

Appendices

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Appendix 1: original design brief

Optimize recreational vehicle fridge design to highly improve manufacturability by removing just one process step

Thetford is an “international company that tries to bring total piece of mind to every recreational vehicle (RV) user in the world through great leisure products.”¹ They started by making the porta potti, a very popular chemical toilet. Their product portfolio slowly increased in the past 45 years to include stoves, sinks, cassette toilets, toilet additives, toilet paper, service doors and fridges. Though they make consumer products their customers are mainly RV’s builders (like Fendt and Hymer) and resellers. They have various factories, warehouses and sales offices spread over the globe.

Recently Thetford found the possibility to leave out a big manufacturing step at their Dutch fridge factory (see image 1 for the various types they produce). At the moment, production is almost at maximum capacity and without any capability to expand. Production personnel equip every workstation (which is even harder in the present corona crisis) and machines are utilized to their maximum potential (the Overall Equipment Effectiveness is close to 95% of the automatic line). Removing this step will most likely double production capacity and decrease the amount of labor involved, therefore solving the quantity problem.

These opportunities can even be made bigger by Thetford’s manufacturing strategy for the coming years! This factory is seen as a pilot factory besides its volume production. New technologies of smart manufacturing and assembly are being implemented at the factory more and more. The prerequisite is to upgrade the fridge design in such a way that it can be assembled and manufactured in the present and future situation with one step less.

So, what is the manufacturing step that could be left out? Image 2 gives a visualization of the process. After assembly, the fridges are filled with isolating foam (PUR) to ensure good cooling performance. For this a two-step process is used to fill the fridge. The first step is a foaming shot is to ensure a stable cabinet. The second step is a shot that embeds the heavy cooling mechanism. The cabinet assembly would collapse when the cooling mechanism is added at the first step. The initial reason for this manufacturing choice was to change the expensive cooling mechanism at the customer. This practice has been abandoned for quite some time now. An internal feasibility

¹Thetford (2019): Our DNA - Think, Feel, Act, https://cms-nl.thetford-europe.com/sites/default/files/2019-07/Think%20Feel%20Act%20Thetford_screen.pdf (accessed May 4th 2020)

study², however, showed it is possible to combine the two steps into one. It also showed several problems related to the change.

The first problem, and the biggest, is more complex assembly work before foaming. These include hard to reach places, difficulty with handling the heavy cooling mechanism and a wobbly assembly. This would be especially hard for the production personnel involved. The second problem is the chance of deformation at the back of the fridge caused by high forces from expanding foam in the foaming machine. The addition of the cooling mechanism causes some places to be more difficult to support thus to counteract the high foaming forces. With two steps this wasn't a problem in the machine thus necessary adjustments need to be made to the machinery as well. The third is the factory setup and layout being able to handle double capacity and the processes connected to the different assembly. The fourth problem is that the end-user could notice the internal manufacturing change in terms of weight. A lightweight fridge is desired in a RV and now it can become heavier.

The goal of this graduation is to enable one-step foaming by redesigning the RV fridge. The unique side of this project is that this is an internal design change thus the 'customer' changes from external (end-user and RV builders) to internal (production personnel). Therefore, the main focus will be on these internal customers to tackle the first three problems while considering the external customer and manufacturing strategy.

The three absorption fridges of

THETFORD



Figure 1: Various types of fridges produced in The Netherlands, each with unique aspects in their design

² Improvia (2018): One Step Foaming - Concept Workshop, Thetford internal documentation, The Netherlands

