

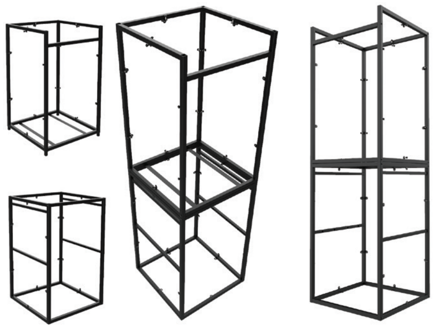
Sound
The enclosure communicates its sound-dampening function through the use of perforated side panels that reference acoustic plaster panels commonly found in architectural sound treatments. These precisely arranged square or round holes not only suggest acoustic performance through their visual language but also serve a dual purpose as a functional pegboard for tool storage. In the interior, acoustic felt lines the panels, providing a soft, calm visual impression while reinforcing the enclosure's role in quieting the 3D-printing.

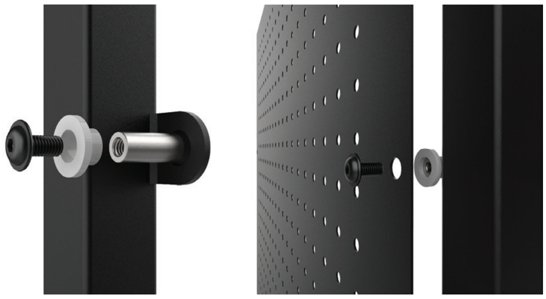
Stability
The Print Pod communicates stability and sturdiness through its exposed structural frame. Made from 25mm powder-coated metal profiles, the frame remains visually present on all sides, only interrupted by the hinged front door. This deliberate exposure of the enclosure's skeleton is a visual strategy to convey durability and engineering confidence. By revealing the structure rather than concealing it, the design emphasizes that the product is solid, reliable, and built to last.

Personalization
Personalization is a key feature of the Print Pod's design. The side panels can be swapped to suit individual preferences, accommodating a range of materials such as: wood, plastic or metal panels with different finishes that align with the user's environment or style. The powder-coated metal frame is engineered for adaptability, incorporating threaded inserts both behind the pegboard panels and internally via welded coupling nuts. This allows users to easily mount custom fixtures or accessories, making the interior of the enclosure just as customizable as its outer appearance.

"This furniture is for 3D-printing"
The overall visual expression of the Print Pod is designed to resonate with 3D-printing enthusiasts. From the exposed frame to the viewing window and modular storage, every detail signals: this is a purpose-built cabinet for 3D-printing. It communicates function, customization, and creative potential at a glance. The inclusion of visable filament in the storage module celebrates the colorful, material-driven nature of the hobby, making it clear that this enclosure isn't just for hiding a 3D printer, but for proudly owning and using one.


Illu 64: Print pods square panel


Illu 65: Print pods structual frame


Illu 66: Cupling nuts and nylon washer

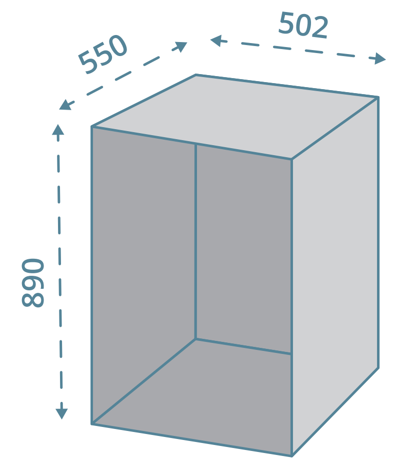

Illu 67: Storage module

5.2 Dimensions & Compatibility

To ensure functional and ergonomic integration within the home office environment, the Print Pod's dimensions have been carefully calibrated to balance interior printer compatibility with exterior spatial constraints. This section outlines the internal clearance required for modern multi-material 3D printers, the outer limits dictated by domestic furniture systems, and the embedded infrastructure necessary to support clean cable routing and power distribution.

Internal clearance

Internal clearance and compatibility
The internal dimensions of the Print Pod were initially defined using footprint data from popular 3D printer and AMS combinations, as outlined in Section 2.3. However, further testing revealed that the height requirement for CoreXY printers with a top-mounted AMS had been neglected. Specifically, the original figures did not account for the clearance needed to fully open the AMS lid, a critical aspect of everyday operation for systems such as the Bambu Lab X1.
To address this, the minimum internal height of the Print Pod has been increased from 760 mm to 890 mm, ensuring full functional access to both the printer and AMS without obstruction. The width and depth remain unchanged at 502 mm and 550 mm, respectively, allowing continued compatibility with both bedslinger and CoreXY models. This adjustment reflects a more accurate representation of the spatial demands of modern multi-material 3D printers and reinforces the Print Pod's ability to support real-world usage.



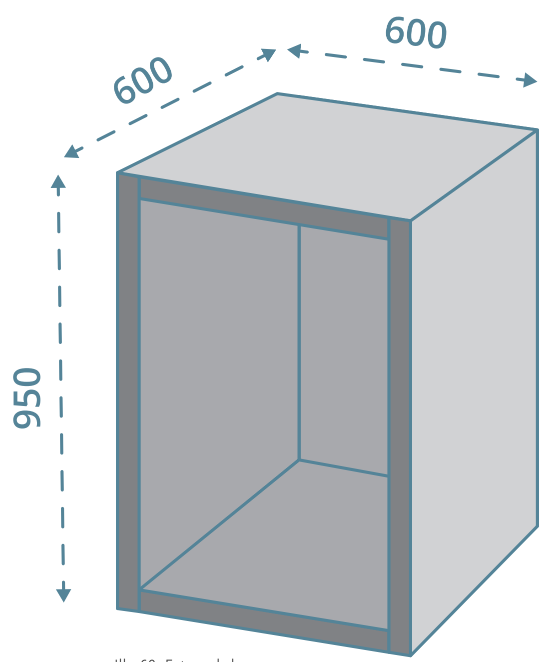
Illu 68: Internal clearance

Outer dimensions

The outer dimensions of the Print Pod have been carefully defined to fit within the spatial and ergonomic constraints typical of home environments, particularly those shaped by modular furniture systems such as IKEA's. This approach was reinforced during the 1:1 interaction study (see Section 4.6), where one participant specifically noted a desire for the unit to fit within a standard IKEA cabinet. This echoed a broader trend identified earlier in the research, where hobbyist users often adapted or built DIY enclosures to align with existing modular storage dimensions.
In response to these insights, the Print Pod's maximum outer dimensions have been set as:

- Width: ≤ 600 mm
- Depth: ≤ 600 mm
- Height: ≤ 1900 mm

The 1900mm height accommodates both key configurations: two enclosures stacked vertically, or a single enclosure with storage module. This height ensures ergonomic access to the print area and any components placed on top, such as AMS units or filament spools, without requiring additional aid like a step stool. The result is a flexible yet space-conscious system that integrates cohesively into home environments that users are already working in.



Illu 69: External clearance

Electrical integration

To support the operational needs of the 3d printer and essential enclosure functions, the Print Pod includes an internal electrical infrastructure. The enclosure requires power not only for the printer itself but also for internal components such as the LED lighting, control screen, and an air-extraction fan.
To provide flexibility and avoid limiting the user to a single-machine setup, the enclosure features two internal power outlets. This allows users to run mutiple smaller 3D printers, such as two Prusa Minis or Bambu Lab A1 Minis, within a single enclosure. This dual-outlet setup ensures compatibility with evolving user needs, including future upgrades or expanded workflows, while keeping cable routing organized and discreet.

Illu 70: Internal circut

5.3 Structural Components

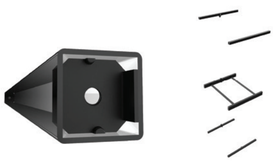
The structural design of the Print Pod prioritizes stability, modularity, and integration. Welded steel frames, a suspended base platform, and adaptable panel mounts form a rigid system that supports both function and acoustic control. This section outlines the key construction methods and material choices that give the enclosure its strength and flexibility.

Structural Frame and Assembly Logic

Welded Side Frames for Rigidity
Each side frame of the Print Pod is constructed from 25mm powder-coated steel profiles and fully welded into a single rigid unit. This approach ensures high structural integrity and minimizes flex, which is essential for supporting both the internal 3D printer and any additional modular components mounted to the frame.

Illu 71: Frame component

Cross-Frame Connections
The two welded side frames are connected using horizontal steel square profiles. Each profile features a welded-in threaded insert at both ends, allowing bolts to pass through pre-drilled holes in the side frames. This system provides strong, aligned connections while keeping the frame partially demountable for flat-pack shipping.

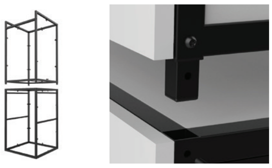


Illu 72: Threaded inserts and cross bars

Panel Mounting System
Panels are mounted using a welded steel lip that runs along the inside edges of the frame. Each lip includes a welded-on M5 coupling nut with a 20mm thread depth. This design allows panels to be fastened from the exterior while also enabling internal attachments.

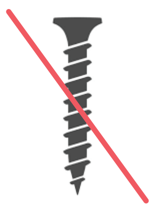
Illu 73: Side panel mounting

Modularity and Expandability
The frame is designed for modular stacking. Vertical tube ends of the enclosure, that normally function as feet, doubling as connection pieces allowing users to stack additional modules such as another enclosure or a lower storage module. When not in use, these ends can be neatly closed off with plastic caps, maintaining a clean appearance.



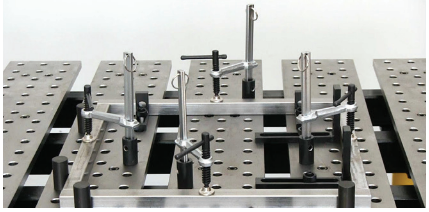
Illu 74: Structual Modularety and connectivity

Why Not Just Screws?
Alternative approaches using screw-only assembly were considered early in development. However, these were ultimately rejected due to the risk of structural flex and reduced overall rigidity. Welded frames offered significantly improved torsional strength and also simplified the user assembly process. Additionally, the decision was driven by the need for the front of the enclosure to be as flush as possible in order to optimize the seal of the door. On top of that, it was not possible to position two beams at the same level, as the screws would intersect.



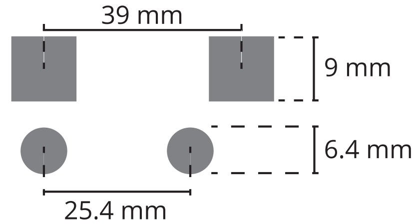
Illu 75: Sympol of no screws

Manufacturing Considerations
Precision jigs are required during production to ensure consistent welding and tight tolerances. Jigs will be used for fabricating the side frames, accurate positioning the panel lips. This approach ensures that Print Pod can be assembled accurately while maintaining a high-quality fit and finish.

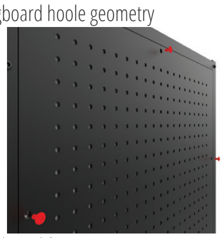


Panel Design and Attachment System

Design Inspiration and Geometry
The Print Pod's perforated side panels take visual cues from acoustic plaster systems but are functionally inspired by industrial tool walls. They feature a 9×9 mm square hole pattern, spaced 39 mm center-to-center, ideal for secure, multidirectional mounting. This layout appeals to makers, enabling easy attachment of tools, trays, or accessories.
An optional pegboard with 6.35 mm round holes (25.4 mm spacing) offers a more domestic look while preserving full mounting flexibility.

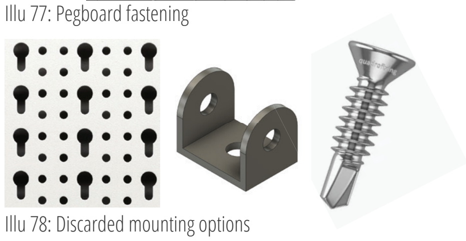


Illu 76: Pegboard hoole geometry


Illu 77: Pegboard fastening

Attachment Method
Panels are mounted directly to the frame using M5 screws, which thread into 22 mm coupling nuts that are welded to the internal lips of the structural frame. This provides a secure, removable and durable connection method that aligns with the Print Pod's modular intent, allowing users to easily remove or replace panels as needed for upgrades or customization.

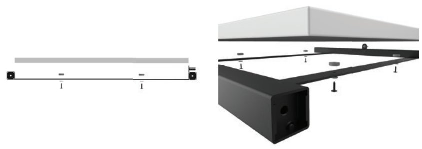
Exploration of Alternatives
Several alternative mounting strategies were explored during development, including rivets, self-tapping screws, set screws, and a keyhole-style cutouts, to allow for tool-free hanging. A C-bracket solution was also considered for simplified panel alignment and attachment. However, with the decision to weld the side frames, the C-bracket approach became unfeasible, as it required clearance that is not present in the final welded design.


Illu 78: Discarded mounting options

Manufacturing Considerations
Panel fabrication will depend on production scale. For smaller batches or prototyping, laser cutting is the preferred method due to its flexibility and low tooling costs. If demand scales, progression stamping will be considered as a more cost-efficient and rapid process. However, this would require a significant upfront investment in tooling, justifiable only if sales volumes reach a threshold that offsets the cost of the stamping die.

Vibration-Absorbing Base Plate

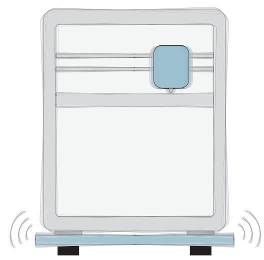
Purpose and Design Intent
To minimize the transmission of vibrations from the printer into the enclosure, the Print Pod incorporates a specially designed vibration-absorbing base plate. Rather than rigidly fixing the printer to the structure, the base isolates it using layered materials that reduce resonance and improve acoustic performance, supporting quieter and more stable printing.


Illu 79: Base plate construction

Structural Configuration
The base structure consists of two horizontal 25mm steel profiles that mounted between the enclosure's welded side frames. These profiles form the foundational connection and are aligned with the rest of the structural frame. Between these profiels, two 3mm-thick flat iron bars are welded in place, running across the depth of the enclosure. These flat irons form the mounting rails for the platform above and include mounting holes.


Illu 80: Base plate stryctual components

Mounting Platform and Damping Layer
A wooden platform rests on top of the the flat iron and is attached using screws that pass through the flat iron and into the wood. Sandwiched between the wood and the steel is a soft rubber washer, these act as vibration dampeners. This material absorbs small movements and operational noise from the printer before they can propagate into the rest of the enclosure. While the platform introduces a slight degree of flex, it effectively isolates vibrations, using the design logic seen in older 3D printers with spring-mounted beds.


Illu 81: Vibratition dampening washer function

Manufacturing Process
The entire base assembly is welded using a dedicated jig at a welding table. The jig ensures precise placement of both the 25mm profiles and the flat iron, guaranteeing parallel alignment and accurate mounting-hole positioning. This repeatable process supports consistent performance and ease of integration during enclosure assembly.

5.4 Modularity and Customization

The Print Pod is designed as a flexible system that can evolve with user needs. Its modular structure allows for expansion, such as stacking enclosures or adding storage, while customizable elements like side panels, mounts, and printable accessories, that enable personal adaptation. This section outlines the key components that support both functional modularity and user-driven customization.

Illu 82: Print pods 2 modules

Modularity

Enclosure (Core Unit)
The enclosure itself is the core component of the Print Pod system. Designed as the starting point for any setup, it houses the printer, includes built-in air filtration, and provides all the essential structural and functional features, such as the viewing window, vibration-isolated base and internal lighting.
Users can expand from this central unit in two directions. A storage module can be added below to organize tools, filament, or accessories, while a second enclosure can be stacked on top, if the user wishes to run dual printers within the same vertical footprint. The frame's feet are designed to fit into the vertical profiles of both the storage module and top part of the enclosure. for secure stacking, and these points can be closed with plastic caps when not in use.
The internal cupling nuts also allow for future hardware integration or upgrades, letting users evolve their setup over time without having to modify the core structure of the enclosure.

Illu 83: Enclosure module

Illu 84: Connection method

Storage module
Below the primary enclosure, users can add a modular storage unit that follows the same footprint. The unit connects to the enclosure using connection pieces, designed to align the modules securely and support vertical expansion.
The storage module comes standard with filament display rails, allowing users to showcase the colorful material palette that defines 3D-printing.
To accommodate different user preferences, official add-ons, such as a cabinet door and side panels. These options provide flexibility for users who may not want their filament always on display.

Illu 85: Storaage module

Side panels
The side panels of the Print Pod are designed to be easily replaceable, giving users the freedom to tailor the enclosure's appearance and function to their needs. Each panel is mounted using M5 screws that thread into coupling nuts welded to the frame's internal lips, making removal and reinstallation straightforward.
This system supports a wide range of material and finish options, from standard perforated metal that can be used as a tool wall to painted MDF or other personalized surfaces. Whether the goal is to match an interior, further reduce noise, or simply customize the visual expression of the enclosure, the side panels offer a flexible canvas for individual preferences.

Illu 86: Pegboard options

Customization Through Printing

Beyond physical modularity, the Print Pod is designed to be extended and personalized through 3D-printed upgrades. An evolving STL library will offer users a wide range of printable components to adapt the enclosure to their specific need, whether practical, aesthetic, or just fun. These upgrades are meant to empower the community to take ownership of the system and build on it over time.

Printable examples:

Poop Collector & Trash Tray
For new-generation printers that purge filament, commonly known as "poop", during filament changes, the library will include a printable and removable tray that catches this waste. Since purge direction varies by printer model (side or rear), multiple tray designs will be provided. The tray will sit next to the printer and be easily removed for emptying.

Illu 87: Poop collectors for Bambulab A1 and X1c

Pegboard Accessories
The perforated side panels function as a pegboard, offering endless options for printable accessories such as:

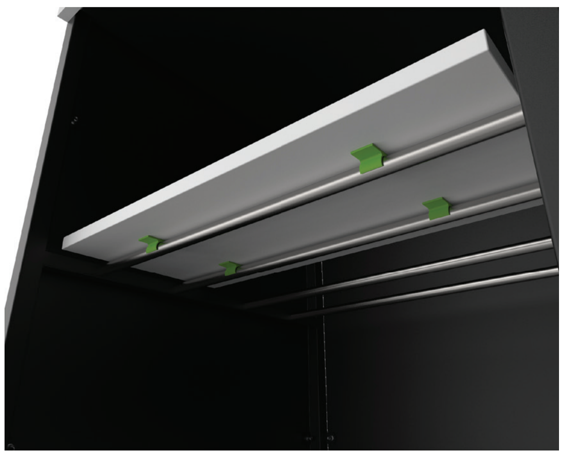
- Tool hangers
- Modular shelving
- Spool holders
- Display stands for prints
- Plant/Pot holders

The goal is to provide a foundation, but community-created accessories will also be supported and encouraged to expand possibilities.

Storage Rack Add-ons
Printable accessories for the storage module will allow users to adapt the lower compartment to fit their workflow. Concepts include:

- A pivoting trash bin that mounts on the filament rack
- Printable adaptors to add a shelf above filament spools
- Mounting clips, dividers, or label holders

These printable options make it easy to adapt the system without additional hardware or tools, just download, print, and integrate.



Illu 88: Mounting clips for racks

5.5 Air Filltrations and Purification System

Ensuring clean and safe air during 3D-printing is critical, especially in enclosed indoor environments like home offices. The Print Pod integrates a purpose-built filtration and purification system designed to manage both ultrafine particles (UFPs) and volatile organic compounds (VOCs) produced during FDM printing. This system is engineered not only for performance, but also for quiet, continuous operation that supports long-term use without disrupting the workspace. The following section outlines the technical rationale behind the system's design, including filter selection, airflow calculations and component specification, alongside a visual overview of the internal air path.

Air Filtration and Purification System

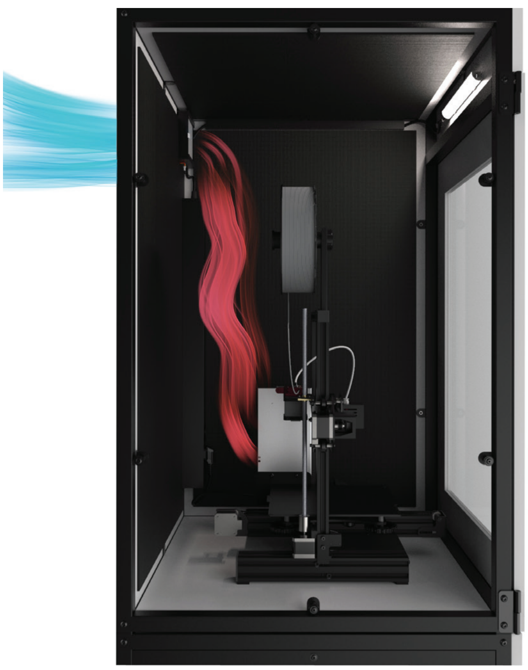
To ensure safe use in indoor environments such as home offices, the Print Pod integrates a dedicated filtration system designed to handle emissions generated during FDM 3D-printing. These emissions include both UFPs and VOCs. The system combines a HEPA filter, an active carbon filter and a low-noise axial fan, all chosen based on performance calculations detailed in the accompanying Filtration Specification Worksheet (see Appendix 9).

HEPA Filtration for Ultrafine Particles
UFPs are emitted continuously during the extrusion process and can pose long-term health risks if not properly managed. The Print Pod uses a HEPA H13 filter, capable of capturing particles as small as 0.1 µm. While the calculated minimum surface area needed is approximately 22.5 cm^2, the final design specifies a pleated HEPA filter with a minimum of 100 cm^2 surface area. This reduces pressure drop, maintains airflow performance and ensures the fan operates within a quiet and efficient range. These design decisions are informed by aerosol filtration literature and performance studies at low face velocities (Heikkinen et al., 1997; Hinds, 1999).

Fan Selection and Airflow Management
Airflow through the filtration system is maintained by a 80 mm axial fan, selected for its balance of static pressure (1.55 mm H^2O) and quiet operation (16.1 dB(A)). The fans airflow is rated up to 56.9 m^3/h and provides significant overhead beyond the required of 2.43 m^3/h, ensuring it can handle filter resistance without excessive noise. Its performance characteristics are well suited for a home office or studio setting, and its adjustable speed capability allows for future scaling (Noctua, 2024a).

VOC Filtration Using Activated Carbon
To address gaseous emissions such as VOCs, the Print Pod includes an activated carbon stage following the HEPA filter. While the minimum required carbon mass is calculated at 0.12 g, the filter is designed to accommodate 5–10 g to ensure sufficient adsorption capacity and filter longevity. The filter's geometry, specifically, a thickness of 10–20 mm and an airspeed below 0.4 m/s, is optimized for adequate dwell time, following best practices in carbon filtration design (Dąbrowski et al., 2001; Jankowska et al., 1991).

Air Exhaust and Thermal Management
Air is exhausted through the rear of the enclosure. This setup supports continuous air refreshment while also mitigating internal heat buildup from the printer and electronics. The filtered exhaust system ensures both clean air quality and thermal stability, contributing to a safe, quiet and professional user experience.



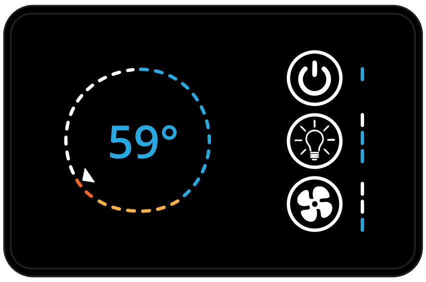
Illu 89: Air path

Illu 90: Filtration flow

Adapting to Filament Type Variability

While the Print Pod's filtration system is designed to meet the general performance needs of FDM 3D-printing, it also accounts for the variability in thermal load and emissions introduced by different filament materials. The enclosure and ventilation system have been engineered with sufficient capacity to support a wide range of filaments, including those that produce higher levels of heat or pollutants.

Thermal Considerations
Materials like PETG, ABS, and ASA require elevated extrusion and bed temperatures, which can lead to heat buildup inside the enclosure. To manage this, fan speed can be adjusted in 3 steps manually via the control display, located on the top panel of the enclosure, giving users direct control over airflow based on printing conditions or personal preference. Here the whole system can also easily be turned on and off.



Illu 91: Control display

Filtration Load and Emission Differences
As outlined in Section 2.1, different filaments emit different concentrations of VOCs. While some materials like PLA, emit relatively benign compounds, others such as ABS, ASA and PETG were found to release higher levels of potentially harmful VOCs, including styrene and formaldehyde, which exceed commonly accepted short-term indoor air quality thresholds. These differences directly influence the demands placed on the filtration system.
To accommodate these different polutants, the Print Pod's filtration system is intentionally overdimensioned. The HEPA H13 filter includes generous surface area to minimize pressure drop and extend lifespan. Furthermore, the active carbon filter is capable of holding 5–10 g of adsorbent, ensuring effective VOC capture across a wide range of materials, without the need for user intervention.

Illu 92: HEPA 13 and active carbon filters

5.6 Storage and clutter management

A well-organized workspace is essential to a smooth and enjoyable 3D-printing experience. The Print Pod has been designed with thoughtful features that help users manage both the physical tools of 3D-printing and the visual clutter that often comes with it. From modular storage solutions and filament organization to integrated cable routing and pegboard systems, every aspect of the enclosure supports a clean, functional and adaptable environment. This section outlines the ways in which the Print Pod helps users stay organized, whether they're aiming for efficiency, aesthetics, or both.

A Flexible System for Organization

The bottom compartment of the Print Pod is designed not only as a structural base but also as a flexible storage solution to help users manage the often messy realities of 3D-printing. Recognizing that no two workspaces, or workflows are the same, the storage module is intentionally left open-ended and highly customizable.
By default, the unit includes a filament display rack, intended for holding opened filament spools that are in active rotation (ready to be loaded into the printer when needed). This rack runs side to side across the 550 mm internal width, rather than front to back. This orientation not only improves visibility and access but also enhances the structural stability of the unit by mechanically connecting the two vertical frames together.

Beneath the rack, there is space allocated for unopened filament rolls, boxes or other supplies. This dual-function layout separates everyday-use materials from backup stock, supporting better organization and workflow clarity.

Illu 93: Printeble storage for tool drawer

During layout testing, the 550 × 550 mm footprint was evaluated for optimal spool storage. Based on standard spool dimensions, the configuration was designed to accommodate two horizontal rows of seven spools, enabling up to 14 rolls to be neatly stored and easily accessed. This setup maximizes space efficiency while keeping the enclosure tidy and visually balanced.

Users can further configure the storage module to fit their preferences, choosing between a closed or more open layout, featuring printed bins, adjustable shelves, or tool organizers. The system supports both official add-ons and user-generated STL components, offering flexibility for both functional needs and aesthetic personalization.

In addition to the storage module, the perforated side panels of the enclosure serve as a valuable tool for clutter management. Functioning as a pegboard system, they can be equipped with printed or official accessories such as tool hangers, containers or hooks. This vertical surface offers a convenient way to keep essential items visible, accessible, and off the workspace, promoting a clean and organized environment.

The same mounting holes used to fasten the panels on the outside of the enclosure are also accessible from the inside, enabling users to mount a pegboard or tool wall on both the outside and the inside for added customizability.


Illu 94: Externnal and internal pegboard solution

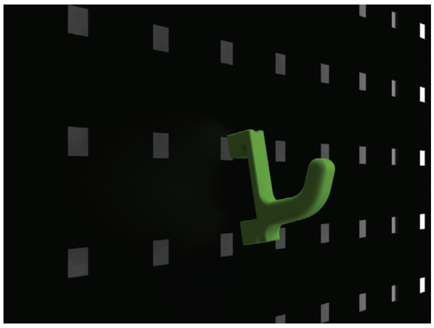
Pegboard Options: Industrial vs. Home Standards

The Print Pod offers two distinct pegboard configurations to accommodate varying user preferences and functional requirements:

Industrial Square-Hole Pegboard

- Hole shape and size: 9×9 mm square holes
- Center-to-center spacing: 39 mm
- Material: Typically manufactured from sheet metal
- Applications: Common in workshops, garages, and industrial tool wall systems

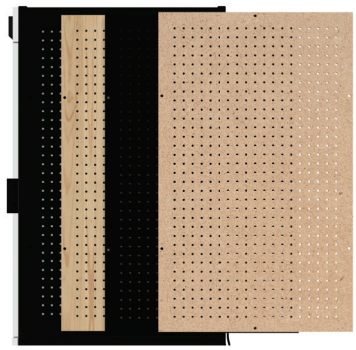
This configuration is inspired by the industrial tool wall standards commonly found in professional environments. The square hole system, used in products such as SHUTER's workstation walls, offers high strength and a locking interface that prevents tool hooks from shifting. Due to the need for rigidity and load-bearing performance, these pegboards are typically made only from steel sheets.


Illu 95: Square tool wall system

Standard Round-Hole Pegboard

- Hole diameter: 1/4 inch (6.35 mm)
- Center-to-center spacing: 1 inch (25.4 mm)
- Materials: Available in MDF, plywood, plastic, or metal
- Applications: Popular in home workshops, studios, and general-purpose storage

This setup follows traditional pegboard standards often seen in home improvement and craft settings. It is compatible with a wide range of hook and accessory types, and its material versatility allows it to suit different aesthetic and functional needs. MDF and plywood offer a warmer, workshop-style look, while plastic and metal provide more robust finishes.


Illu 96: Round pegboard system

By offering both pegboard types, the Print Pod gives users the choice between a robust, industrial tool wall system and a more flexible, home-oriented interface, without compromising functionality.

Cable Management and Clutter Reduction

To support a clean and organized workspace, the Print Pod includes an internal cable rail along the right side and backpanel of the enclosure. the top mounted channel allows users to route and conceal cables for the LED lighting and control display at the power outlet.
By centralizing all wiring in a dedicated space along the side wall, the design avoids loose cables hanging inside the print area or draping across components. The power cable runs through a dedicated hole on the backside panel.


Illu 97: Cable channeling

5.7 Sound Dampening Features

To ensure quiet operation in home office environments, the Print Pod incorporates a range of sound-reducing elements. These include acoustic panels, vibration isolation, and sealing strategies, each aimed at minimizing noise from motors, fans, and structural resonance. This section details the materials and design choices that contribute to a calmer, more comfortable printing experience.

Sound Dampening Strategy and Material Testing

The Print Pod is designed to operate quietly in a home office environment, where controlling background noise is essential for focus and comfort. To support this, sound dampening features were developed based on material performance tests conducted using a Creality Ender 3 V2 printer as the reference device (Appendix 10).

Material Testing and Selection

A range of insulation materials, such as black felt, glass wool, and cloth were tested individually and in layered combinations. Estimated sound levels were recorded 30 cm from the enclosure opening using a mobile phone decibel reader app, while the printer was running a standardized high-speed test file.

- The baseline without panels showed an average of approximately 63 dB.
- Glass wool (Panel 2) alone reduced the level to around 51 dB.
- The combinatio of black felt and glass wool resulted to 50 dB, making it the second best performing configuration.
- A three-layer combination (glass wool + black felt + fabric) showed slightly lower values but was less practical to integrate.

The glass wool + black felt configuration was selected for the final enclosure design due to its strong acoustic performance, manageable material thickness, and ease of installation. The black felt layer helps dampen higher-frequency motor sounds, while the glass wool targets lower-frequency structural vibrations. Each material used in the combination is approximately 20–40 mm thick.

Integration in the Enclosure

- Perforated exterior panels allow sound to pass through to the absorbent layers, improving performance while visually referencing architectural acoustic treatments.
- The sound-dampening materials are installed on the side and rear walls, which are most exposed to printer and fan noise.
- This setup reduces the overall sound level to an estimated 50 dB, comparable to a quiet room, making the Print Pod highly suitable for use in shared or quiet workspaces.

This sound mitigation strategy enhances both comfort and usability, reinforcing the Print Pod's role as a purpose-built solution for modern home-office 3D-printing.

Illu 98: Panel - glass wool - filt

Sealing Strategy

To enhance acoustic insulation, control internal airflow and reduce leakage of particles or VOCs, the Print Pod features a carefully selected door sealing system. Several sealing solutions were explored during development, drawing from both consumer appliance and industrial enclosure designs.

Explored Options

- Refrigerator-style magnetic seals offered strong, self-aligning closure, but were ultimately dismissed due to bulk, cost, and mounting complexity .
- Shower door seals presented a lower-profile but lacked consistent compression and long-term durability.
- Additional magnetically assisted sealing profiles were also considered, but proved complex to integrate at scale.

Final Seal Choice

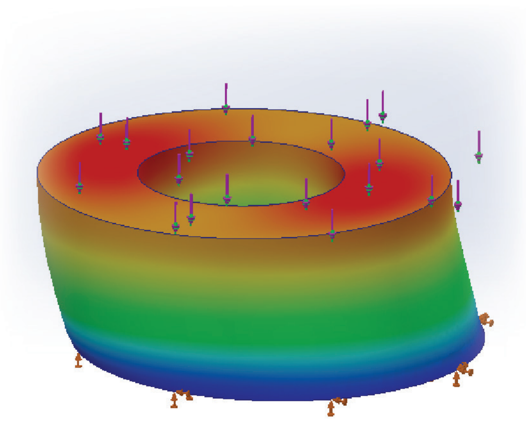
The final design uses a wide D-profile EPDM rubber seal, selected for its excellent sealing performance, durability, and ease of installment. EPDM (ethylene propylene diene monomer) is commonly used in demanding applications due to its resistance to heat, deformation, and environmental wear, as well as its effectiveness at dampening vibration and sound.
The seal is mounted directly on the enclosure frame using the provided sticking layer for a secure and long-lasting bond without mechanical fasteners. To maximize sealing effectiveness:

- Two magnets are integrated into the door frame, increasing contact pressure and improving overall airtightness.

This sealing solution supports the Print Pod's goals of quiet operation and internal air control while maintaining a simple and clean exterior suitable for home office integration.

Vibration Absorption Platform

To prevent mechanical vibrations from amplifying inside the enclosure, the Print Pod features a suspended platform where the printer stands on, specifically designed to isolate motion and reduce resonance. Vibrations generated during high-speed, or long-duration prints can otherwise resonate into the enclosure's metal frame, resulting in low-frequency noise and unwanted structural amplification.



Illu 99: Vibration consentration

Finite element analysis of how frequencies affect the rubber spacer

The printer platform is mounted on the enclosure's steel base frame using a set of rubber spacers, positioned between the platform and two welded flat steel support bars. These elastomeric components act as vibration dampers, absorbing energy from stepper motors and motion systems before it can pass into the structure.

The platform itself consists of a wooden surface, supported by a welded steel subframe, and is secured using screws that pass through the rubber isolators. This sandwich construction allows the platform to remain sturdy while still flexing microscopically under load, breaking the transmission path for vibration.

By mechanically decoupling the printer from the enclosure structure, this system helps prevent:

- Resonance within metal components
- Amplification of low-frequency motor vibrations
- Sound reflections that increase overall noise levels

This passive isolation strategy contributes to the overall acoustic control of the Print Pod and supports smoother, quieter operation in home and shared workspaces.

5.8 Maintenance & Safety

The Print Pod has been developed to support safe, reliable, and low-maintenance operation in home and office environments. From fire-resistant materials and airflow control to accessible system switches and user-friendly upkeep, every component is designed to minimize risk and maximize longevity.

