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PRODUCT REPORT

REITAN // MA4-ID5 // MAY 2025

WHAT WOULD HAPPEN IF ALL SINGLE-USE PLASTIC PACKAGING FOR FRESH PRODUCE WAS BANNED?


økologi
økologi
økologi
økologi
Nordic Greens
ØKO
HJERTESALAT
meget mere
ØKOLOGI
Økologiske Cherrytomater
på stilk
Oprindelse: Spanien
Klasse 1
500g

THE STRUGGLE

PLASTIC PACKAGING VS. FOOD WASTE

Single-use plastic ban

From 2030, a new EU regulation will ban single-use plastic on fresh produce (European Union 2025). At first glance, this may appear to be a positive environmental initiative. However, plastic packaging plays a crucial role in extending the shelf life of fresh produce. Without the packaging, many items deteriorate faster, increasing the risk of spoilage before they even reach consumers. (Herlufsen 2020) This leads to more food waste, higher emissions, and unnecessary resource loss.

REMA 1000 against food waste

REMA 1000 has taken proactive steps to combat food waste – particularly at the household level. By encouraging customers to purchase only what they need, the chain promotes smaller packaging sizes, has eliminated bulk discounts, and offers root vegetables by weight. However, this creates a challenge at store level.

The root vegetable problem

Loose, unpackaged root vegetables have a very limited shelf life. Often, they begin to appear shrivelled or dehydrated after just half a day on display. This not only reduces their visual appeal and sales potential, but also leads to higher levels of food waste. For the grocer, this means lost earnings, wasted investment, and additional labour demands to restock and/or sort produce frequently to maintain an appealing produce section.

The future scenario

As we move toward a retail future without single-use plastic, such challenges will become increasingly common. Addressing this specific issue now is a crucial first step in adapting to the upcoming regulatory landscape – ensuring fresher produce, reduced waste, and a smoother transition to sustainable in-store practices.

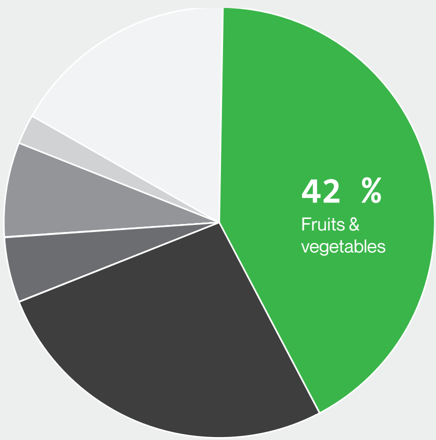
IN NUMBERS

FRUIT AND VEGETABLE WASTE IN RETAIL/WHOLESALE
(DENMARK 2021)

40.637
tons produce food waste/year

37.840
tons CO_2e/year

365
million DKK/year



Fresh produce makes up 42% of food waste in retail and wholesale. With plastic bans likely to increase spoilage, there's a strong need for new solutions to reduce waste in this category.

(ONE THIRD 2021)

INTRODUCING REITAN

Extend Freshness – Reduce Waste

REITAN

Reitan is a simple, discreet solution designed to prolong the shelf life of loose root vegetables in the produce section. By providing a controlled environment, Reitan can extend freshness by up to 3 days, giving grocers more time to sell the produce, reducing waste.

The clean and minimalistic design integrates seamlessly into existing store layouts and staff routines, requiring no change to daily operations. This ensures that workflow and efficiency are maintained, while enhancing the quality of product presentation.

For customers, Reitan keeps vegetables sealed, fresh, and visually appealing, helping them feel confident in the cleanliness and quality of the produce. The easy-to-use lid allows for a smooth shopping experience without any inconvenience.

Beyond functionality, a consistently stocked and well-maintained root vegetable section also improves the overall aesthetic appeal of the produce department, contributing positively to the store environment and customer satisfaction.

WITHOUT

AFTER 1 DAY

WITH

AFTER 3 DAYS

CUSTOMER

INTERACTION

The transparent, curved lid offers a seamless user experience with excellent visibility, easy interaction, and a clean, minimal look.

STAFF

INTERACTION

IN

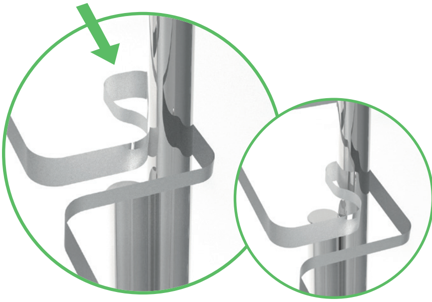
OUT

The combination of the bent lid and the shape of the brace makes the interaction run smoothly, not interfering with the existing workflow.

KEY FEATURES

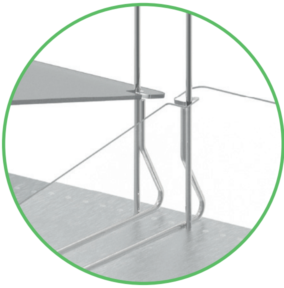
SNAP-FIT

Lid securely clicks into place, preventing accidental detachment.



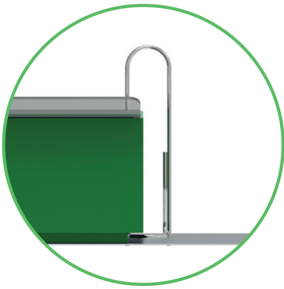
LID STOPPER

The height of the brace stops the lid from tilting backward, ensuring it slides onto the produce tray.



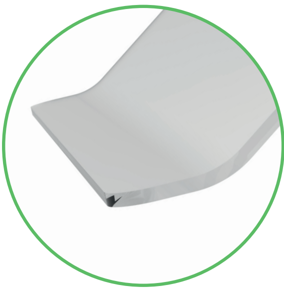
ALIGNMENT

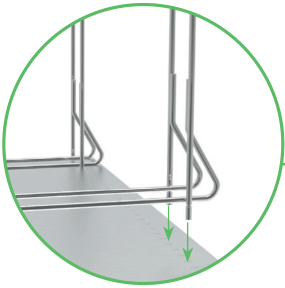
Brace ensures perfect lid-tray alignment and consistent spacing.



BEND

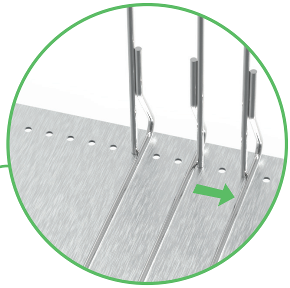
Enables smooth tray sliding and provides a comfortable customer interaction.





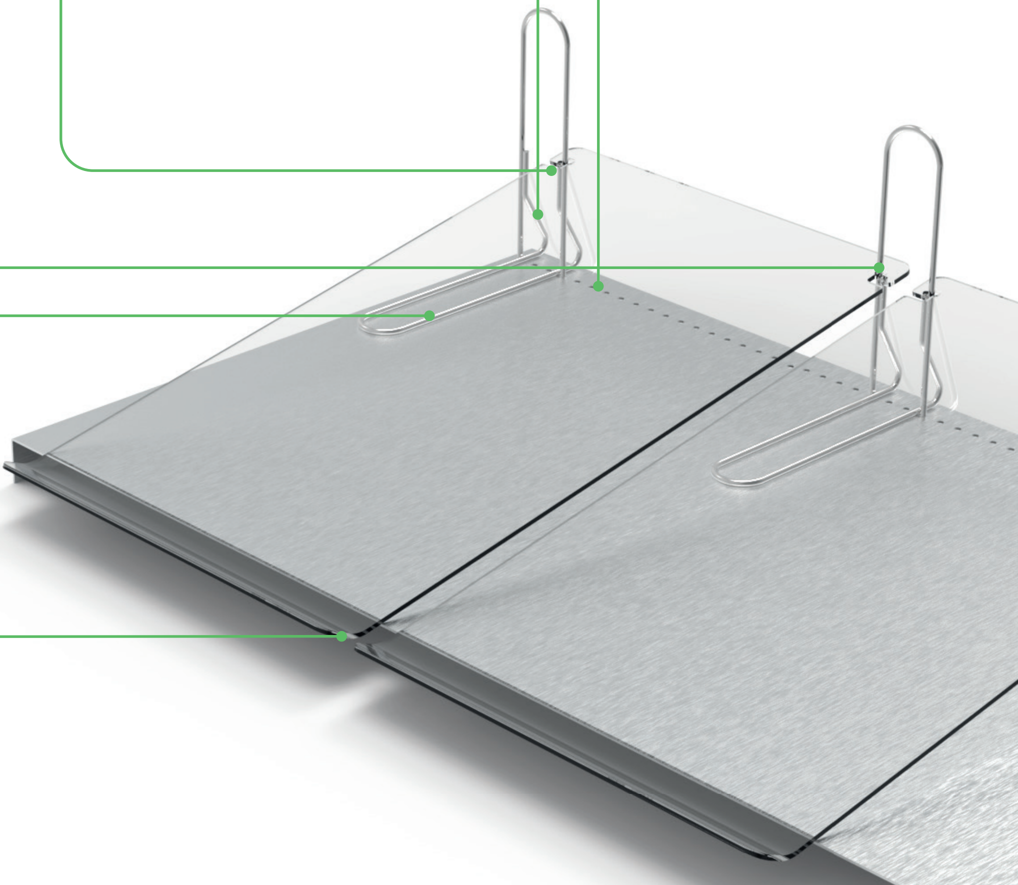
STABILITY

The brace and prongs provide stability against push-pull forces.



FLEXIBILITY

The hole pattern in the sheet allows the braces to be freely positioned, making it adaptable to various shelf setups.

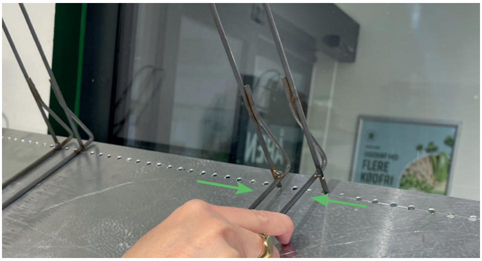


INSTALLATION & MAINTENANCE

Reitan is easily installed on the top shelves on the already existing shelving units in the produce section.

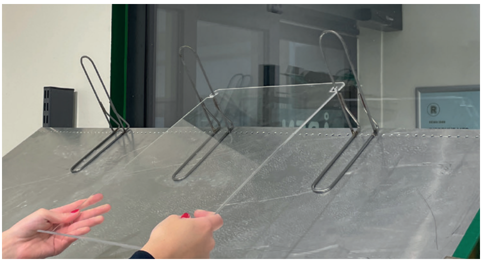
01. SHEET

Place the sheet on top of shelf. The bent sides on the sheet fit the outside of the shelf.



02. BRACE

Squeeze the brace slightly together and insert in holes. Distance is measured with a tray or lid.



03. LID

The lid is clicked onto the braces.

MAINTENANCE

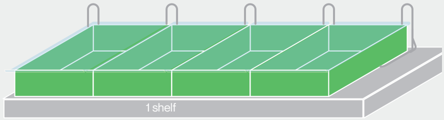
The lid can be wiped off with a damp cloth or a cleaning wipe. If broken or badly scratched, the lid can easily be replaced.

MODULARITY

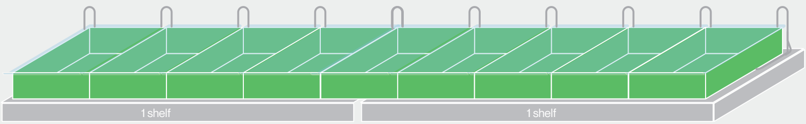
CONSTELLATIONS

One Reitan unit fits four trays. Two units fit nine trays, as the shelf width does not divide evenly by the tray width.

1 UNIT
(4 TRAYS)
1 SHEET
4 LIDS
5 BRACES



2 UNITS
(9 TRAYS)
2 SHEETS
9 LIDS
10 BRACES



EXPANSION

Due to the height of the brace, Reitan fits both the low and tall produce tray giving the grocer more freedom to choose where to use the lid.

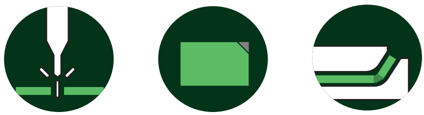
MATERIALS & MANUFACTURING

LID

ACRYLIC

A food-safe, transparent polymer with a high degree of stiffness and scratch resistance.

1. Laser cut 2. Deburr 3. Heat bend

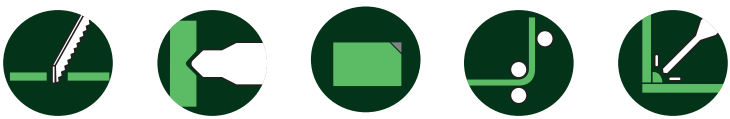


BRACE

STAINLESS STEEL

High durability and corrosion resistant. Used in existing similar solutions in the dairy cooler.

1. Cut 2. Turn 3. Deburr 4. Bend 5. Weld

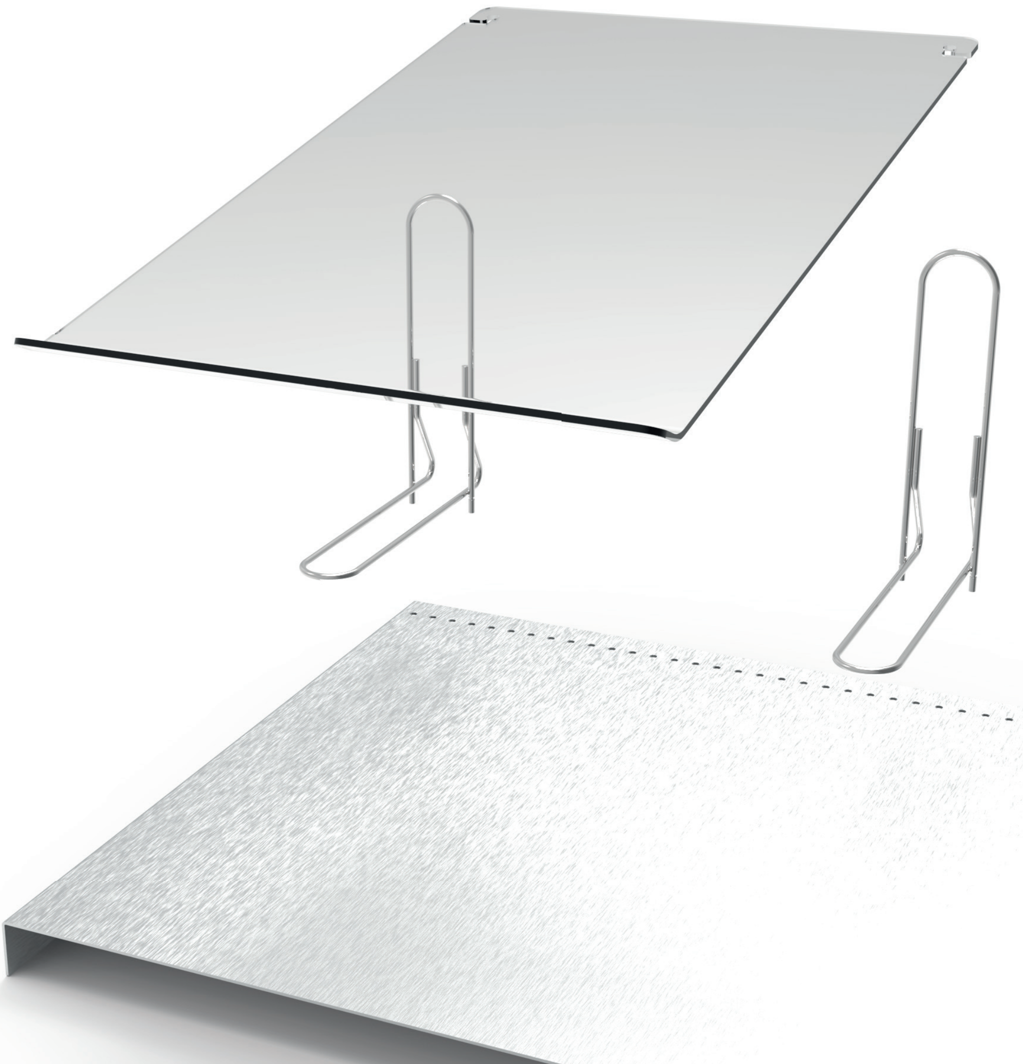


SHEET

STAINLESS STEEL

High durability and corrosion resistant. Low-maintenance.

1. Punch 3. Bend 4. Deburr



BUSINESS CASE

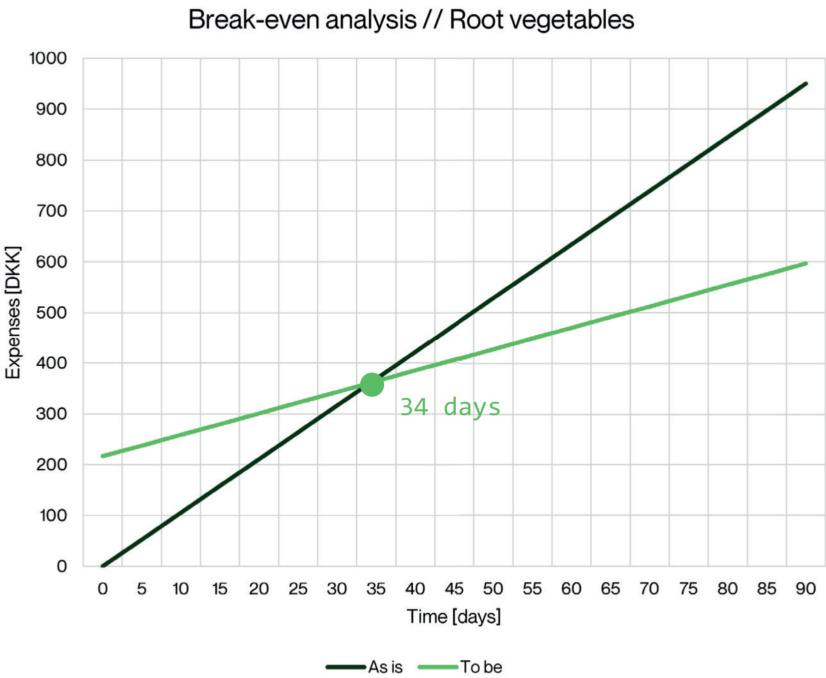
FINANCIAL PROJECTIONS

PRICE PR. TRAY: 216,6 DKK

The total price for a complete shelf unit solution – including the sheet, five braces, and 4,5 lids – is 974,5 DKK. Dividing this by 4,5 gives the unit price for a single solution.

BREAK-EVEN: 34 DAYS

Reducing food waste also reduces economic loss. Within 34 days, the savings from avoided waste cover the cost of implementing Reitan (based on carrots).



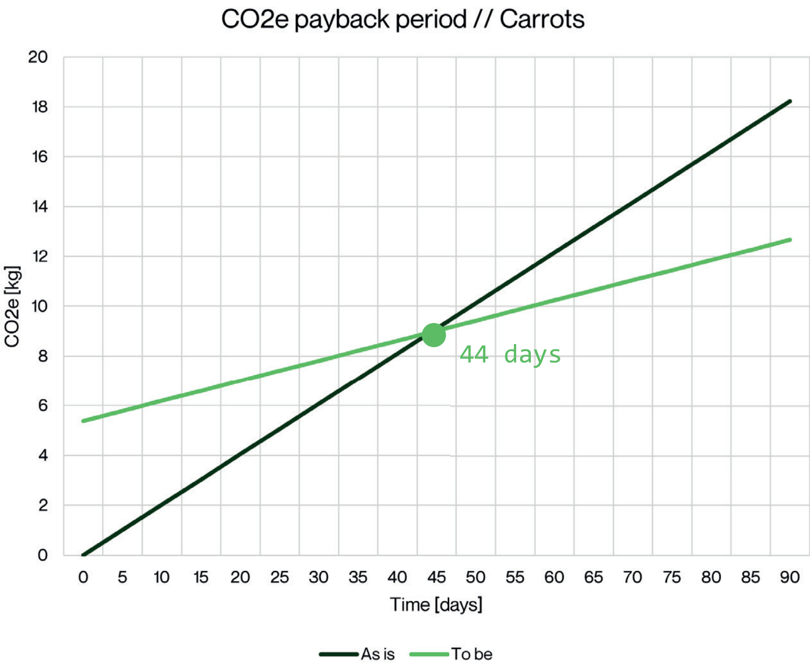
ENVIRONMENTAL FOOTPRINT

CO_2e PR. TRAY: 5,38 KG

This includes production, material, and transportation emissions for 4,5 sections of the sheet, two braces, and one lid.

CO_2e PAYBACK PERIOD: 44 DAYS

Comparing the CO_2e lost through discarded produce with the CO_2e generated from producing Reitan.



Reitan reaches break-even after 44 days, not only in financial terms but also in terms of environmental impact.

IMPLEMENTATION PLAN

This strategy explores two possible implementation paths for the implementation of Reitan into REMA 1000:

Scenario 1) A voluntary solution where individual grocers adopt Reitan based on their needs, aligned with regular reorder cycles. Adoption is expected to grow after the 2030 plastic ban.

	NEW NEED	DEVELOPMENT	**GATE 1: VALIDATION**
REMA 1000 stores	A new need/ problem is identified by grocers or the purchasing department - in this case, the short shelf life of root vegetables.		
REMA 1000 Group		Interior and technology department develops a solution in collaboration with relevant supplier	The purchasing director decides if the solution should be tested in model stores
Supplier			

SCENARIO 1 // OPTIONAL INVENTORY	ORDER #1	IMPLEMENTATION	MAINTANENCE
REMA 1000 stores	Each store orders the desired quantity if they choose to carry the product.	Reitan is installed in the stores that placed an order	If needed, more orders are placed
REMA 1000 Group	An order for the desired amount is placed with the supplier.		
Supplier	Manufacturing		Stock and continued manufacturing

Scenario 2) A top-down rollout, making Reitan a mandatory part of the store interior, implemented across all REMA 1000 stores as part of a unified concept.

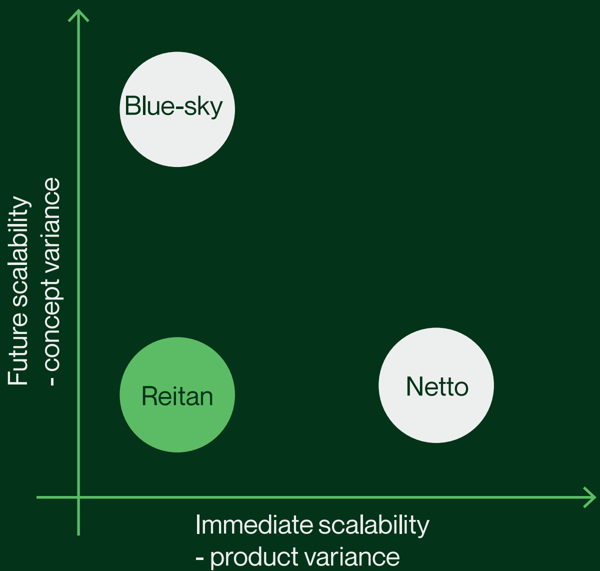
There is also potential for implementation in Norway (Gate 3: validation Norway). Although the interior departments in Denmark and Norway work independently, they regularly share ideas when a solution is believed to benefit both markets.

TESTING	ANALYSIS	**GATE 2: VALIDATION**
Testing in 3-5 model stores	Running evaluations (food waste, sales, cost-benefit, durability, user interaction/ feedback) and design optimization	The purchasing director decides if the solution should be rolled out. **Two possible scenarios: Mandatory or optional inventory**
Manufacturing of small badge of prototypes		

SCENARIO 2 // MANDATORY INVENTORY	ORDER #1	IMPLEMENTATION	MAINTANENCE
REMA 1000 stores		Reitan is installed in all Danish REMA 1000 stores	If needed, more orders are placed
REMA 1000 Group	An order is placed with the supplier to cover all Danish REMA 1000 stores.		
Supplier	Manufacturing		Stock and continued manufacturing

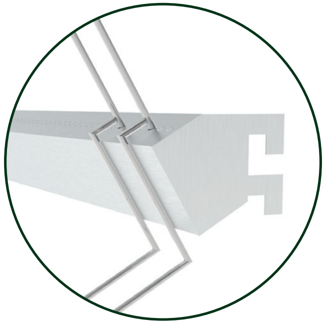
SCALABILITY

To broaden the perspective, Reitan was developed both horizontally (at the same level of abstraction) and vertically (a higher level of abstraction). The horizontal development involveed adapting variations of the solution to suit other store concepts. In the vertical development, a blue-sky approach was applied to fundamentally rethink the entire store layout and operational routines.

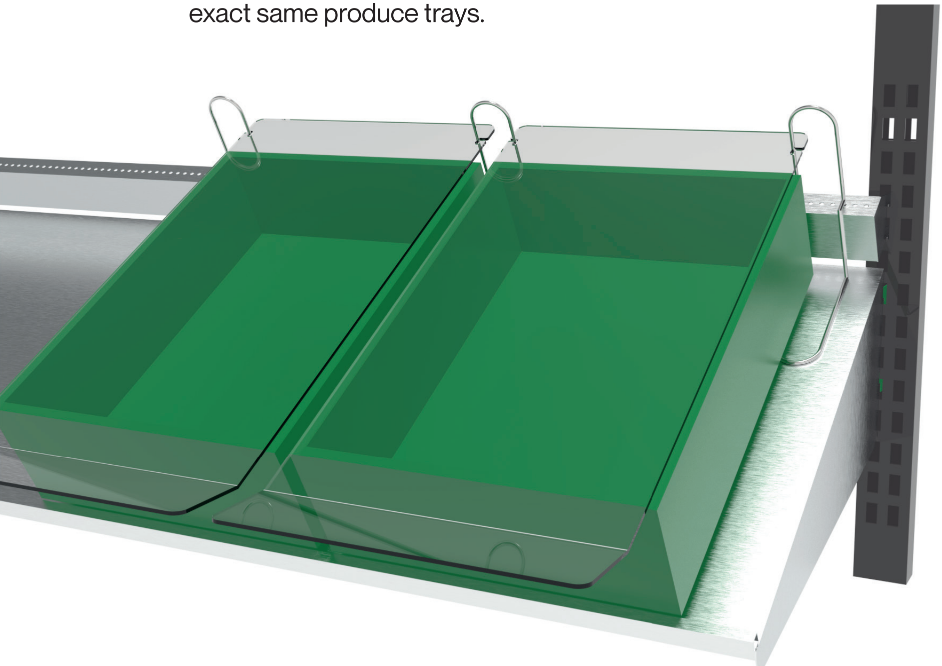


CASE 02: NETTO

Reitan is specifically designed for REMA 1000, tailored to their produce section layout and customized to accommodate their specific suppliers. With some design adjustments, the solution could be adapted for other store concepts as well.



A different case is Netto, where the shelves are solid. As a result, the sheet concept is modified into an attachment that fits the vertical shelving structure. Netto uses the exact same produce trays.



The lids remain unchanged, while the sheet is replaced with a specialized bracket. The brace also requires adjustment, but the production methods remain consistent.

BLUE-SKY CONCEPT

It is evident that the most efficient way of storing most produce and prolonging the shelf life is cooling.

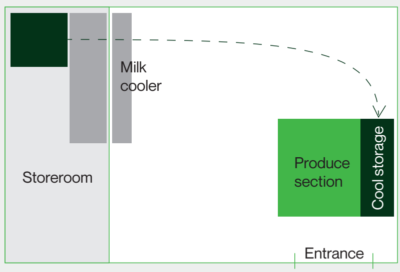
In this blue-sky concept for REMA 1000, the existing cold storage room is relocated to the front of the store – directly behind the produce section. Staff can restock from the back without disrupting customers or using floor space inefficiently.

This setup not only increases shelf life but also ensures fresher and cleaner produce on display.

The concept is best suited for new store builds, where layout flexibility allows for full integration.

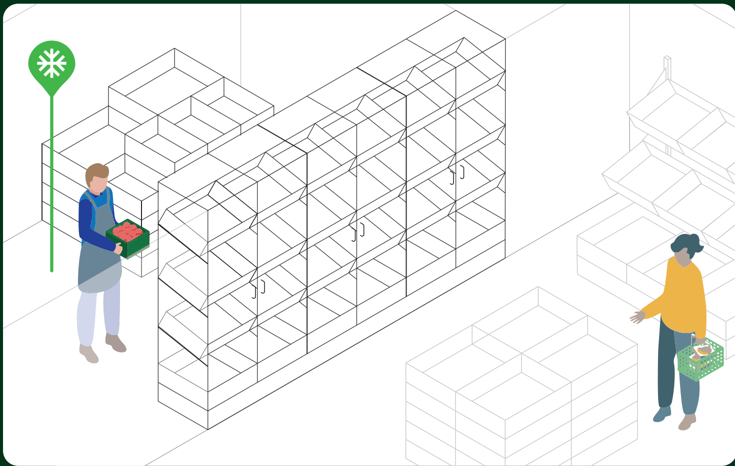
AS IS

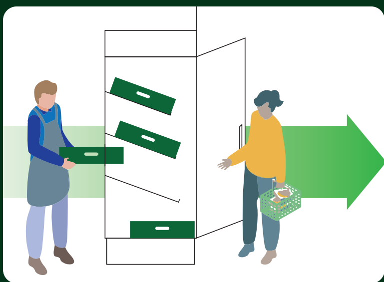
FLOOR PLAN CHANGES



The concept of connecting the storage and display from the milk cooler is applied to the produce section.

THE CONCEPT



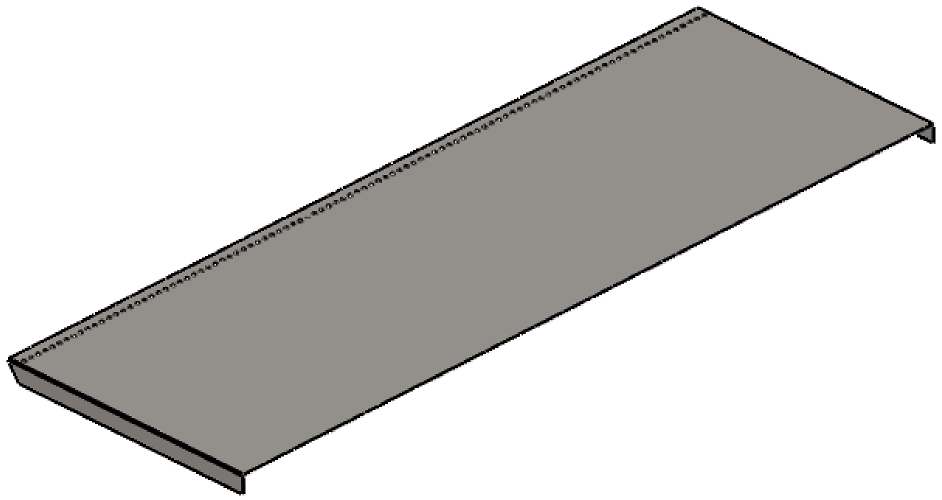


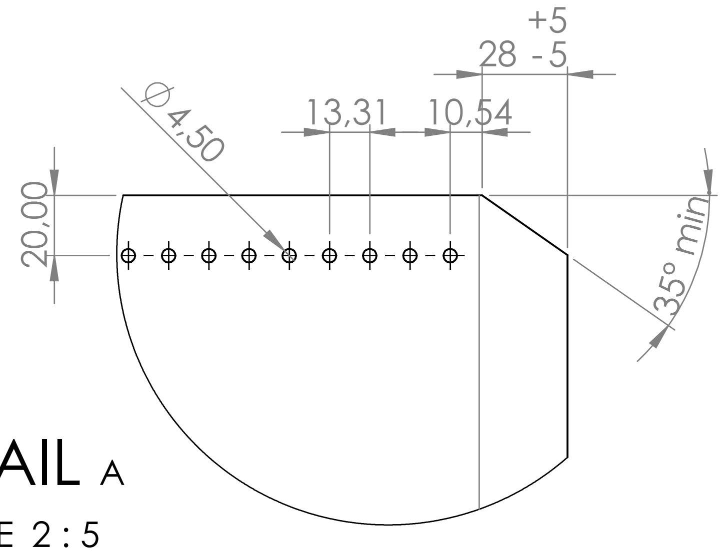
By creating a one-way flow, staff no longer need to check what produce needs restocking or what is available in storage – they can simply refill directly from the connected cool storage using the leftover produce.