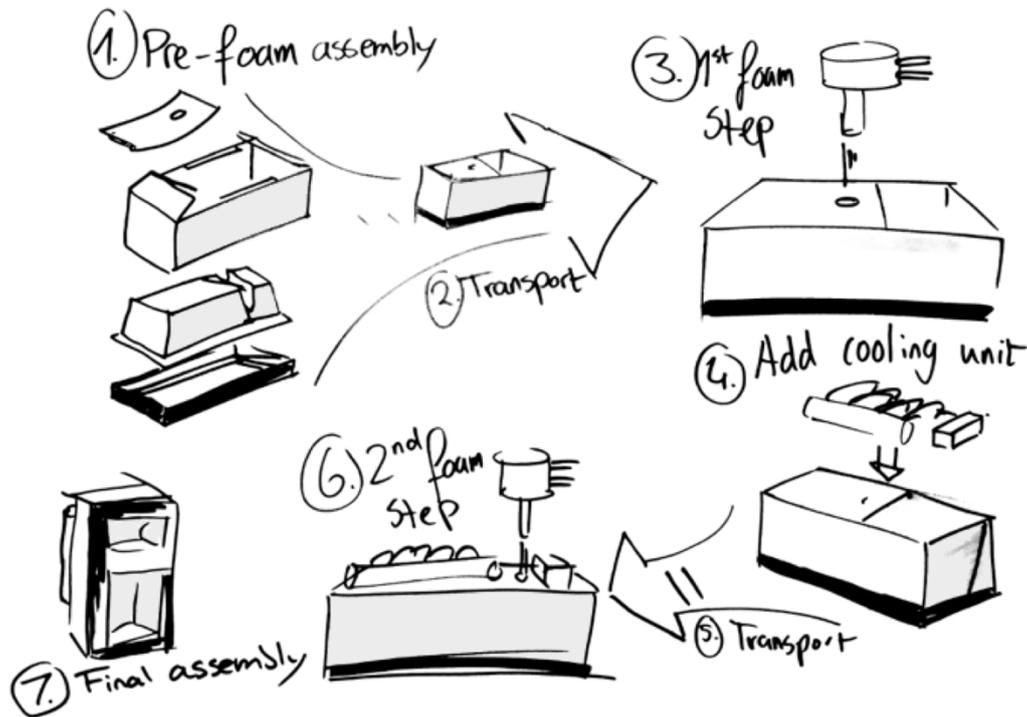


Figure 2: Manufacturing process of the RV fridge. When step 3 could be eliminated and step 1 and 4 should be combined.

Problem definition

As stated, the goal of this project is to enable one-step foaming by redesigning the RV fridge. The main aspects to consider for this project are the following things:

- Requirement of the external customer on not noticing an internal manufacturing change, especially the weight increase (which was stated as a problem)
- Opportunity of production capacity increase within the limits of the present factory
- Opportunity to integrate the manufacturing strategy towards smart manufacturing and assembly
- Problem of a more complex pre-foam assembly
- Problem of keeping the correct shape of the fridge during foaming
- Problem of impact on present machinery
- Problem of processes being able to handle the change in the factory

The challenge will be to redesign the fridge in such a manner that the solutions for the problems meet the requirements and integrate the opportunities. In the end, the redesign mostly effects the internal customers but could also open value adding possibilities for external customers. Therefore, methods for using design thinking with them will be explored to find solutions. Methods like DFMA (Design For Manufacturing and Assembly) and LEAN (methods for operational processes and incorporating internal customers) will be used as a guide. During the design iteration steps, they will help to ensure the requirements and opportunities are well integrated.

Assignment

The outcomes will be a modified fridge design generated within the context of both the manufacturability and appealing for the various customers (internal, external, company), a plan on how the changed key manufacturing and assembly processes will look like and recommendations on factory process changes.

The method that will be used to generate the outcomes is design thinking with support from DFMA and LEAN. During the various iteration steps input will be gained from the internal customers and connected departments (not limited to production, so also product engineering, process engineering, customer relations, product management, etc.).