Accessible Controls
Essential functions such as the ventilation fan and LED lighting are operated through the control display at the top. This allows users to turn systems on or off without opening the enclosure, helping maintain internal temperature, contain VOCs and avoid unnecessary air disruption during active prints.

Thermal Safety and Fire Protection
Continuous ventilation is provided by a high-capacity axial fan that helps prevent heat buildup, particularly during long or unattended print sessions.

In the event of an electrical or thermal failure:

- The interior acoustic insulation consists of glass wool, a non-combustible material with a melting point above 1,000 °C, helping prevent flame spread (ROCKWOOL Group, 2024).
- The black felt layer, located on the interior side for acoustic control, is a synthetic material that can melt or ignite at extreme temperatures. However, it is backed by the fire-resistant glass wool, which acts as a barrier against flame propagation.
- The printer platform, made of laminated MDF would be the biggest concern if a fire situation where to happen, future iterations could look into materials such as compact laminate, wich have a class A/1 fire rating. (Wilsonart. 2023)

Together, these measures support both thermal management and basic passive fire resistance, contributing to a safer operating environment for indoor use.

Routine Maintenance
The Print Pod is designed for long-term use with minimal effort. HEPA and activated carbon filters are installed in a rear-mounted housing, allowing for tool-free replacement. Users can remove and replace filters by simply sliding them in and out of the frame, no disassembly required.
Other components such as cable channels, panel surfaces, and the printer platform are made with easy-to-clean finishes, helping reduce dust buildup and simplify general maintenance. This design supports a clean user-friendly printing experience over time.


Illu 100: Exploded view

06

BUSINESS AND MARKET STRATEGY

This section outlines the strategic foundation for bringing Print Pod to market as a commercially viable product. It explores the value delivery to users and stakeholders, defines its target customer segments, and positions it within the broader market landscape. The business model is built around a licensing partnership that minimizes risk while enabling scalability, supported by a focused implementation plan and low-overhead market strategy. Finally, a cost and pricing feasibility estimate confirms alignment with the intended market segment and validates the economic potential for Print Pod.

6.1 Value Proposition

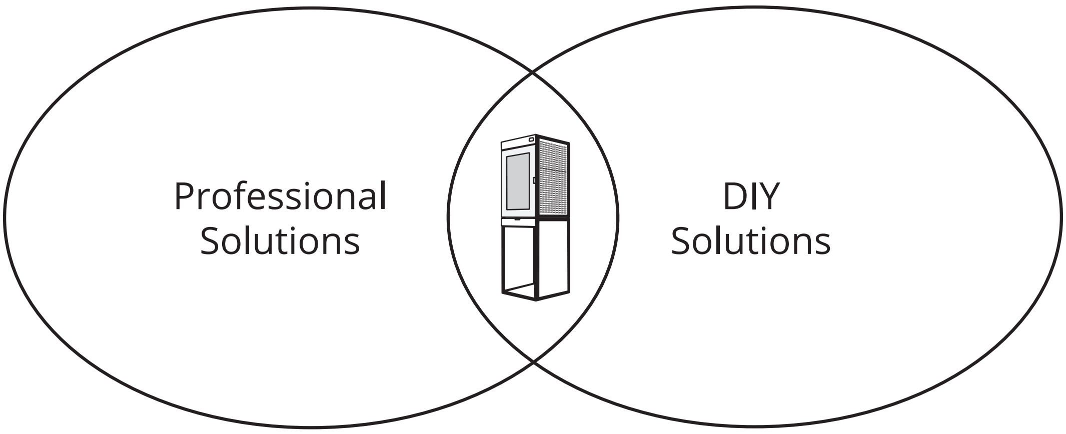
The Print Pod is a furniture designed to transform how hobbyists integrate 3D-printing into their homes. Rather than hiding the printer or relocating it to inconvenient spaces, Print Pod creates a dedicated, optimized environment that celebrates the hobby while adressing its biggest challenges: noise, odor and clutter.

For the primary user, Print Pod enhances usability by reducing disruptive noise and filtering harmful fumes. It offers organized storage for tools, filament and the furniture-inspired design aligns with the modern home office and hobby room. The enclosure is designed to be modular and customisable, allowing users to adapt it to different 3d printer setups, add functional extensions, upgrades, and reconfigure components as their needs evolve. This flexibility supports the "DIY" spirit of the hobby itself. The result is a more comfortable, more productive, and more aesthetically integrated 3d printing experience, one that supports both technical needs and creative expression.

For indirect stakeholders, partners, roommates, or family members who share the environment, Print Pod reduces the negative environmental impact of 3D-printing. By containing noise and odors and eliminating visual mess, it enables peaceful coexistence in shared living spaces, supporting domestic harmony without requiring the hobbyist to compromise.

For retail stakeholders, such as 3D Eksperten, Print Pod represents a unique market opportunity. It fills a clear gap between DIY enclosures and professional solutions, enabling retailers to promote their 3d printing accessories with a new and expandable product. Print Pod strengthens 3D Eksperten's brand identity as a comprehensive, solutions-oriented player in the 3D-printing space.

In short, Print Pod delivers functional comfort for the user, improved quality of life for the household, and a strategic growth opportunity for the retailer.

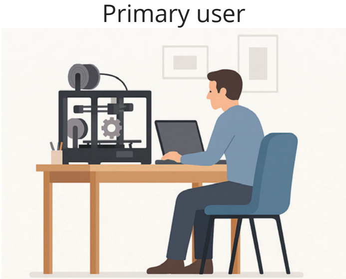


Illu 101: Market fit

6.2 Target Customers

Print Pod is primarily designed for hobbyist users of FDM 3D printers who operate their machines in domestic environments. These users, typically aged 21–50, print regularly and often place their printers in home offices, bedrooms, or shared living spaces. They are financially and emotionally invested in their printers, actively seeking solutions that reduce noise, odors, and clutter without sacrificing accessibility or aesthetic appeal.
The product also addresses the needs of secondary user segments, including students, small-scale makers, or semi-professionals. These users tend to work in shared environments and value self-contained solutions that make printing less disruptive and easier to manage.
Finally, cohabitants and indirect stakeholders, those who share the space with the printer but do not operate it, represent an important influence on purchasing decisions. Print Pod directly addresses their concerns, helping reduce friction in shared environments and enabling greater acceptance of 3D-printing as a part of everyday home life.

Primary user

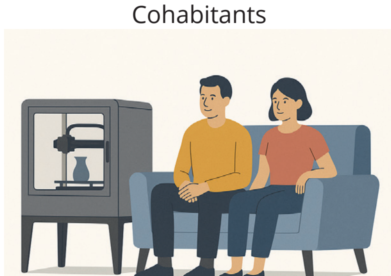


Illu 102: Primary user

Secondary user

Illu 103: Secondary user

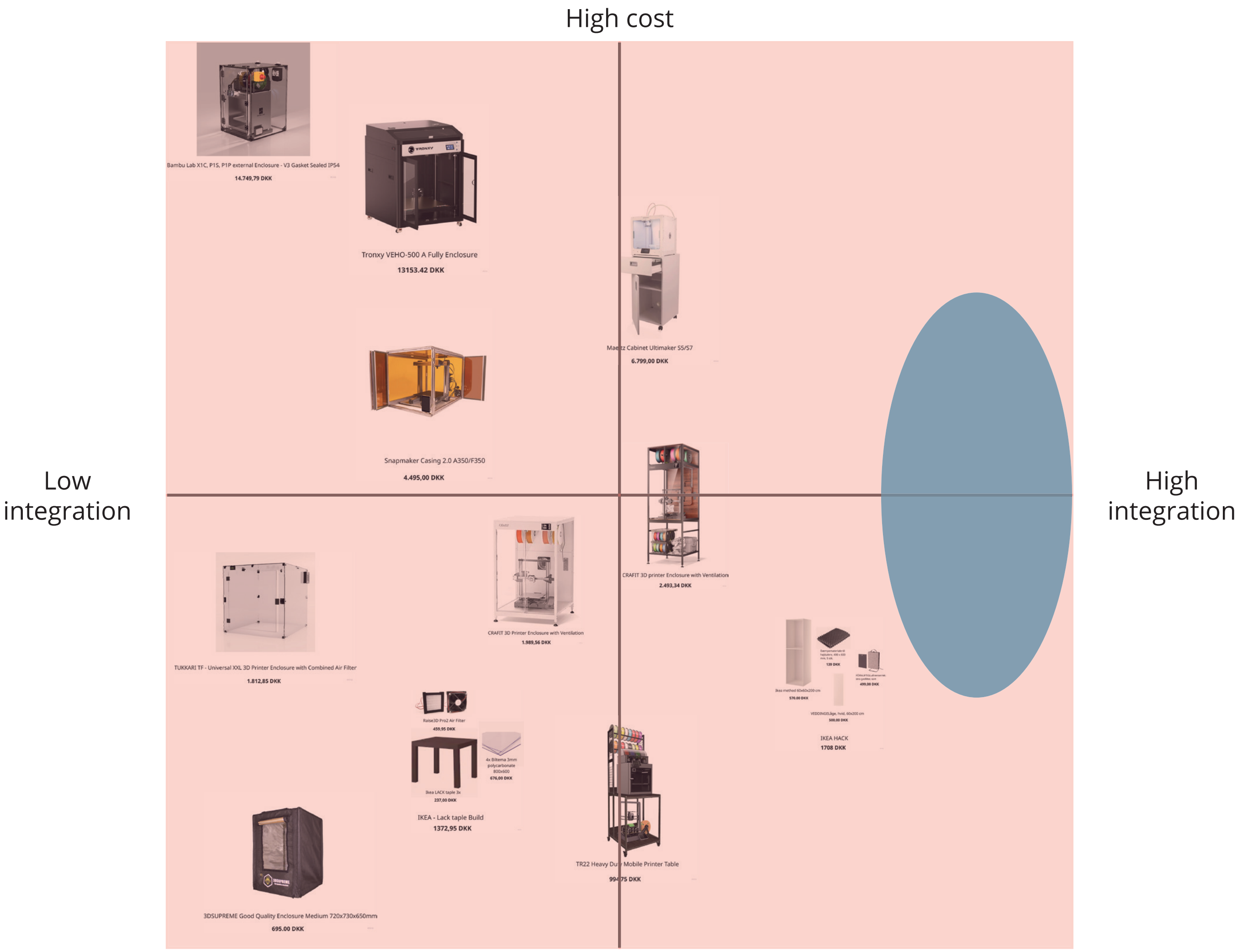
Cohabitants



Illu 104: Cohabitants

6.3 Market Opportunity

To assess Print Pod's market potential, a comparative analysis was conducted based on two key parameters: cost and integration quality. The resulting matrix illustrates the current distribution of 3D printer enclosures across the market, identifying distinct clusters and gaps.



Illu 105: Market gap (red ocean, blue ocean)

The analysis reveals that most existing products fall into either the low-cost, low-to-moderate integration segment or the high-cost, low-to-moderate integration segment. The first category includes tent-style enclosures, IKEA hacks, and basic DIY solutions. These are typically affordable but offer minimal performance in terms of noise reduction, odor control, or aesthetic compatibility with modern living spaces.

In contrast, the high-cost segment includes rigid acrylic enclosures or manufacturer-specific cabinets that may reach prices of 4,000 to over 15,000 DKK. While these often offer better structure and safety, they frequently lack real integration features such as sound dampening, effective air filtration, storage solutions, or a design suited for domestic environments. These products tend to prioritize form-factor precision or industrial durability over day-to-day usability or comfort in shared spaces.

What is notably absent from the market is the high-integration, mid-cost category, an area identified in our matrix as a clear blue ocean opportunity. This represents a segment with unmet demand: users who value environmental control, organisation, and visual harmony, but are not willing to pay premium prices associated with lab-grade or manufacturer-specific solutions.

With an intended price range of 2,000–4,000 DKK, Print Pod aims to offer:

- Effective noise and odor control,
- Integrated storage and cable routing,
- A modular, furniture-grade design language,
- And a footprint that fits into common hobbyist spaces.

Furthermore, our findings suggest that the lack of competition in the high-cost, high-integration quadrant is not a missed opportunity but a reflection of market rejection. Very few users are willing to invest in expensive integration solutions unless they are professionals or industrial operators. This validates our pricing strategy and user-focused design choices, aligning Print Pod with the expectations of dedicated hobbyists and practical users alike.

This insight is further supported by direct feedback from industry stakeholders. In a correspondence with Emil Sahlin, the owner of 3D Eksperten, one of Denmark's leading 3D-printing retailers, the following statement was shared: "Yes, we regularly receive inquiries about enclosures, particularly due to noise and odor issues. Most solutions on the market are quite technical or 'boxy', so a more furniture-like option with filtration and storage could definitely have potential."

This feedback directly reinforces our findings: there is a real and ongoing demand for enclosures that balance technical function with home usability. Print Pod is designed precisely to meet this need.

2000-4000 DKK

Illu 106: Print pod

6.4 Business Model

The business strategy for Print Pod is built around a licensing-based collaboration with a retail partner, designed to bring the product to market efficiently at a low risk. This section highlites the business model using the Business Model Canvas framework, with each subsection corresponding to one of its key building blocks. The full canvas is available in Appendix 11.

Primary Business Partner (Key Partnerships)
Print Pod's success relies on a strategic partnership with 3D Eksperten, one of Denmark's leading retailers in the 3D-printing space. Rather than pursuing in-house production, Print Pod is offered to 3D Eksperten through a licensing agreement. This grants them exclusive rights to produce, brand, and sell the product within their existing white-label portfolio. 3D Eksperten is well-suited for this role due to their existing:

- Manufacturing and distribution infrastructure
- Customer base of hobbyist 3D printer users
- Experience with enclosures, accessories, and value-added products

This partnership minimizes operational complexity for the Print Pod team and enables immediate acces to a relevant market.

Product Development and Support (Key activities)
The core activities for the Print Pod team revolve around product design, documentation, and partner support. This includes:

- Developing a production-ready design
- Preparing CAD files, BOMs, and assembly instructions
- Creating marketing visuals and instructional content
- Supporting onboarding and training for the retail partner

These activities ensure that the design is clearly transferable and that the partner can bring the product to market with minimal friction.

Resources and Expertise (Key Resources)
The project's key resources are concentrated in intellectual property and design capability. This includes:

- The CAD files and documentation package
- Prototypes and testing feedback
- A design team focused on usability and manufacturability
- Early insights gathered from potential users and stakeholders

These resources allow Print Pod to be delivered as a market-ready product with clear production value.

Customer Focus (Customer Segments)
Print Pod targets three interconnected customer groups:

- Primary users: Hobbyist 3D printer owners, typically aged 21–50, who operate printers at home and seek better integration into their living spaces.
- Secondary users: Students and semi-professional makers who need compact, manageable setups.
- Indirect stakeholders: Partners or roommates who don't operate the printer but are affected by its noise, smell, and clutter.

These segments are unified by a shared problem space: the difficulty of fitting 3D-printing into domestic environments without disruption.

Relationship Model (Customer Relationships)
Customer interaction is handled entirely by 3D Eksperten through their webshop, physical store, and support channels. The Print Pod team may provide supporting content such as guides: FAQs, promotional material etc. but is not involved in customer service or direct sales. This keeps operational overhead low while ensuring quality information is available to end users.

Route to Market (Channels)
Print Pod will be distributed through 3D Eksperten's existing sales channels:

- Their webshop
- A physical showroom/storefront
- Possible bundle promotions with 3D printers or accessories
- Influencer collaborations or seasonal campaigns (optional)

These channels ensure immediate access to the right audience without needing to build a network from the ground up.

Value Delivered (Value Propositions)
Print Pod delivers different types of value to each stakeholder:

- To the user: Reduced noise, odor, and clutter; improved workspace integration; modularity and personalization
- To the household: A more livable environment; fewer compromises for cohabitants
- To the retailer: A differentiated and potentially high-margin product that fills a clear market gap

The design is functional, home-friendly, and adaptable, offering a well-balanced combination of technical and lifestyle benefits.

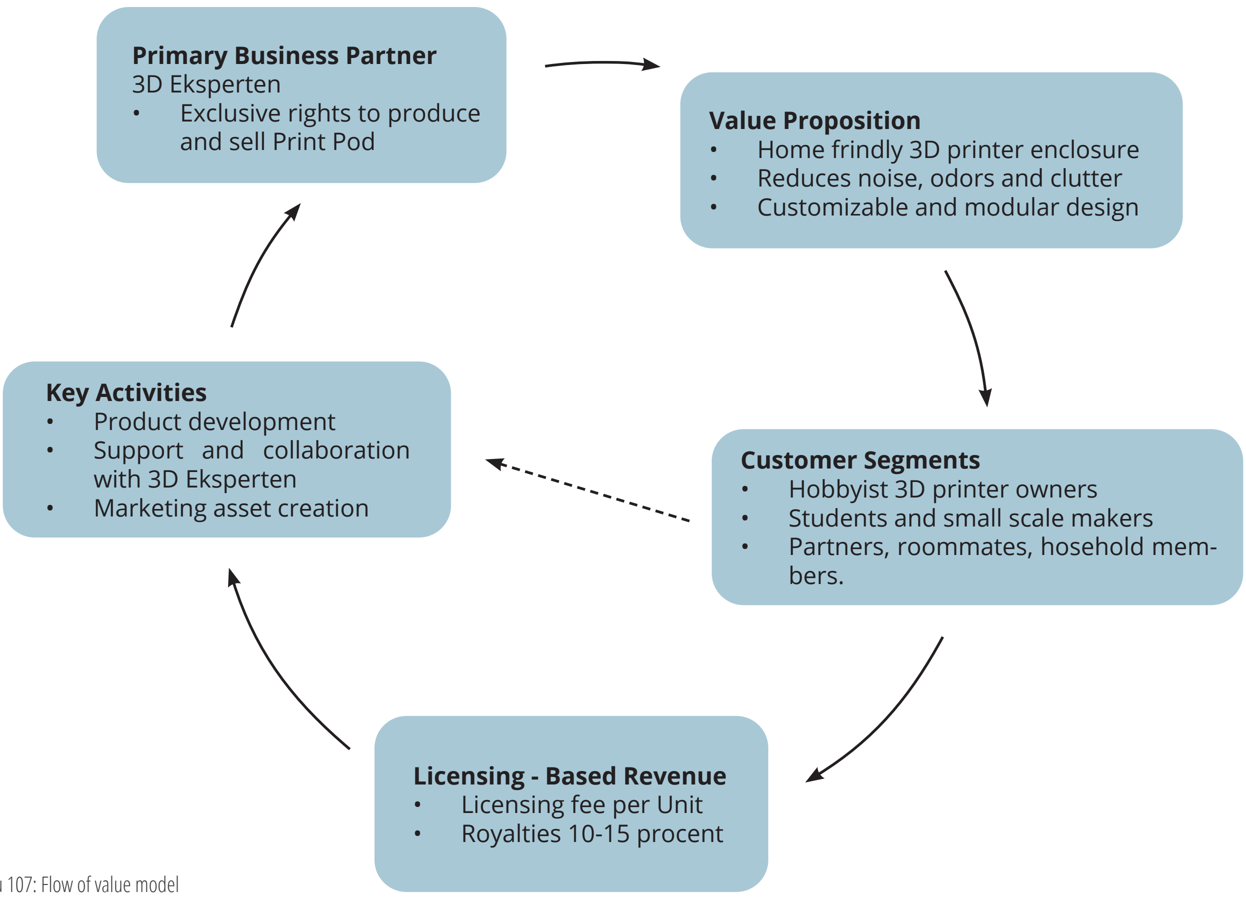
Money spend (Cost Structure)
Costs for the Print Pod team are limited to development and support:

- Prototyping and materials
- Documentation and media preparation
- Occasional design updates

There are no ongoing costs for manufacturing, logistics, or customer service, keeping the operation lean and scalable.

Money income (Revenue Structure)
The Print Pod team earns income through a licensing fee or per-unit royalty paid by 3D Eksperten. This could be structured as a flat fee per unit or a percentage of retail price. As the product scales, additional variants or accessories can be licensed under the same model, offering recurring, low-overhead revenue potential.

The Print Pod business model is intentionally lean, scalable, and grounded in real market needs. By focusing on design and leveraging an established retail partner through licensing, the project avoids the traditional barriers of production and distribution while still delivering high impact. Each component of the Business Model Canvas reinforces this approach. This strategy is further illustrated in the value flow diagram (see figure X), which maps how design efforts translate into customer value, generate revenue through a licensing partner, and then feedback into continued development. It visualizes a closed-loop system of value creation, distribution, and reinvestment a model built on alignment, not complexity.
In doing so, Print Pod is positioned not as a one-off product, but as the foundation for a growing platform of user-centered, integration-friendly 3D-printing solutions.



Illu 107: Flow of value model

6.5 Implementation Plan

The implementation of Print Pod follows a phased and focused approach, designed to deliver a production ready product into the hands of our licensing partner, with minimal risk and maximal efficiency. Because the Print Pod team does not engage in direct production or distribution, the plan centers on: design finalization, partner onboarding, and strategic support allowing us to bring the product to market quickly without the need for heavy infrastructure or capital investment.

In the first quarter, the focus is on completing the final product design and validating it for production. This includes making any remaining adjustments based on testing feedback, ensuring that the design performs well in terms of usability, airflow, and structural integrity. Alongside these final refinements, the full documentation package is assembled. This includes CAD files, technical drawings, a detailed bill of materials, and a clear step-by-step assembly guide. These materials are essential, not only for enabling smooth manufacturing but for ensuring that 3D Eksperten can take over the product with confidence and minimal friction. The reliability of the entire implementation hinges on how effectively this knowledge is transferred.

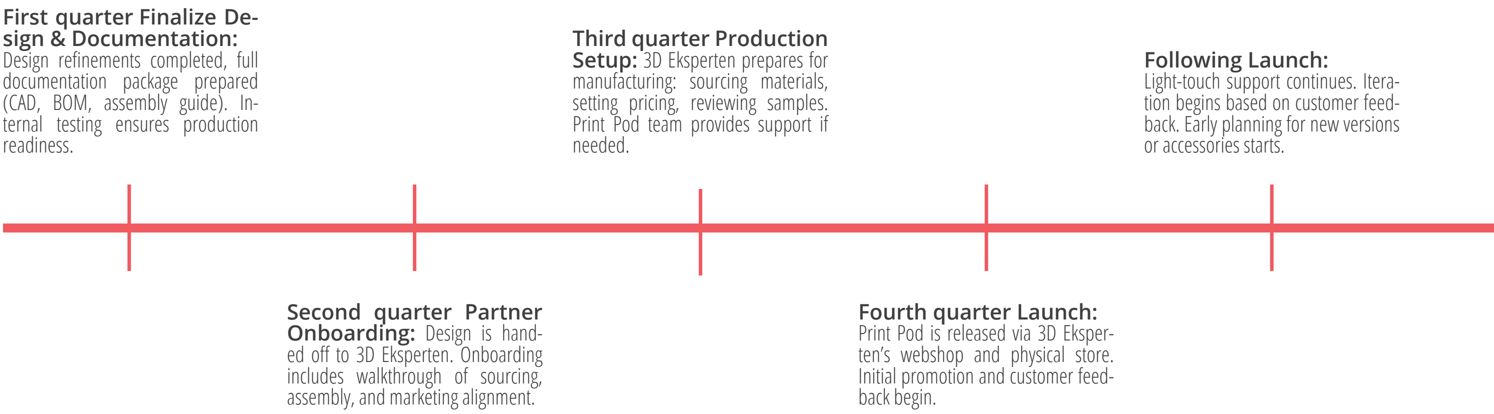
In the second quarter, the Print Pod team hands over the finalized design to 3D Eksperten and facilitates a structured onboarding process. This includes a meeting to walk through the documentation in detail, clarify assembly or sourcing questions, and align on marketing direction and brand messaging. Visual assets, product descriptions, and suggested positioning language are also delivered during this phase. This moment is a pivotal bridge between design and production, ensuring that the product will be manufactured and presented in line with its intended purpose: a practical, aesthetic, home-friendly enclosure solution.

In the third quarter, 3D Eksperten begins preparing for production. They handle all material sourcing, pricing calculations, and internal planning to bring Print Pod into their white-label product portfolio. If needed, the Print Pod team remains available to support with sample review or minor production adjustments, but the operational responsibility now lies fully with the partner. This model allows Print Pod to scale without building or managing supply chains (one of the key advantages of a licensing strategy).

In the fourth quarter, Print Pod is launched on 3D Eksperten's webshop and in their physical store. The product enters the market with support from the partner's existing customer base, and its visual appeal and user-centered design provide strong grounds for effective promotion. Optional influencer outreach, bundle offers, or seasonal campaigns may be used to accelerate traction, depending on the retailer's marketing calendar.

Following the launch, the Print Pod team provides post launch light-touch support. This may involve responding to feedback, making small improvements to documentation, or advising on material alternatives. If the product performs well, this period also allows for early planning of additional variants or complementary accessories. Because the licensing model is scalable, future iterations can be introduced with minimal structural change, building on the success of the initial launch.

In summary, this phased plan is built for reliability. It places core responsibility where it belongs, on the design team for clarity and on the retail partner for execution. By keeping each phase intentional and clearly sequenced, Print Pod can move from concept to market-ready product without unnecessary complexity, while retaining design integrity and market focus throughout.



Illu 108: Implementation time line

Looking beyond the initial launch year, the Print Pod concept is structured for long-term scalability and adaptability. Once the first version is in market and operating successfully, the focus shifts toward building on that foundation, expanding the product line, refining the design (based on user feedback), and exploring new markets or retail partnerships where the concept can be replicated.

In the second year, the priority becomes scaling. With real-world performance data available, the team can assess usage patterns and customer needs to inform potential product variants. There is also potential to collaborate further with 3D Eksperten on targeted marketing campaigns, seasonal promotions, or bundle offerings that pair the enclosure with popular printer models. By the end of this phase, Print Pod could evolve from a single offering into the foundation of a purpose-driven product ecosystem. To support this evolution, the Print Pod team may also analyse community-generated STL files and mods shared online. This open-source ecosystem offers valuable insight into how users adapt their setups and solve emerging problems. The underlying philosophy is simple: if a problem exists, the community will create a printable solution, providing clear signals about what future features or modules might be worth formally developing.

In the third year, the focus may broaden toward diversification and international expansion. If sales and reception remain strong, the Print Pod concept could be licensed to additional partners in adjacent markets, such as Germany, the Netherlands, or other Nordic countries. Alternatively, if the collaboration with 3D Eksperten remains exclusive, efforts may instead focus on increasing production volume and deepening the brand's footprint in the Danish market.

Throughout the mentioned trajectory, the Print Pod team remains committed to its core strengths: design innovation, user-centered problem solving, and delivering high-quality, production-ready solutions. By maintaining a licensing-based model, the project avoids the overhead and complexity of production while retaining creative control, brand direction, and long-term scalability.

Year 3 Diversification or New Markets: Explore international licensing. Develop accessory modules or expand Print Pod as a brand ecosystem.

Year 2 Product Line Expansion: Introduction of variants (e.g. compact model, upgraded features). Continued refinement and marketing collaboration.

6.6 Market strategy

The market strategy for Print Pod is built around its licensing partnership with 3D Eksperten, who will handle both production and distribution. As a result, the approach prioritizes low-cost, high-leverage marketing through established retail channels and direct access to the target customer base.

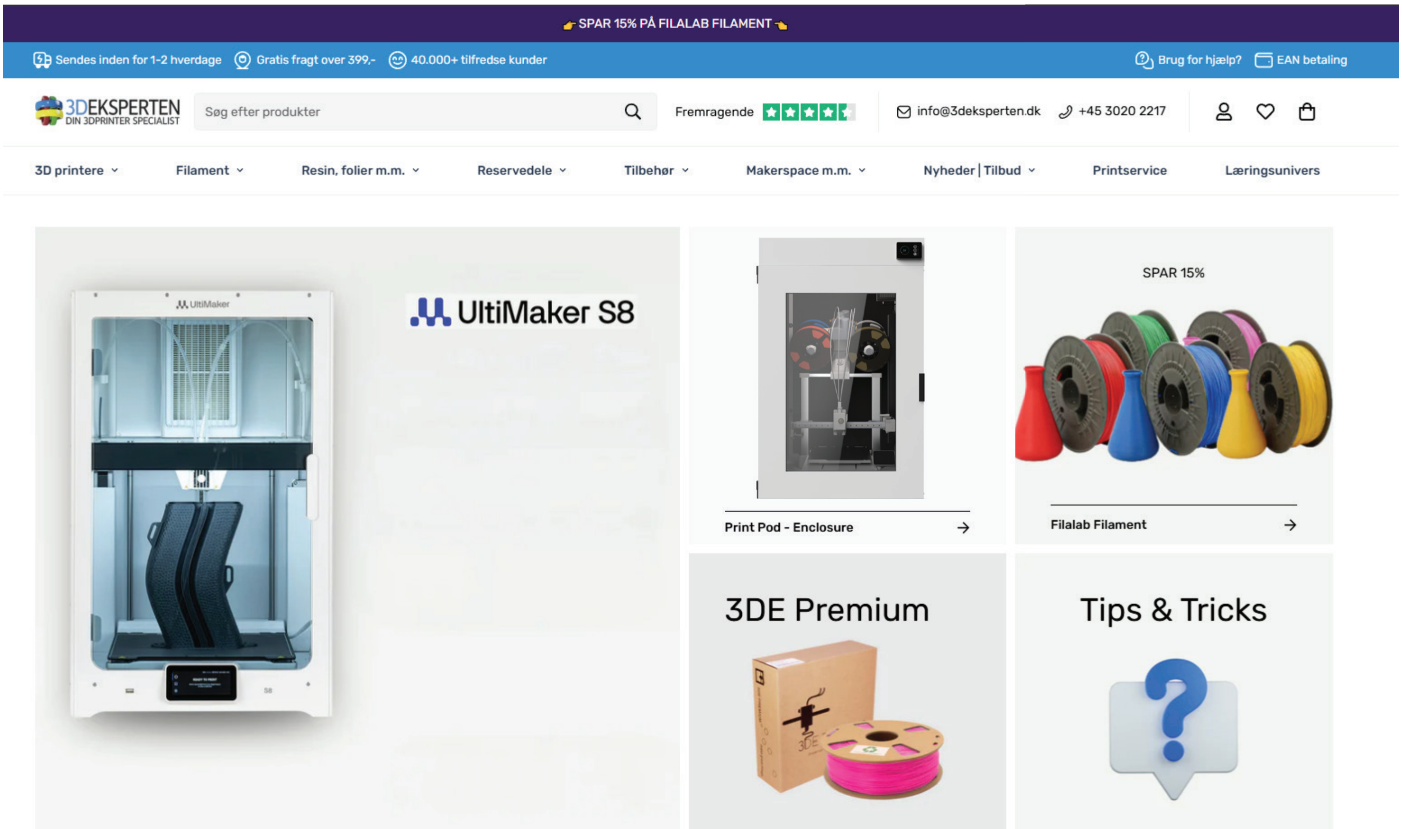
3D Eksperten already serves the hobbyist 3D-printing market through its online and physical store. Their customer base includes exactly the kind of users Print Pod is designed for: individuals who print at home and actively seek accessories to improve their setup. By integrating Print Pod into 3D Eksperten's existing ecosystem, alongside 3d printers, filament and enclosures, the product can be launched with immediate relevance and minimal marketing overhead.

The strategy relies on two main sales channels:

- **E-commerce:** The primary sales platform will be 3D Eksperten's webshop, where Print Pod will be listed alongside related products. This channel provides broad national reach and allows customers to explore technical specs, imagery, and use cases.
- **In-store retail:** The product will also be available at 3D Eksperten's physical location, giving local customers the opportunity to see the enclosure firsthand and ask questions in person. This is especially useful for showcasing the product's visual and structural quality, which is a key part of its appeal.

To support the launch, the Print Pod team will deliver marketing assets including rendered visuals, product photos, and other promotional material. These will help position the product not as a generic enclosure, but as a thoughtful, well-integrated solution for modern hobbyists. Depending on timing and budget, additional promotional activities may include influencer outreach, seasonal campaigns (e.g. black friday or holiday bundles), or product pairings with popular 3D printer models.

Importantly, this strategy remains flexible. Because Print Pod is designed to solve common problems and its value is immediately visible to users, it lends itself well to both passive discovery through store browsing and targeted promotions. By leveraging 3D Eksperten's existing presence and customer trust, Print Pod can enter the market with high visibility, minimal cost, and strong product-market fit.



6.7 Cost and Revenue Estimates

The cost and revenue structure of Print Pod reflects its core business model: a design-led product licensed to a retail partner. This means the project carries relatively low upfront and operational costs, while offering long-term revenue potential through royalties or licensing fees.

Development Costs

The primary costs associated with launching Print Pod are concentrated in the early stages:

- Prototyping and materials for multiple iterations, including metal, wood, glass, fans, filters, fasteners ect.
- Design time and CAD modeling: Depending on team setup, this could represent 100–200 hours of work, internally valued based on the contributors' roles.
- Documentation and preparation: Creating the BOM, assembly instructions, marketing renderings, and user guides may take an additional 30–50 hours.

Overall, the total cost to bring Print Pod to a licensable, production-ready state is expected to fall within 15,000–25,000 DKK, assuming in-house design capacity and modest material expenses.

Revenue Model

The expected revenue for the Print Pod team will come from a per-unit licensing fee or percentage-based royalty, paid by 3D Eksperten for each unit sold. The exact terms would be defined in the licensing agreement, but one of two general models would apply:

- Licensing Fee per Unit (e.g. 100–200 DKK per enclosure sold)
- Percentage Royalty (10–15% of retail price)

With conservative sales estimates of 100–300 units in the first year, the Print Pod team would generate 10,000–60,000 DKK in royalties with minimal ongoing involvement. If the product performs well and scales into additional variants or markets, this revenue could grow significantly in years two and three.

Scalability and Risk

Because the Print Pod team does not manage production, logistics, or inventory, the financial risk remains low, even in the event of sales underperforming. Conversely, the model is highly scalable: once the core design is licensed, additional variants can be developed and monetized through the same structure.

In summary, Print Pod is a low-cost, low-risk project with recurring revenue potential. Its success depends primarily on quality of execution and partner collaboration, not on large-scale investment or fixed overhead. This makes it a sustainable and flexible business case, with room to grow through future licensing and design extensions.

6.8 Pricing Feasibility

Although the final retail pricing and production costs will be determined by 3D Eksperten as the licensing partner, it is important to establish whether the Print Pod concept aligns with its intended market segment in terms of pricing. This feasibility check provides an internal reference point for whether the product can realistically meet both cost expectations and value perception in the eyes of the target customer.
As part of this assessment, it was decided to base the production model on 3D Eksperten's existing logistics strategy, outsourcing manufacturing to China and importing fully assembled products to Denmark, ready for sale. This approach, already used by 3D Eksperten for products such as tent enclosures and accessories, offers significant cost advantages compared to in-house or European production.
To remain competitive within the intended market segment, it was determined that the production cost of the enclosure must not exceed DKK 2,000. Based on early analysis and comparisons, this target is only realistically achievable through China-based manufacturing at this time. This strategy has therefore been adopted as the baseline for feasibility.
Using a simplified cost model, we estimate that the production cost, including materials, machining, assembly, packaging, and indirect overhead, can stay below this DKK 2,000 threshold. This estimate applies only to the core enclosure unit, as additional modules reuse many of the same components and add little cost in proportion to the full product.
Rather than applying a typical 2× retail markup, 3D Eksperten generally works with a 30% markup on their in-house products, to compete with well known brands, based on direct correspondence. They also offer a 10% discount to students, which aligns with one of Print Pod's secondary target groups and enhances affordability in that segment. Taken together, these parameters suggest that Print Pod can realistically be brought to market within the desired price range. To test this, a simplified cost model has been constructed using estimates based on a China-based production.