REFLECTIONS ON THE FUTURE

With the EU ban on single-use plastic packaging for fresh produce, food waste is expected to rise significantly, creating a strong incentive to develop more effective and radical solutions. While a complete store layout redesign may seem excessive by today's standards, such large-scale changes could become increasingly common in the near future as retailers adapt to stricter regulations and shifting sustainability demands.

TECHNICAL DRAWINGS





DETAIL A
SCALE 2 : 5

DIMENSIONS ARE IN MILLIMETERS			DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	
DXF file available upon request					
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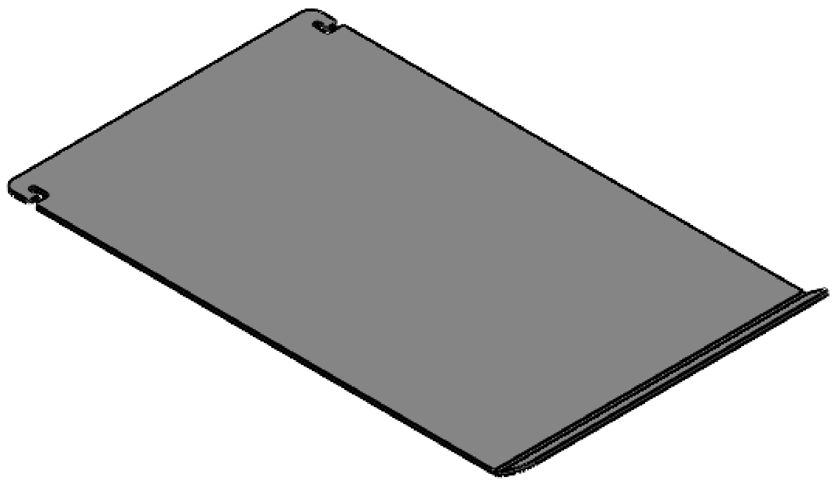
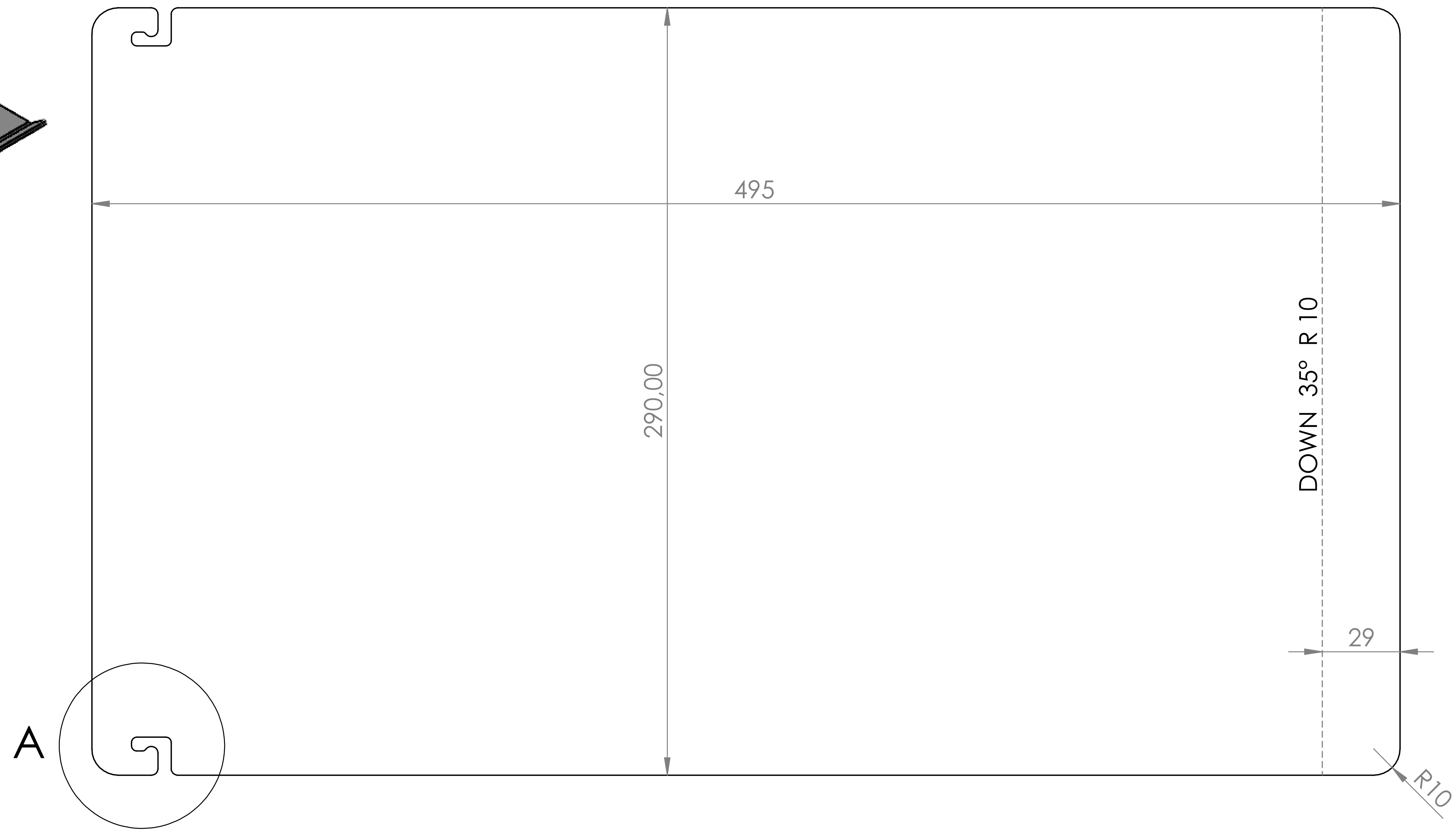
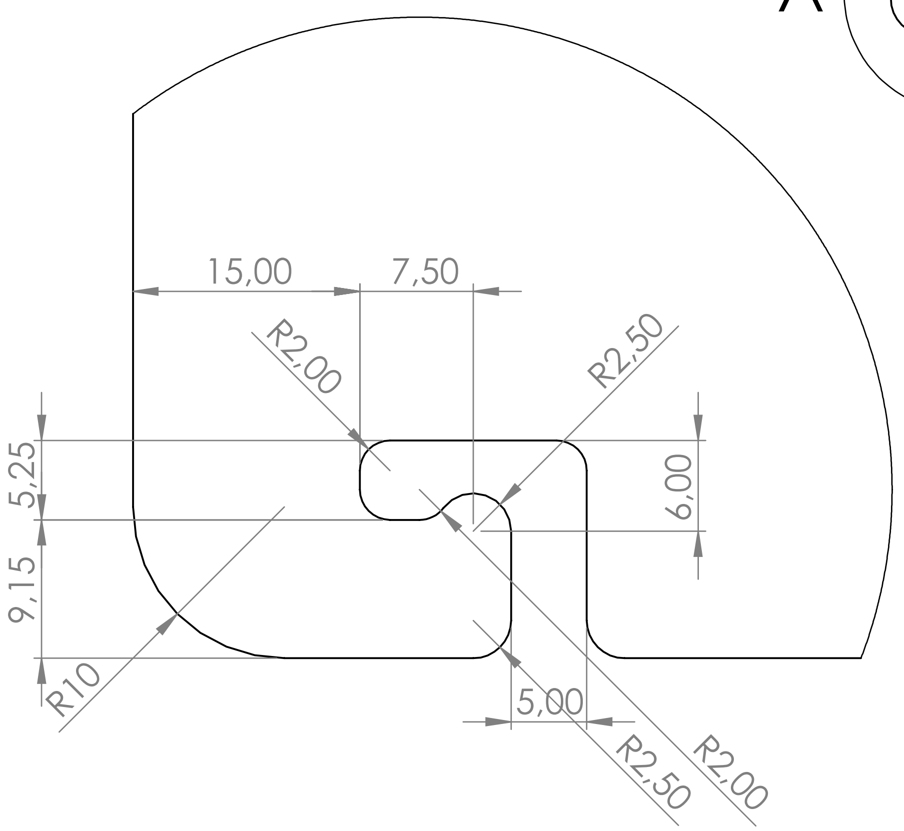
			WEIGHT: 4752.56 grams	SCALE:1:5	SHEET 1 OF 5





DETAIL A

SCALE 2 : 1



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DXF file availible upon request					
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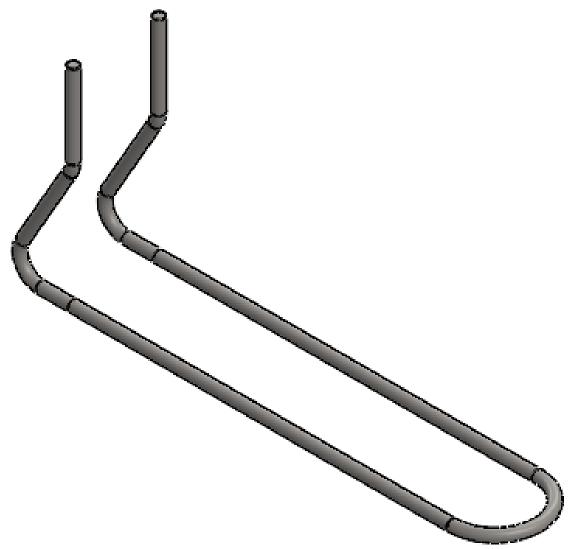

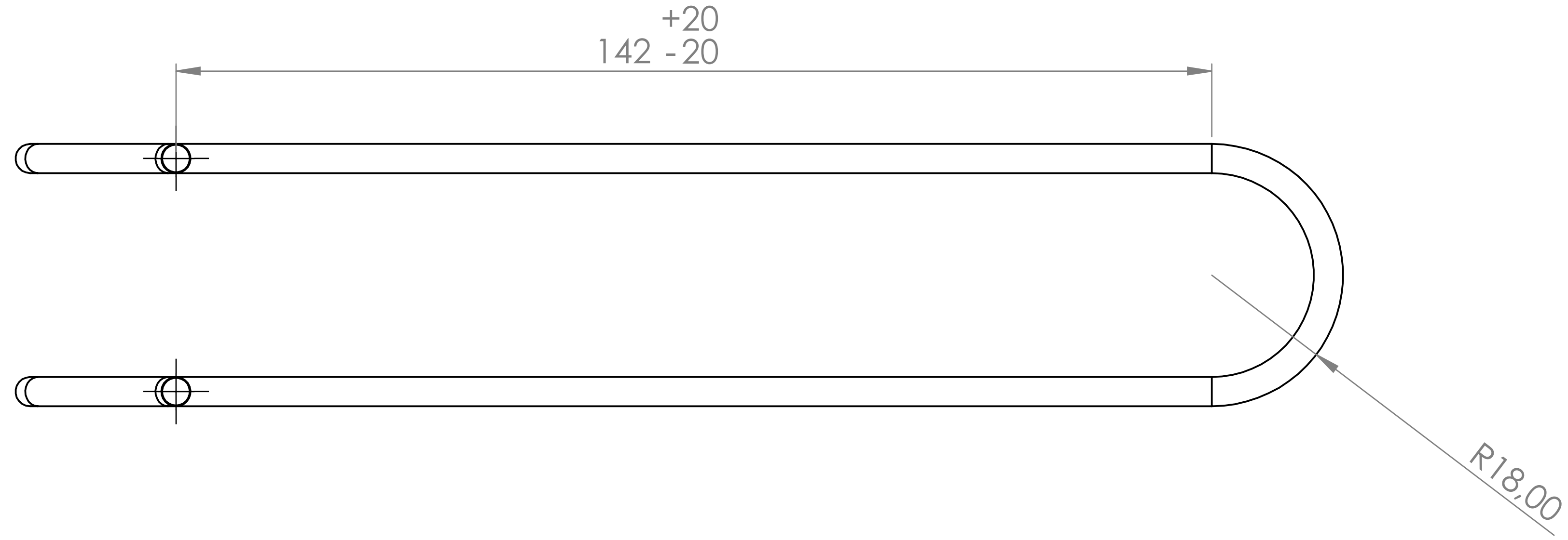

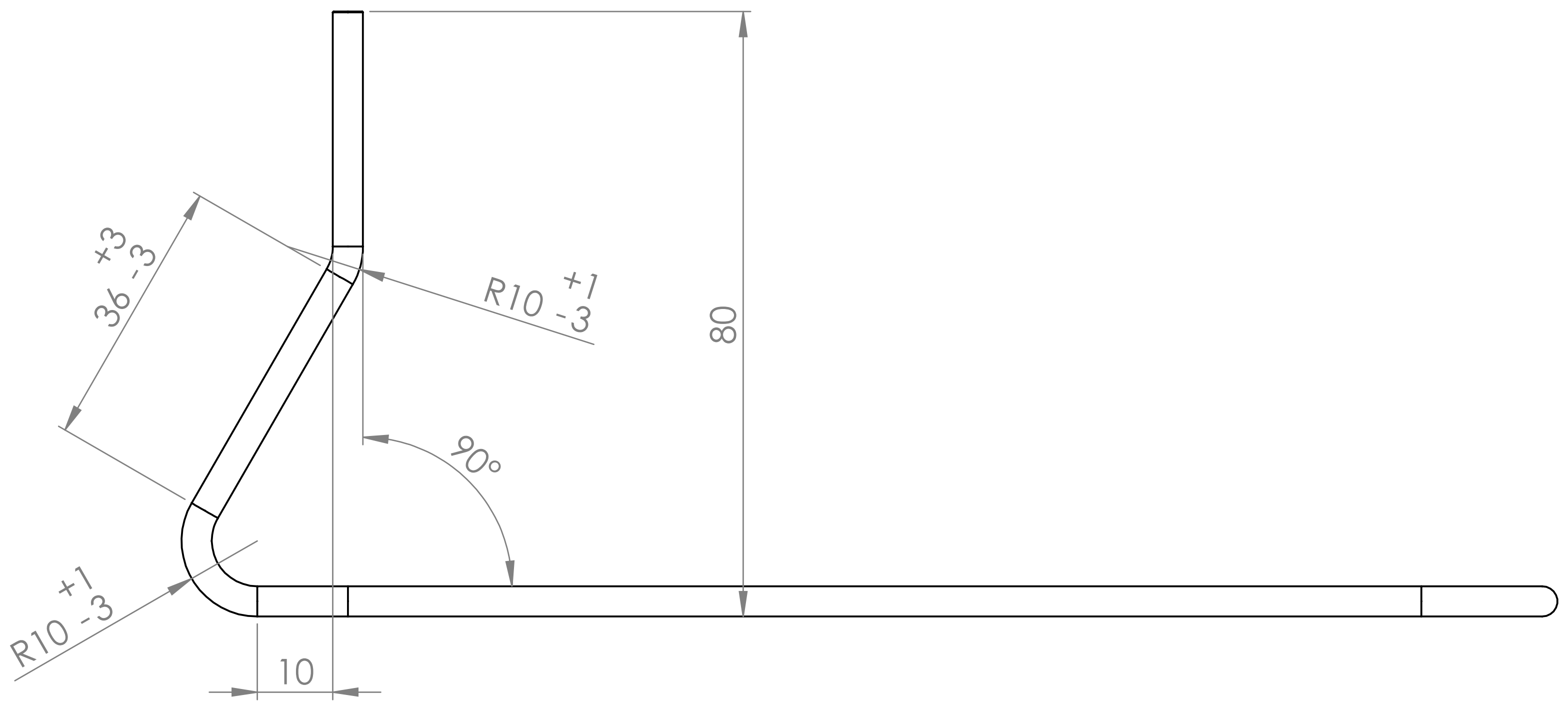

DIMENSIONS ARE IN MILLIMETERS				DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING
STEP file available upon request					
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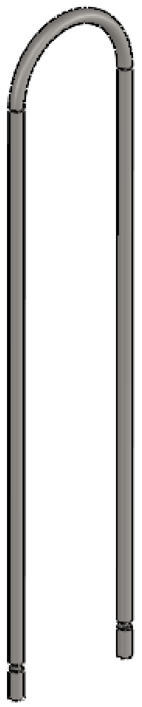
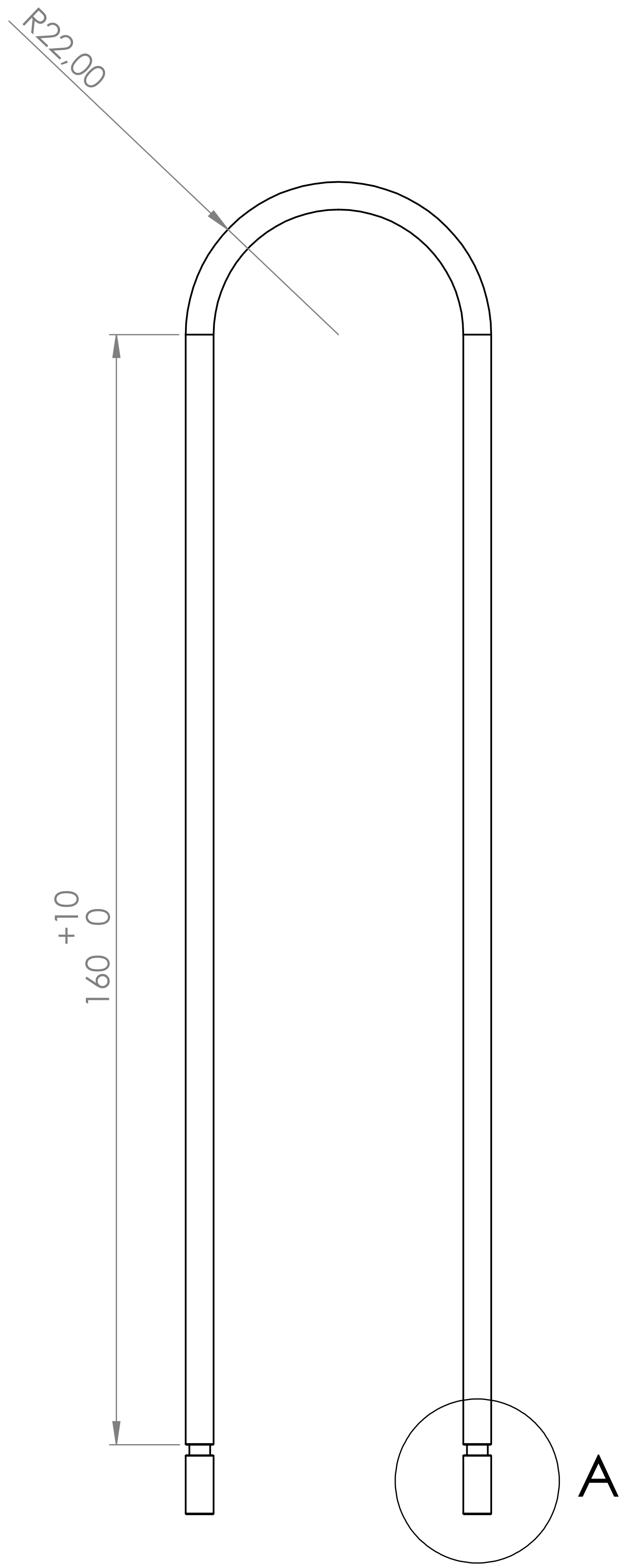
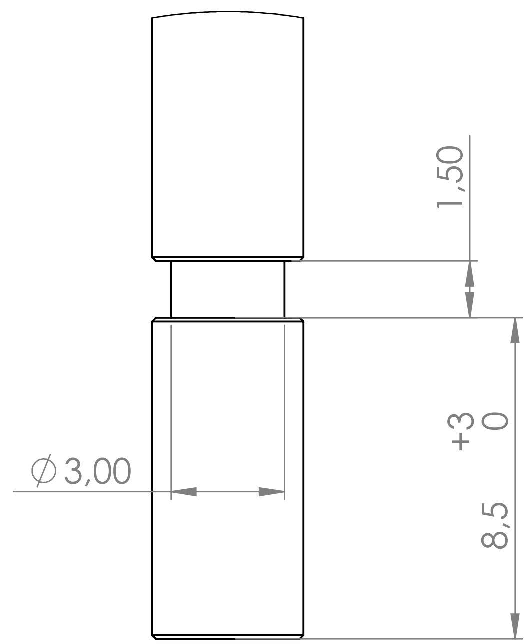
DRAWN	MA4-ID5	26.05.2025	Stainless steel grade 304 Rod Ø4,00 mm	Brace horizontal	
			WEIGHT: 53.65 grams	SCALE:1:1	SHEET 3 OF 5





DETAIL A

SCALE 5 : 1



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STEP file available upon request					
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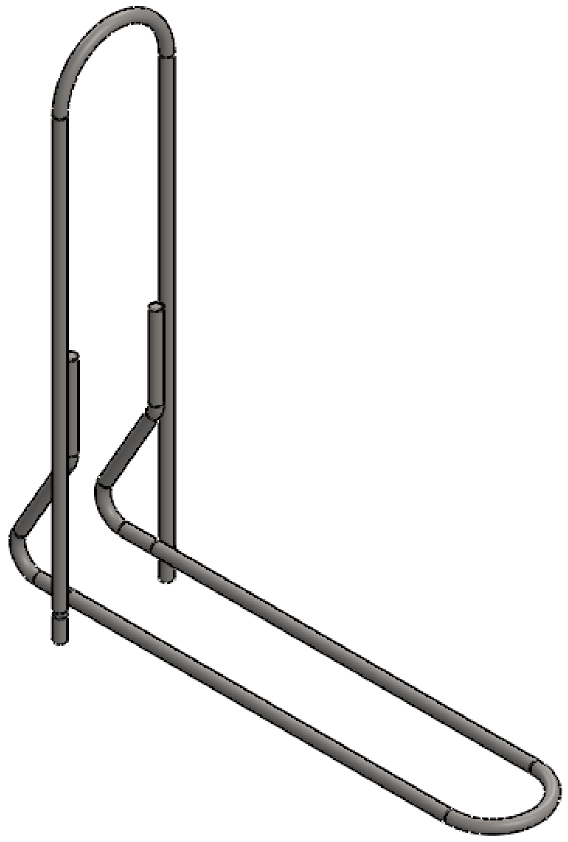
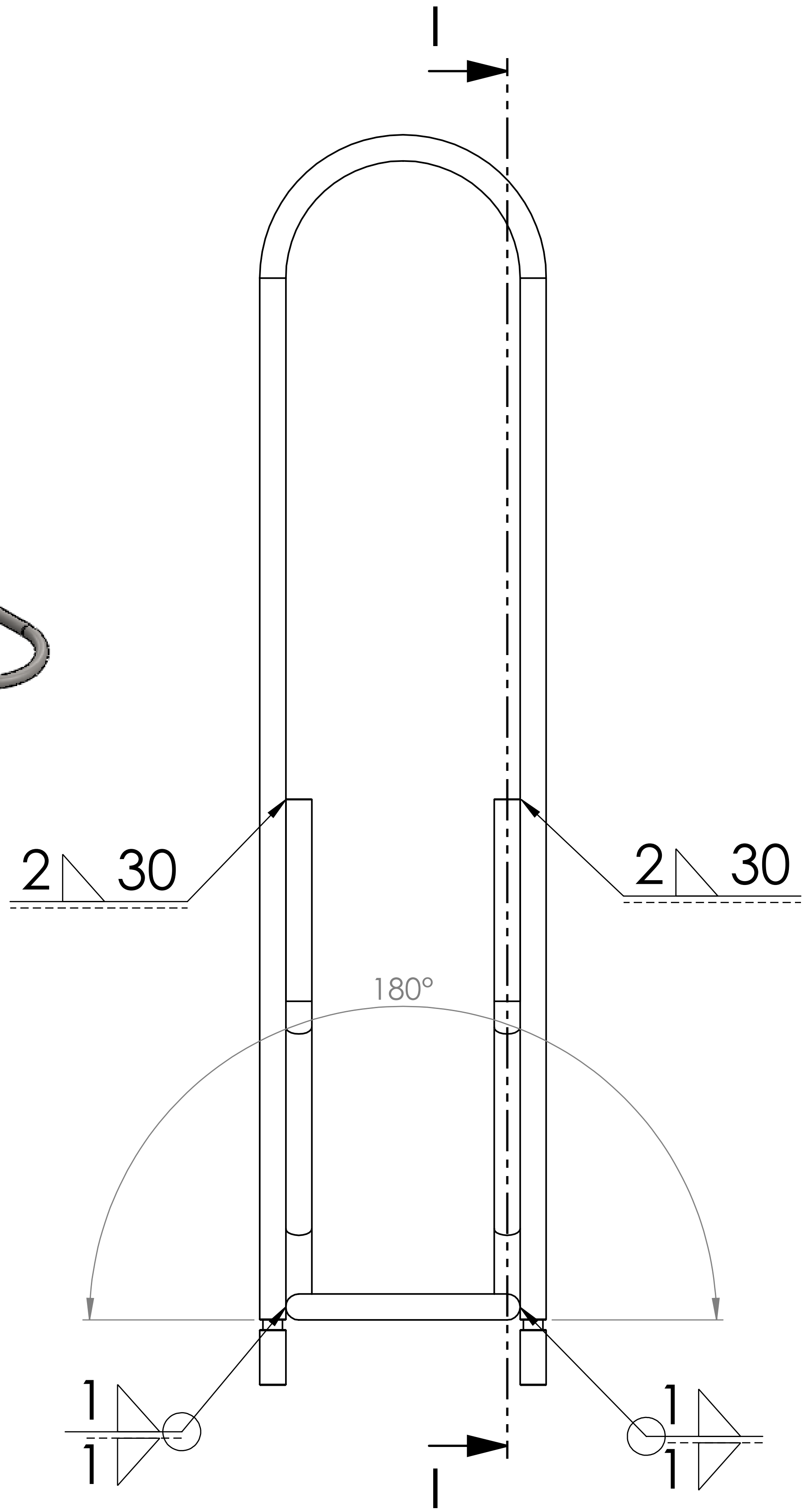
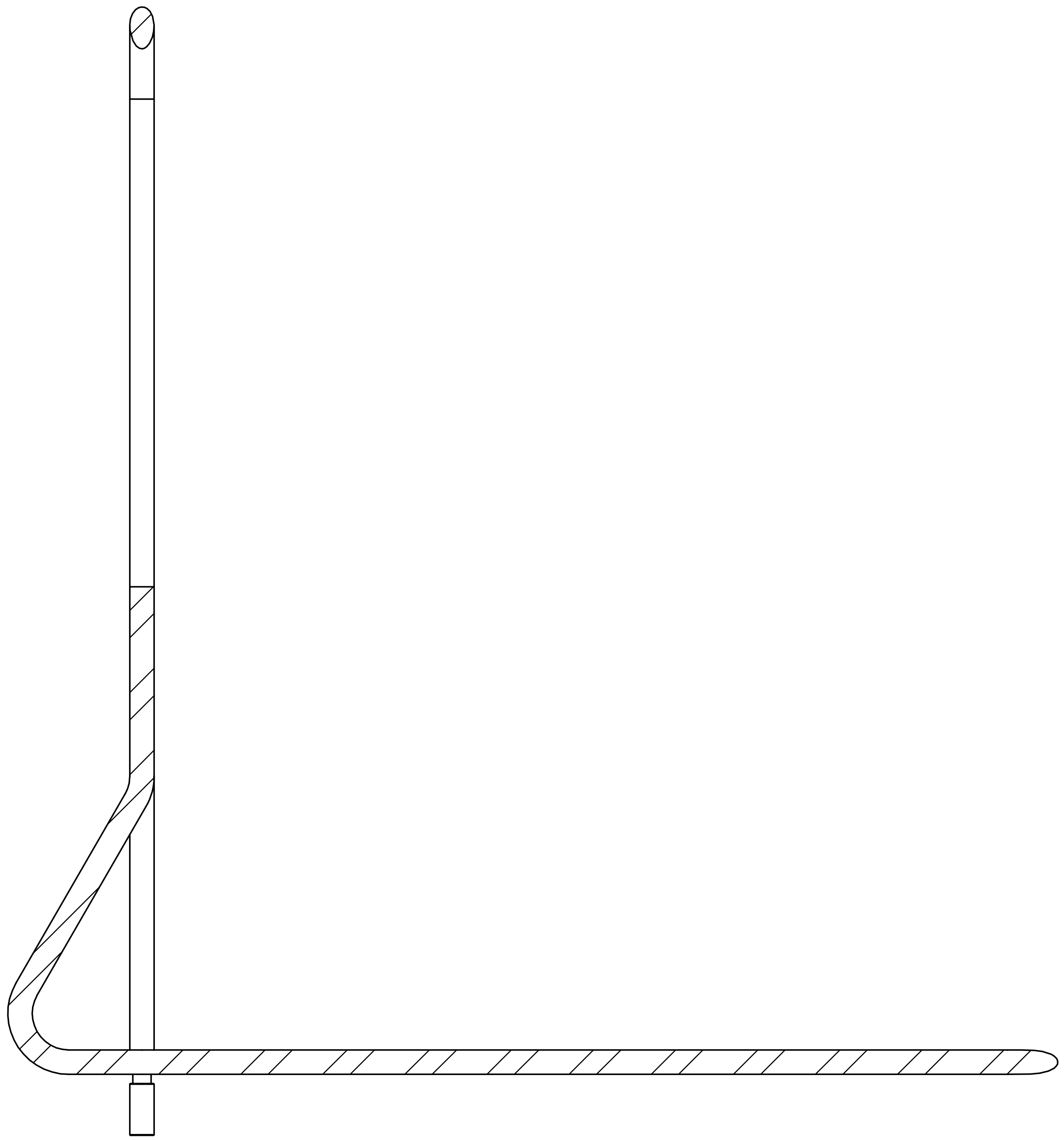




SECTION I-I

SCALE 1 : 1



DIMENSIONS ARE IN MILLIMETERS				DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	
STEP file available upon request						
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DRAWN	MA4-ID5	26.05.2025	Stainless steel grade 304 Rod Ø4,00 mm		Brace assembly	A3
			WEIGHT: 94,01 grams		SCALE:1:1	SHEET 5 OF 5

PROCESS REPORT

REITAN
MA4-ID5
MAY 2025

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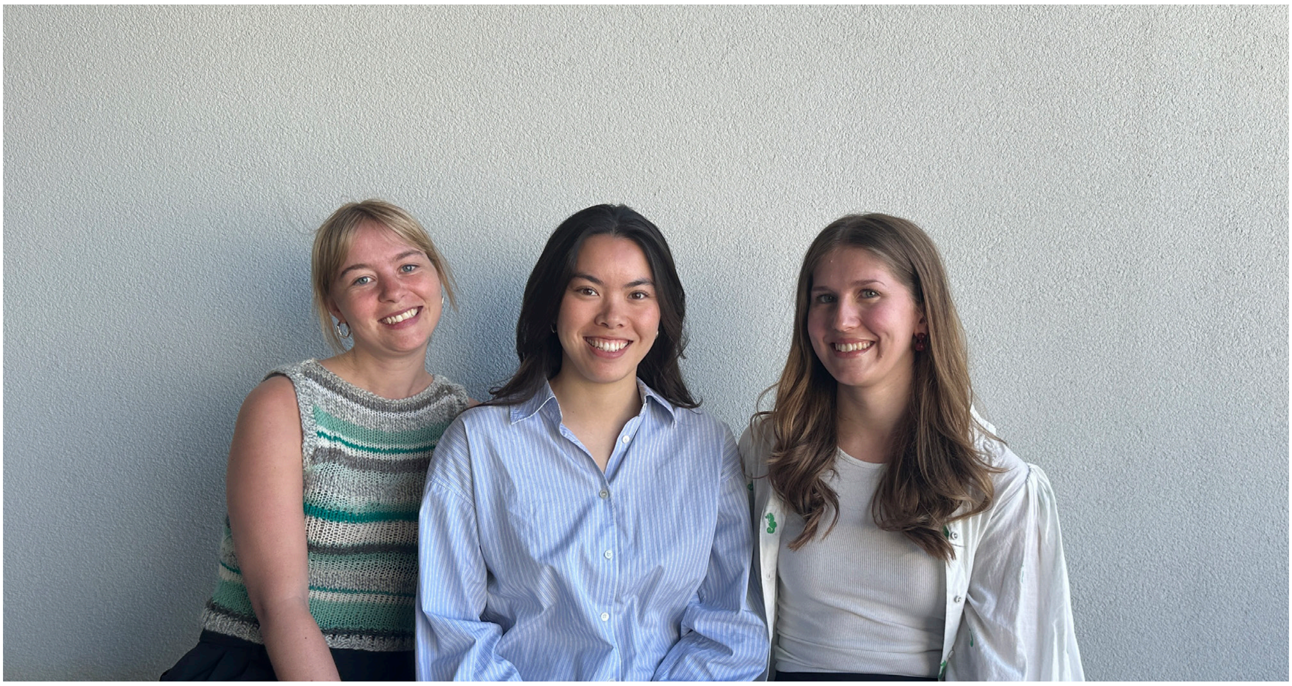

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Master's Thesis

Industrial Design

Aalborg University

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Supervisor: Christian Tollestrup

Technical supervisor: Mikael Larsen

Total pages // process report: 90

Total pages // product report: 24

ABSTRACT

This master's thesis was developed by a group of industrial design students at Aalborg University in the spring of 2025.