Planning and approach

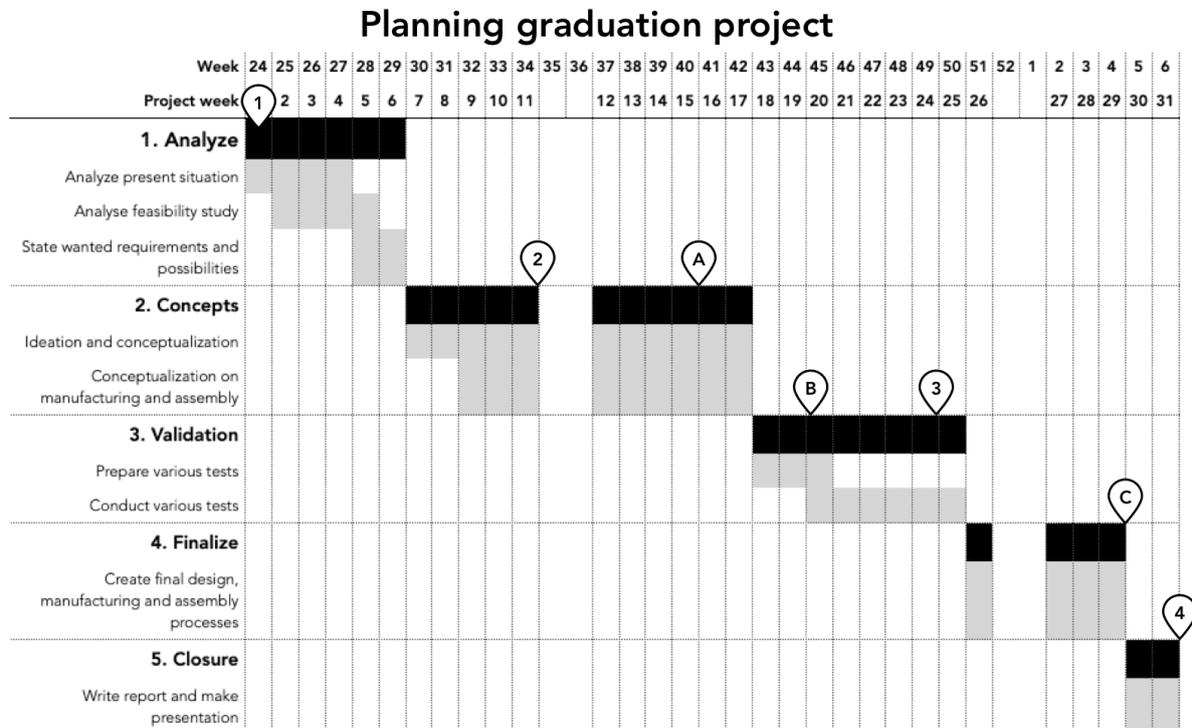


Figure 3: graduation planning

Milestones:

1 - Kickoff on the 9th of June; 2 - Mid-term evaluation; 3 - Green light meeting, 4 - Graduation
 A - choice on final concept(s) and start ordering necessary prototype parts; B - prototypes ready for testing; C - All necessary information gathered and ready to finalize.

Each phase will be concluded with a report. During each phase various input methods, which will be determined, will be used to commit and involve stakeholders from all departments. These will either be interviews, creative sessions, context analysis, co-assembly with production workers and more as described by design thinking methods.

Personal motivation

- Added value of the project to the company I work for and a practical outcome
- Gain better understanding of both the design and manufacturing process and their connection by the combination of Design thinking, DFMA and LEAN.
- Use both mechanical engineering and design engineering skills in the graduation process

Appendix 2: interview result

Setup for interviews

The line in the setup starts with the stated goals for the interviews. From these goals the main research question is formulated with supported directional questions. How the questions are answered via interviews is discussed in the method. Included in the method are the persons that were involved in the results of the questions. The setup ends there.

Goal of the interviews

1. Gather information related to one-step foaming (from feasibility study, present practices and automation) that can help the further development (related to lessons learnt, stakeholder involvement and requirements)
2. Get understanding of the culture within Thetford related product development and production
3. Learn from various people and form me as a designer in this project focused on stakeholder engagement and general product improvement

Research question

The main research question for the interviews can be formulated as such:

What is the experience on the relation (good and bad) between product engineering, process engineering and production in new product development and current engineering?

Sub- questions can be stated as follow:

- Where does this experience originate from within the organization?
- What can be learned from the experience and applied to one-step foaming?
- What is experience related to one-step foaming and what could be contributed to the project?

Method

The group of people that could answer (parts) of the interview questions is very broad. The interview method is therefore split into two settings: formal interviews and talks. During formal interviews the list of questions is used as a guide and all questions should be answered at certain level. During the talks certain topics are touched but never in the format of an interview. This means that the interviewer will ask questions or collect reactions from talks that arise with these people.

The atmosphere during the interviews or talks should be informal because the questions are about cultural aspects that reside within Thetford. As there is quite an informal setting within Thetford and they know the interviewer, this isn't expected to be a big issue. Especially for the talks because they are based on the cultural aspects as they appear, not how they are formulated in a special setting.

Interview questions are stated in a later chapter. A guide is used instead of a list of questions during formal interviews. This is done to increase the informal setting. The list of questions is used to verify results and allow specific questions to be asked during talks.

Persons involved

The persons involved in formal interviews are seen as key influencers on the one-step foaming project or that have a good image of the cultural aspects. Persons involved in the talks come from the broad spectrum.

1. Official interviews

Registered and planned meeting that went through the stated interview questions. Notes and/or recordings are made from these interviews. No transcripts. Quotes and statements are abstracted and grouped in results.

Name person	Role
Mario Nuyes	Supervisor
Dimitri	Automation engineer
Yannick van Hoof	Current product engineer
Conrad	Process engineer
Wout	Process engineer
Dirk Valder	Product management manager

2. Talks

People I talked to that gave valuable information related to the interview questions. Quotes and statements are abstracted and grouped.

Name person	Role
Dennie van Opstal	Plant manager
Maciek	Operator
Larbi	Production worker
Dennie	Production worker
Joost	Assistant supervisor (for fridges)
Bennie	Assistant supervisor (for fridges)
Marc van Loon	Senior product engineer
Dennis	Distribution coordinator
Ronald Gram	Technical MT member
Pieter	Senior product engineer/ project manager
Alain	Process engineer
Gianmario - Hennecke-OMS	Foaming machinery supplier
Pentha	Foaming mold supplier
Jorgen	Automation engineer

Condensed interview questions

A lot of questions were initially written down as format during the interview. This was later condensed in order to run the interview more smoothly and improve the interaction. The extended list is added after conclusions.

Introductions

Wie, wat, etc.

Lijn van interview

Nice starters

Wat is een project waar je nog wel eens aan terug denkt?

Wat vind je leuk in je werk?