Estimated Production Cost and Break Even Points

The following section outlines the projected production cost per unit of the core Print Pod enclosure, based on values and assumptions detailed in Appendix 12. This estimate serves as the basis for determining pricing feasibility and supports the broader business strategy described in previous sections.

The financial analysis of the Print Pod enclosure confirms that the product is economically viable within the intended pricing and production strategy. With an estimated production cost of DKK 1.399,80 per unit delivered to 3d Eksperten, including materials, production, labor, packaging, and shipping, the product is well positioned to meet retail pricing targets while remaining accessible to its core market segment.

The proposed retail price is DKK 2.100 which allows sufficient room for both a 10% royalty to the Print Pod development team and a markup of 50% for 3D Eksperten, instead of their usual 30%, to profit from. Under these assumptions, Print Pod breaks even on its initial development investment of DKK 25.000 after approximately 120 units sold. Simultaneously, 3D Eksperten reaches break-even after around 170 units sold, assuming they invest in the progressive stamping tool for the metal side panels, identified as the most cost-intensive components of the enclosure.

While MDF is significantly cheaper as a raw material for the side panels, the difference in production cost between MDF and metal side panels is relatively small, not taking the initial tooling investment into consideration. Therefore, the decision to favor the metal side panels in this estimate was deemed the most insightfull.

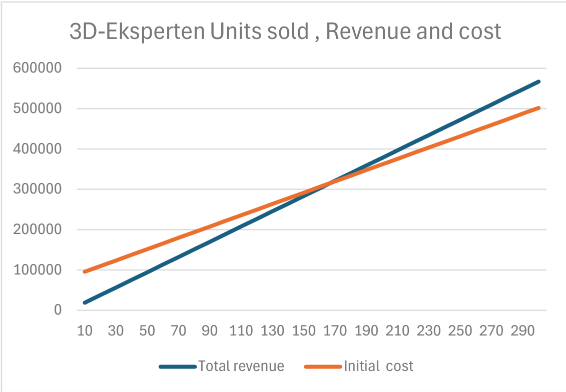
All calculations in this assessment are based solely on the core enclosure unit. Modular accessories and add-ons are not included in the pricing. Shipping estimates are based on a full truckload of 32 EU pallets, each carrying 20 Print Pod units, reflecting the most cost-efficient logistics strategy available. However, 3D eksperten might want to mix in some of their other products. But that shouldn´t affect the price.

Material and labor cost estimates are derived from validated worksheets, referencing real supplier data from Chinese manufacturers and service providers. This ensures that all assumptions are grounded in realistic, current market conditions. Furthermore, these estimates are based on the smallest available MOQs, meaning that actual raw material costs may decrease further with higher volume orders, offering additional potential for cost reduction as the production scales.

This financial overview affirms that Print Pod can be brought to market at a sustainable cost level, with clear paths to profitability for both the design team and retail partner under the proposed licensing model.

TOTALs		
Electronics total	110,45	dkk
Standard total	42,00	dkk
Raw materials total	220,62	dkk
production total	803,09	dkk
paccкeging	151,42	
shipping	72,23	
TOTAL	1399,80	dkk
Initial investment for tools	81740,00	dkk

Print pod initial dev. Investment	25000	dkk



Production cost	1400	dkk
revenue 50%	2100	dkk
total ernings	700	dkk
print pods cut 10%	210	dkk
3d ekspertens cut 90%	490	dkk

units sold	Total revenue	Initial cost	Profit 3d eks.	Profit print pod
10	18897	95738	-76841	-22900
20	37795	109736	-71941	-20801
30	56692	123734	-67042	-18701
40	75589	137732	-62143	-16601
50	94487	151730	-57243	-14501
60	113384	165728	-52344	-12402
70	132281	179726	-47445	-10302
80	151179	193724	-42545	-8202
90	170076	207722	-37646	-6103
100	188974	221720	-32747	-4003
110	207871	235718	-27848	-1903
120	226768	249717	-22948	196
130	245666	263715	-18049	2296
140	264563	277713	-13150	4396
150	283460	291711	-8250	6496
160	302358	305709	-3351	8595
170	321255	319707	1548	10695
180	340152	333705	6448	12795
190	359050	347703	11347	14894
200	377947	361701	16246	16994
210	396844	375699	21146	19094
220	415742	389697	26045	21194
230	434639	403695	30944	23293
240	453537	417693	35844	25393
250	472434	431691	40743	27493
260	491331	445689	45642	29592
270	510229	459687	50541	31692
280	529126	473685	55441	33792
290	548023	487683	60340	35891
300	566921	501681	65239	37991
310	585818	515679	70139	40091
320	604715	529677	75038	42191
330	623613	543675	79937	44290
340	642510	557673	84837	46390
350	661407	571671	89736	48490
360	680305	585670	94635	50589
370	699202	599668	99535	52689
380	718100	613666	104434	54789
390	736997	627664	109333	56889
400	755894	641662	114233	58988
410	774792	655660	119132	61088
420	793689	669658	124031	63188
430	812586	683656	128931	65287
440	831484	697654	133830	67387
450	850381	711652	138729	69487
460	869278	725650	143628	71586
470	888176	739648	148528	73686
480	907073	753646	153427	75786
490	925970	767644	158326	77886
500	944868	781642	163226	79985

Illu 109: Costs and brak even points

07

EPILOGE

As this project reaches its conclusion, it offers a moment to reflect on the journey from identifying user frustrations to proposing an integrated design solution for home-based 3D-printing. This epilogue looks back at the research-driven decisions that shaped the outcome, highlights key lessons learned, and considers the broader implications of the work. While the project addressed practical challenges like noise, odor, and space, it also raised questions about how digital tools coexist with domestic life. The following reflection outlines the project's impact, its limitations, and potential directions for future exploration.

7.1 Product Specification

Enclosure:	Enclosure:
Internal size H,L,W;	890, 550, 550 mm
External size H,L,W;	990, 600, 618 mm
Box dimensions H,L,W;	1025, 675,180 mm
Weight	37 kg
Power input	220 volt
Power out	2 x EU 220 volt
Ventilation unit	80 mm quiet fan
Filtration	HEPA, active carbon
Supported materials	PLA, PETG, ASA, TPU, ABS, PC, HIPS, Nylon, PP, Carbon,
Light source	LED
On/Off	3” LCD screen with buttons
Friction hinges	Torque adjustable 3N - 8N
Latch mechanism	Magnetic
Noise reduction level	≈15 dB
Airflow rate	15 m^3/h, 25 m^3/h, 50 m^3/h
Color options	White, Black, Walnut
Assembly type	Bolt-together construction

Storage Module:	Storage Module
External size HxLxW;	950, 600, 616
Box dimensions H,L,W;	1050, 650,140 mm
Weight	35 kg
Drawer size H,L,W;	70, 557, 522 mm
Drawer load capacity	30 kg
Color options	White, Black, Walnut
Assembly type	Bolt-together construction

7.2 Conclusion

This project set out to improve how 3D printers can fit into homes, not by changing the printers themselves, but by making the spaces around them more comfortable and functional. Through surveys, interviews, home visits, and noise measurements, we learned that many users struggle with the same three issues: the loud noise of printers, the smell from printing materials, and the lack of space to store tools and filament rolls. These challenges often lead people to move their printers to basements, bedrooms, or garages, which is inconvenient and can be frustrating especially when sharing space with others.

From the beginning, we decided not to redesign the printer hardware. Most users are already invested in their machines and have customized them to fit their needs. Instead, we focused on designing a modular system that could improve the home printing experience without requiring a new printer. The final result is a sound and odor reducing enclosure that works as a standalone product, with the option to expand with a storage module. This gives users more flexibility to grow their setup over time and adapt it to their space.

Our main target group played a big role in shaping the design. These users often print for fun, creativity, or small personal projects. They care about how their setup looks, but they also want it to work well in everyday life. That's why the design focused on quiet operation, improved air quality, and efficient use of space. By observing how people actually use their printers, we were able to design something that fits within real homes not just ideal setups.

An important lesson we learned is that technical problems such as noise and ventilation also affect people emotionally and socially. Some users avoided printing at night to keep their partners from waking up, others had to move their printers out of shared spaces because of complaints from roommates or family. Designing around these real-world situations helped us create a solution that goes beyond just solving a problem, it improves the experience of using a 3D printer at home.

This project shows how design can eliminate the shortcomings of radical technology and create a harmonious environment for people and machines.

Illu 110: Customized print pod high view render

Illu 111: Customized print pod Low view render

7.3 Reflection

User Research: Interviews vs. Shadowing
The first six home visits provided strong insights through semi-structured interviews. These conversations helped uncover how users adapt their environments, manage noise, and organize their setups, offering depth that informed the design direction. However, the shadowing study, which involved asking participants to print a simple 10mm cube, yielded more limited insights. The simplicity of the task may not have fully revealed users' natural behavior or problem-solving strategies. A more complex or personally relevant print job might have encouraged deeper engagement and provided richer data. Future observational studies could benefit from giving users open-ended or context-specific challenges.

Production Location and Environmental Impact
The final product will be manufactured in China, which introduces sustainability concerns related to transportation emissions and carbon footprint. While overseas production allowed for fast and cost-effective production with access to specialized fabrication tools, it also creates a disconnect between design and local manufacturing. This raises important questions about how sustainable practices can be balanced with speed and feasibility, especially for products aimed at improving quality of life within the home.

Welding and Frame Construction
A key detail in the final design involves small welded lips on the frame that support mounting points and structural alignment. Multiple alternatives to welding were explored, including fasteners, snap-fit joints, and folded geometries. However, none offered a balance between strength, simplicity, and manufacturing ease. Welding was ultimately chosen for its sturdiness and simplicity. Despite this, welding on small surfaces poses production challenges, especially around tight tolerances and consistency during fabrication. To compensate, tolerances for the side panel mounting holes were widened slightly, allowing them to be mounted even when minor frame variations occurred. This approach ensured assembly reliability while acknowledging the trade-offs in precision and production repeatability.

Enclosure Size and Domestic Fit
The enclosure was designed with outer dimensions of 60 × 60 × 90 cm to accommodate a variety of common FDM 3D printers, including models with top-mounted AMS units and additional accessories. While the internal volume is well suited for mid-sized machines, this generous outer size introduces limitations in terms of domestic fit, particularly in smaller homes, bedrooms, or shared living areas.

For users with compact printers, the enclosure may appear disproportionately large, taking up more space than necessary for their needs. This affects not only where the enclosure can be placed but also how visually integrated it feels within a room. The design prioritizes universal compatibility, but the trade-off is reduced efficiency for users with smaller equipment or limited floor space.

This raises the question of whether future iterations could offer size variants such as smaller enclosures optimized for compact printers, without compromising functionality. Doing so would make the product more accessible to a wider range of users and improve adaptability in space constrained environments, which are common among hobbyist users.

Assembly and User Interaction
While the frame and panels were designed for simple mounting and easy setup in a home environments, it wasn't fully tested with actual users. It remains an open question whether users will find the assembly intuitive, especially if tolerances vary slightly during mass production. Future iterations could benefit from user-assembled prototype testing or instructional material design.

Testing and Validation Limitations
Due to time and scope constraints, real-world testing of the final product were limited. User reactions to the actual physical prototype were not fully measured. While many decisions were informed by interviews and observations, post-launch feedback and long-term use testing would be essential for refining the concept. This highlights the value of iterative prototyping even after a "final" design is reached.

Safety and Compliance
The enclosure addresses safety indirectly by improving air quality and reducing noise, but it introduces its own considerations, especially around heat buildup, ventilation design, and flammability of materials. These aspects were considered but not validated through formal standards or testing. A future development phase could involve working with industry standards to ensure the enclosure supports safe operation under various conditions.

Aesthetics vs. Function
Balancing form and function was a continuous theme. While users valued visual integration into their home environment, many prioritized function (noise reduction, odor control) over aesthetics when forced to choose. This balance influenced the choice of materials and shapes, but also raises questions about how design can evolve to serve both without compromise. Further iteration could explore finishes, material textures, or color schemes that better complement domestic spaces.

Business Model Dependency and Scalability Risk
The product's go-to-market strategy currently relies on a partnership with 3D Eksperten, a Danish retailer with experience in the 3D-printing industry. While this offers credibility and access to an existing customer base, it also creates a dependency that places the product's future in the hands of a single stakeholder.

3D Eksperten holds control over key decisions such as pricing, timing, and whether the product is scaled at all. Although the Print Pod system was developed with modest production demands, its success now depends entirely on their willingness to invest. If they delay or shift focus, the product may remain dormant despite being market-ready.

This results in a clear asymmetry in risk: Print Pod avoids financial risk in production but risks the entire future of the product. For 3D Eksperten, hesitation costs little; for the design team, it could mean the end of the project.

Scalability is also constrained under this model. A limited regional rollout may fall short of user needs identified in the research, such as flexible placement and seamless home integration, which are relevant globally. To mitigate this, alternative paths like additional retail partners, direct-to-user sales, or modular kits could be explored to reduce dependency and support broader adoption.

Cost Calculation Assumptions
When estimating production costs for the Print Pod, we were unfortunately unable to base our calculations on actual hands-on manufacturing, due to time constraints. Ideally, we would have produced at least one full prototype ourselves to gather accurate timing and resource data from each station. This would have allowed us to create a more precise and experience-based cost breakdown.

Instead, we opted for a standardized approach, assigning a uniform duration of one hour per production method per station. This was a deliberate decision to avoid speculative guessing, especially in areas where we lacked direct production experience. While this method introduces a level of generalization, acknowledging that some operations, such as welding, could take longer and others significantly less, we set a consistent one-hour estimate per method as a baseline across all stations.

We recognize that this may lead to a somewhat inflated or uneven estimate for certain steps, particularly those involving simple cuts or fast assembly processes. However, our choice aimed to avoid underestimating complexity or overlooking hidden time costs. It also helped maintain coherence across different production types and suppliers.

Illu 112: Packaging

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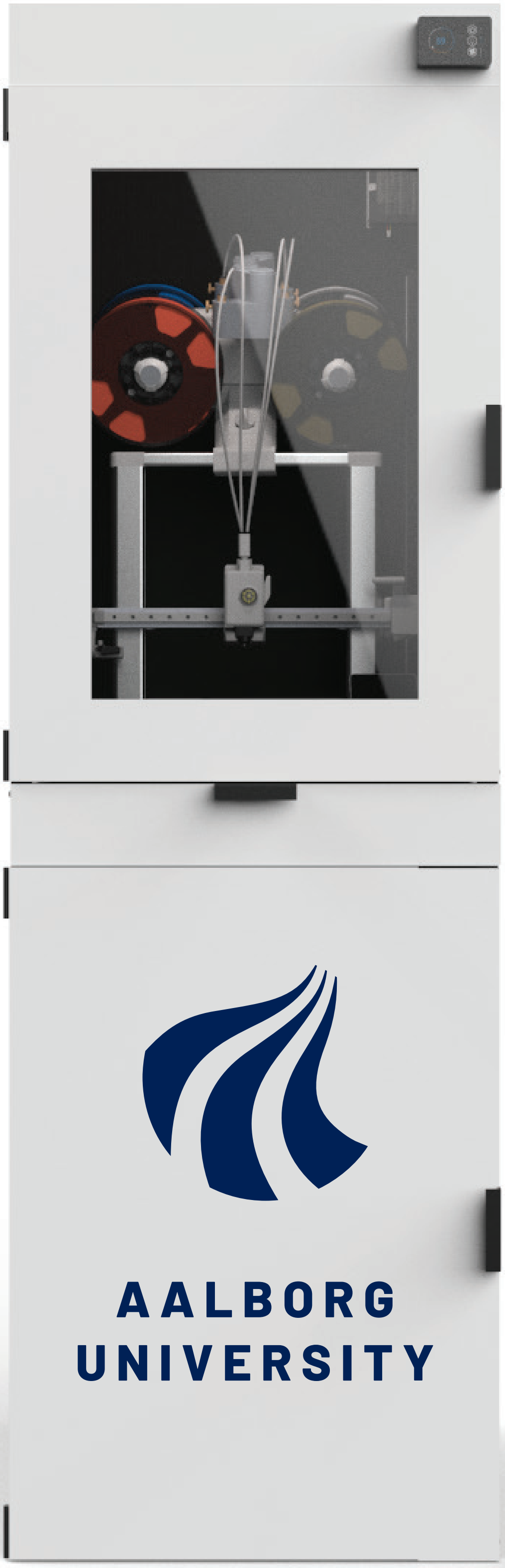
Illustrations

Print Pod

Artificial Intelligence

Assistance was provided by AI language models like Chatgpt and Otter ai, for drafting, transcribing and refining content. These text portions were then subsequently reviewed and edited by the author. Visual assistance was provided through Photoshop ai, Vizcom and Adobe stock to enhance the story telling of the images.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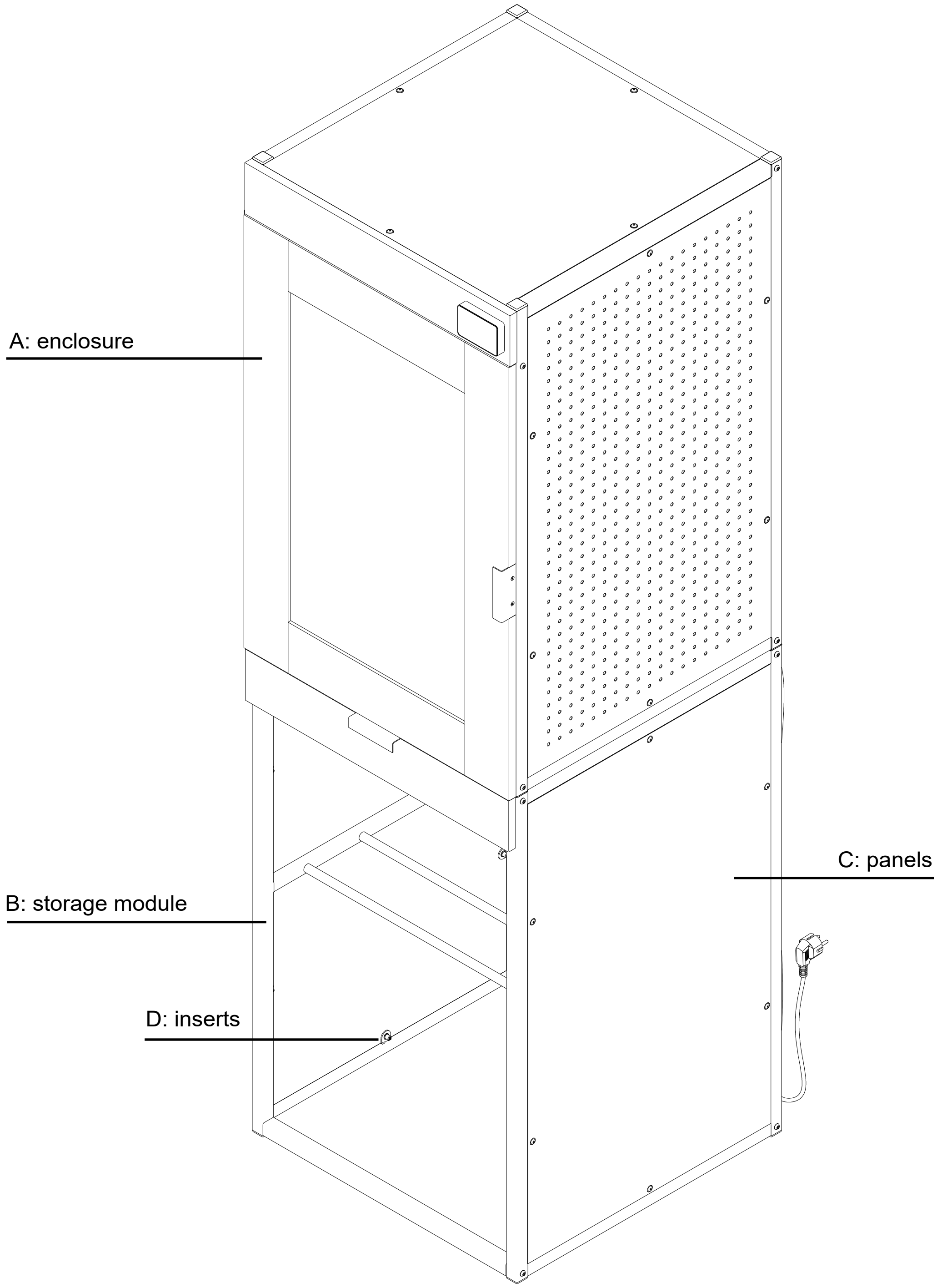

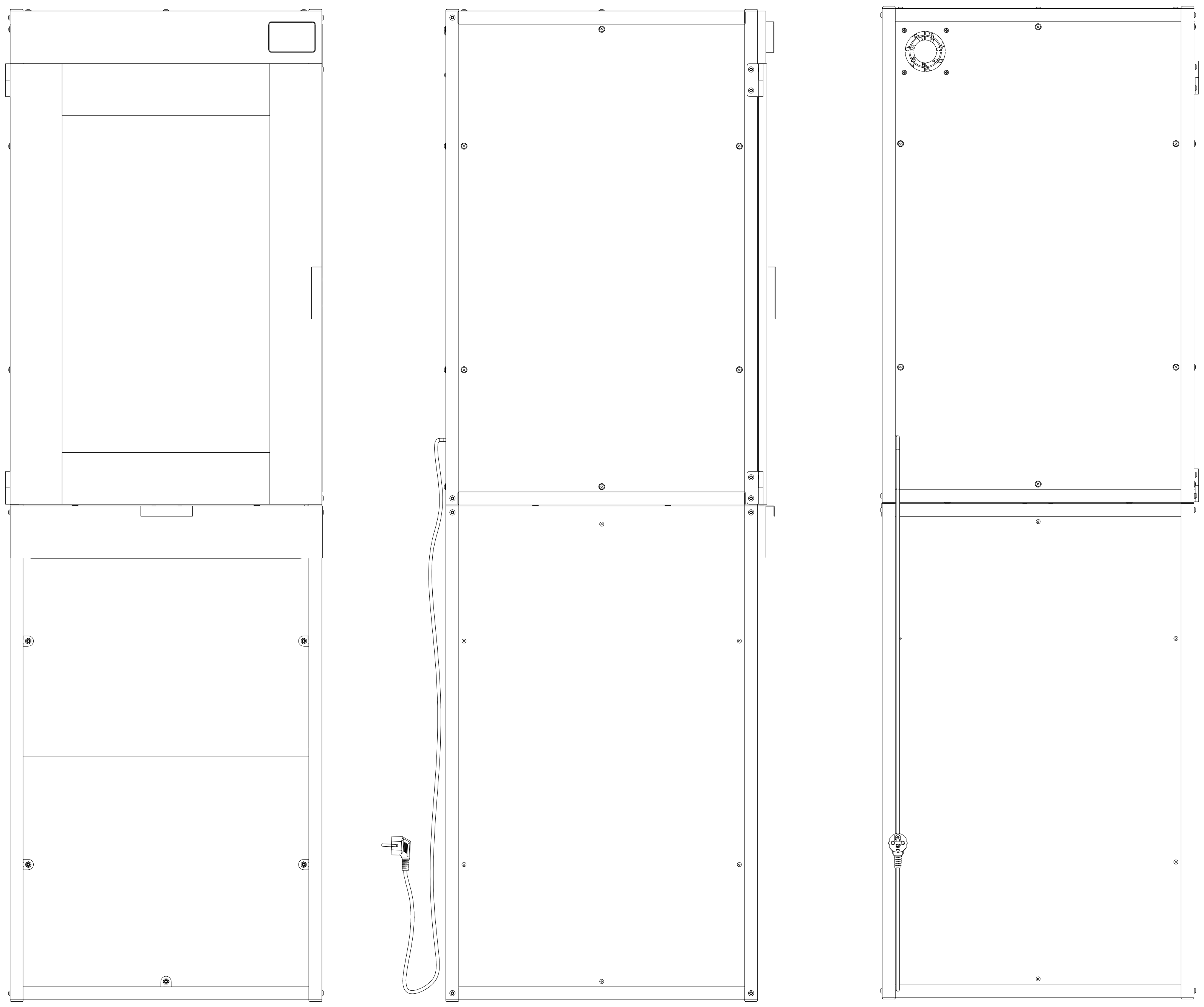

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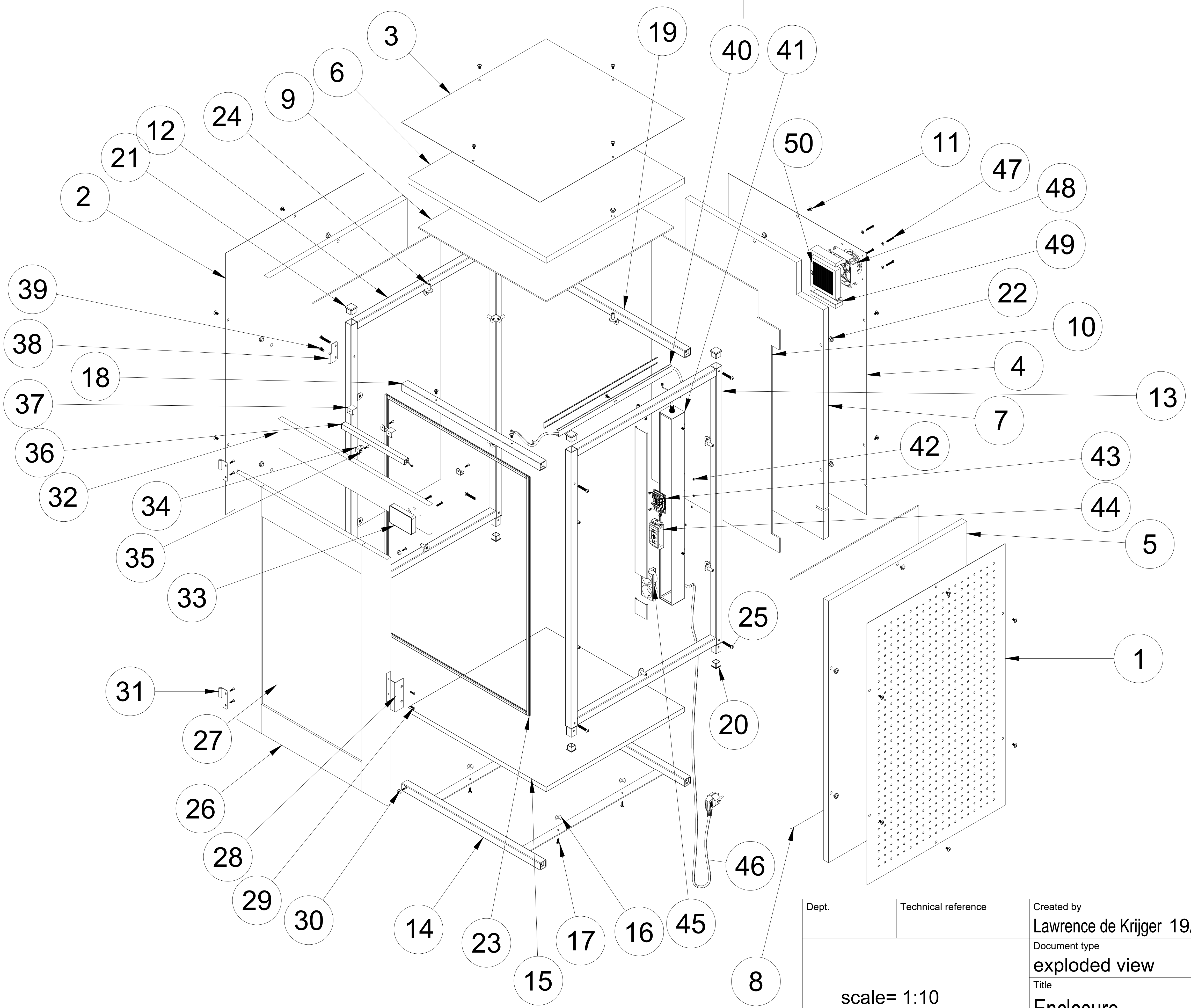

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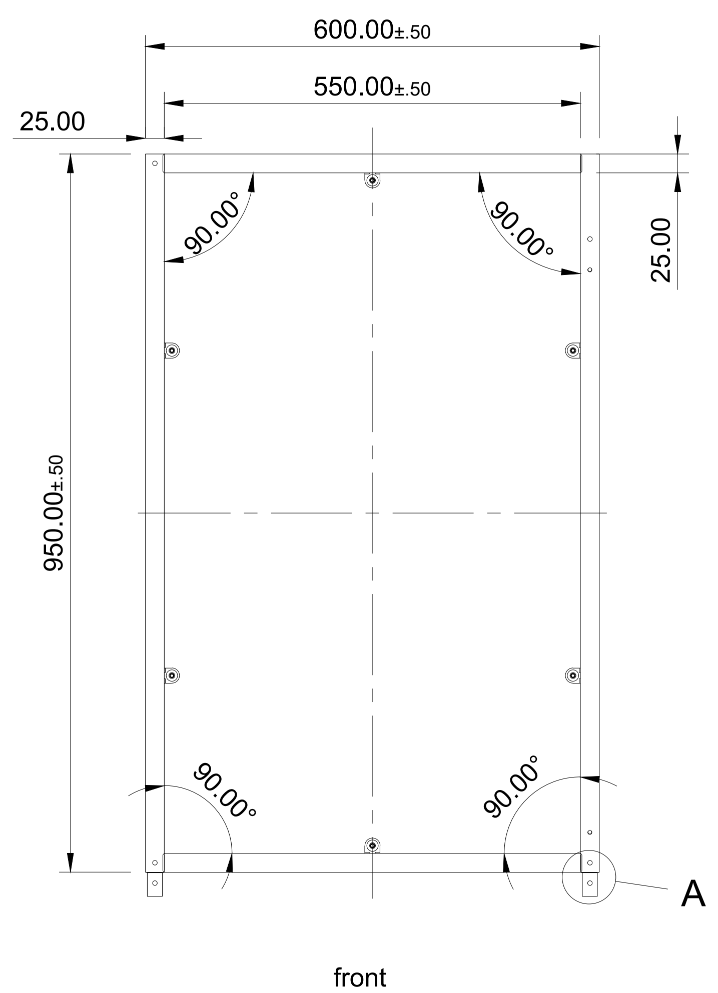
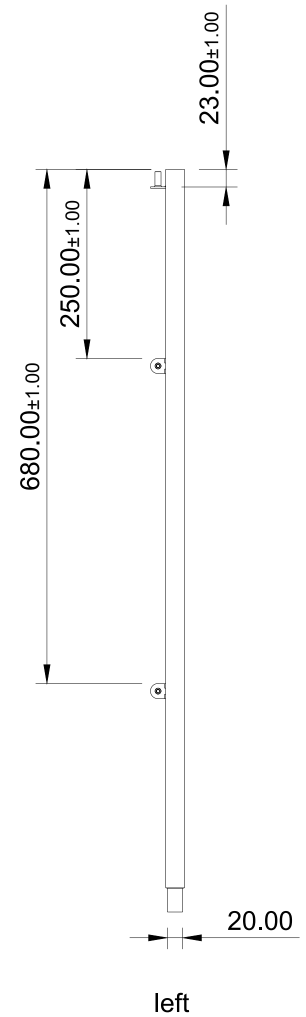
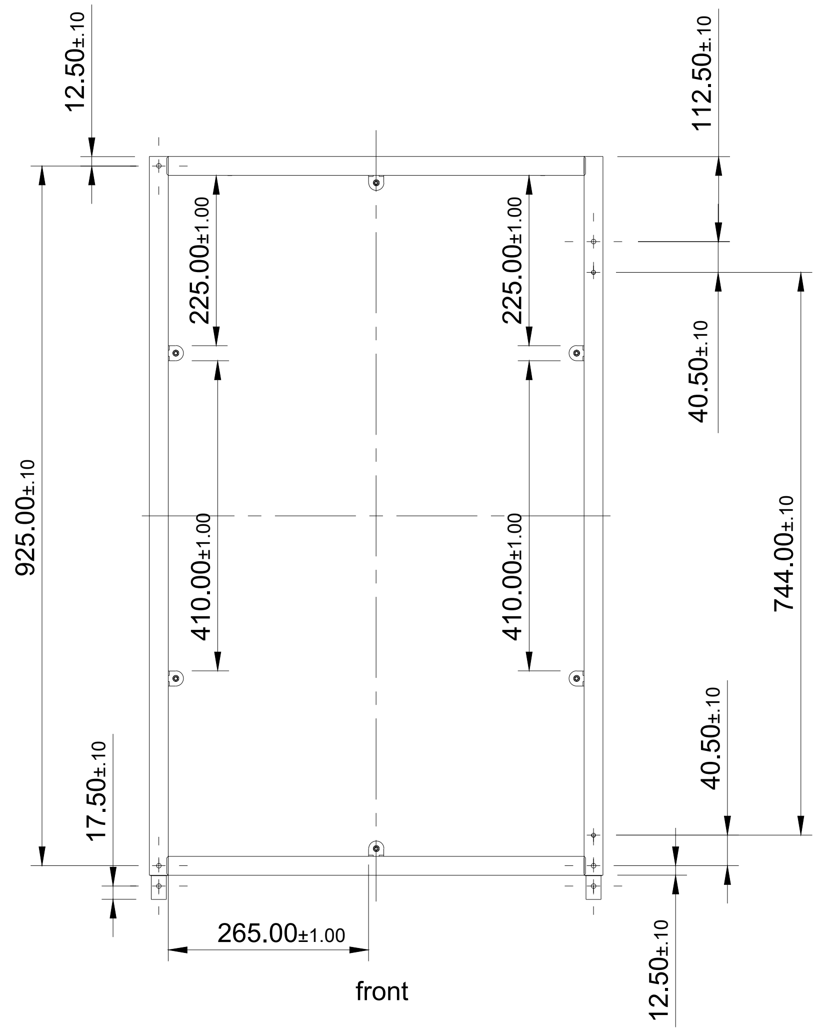
			Rev. / Date of issue / Sheet: 2/39