The project takes its starting point in new EU legislation set to come into force in 2030, which will ban single-use plastic packaging for fresh fruit and vegetables. While the law initially sounds promising, experts predict it may lead to increased food waste, as plastic packaging helps extend the shelf life of fresh produce.
Consequently, this project investigates how a product can be developed to mitigate the consequences of a future scenario in which single-use plastic packaging is banned.

The project's framework is case-based and primarily centers on the grocery chain REMA 1000, where a storage and display solution for the produce section is designed to both extend the shelf life of fresh produce while maintaining an attractive produce display. The product was developed with store employees in mind, focusing on user-centered design to simplify produce restocking and align with existing workflows. Simultaneously, it provides customers with a visually appealing shopping experience. The design proposal is largely informed by empirical data gathered through prototype testing and experiments.

Building on the principles of this proposal, the project broadens its scope by also presenting a solution for the Danish grocery chain Netto, and concludes with a blue-sky concept that integrates all learnings and insights from the project into a bolder, more innovative concept.

READING GUIDE

The project report is divided into two parts: a process report and a product report. The process report outlines the design process which culminates in the final design proposal, presented in the product report.
While both reports can be read independently, it is recommended to start with the product report to gain a foundational understanding of the final design proposal. All technical documentation related to the design can be found at the beginning of the appendix.

The appendix is included with the process report and will be referenced as (app. xx). Although the appendix provides more detailed and specific information on the design process, it is not essential for understanding the project.

The structure of the process report follows the Double Diamond design process model by the Design Council (n.d.), which divides the project into four phases and provides a structured, chronological overview of the design process. This structure reflects how the project evolved from initial exploration to final solution, guiding through the stages of discovering the problem, defining insights, developing ideas, and delivering the final design proposal.

ACKNOWLEDGEMENTS

The team would like to extend special thanks to REMA 1000 – both to Kristian, Annanoi, Jørgen, Mikkel, and the team at headquarters, including Ketty Nielsen, Interior Coordinator, and Jeppe Nielsen, CSR Coordinator – whose insights, resources, and openness played a vital role in shaping and grounding the project in real-world practice.
The team would also like to extend their sincere thanks to pr trading & HL Display and ITAB, for their generous help throughout this project.

INTRO

In the past century, the focus on the green transition has continuously intensified, with increasing attention on reducing environmental impacts across industries. One of the challenges is tackling food waste, which contributes significantly to the problem – accounting for approximately 16% of total greenhouse gas emissions from the EU food system (European Commission n.d.).

This growing awareness and commitment to sustainability motivated the design team to explore how the multifaceted challenge of reducing food waste could be addressed. Driven by this goal, the project investigates the complex balance between sustainability, practicality, and user expectations, aiming to develop a product proposal that can realistically succeed in a greener future.

01

DISCOVER

02

DEFINE

03

DEVELOP

04

DELIVER

05

OUTRO

01

DISCOVER

The first phase, *Discover*, involves a deep dive into the problem space, aiming to understand its scale, complexity, and underlying causes. This stage involves broad exploration to grasp the full context of the issue and identify meaningful directions for further development.

More specifically, this first phase begins by unpacking the EU legislation that serves as both the backbone and catalyst for the project – seeking to understand what the law entails and what implications it might have, particularly for fresh fruit and vegetables in grocery store produce sections.

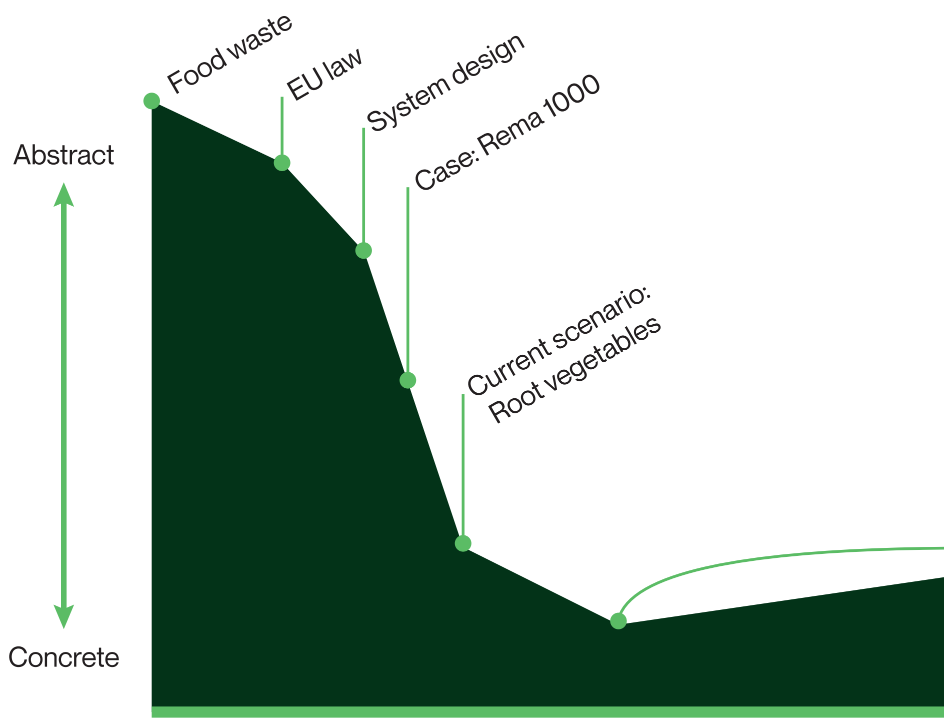
At this stage, the project adopts a case-based approach, focusing on the grocery chain REMA 1000. This allows the design work to be rooted in a real context, offering concrete insights and practical relevance. This also includes mapping the operational context in order to identify how and where a relevant problem space might emerge within REMA 1000's existing workflows and retail environment. Moreover, the phase explores consumer values.

METHODOLOGY

The design process timeline (right) provides an overview of the activities within the project according to level of abstraction as described in Erik Lerdahl's vision-based pyramid model (2005). The abstract level deals with aspects like value and purpose while the concrete level focuses on product details, materials and manufacturing.

While it may appear linear, it should be noted that all phases of the design process – especially 1–3 – were characterized by numerous iterations, and that progress often involved revisiting and refining earlier work.

Disclaimer: AI was used for text refinement and proofreading purposes in the writing of this report.



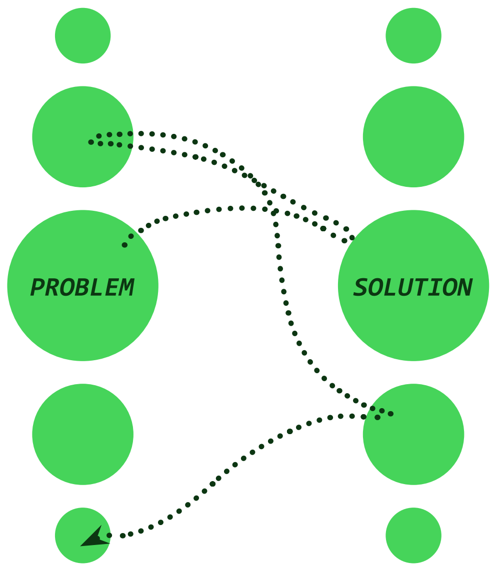
PROBLEM SOLUTION CO-EVOLUTION

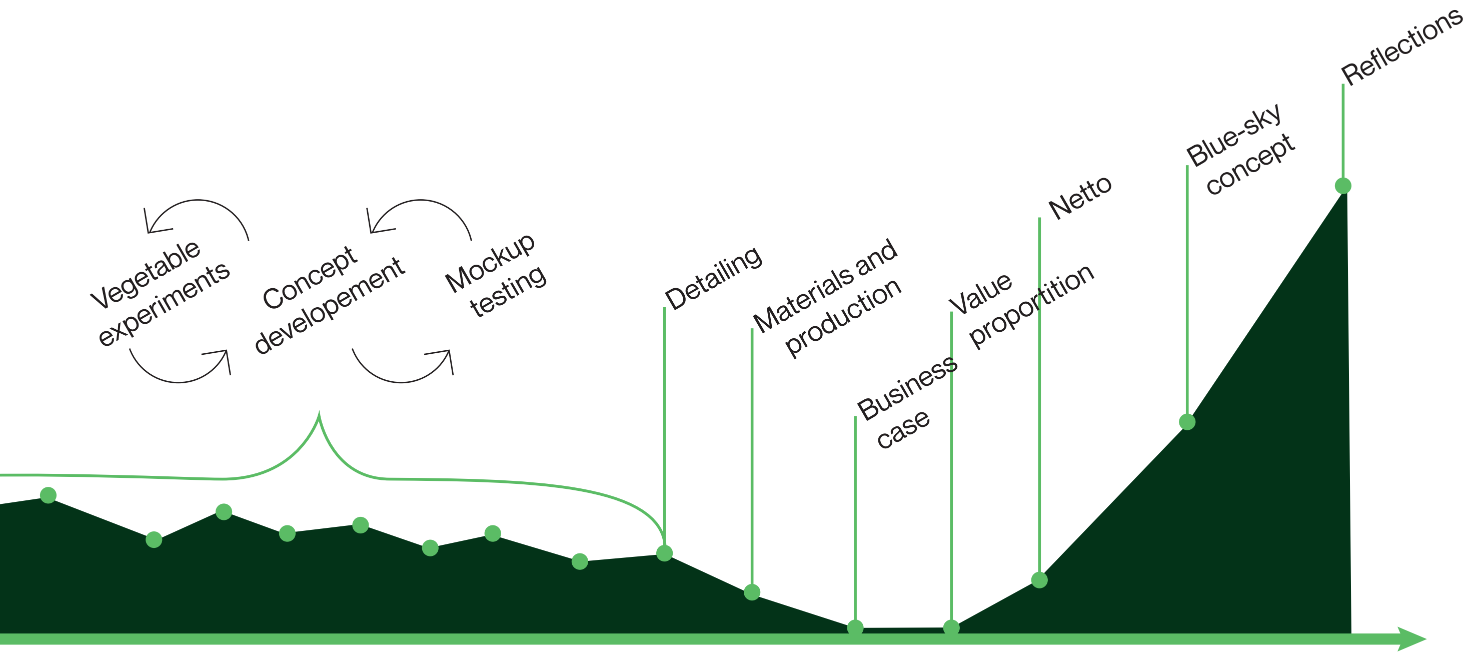
Overall, this project was based on an iterative approach of gradually expanding the problem and solution space (Laursen & Haase 2022):

The beginning of the design process took point of departure in an incredibly complex system of systems that was both difficult to dissect and manage. The team addressed this by identifying a single, concrete, and tangible problem within the larger system – something that could be clearly defined and made actionable. This is the part of the process where the team decided to further investigate root vegetables at REMA 1000.
Once this specific problem was pinpointed, the design team moved forward by developing a solution for it. After gaining relatively stable footing in the solution space, the design team took a step back to revisit the broader problem space. Here, it was then explored how the solution – or some of its underlying principles – could apply to other similar contexts. This is the part of the design process where the team looked at developing a solution for Netto.

This strategy made the problem space more approachable because of the accumulation of knowledge gained from the first problem-solution.

This approach allowed the design team to work with something limited and concrete, within tangible boundaries, while gradually evolving the project and its scope in a manageable way.





LEAN STARTUP

The team approached the product development process with methods from the Lean Startup methodology by Eric Ries (2017).

BUILD-MEASURE-LEARN

A central part of the design process was particularly grounded in the build–measure–learn feedback loop. This iterative cycle guided the team in continuously refining both the solution by testing, experimenting and learning from the outcomes.

MINIMUM VIABLE PRODUCT

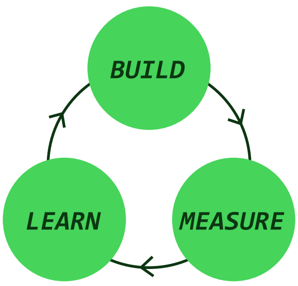
A core element of this method was the use of a Minimum Viable Product (MVP) – a simplified version of the product built with just enough features to allow for meaningful feedback. The use of an MVP closely aligned with the team's continuous rapid prototyping, where simple, low-fi versions of the product were created and tested iteratively. Each prototype acted as a mini-MVP, which allowed the team to experiment, fail fast, and adapt.

REFLECTION IN AND ON ACTION

Donald Schön's concept of "reflection on action" (1983) also played an important role in this process, especially in the measure–learn stages of the Lean Startup loop. In this sense, reflection on action became a natural extension of build–measure–learn, supporting continuous improvement and deeper understanding throughout the project.

In practice, reflection in action also played a key role in the design process, especially during rapid prototyping and mockup testing where a more hands-on understanding of the product was gained.

The combination of rapid prototyping, creating MVP's and reflective practice created a learning-driven design process that helped the team validate ideas early, and evolve the product in a thoughtful, coherent way.



> “
>
> Certain **single use plastic packaging** types will be **banned from 1 January 2030**.
>
> These include packaging for **unprocessed fresh fruit and vegetables** [...]
>
> – European Parliament press release (European Parliament 2024)

EU: REDUCE, REUSE AND RECYCLE PACKAGING

On the 24th of April 2024, the European Parliament adopted new measures to reduce packaging waste. Notably, the regulation will ban certain types of single-use plastic packaging starting January 1st, 2030. This includes single-use plastic packaging for unprocessed fresh fruits and vegetables such as nets, bags, trays and containers:

> "[Restricted use of] Single-use plastic packaging for less than 1,5 kg pre-packed fresh fruit and vegetables.
>
> Member States may set up exemptions in respect of this restriction if there is a demonstrated need to avoid water loss, or turgidity loss, microbiological hazards or physical shocks, oxidation, or if there is no other possibility to avoid commingling of organic fruits and vegetables with non-organic fruits and vegetables (…), without entailing disproportionate economic and administrative costs."
>
> (European Union 2025, p. 102)

The European Parliament describes the background for this new regulation as follows:

"*[Single-use plastic packaging] is an ever-increasing source of waste, the EU total having increased from 66 million tonnes in 2009 to 84 million tonnes in 2021. Each European generated 188.7 kg of packaging waste in 2021, a figure that is expected to increase to 209 kg in 2030 without additional measures.*

In adopting this legislation, Parliament is responding to citizens' expectations to build a circular economy, avoid waste, phase out non-sustainable packaging and tackle the use of single use plastic packaging." (European Parliament 2024).

WHAT DOES THIS MEAN?

Since the rule is set to take effect in 2030, several aspects have not yet been clarified and/or finalized. While exceptions will apply, the specific exemptions are not yet known. The European Commission will provide further details on which packaging formats fall within the scope of the regulation, outline exemptions to the restrictions, and publish a non-exhaustive list of fruits and vegetables that will be excluded from the plastic packaging ban.
However, these guidelines are expected to be published by 12 February 2027 (European Union 2025, p. 57).

Although the exact scope and limitations of the law remain uncertain, it does raise a critical question:

WHAT WOULD HAPPEN IF ALL SINGLE-USE PLASTIC PACKAGING FOR FRUITS AND VEGETABLES WAS BANNED?

PLASTIC PACKAGING FUNCTIONS

To better understand the impact of the new EU legislation and to shed a light on how the produce may be significantly affected when it comes into force in 2030, it is crucial to take a closer look at the role plastic packaging currently plays.

In 2024, the Government of Canada released a report assessing the functional importance of plastic packaging in fresh produce (Government of Canada 2024). The report highlights and describes the key functions of plastic packaging as follows:

	FUNCTION	DESCRIPTION
CONTAINMENT	Seal integrity	Seal integrity prevents leakage of gases, humidity, and liquids, enabling modified atmospheres that extend shelf life by slowing respiration and reducing mould.
	Physical robustness	Physical robustness ensures optimum allocation of resources – both hard (e.g. infrastructure, refrigerators, trucks, etc.) and soft (e.g. labour, energy, etc.).
CONVENIENCE	Portion control	Portion control improves retail efficiency by allowing produce to be sold in units, streamlining labor use and speeding up consumer purchasing and checkout.
	Ease of handling	Facilitates resource optimization throughout the supply chain by enabling efficient packing, transport, stacking, storage, and display. Enhances consumer convenience.
COMMUNICATION	Storage / handling instructions	Ensures participants along the value chain and consumers in the home are informed about the most effective and efficient means to handle, transport and store food.
	Traceability / tracking / ID	Includes date coding, batch numbering, documenting, etc. to help guarantee the quality and safety of food purchased and consumed.
PROTECTION	Process control (transparency)	Packaging mechanics enable more effective management processes and decision making than otherwise possible along the value chain and in the home.
	Preservation	Preservation of nutritional and physical qualities, including maintaining texture and preventing discolouration and decline in taste profile.
	Prevent damage to contents	Shields from accidental mechanical damage during handling, transportation and storage by providing a protective layer between the food and external environment.
	Microbial control	Prevents microbes from occuring and/or multiplying to levels that pose a danger to consumers or results in foods' premature degradation.
	Prevent internal contamination	Prevents contents from being contaminated by external sources, whether environmental or human. In doing so, keeps harmful agents like bacteria and viruses away.
	Prevent external contamination	Prevents harm to surrounding environment, including other products, water, air, etc., due to contents leaking.

EXAMPLES

COMMUNICATION
Plastic packaging is often used to differentiate between organic and conventional produce. Since organic items are typically more expensive, they are more likely to be individually wrapped. In some cases, plastic packaging is replaced with alternatives like stickers to communicate the information.

HANDLING
Customers rarely need just one onion or carrot, so bundling produce can make handling easier and may also encourage additional sales when items are sold in bulk. One way to bundle produce without using excessive amounts of plastic is using elastic bands. However, buying produce in bulk often leads to spoilage before it can be consumed.

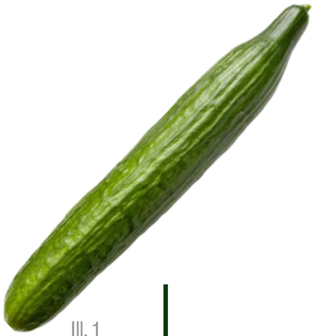
PROTECTION AND PRESERVATION
Plastic packaging helps preserve freshness by retaining moisture for items like cucumbers, providing hard protection against physical damage for delicate produce like grapes, and maintaining a controlled atmosphere with specific CO_2 levels to reduce microbial growth in produce like spinach.

CONSEQUENCES

While the new EU regulation initially seems promising for cutting down on packaging and enhancing the circular economy, removing plastic packaging from certain types of produce could result in significant consequences.

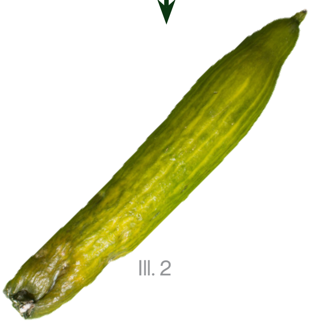
A closer look at the functions of plastic packaging reveals its critical role in extending the shelf life of fresh produce. When packaging is removed, fruits and vegetables tend to spoil more quickly, which can lead to a significant increase in food waste.
As Merete Edelenbos, lecturer at the Department of Food Science at Aarhus University, explains (translated):

> **”Packaging is often criticized, and you only need to look in your trash bag to see why. A large portion of what we throw out each week is food packaging. However, it’s important to note that without packaging, most food items have a much shorter shelf life.**
>
> **In the bigger picture, packaging may account for roughly 5% of a product’s total environmental impact. About 15% comes from transportation, while 75% occurs during production. Most importantly, food must be consumed. If avoiding packaging leads to food waste, the environmental impact can be relatively significant.”**
>
> **– Merete Edelenbos (Herlufsen 2020)**



Ill. 1

3 DAYS
A cucumber wrapped in plastic can stay fresh and firm for up to 14 days. Without the plastic, its shelf life drops to just 3 days (Herlufsen 2017).



Ill. 2

WHAT IS FOOD WASTE?

In their 2024 CSR report, REMA 1000 defines food waste as follows (REMA 1000 2024, translated):

Food waste is the amount of food that is produced but not eaten and ends up as waste. It occurs at producers, in grocery chains, in private households, and in restaurants. There are two main types:

1. Primary food waste: Food that is discarded even though it could have been eaten. This occurs during production, transport, and sales when products cannot be sold.
2. Secondary food waste: When consumers throw away food due to overbuying, poor storage, lack of knowledge about shelf life, or simply because the food is not used in time.

SCOPE

WHERE TO INTERVENE?

As Merete Edelenbos touches upon, fruits and vegetables are, quite literally, consumer products; they are meant to be purchased and used in households. With the new EU law coming into force, a critical question arises: *How can we make sure that fruits and vegetables actually reach consumers in the end?*

The team identified a natural starting point for addressing this question by mapping the general supply chain journey of an arbitrary fruit or vegetable.
To achieve this, the team combined their general knowledge and desk research in a clustering to organise, create an overview, and identify connections that could support the identification of leverage points (app. 01).

The goal was to be able to pinpoint leverage points in the supply chain where an impact could be made – and that the design team would also have access to. Essential questions to guide the team in this were:

1. *Where can the biggest impact be made?*
2. *Who will invest in this solution?*

> **"[Leverage points] are places within a complex system (a corporation, an economy, a living body, a city, an ecosystem) where a small shift in one thing can produce big changes in everything."**
>
> **- Donella Meadows (Meadows 1999, p. 1)**

CONCLUSION

From the clustering, the grocery store level was considered the strongest leverage point for the following reasons:

- Grocery stores like Salling Group and REMA 1000 are already engaged in food waste reduction initiatives.
- They have economic incentives to reduce food waste, and their current initiatives confirm their willingness to invest in solutions (see more on p. 18).
- Currently, grocery stores experience about 42% of their food waste in the fruit and vegetable category (ONE THIRD 2021). With the new EU legislation, this can be expected to worsen.
- On the other hand, consumers can be less reliable users. There is often a discrepancy between consumer intentions and actual behavior. For example, when given the option to buy organic products, many consumers express a willingness to do so but fail to follow through in practice (Johnstone & Tan 2014). This gap suggests that increased consumer agency may lead to increased unpredictability.

The team chose to design for grocery stores, as they are a realistic and scalable target with high implementation feasibility due to their resources and incentive. Addressing grocery stores could also indirectly promote more sustainable consumer behaviour.

CASE 01: REMA 1000

Having decided to further explore the grocery store level, the team managed to establish contact with the international discount chain REMA 1000 to gain insights into how they balance environmental responsibility with business goals.

The team got in contact with Jeppe Friis Nielsen, CSR Coordinator at REMA 1000, who provided valuable insights into the company's approach to food waste as well as their responsibilities in addressing it (app. 02). Some of these are presented below:

Ill. 3

"THE LIVING DEPARTMENT"

- The produce section is REMA 1000's largest source of food waste. Each store discards 3–6 boxes of produce every single day.
- REMA 1000 has introduced by-the-weight root vegetables to help customers buy only what they need, but some of these vegetables have a very short shelf life of only half a day.


Ill. 4


Ill. 5

CONSUMER RESPONSIBILITY

- REMA 1000 had considered becoming a part of "Too Good To Go" but believes it merely shifts the food waste burden onto consumers.
- REMA 1000 emphasizes consumer behaviour as a key driver of change: "Customers vote with their shopping baskets."
- Jeppe mentioned that sometimes, the real test of a product or solution is not whether people love it, but whether it bothers them or not.

"The less we waste to the customers, the less they waste themselves."
– Jeppe

PACKAGING AGAINST FOOD WASTE

- REMA 1000 has introduced a two-part plastic packaging solution for foods such as cold cuts and pizza toppings allowing one half to remain sealed and fresh while the other is being used. This strategy reduced package sizes to support better portion control at home.
- Although this design uses slightly more plastic, REMA 1000 absorbs the additional cost to ensure that customers still pay the same price per kilo. As Jeppe put it:

"You can recycle plastic, but you can't recycle a piece of ham."
– Jeppe

Ill. 6

FOOD DONATION AND BARRIERS

- Only ~20% of surplus food is currently donated due to the significant administrative burden involved, particularly the requirement for item-level registration. Jeppe explains that this is one of the biggest barriers to reducing food waste.

FACTS ABOUT REMA 1000

- Founded in Norway in 1972 by Odd Reitan. Entered the Danish market in 1994 and operates 422 stores in DK and 622 in NO (REMA 1000 n.d.)
- Operates on a franchise model, meaning each store is owned by an independent grocer who manages the store under the REMA 1000 brand and concept

Ill. 7

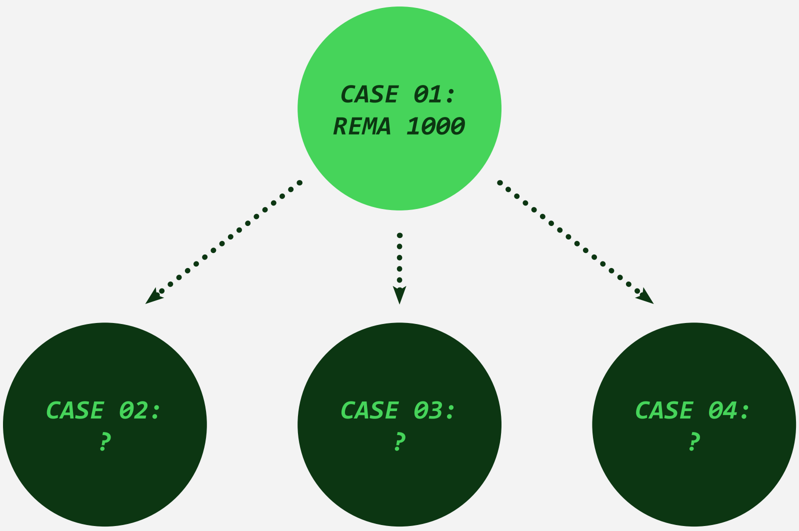
The very first REMA 1000 store. Located in Trondheim, Norway.

"DISCOUNT MED HOLDNING"

- REMA 1000's motto "Discount med holdning" means offering low prices while maintaining clear standards for product quality and their impact on animals, people, and the environment. The idea is that responsible shopping should not come at a high cost (REMA 1000 2023).
- Voted Denmark's most environmentally responsible grocery store in 2023 (Voxmeter 2024).
- Ranked #2 in the Sustainable Brand Index 2025 for sustainability perception (SB Insight 2025).
- Has actively worked to reduce food waste since 2008 in partnership with Stop Spild af Mad.
- Committed to eliminating all edible food waste by 2030 (REMA 1000 2024).
- Has collaborated with Plastic Change since 2018 to reduce plastic use.

CONCLUSION

The team decided to move forward with REMA 1000 as the primary case for the project, seeing it as a starting point to find footing in the solution space. With its significant presence in Denmark and Norway, REMA 1000 provided a strong foundation and opportunities for scaling. This initial focus allowed the team to first develop a solution that was viable for REMA 1000 to then explore how the solution could be adapted and applied to other grocery chains with similar contexts.



Having decided to further investigate REMA 1000, the team moved to defining a vision that could serve both as a baseline and a steppingstone for the next project phases to come. However, arriving at a clear problem understanding turned out to be a challenge.

One of the team's main concerns was that the issue of food waste is already severe and is expected to worsen with the upcoming EU legislation. This raised concerns not only about how to effectively address the problem of food waste – which seemed impossible to completely solve – but also about how to measure the actual impact of any proposed solution. A key concern at this point in time in the project was: *Can a new solution meaningfully replace the role of single-use plastic in preserving produce?*

It became evident that the central objective is to increase the shelf life of produce, which would directly contribute to reducing food waste. This realization formed the foundation upon which the project vision would be built.

VISION 1.0

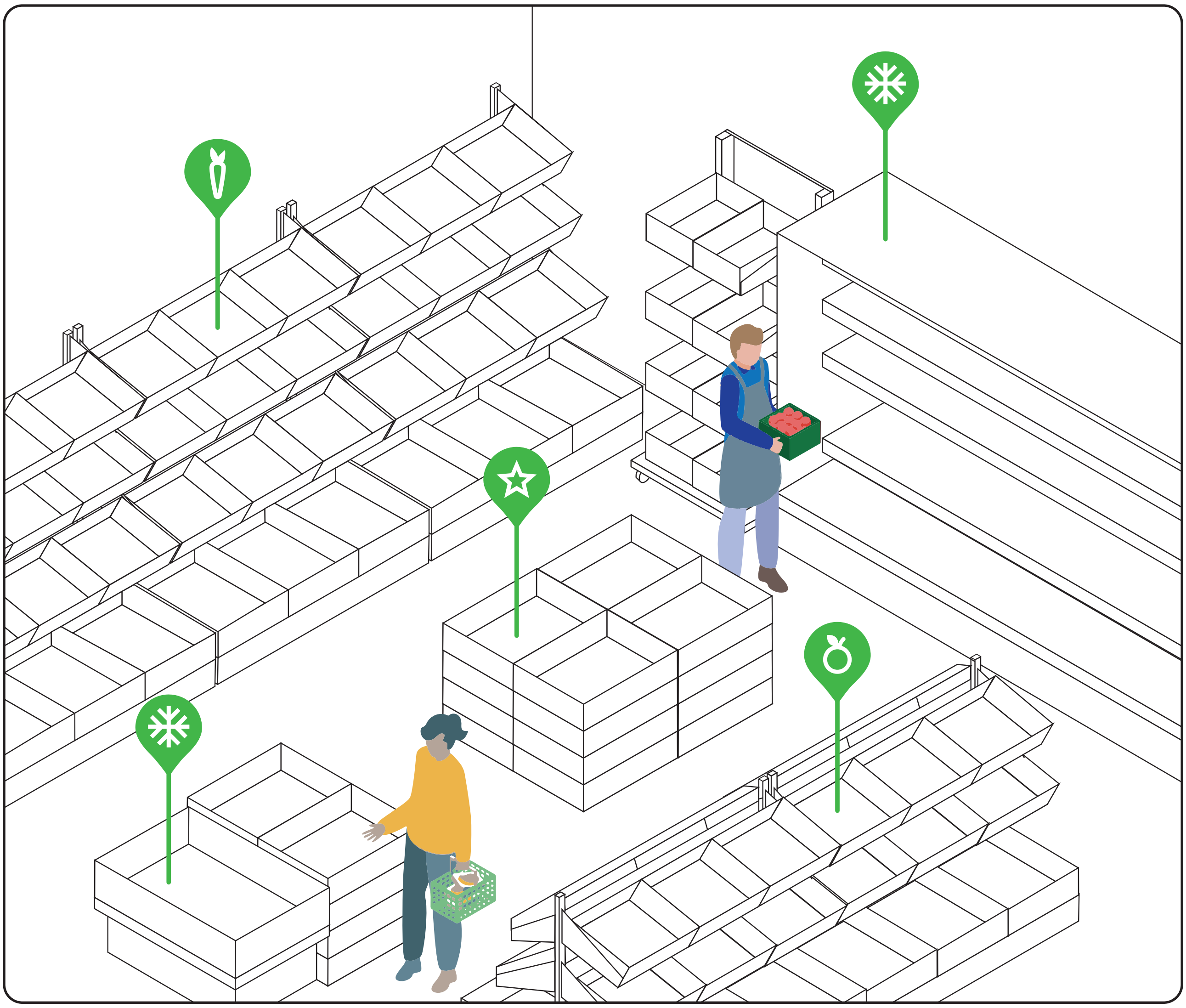
On January 1st, 2030, new EU legislation will **ban single-use plastic packaging** for unprocessed fresh fruits and vegetables. This ban will significantly **reduce the shelf life of produce, leading to increased food waste**.

Therefore, the aim of this project is to design a solution that mitigates the negative effects of the new law by **extending the shelf life of fresh fruits and vegetables in grocery store produce sections**.

THE PRODUCE SECTION

The team reached out to REMA 1000 Viaduktvej, Hadsundvej and Budolfi Plads to gain a deeper understanding of their produce sections. The goal was to learn about the types of tasks and activities involved, how these would be organised and carried out throughout the day, and to gather general insights that could inform the development of the design proposal. See all insights from visits in app. 03.