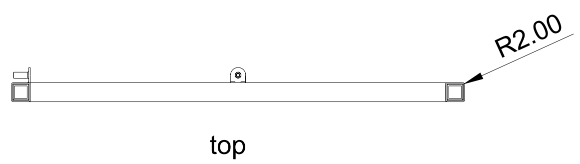
Item	Part name	Qty	Material
	Parts list		
1	Panel sheetmetal - perforated	1	Q195 hot rolled steel - 1 mm
2	Panel sheetmetal	1	Q195 hot rolled steel - 1 mm
3	Panel sheetmetal - top	1	Q195 hot rolled steel - 1 mm
4	Panel sheetmetal - backside	1	Q195 hot rolled steel - 1 mm
5	Sound isolating sheet 1 - side	2	compressed glasswool - 20mm
6	Sound isolating sheet 1 - top	1	compressed glasswool - 20mm
7	Sound isolating sheet 1 - back	1	compressed glasswool - 20mm
8	Sound isolating sheet 2 - side	2	black felt - 4mm
9	Sound isolating sheet 2 - top	1	black felt - 4mm
10	Sound isolating sheet 2 - back	1	black felt - 4mm
11	Flanged M5 buttonhead screw - 15mm	29	Q195 steel
12	Welded frame - left	1	Q195 steel profiles - 25x25mm (4)
13	Welded frame - right	1	Q195 steel profiles - 25x25mm (4)
14	Printer platform - frame	1	Q195 steel profiles - 25x25mm (2)
15	Printer platform - plate	1	MDF - Laminated
16	Rubber washer	4	Rubber
17	Philips decorative rounded head screw - 15mm	4	Q195 steel
18	Horizontal beams - front	1	Q195 steel profiles - 25x25mm
19	Horizontal beams - back	1	Q195 steel profiles - 25x25mm
20	Feet bottom	4	polyethelene
21	Caps top	4	polyethelene
22	Flat edge sleeve washer	21	nylon
23	Door seal	1	TPE rubber (4)
24	Lip - coupling nut	21	Q195 steel
25	Button head M6 hex drive - 25mm	8	Q195 steel
26	Door - frame	1	MDF - Laminated
27	Door - glass	1	Tempered glass - 4mm
28	Handle	1	Q195 steel - 1,2mm
29	Philips flathead screws for wood -10mm	11	Q195 steel
30	Neodymium magnet - 12	2	Neodymium
31	Friction hinge - top	2	Q195 steel
32	Front cover	1	MDF - Laminated
33	Display module	1	/
34	L bracket	3	Q195 steel
35	Zink plated steel hex nut M5	1	Q195 steel
36	Led bar	1	/
37	Clips for Led bar	2	aluminium
38	Friction hinge - bottom	2	Q195 steel
39	Button head M6 hex drive - 10mm	2	Q195 steel
40	Cable canal	1	ABS
41	Power strip housing	1	Aluminium - coated
42	Hex nut M3	6	Q195 steel
43	PCB - operating module	1	/
44	Transformer 220v - 12v	1	/
45	Power socket EU	2	/
46	Cable harnass	1	/
47	Philips screw - 25mm	6	Q195 steel
48	PC fan - 90x 90mm	1	/
49	Hepa/charcoal filter casing	2	ABS
50	Hepa/charcoal filter	1	/

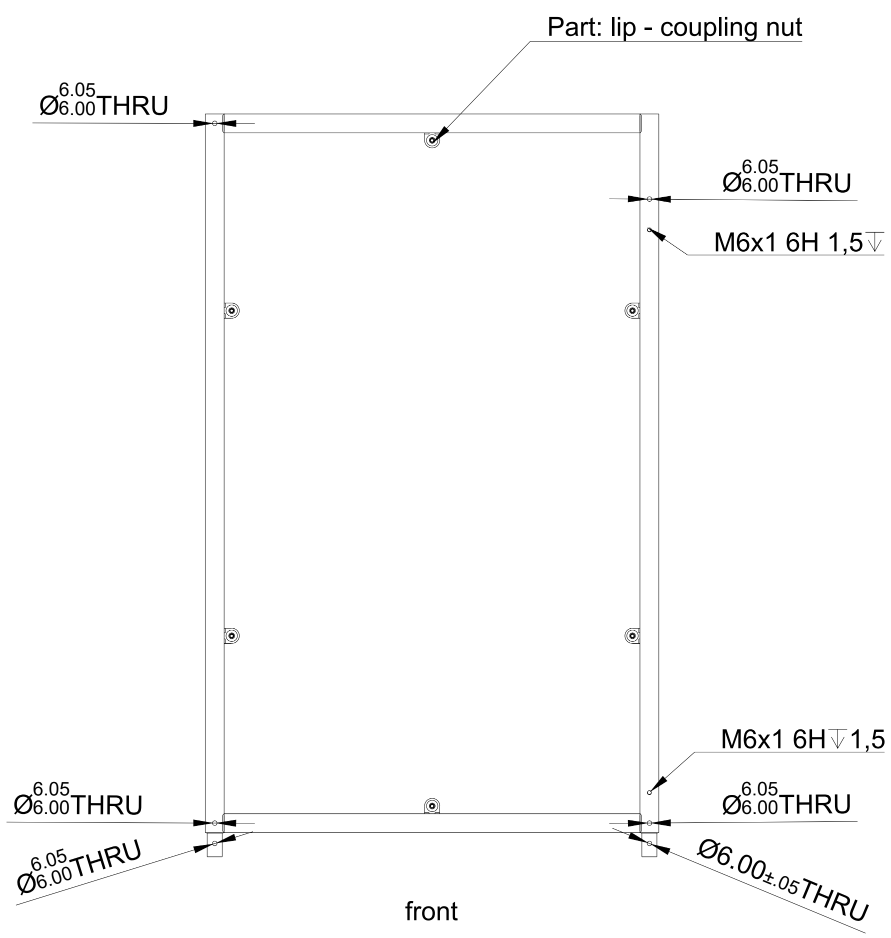
Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 19/05/2025	
		Document type: Bill of materials (BOM)	Document status
		Title: Enclosure	DWG No.: A001.b
			Rev. / Date of issue / Sheet: 3/39

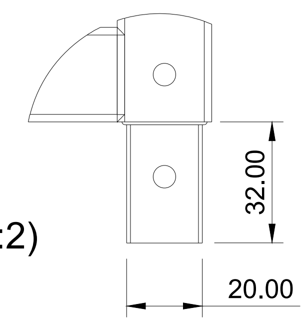






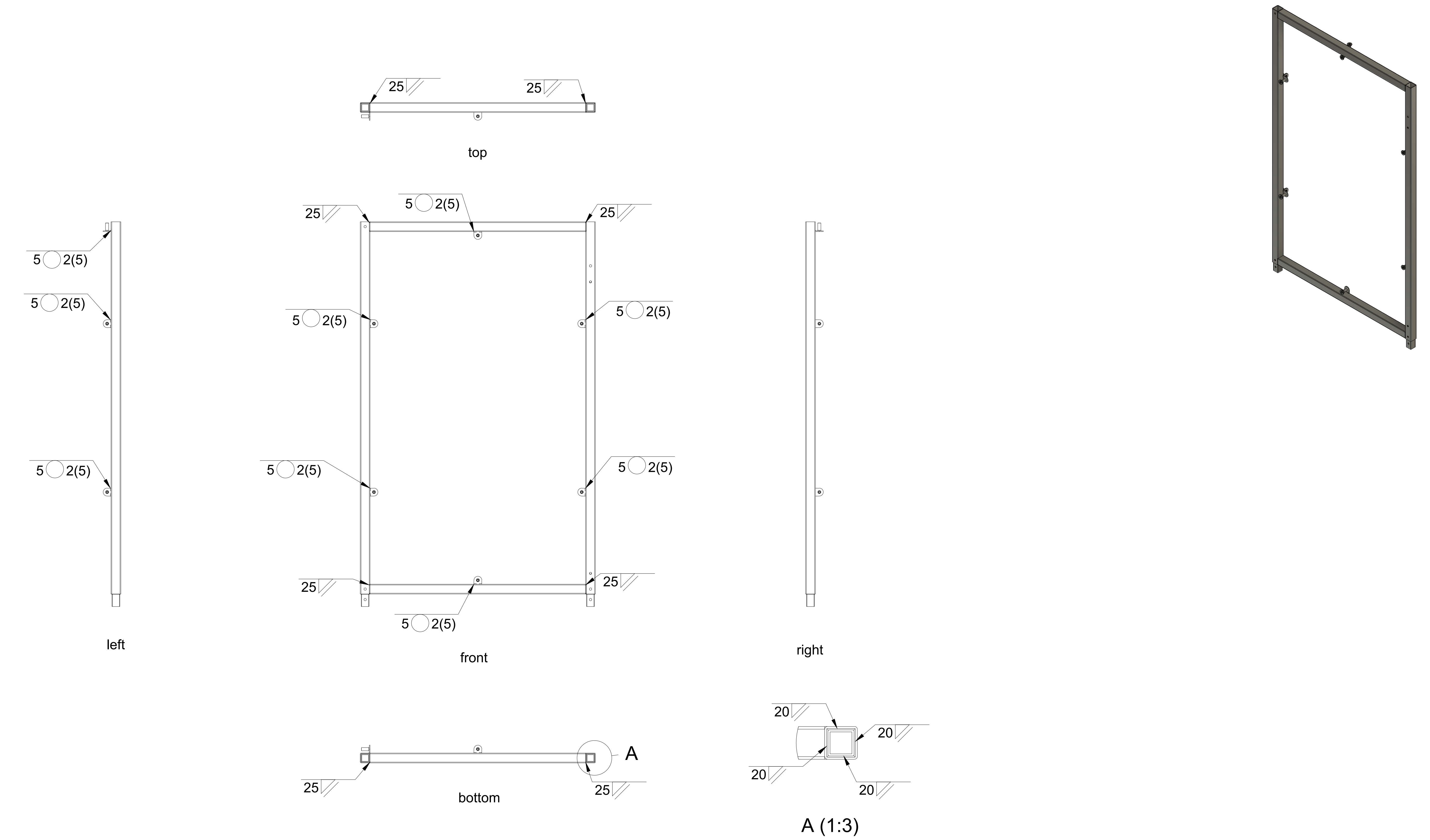




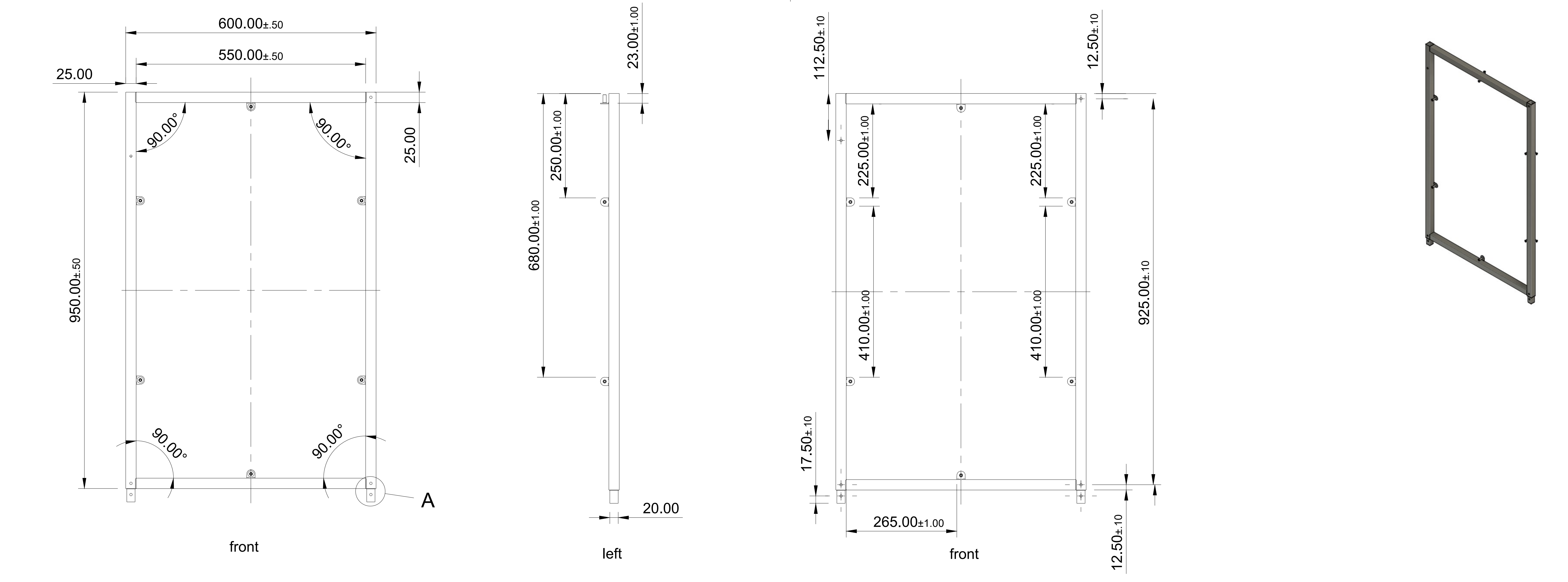


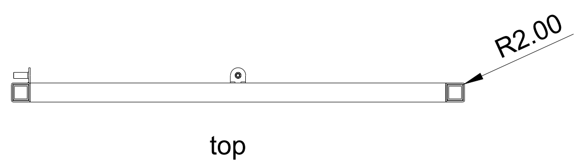
A (1:2)

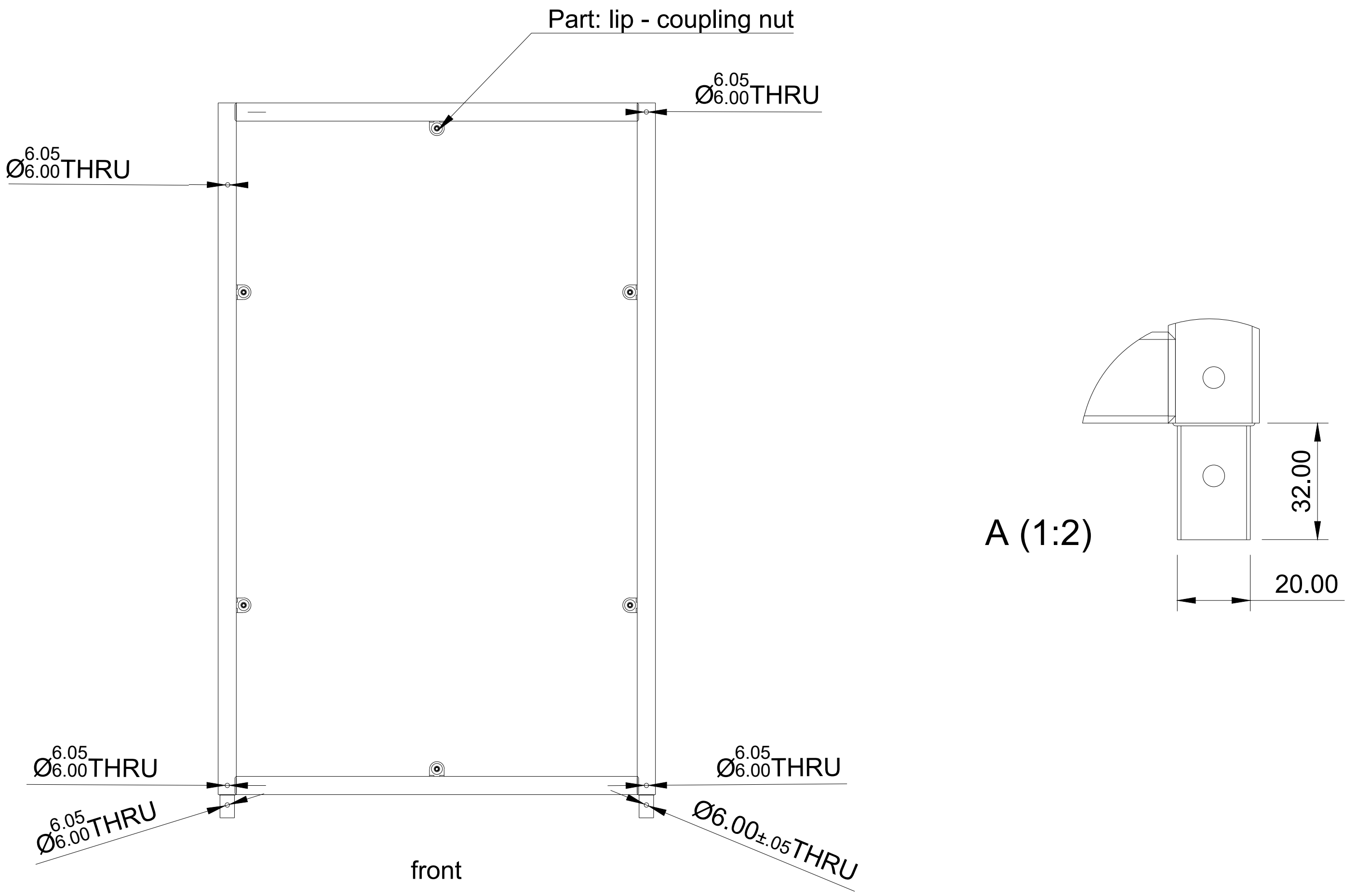
Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 20/05/2025	
unit: millimeters scale: 1:10		Document type technical drawing	Document status
surface finish: powder coat -type: polyester -colour: RAL 9011 -thickness: 60 microns -texture: fine		Title welded frame left	DWG No. A002.a
			Rev. / Date of issue / Sheet 4/39



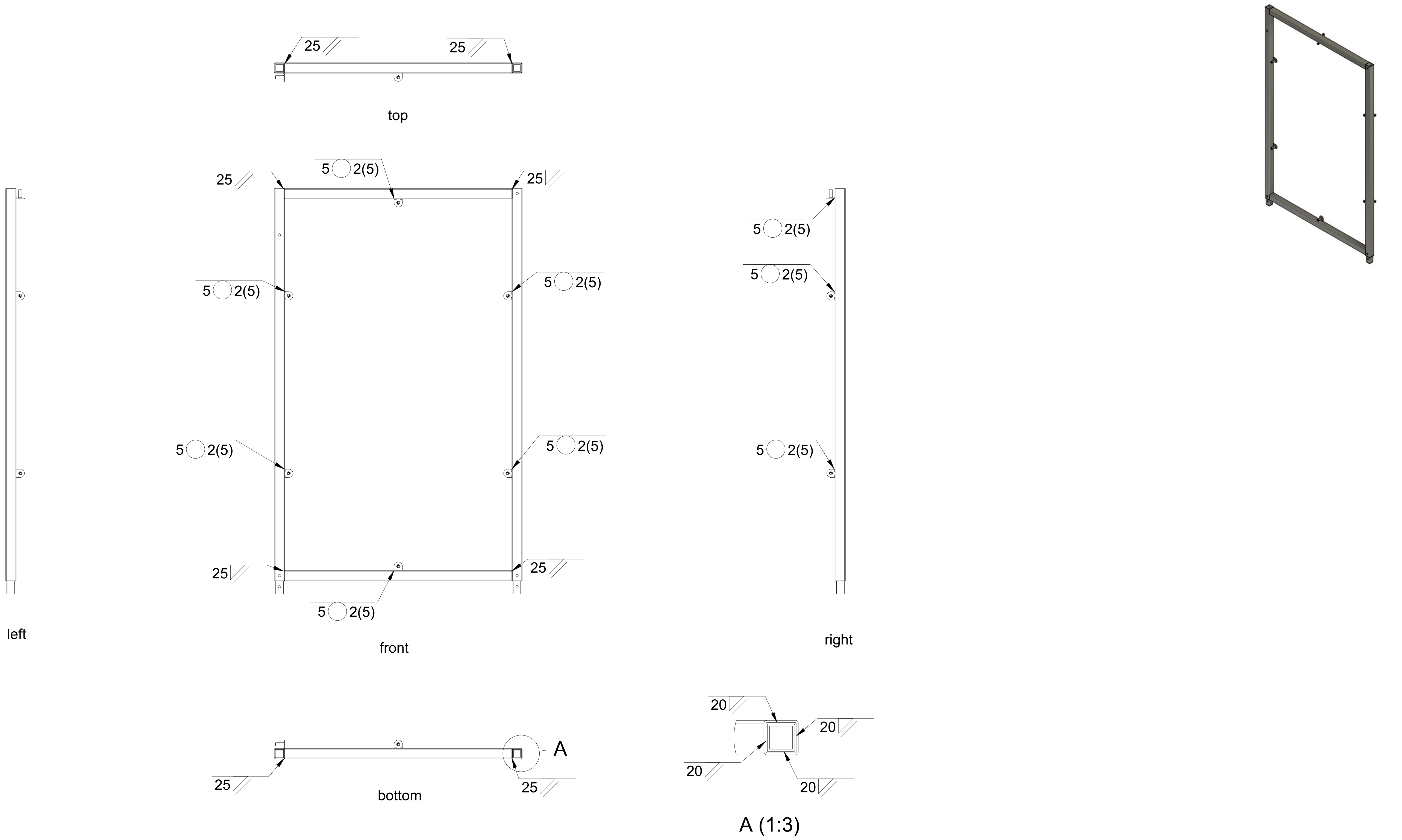
Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 20/05/2025	
unit: millimeter scale: 1:10		Document type welding drawing	Document status
		Title welded frame left	DWG No. A002.b
			Rev. / Date of issue / Sheet 5/39



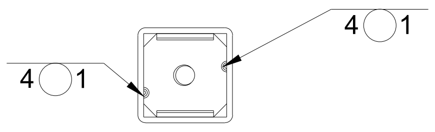




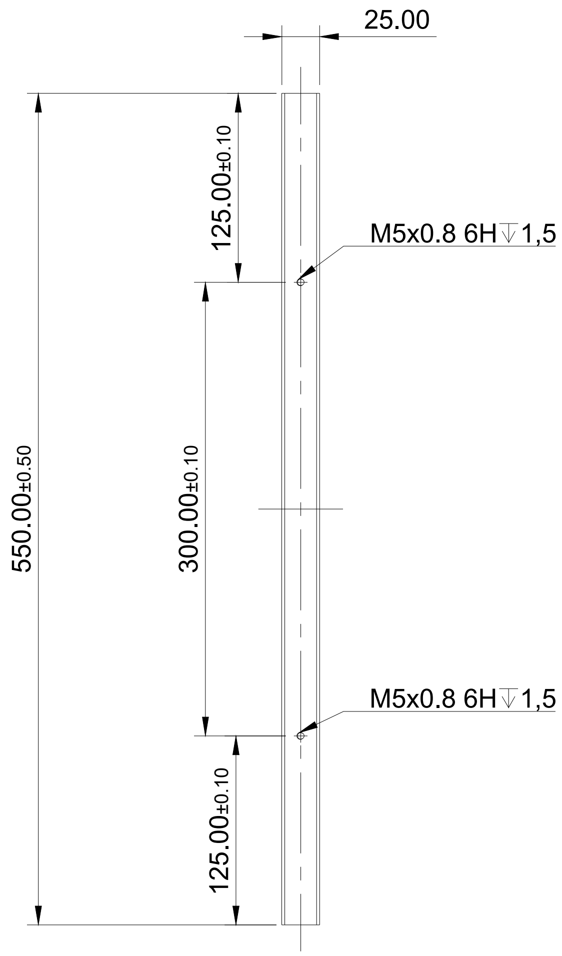
Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 20/05/2025	
unit: millimeters scale: 1:10 surface finish: powder coat -type: polyester -colour: RAL 9011 -thickness: 60 microns -texture: fine		Document type technical drawing	Document status
		Title welded frame right	DWG No. A003.a
			Rev. / Date of issue / Sheet 6/39



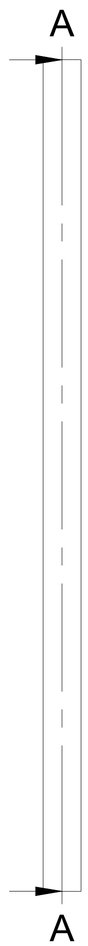
Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 20/05/2025	
unit: millimeter scale: 1:10		Document type: welding drawing	Document status
		Title: welded frame right	DWG No. A003.b
			Rev. / Date of issue / Sheet 7/39



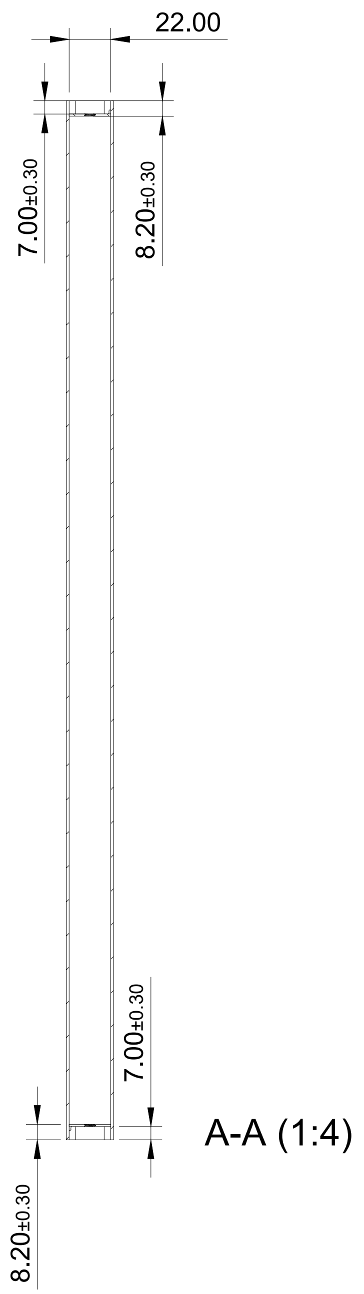
top (1:2)



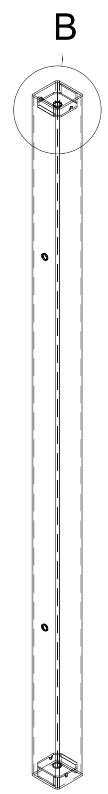
front

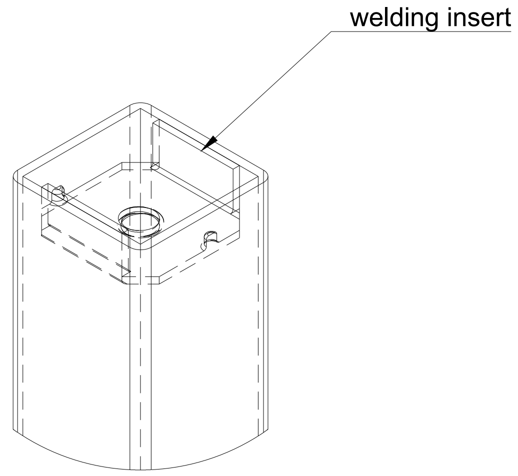


left

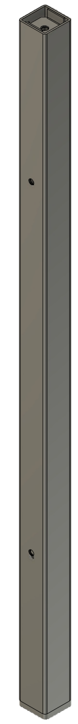


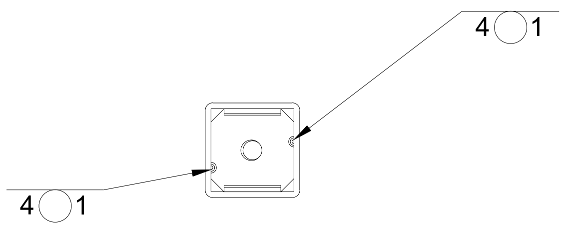
A-A (1:4)





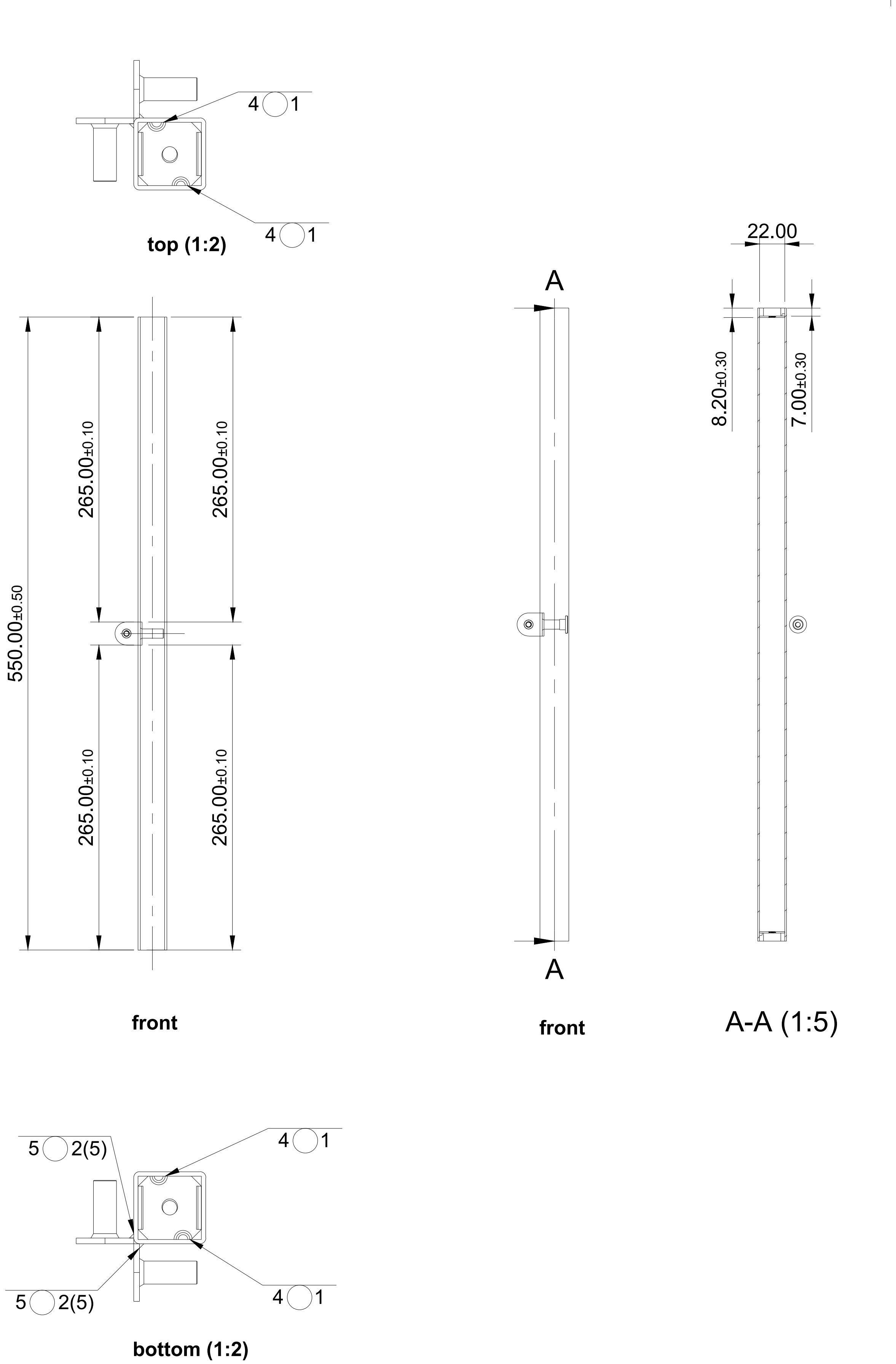
B (1:1)

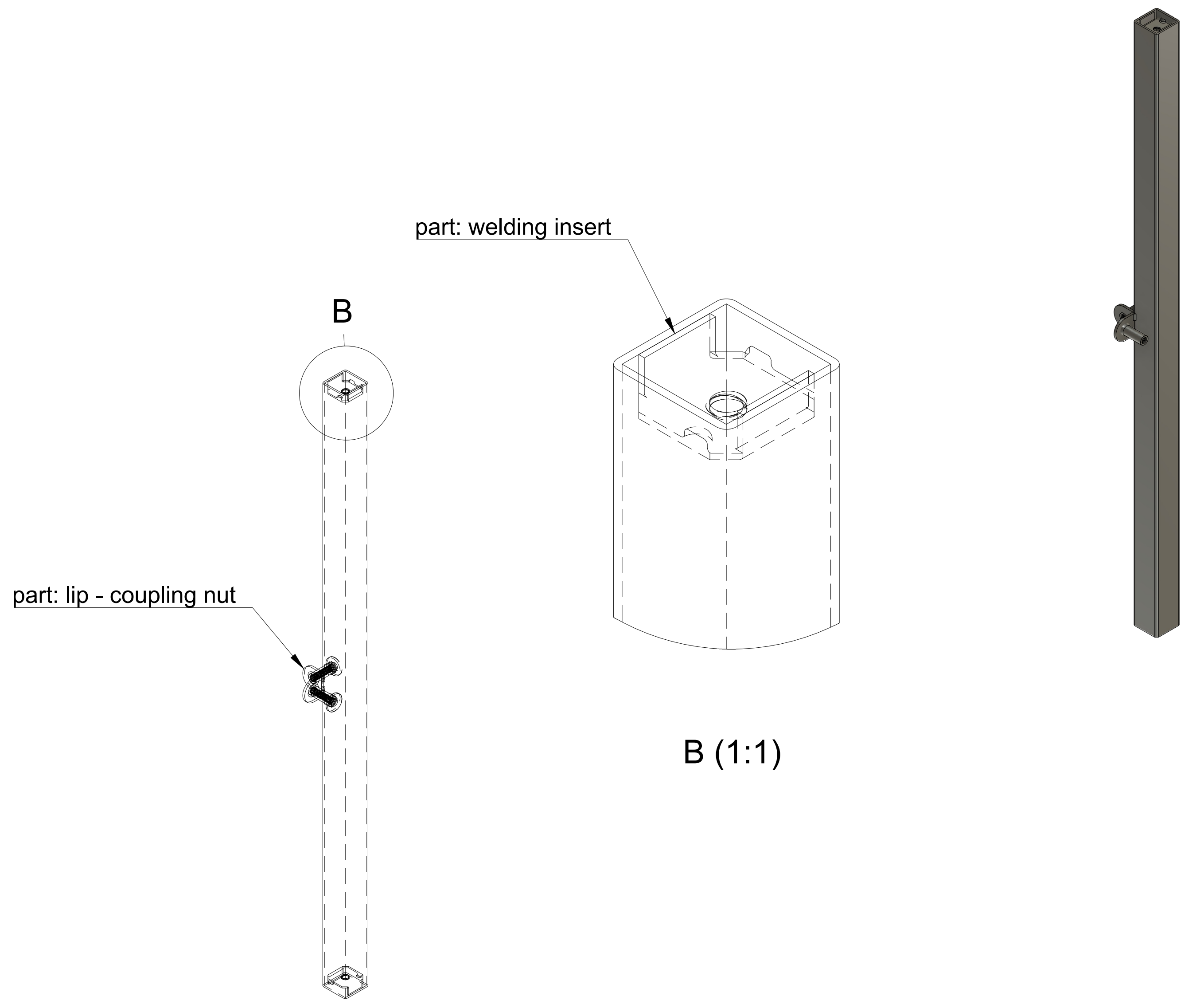




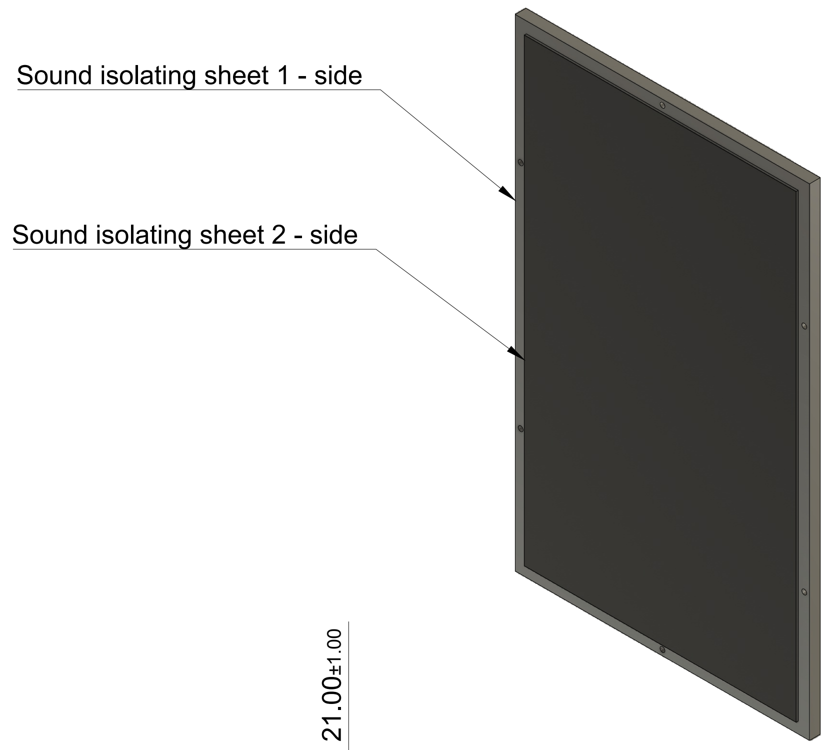
bottom (1:2)