ENVIRONMENT & SETUP



The structural base of the produce section consists of slanted shelving systems and green Euro Pool folding trays (for more on these, see p. 23). The shelving units for vegetables are typically placed up against the wall while the shelving units for fruits are placed in the middle of the floor. Weekly offers are also in the middle of the floor. The produce section always has a refrigerated counter for berries and convenience products (e.g. bagged salad or ready-to-eat sandwiches).

~18°C. Remains consistent throughout the store, 24/7. Can fluctuate depending on the season. ~3°C in the cold room where produce is stored.

~30% humidity level (Edelenbos et al. 2010).

EXPERT USERS & INTERVIEW TYPES

Ill. 8

Ill. 9

APPRENTICESHIP

The team helped the REMA 1000 employees in restocking produce. This allowed the team to truly understand the context by experiencing the workflow, challenges, and physical aspects of the job firsthand.

SITUATED & SEMI-STRUCTURED INTERVIEWS

Employees spoke about their thoughts and routines while performing their tasks in the produce section. Moreover, predefined questions were asked, with room to explore interesting insights in more depth. Answers received from one REMA 1000 were held up against answers from the other to understand similarities and differences. (Laursen & Haase 2022).

TASKS AND ACTIVITIES

Mikkel explained that there are no official guidelines for maintaining the produce section; only best practices passed down from previous staff. New employees are trained based on how more experienced workers believe the job should be done. As such, the timeline below presents a typical routine:

6:30 - 7:30 AM

Fresh and leftover produce from the day before is moved from the cold room in the back of the store to the produce section.

The employee goes through all the produce, removing pieces that have gone bad. For vegetables like cabbage, salads and leeks, the outer layer is peeled off and discarded, making it look fresh again. The produce is touched and smelled to check if it has gone bad.

A cart is filled with the produce that needs restocking. It is driven to the section where the fruit/vegetable belongs.

The “old” tray is switched with the “fresh” one. Old produce is placed on top of the new (rotation). If there is too much produce, the rest is moved back to the cold room.

Repeat until everything is restocked. This process is very time consuming and therefore fast paced.

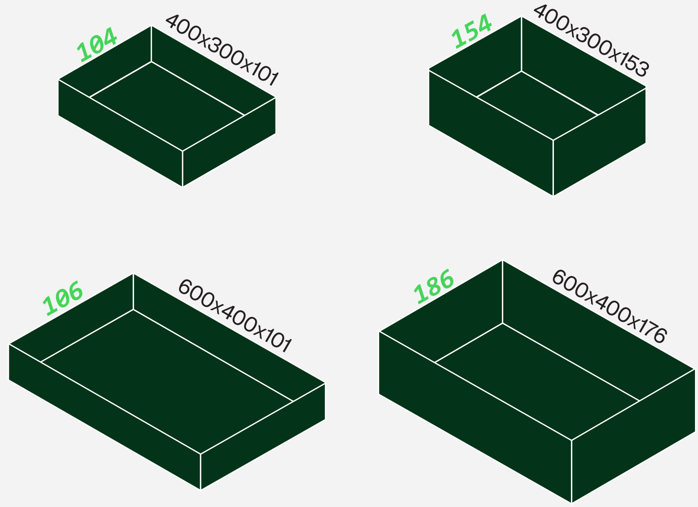
THE EURO POOL SYSTEM

The folding trays from the Euro Pool System (EPS) are a central part of the produce section. They are a reusable transport solution widely used in the fresh produce supply chain across Europe.

HOW IT WORKS:

1. EPS delivers clean trays to producers or suppliers.
2. Producers unfold the trays and pack fresh produce directly into them.
3. Packed trays are stacked and shipped through the supply chain: from farms to distribution centers to retail stores.
4. Once empty, the trays are folded again and returned to an EPS service center where they are cleaned and maintained.

While Euro Pool folding trays come in many sizes, the ones found in REMA 1000 are seen below.



7:30 - 10 AM

3 PM

The pallet with all the leftover produce is brought back to the cold room.

Empty cardboard boxes are put in the baler, and the plastic trays are stacked and put in the back to be picked up by delivery personnel.

The floor is swept with a broom to catch dirt, onion peels, etc.

The employee takes notes on which types of produce need to be reordered. These are ordered before 10 AM that same day.

In the afternoon and sometimes in the evening, they restock where needed and remove any bad produce.

The produce that was reordered arrives in the night from REMA 1000's distribution center in Vejle, Denmark. It makes up around 2 pallets per day.

PRODUCE HANDLING

EXCESSIVE HANDLING
Frequent handling negatively impacts produce quality. For instance, Jørgen only checked the fruits at the top of the EPS tray to avoid touching the fruit as much as possible, hereby limiting damage and bruising.

Contradictorily, the customers' only way of judging the freshness of the produce is by touching, smelling, and visually inspecting it.

"Every time you touch or grab something, it affects the quality."
– Mikkel

STRATEGIC PRODUCE PLACEMENT TO EXTEND SHELF LIFE
In general, fruits and vegetables are loosely grouped by type, but there are no strict rules.

Most stores place heavy, high-turnover produce in large trays (sizes 106 and 186) on the lower shelves, while more delicate, perishable produce is placed in smaller boxes (sizes 104 and 154) on the top shelves.

RESTOCKING
Restocking produce more frequently helps reduce food waste because it allows stores to keep more of the produce in the cold room, where it stays fresh longer. Instead, only smaller amounts are brought out as needed, giving the produce a better chance of being sold before going bad.

Ideally, one person would manage the produce section continuously throughout the day. This is the case with many greengrocers in southern Europe, who run their own market booths and can constantly monitor, care for, and adjust the display of produce, making it possible to avoid single-use plastic packaging. However, this level of attention is not financially viable in larger grocery store settings.

"The more often you restock, the less you throw away."
– Mikkel

LIMITING HANDLING
At REMA 1000 Hadsundvej, some of the produce is arranged in two rows of green folding trays, allowing staff to move full trays instead of handling individual items. This reduces the risk of damaging the produce.

Acrylic sheets at the front of the trays are used to stack produce higher. These are avoided at REMA 1000 Hadsundvej because overstocking can damage the produce (see red onions below).

LOOKS MATTER...

90%

OF ALL DISCARDED PRODUCE IS STILL EDIBLE

"You don't want to buy something that's imperfect when there's something perfect lying right next to it."
– Mikkel

During the store visits, the team gained a though-provoking insight: 90% of all produce is discarded not because it has actually gone bad, but simply because it *looks like it has* (app. 02). The reason is straightforward: Consumers naturally gravitate toward what appears to be the freshest and most appealing fruits and vegetables. This preference means that even slightly blemished or irregular-looking fruits and vegetables are left behind, despite being perfectly edible. Over time, this visual bias contributes to significant food waste in the produce section.

"People shop with their eyes."
– Jørgen

EXAMPLES OF FRUITS AND VEGETABLES THAT LOOK BAD BUT ACTUALLY ARE NOT

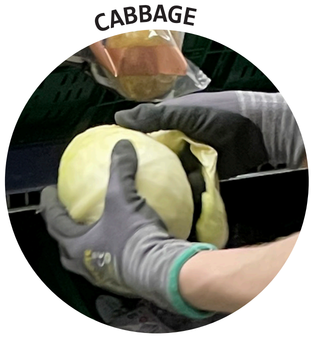
BANANAS

While the peels have brown spots, the inside is just fine!

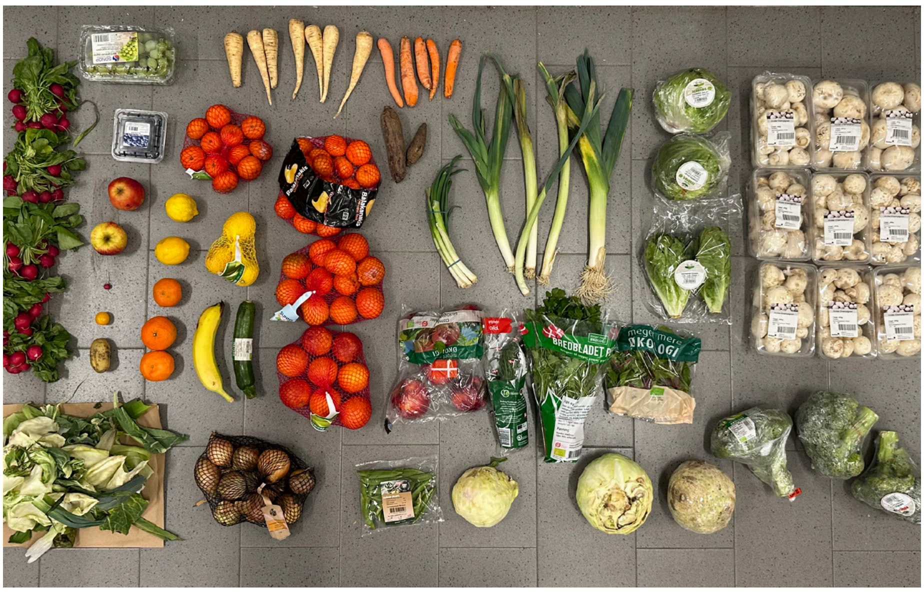
RADISHES

The leaves look a bit sad, but the radishes are still crunchy!

CABBAGE



The outer layer looks bad, but the inside is still great!



AVERAGE DAILY AMOUNT OF PRODUCE WASTE FOR 1 REMA 1000 STORE

Although the amount of food waste and the types of produce vary by season, this picture displays the **average daily amount of waste** generated in the produce section.

The picture is from an arbitrary day in February where the team visited REMA 1000 Viaduktvej.

... AND SO DOES THE OVERALL IMPRESSION

Interestingly, Mikkel and Jørgen revealed that it is not just the appearance of the fruits and vegetables themselves that influences whether they get sold, but also the visual impression of the produce section as a whole.

In fact, an unattractive produce section does not just impact sales in the produce section itself – it influences sales throughout the entire store (Retail Space Solutions 2020).

"If the produce section is lacking, you can see it affect the bottom line later that day."
– Mikkel

"If the produce section is alright, the rest of the grocery store probably is too."
– Jørgen

It becomes evident that the produce section plays a major role in the overall success of a grocery store. This importance is also reflected in the effort REMA 1000 employees put into maintaining it. Even though restocking is done quickly and often under time pressure in the morning – before the store opens and while employees juggle many tasks and responsibilities – they still take the time to make the produce section look presentable.

Examples include carefully organizing zucchinis or placing boxes of berries and grapes at a diagonal. These are all efforts ultimately aimed at improving the so-called "varespejl".

VARESPEJL

"Varespejl" is a Danish term used in retail, which refers to the organized and visually appealing presentation of products on shelves or display areas. The goal is to create the impression of a well-stocked and inviting store layout.

KEY ASPECTS OF A VARESPEJL:

- Visual Appeal: Products are arranged to look full and tidy, even if stock levels are limited.
- Facing: Items are pulled forward to ensure shelves appear fully stocked.
- Organization: Products are often grouped by category, brand, or color for easier customer navigation.

A well-maintained varespejl can improve customer experience and boost sales by making products appear more attractive.

Ill. 10

3 REASONS WHY THE PRODUCE SECTION MIGHT BE THE MOST IMPORTANT PART OF THE GROCERY STORE

#1 The grocery store's produce section is the most important factor when consumers choose where to shop (The Nielsen Company 2016).

25% The availability of produce is one of the key reasons why 25% of consumers switch their preferred grocery store (Food Marketing Institute 2016).

53% The contents of the shopping basket increase by approximately 53% if the store offers fresh fruit and vegetables (Food Marketing Institute 2016).

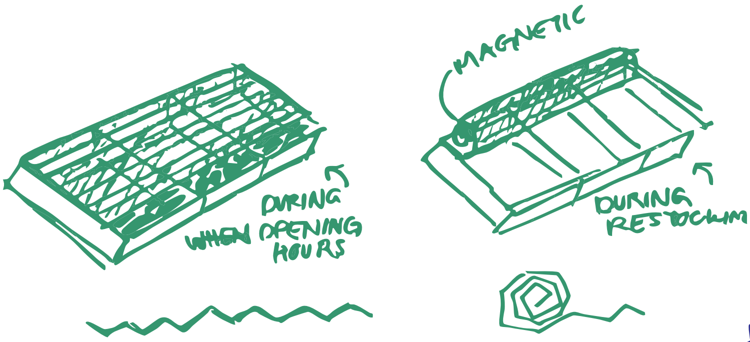
outside sells

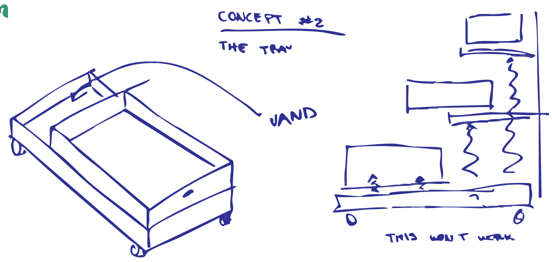
It is the ~~inside~~ that ~~counts~~

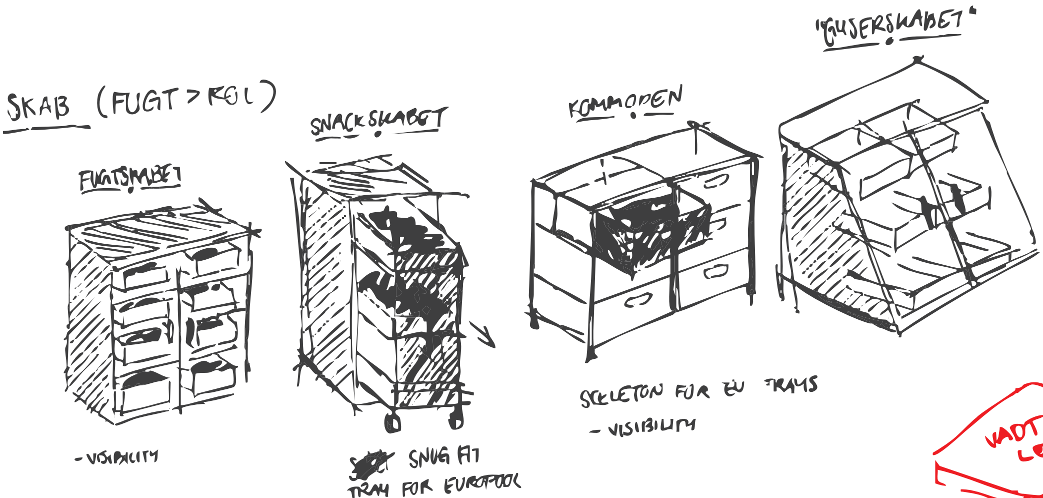
IDEATION 01 & INITIAL CONCEPTS

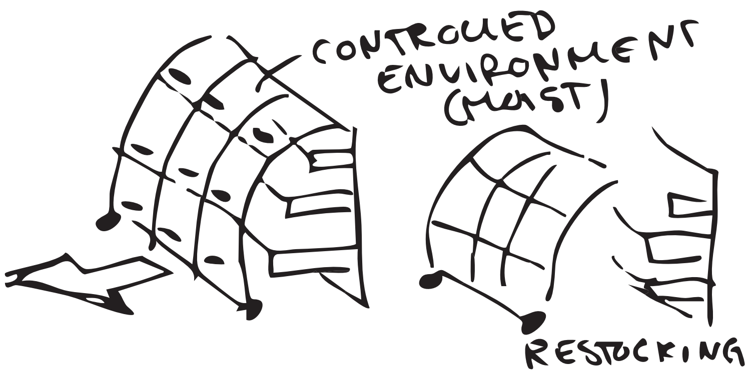
Based on the three REMA 1000 store visits and speaking with grocers and the staff responsible for the produce sections, the team began ideating (see below). This part of the process was characterised by rapid ideation to transfer immediate ideas onto paper.

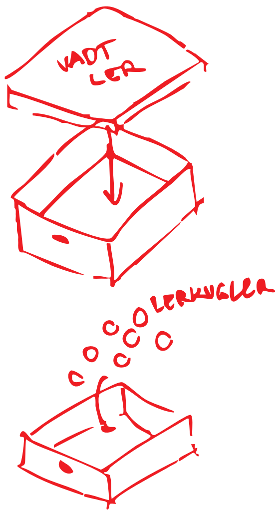
From all the ideas, the team developed two initial concepts that merged insights with working principles aimed at extending the shelf life of produce (right).









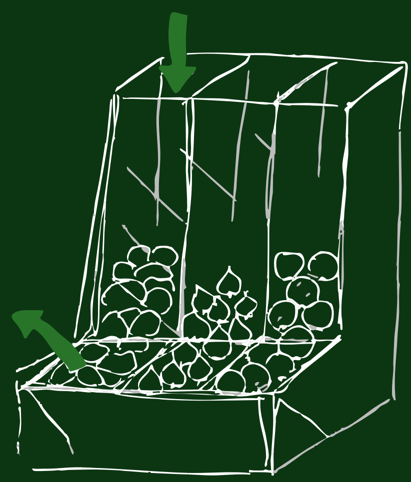


01 BEAUTY SLEEP

- This principle takes advantage of the inactive hours during the night when the store is closed, and produce is left to sit and age.
- Designed to be visually unobtrusive when not in use as to disturb the produce display as little as possible.
- The concept explores ways to "refresh" the produce overnight – either by covering it, maintaining proper moisture levels, or adjusting dryness, depending on the needs of the produce.

02 FLOW

- This principle focuses on changing how produce is restocked.
- It emphasizes rotating stock to ensure the oldest items are sold first, while also limiting exposure and customer access to prevent unnecessary handling or damage.
- The sketch should be understood at a very abstract, conceptual level and not interpreted too literally; the team had not fully developed this concept before Milestone 01, and as such the sketch is intended to illustrate the underlying idea of rethinking the produce restocking process and produce display to extend produce shelf life.



MILESTONE 01

The initial framing of the project proved strong and showed potential for an interesting project.

However, it seemed the team was heading into an overwhelmingly complex system of systems, where any single change would be almost impossible to predict. Without a clearer focus, the scope risked becoming too broad and unmanageable.

To improve the project framing, the following suggestions were given:

1. Narrow the focus. For example, select a specific Danish fruit or vegetable that heavily relies on single-use plastic, and address that specific case. This would help ground the problem in a concrete, relatable context.
2. Identify "patient zero" within the supply chain. Identify where the first problem of removing single-use plastic packaging occurs – patient zero. Trace how changes could impact and create ripple-effects in the rest of the system.

02

DEFINE

In the *Define* phase, insights from *Discover* are synthesized into a clear and actionable problem.

This phase is characterised by being highly iterative, involving framing and reframing to capture the problem realistically while keeping it manageable within the project scope.

Specifically, that means mapping the broader system and identifying a specific scenario to address. Key themes and patterns emerge to narrow the focus, clearly defining the problem and the relevant stakeholders.

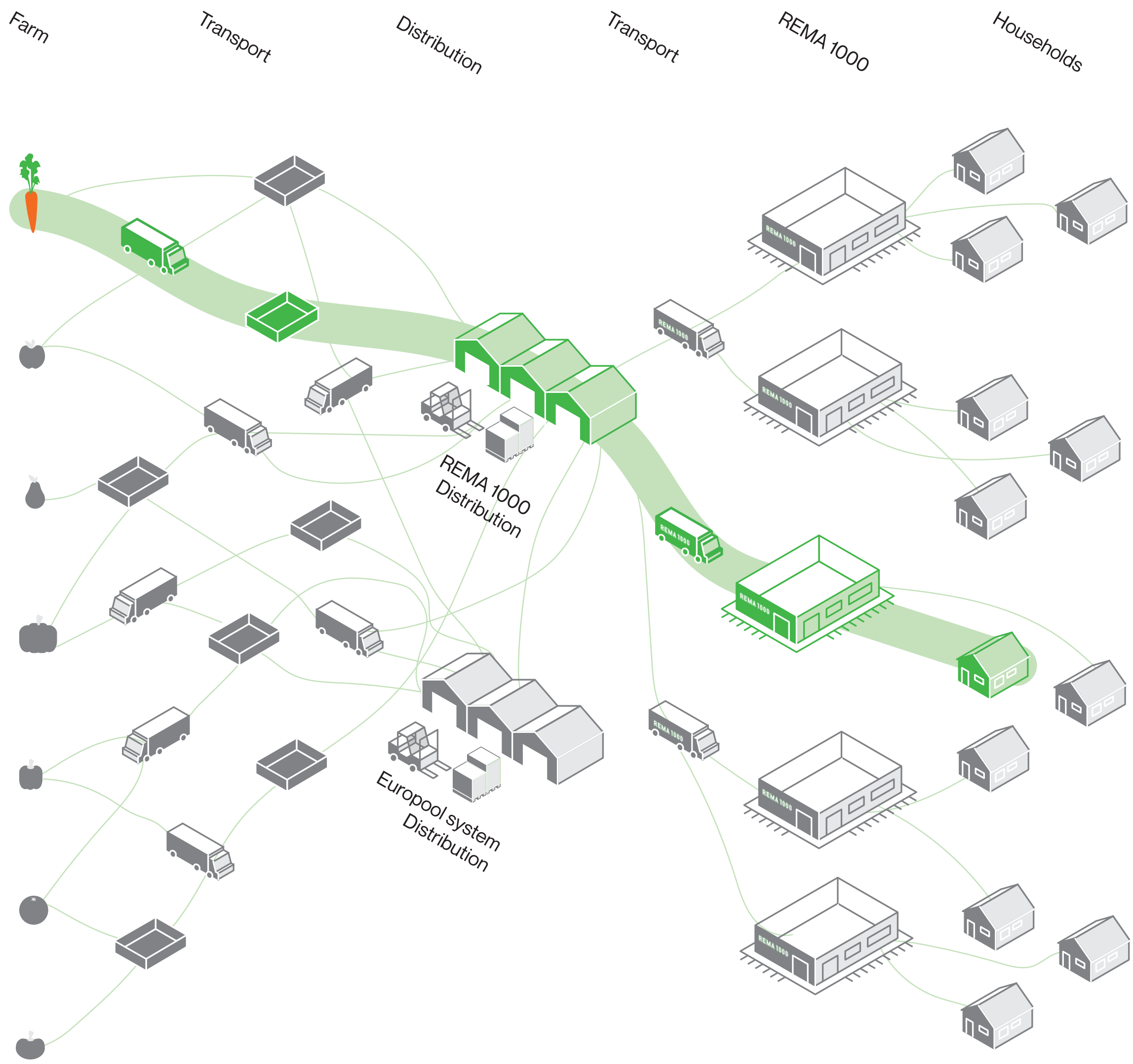
The main objective is to ground the project in a realistic and feasible context, providing a solid foundation for the next phase, *Develop*, where ideas and concepts can be generated and tested.

NARROWING DOWN THE SCOPE

Following feedback from the Milestone 01 presentation, it became clear that the project needed greater tangibility and a more focused approach.

The team was headed in the direction of tackling a highly complex system involving multiple variables, such as different suppliers, varying packaging regulations, the Euro Pool System, and the need to address many different types of produce, each with its own specific requirements and needs, across multiple countries. The complexity of managing such a system made it difficult to pinpoint a clear starting point and to design a feasible solution within the project's scope. Narrowing the focus to a more isolated problem would be essential for making meaningful progress and developing an actionable solution. As such, the team decided to converge by selecting a specific type of produce highly dependent on plastic packaging to maintain freshness.

The aim was that by tackling the most challenging case first, the solution could potentially be scaled more easily to the broader produce section.



WHICH TYPE OF PRODUCE IS MOST DEPENDENT ON PLASTIC?

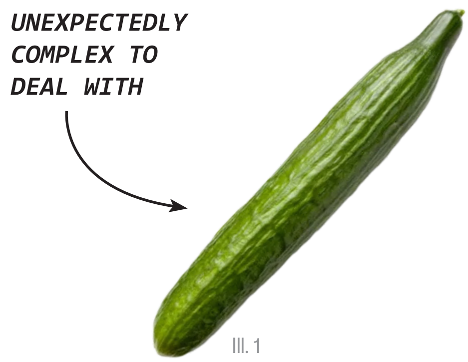
To identify the type of produce most dependent on plastic packaging, the team looked to the final report by the Government of Canada, which includes a comparison of the robustness and perishability of different fruits and vegetables (2024, app. 04).

On the basis of the report, the team decided to focus on cucumbers for the following reasons:

- Cucumbers are considered highly perishable.
- 90% of all cucumbers are wrapped in plastic.
- Cucumbers are a commonly consumed vegetable, meaning that addressing this issue could lead to a significant impact.
- They are also grown in Denmark, providing an opportunity to access and hereby better understand the supply chain.

Having decided to further explore cucumbers, the team began by mapping their journey from farm to private household. In doing so, it became apparent that cucumbers were not as manageable as initially expected:

- Cucumbers will become soft within hours if not wrapped in plastic (app. 05). Because they deteriorate so early in the supply chain, the design team figured that the most relevant solution would need to follow the cucumber through the entire supply chain. This is exactly what single-use plastic packaging can accommodate at the moment, as consumers simply dispose of the packaging after use. *Would this even be feasible with a reusable product? Would it require some kind of deposit or return system?*
- The team also considered developing a solution linked to the Euro Pool trays, which would not only involve the cucumber's journey but also intersect with the Euro Pool system. This quickly revealed itself to be yet another complex, multi-system challenge, with limited access to many of the involved actors in the system.
- Additionally, even though the problem had been narrowed down to focus only on cucumbers, the effects of making changes within the system were still very difficult to predict.
- To top it all off, the team discovered, after talking to yet another cucumber farm, that there is a widespread expectation within the cucumber industry that cucumbers will likely be exempt from the EU legislation – confirming one of the team's early concerns about the uncertainty of working with future scenarios.



Ill. 1

A SLIGHT REFRAMING

It became necessary to bring the project back to a manageable level, with concrete and tangible boundaries that would allow the team to effectively understand and address the problem.

Instead of navigating a complex system of systems, the problem was reframed around a more actionable approach (right).

This would also shift the focus to physical, concrete challenges rather than logistical or organizational ones, making the problem more actionable for the team to solve while allowing for hands-on prototype testing in stores.

HOW CAN GROCERY STORES PRACTICE HANDLING NON-PACKAGED PRODUCE NOW, SO THEY ARE PREPARED FOR 2030?

THE ROOT VEGETABLE REFRAMING

In addition to the challenges outlined on the previous pages, there was another significant aspect to consider:

The insights gained and concepts proposed up until this point were rooted in the conditions of the current as-is scenario, where single-use plastic packaging would allow the produce to stay fresh up until reaching the store. In other words, the team had based its understanding and solution space on the existing system, without fully accounting for how fundamentally different a future scenario might be.

More precisely, the team needed to detach from the as-is conditions and consider what would happen if plastic packaging were removed entirely. A future-proof solution would require a clean break from the conditions of the as-is scenario.

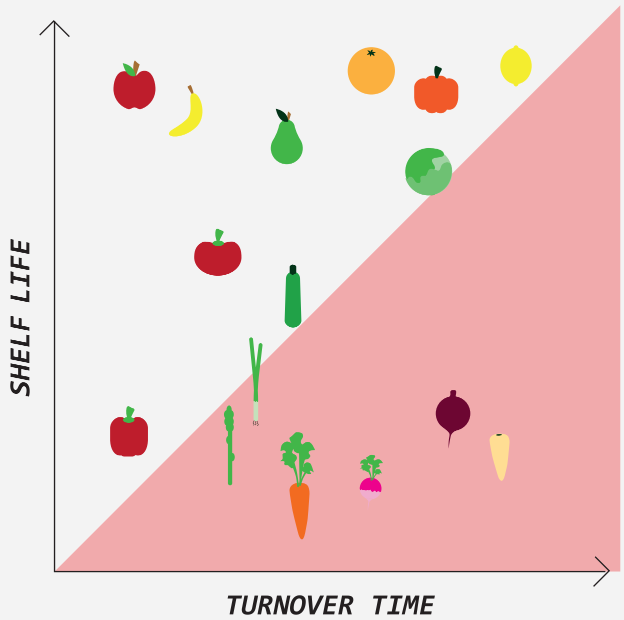
ROOT VEGETABLES

Root vegetables were selected as the focus because they are already being sold without packaging, making them an ideal starting point for testing alternatives to single-use plastic packaging. Since they are already situated in "future conditions", they create a controlled environment for evaluating solutions, without the added complexity of removing current packaging or disrupting the supply chain.

Moreover, root vegetables belong to a specific category of produce characterized by both a short shelf life and low turnover (right). Because they are perishable and infrequently purchased, they often end up being discarded.

To clarify this, consider red bell peppers. While also perishable, they have a high turnover rate – customers buy them frequently – so they are typically sold before they spoil.

This highlights why low-turnover perishables like root vegetables are placed in small Euro Pool folding trays, whereas high-turnover items are stored in larger trays. The larger trays accommodate higher stock levels to meet frequent demand.



It should be noted that, in addition to turnover time, other factors also influence whether produce is discarded.

VISION 2.0

The aim of this project is to design a solution that **extends the shelf life of loose root vegetables** in REMA 1000 while **preserving an attractive produce display**.

Having decided to develop a solution for root vegetables, the team decided on a new, updated vision for the project. The vision consists of two components: Extending the shelf life of root vegetables and enhancing the produce display. While both aspects are important, the primary challenge and ultimate goal is to extend the shelf life. Creating an attractive produce display is secondary in regard to meeting the EU legislation.

THE ROOT PROBLEM

The short shelf life of loose root vegetables was a concern raised by all interviewed grocers, as well as Jeppe Friis Nielsen (CSR). Without any active measures to extend freshness, the vegetables become shriveled in less than a day on display. To address this, many grocers have developed their own workarounds:

BUDOLFI PLADS

Root vegetables are stored in their original plastic bags from the farm and put in the cold room overnight.

+ Extends the shelf life
+ Allows for fully stocked displays
÷ Poor user experience, as customers must reach into a damp plastic bag
÷ Appears untidy
÷ Adds an extra, inconvenient step for the staff during store closing

GODSBANEN

Loose root vegetables are entirely removed from the produce range.

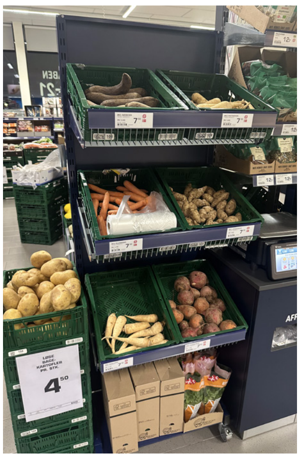
+ Less food waste
÷ Smaller assortment for the customer
÷ Less consistency across the REMA 1000 chain

HADSUNDVEJ

Root vegetables are placed in the convenience cooler.

+ Extends the shelf life.
÷ Takes up valuable space from other products
÷ Expensive upfront and running costs (app. 03)

VIADUKTVEJ



The root vegetable section is not fully stocked.

+ Less food waste
÷ Produce display looks empty
÷ Ongoing restocking during the day – more work for the employees

A ROOT'S NEEDS

The optimal conditions for extending shelf life of root vegetables were investigated using desk research supported by an interview with Lone Kondrup Jensen, project manager at DanRoots (app. 06).

Essentially, root vegetables should be stored in conditions that mimic their natural growing environment – soil – which means a cool, humid, and dark setting.

OPTIMAL ROOT CONDITIONS

0 – 4 °C

Darkness

Humidity 90 – 95%

WHY DO ROOTS EVEN DIE?

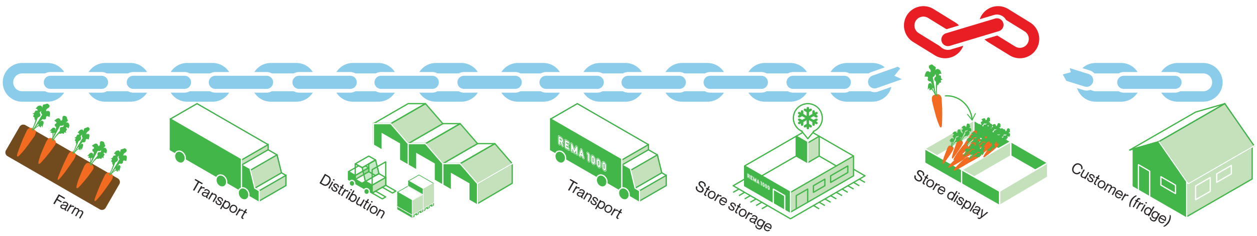
Vegetables continue to live after harvest. Two key processes affecting shelf life are respiration and transpiration. Slowing these processes is essential to extending shelf life.

For root vegetables, the effects of transpiration appear before those of respiration, as they have a relatively low respiration rate and a high water content (Edelenbos et al. 2010).

RESPIRATION
Fruits and vegetables "breathe" to maintain cell functions, but it also causes the produce to age, lose freshness, and eventually spoil.

TRANSPIRATION
Transpiration is the loss of water through the surface of the skin or peel. Its visual effects (shriveling, limpness) are often the first signs of quality loss.

THE COOL CHAIN



At DanRoots, root vegetables are harvested daily to ensure maximum freshness. After harvesting, they are stored in a dark, cool room at 4–7 ˚C. This temperature is maintained during both transport and storage at the distribution center (app. 06).

The issue arises once the root vegetables reach the produce section in the store, where the temperature increases to around 18 ˚C, significantly reducing their shelf life.

Once customers bring home the root vegetables, they usually go back into a cold environment: the fridge.

CONCLUSION
It became clear that the grocery store is the weak link in the cool chain. To preserve the freshness and extend the shelf life of root vegetables, it is essential to keep them within the cool chain – or ensure they are otherwise stored under conditions that maintain their quality.

ACTORS

In addition to the root vegetables themselves, the team identified two key stakeholders: the customers and the store staff. These three actors – produce, customers, and staff – turned out to have differing, conflicting needs. For instance, what benefited the produce in terms of preservation could complicate handling for staff or reduce convenience for customers. To develop an effective solution, the team focused on identifying which needs were most important to prioritize.

ROOT VEGETABLE

- Cold
- Humid
- Dark
- Minimal handling and touching

= OPTIMAL CONDITIONS

EMPLOYEE/GROCER

- Financially viable
- Efficient workflow
- Customer satisfaction
- Less food (and money) waste

= EFFICIENCY AND PROFIT

CUSTOMER

- Visually appealing – fresh and fully stocked
- Ease of seeing and reaching the produce

= PRESENTATION AND FRESHNESS

THE PARADOX

The grocer's primary goal is profit – and profit comes from satisfied customers. As a result, grocers naturally prioritize customer needs when designing the produce section. However, a truly effective solution must also take into account the optimal storage conditions of the produce itself. By doing so, it is possible to extend shelf life, reduce waste, and ultimately improve the customer experience by offering fresher, higher-quality products.

The paradox arises when examining the needs of the three key actors: the produce, the customers, and the store staff. These needs are often in direct conflict. Most notably, root vegetables require darkness and high humidity to stay fresh, whereas customers and staff need well-lit, relatively dry environments for comfort, visibility, and accessibility.

Meeting the vegetables' needs by, for example, hiding them in darker, more humid storage would likely be unacceptable from a retail perspective, as it would compromise the visual appeal and effectiveness of the produce display.

Is it possible to design a solution that balances the needs of all three key actors?

WISHES & DEMANDS 01

To establish a common understanding and gain a clear overview of the insights gathered up to this point in the design process, the design team consolidated their findings into a list of wishes and demands. These reflected both user needs and contextual considerations, helping to articulate what an ideal solution would aim to accommodate.

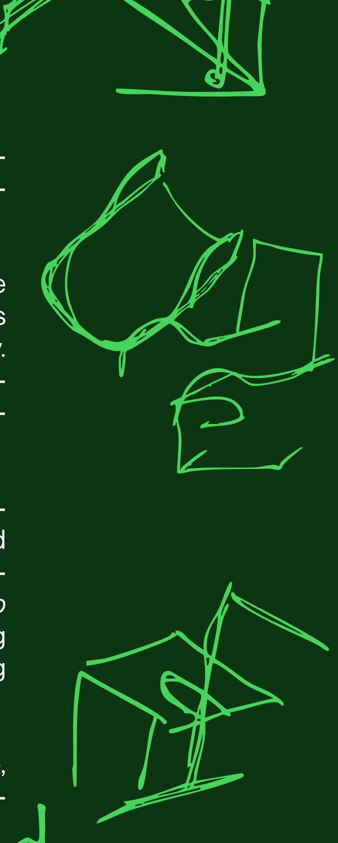
The list of wishes and demands played a particularly important role at the beginning of the *Develop* phase (p. 40), where it helped define the initial boundaries of the solution space. While it was not actively used throughout the entire process, it provided direction and focus, ensuring that early ideation remained grounded in the insights gained from previous research.

	REQUIREMENT	SOURCE
DEMANDS	The solution must slow down the transpiration process for root vegetables, ensuring they remain marketable for a minimum of three days in the store.	Root vegetables have a low respiration rate but high water content, causing them to lose moisture quickly through transpiration. This results in wilting, shriveling, and loss of freshness, making them less appealing to customers. During store visits, grocer Kristian stated he would only invest in a solution that extends shelf life to at least three days. Therefore, reducing moisture loss through transpiration is essential to maintain marketability and meet retailer expectations.
	The solution must preserve an attractive produce display.	Customers make purchasing decisions based on visual appeal. It is not just the condition of individual fruits and vegetables that matters, but the overall appearance of the produce section. A fresh and appealing display is essential to attract customers and maintain store-wide sales.
	The solution must fit the Euro Pool System's green folding tray no. 104.	Root vegetables are most commonly stored and displayed in these trays. The trays are also preferred for other low rotation produce since their size offers a visual advantage: they appear small, so even a moderate amount of produce makes the tray look full. This supports an attractive produce display.
	The solution must be possible to wipe clean using a damp cloth or a cleaning wipe.	This is the current method used for quick cleaning in the produce section. Since employees work in a fast-paced environment, the maintenance process must be quick and simple. The design should have no hard-to-reach areas so that all surfaces can be easily and thoroughly cleaned without slowing down daily operations.
	The solution must be made of food-grade materials.	The solution will have both direct and indirect contact with food. Using food-grade materials is essential to ensure the quality and safety of the root vegetables and to meet hygiene standards and regulatory requirements.
	The solution must not contain or rely on single-use plastic packaging.	Upcoming EU legislation will ban single-use plastic packaging for fresh produce. To comply with these regulations, the solution cannot rely on single-use plastics.
WISHES	The solution should not change the employee's routines, especially during restocking.	Employees work under tight time constraints and need to complete tasks quickly, for instance before store opening and during rush hours. An effective solution should disrupt their workflow as little as possible.


!LÅG BØR IKKE
VÆRE MONTERET
PÅ KASSEN
RESTOCKING
TAGER LANG
TID
ØKOLOGI
ACRYLIC
SHEET
SKYDELÅGE

03

DEVELOP

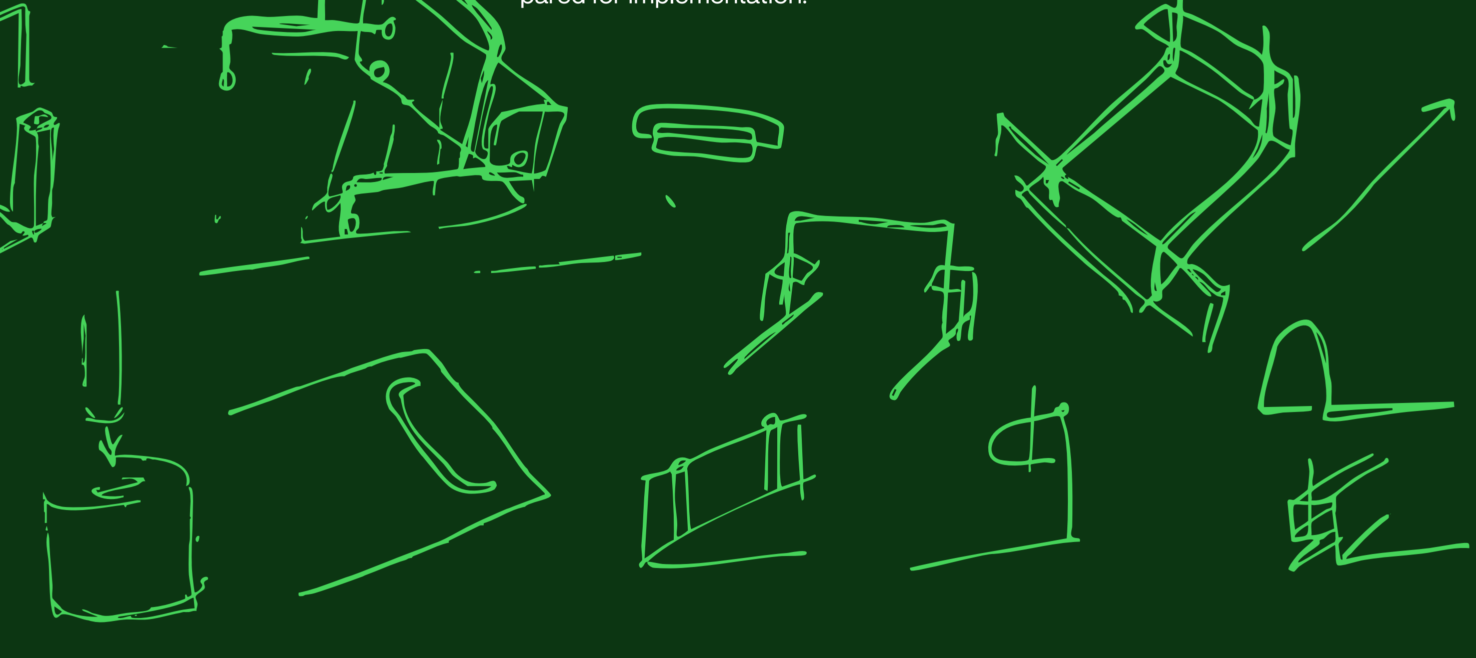


Building on a clearly defined direction, the process advances into the *Develop* phase, where creativity and experimentation become central.

This phase begins with a focused exploration of the challenge of produce shelf life – examining what it takes to keep root vegetables sellable for more than one day. By studying existing solutions, key principles are extracted to guide experiments designed to test and expand on these ideas.

Building from this foundation, the team develops concepts through ideation, which are then prototyped and mockuped for iterative testing and validation to determine which approaches are most effective. The *Develop* phase culminates in in-store prototype testing, providing valuable real-world feedback and a baseline for maturing the concept.

This lays the groundwork for the final *Deliver* phase, where the product will be further developed and prepared for implementation.

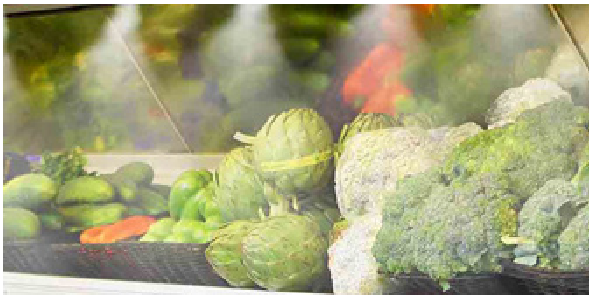


KEEPING ROOTS ALIVE // EXISTING SOLUTIONS

Existing solution principles were explored to identify methods that could be applied to create the ideal environment for extending the shelf life of root vegetables (app. 07).

These principles are grounded in the ideal storing conditions for root vegetables, as described on p. 37.

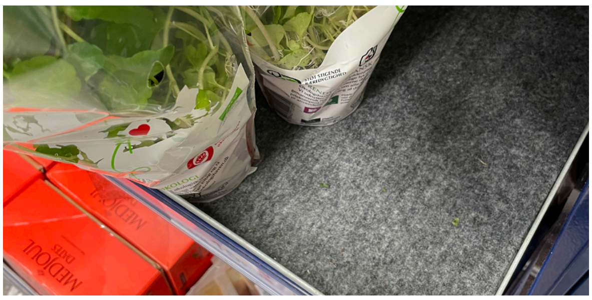
HUMIDIFIER



Ill. 11

- + 30% less weight loss → extends shelf life (Energy Supply 2014)
- + Enhances the scent of produce → enhanced sensory experience
- ÷ Customers find the spray unpleasant (Stage 2019)
- ÷ Risk of spreading bacteria (Stage 2019)
- ÷ Expensive, high-maintenance (Stage 2019)
- • The system has become obsolete in Danish supermarkets due to the cons above. The team saw potential in creating a humid environment – but not through this approach.

MOIST HERB MAT



- + Extends shelf life by adding moisture
- ÷ Requires maintainence (watering, cleaning/replacing the mat) to avoid bacteria growth
- • The team saw a potential in adding moisture without the produce getting wet and creating a risk of decay.

CLOSED CONTAINERS

Ill. 12

- + Extends the shelf life with three days by containing moisture (pr trading & HL Display n.d.)
- ÷ Time consuming restocking process
- • The team saw a potential in creating a closed environment for the root vegetables, but it should fit into the employees' current restocking routines utilizing the Euro Pool trays.

COLD COUNTER

- + Extends the shelf life
- + Hygienic (the produce is contained)
- ÷ High investment and ongoing energy expenses
- ÷ Time consuming restocking process
- • The team saw a potential in cooling down the environment but without the big upfront investment and continuous expenses of electricity. It would be too big of an investment in a REMA 1000 store to have refrigerators in large parts of the produce section (app. 03).

EXPERIMENT 01

To better understand the conditions that effectively extend the shelf life of root vegetables, a series of experiments were conducted. These experiments were based on desk research and existing solution principles.

For more details on Experiment 01, including sources of error, see app. 08.

EVALUATION CRITERIA

Root vegetables are deemed unsellable if they look shrivelled, discoloured or bruised.

Root vegetables are deemed unsellable if they are easily bendable and have lost their turgidity.

SETUP

Cold

Cold, wrapped

Moist

Wet

Dark

Cold and room temp.

Wrapped

Control

KEY INSIGHTS

- The experiments confirmed that refrigeration provides the most optimal conditions for extending the shelf life of root vegetables.
- Placing root vegetables directly against a moist surface, such as a damp towel, helped prevent shrivelling in the areas in contact with moisture. However, the uncovered parts will still shrivel. The team deemed using water to preserve freshness unrealistic because of the level of maintenance required.
- The parts of the root vegetables in contact with surfaces – such as the tray bottom or other root vegetables – retained freshness better than exposed areas. This suggests that direct contact between root vegetables may help extend their shelf life.

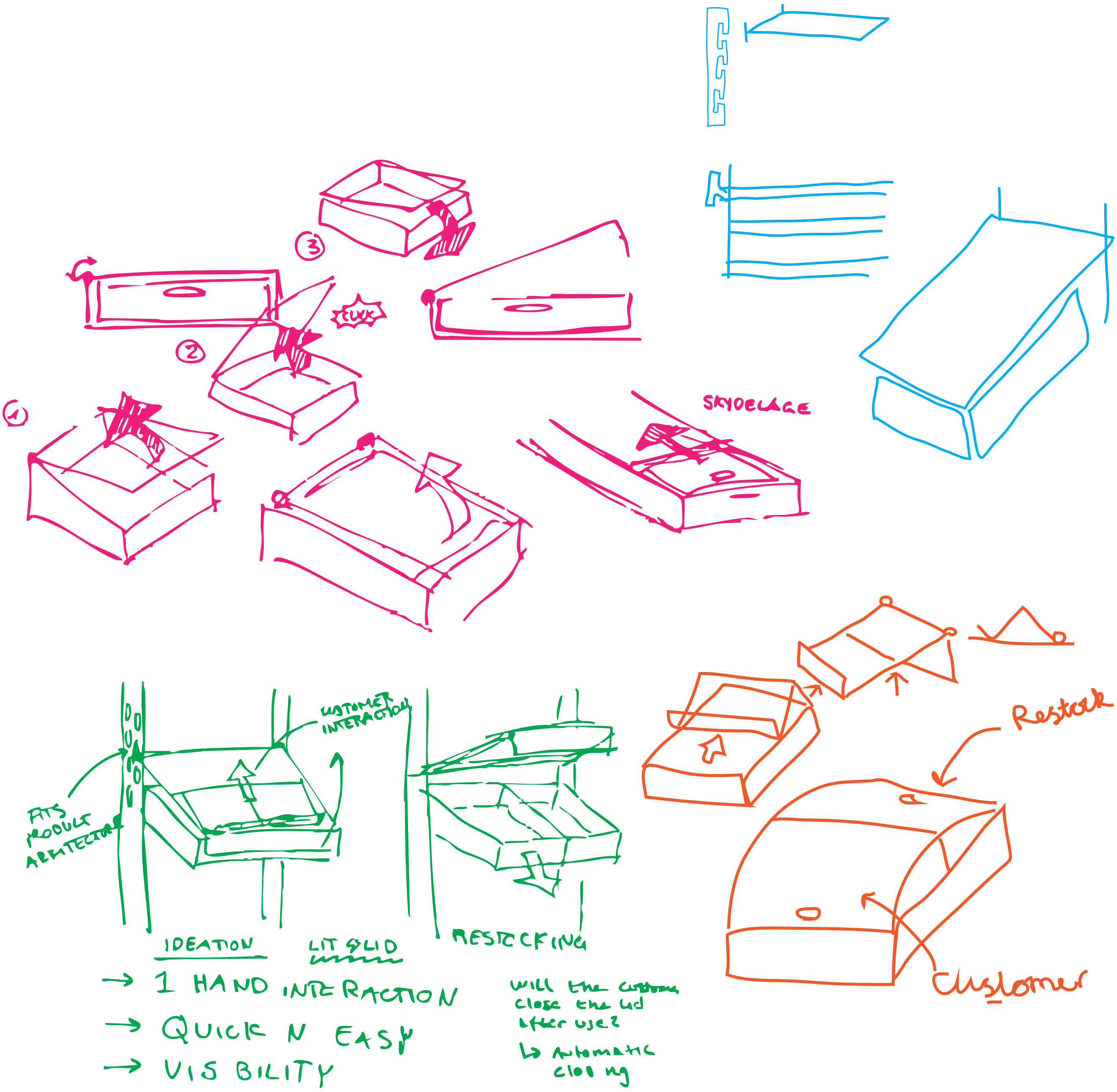
Experiment 01 showed that darkness helped reduce shrivelling in the root vegetables, though not sufficiently on its own. Wrapping the root vegetables also proved effective, mimicking some of the protective functions of single-use plastic packaging. These findings led the team to explore whether combining darkness with some form of containment could deliver better results.

IDEATION 02

Based on the findings from Experiment 01, the team ideated, focusing on concepts that would create a humid and dark environment. Some of the ideas can be seen on this page. Most of them feature some type of lid that traps moisture within the Euro Pool tray.

While still exploring the concepts at an abstract level, the team considered the possibility of making the lids from tinted to minimize exposure to light while still allowing customers and staff to see the contents inside. Well aware that this would compromise the visibility of the produce display, the idea was not dismissed, as it may ultimately prove necessary in keeping the root vegetables fresh.

It was decided to focus on a solution for the small Euro Pool trays on the upper shelf in the produce section, as this is where most REMA 1000 stores place loose root vegetables (with exceptions as shown on p. 36).



MOCKUP TESTING

Simultaneously, with point of departure in the sketches on the previous page, the mockups below were created to better understand scale and user interaction.

	1	2	3
A			
B			

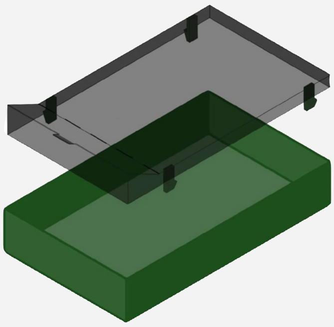
EVALUATION & CONCLUSION

- The ideas focused on customer interaction, but what would the restocking process for employees be like? It would need to be quick and efficient and introducing a lid might add an extra step of having to (de)mount the lids onto the Euro Pool trays. The team reflected that the solution might not need to fit seamlessly into existing routines – as long as the process remained relatively fast and would not significantly slow down the restocking processes.
- Customers must be able to operate the product with one hand, as many customers carry a shopping basket in the other hand.
- Some of the mockups rely on customers to close the lids after use, compromising the lid's function. A self-closing lid would solve this.
- At this point, the team assumed that a lid alone would create a sufficiently humid environment – but would this be enough? An answer to this would require a new test to evaluate the effectiveness of the lid on its own (p. 47).
- Shaping the acrylic as seen in concepts B1 and B2, significantly increases production costs due to the need for a thermoforming process.
- Some of the concepts do not allow for overstocking the Euro Pool trays. Would this become an issue and negatively impact the produce display?

The team found the idea of introducing a lid to be an interesting concept worth investigating further.

The mock-up tests offered valuable insight into how customers would interact with the product. However, the design would still have to address the needs of all users – both customers and produce staff.

MILESTONE 02



The team probed the concept to the left at Milestone 02, which prompted the following feedback and comments:

- The concept is shy. What scale is appropriate to address the issue effectively? Should the entire produce section be enclosed to control the environment? If so, the core issue may be a resource problem and not a design problem...
- The solution replaces single-use plastic with "reusable" plastic – is this more sustainable, both environmentally and financially?

Given the feedback from Milestone 02 and the results of the design process so far, the design team planned the following next steps:

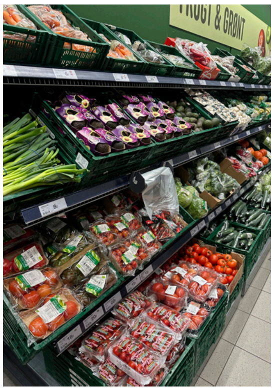
1. Challenge the solution space. Does it make sense to create a solution for each Euro Pool tray, or would it be better to design something more modular or larger in scale?
2. Design for a quicker, more seamless restocking process. This concept adds two extra steps to the process as employees have to detach the lid during restocking and attach it again afterward.

STYLEBOARD

Parallel to the next steps presented above, the team developed a styleboard showcasing various produce section designs which was shown to random customers (app. 09). The aim was to identify if certain aesthetic choices could help improve the produce display.

Multiple produce managers emphasized the importance of a clean, fully stocked, and fresh-looking produce section. This was supported by the styleboard results, where most participants ranked the produce section on the left as the most attractive. However, the responses also showed that while aesthetics are appreciated, they are not the deciding factor in where customers choose to shop. Instead, hygiene, freshness, and product availability were viewed as significantly more important – aligning with earlier findings from both grocers and customers.

REMA 1000 was instantly recognized by all participants, who described it as "cheap" and "messy". However, this did not discourage the participants from shopping here – low prices are ultimately seen as more important than the visual appearance of the produce section. Thus, the styleboard helped confirm that a strong aesthetic direction was "nice to have", but ultimately non-essential for the product proposal.



Ill. 13

ORGANIC STORE

- Fresh
- Fully stocked
- Wood enhances natural, cozy aesthetics

REMA 1000

- Lacks freshness (excessive use of plastic makes it look like the produce came from far away)
- Messy
- Cheap looking

EXPERIMENT 02

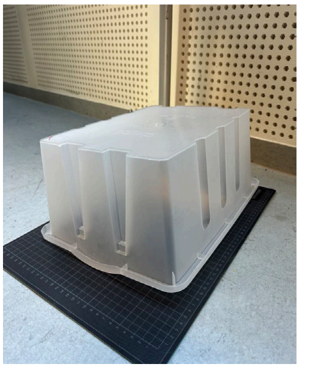
As concluded in Experiment 01, the team had a hypothesis that a lid would create a sufficiently humid environment for the root vegetables. However, before proceeding further with this principle, it was necessary to test the actual effects of covering the root vegetables with a lid.

The success criterion was for the root vegetables to remain marketable for at least three days. This benchmark was based on a conversation with Kristian, grocer at REMA 1000 Budolfi Plads, who stated he would be willing to invest in the solution if this requirement was fulfilled (app. 03).

Find more details and sources of error on the experiment in app. 10.

SETUP

A. Small box



B. Big box

RESULTS

The experiments demonstrated that reduced exposure to air significantly improves shelf life. In experiment A, the parsnips stored in a small plastic box with a 50/50 air-to-parsnip ratio remained marketable for four days. In contrast, experiment B – with a 90/10 air-to-parsnip ratio – resulted in the parsnips becoming unsellable after just one day.

Setup A worked surprisingly well and even made the root vegetables develop root hairs. These are formed when the root vegetable senses water and nutrients in its surroundings. Root hairs do not alter the quality of the roots, nor are they harmful to consume (Klaassen 2011).

Parsnip from the small box. Insignificant change. Still turgid and plump.

Parsnip from the big box. Deemed unsellable after one day due to shrivelling.

CONCLUSION

Experiment setup A met the success criteria defined by grocer Kristian, indicating the lid-based solution to be very promising. The team would further pursue this direction.

Additionally, this experiment confirmed that keeping the root vegetables in a dark environment, for instance through the use of tinted acrylic, would not be necessary as long as a certain level of humidity was maintained.

Since this experiment did not incorporate the Euro Pool trays, the team would have to conduct yet another experiment to validate the effects of the lid solution.

Next steps would include:

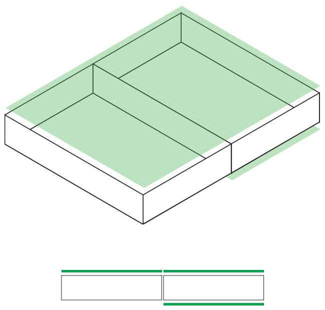
- Testing the lid solution in a Euro Pool tray
- Evaluating whether a lid presents too much of a barrier for customers or complicates the restocking process for produce employees.

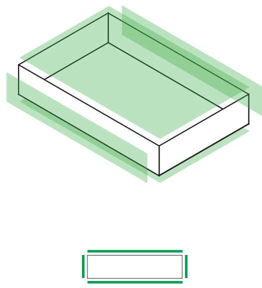
EXPERIMENT 03

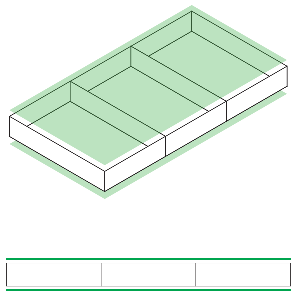
The results from Experiment 02 clearly showed that creating a more enclosed environment that retains some of the moisture from the root vegetables has a positive effect on shelf life. Based on this, the team conducted Experiment 03 to investigate how enclosed the environment needs to be to achieve the desired shelf life of at least 3 days (app. 11).

01 // TOP | *02 // TOP + BOTTOM* | *03 // FOUR SIDES* | *04 // ADJACENT*

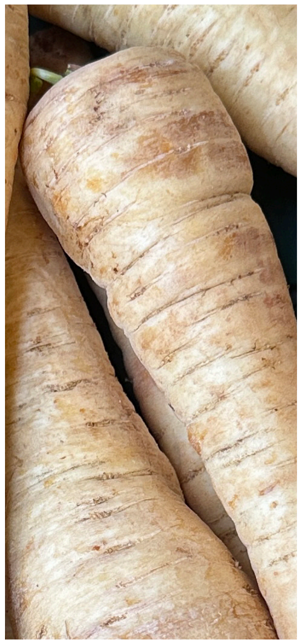
SETUP

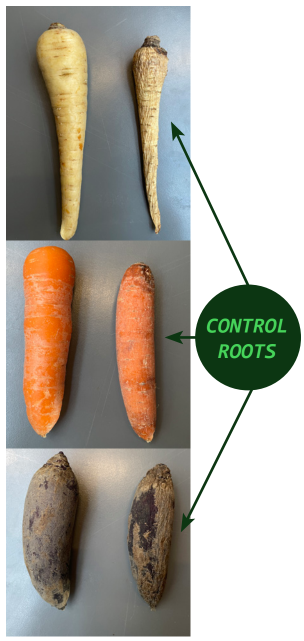






AFTER 4 DAYS





CONCLUSION

After four days, the parsnips in setup 01 visibly shrivelled, while those in setup 02 where both the top and bottom were covered, remained noticeably fresher – indicating that covering the bottom of the tray is essential.

Covering the sides, top, and bottom as seen in setup 03 was effective – the parsnips remained sellable after four days.

Placing the trays closely together while covering the top and bottom also proved effective – both the parsnips, carrots and beetroots remained sellable after four days.

The experiment revealed that it is essential to cover the top and bottom of the Euro Pool trays. Placing the trays close together is sufficient to minimize exposure to air from the sides. This indicates that the solution should include coverage for the top and bottom while also allowing the trays to be positioned tightly next to one another.

WISHES & DEMANDS 02

New wishes and demands were added to the existing list as a result of ongoing observations and feedback gathered during the project. Like the initial version, this updated list served to guide ideation and ensure the development of viable solutions. New wishes and demands are written in *italic*.

	REQUIREMENT	SOURCE
DEMANDS	The solution must slow down the transpiration in root vegetables, ensuring they remain marketable for a minimum of three days in the store.	Reducing moisture loss through transpiration is essential to maintain marketability and meet retailer and customer expectations.
	The solution must preserve an attractive produce display.	A fresh and appealing display is essential to attract customers and maintain store-wide sales.
	The solution must fit the Euro Pool System's green folding tray no. 104.	Root vegetables are most commonly stored and displayed in these trays.
	The solution must be possible to wipe clean using a damp cloth or a cleaning wipe.	Staff work in a fast-paced environment, so the maintenance process must be quick and simple.
	The solution must be made of food-grade materials.	The product will be in direct and indirect contact with food.
	The solution must not contain or rely on single-use plastic packaging.	Upcoming EU legislation will ban single-use plastic packaging for fresh produce.
	The solution must enable workers to remove an entire Euro Pool tray form the shelf using both hands.	*When stocked with produce, trays are heavy and require two hands to move, so the solution must not require any additional support or actions that would interfere with efficient restocking.*
	Customers must be able to operate the solution with one hand while carrying a basket or bag in the other.	*Customers often carry a basket or bag around the store. The solution must not rely on two-handed operation, as this would make it inconvenient and potentially discourage customers from selecting the produce.*
WISHES	The solution should not change the employee's routines, especially during restocking.	Employees work under tight time constraints. An effective solution should disrupt their workflow as little as possible.
	If possible, the solution should also be able to fit EPS tray no. 154 (400x300x153 mm).	*While tray no. 104 is the preferred choice among grocers, the team also observed that some used tray no. 154. To allow greater flexibility in the produce display, it would be explored if the solution could accommodate both tray types.*

IDEATION 03

The solution principle for the concept so far is some way of containing the produce to keep a humid environment. To gain some structure in the direction for the ideations, the illustration to the right was developed.

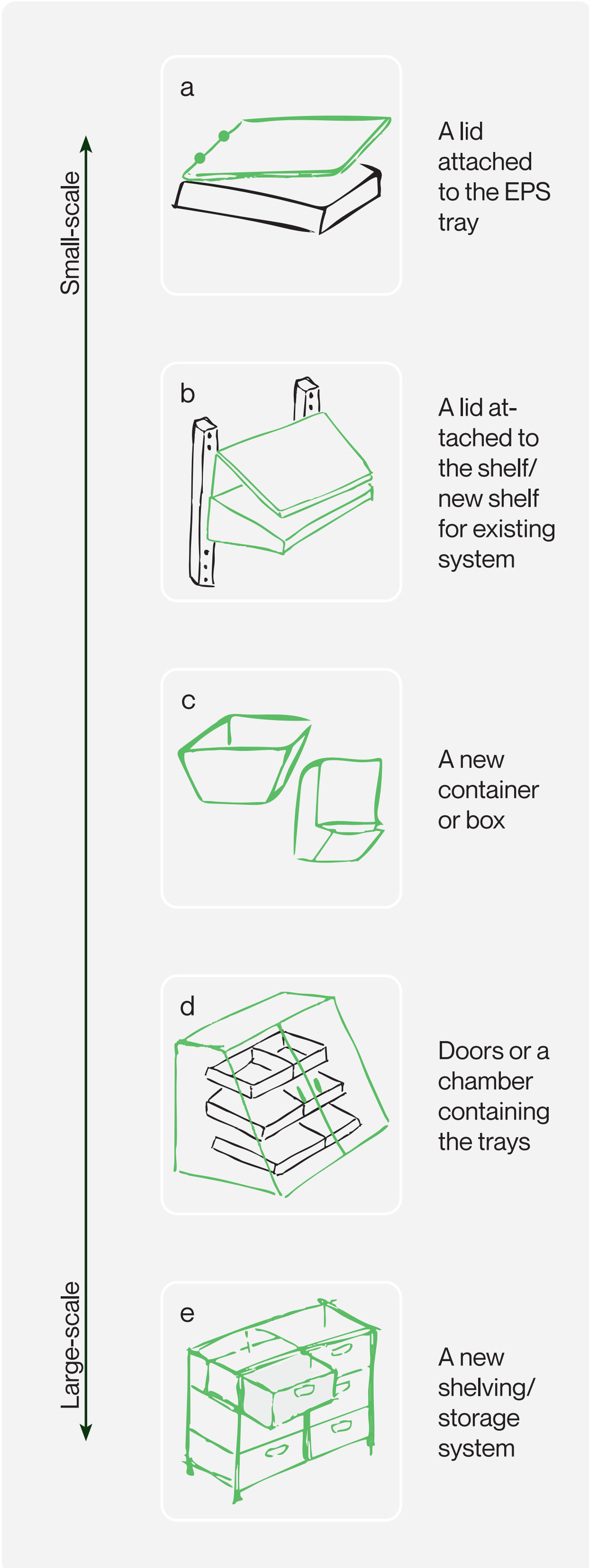
The Euro Pool System and the shelving units are two well-integrated systems that the team decided not to change. Attaching anything directly to the Euro Pool tray (a) would disrupt staff workflow, as the trays need to be quick and easy to swap. Similarly, using a different container (c) would not have been practical. Creating a new shelving unit or adding doors (d, e) was deemed too costly, given that the current setup functioned well.