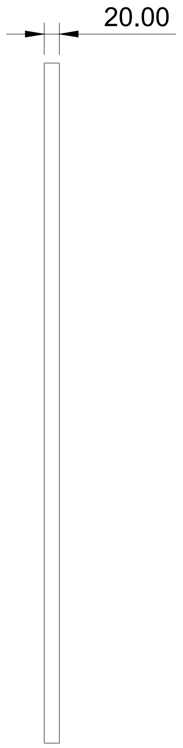
Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 21/05/2025	
unit: millimeter scale: 1:5 surface finish: powder coat -type: polyester -colour: RAL 9011 -thickness: 60 microns -texture: fine		Document type technical drawing	Document status
		Title horizontal beams front	DWG No. A004
			Rev. / Date of issue / Sheet 8/39



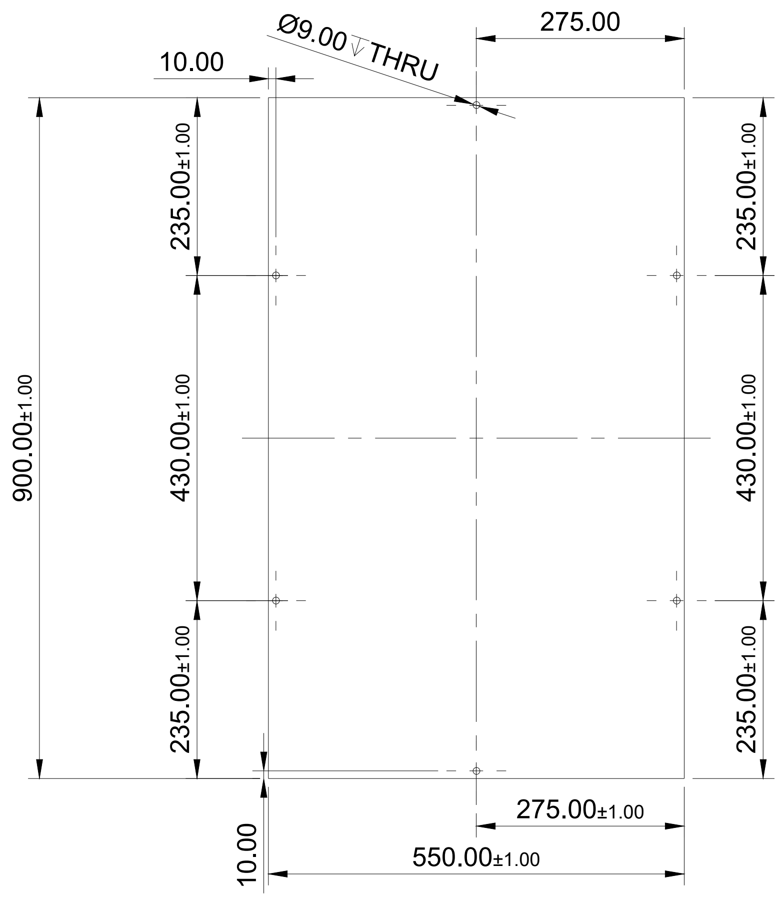


Dept.	Technical reference	Created by Lawrence de Krijger 21/05/2025	Approved by
unit: millimeters scale: 1:5 surface finish: powder coat -type: polyester -colour: RAL 9011 -thickness: 60 microns -texture: fine		Document type technical drawings	Document status
		Title horizontal beams - back	DWG No. A005
			Rev. / Date of issue / Sheet 9/39

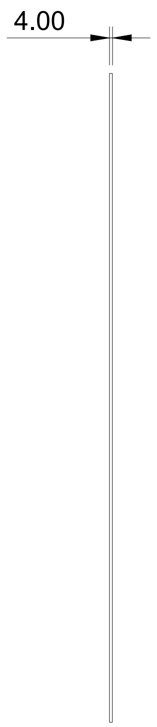




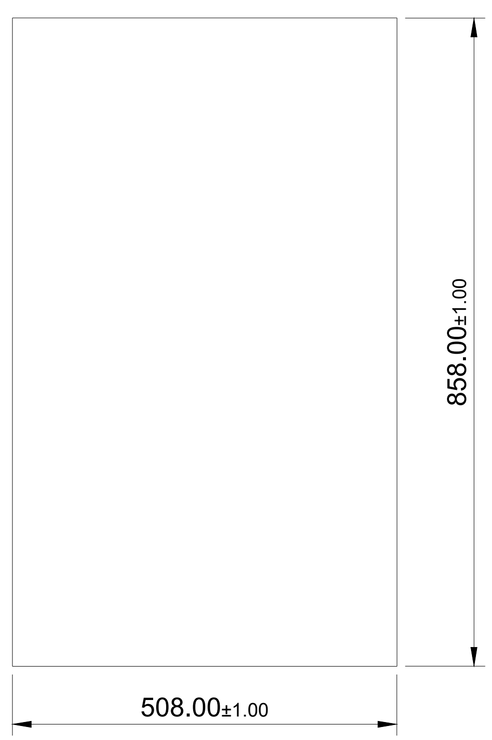
Left: sound isolating sheet 1 - side



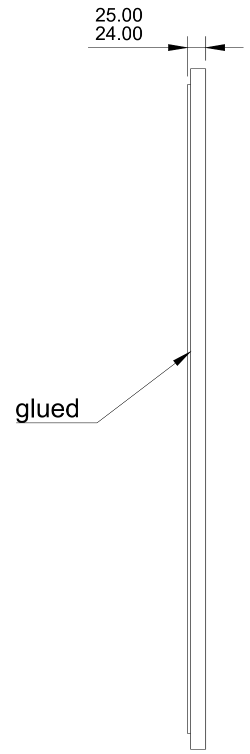
Front: sound isolating sheet 1 - side



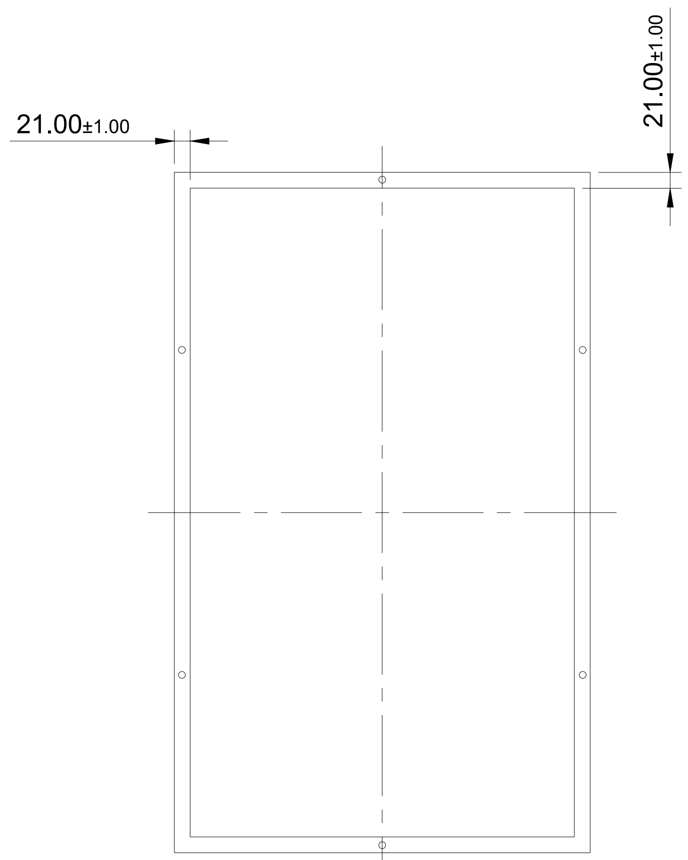
Left: sound isolating sheet 2 - side



Front: sound isolating sheet 2 - side

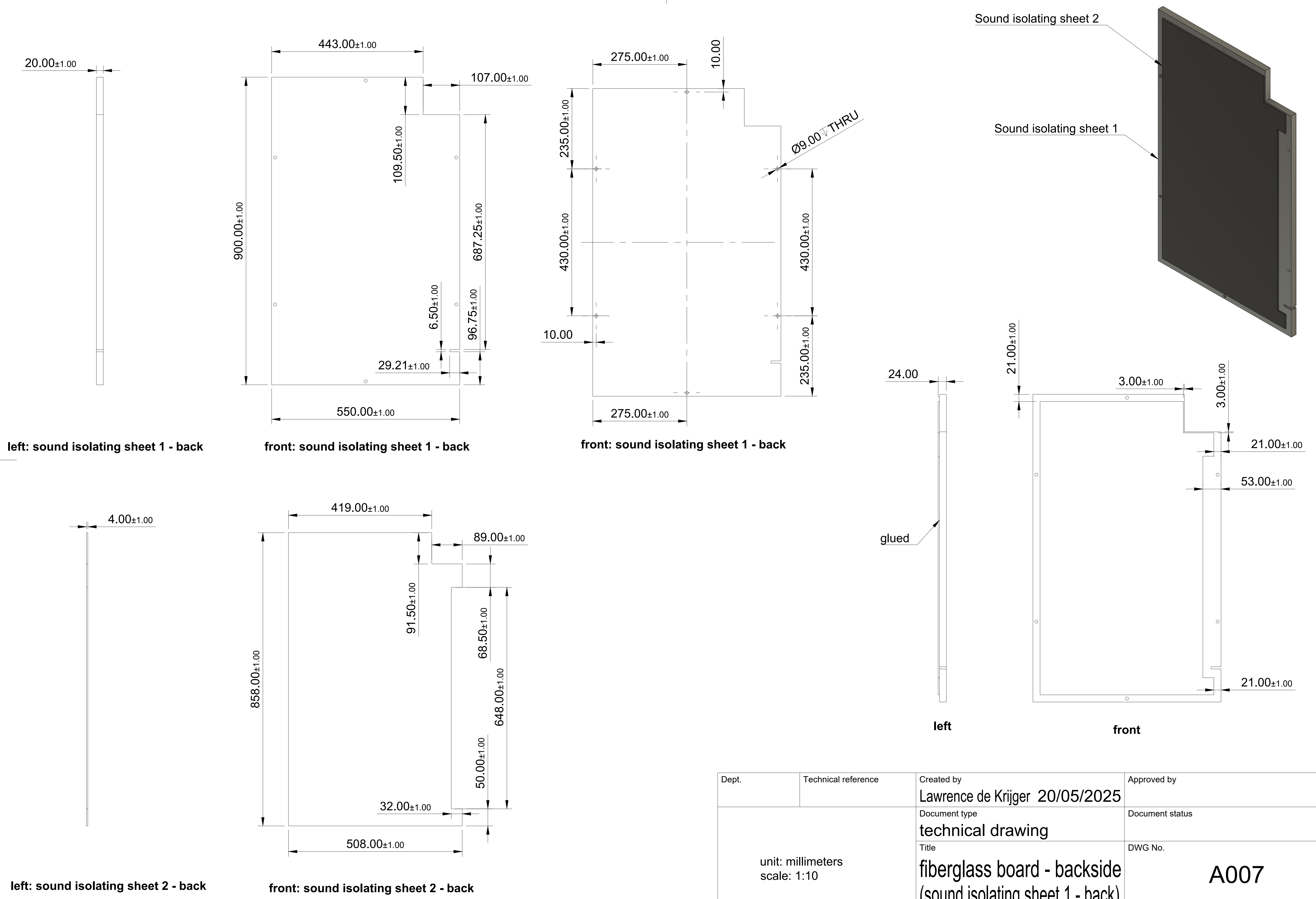


left

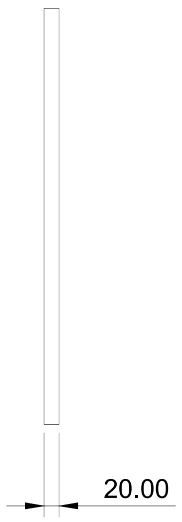


front

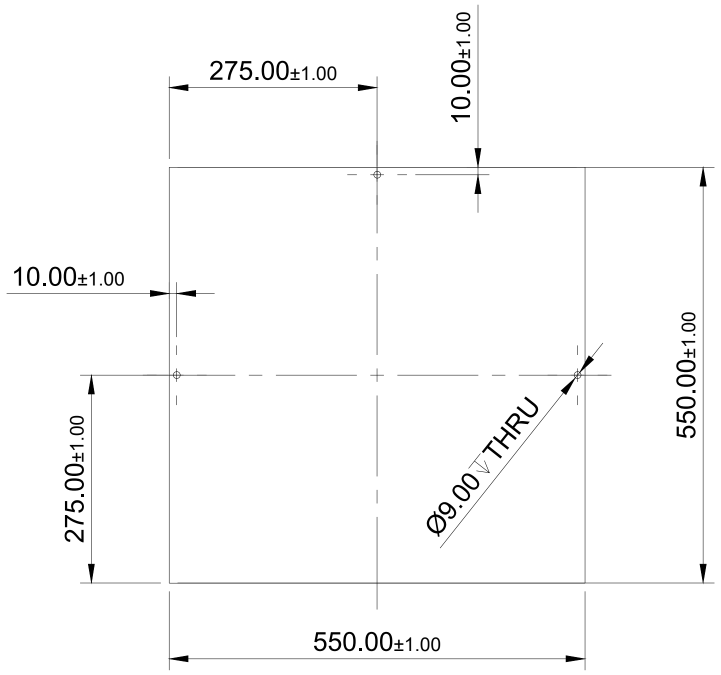
Dept.	Technical reference	Created by	Approved by		
		Lawrence de Krijger 20/05/2025			
unit: millimeter scale: 1:10		Document type: technical drawing	Document status		
		Title: fiberglass board - side 1 + 2 (sound isolating sheet 1 - side) (sound isolating sheet 2 - side)	DWG No.: A006		
			Rev.	Date of issue	Sheet 10/39



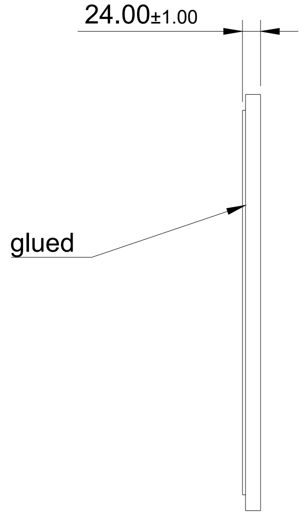
Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 20/05/2025	
unit: millimeters scale: 1:10		Document type: technical drawing	Document status
		Title: fiberglass board - backside (sound isolating sheet 1 - back) (sound isolating sheet 2 - back)	DWG No. A007
			Rev. / Date of issue / Sheet 11/39



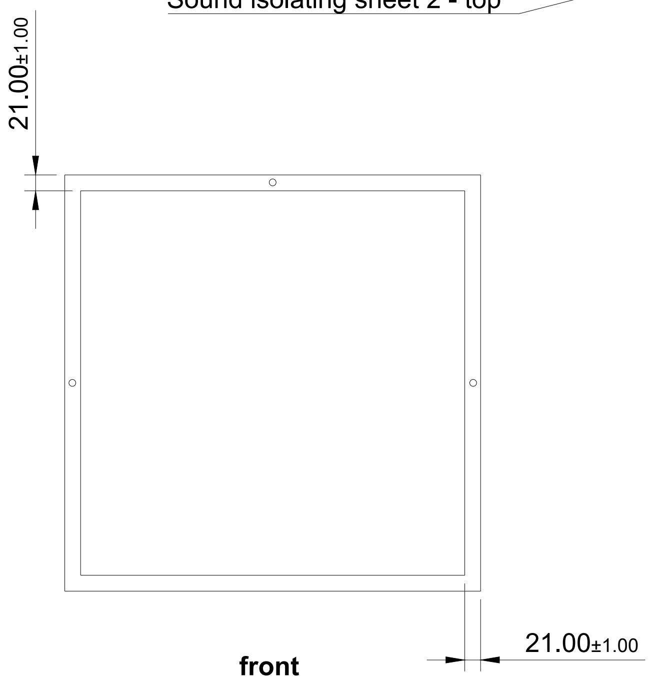
left: sound isolating sheet 1 - top



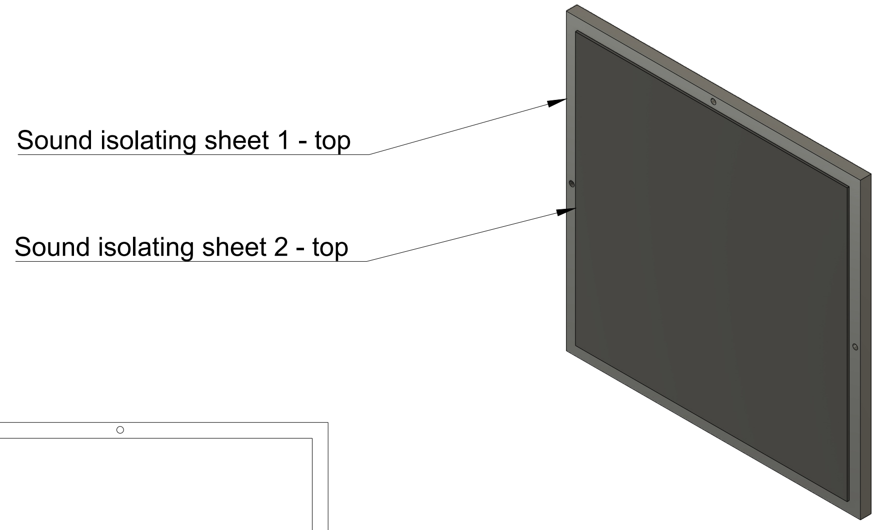
front: sound isolating sheet 1 - top

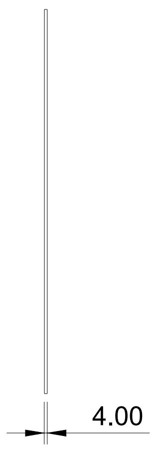


side

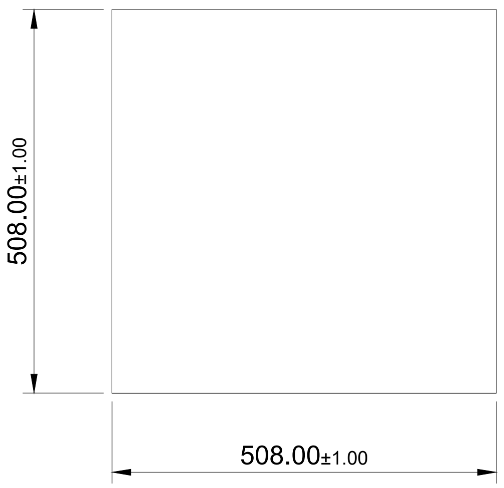


front



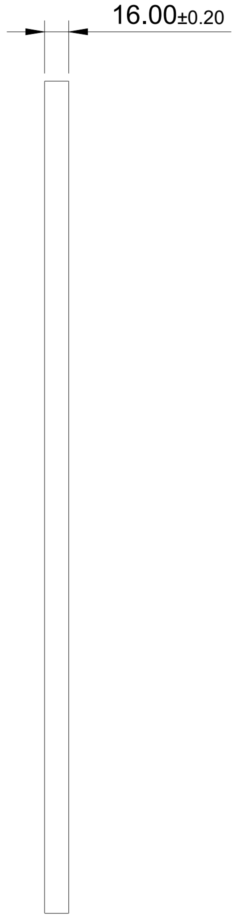


left: sound isolating sheet 2 - top

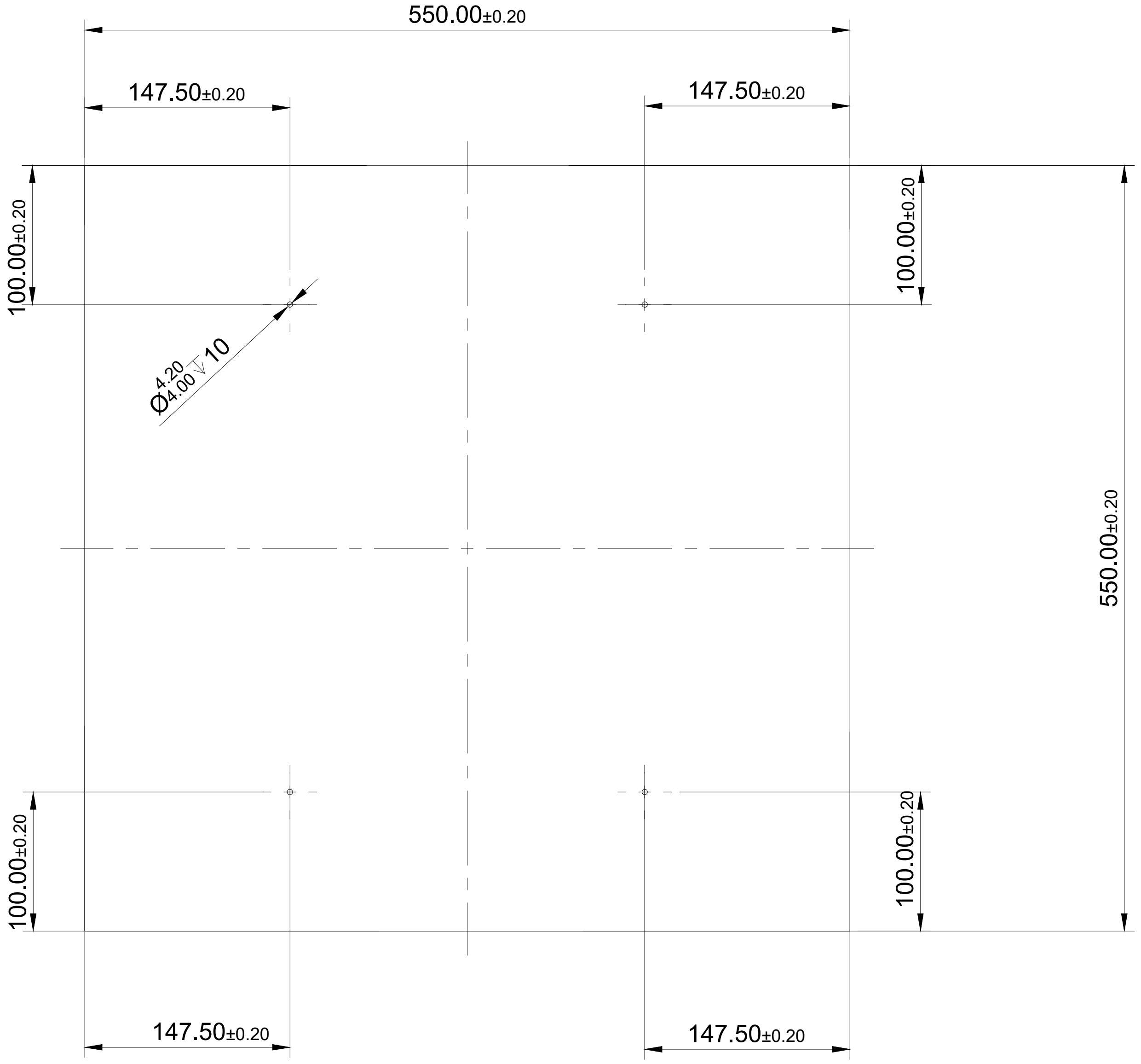


front: sound isolating sheet 2 - top

Dept.	Technical reference	Created by Lawrence de Krijger 20/05/2025	Approved by		
unit: millimeter scale: 1:10		Document type Technical drawing	Document status		
		Title fiberglass board - top (sound isolating sheet 1 - top) (sound isolating sheet 2 - top)	DWG No. A008		
			Rev.	Date of issue	Sheet 12/39

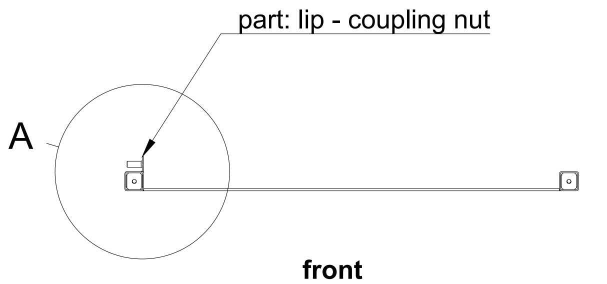


Left

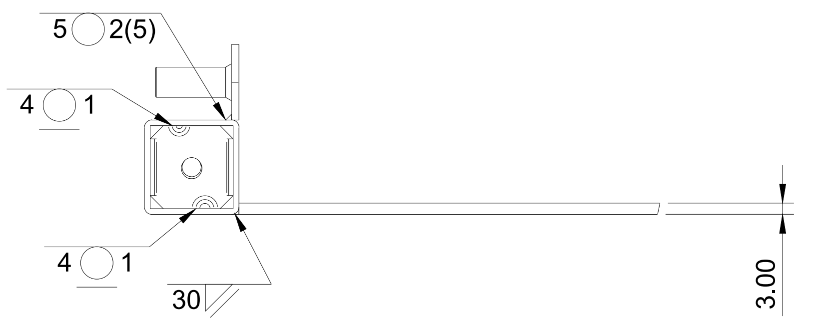


Front

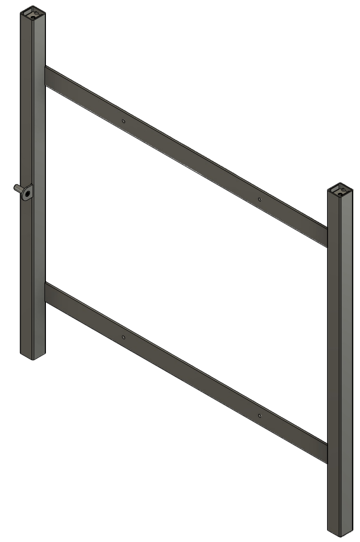
Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 20/05/2025	
unit: millimeter scale: 1:5 surface finish: laminated -colour: RAL 9001 -thickness: 0,15mm -texture: smooth		Document type technical drawing	Document status
		Title printer platform - plate	DWG No. A009
			Rev. / Date of issue / Sheet 13/39

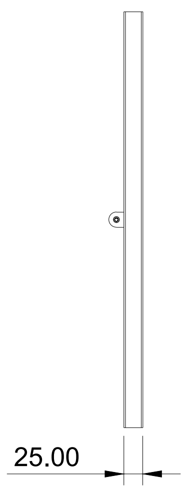


front

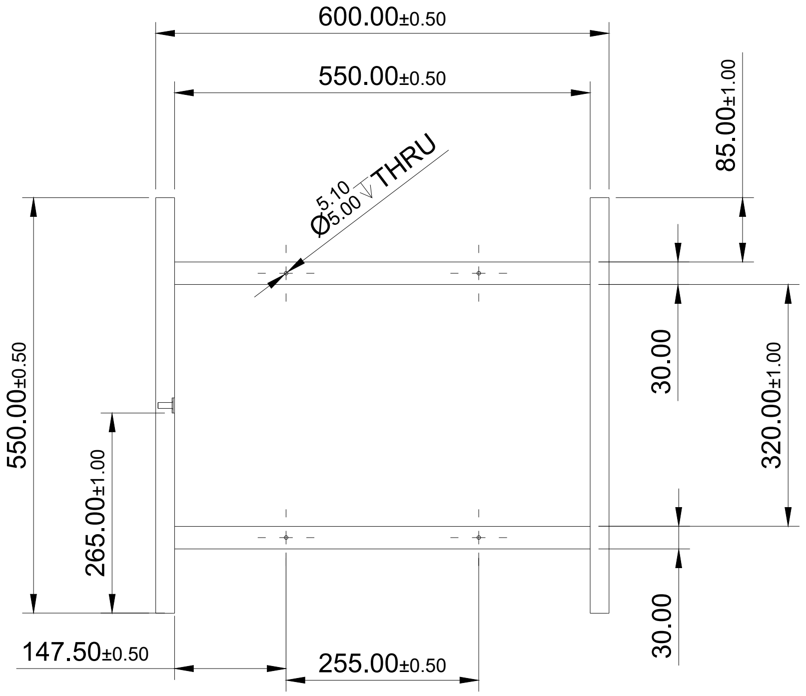


A (1:2)

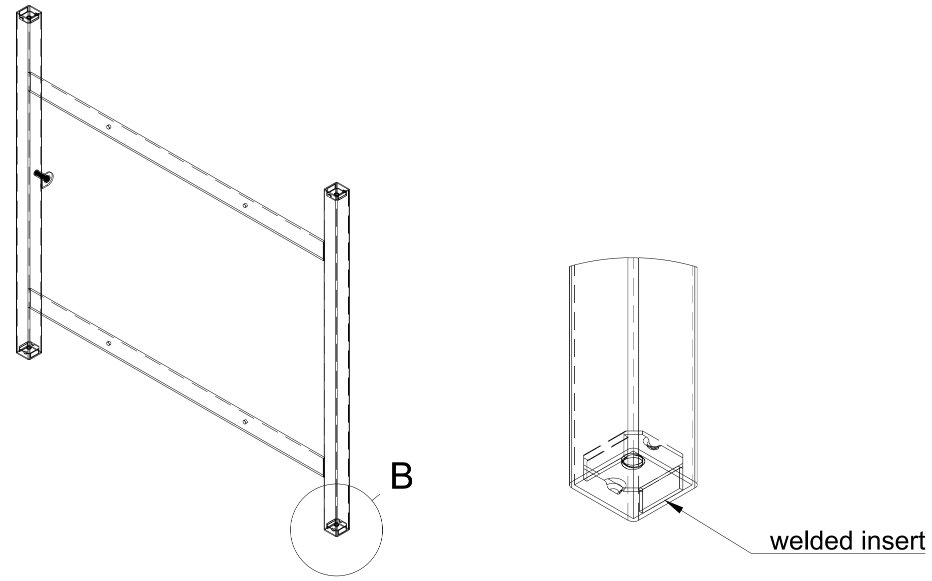




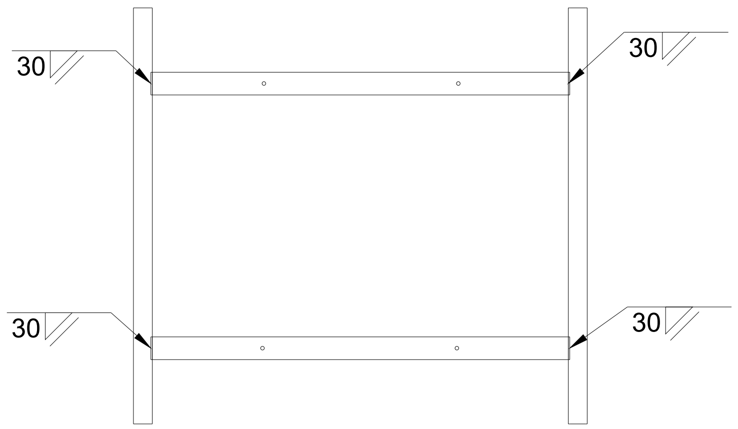
left



top

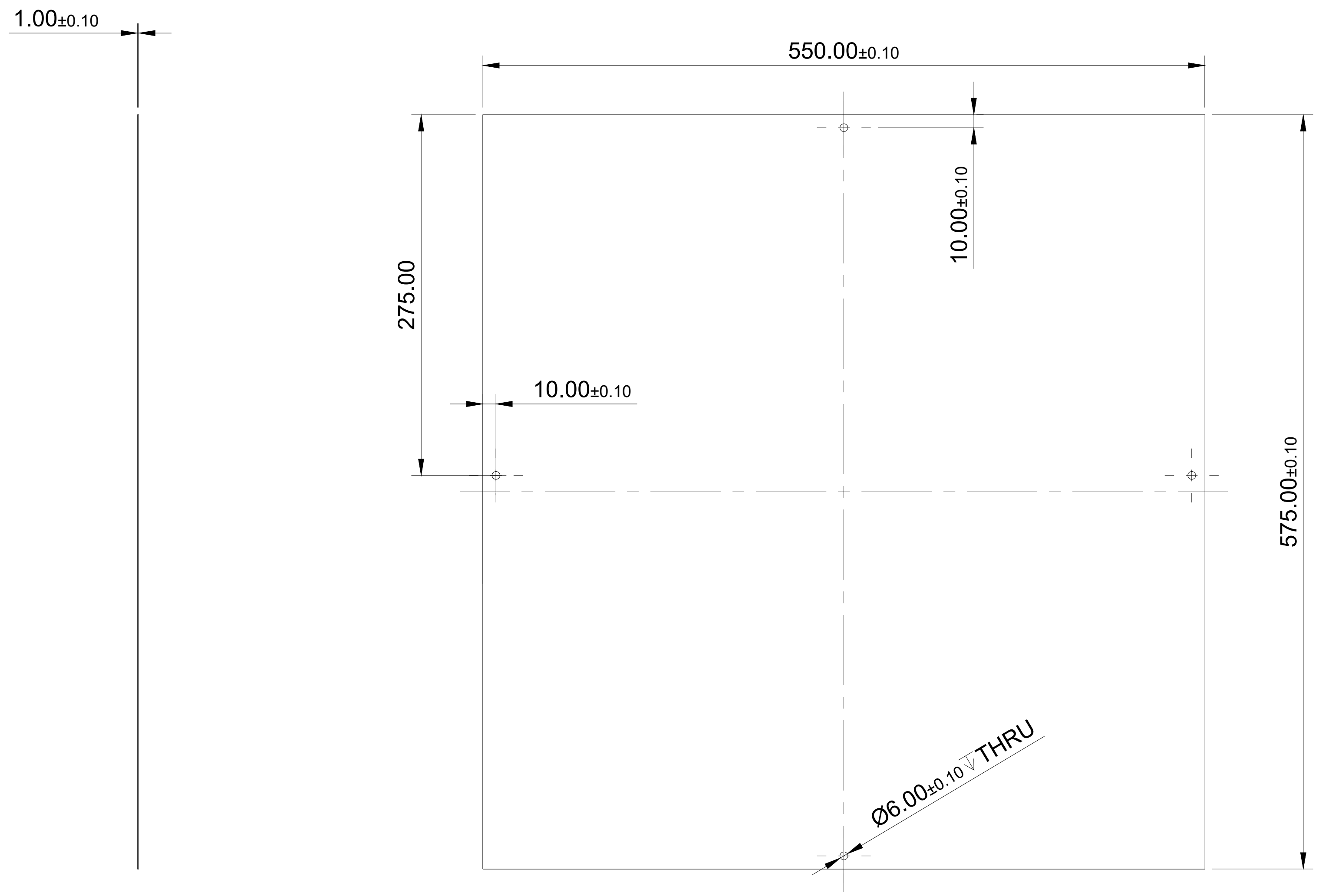


B (1:2)