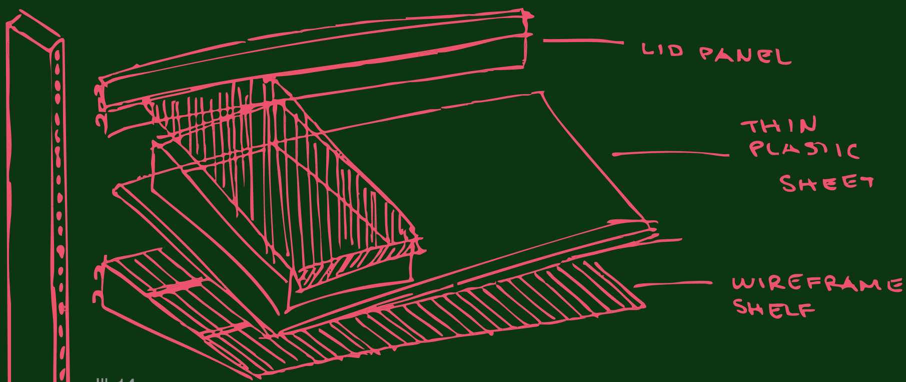
Based on this evaluation, the decision was made to further develop a concept at the scale of a shelf (b). At this point it was still undetermined whether the concept would be a new shelf for the existing system or an add-on to the current shelf. The design process to come would focus on:

1. Aligning a lid with the tray without attaching it to the EPS tray. The lid should fit securely over the tray to create a controlled environment, without being fixed to it, to avoid disrupting handling and restocking.

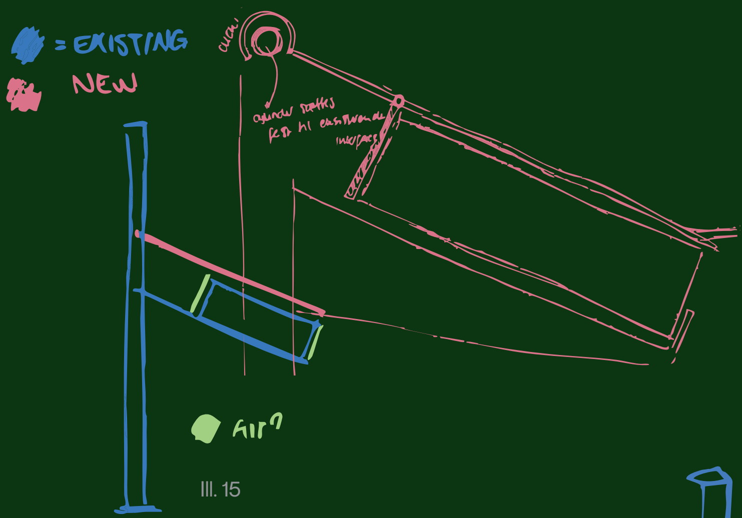
2. Designing a new shelf or an add-on for the existing one. The solution should be modular to improve functionality without replacing the current system.

The placement of the concepts on the scale is based → on required investment, change of routines, and level of in-store intervention.

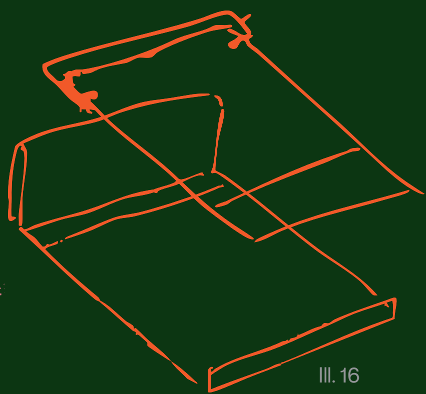


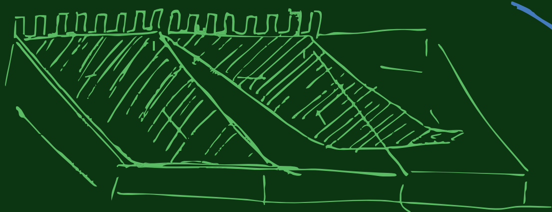


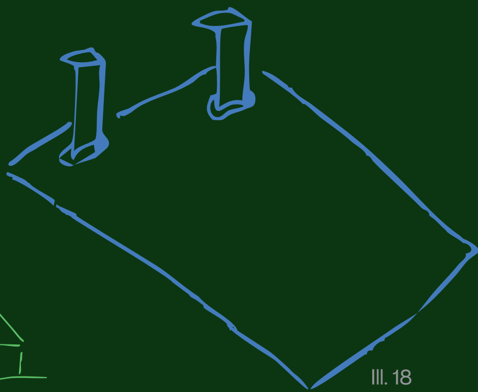
Ill. 14



Ill. 15


Ill. 16


Ill. 17


Ill. 18

The team began ideation, exploring different small-scale ways to add a lid to the Euro Pool tray.

One option considered was mounting a panel for attaching the lids, using the existing shelf installation interface (ill. 14 and ill. 15).

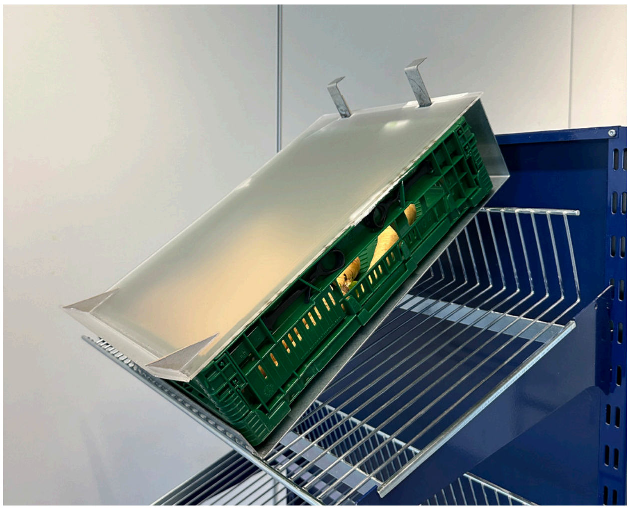
Other ideas involved combining the sheet beneath the trays with a brace or hinge, allowing the lid to be mounted closer to the trays (ill. 16–18). Combining a sheet under the trays with a brace to hold the lid was considered a feasible solution, since it is simple and uses fewer parts than the concepts shown in ill. 14 and 15.

REITAN 01

Based on Ideation 03, the team constructed a mockup of the concept so far, Reitan 01, which was tested in both restocking and customer interaction scenarios.

Since the team did not have access to the actual shelving system used in the produce sections, a similar shelving unit was used. To simulate the REMA 1000 store context, a 110 cm distance from the user to the back of the shelving unit was used, and the shelves were angled to match the store's shelf inclination.

It should be noted that the lid was intended to be fully transparent; however, this matte acrylic was the only material available at the time.

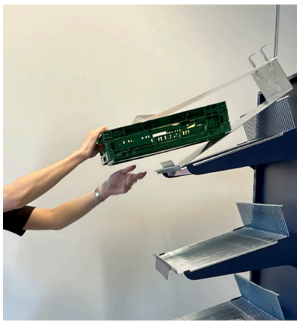


RESTOCKING // TRAY INSERTION

The edge of the tray is used to push open the lid.

The tray is pushed forward and up, opening the lid to fit the height of the tray.

The tray makes contact with the shelf. This movement requires a bit of precision to make the lid go directly on top of the tray and not inside it (right).



The tray is slid forward. The user removes one hand to do this.

The user pushes the tray past the edge of the shelf.

The tray slides to the front edge when letting go of the tray.

RESTOCKING // TRAY REMOVAL

To grab the tray, the lid is pushed up with the backside of the hand. The edge feels sharp.

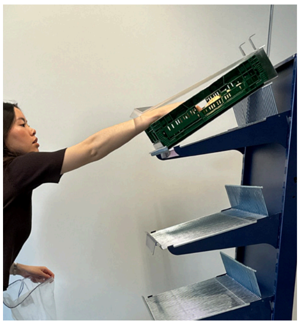
The tray is lifted above the edge of the shelf.

When slid far enough, the other hand can support the bottom of the tray.

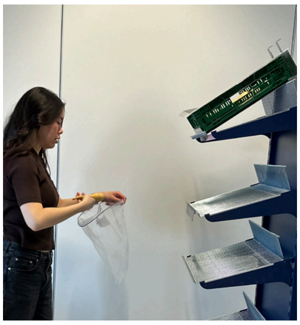
When the tray is out, the lid automatically closes. Can make an unpleasant sound, also potentially damaging the lid?

CUSTOMER INTERACTION

The customer opens the lid to get an overview.



Customer grabs vegetables while holding the lid with backside of the hand. Edge is sharp. Scratches on lid from watch/jewellery (and vice versa?).



Lid closes while putting the produce in a bag.

Customer repeats the process of opening, inspecting and choosing vegetables. Lid gets dirty with time.

EVALUATION & CONCLUSION

The team saw a big potential in this concept, however, improvements needed to be made:

1. The lid should be extended to make sliding the tray under easier. Also, the sharp edge of the lid should be rounded.
2. The lid and its attachment should be designed to reduce sideways wiggling.
3. A potential was seen in using the tray "feet" as guidelines for aligning the lid and Euro Pool tray.

1

2

3

REITAN 02

The mockup testing of Reitan 01 revealed the need for precise alignment between the tray and the lid to avoid the risk of the lid not fully covering or falling into the tray. This led to an idea inspired by the cooling counters in REMA 1000, where the shelf has holes at the front and back, allowing for the attachment of various modules that keep the products in the desired spaces.

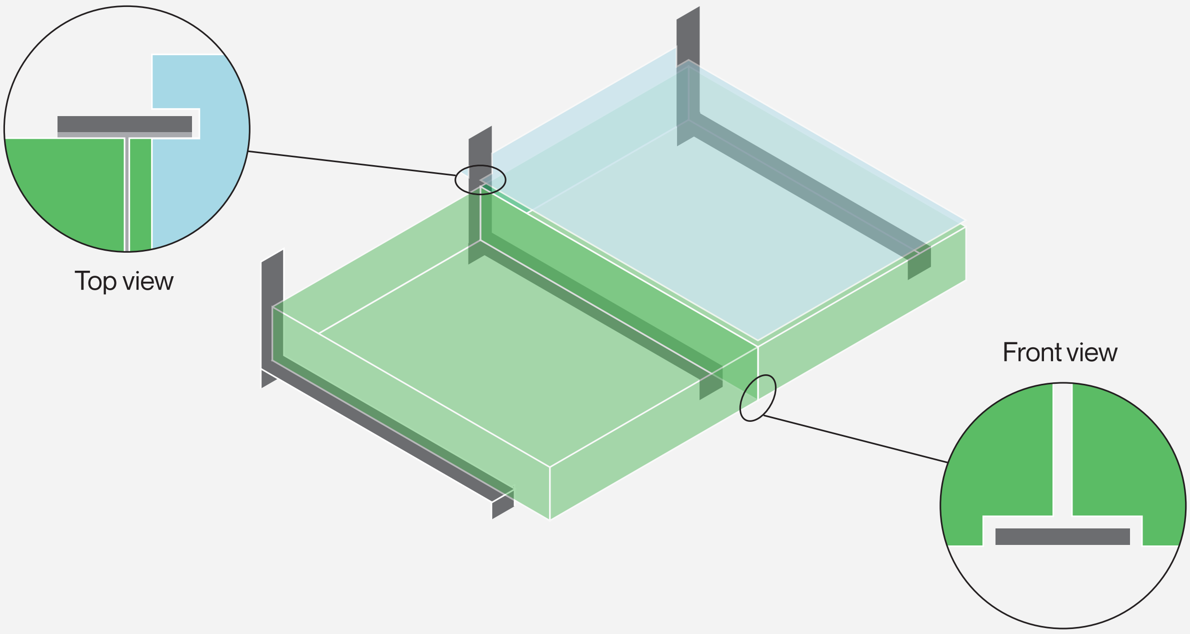
The numerous holes give staff flexibility to adjust the dairy section based on the sizes and shapes of the products.

THE IDEA

In this concept, a rail is attached to the front and middle of a sheet shelf. This serves two main purposes: to hold the lid in place and to ensure that the lid and tray align.

The rail is positioned beneath the "tray feet" (front view), guiding the employee to place the tray correctly. As shown below, adjacent Euro Pool trays share a common rail to reduce material use – since root vegetables are typically placed side by side. The lid was redesigned to accomodate this configuration. Also, the lids are slightly narrower than the trays to prevent overlap when closed.

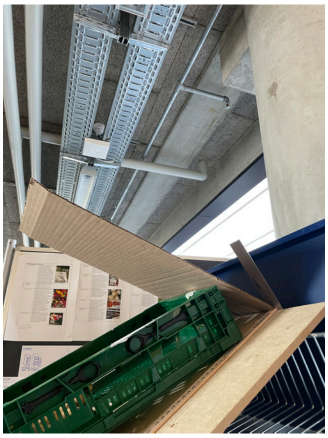
A simplified prototype was built to test the concept and its core functionalities (right).



MOCKUP TESTING

PROBLEM 01

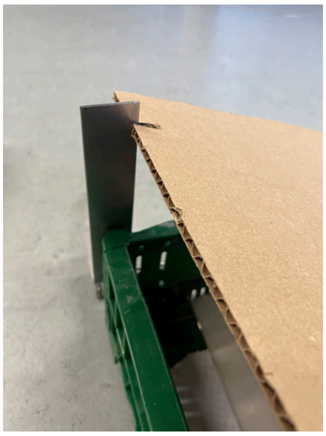
The lid holders need a built-in stopper to ensure the lid falls into place instead of opening wide up when the tray is slid in.



PROBLEM 02

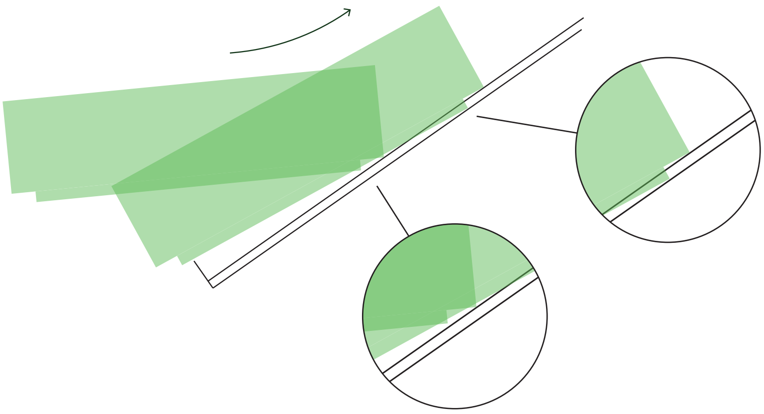
The lid detaches too easily when pulled upward. If customers reach in from the side, the lid may tilt and fall off.

The team reflected that if lid removal was this effortless, some customers might simply remove the lid entirely rather than using it as intended.



PROBLEM 03

The tray's angle impacts the effectiveness of the rail. The tray's "foot" does not touch the shelf until the angle between the shelf and tray is reduced – approximately two-thirds up the shelf. Therefore, the rail only needs to extend partway down the shelf, not all the way to the front edge.



CONCLUSION

Overall, the team found the solution to work well as it addressed the issues identified in the mockup testing of Reitan 01.

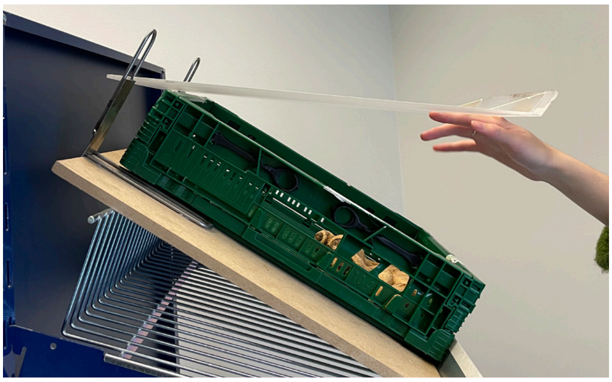
However, it still presented some of the problems outlined above, which would need to be resolved in further development.

REITAN 03

Testing Reitan 02 revealed the following problems to be solved:

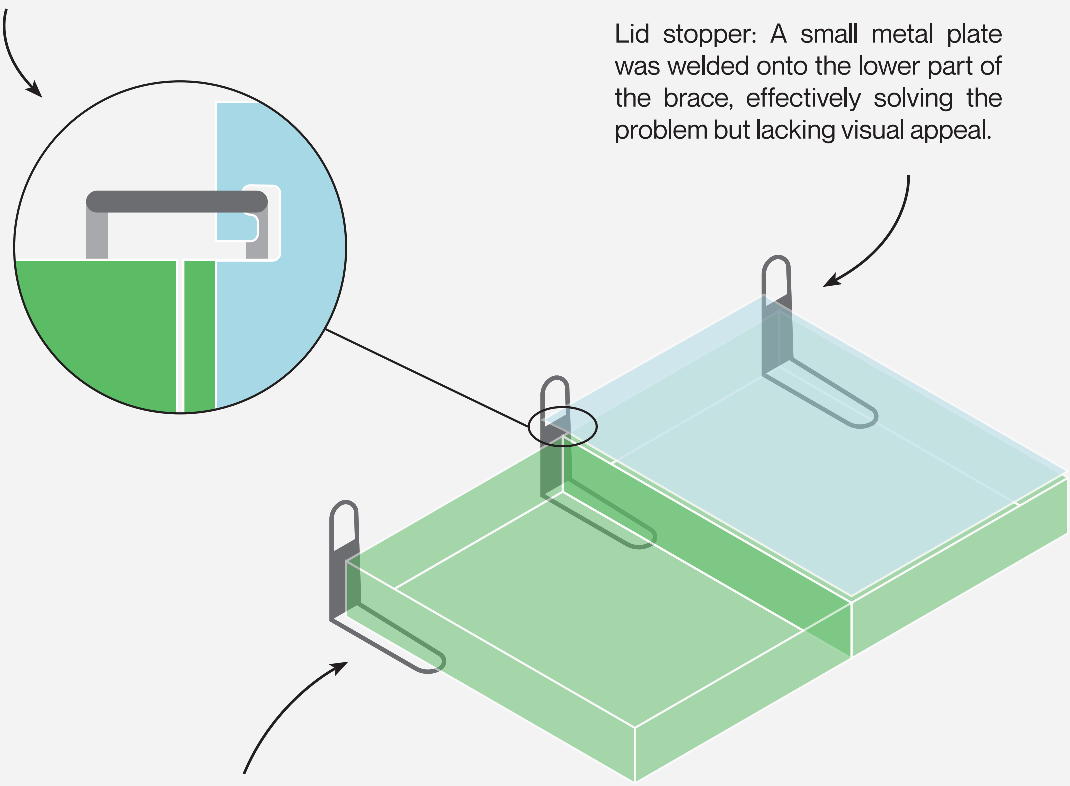
1. The lid detaches too easily
2. Lid holders need a “stopper” to ensure the lid falls into place and does not swing open when insterting the tray.
3. Customers might remove the lid entirely instead of using it as intended.

These concerns were addressed in the next mockup iteration, Reitan 03:



A bent rod is used to create a brace that fits into the cutout in the new lid design. The cutout in the lid improves secure placement by using gravity to hold it in position.

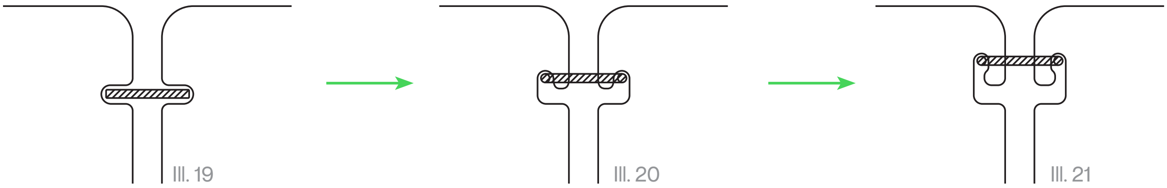
Lid stopper: A small metal plate was welded onto the lower part of the brace, effectively solving the problem but lacking visual appeal.



The shape of the brace touching the base creates a funnel effect that guides the tray into place. It is shorter than in Reitan 02, as the lower part of the rail was functionally unnecessary. The adjacent trays further assist in guiding the tray into the correct slot and aligning it with the lid.

PROBLEM 01 + 02

The illustrations below shows the iterations developed to address Problem 01: The lid detaching too easily. Ill. 19 shows the solution from Reitan 02, which led to the iteration on ill. 20. This improved the issue slightly, but the risk of accidentally detaching the lid remained. By creating a snap lock (ill. 21–22), the risk of the customer accidentally detaching the lid was eliminated.

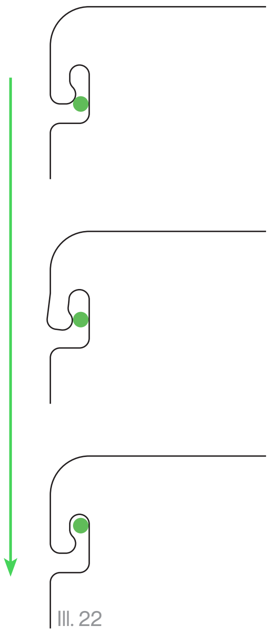


Ill. 19 Ill. 20 Ill. 21

SNAP FEATURE

A distinct "snap" sensation was desired to provide tactile feedback and a sense of security for the employee. Different cutout dimensions were tested (ill. 23) to balance secure attachment with durability – small enough to prevent accidental detachment, yet strong enough to avoid breakage. The rounded shape of the brace further reduces the risk of unintentional lid detachment.

Additional analysis of the durability of the cutout were conducted using analytical models and FEM (p. 68).



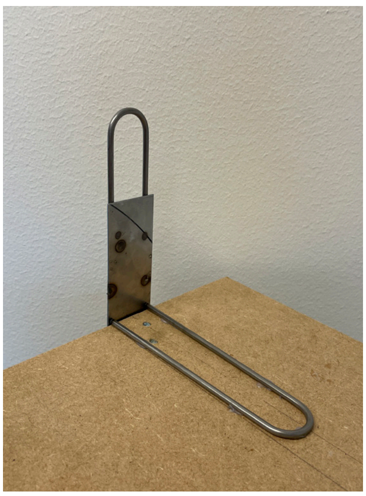
Ill. 22

Snap feature sizes were tested to find the optimal balance. If the fit was too tight, it caused the material to break. If there was too little friction, the snap lacked tactile feedback and gave a reduced sense of security. The ideal snap fit provided strong tactile feedback without causing material damage.

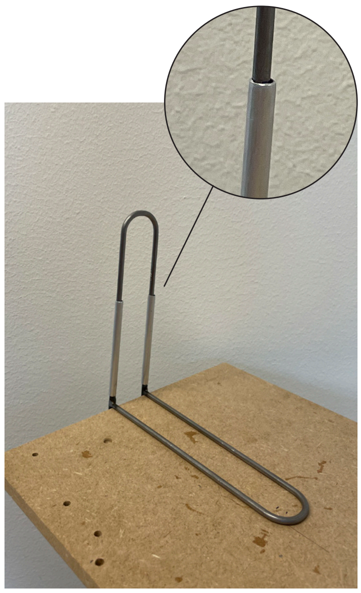
Ill. 23

PROBLEM 03

Due to the poor visual appeal of the plate welded onto the brace (ill. 24), an alternative was developed (ill. 25) that achieves the same function, solving Problem 02, but with a slightly better appearance. However, this solution is not optimized for production, as it requires placing tubes over rods before welding. Neither option looked fully integrated – balancing aesthetics with production efficiency remained a challenge.



Ill. 24



Ill. 25

IN-STORE PROTOTYPE TESTING

To gather insights and feedback from both staff and customers, an MVP of Reitan 03 was developed, incorporating the key findings detailed on page 57. This prototype was installed in REMA 1000 Budolfi Plads for a trial period of five days.

During this time, the root vegetables stored in the system demonstrated the same shelf life improvements previously observed in earlier experiments. This real-world testing helped validate the prototype's effectiveness while providing practical input for further refinement.

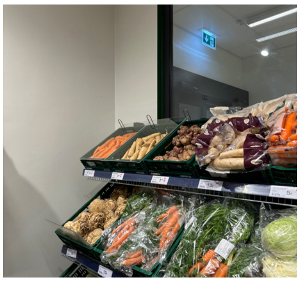
All insights can be found in app. 12.

PROTOTYPE EVALUATION

NO OVERSTOCKING

With Reitan, overstocking the EPS trays as they currently do is not possible. However, grocer Kristian did not view this as a major issue, suggesting more frequent restocking as a solution, particularly since root vegetables have low turnover.

DISCREET DESIGN



Customers and even one employee did not notice the lids, confirming the discreet design works as intended – functional without disrupting the shopping experience or display.

LID OPENED

Produce may prevent the lid from closing fully, potentially lowering the humidity level in the tray. Further long-term investigation is needed to determine whether this has a significant impact.

STAFF INTERACTION

Annanoi held up the lid with one hand holding the tray in the other, first time using the lid. After explaining the intended interaction, she found it much easier to use, maintaining the same existing workflow.

INSIGHTS FROM CUSTOMERS

- A customer mentioned liking the solution better than the current workaround of displaying the root vegetables in a plastic bag (p. 36).
- Some customers thought the lids made the produce section appear more hygienic, as covering unpackaged produce seemed logical.
- A customer disagreed, noting it did not feel more hygienic than the current setup, since customers would still touch produce they do not intend to buy.
- The design team had intended that customers should be able to open the lid and grab the vegetables using only one hand. However, one customer opened the lid with the hand holding the plastic bag and used the other hand to pick up the vegetables. It is unclear whether this was due to it being her first time using the product or a lack of affordance in the design. However, it might not even be an issue.

GENERAL INSIGHTS // CONCLUSION

Overall, the test results were positive; both customer and staff interaction were satisfactory, and the shelf life was extended as intended. Key insights include:

- Customers generally do not seem to care, which aligns with the conclusions from the style board (p. 46): Customers at REMA 1000 do not expect a luxurious experience, as they pay for discount. However, this does not mean the product should be low-quality; functionality, durability, and seamless integration remain essential, even with a focus on low cost.
- It is positive that both customers and staff did not notice the mockup, as it visually blends seamlessly with the rest of the produce section.
- After a brief explanation, staff found the product easy to use, as it did not interfere with current routines, requiring only slightly more frequent cleaning.

EXPERIMENT 04 // EXPANDING THE SOLUTION

The initial goal of developing a solution for extending the shelf life of root vegetables was to eventually expand it to a larger portion of the produce section, addressing the challenges REMA 1000 will face when the new EU ban on single-use plastics takes effect.

Accordingly, the design principle was tested on other vegetables with high perishability and low rotation that are placed in the small Euro Pool trays, as explained on page 34. These vegetables also experience high waste due to shriveling quickly after being displayed in-store. After consulting with grocer Kristian and Annanoi from REMA 1000 Budolfi Plads, and reviewing desk research on vegetable requirements, the following vegetables were selected for testing: radishes, asparagus, Brussels sprouts, and mushrooms. Although some of these are currently sold in plastic packaging, they were included to prepare for a future scenario.

For more details, see app. 13.

SETUP

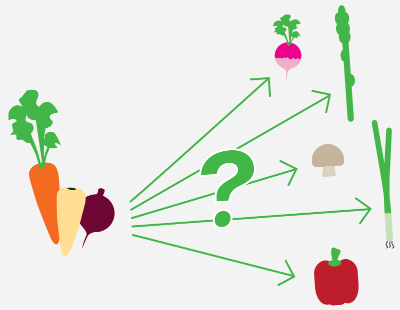
CONCLUSION

The experiment showed that placing the vegetables under a lid had a slight positive impact on their shelf life. However, Brussels sprouts, asparagus, and radishes still appeared wilted and lacked crispness after 1 day, making them unsellable. Mushrooms, which are prone to drying out quickly, looked noticeably better under the lid compared to the control mushrooms.
Overall, the solution did not have as significant an impact as it did on root vegetables. However, the vegetables still appeared to be in slightly better condition with the lid in place.

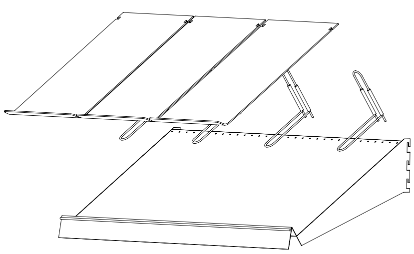
Therefore, while the solution may not extend the shelf life of other produce as effectively as it does for root vegetables, it can still offer benefits. Certain types of produce may experience improved freshness, contributing to a reduction – though not a complete elimination – of food waste. Further testing under store conditions or calculations on food waste will be needed to fully validate this (p. 73).

SOURCES OF ERROR

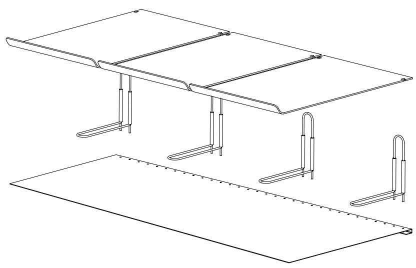
- The mushroom tray was not placed alongside the other trays, which may have affected how securely it was sealed.
- REMA 1000 stores maintain cooler temperatures (16°C) than the experimental environment (20–24°C), potentially allowing vegetables to last longer in-store.
- The trays were not fully stocked during testing. The vegetables would presumably last longer when grouped closely together.



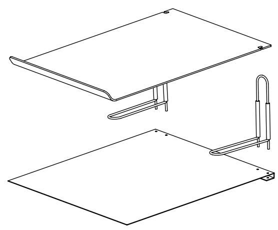
SOLUTION SCALE



a) A new shelf designed to fit the interface of the current shelving unit



b) An add-on solution for the entire shelf



c) An individual add-on for each Euro Pool tray

As mentioned earlier, it was still undecided whether the design should be a complete shelf or an add-on to the existing one. However, once the working principles of Reitan 03 were established (p. 58), it became clear that further refinement of the design was necessary.

The three main options shown above were considered.
Option a was ruled out, as manufacturing an entirely new shelf structure would require significant investment to achieve the necessary stability – something the current wire shelves already provide effectively. Given their strength, functionality, and widespread use, replacing the existing shelves would be unnecessarily costly.
An add-on solution was considered more feasible in terms of investment and production.

The current concept places trays side by side, allowing adjacent trays to share a humid environment. By offering an add-on solution for an entire shelf (b) instead of a solution per tray (c), staff is nudged to group vegetables that require a lid, promoting more efficient use. Furthermore, the design allows trays to share a brace, which minimizes the amount of braces compared to solution c. From a manufacturing standpoint, producing one large sheet component is more practical than several smaller ones; for example, bending the sheet's edges is more time efficient with a single, unified part.

Ultimately, option b – an add-on for the entire shelf – was selected as the most feasible solution in terms of cost, usability, integration, and manufacturing.

04

DELIVER

The final phase, *Deliver*, focuses on maturing the concept selected in the previous phase by refining and detailing the design to ensure it is both functional and ready for manufacturing. This includes iterating on the design with a focus on Design for Manufacturing to achieve the most efficient and cost-effective production. In parallel, the mechanical performance of the design is evaluated to ensure its structural integrity.

Materials are carefully chosen to meet the design requirements, taking into account factors such as durability and cost. In parallel, a business case and implementation plan are created to support a successful market introduction.

THE BRACE

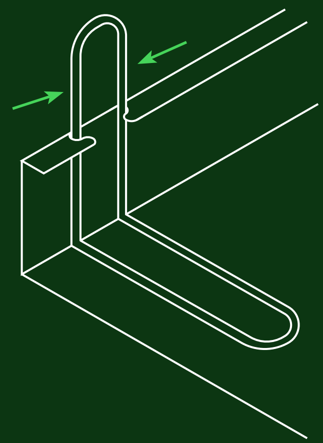
A solution was needed to securely mount the braces onto the sheet, minimizing the risk of accidentally detaching the brace while still making it easy for staff to mount and remove them. Two approaches were under consideration:

Concept 01: Creating an integrated feature in the sheet that holds the brace firmly and maintains the lid at the correct height.
Concept 02: Adding holes to the sheet and developing a more advanced brace to keep the lid at the correct height.

CONCEPT 01

The brace is sqeezed together, which allows it to be inserted into the slot from the front.

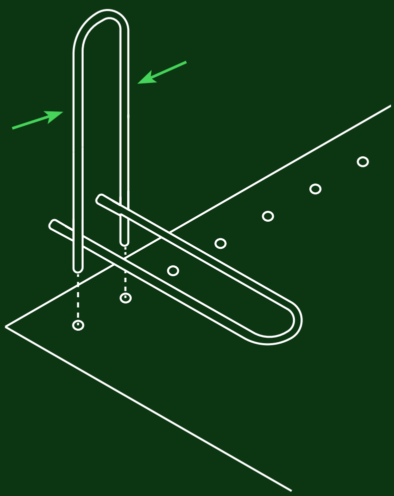
- + Brace can be manufactured in just a few steps: 2 bends, 2 welds, and deburring.
- + (Not dependent on the wire shelf underneath, eliminating the risk of interference and allowing greater flexibility. Again, this concern only applies if the product is used on the second upper shelf)
- ÷ Low flexibility in terms of moving the brace horizontally
- ÷ Excessive material usage in the sheet.

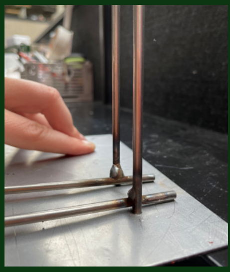


CONCEPT 02

The brace is squeezed together to make the prongs align with the holes.

- + The sheet can be manufactured in just a few steps: Punching/laser cutting and deburring.
- + The brace is easy to mount and remove with a two-step motion.
- ÷ Concept 02 requires the brace to pass through the sheet, making it dependent on the holes between the wire shelf – they must align perfectly and have consistent spacing. However, this concern only applies if the product is used on the second upper shelf, as the top shelf does not extend far enough back for it to pose a problem.





CONCLUSION

Since both interaction methods were considered acceptable, the decision was based on an assumed cost, guided by our general expectations rather than exact figures. However, Concept 01 involved an extra step when mounting and removing the brace. Ultimately, the team chose to move forward with Concept 02, as it offered greater flexibility – the brace could be adjusted more easily by adding extra holes for incremental movement.

Simultaneously, the team considered the possibility of placing the solution on the second upper shelf. This was explored (app. 14), but it was concluded that balancing the following factors was not ideal:

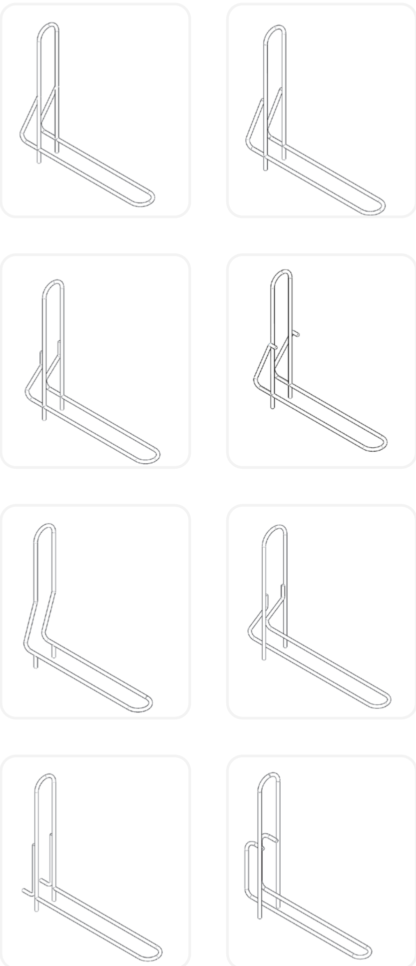
- Hole and wire spacing
- Shelf length
- Horizontal distance between shelves
- Euro Pool tray width

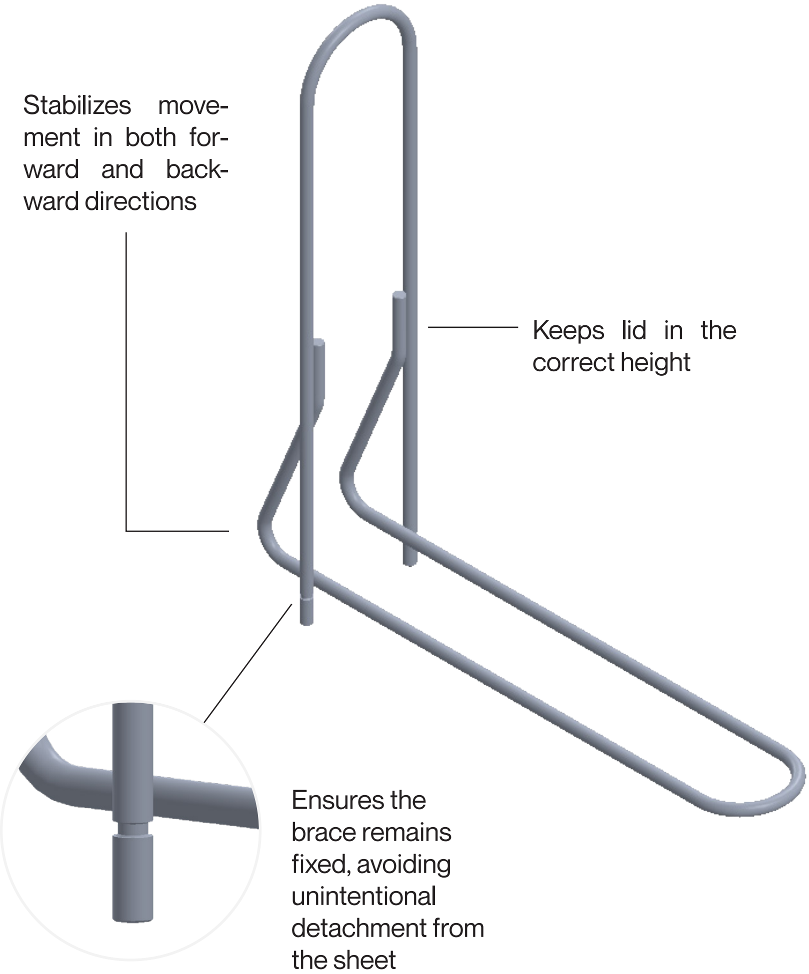
Creating measurements that would fit all these factors would result in approximately a 1 cm gap between the Euro Pool trays. This is not acceptable, as it would allow too much air to enter the trays. Therefore, it was decided to only focus on the upper shelf. Moreover, as explained earlier, this is where root vegetables and other low rotation vegetables are typically placed.

SHAPE

Based on Concept 02, several iterations were developed, resulting in the shape shown to the right, constructed from two welded braces.

ITERATIONS

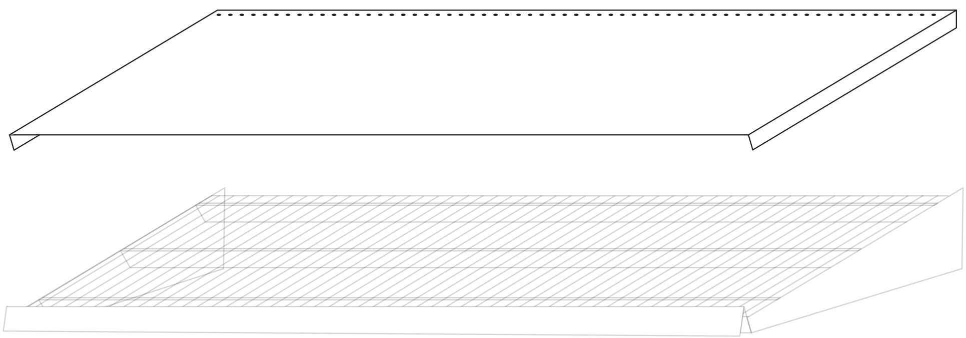




THE SHEET

MOUNTING THE SHELF

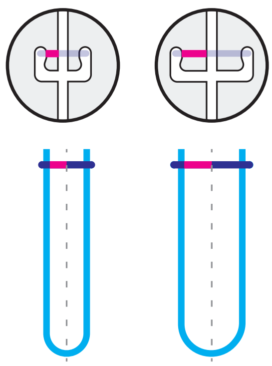
To mount the sheet, a 90-degree bend is made at each end to prevent sideways movement. Vertical fastening is not necessary, as gravity and the weight of the trays keep it in place.

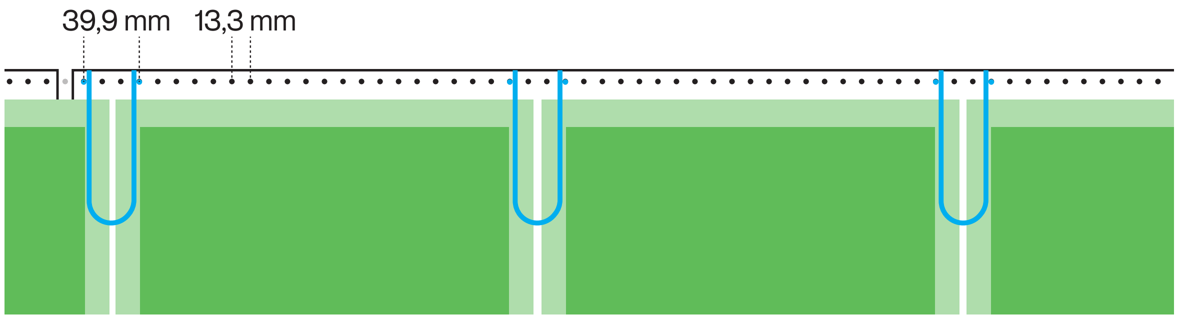


HOLE DISTANCE

To create a modular system where all measurements align, more than two holes per brace are required. After testing various spacings (app. 14), a center-to-center distance of 13,3 mm was identified as the most optimal one. This spacing allows for:

- A sufficiently wide brace (with 39,9 mm between the centers of the prongs). This accomodates lid durability (right).
- The trays to fit between the braces without excessive gaps between adjacent trays.
- A hole pattern that continues seamlessly onto the next shelf, ensuring the trays can be placed across two shelves.



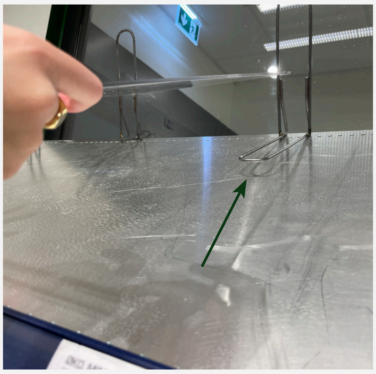


FINAL IN-STORE PROTOTYPE TESTING

The final design proposal for Reitan was created as a full-scale mock-up and tested in-store, providing valuable insights across several key areas.

The testing revealed important information about the production process, highlighting potential challenges and efficiencies. It also demonstrated how well the design integrates with the existing shelving structure, ensuring compatibility and ease of installation. Additionally, the in-store testing offered a clear understanding of customer and staff interactions with the design, uncovering usability factors and opportunities for improvement before moving forward.

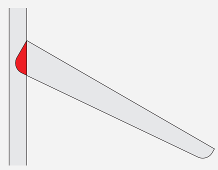
KEY INSIGHTS & REFLECTIONS



STRUCTURAL STABILITY
Some wobbliness was noted, likely due to prototype material and tolerance limitations. This may be resolved through higher production accuracy for the brace.

Attaching the lid was challenging when no trays were in place, due to both brace instability. This issue disappeared when trays were present, suggesting it may not be a problem in use.

TRAY SPACING VS. LID ROBUSTNESS
A small gap appears between trays due to the brace's width. This raised the design questions: Is it more important to minimize the gap to maintain a more controlled, humid microclimate? Or is it better to have a wider brace to maintain a stronger snap-fit?



SHEET ADJUSTMENT – CORNER CUT
Minor design alteration – like cutting the corner of the sheet – highlighted the importance of testing in real context to catch simple but impactful oversights early.

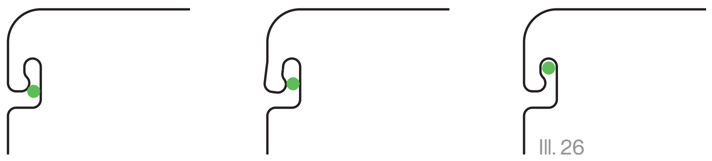
FUTURE STEPS
- Test with final materials, ideally stainless steel, for better stiffness.
- Adjust tolerances for industrial production.
- Validate tray spacing against lid support needs.

LID DURABILITY

SNAP LOCK

A key feature of the lid design is the snap lock mechanism, which relies on a critical spot (B, see ill. 27). This mechanism operates by forcing the plastic cutout to flex around a metal rod (the brace), causing a temporary deformation of the material (ill. 26). The behavior of this critical area is essential to understanding the durability of the snap lock.

Physical testing (p. 57) showed that the snap lock functioned properly without any visible deformation in the acrylic lid when the difference between the gate width and the rod diameter was 0,5 mm (δ, ill. 27). Although the test showed positive results, calculations were relevant to provide a quantitative basis to ensure that the strain does not exceed the material's limits.



Ill. 26

ANALYTICAL MODEL & FEA

In the calculations, the cutout was analyzed as a beam, and beam theory was used to calculate the strain in the critical spot B:

$$\varepsilon_B = \frac{\delta 3y}{2L^2} = \frac{0{,}5\text{ mm} \cdot 3 \cdot 9{,}15\text{ mm}}{2 \cdot (10\text{ mm})^2} = 0{,}206 = 20{,}6\%$$

This calculated strain significantly exceeds the maximum allowable short-term strain for PMMA, which is 1,5% (Bay & Larson 1991), meaning the material would theoretically experience plastic deformation or develop crazes and fracture.

However, when calculating the strain using beam theory, the local deformation that occurs where the metal rod pushes through the cutout is not taken into consideration. In this spot, the PMMA deforms locally, which should reduce the strain in spot B. This local deformation may partly explain why the strain in the Finite Element Analysis (FEA) is significantly lower, with a value of 1,43% (ill. 28).

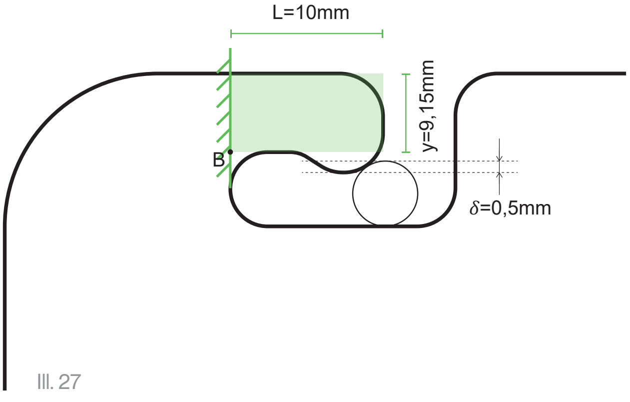
The FEA does not account for the material's response to repeated loading over time. This means that the analysis may underestimate the risk of gradual fatigue or crazing, and the lid's long-term performance could be affected if the strain occurs repeatedly.

REFLECTIONS

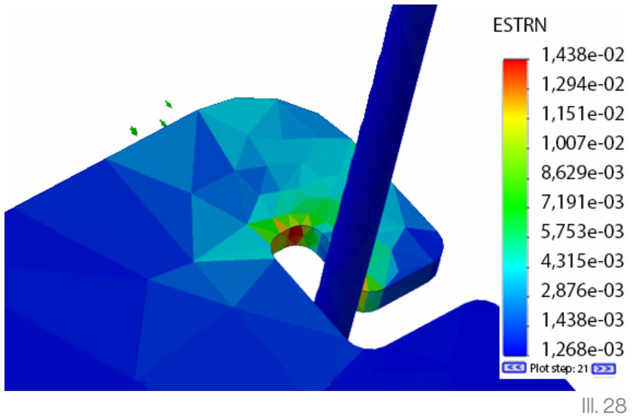
By considering the formula to the left, the following could be altered to lower the strain:

1. Decrease the beam height *y*.
2. Increase the length *L*. Since *L* is squared, a small change in *L* can yield big changes in the strain level.

While implementing these changes would reduce the strain in point B, it should be noted that making the beam longer or thinner would also make it more fragile in the use case. Therefore, a balance must be struck between ensuring sufficient strength and maintaining an appropriate level of flexibility. Long-term testing of the lid in the actual context would help validate this balance.



Ill. 27



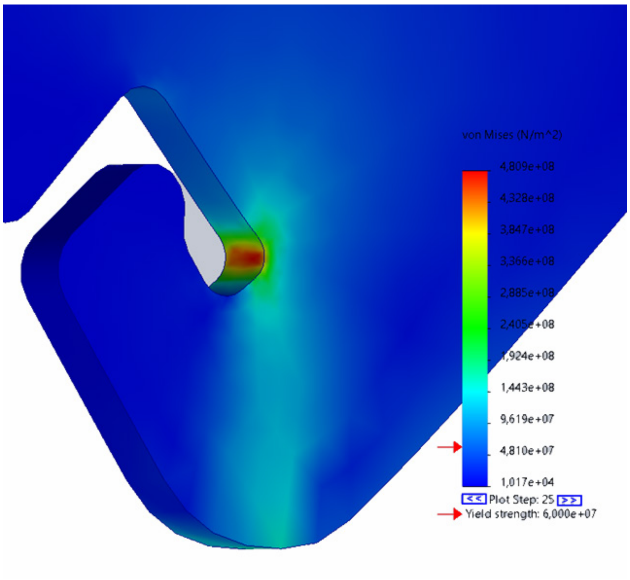
Ill. 28

DROP TEST

When attaching or removing the lid, there is a risk of it being dropped.

To assess the worst-case scenario, a drop test simulation was conducted, focusing on the impact to the corner of the lid – the most critical point. FEA results show that stress in the red-marked area exceeds the material's yield strength when dropped from a height of 2 meters. Since PMMA is a brittle material, it is likely to fail suddenly through cracking or fracture under these conditions (Fujimoto et al. 2019).

Although a drop of this nature would require the lid to be replaced, the probability of it happening regularly is expected to be minimal.



SCRATCHES

Since the lid is made of PMMA, it will accumulate visible scratches over time. Similar PMMA items in the REMA 1000 stores show signs of wear, which is generally accepted.

After the 5-day in-store testing, the lids had some scratches, but these were not noticeable when placed over the root vegetables (right) – only upon closer inspection when the lid was removed.

At this stage, determining when scratches would become severe enough to require replacement is not possible. This would require long-term in-store testing, which was not feasible within the project's timeframe.

CONCLUSION

With the sheet and brace components made of stainless steel, the lid stands out as the most fragile part of the product–but also the least expensive to replace.

In the event of a drop, the lid would require immediate replacement due to the high risk of fracture. In contrast, wear from accumulated scratches is a more gradual process. The point at which the lid should be replaced due to scratching will vary between stores, as it depends on individual standards and customer expectations. Eventually, excessive scratching may impact the perceived freshness and quality of the produce on display – which, as previously established, is undesirable.

While it would be useful to propose an expected lid replacement rate, doing so is difficult. User handling varies widely: the lid could be dropped on the first day, or it might last for several months if only minor wear occurs and scratching remains within an acceptable level.

The topic of the lid's replacement rate will be revisited in the business case (p. 74).

MATERIALS

The material suggestions presented here are based on desk research and insights into the materials currently used in REMA 1000's interior. These insights were gathered through meetings with key stakeholders, including REMA Interior, ITAB, and pr trading (app. 15).

ITAB, REMA 1000's primary interior supplier, operates its own manufacturing facilities but frequently collaborates with external partners when specific machinery or production capacity is not available in-house. This flexibility allows for the adaptation of material suggestions to fit different production setups or to align with preferred materials and surface treatments.

Across all material decisions, cost-efficiency remained a key priority – as long as the materials continue to meet the product's functional requirements.

<table>
<tr><th></th><th>CONSIDERATIONS</th><th>CONCLUSION</th></tr>
<tr><td>SHEET</td><td rowspan="2">Both the sheet and the brace should be made of metal to ensure the required functionality, durability and strength.

Aluminum was initially considered for the sheet due to its low weight and typically lower cost compared to stainless steel.
However, the brace must be made of stainless steel to achieve the necessary strength for the snap-lock mechanism.

Because of this, the sheet must also be made of stainless steel to avoid galvanic corrosion, which can occur when dissimilar metals are in contact (Marsh Fasteners 2024) – especially in semi-humid environments like the produce section. Corrosion would be unacceptable in this context.</td><td>Stainless steel is used for the sheet because it is stronger, harder and more resistant to scratches than aluminum. Additionally, it provides the required stiffness at a lower thickness, making it a more efficient choice for this application.</td></tr>
<tr><td>BRACE</td><td>Ø4 mm stainless steel rod is used for the brace.

Moreover, stainless steel is also used for the braces in the dairy coolers (p. 54), which have the desired flexibility that allow them to be squeezed together.</td></tr>
<tr><td>LID</td><td>The main requirements for the material are that it is transparent, food-safe, stiff, and can be cleaned with a damp cloth or cleaning wipe without being damaged.

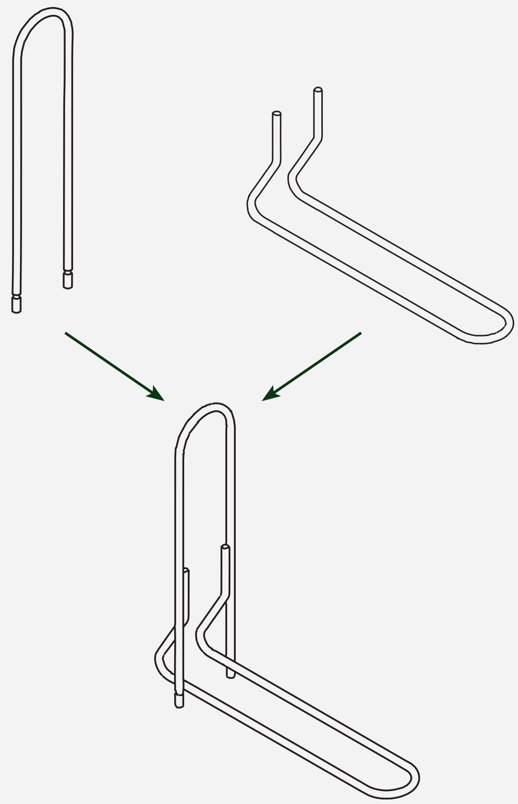
Two materials were considered: PETG and PMMA. The key difference lies in their processing methods: PMMA can be laser cut efficiently, while PETG emits toxic fumes when laser cut and should instead be milled.
Additionally, PETG requires a greater material thickness to achieve the same level of stiffness as PMMA.</td><td>PMMA is used for the lid. The material is food-safe, rigid, and well-suited for laser cutting, which is both fast and precise, ensuring accurate cut-outs.

REMA 1000 Budolfi Plads already uses cleaning wipes on their acrylic items, indicating that this cleaning method is suitable and does not damage the material.</td></tr>
</table>

MANUFACTURING

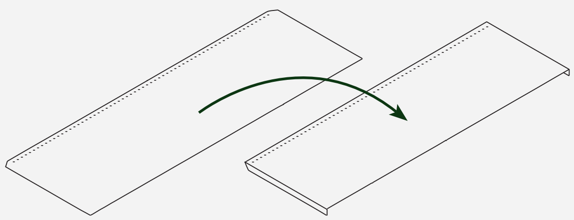
BRACE

1. Cold sawing. The rods are cut in precise lengths for both the horizontal and vertical part of the brace.
2. CNC turning. CNC turning is used to create the indent in the part of the brace that fits into the holes of the sheet. This method ensures high precision, which is essential for the stability of the brace. This feature is critically important for the functionality of the part, but it presumably increases production costs (app. 15). Additionally, not all manufacturers are equipped with the specialized machinery required to perform this process.
3. Deburring.
4. CNC wire bending. Both sections of the brace are bent. The horizontal part requires bends in multiple directions, with varying angles and radii. Due to this complexity, high precision and uniformity are essential, making CNC bending the necessary method.
5. Spot welding. The two sections are welded to form a single, solid brace.



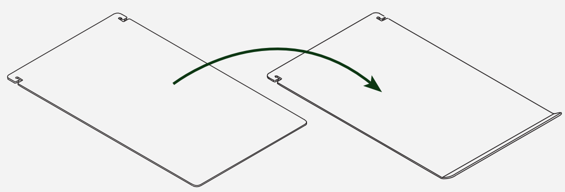
SHEET

1. Punching. The sheet is punched into the desired shape, including the holes. To reduce machine running time and improve efficiency, multiple sheets can be stacked and punched simultaneously.
2. Deburring.
3. Bending. The ends of the sheet are bent to form two 90-degree angles.



LID

1. Laser cutting. The lid is precisely cut to size and shape using a laser cutter.
2. Deburring. Sharp edges are manually deburred to ensure a smooth finish.
3. Bending. The lid is positioned on a strip heater to heat a specific line, making it possible to bend. Once heated, it is bent to the required angle using a manually operated jig.



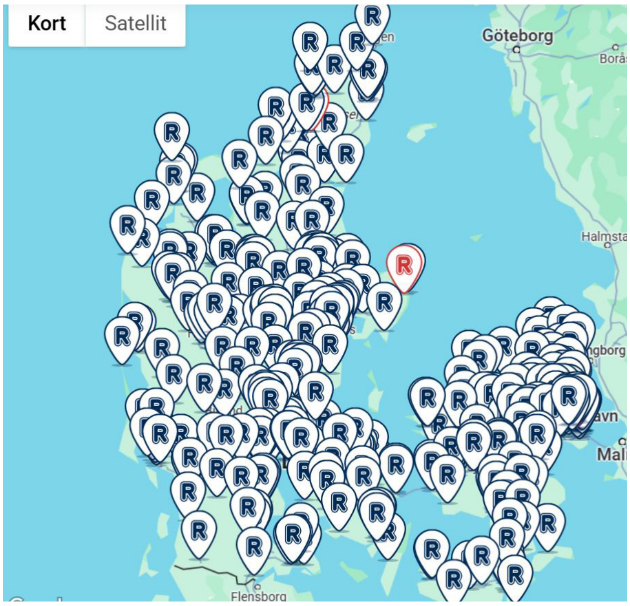
BUSINESS CASE

STRATEGIC FIT AND SCALABILITY WITHIN REMA 1000

With more than 400 stores and a 17% market share in Denmark (Danmarks Statistik 2024), REMA 1000 represents a strong platform for scalability. Its significant presence in Denmark – and in Norway – creates clear opportunities to expand the proposed solution across borders.

Furthermore, environmental, economic, and social responsibility are the foundation of REMA 1000's brand DNA, providing a natural incentive for the company to pursue more sustainable practices. REMA 1000 is already actively engaged in reducing food waste and has demonstrated a willingness to adopt innovative approaches.

Adopting the proposed design solution, Reitan, would both support and strategically align with REMA 1000's goal of minimizing food waste – a key CSR priority (REMA 1000 2024).



PRODUCTION COSTS

Production costs and quotes were gathered from REMA 1000's current approved suppliers and manufacturers (app. 16). These were based on the requirement to cover 1,300 produce shelf sections – approximately three Reitan's per Danish REMA 1000 store.

Unfortunately, the team was only able to obtain the total price for each component, without detailed manufacturing costs for each production step. Had these detailed costs been available, the team could have been more informed in their design decision-making by analysing the cost breakdown and focusing on the most expensive parts of the production process to reduce overall costs.

COMPONENT	*MANUFACTURER*	*QUANTITY*	*COST PER PC.*	*COST PER SHELF SECTION*
Metal sheet	ITAB	1 pc.	495 DKK	495 DKK
Brace	ITAB	5 pcs.	50 DKK	250 DKK
Lid	pr trading & HL Display	4,5 pcs.	51 DKK	229,5 DKK
Total cost per shelf section				974,5 DKK
Total cost per Euro Pool tray				216,6 DKK

BREAK-EVEN ANALYSES

The following section dives into Reitan's financial projections.

After experiment 04, the team became concerned about the scalability of the solution: The experiment showed that while it was possible to improve the shelf life of certain items, such as radishes, they likely would not last more than one additional day. As grocer Kristian mentioned, a three-day shelf-life extension was the benchmark for the investment to be viable, and the team realized it might not be possible to achieve this for other vegetables.

In other words, the team questioned whether the solution worked effectively only for root vegetables. This contradicted the team's initial ambition for the project which was to solve the problem for root vegetables first and then expand the solution to other types of produce. The team questioned whether the investment would be justified for other vegetables if their shelf life could only be extended by half a day. To address this, the team worked to quantify the problem more precisely through a break-even analysis.

It should be made clear that REMA 1000's sales volume would not increase if shelf life was extended – demand and product turnover would remain constant. Instead, the solution would enable REMA 1000 to reduce food waste: By extending the shelf life of fresh produce, products would stay fresh longer, allowing more time for sale before spoiling, which would result in less waste. As such, the financial projections focus not on how much profit REMA 1000 would generate by adopting Reitan, but on how much money they would be able to save through Reitan's ability to reduce food waste.

Two scenarios should be considered with the implementation of Reitan:

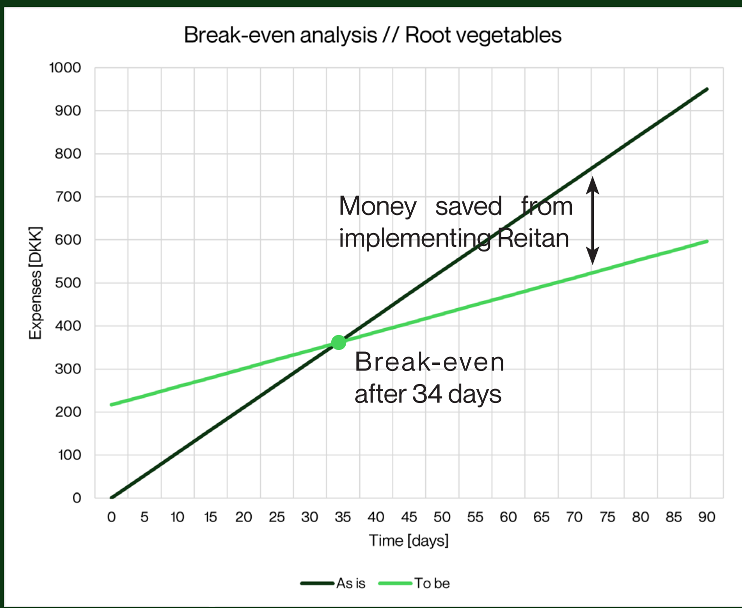
1. The root vegetable scenario (turnover time < shelf life). The most optimal scenario where the produce is sold before spoiling. This would be the case for root vegetables, since their shelf life would be extended to four days while their rotation time would still remain at two days. In theory, this suggests that root vegetables will not generate any food waste. However, this is very unlikely due to the occurrence of natural biological defects that could cause spoilage. Therefore, it should be assumed that a limited amount of root vegetable waste would still occur.

2. The radish scenario (turnover time > shelf life). This would be the case for radishes. Currently, radishes spoil after just half a day, but it typically takes longer to sell the entire tray. As a result, the unsold radishes are discarded each day. With the adoption of Reitan, the radishes last longer, giving the store more time to sell them. This would result in fewer radishes going bad before being sold.

SCENARIO 01: ROOT VEGETABLES

Suppose instead of discarding 1/4 tray of root vegetables daily, Reitan reduces the waste to just 1/10 tray per day. The cost to purchase one tray of root vegetables is 42,24 DKK. With the total cost of Reitan for one Euro Pool tray being 216,6 DKK, the graphs to the right can be plotted.