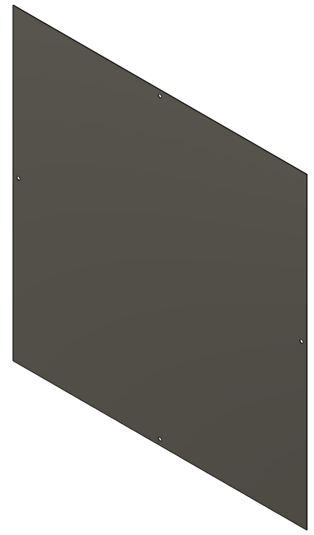
bottom

Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 21/05/2025	
unit: millimeter scale: 1:10 surface finish: powder coat -type: polyester -colour: RAL 9011 -thickness: 60 microns -texture: fine		Document type: technical drawing	Document status
		Title: printer platform - frame	DWG No.: A010
			Rev. / Date of issue / Sheet: 14/39

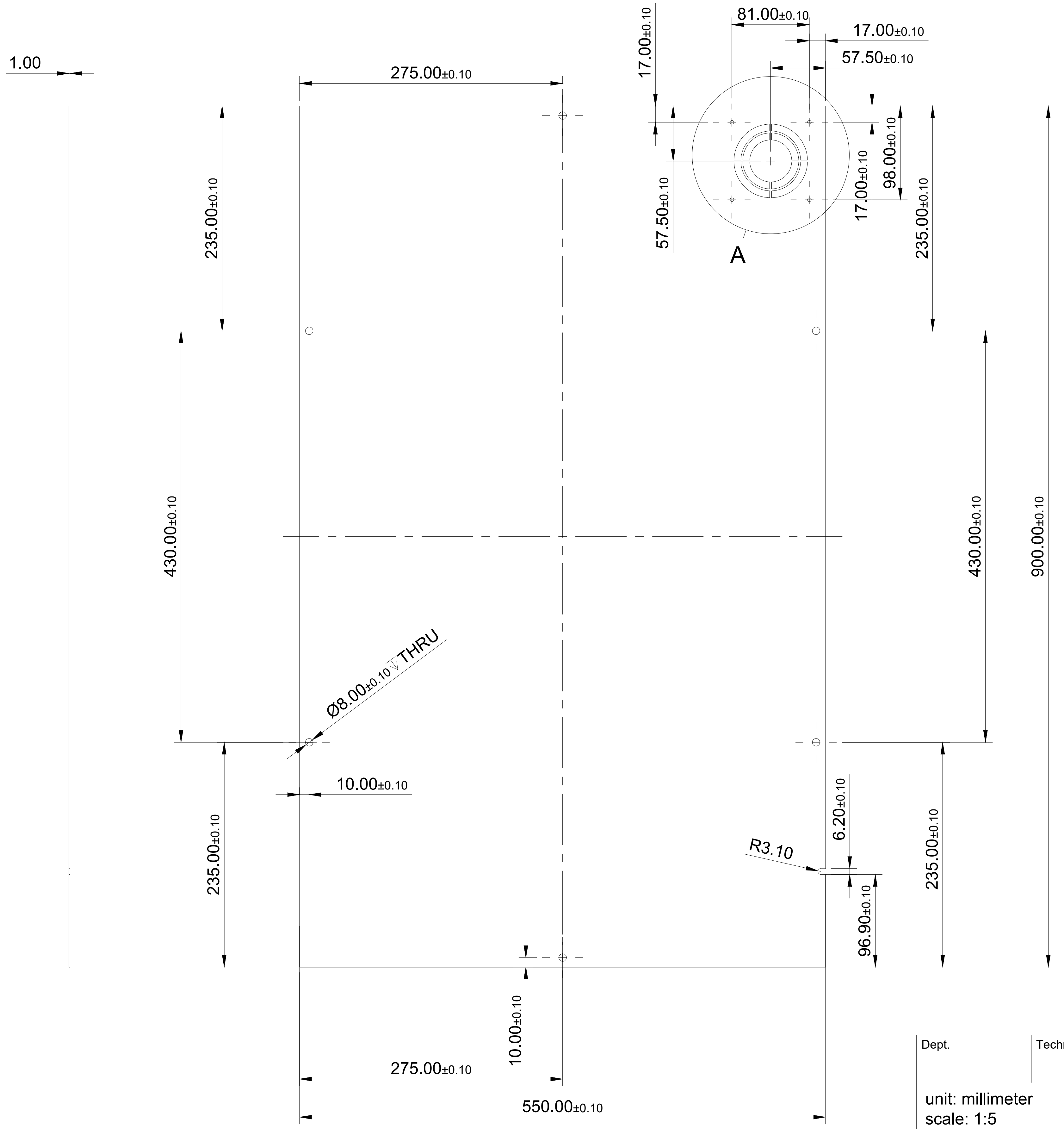


left

top

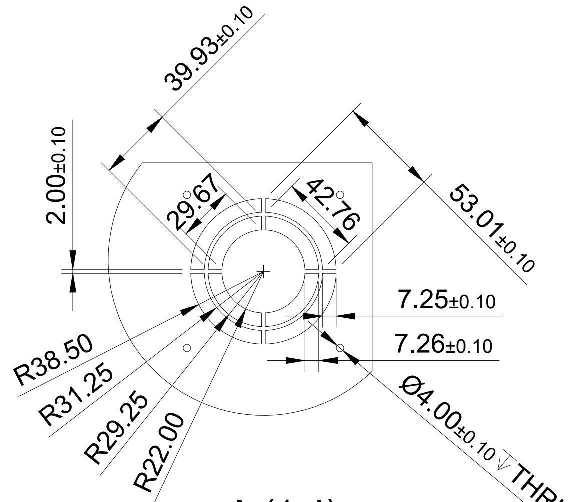


Dept.	Technical reference	Created by Lawrence de Krijger 20/05/2025	Approved by
unit: millimeters scale: 1:5 surface finish: powder coat -type: polyester -colour: RAL 9011 -thickness: 60 microns -texture: fine		Document type technical drawing	Document status
		Title panel sheetmetal - top	DWG No. **A011**
			Rev. / Date of issue / Sheet 15/39



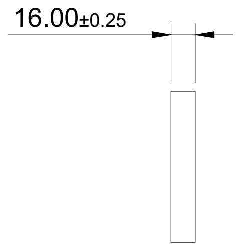
side

front

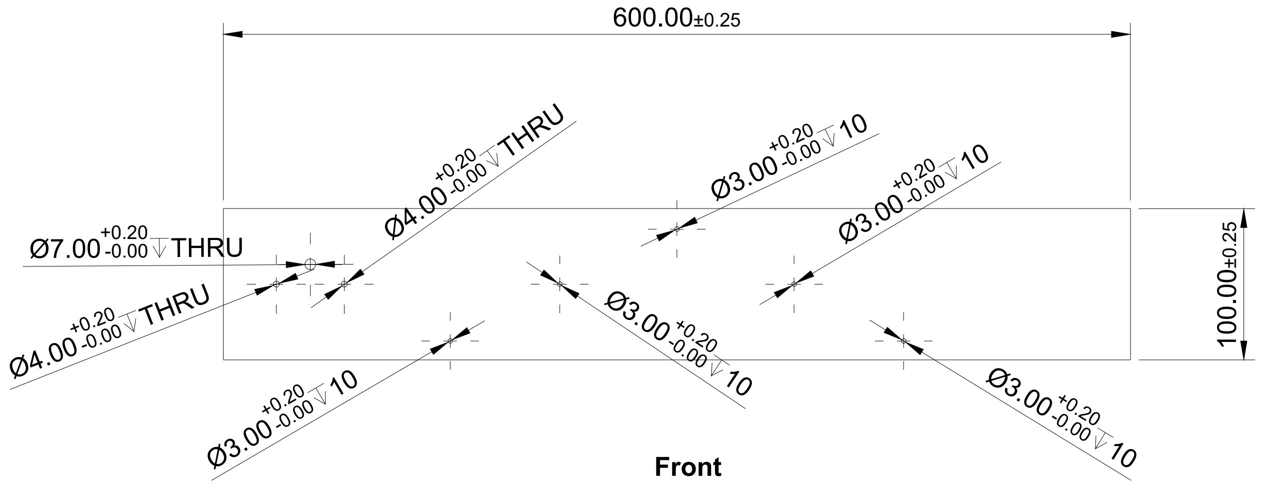


A (1:4)

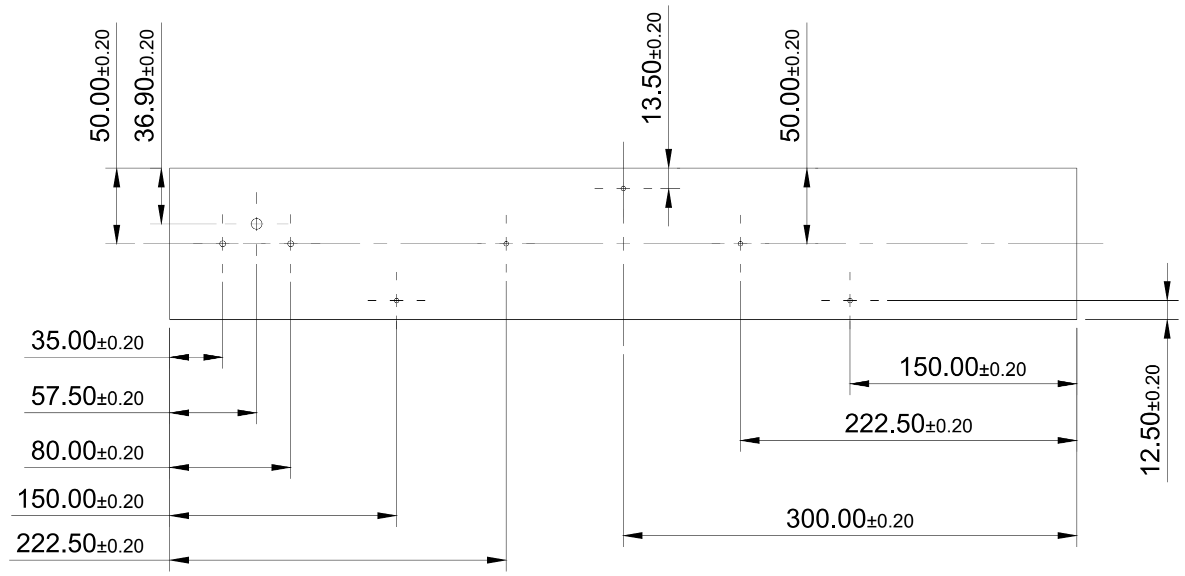
Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 20/05/2025	
unit: millimeter scale: 1:5 surface finish: powder coat -type: polyester -colour: RAL 9011 -thickness: 60 microns -texture: fine		Document type technical drawing	Document status
		Title panel sheetmetal - backside	DWG No. A012
			Rev. / Date of issue / Sheet 16/39



Left

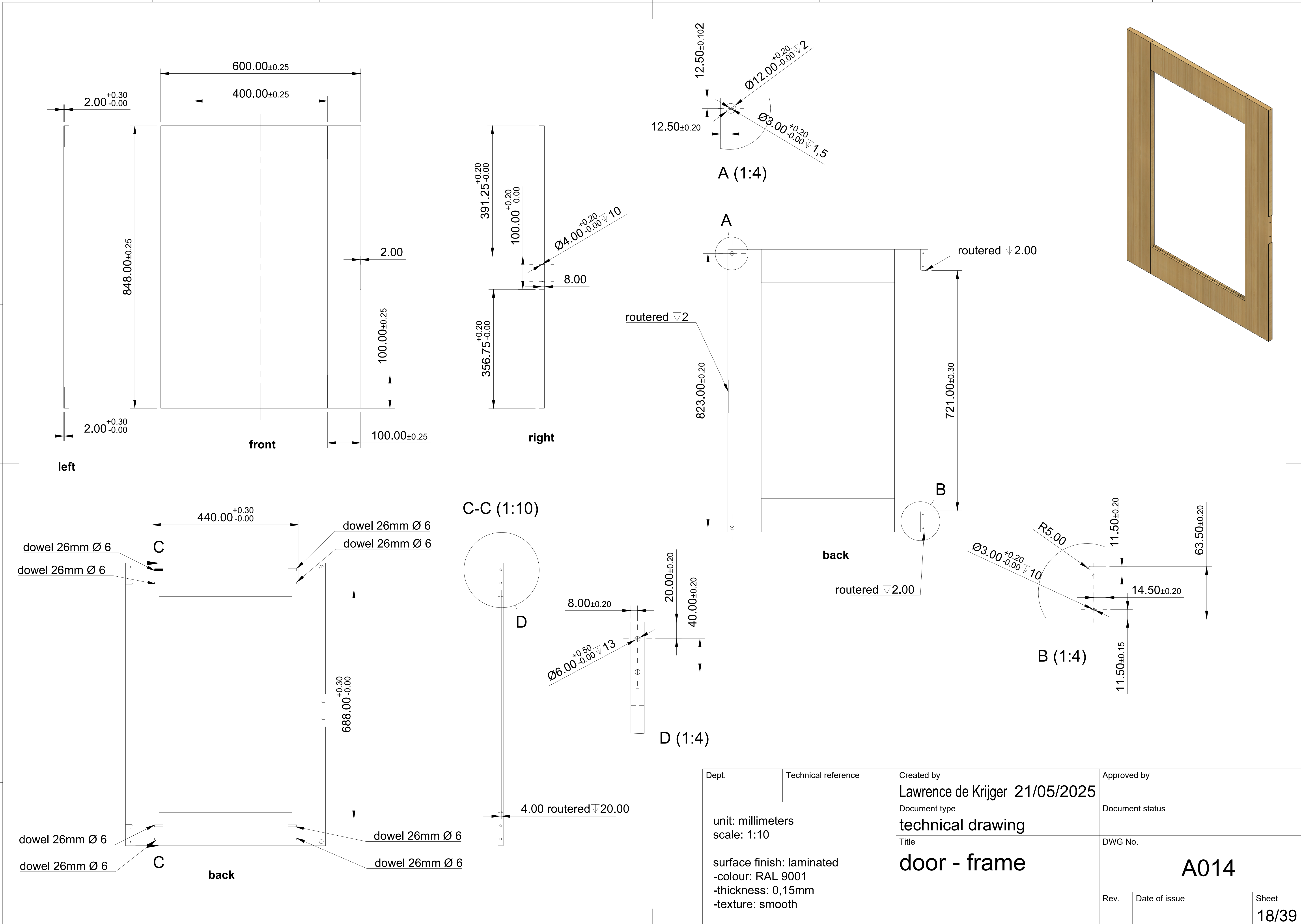


Front



Front

Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 20/05/2025	
unit: millimeters scale 1:5 surface finish: laminated -colour: RAL 9001 -thickness: 0,15mm -texture: smooth		Document type Technical drawing	Document status
		Title Front cover	DWG No. A013
			Rev. / Date of issue / Sheet 17/39



Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 21/05/2025	

unit: millimeters
scale: 1:10

surface finish: laminated
-colour: RAL 9001
-thickness: 0,15mm
-texture: smooth

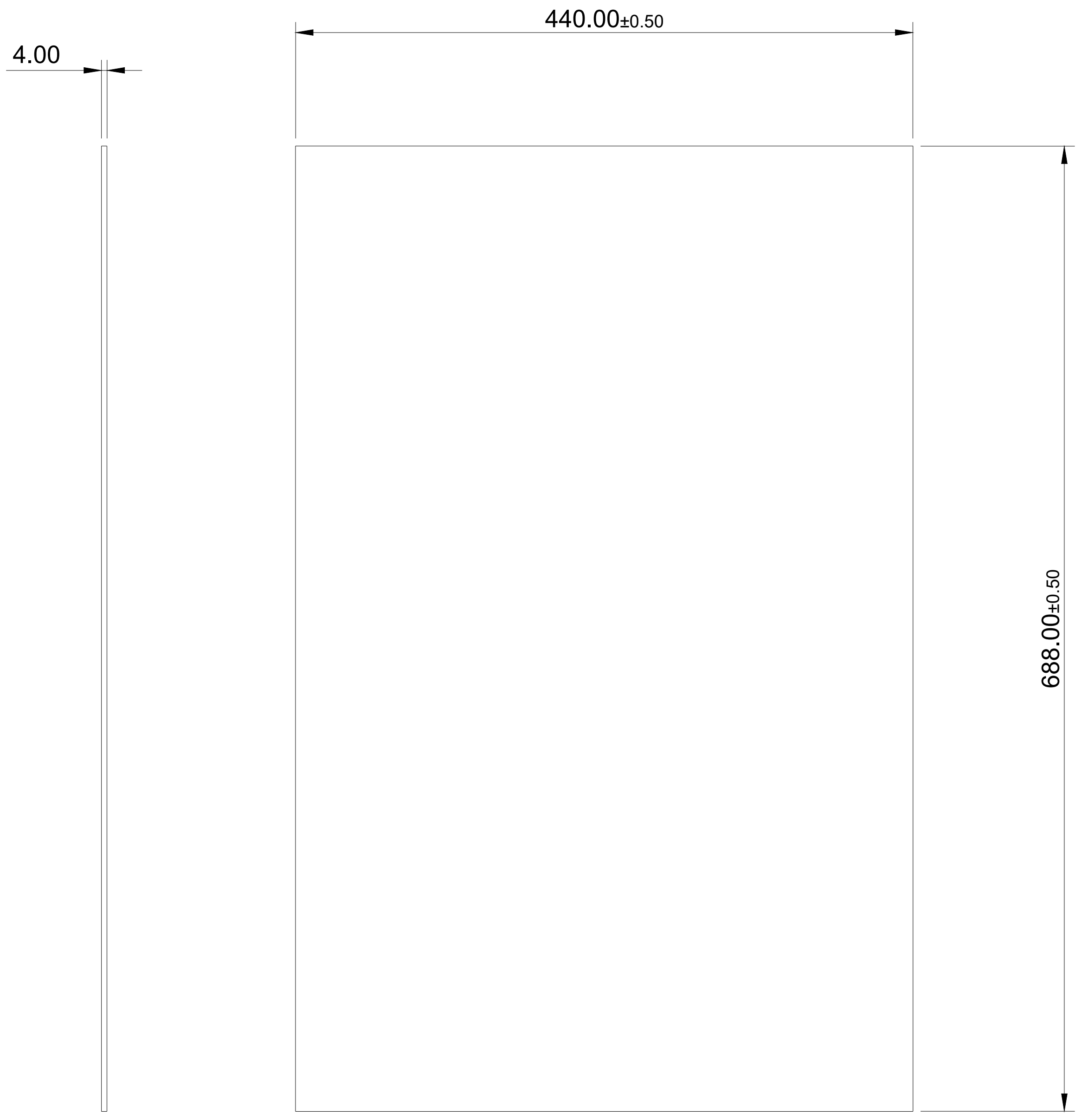
Document type: technical drawing

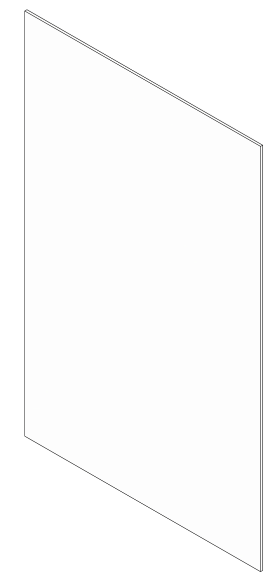
Document status:

Title: door - frame

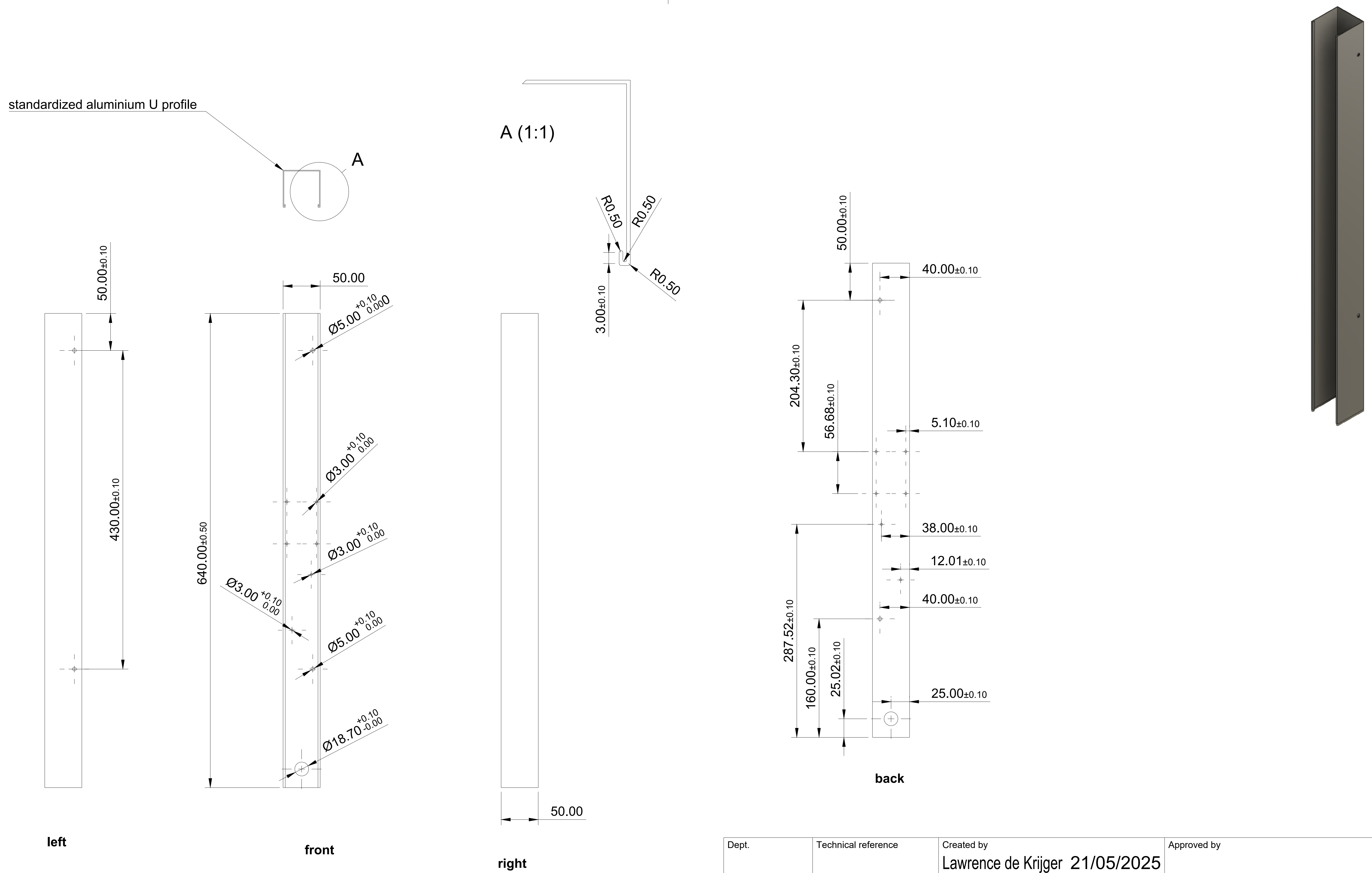
DWG No.: A014

Rev.	Date of issue	Sheet
		18/39

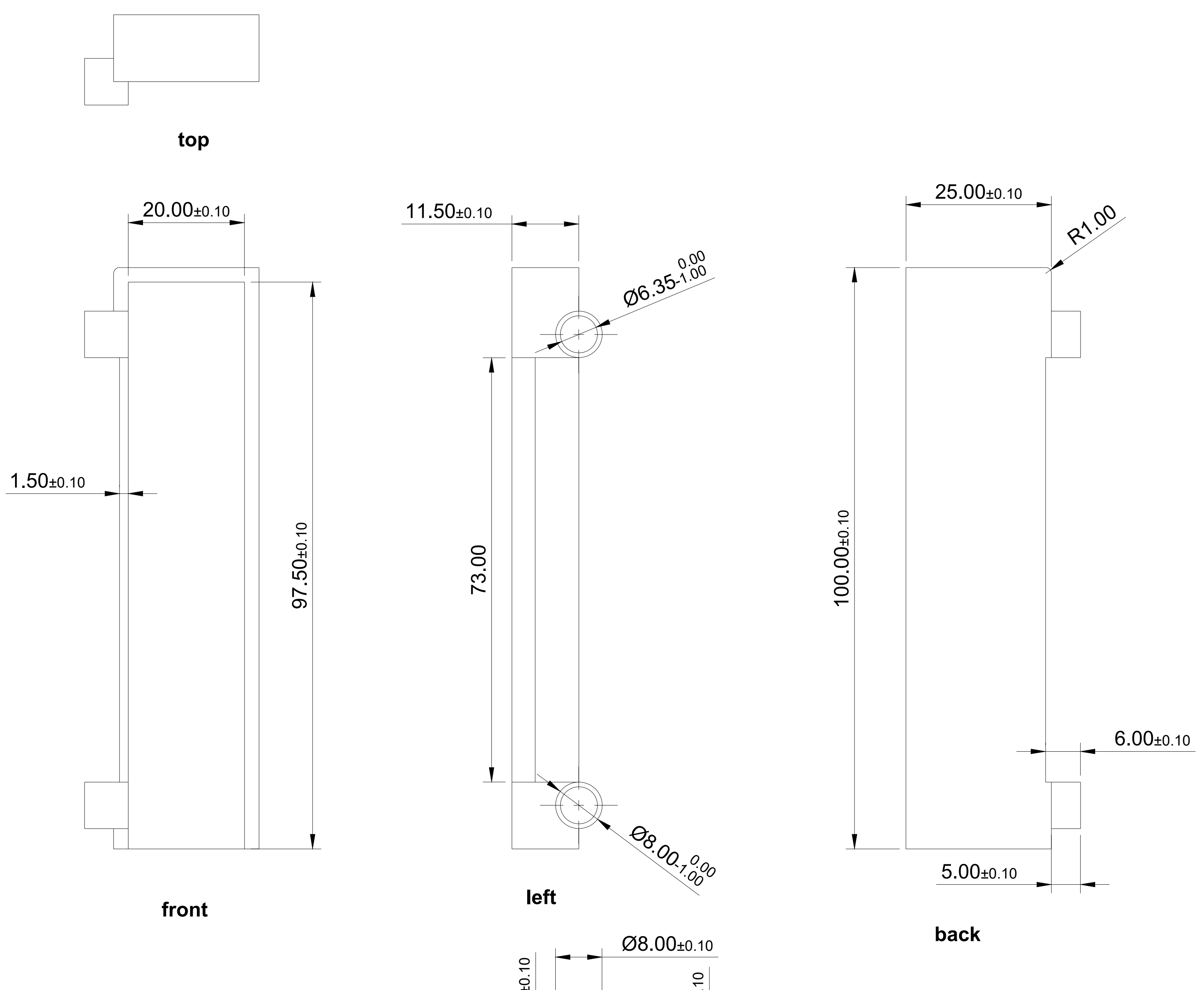


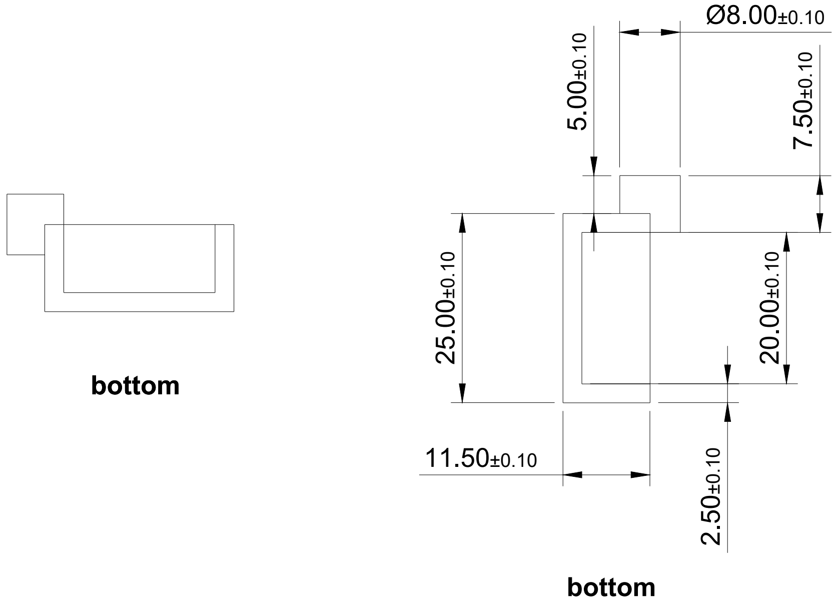


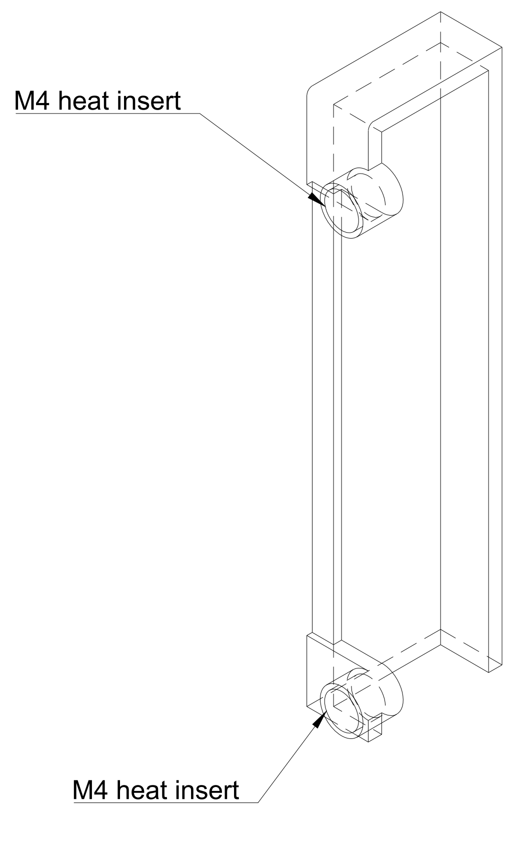
Dept.	Technical reference	Created by Lawrence de Krijger 21/05/2025	Approved by
unit: millimeter scale: 1:5		Document type technical drawing	Document status
		Title door - glass	DWG No. A015
			Rev. / Date of issue / Sheet 19/39

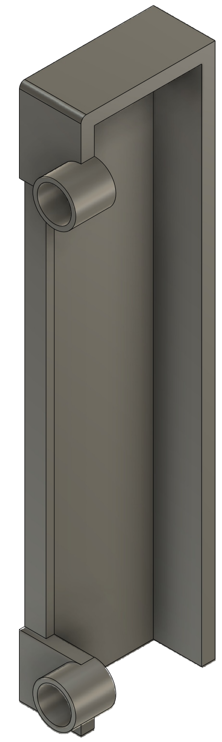


Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 21/05/2025	
unit: millimeter scale: 1:5		Document type technical drawing	Document status
		Title power strip housing	DWG No. A016
			Rev. / Date of issue / Sheet 20/39

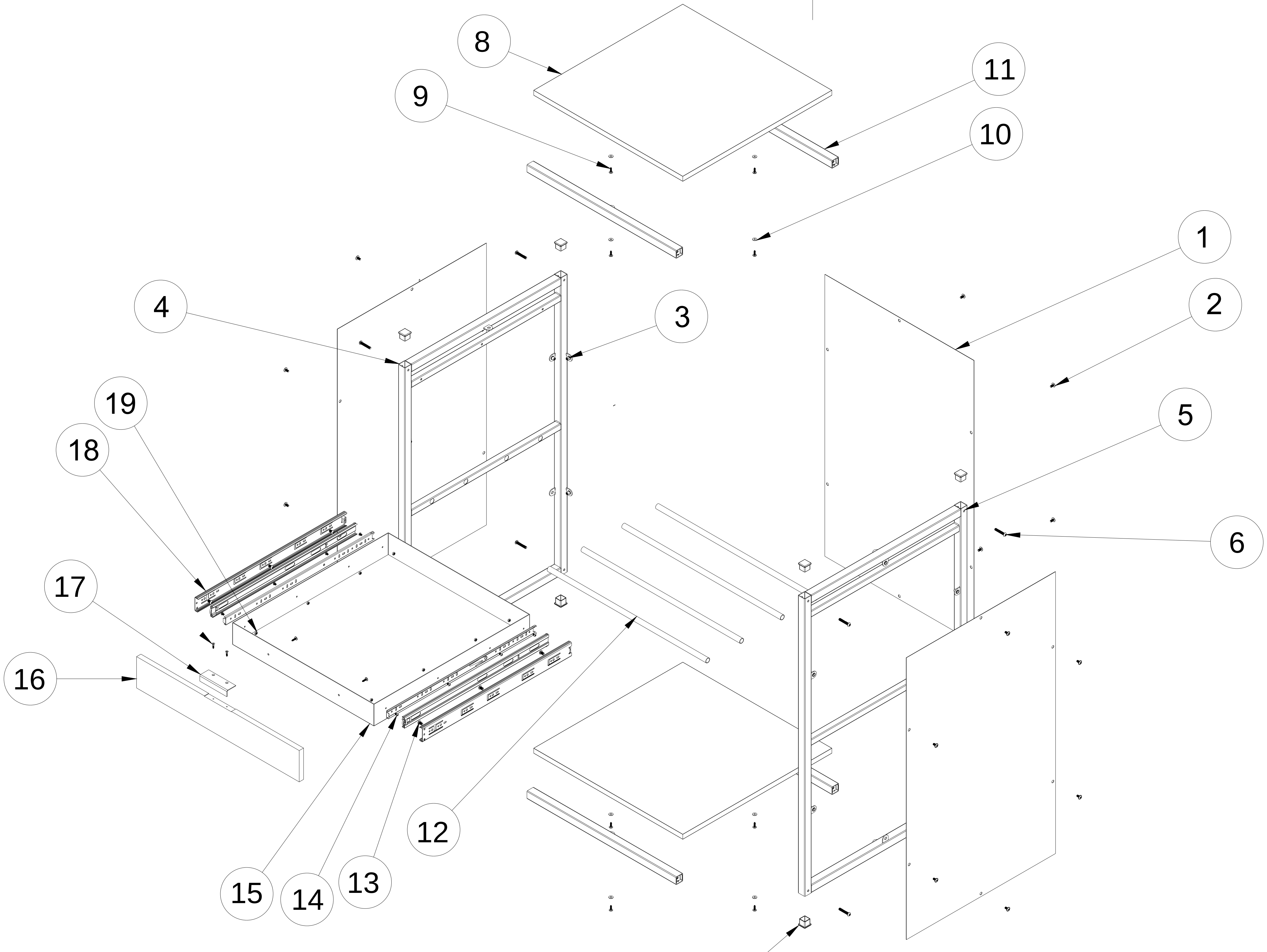








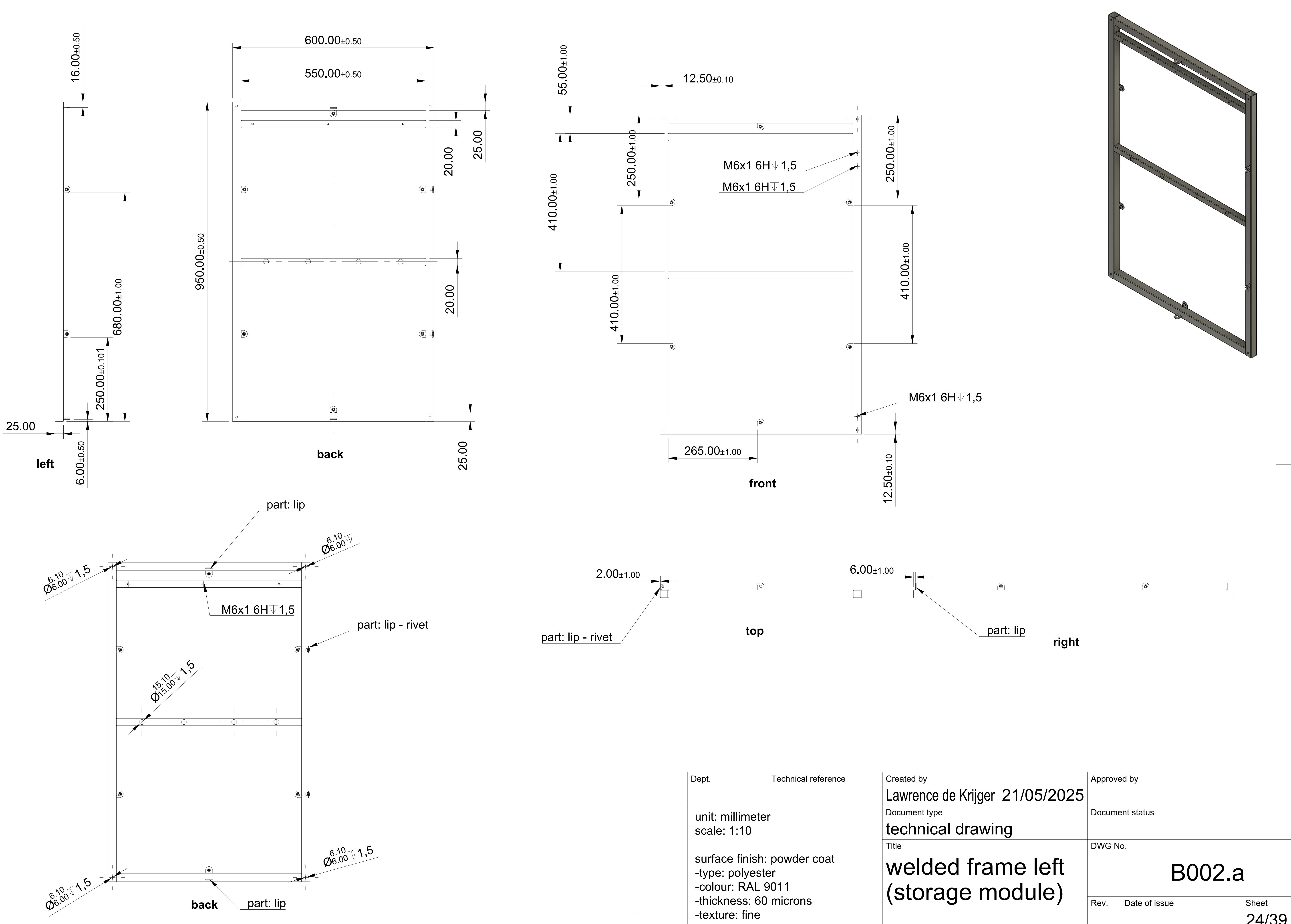
Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 21/05/2025	
		Document type: technical drawing	Document status
unit: millimeter scale: 1:1		Title: hepa/charcoal filter casing	DWG No. A017
			Rev. / Date of issue / Sheet 21/39