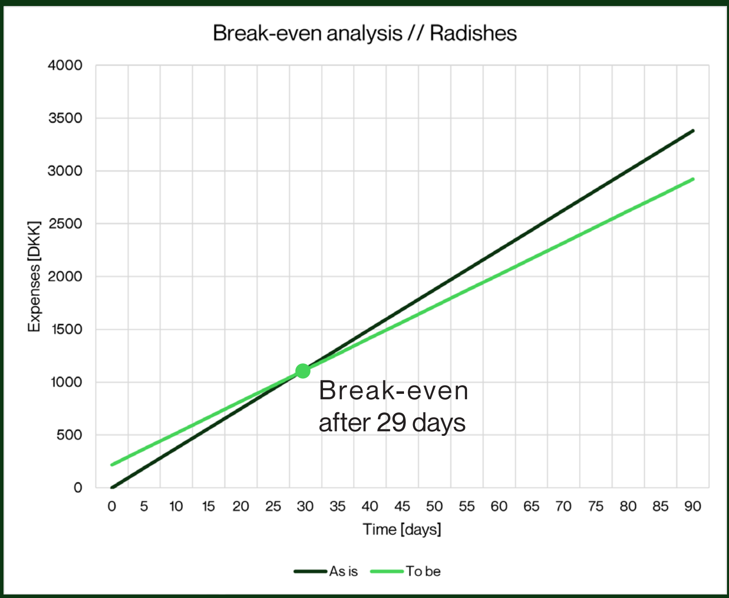
The intersection between the as-is graph and the to-be graph shows the break-even period. This means that after approximately 34 days, the investment in Reitan and the loss from food waste become smaller than the loss REMA 1000 would have incurred from discarding root vegetables without the solution.



SCENARIO 02: RADISHES

Suppose instead of discarding 5 bundles of radishes daily, Reitan reduces the waste to just 4 bundles each day. The purchase cost of each radish bundle is 7,51 DKK. Remembering the total cost of Reitan for one Euro Pool tray, the graphs to the right can be plotted:

The intersection between the as-is graph and the to-be graph shows the break-even period. This means that after approximately 29 days, the investment in Reitan and the loss from food waste become smaller than the loss REMA 1000 would have incurred from discarding root vegetables without the solution.



CONCLUSION

In both scenarios, the graphs show that adopting Reitan allows REMA 1000 to reach break-even within around a month. Although this implementation is tied with initial costs, these are recovered relatively quickly, after which the company begins saving money by reducing food waste. The short break-even period makes the investment low risk, with long-term returns.

It should be noted that the current break-even calculations only account for cost savings from reduced food waste. They do not consider the potential revenue gain if the solution extends shelf life–allowing REMA 1000 to sell produce that would otherwise be discarded. This additional income could offset costs more quickly, meaning the actual break-even point may occur earlier than suggested by the current models.

Considering the graphs, the maximum lid replacement rate can also be calculated. This varies between 6–8 days (app. 16), meaning after hitting break-even, REMA 1000 can replace a lid per tray every 6–8 days without incurring a financial loss. However, a replacement rate this high is highly unlikely.

It should also be noted that grocery stores must pay for the disposal of their food waste. By generating less food waste, REMA 1000 also lowers these disposal costs, further decreasing overall expenses with the implementation of Reitan.

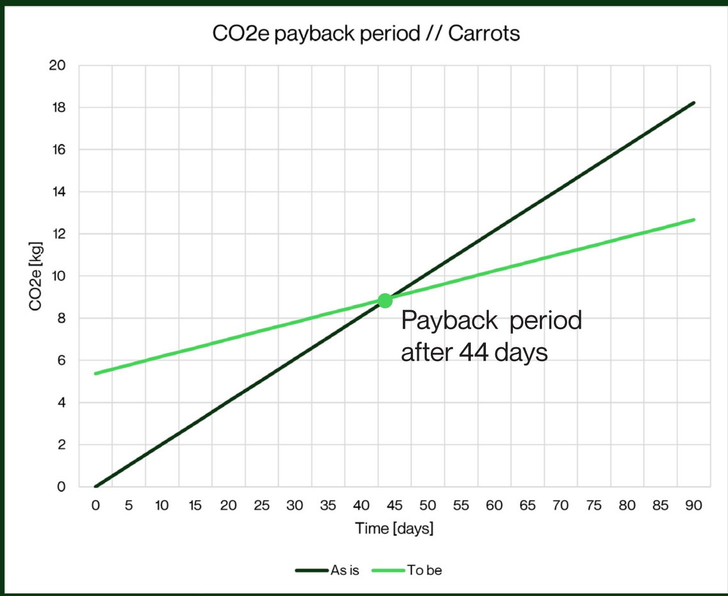
SUSTAINABILITY AND ENVIRONMENTAL FOOTPRINT

Similar to the break-even analyses above, it is also calculated when the implementation of Reitan reaches its CO_2e payback period. For simplicity, this calculation is limited to Scenario 01, which focuses on root vegetables – specifically carrots.

SCENARIO 01: ROOT VEGETABLES (CARROTS)

Per Euro Pool tray, Reitan emits 5,38 kg CO_2e (app. 16). Given that 1 kg of carrots emits 0,27 kg CO_2e (Den store klimadatabase n.d.), the graphs to the right can be plotted:

The intersection between the two graphs shows that after approximately 44 days, Reitan reaches its CO_2e payback period. This means that from this point on, the CO_2e saved by reducing food waste is greater than the CO_2e caused by introducing Reitan – compared to the current situation, where root vegetables are simply thrown away.



CONCLUSION

Subject to limitations and assumptions, the analysis indicates that implementing Reitan offers clear environmental benefits for REMA 1000.

Within roughly 44 days, the carbon savings from reduced food waste outweigh the emissions associated with the Reitan system's rollout. Beyond the immediate environmental gains, this improvement supports REMA 1000's broader carbon accounting efforts and strengthens progress toward long-term sustainability targets.

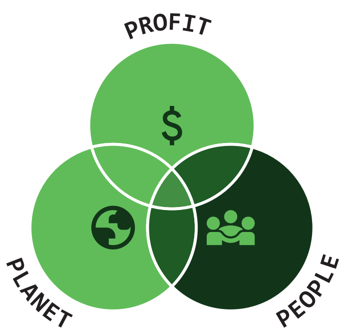
Considering all three graphs, this means that by day 44, Reitan has reached break-even not only in financial terms but also in terms of environmental impact – further strengthening the case for its adoption.

VALUE PROPOSITION

While the above demonstrates that Reitan reduces expenses for REMA 1000 long-term, the savings might not appear significant from a grocery chain's perspective. However, even if the direct financial gains are modest, the solution offers additional benefits, particularly in terms of sustainability.

These broader advantages are captured by the concept of the triple bottom line (right) which urges companies to consider not only economic value but also environmental, and social value:

"The triple bottom line is a business concept that states firms should commit to measuring their social and environmental impact – in addition to their financial performance – rather than solely focusing on generating profit, or the standard "bottom line."" (Miller 2020).



Implementing Reitan would support REMA 1000 not only financially, but also by reinforcing the company's broader environmental commitments.

The solution aligns directly with REMA 1000's overarching sustainability strategy, "Discount med holdning". REMA 1000 has clearly stated its ambition to minimize its environmental footprint and meet the Paris Agreement goals by 2030 (REMA 1000 2024, p. 8). A key target under this priority is reducing food waste, highlighted in the company's materiality analysis as a long-term priority with significant stakeholder importance.

In fact, REMA 1000 has set the goal that by 2030, no food fit for human consumption should be discarded, a mission that also supports the UN's 12th Sustainable Development Goal: Responsible Consumption and Production, as outlined in REMA 1000's 2024 CSR report.

By extending the shelf life of fresh produce, Reitan directly contributes to this objective and helps reduce unnecessary waste. It also reinforces REMA 1000's position as Denmark's most sustainable brand (SB Insight 2025).

Given the company's existing efforts (see below), adopting Reitan would be a natural extension of REMA 1000's commitment to sustainability and social responsibility.

The implementation of Reitan in REMA 1000's stores would align with the triple bottom line framework by delivering financial and environmental value.
Environmentally, Reitan helps reduce food waste, which lowers the company's carbon footprint by preventing the waste of resources. Over time, the CO_2e emissions saved through waste reduction surpass the emissions associated with producing and implementing the Reitan units, as demonstrated by the CO_2e payback period analysis.
By implementing Reitan, REMA 1000 also sets a positive example – both within the retail industry and for its consumers.

In this way, Reitan offers REMA 1000 an opportunity to strengthen its sustainability profile and meet growing consumer expectations for responsible business practices, making it a strategically beneficial investment beyond its financial return alone.

Ill. 29

← A look at some of REMA 1000's sustainability initiatives over the years highlights their ongoing efforts to reduce food waste.

Reitan is well-positioned to build on this legacy and drive further progress in reducing food waste.

IMPLEMENTATION PLAN

In collaboration with REMA 1000's interior and technical department, an implementation plan was developed. In practice, it is REMA 1000's purchasing department that decides if new inventory should be mandatory or optional for the grocers to adopt. To accommodate this, two implementation scenarios, mandatory and optional, were outlined.

The implementation plan is structured as a modular rollout, meaning the product is introduced in stages. This allows REMA 1000 to avoid a full upfront commitment, thereby lowering both risk and initial investment. Since the product can be integrated into their existing produce shelving systems, installation requires minimal disruption to store operations and can be adapted to each store's specific layout and needs. This flexibility ensures smoother transition and faster adoption, whether implemented chain-wide or store-by-store.

	NEW NEED	DEVELOPMENT	**GATE 1: VALIDATION**	TESTING	ANALYSIS	**GATE 2: VALIDATION**
REMA 1000 stores	A new need/ problem is identified by grocers or the purchasing department - in this case, the short shelf life of root vegetables.			Testing in 3-5 model stores	Running evaluations (food waste, sales, cost-benefit, durability, user interaction/ feedback) and design optimization	
REMA 1000 Group		Interior and technology department develops a solution in collaboration with relevant supplier	The purchasing director decides if the solution should be tested in model stores			The purchasing director decides if the solution should be rolled out. **Two possible scenarios: Mandatory or optional inventory**
Supplier				Manufacturing of small badge of prototypes		

SCENARIO 1 // OPTIONAL INVENTORY

	ORDER #1	IMPLEMENTATION	MAINTANENCE	**GATE 3: VALIDATION**
REMA 1000 stores	Each store orders the desired quantity if they choose to carry the product.	Reitan is installed in the stores that placed an order	If needed, more orders are placed	
REMA 1000 Group	An order for the desired amount is placed with the supplier.			If the solution works well, it is expanded to REMA 1000 Norway
Supplier	Manufacturing		Stock and continued manufacturing	

SCENARIO 2 // MANDATORY INVENTORY

	ORDER #1	IMPLEMENTATION	MAINTANENCE	**GATE 3: VALIDATION**
REMA 1000 stores		Reitan is installed in all Danish REMA 1000 stores	If needed, more orders are placed	
REMA 1000 Group	An order is placed with the supplier to cover all Danish REMA 1000 stores.			If the solution works well, it is expanded to REMA 1000 Norway
Supplier	Manufacturing		Stock and continued manufacturing	

05

OUTRO

Firstly, the phase considers future opportunities by exploring how the concept – and the insights gained throughout the project – can be expanded or adapted to new contexts. Both immediate and future potentials are investigated.

Finally, the following pages offer a brief summary of the project, including a final conclusion and reflections.

These reflections address the product – highlighting future opportunities and improvements to optimize its quality – as well as the overall process, sharing insights into the experience of working on this project.

CASE 02 // NETTO

The focus had been on REMA 1000 and designing a product tailored to their specific needs. The next step was to identify immediate opportunities and explore how the concept could be scaled and adapted for other supermarkets within similar budget constraints. More exclusive chains had already invested in refrigerated displays for delicate produce, making them less relevant Reitan users.

Ill. 30

THE NETTO CONTEXT

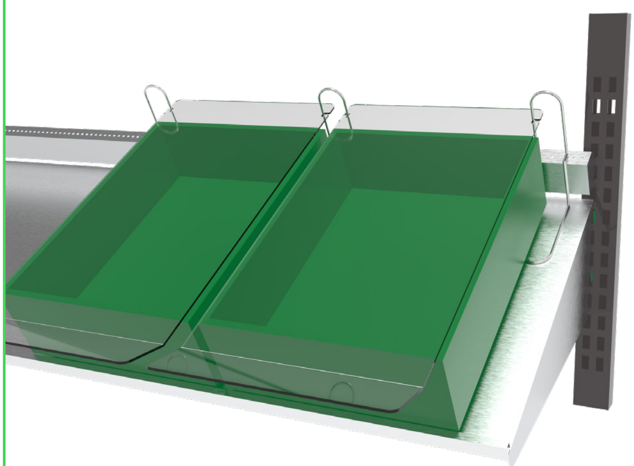
Netto was identified as Case 02 because, like REMA 1000, it operated in the low-price segment and faces similar challenges, though with a different store setup. This investigation focused on identifying which elements of the Reitan concept needed to be modified or adjusted to fit Netto's layout.

Netto used sheet metal shelves, while REMA 1000 used wire shelves. With versions developed for both formats, the goal was to make the solution adaptable to a wider range of supermarkets, as the main variation in shelving setups was the use of solid and/or wire shelves. Aside from this, the shelving systems were identical in measurements and interfaces. One key difference was that Netto used a three-level shelving system, whereas REMA 1000 used four levels.

Both chains use the same EPS trays and follow similar restocking routines, ensuring compatibility in terms of handling and logistics.

REITAN GONE NETTO // ALTERATIONS

Since the shelf is solid, there is no need for covering the tray bottom as necessary in the REMA 1000 design. This also means that the brace must be attached in a different way. An existing accessory (ill. 30) for the shelving unit was used as inspiration for the attachment of the braces. The brace was altered to fit the new attachment part. Production wise, the brace would go through the same processes as the original (cut, bend, weld). The attachment part would be produced the same way as the reference piece with changes in size and shape and added holes to insert the braces. The lid would not need any alterations.



FUTURE PERSPECTIVES // BLUE-SKY CONCEPT

Following the expansion of the Reitan concept to also include Netto, the team sought to push the project even further.

IDEATION

Reflecting on the above, the team decided to build on the unique insights gathered throughout the design process and explore how these could be exemplified in a bolder, more innovative design proposal.

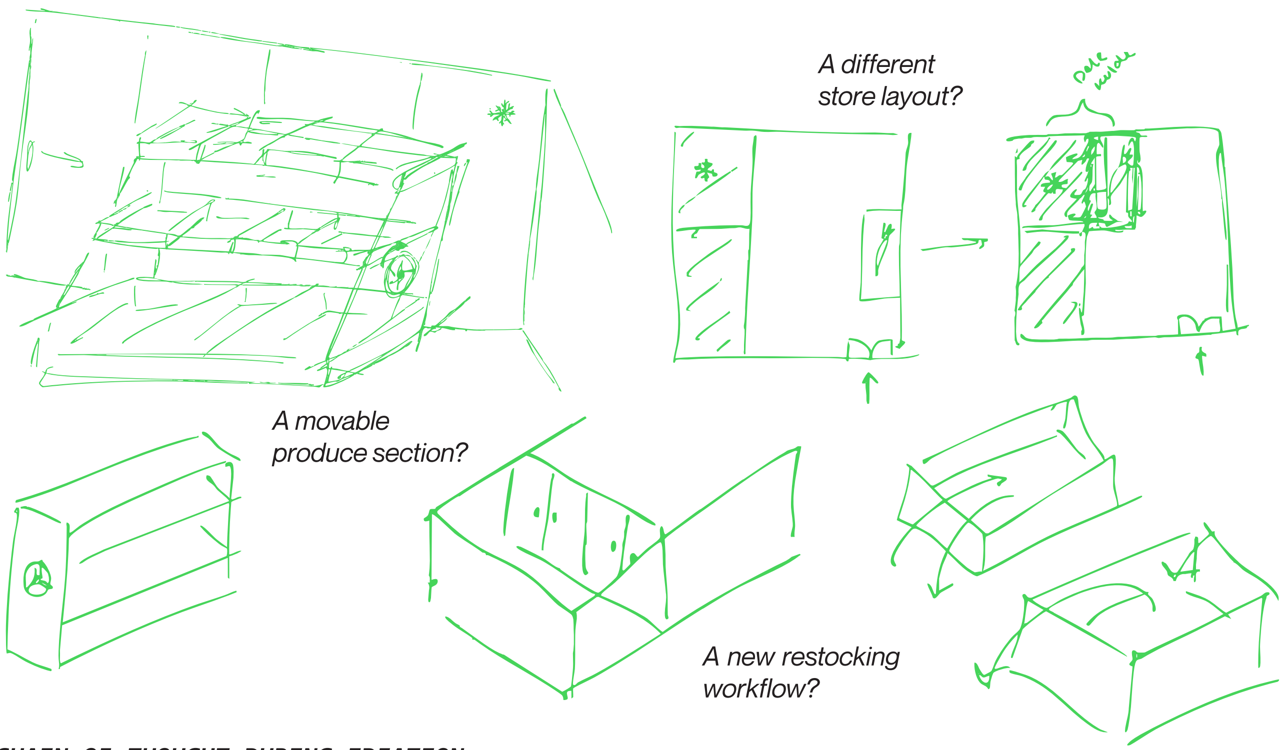
This part of the project was grounded in a blue-sky mindset, allowing the design team to push the project in a radical, unrestrained direction.

"Blue-sky thinking refers to ideas that are not limited by the current beliefs or norms of a group or society.

Blue-sky thinking can be ideas that are creative or whimsical and maybe even bizarre. Such thinking might lead to just the solution you need.

Blue-sky thinking can be an important part of coming up with something new and unconventional."

(Dictionary.com n.d.)

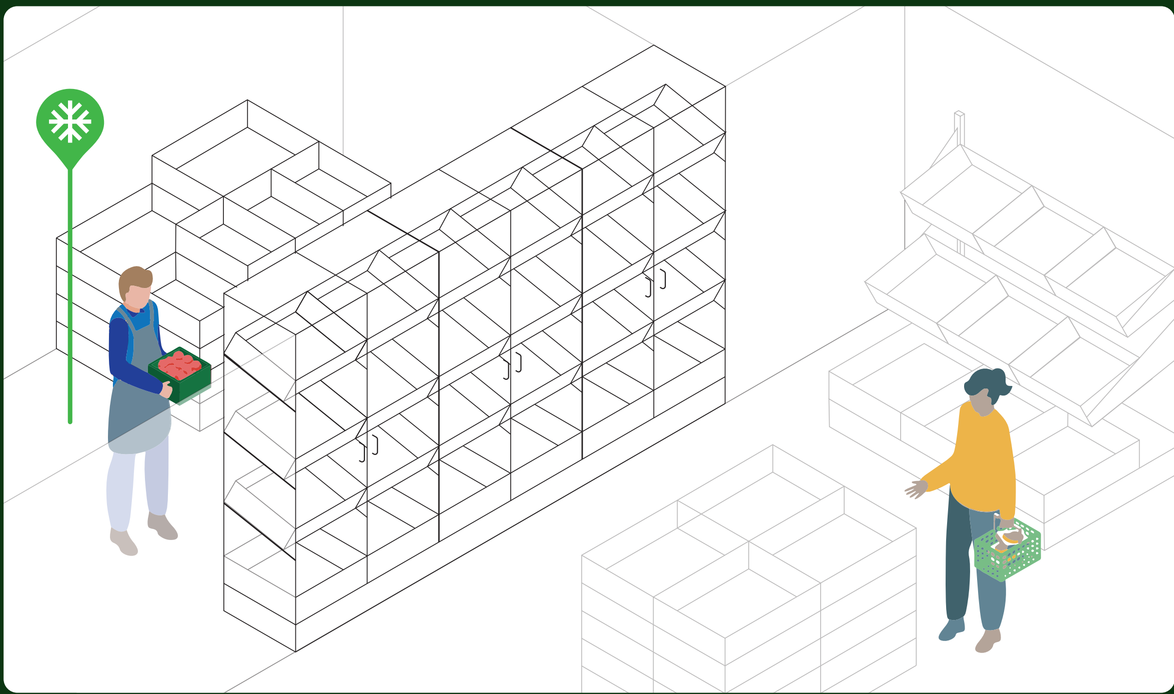


CHAIN OF THOUGHT DURING IDEATION

- Refrigeration is the most effective way to extend the shelf life of most fresh produce.
- Produce starts to deteriorate as soon as it is removed from cold storage.
- Installing open coolers in the produce section is costly.
- So, what if the produce never had to be taken out from cold storage?
- What if the cold storage was moved to the produce section?

Based on these reflections, a strategic store layout concept, inspired by the dairy section – was developed.

THE CONCEPT



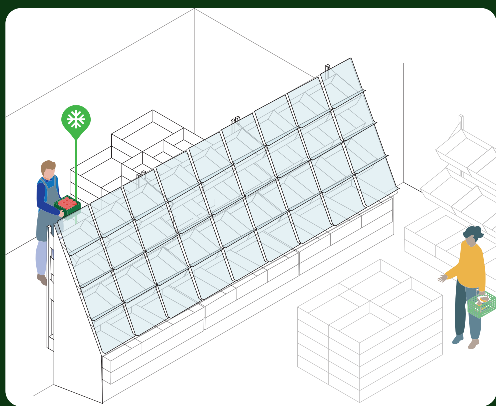
The concept draws inspiration from the design of milk coolers. These are:

- Connected directly to the cold storage area
- Efficient, as milk is stored and sold from the same refrigerated environment
- Stocked from the back

The setup of this new blue-sky concept works well because stores need cool storage for produce regardless, and customers simply take products directly from the source.

This layout allows employees to move pallets from the delivery area to the cooler only once per day, rather than making multiple trips to a separate store section. It also frees up floor space, providing a convenient customer experience. Importantly, placing fresh produce at the entrance enhances the overall perception of freshness and quality throughout the store (Retail Space Solutions, 2020).

REITAN FEAT. BLUE-SKY



A slanted wall with smaller doors was explored as a way to mimic the customer interaction seen in Reitan. This design would reduce the cooled volume and limit cold air loss compared to full-size doors like those in the dairy section.

However, the concept should be further developed to address concerns that the doors would be too heavy, since they should presumably be made of glass, which would negatively affect the customer experience.

CONCEPT EVALUATION

	POTENTIALS	BARRIERS
Vegetables	Storing produce under optimal conditions extends its shelf life, ultimately reducing food waste.	If the solution affects the customer negatively, they will buy less
Money	Less food waste means increased profit. With produce kept in cold storage 24/7, shelf life is extended, helping to minimize waste and maximize returns.	The solution requires a significant upfront investment, and it may take a long time to reach the break-even point. Additionally, there are potentially higher costs for electricity if the system occupies more space than the existing cold storage setup.
Implementation	Works well in stores where the layout is undefined. This could for instance be for new store opening, although the investment would still be larger compared to the current setup.	Larger architectural changes in the store layout needed. Might not be financially possible in some stores.
Staff interaction	Restocking from behind – taps into flow of goods.	How will the restocking from behind work? The shelving system needs to be adjusted for this workflow, since the shelves are slanted.
Customer interaction	Familiar interaction from the milk cooler. Other stores also used cooling counters with glass doors e.g. Føtex.	The produce requires a certain level of visibility and accessibility unlike the dairy section where quality checking is done by date labelling.
Customer experience	More hygienic, clean and fresh	How will it affect the produce display? Will it feel like a barrier? Will the display seem flat?

CONCLUSION // NETTO

A solution was developed for Netto using less material than the Reitan version, as Netto's shelves are already made of sheet metal, unlike REMA 1000's wire shelves.

The lid used in Reitan can be reused, but the other components are not directly compatible due to the different mounting systems. However, the core principles – lid mounting, restocking, and user interaction – remain the same, and would need to be tested in the context of Netto's setup.

This concept is well-suited for a discount chain like Netto, which presumably cannot invest in full refrigeration across the entire produce section, similar to REMA 1000.

CONCLUSION // BLUE-SKY

Refrigeration is a well-established and highly effective method for extending the shelf life of fresh produce, with strong potential to significantly reduce food waste.

By relocating the entire produce cool room to the produce section, the concept represents a strategic long-term solution. Due to the scale and cost of the architectural changes involved, the concept is best suited for integration into new store layouts rather than retrofitting existing ones.

Further development should focus on customer interaction and restocking logistics to ensure smooth day-to-day operation.

CONCLUSION

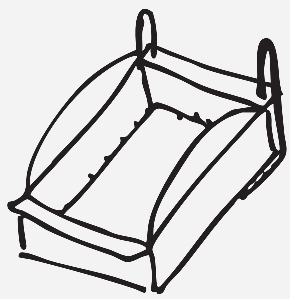
This master's thesis responds to the upcoming EU legislation banning single-use plastic packaging for fresh fruit and vegetables, set to take effect in 2030.
While the law aims to reduce plastic waste, it also raises concerns about increased food waste due to the role packaging plays in extending produce shelf life. This project investigated how a product can be developed to address this challenge by extending shelf life without relying on single-use plastic packaging.

The project is rooted in a real-world context through a close collaboration with REMA 1000, using a case-based approach to ensure practical relevance and user-centred design. The structured design process, progressing through the Discover, Define, Develop, and Deliver phases, allowed the team to explore the complex problem space, identify actionable challenges, and iterate on design solutions.

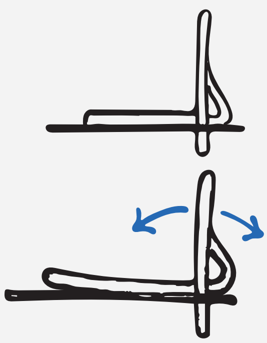
Central to the project is the development of a simple yet effective lid design aimed at protecting root vegetables while maintaining an attractive produce display for customers and a streamlined workflow for employees. Prototype testing provided valuable insights, which informed iterative improvements focused on durability, usability, and manufacturability.

Beyond the initial case, the project also considered scalability and adaptation of the solution to other retail environments, exemplified by the broader concept proposed for Netto and a more innovative, future-facing blue-sky concept.

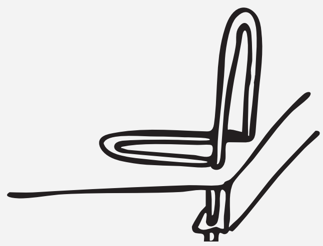
While the future implications of the legislation remain uncertain, this project proposes a practical approach to addressing the ban on single-use plastic packaging by balancing the interests and needs of users and stakeholders, manufacturing costs, and functionality in a simple product aimed at reducing food waste in the future.



Ill. 31



Ill. 32



Ill. 33

REFLECTIONS

PRODUCT EVALUATION

SCRATCHES ON THE LID

Over time, there is a risk that the lid may accumulate scratches to the extent that it compromises the visual appeal of the produce display.

Due to the time constraints of this project, the team was unable to conduct long-term testing that would simulate the full lifespan of the lid – from installation through daily use, handling and maintenance, to its eventual wear and tear. Consequently, it was not possible to determine how the material would perform under prolonged use or how quickly it might need to be replaced.

LID CONSTRAINS

The final design proposal requires that the produce is not overstocked, as overfilling prevents the lid from fully closing, seemingly defeating the purpose of having a lid in the first place. Naturally, this can be considered a big limitation in the design as overstocking is a big part of creating an attractive produce display in the produce section.

The design team's decision to choose the current lid design was informed by several key considerations:

First and foremost, the product proposal targets produce with a low rotation rate, i.e. items that are not purchased frequently and thus do not require overstocking or even fully stocking the tray.
Secondly, in the process of designing the lid, the design team did consider thermoforming it into a dome shape to allow for some overflow (ill. 31). However, this approach would increase manufacturing costs and create excessive empty space inside the tray which would negatively impact shelf life due to a higher produce-to-air ratio. Additionally, this design would not guarantee that the lid could fully close, as produce could still get caught between the lid and the tray, leaving it ajar.

It should be noted that it remains unclear whether the lid being slightly ajar has a notable negative impact on produce quality. During the first in-store prototype testing, the team observed the lid slightly ajar after a few days, but the produce showed no visible damage. Since the duration the lid had been ajar was unknown, further testing is needed to draw a conclusion.

BRACE STABILITY

The final in-store prototype testing revealed that the braces could feel loose and not securely attached in cases where the brace was pushed backwards. This happened for instance when the lid was clicked out of the braces.

Upon closer inspection, it became apparent that the team-built prototype was not entirely flat on the bottom, which likely compromised the stability of the back stabilizer (ill. 32). Had the brace been professionally manufactured, this issue might not have occurred. Out of this uncertainty, the team developed an alternative brace solution to be considered:

Since there is sufficient space at the back of the top shelf, the metal sheet could be bent down below the wireframe shelf (ill. 33). This would allow for a stabilizing method similar to that used in the REMA 1000 milk coolers, where the brace passes through two sheets of metal, ensuring a secure and stable fit.

This alternative should be evaluated alongside the professionally manufactured brace. Both approaches have their respective pros and cons, and the final decision should be made based on manufacturing costs.

ORGANIC OR CONVENTIONAL?

Reitan does not address the challenge of helping both customers and employees (during restocking and at checkout) distinguish between organic and conventional produce. A potential solution could be for REMA 1000 to simplify its product range by offering only one variant per category – for example, only organic carrots instead of both organic and conventional options. This approach would directly address the issue while also supporting REMA 1000's broader sustainability ambition to expand its organic assortment, as indicated in their annual report (REMA 1000 2024). However, this is not a solution rooted in product design, as it relies on REMA 1000's internal decision-making.

PROCESS

WORKING WITH THE FUTURE

This project was largely based on the challenge of designing a product for a future scenario.

The starting point was new legislation passed by the European Parliament in 2024, in which a law was enacted to ban single-use plastic packaging for certain types of fresh fruits and vegetables. Since the rule is set to take effect in 2030, the implications of adopting such a law remain unclear; this was the initial starting point for the team.

However, although the exact scope and limitations of the legislation were uncertain, it served as a prompt for the team to raise a critical question: *What would happen if all plastic packaging were removed from the produce section?*

To make the challenge actionable, the team identified root vegetables as a starting point. Since these were already being sold without packaging, they were already situated in a "future scenario," hereby offering a controlled environment for evaluating potential solutions – without the added complexity of removing existing packaging or disrupting the current supply chain. This decision enabled the team to move forward with concrete insights and develop testable solutions.

That said, there were fundamental flaws in this approach. Anchoring the project in the current system and working from an as-is scenario may have caused parts of the project to rely on assumptions that could shift entirely – and unpredictably – once the law would come into force.

This speculative starting point also had a clear impact on the design process, especially in the early phases of the project, where defining a problem that was both meaningful and manageable proved difficult. The team went through several iterations of framing and repeatedly refining the focus in order to strike a balance between the future-oriented premise and the need for a concrete, solvable design challenge.

"SIMPLE IS BEST"

The final design proposal concludes with a product design that is relatively simple, both in its product architecture and in the design of its components.

While the team did not initially set out to make as simple of a product as possible, the project revealed that this complex problem of extending the shelf life of produce could actually be solved with a surprisingly simple solution: a lid.

Consequently, the design team spent a significant amount of the design process refining the details of this solution, taking on the notorious challenge of making something both good and simple. The principle that guided the team in this process was that the strength of a simple product lies in the fact that it has been thoroughly considered and executed in all of its aspects.

In retrospect, the team may have gone too deep into this first case, which was initially intended only as a springboard for further exploration. The project might have benefited from accepting a design that is "good enough" – and focusing more on pushing the concept, its complexity, and development in other areas of the project.

PRODUCT SIMPLICITY VS. PROJECT COMPLEXITY

Fairly early in the project, the team established a strong working relationship with REMA 1000, both as a case study and as an unofficial project partner. As the project progressed, REMA 1000 became increasingly central to the work, eventually turning into a core focus.

Through this close collaboration, it became clear that the design proposal needed to be a plug-and-play solution – an incredibly simple product, distilled down to only its necessary parts, that would fit REMA 1000's discount brand.

Because the team found the biggest motivation in working closely with a partner and engaging in ongoing dialogue about making the product feasible, the team became fixated on working only on the REMA 1000 case.
The master's thesis, as a project, required that the team engage with more complex challenges. This requirement introduced complexity into the broader design process – not for the sake of the product itself, but to fulfill the academic learning goals – resulting in the team eventually finding a balance between a simple solution in the context of a complex project.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46

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ILLUSTRATIONS

Unless otherwise indicated, all illustrations and photographs are self-made or taken by the team.

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