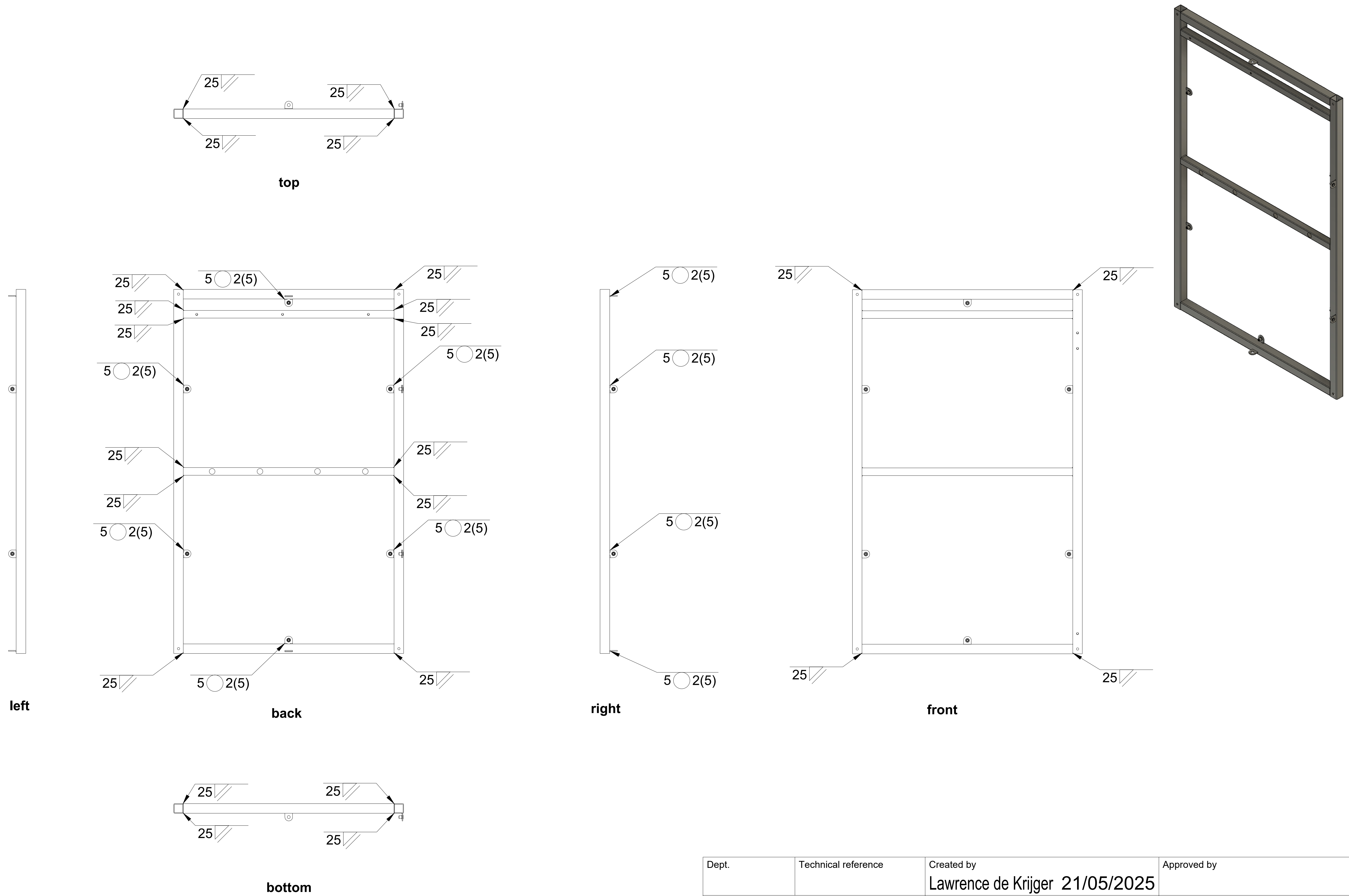
Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 19/05/2025	
		Document type: exploded view	Document status
scale= 1:10		Title: storage module assembly	DWG No. B001.a
			Rev. / Date of issue / Sheet 22/39

	Parts list		
Item	Part name	Qty	Material
1	Panel sheet metal	3	Q195 hot rolled steel - 1 mm
2	Flanged M5 buttonhead screw - 15mm	18	Q195 steel
3	Rivet nut M5	18	Aluminium
4	Welded frame left	1	Q195 steel profiles - 25x25mm (4) + 20x20mm (2)
5	Welded frame left	1	Q195 steel profiles - 25x25mm (4) + 20x20mm (2)
6	Button head M6 hex drive - 25mm	8	Q195 steel
7	Caps top	8	polyethelene
8	Plate -top/bottom	2	MDF - Laminated
9	Philips decorative rounded head screw - 15mm	10	Q195 steel
10	Washer 8mm	8	Q195 steel
11	Horizontal beams	4	Q195 steel profiles - 25x25mm
12	Filament rack pipe 15mm	4	Q195 steel pipe
13	Button head M6 hex drive - 10mm	6	Q195 steel
14	M5 buttonhead screw - 10mm	8	Q195 steel
15	Drawer	1	Q195 hot rolled steel - 1 mm
16	Drawer - front cover	1	MDF - Laminated
17	Handle	1	Q195 steel - 1,2mm
18	Railing system	2	galvinised steel
19	Zink plated steel hex nut M5	8	Q195 steel

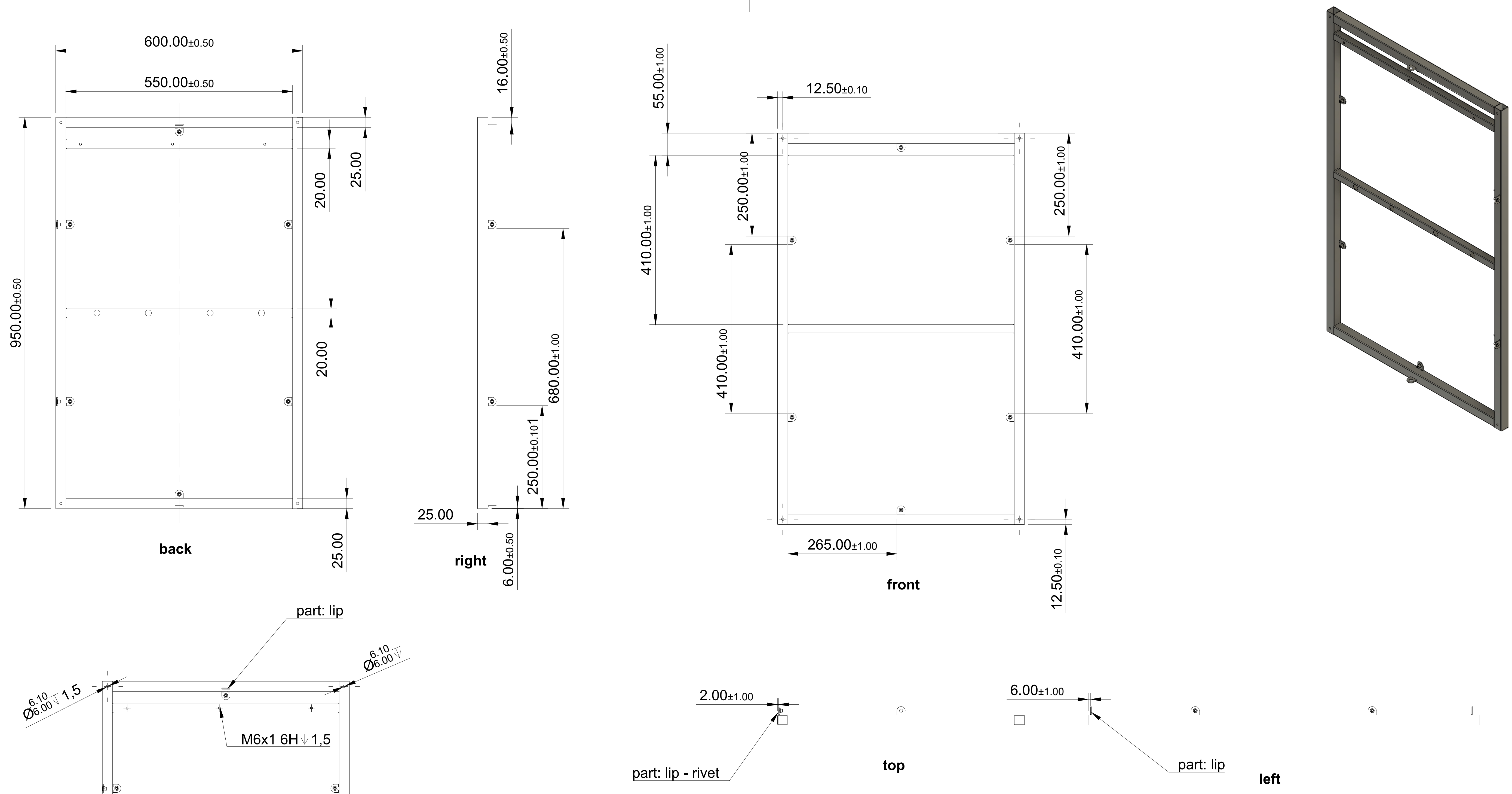
Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 19/05/2025	
		Document type: Bill of materials (BOM)	Document status
		Title: Storage module BOM	DWG No. B001.b
			Rev. / Date of issue / Sheet 23/39

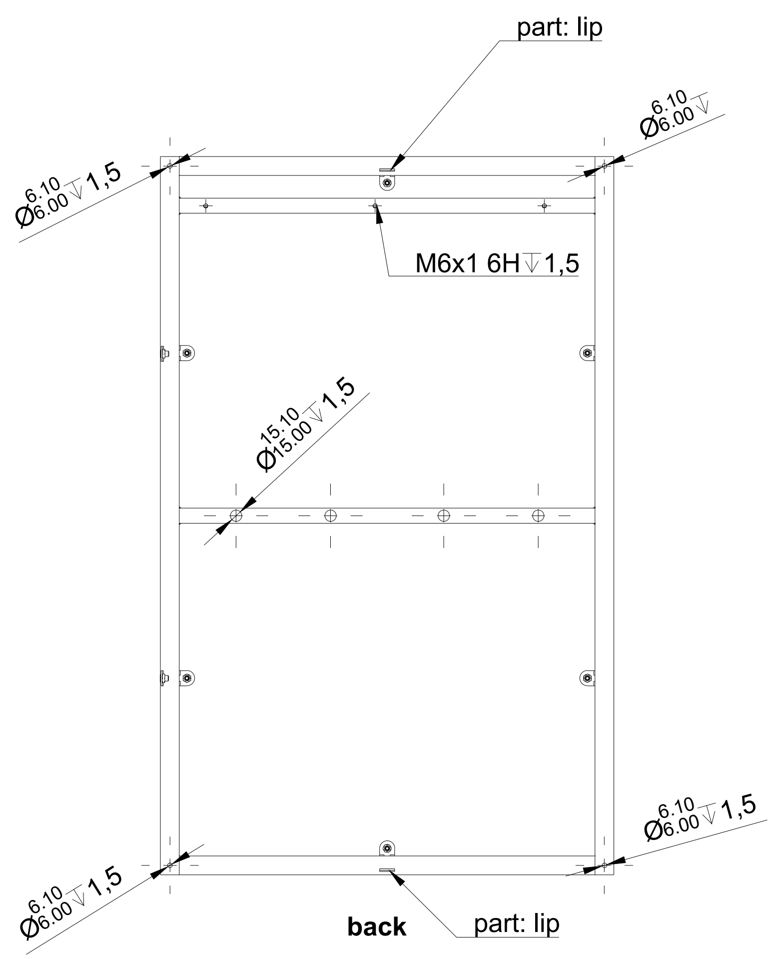


Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 21/05/2025	
unit: millimeter scale: 1:10 surface finish: powder coat -type: polyester -colour: RAL 9011 -thickness: 60 microns -texture: fine		Document type: technical drawing	Document status
		Title: welded frame left (storage module)	DWG No. B002.a
			Rev. / Date of issue / Sheet 24/39

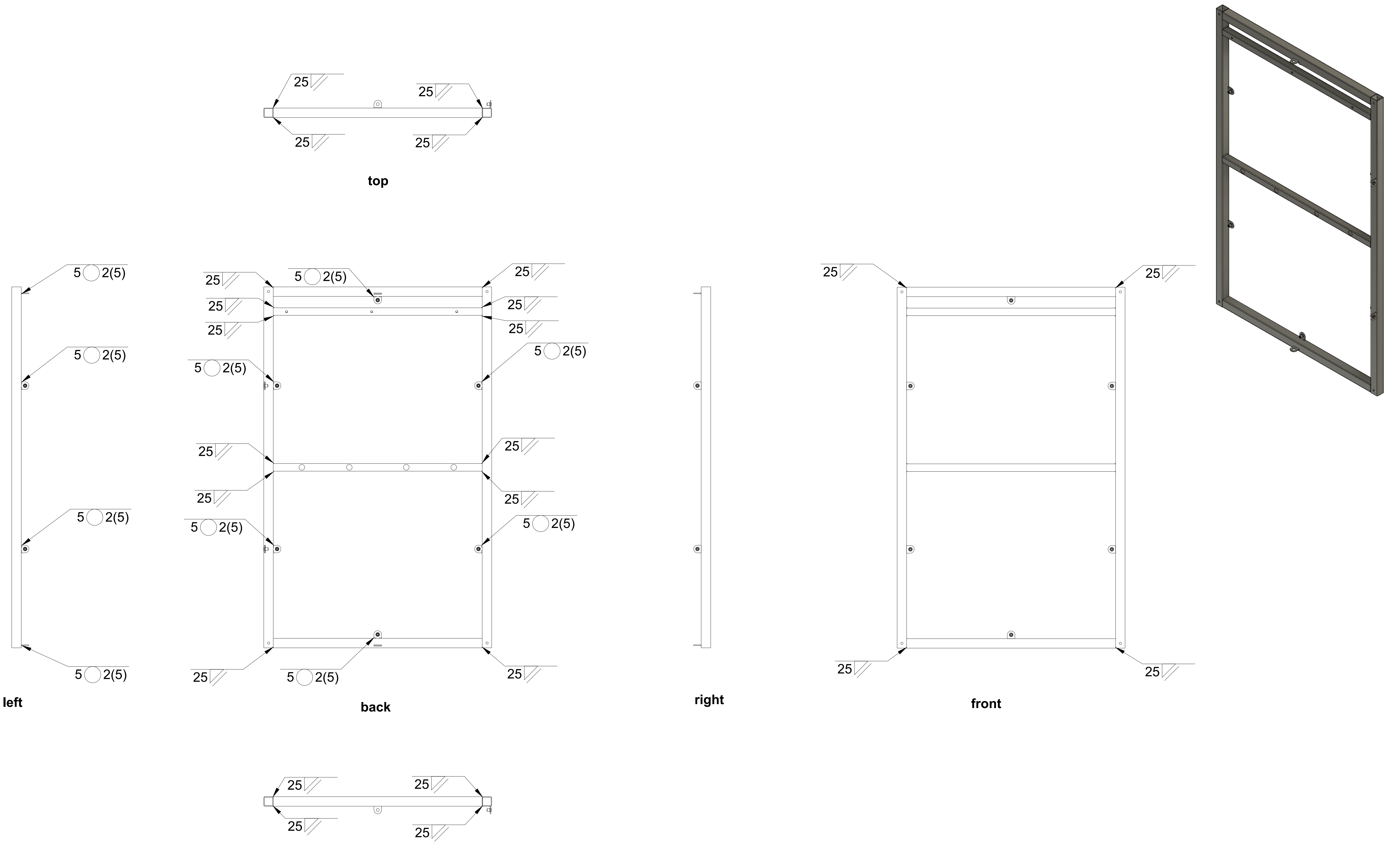


Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 21/05/2025	
unit: millimeter scale: 1:10		Document type welding drawing	Document status
		Title welded frame left (storage module)	DWG No. B002.b
			Rev. / Date of issue / Sheet 25/39

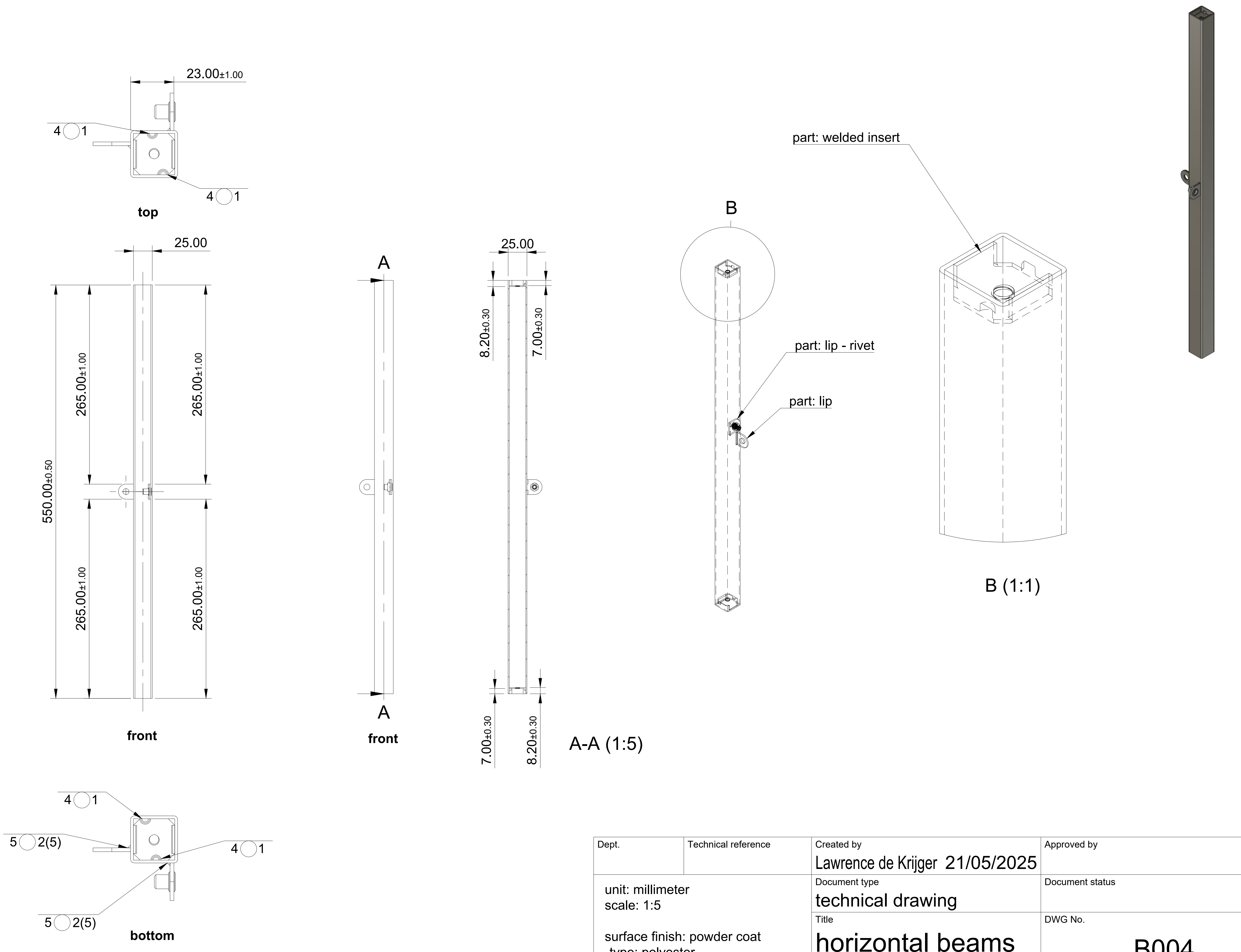




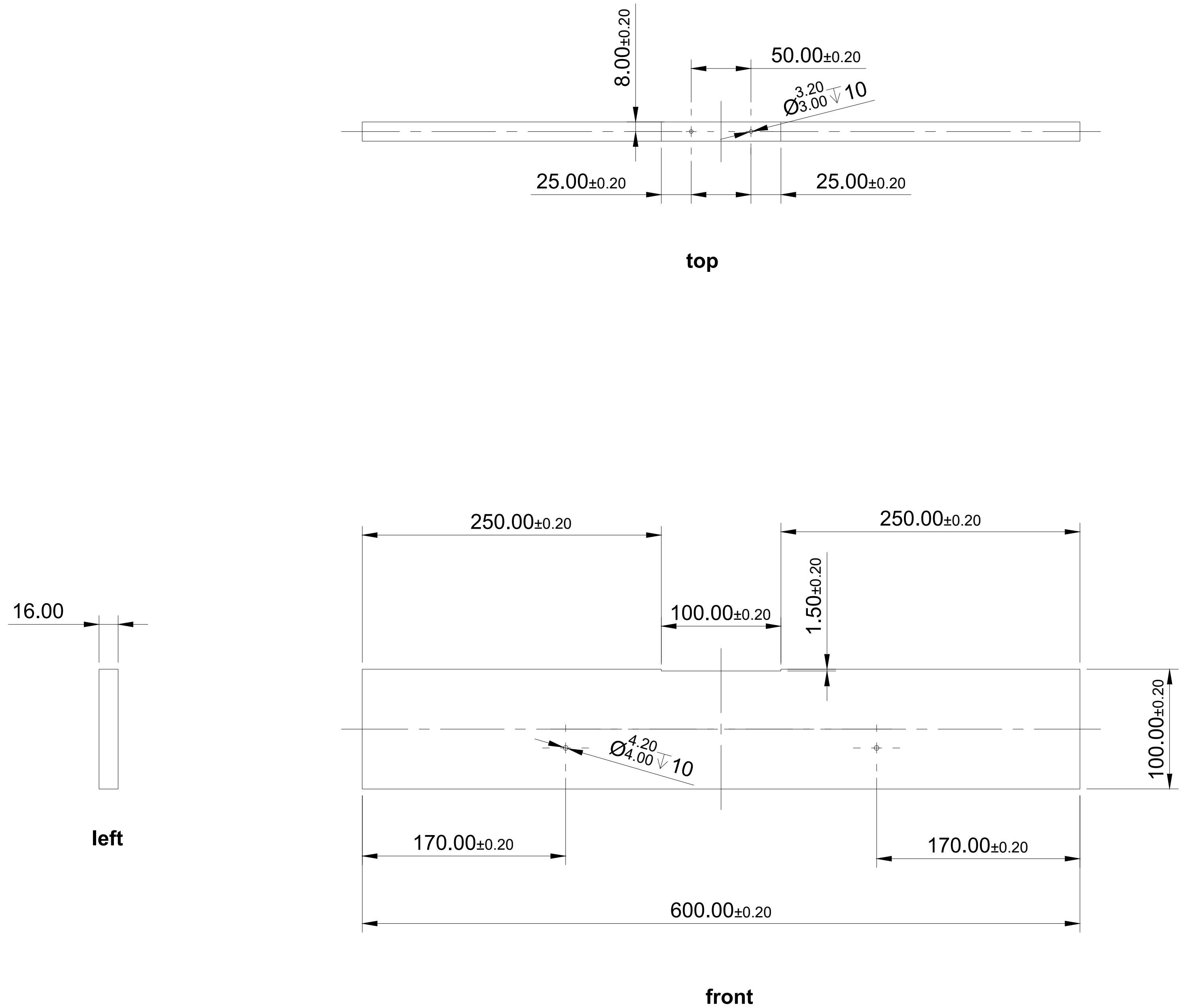
Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 21/05/2025	
unit: millimeter scale: 1:10 surface finish: powder coat -type: polyester -colour: RAL 9011 -thickness: 60 microns -texture: fine		Document type technical drawing	Document status
		Title welded frame right (storage module)	DWG No. B003.a
			Rev. / Date of issue / Sheet 26/39



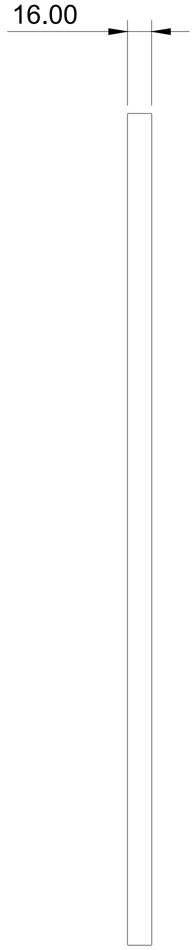
Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 21/05/2025	
unit: millimeter scale: 1:10		Document type welding drawing	Document status
		Title welded frame right (storage module)	DWG No. B003.b
			Rev. / Date of issue / Sheet 27/39



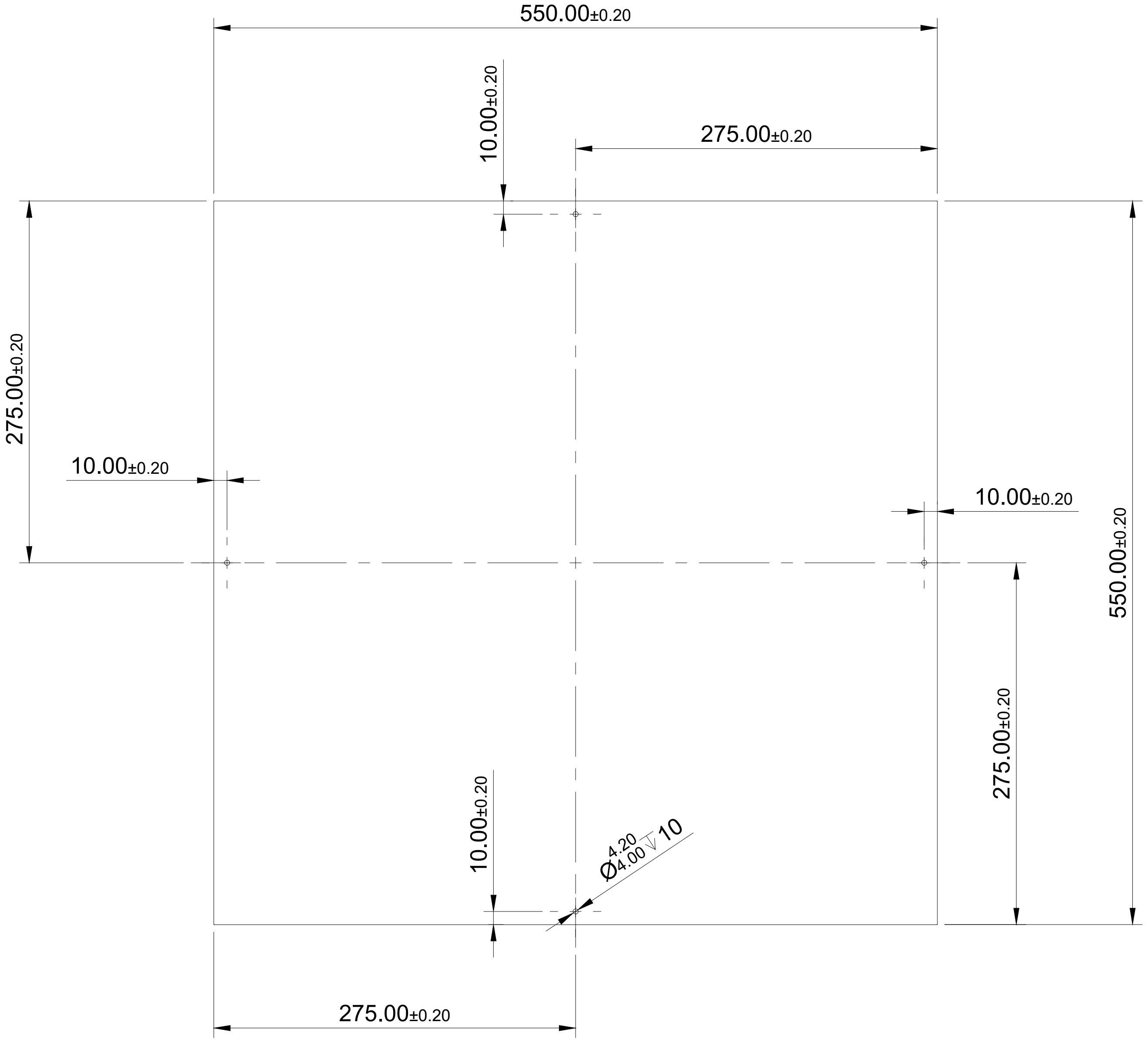
Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 21/05/2025	
unit: millimeter scale: 1:5		Document type technical drawing	Document status
surface finish: powder coat -type: polyester -colour: RAL 9011 -thickness: 60 microns -texture: fine		Title horizontal beams	DWG No. B004
			Rev. / Date of issue / Sheet 28/39



Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 21/05/2025	
unit: millimeter scale: 1:5 surface finish: laminated -colour: RAL 9001 -thickness: 0,15mm -texture: smooth		Document type technical drawing	Document status
		Title drawer - front cover	DWG No. B005
			Rev. / Date of issue / Sheet 29/39

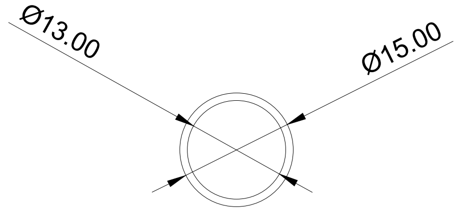


left

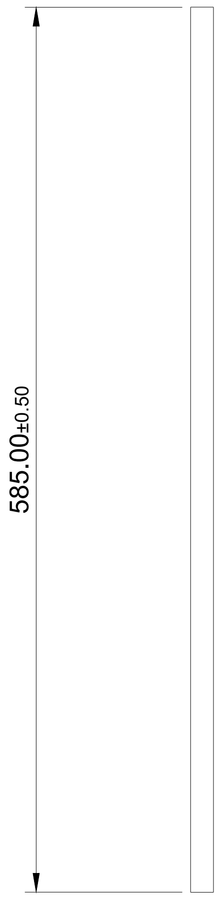


top

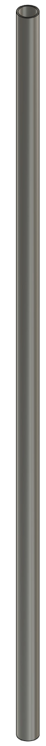
Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 21/05/2025	
unit: millimeter scale: 1:5 surface finish: laminated -colour: RAL 9001 -thickness: 0,15mm -texture: smooth		Document type technical drawing	Document status
		Title plate - top/bottom	DWG No. B006
			Rev. / Date of issue / Sheet 30/39



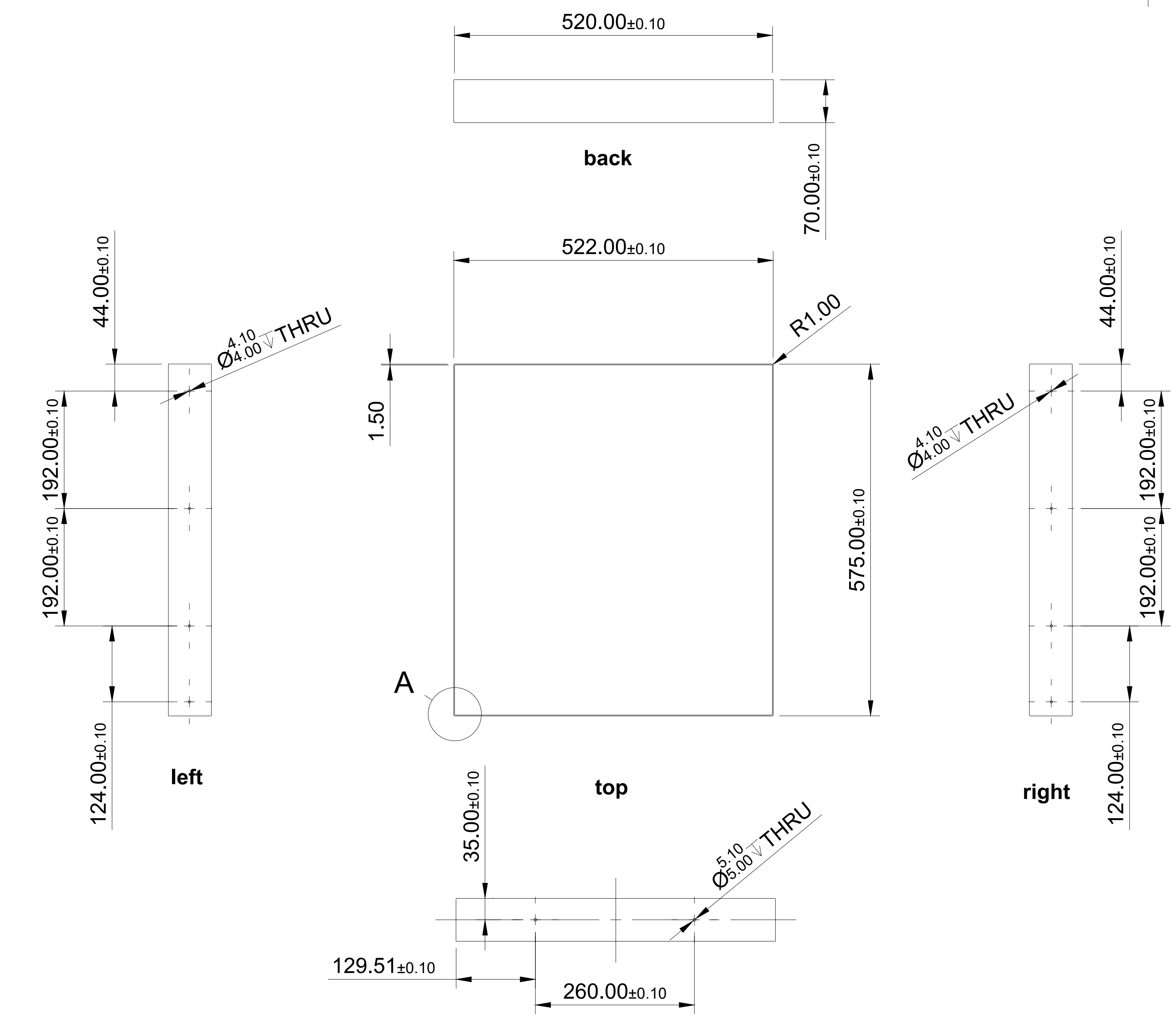
top (1:1)

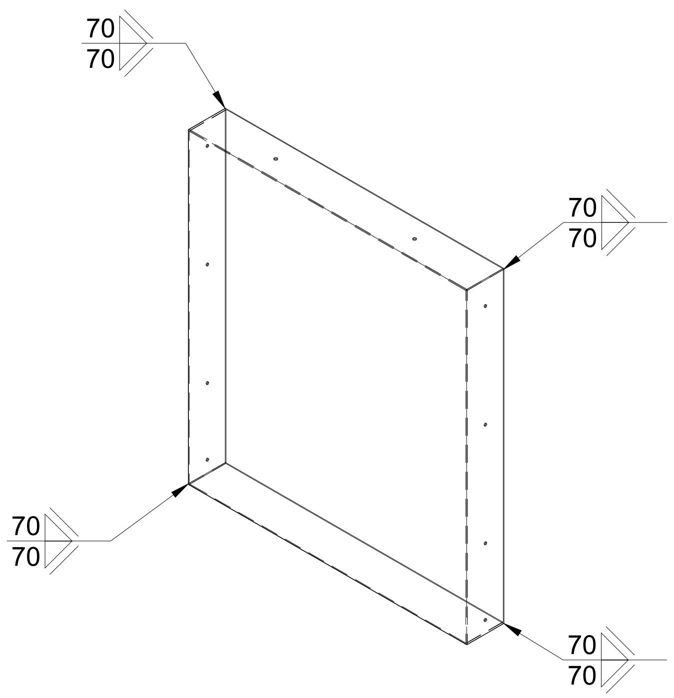


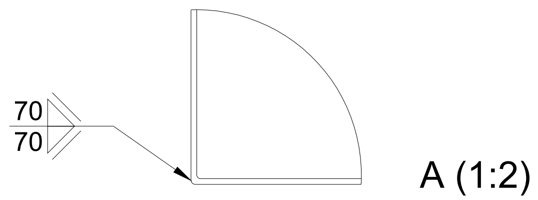
front

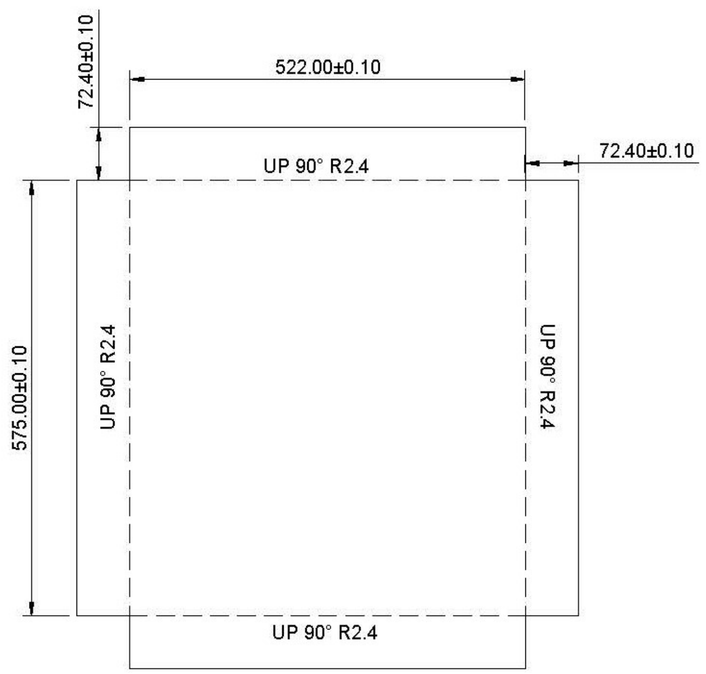


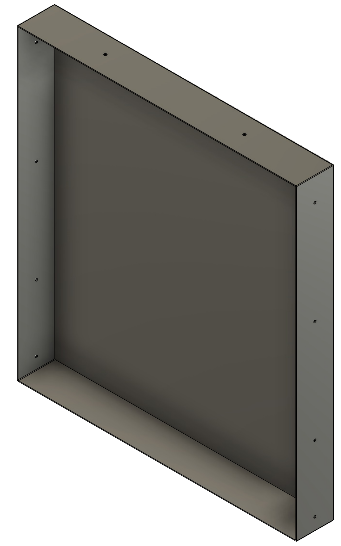
Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 21/05/2025	
		Document type: technical drawing	Document status
unit: millimeter scale: 1:5		Title: filament rack pipe15	DWG No.: B007
			Rev. / Date of issue / Sheet: 31/39



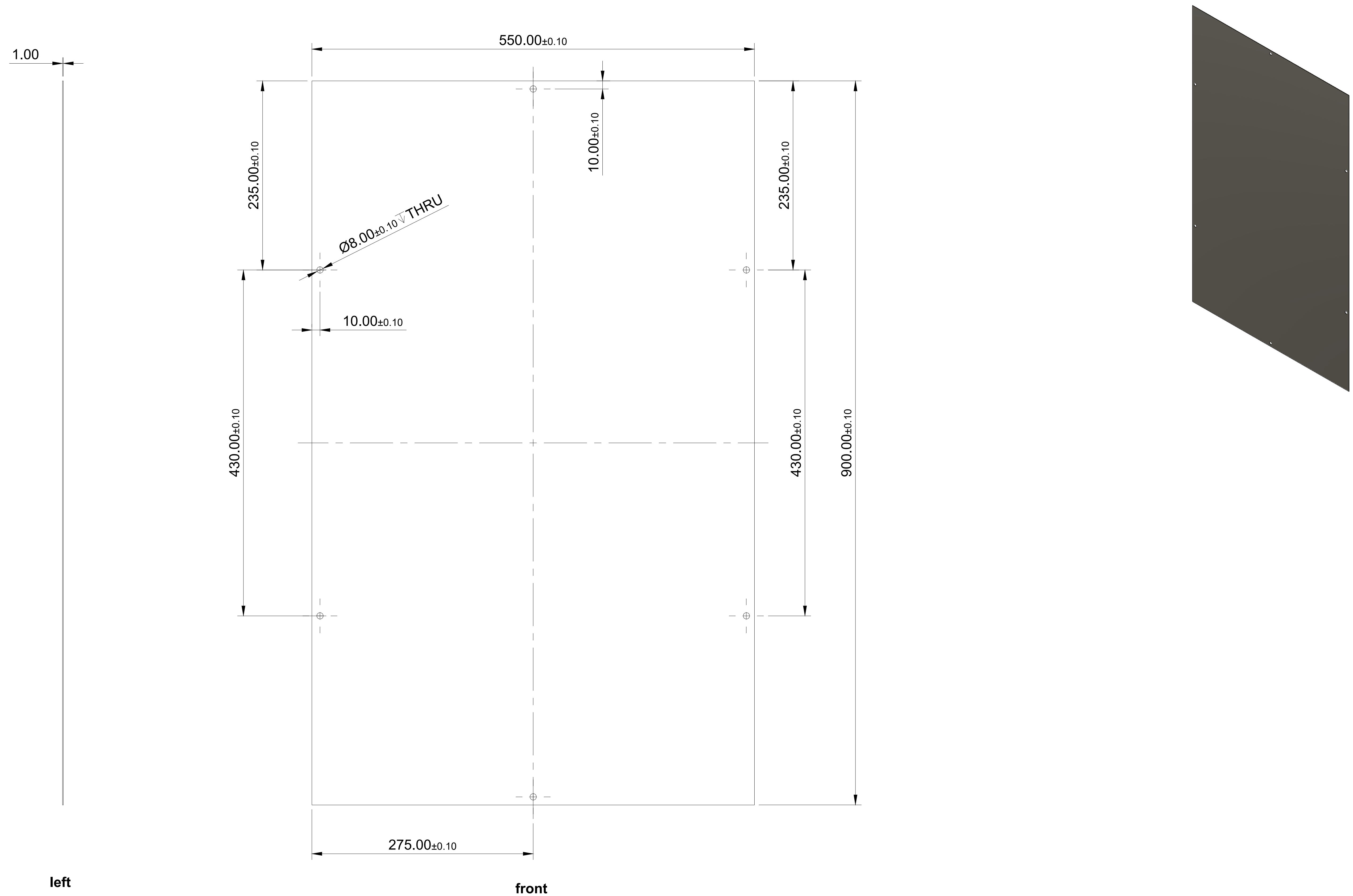




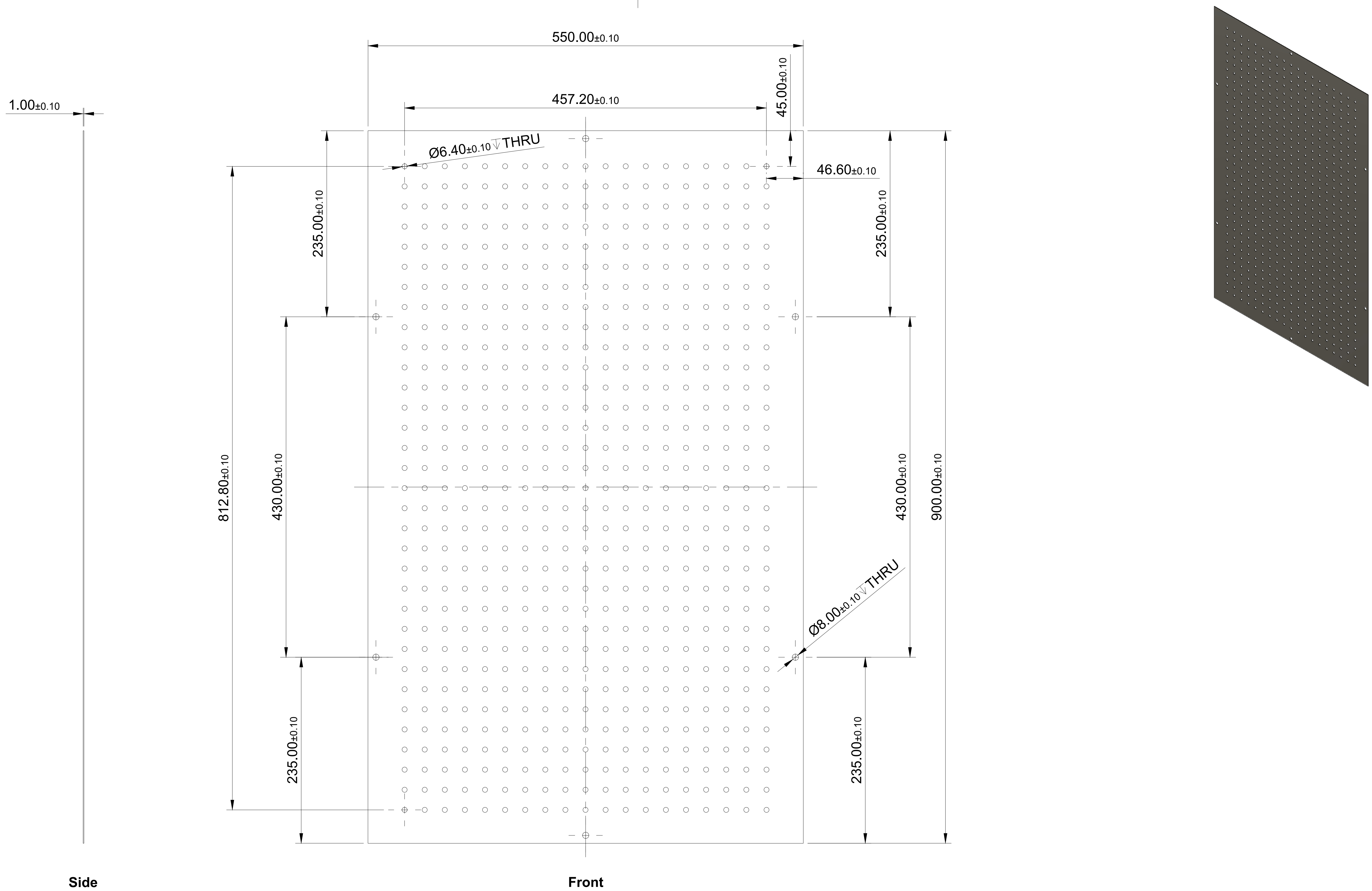




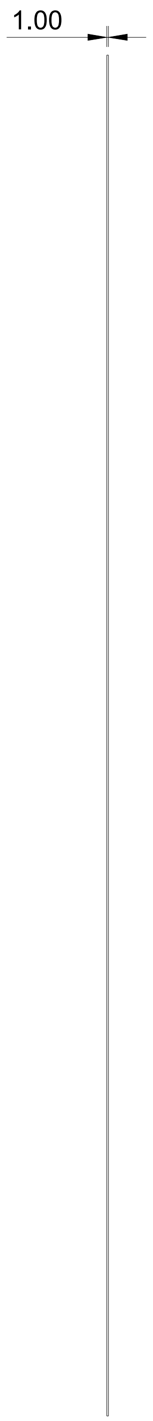
Dept.	Technical reference	Created by Lawrence de Krijger 21/05/2025	Approved by
unit: millimeters scale: 1:10 surface finish: powder coat -type: polyester -colour: RAL 9011 -thickness: 60 microns -texture: fine		Document type technical drawing	Document status
		Title drawer	DWG No. B008
			Rev. / Date of issue / Sheet 32/39



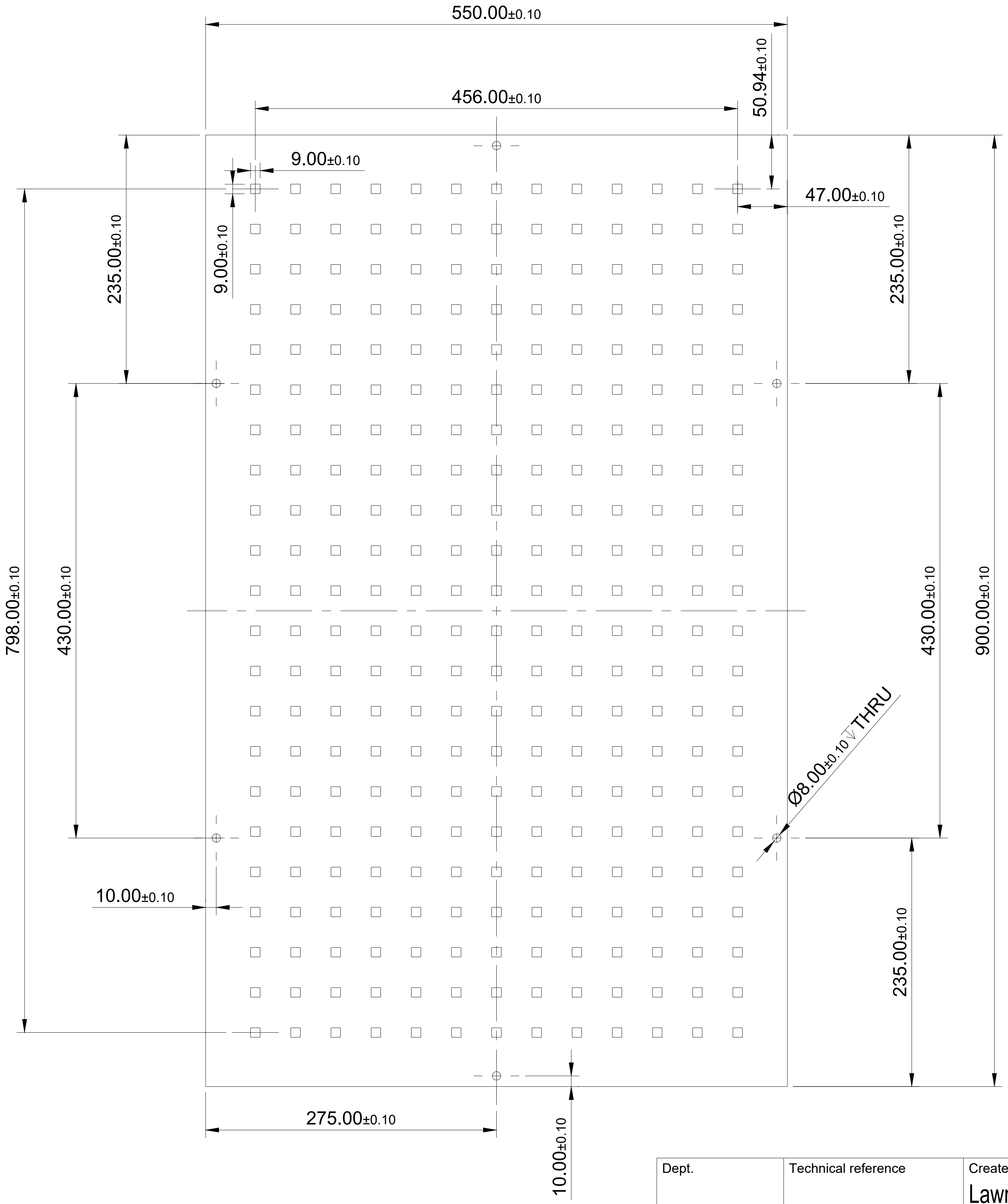
Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 20/05/2025	
unit: millimeter scale: 1:5 surface finish: powder coat -type: polyester -colour: RAL 9011 -thickness: 60 microns -texture: fine		Document type: technical drawing	Document status
		Title: panel sheetmetal	DWG No. C001
			Rev. / Date of issue / Sheet 33/39



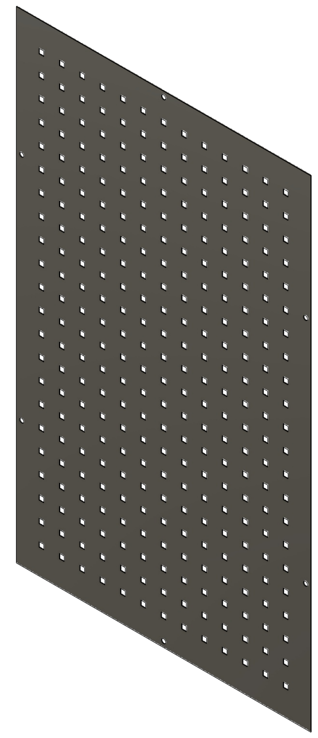
Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 20/05/2025	
unit: millimeter scale: 1:5 surface finish: powder coat -type: polyester -colour: RAL 9011 -thickness: 60 microns -texture: fine		Document type technical drawing	Document status
		Title panel sheetmetal - perforated	DWG No. C002
			Rev. / Date of issue / Sheet 34/39



side



front



Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 20/05/2025	

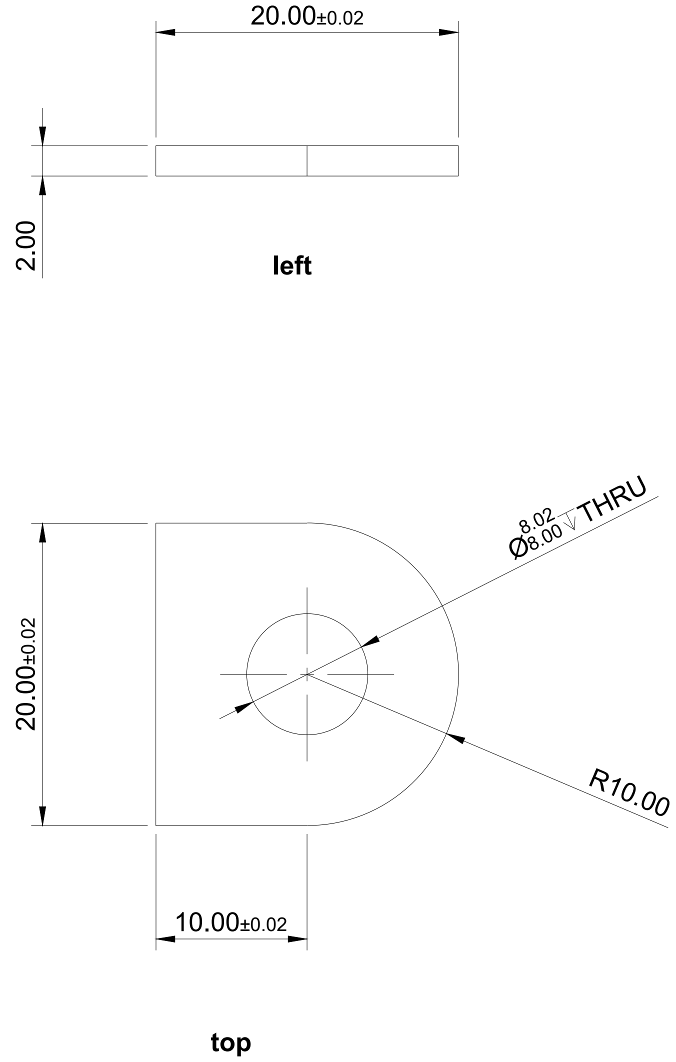
unit: millimeter
scale: 1:5

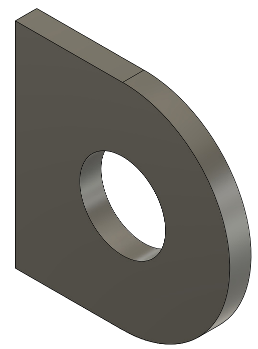
surface finish: powder coat
-type: polyester
-colour: RAL 9011
-thickness: 60 microns
-texture: fine

Document type	Document status
technical drawing	

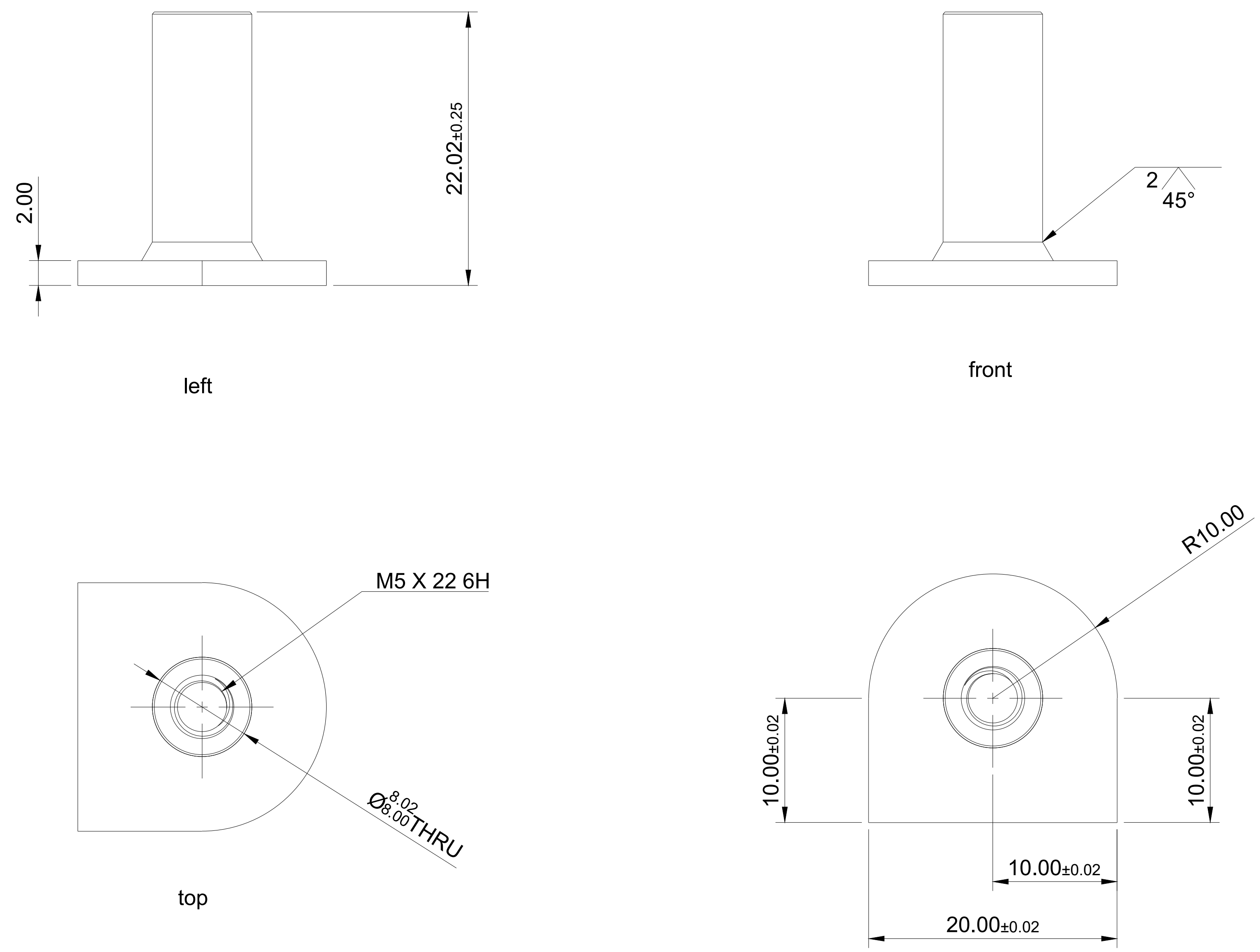
Title	DWG No.
panel sheetmetal - perforated - square	C003

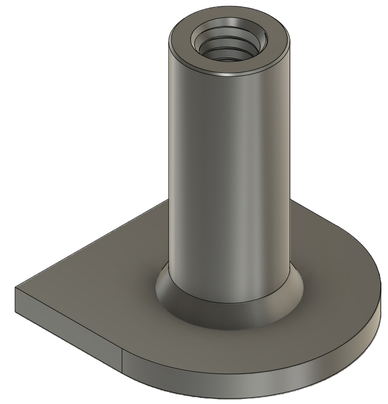
Rev.	Date of issue	Sheet
		35/39



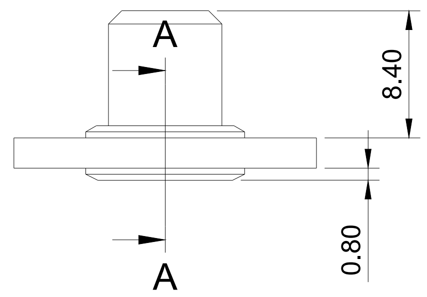


Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 21/05/2025	
unit: millimeter scale: 2:1		Document type: technical drawing	Document status
		Title: lip	DWG No. D001
			Rev. / Date of issue / Sheet 36/39





Dept.	Technical reference	Created by	Approved by
		Lawrence de Krijger 20/05/2025	
unit: millimeter scale: 2:1		Document type: technical drawing	Document status
		Title: Lip - coupling nut	DWG No.: D002
			Rev. / Date of issue / Sheet: 37/39



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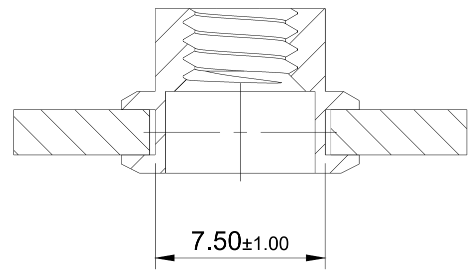
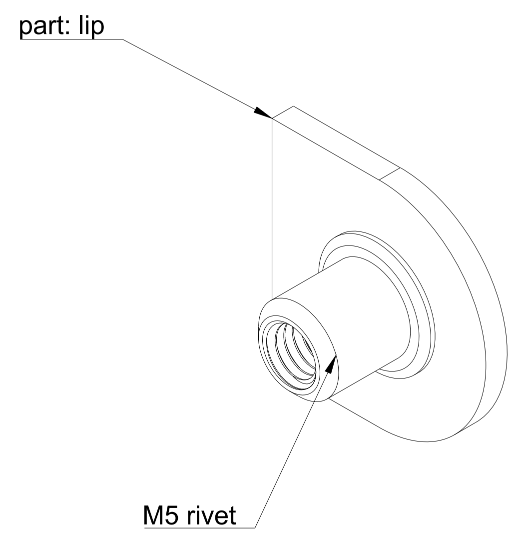
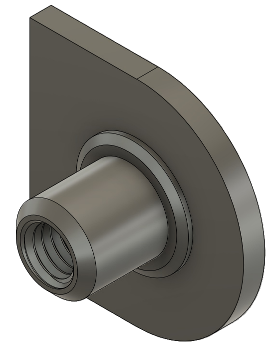
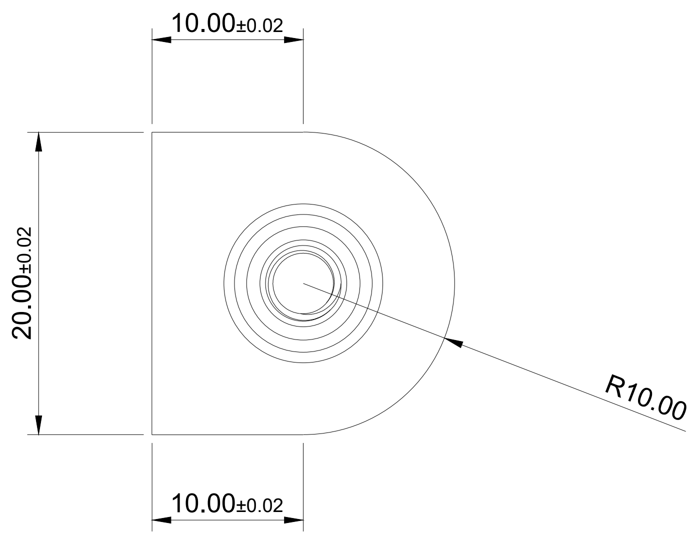


A-A (3:1)

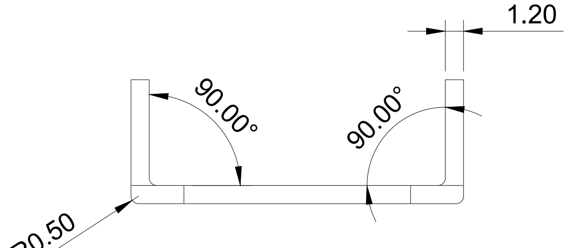




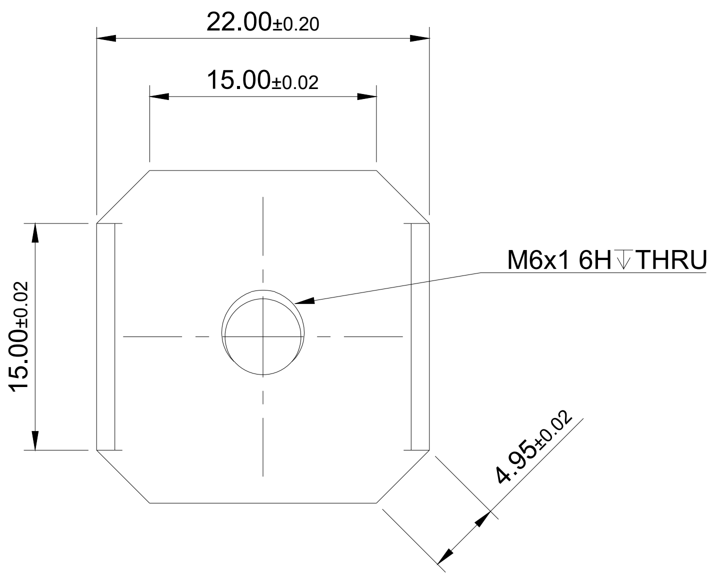


Top

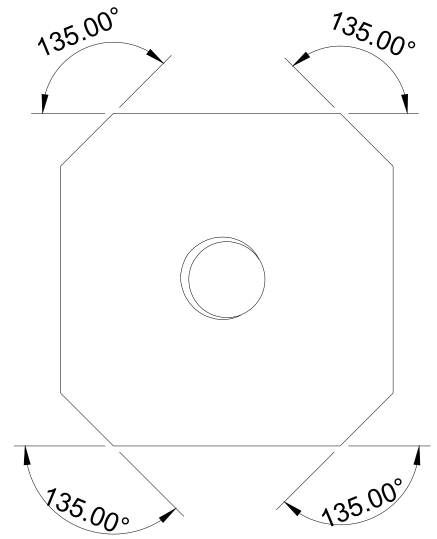
Dept.	Technical reference	Created by: Lawrence de Krijger 21/05/2025	Approved by
unit: millimeter scale: 2:1		Document type: technical drawing	Document status
		Title: lip - rivet	DWG No.: D003
			Rev. / Date of issue / Sheet: 38/39



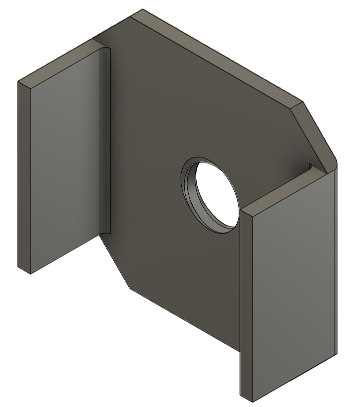
left



top



bottom



Dept.	Technical reference	Created by	Approved by		
		Lawrence de Krijger 21/05/2025			
unit: millimeters scale: 2:1		Document type technical drawing	Document status		
		Title welded insert	DWG No. D004		
			Rev.	Date of issue	Sheet 39/39