Kies een plek uit in het bedrijf waar je het liefste bent, en het minste?

Production and products

Oneliners:

- Interne of externe klant
- Industry 3.0 of industry 4.0
- Product leadership, customer intimacy of operational excellence
- Automatisering of assemblagewerk
- Product of productie
- DFM of DFA
- Koelkasten of toiletten
- Beaker, LF of SF

Interne klant/proces

Wat is daar belangrijk voor?

Hoe wordt productie nu meegenomen in projecten? Hoe doe jij dat?

DFMA?

Waar moet op gelet worden bij productiepersoneel?

Automatisering

Wat vind je van automatisering?

Hoe toepassen in projecten?

Waar moet dan mee worden rekening gehouden en hoe heb je dit al gedaan?

Industrie 3.0 en 4.0, waar denk je vooral aan?

Externe klant

Beschrijf deze in 1 zin.

Wat vind je van de uitspraak: 'de externe klant mag deze productwijziging niet merken?' Wat mag de klant dan niet merken?

One-step foaming

Feasibility

Hoe betrokken?

Wat was jouw indruk tijdens dit project? Wat zijn de grootste dingen waar je tegenaan liep? Waar juist niet?

Metaal, ervaring?

Afstudeerproject

Keuze product/lijn?

Nog een goed woord? Richting?

Closure

Wat heb je nog niet kunnen zeggen?

Statements from results of interviews

The in-depth results from the interviews are the manuscripts. The statements shown here are combined in order to give a high-level overview of what is discussed. This is done primarily by making a general statement that is supported by quotes. Another method is by making a statement that is a conclusion without the support by a quote. It is either that the statement is the quote or that the supporting quote is too long.

Culture related grouped statements

Each statement related to the culture can be split into 3 levels within the company:

1. Strategic - Board of directors level (MT)
2. Tactic - Middle Management level (MMT) and supervisors production
3. Operational - Workers (engineers and production)

Operational (other office workers and direct labor (DL))

- Lot of promises made but they aren't kept. Trust towards NDL (non-direct labor) is therefore low. Manage expectations.
 - o "We had a brainstorm together with engineers and put a lot of ideas on the table, but nothing was done with the ideas." - supervisor
 - o "I've made promises towards production on changes that were not a lot of work for product engineers but the priority was set differently in the project so I couldn't keep those anymore. This made them feel forgotten." - process engineer
- Wasteful work is done that decreases morale (because it's basically unnecessary)
 - o "Why is there a production worker's job to sit on a chair and only check whether there is a lid on the bottle?" - supervisor
 - o "Why do we need to daily print hundreds of color pages in production. That must cost a lot of money!" - supervisor
 - o "Why do we need to glue and screw so much?" - supervisor
 - o "Why did they make this design so complex? If they would've done it like this it would've been much easier to assemble." - production worker
 - o "Production workers don't want to work at that line anymore." - plant manager and current product engineer on a line with history of not involving production (workers) on the redesign of the product
- Relationship is really important to best help production and vice versa. Imbalance between departments.
 - o Production workers look up towards NDL. They don't always feel appreciated by them because of their attitude.
 - o "Look there an engineer walks with his head raised through production. I'm really not going to talk to him." - operator
 - o "It's important how you approach someone (eg NDL to DL)" - supervisor
 - o "My relationship with production workers is quite good. I know them by name. They talk to me and are quite direct about their opinion." - current product engineer
 - o "It takes a lot of time to walk through production because everyone knows me and want to share thoughts with me." - process engineer

- "It's in the character of the product engineers how to involve people." - project member
- "It's only about the numbers, not about quality" - MAA
 - "We say we focus on quality and safety but we actually don't!" - supervisor
 - Present rework quantity for fridges is 20%!
- Importance of process engineer to involve production workers low due to priorities stated in company
 - "It's the task of the process engineer to represent production in projects" - MT member
 - "I only once was at a meeting together with product and process engineers for an NPD project. This made us feel heard because otherwise it would've been much more difficult. This was a good method!" - supervisor
- Limited involvement of process engineers by product engineers in projects.
 - "Why didn't they involve us on this decision or why did I hear it so late?" - process engineer about a decision made by product engineering which involves production
 - "I was involved too late in the project and alterations to the design which could ease assembly a lot weren't possible anymore." - process engineer
 - "Is DFMA responsibility of product or process engineer? You need to involve the right persons at the right time"
- Lack of involvement in projects that could have high interest for production
 - "I think it's good to show production workers samples of design and involve them in the development story." - current product engineer
 - "Production lacks time besides their operational tasks. However, you should involve them to generate a support base. Like certain project meetings." - process engineer
 - "We are seldom involved as distribution." - distribution coordinator

Tactical (MMT, seniors and NPD project managers):

- No complete transfer from project to line organization
 - Too early closure of projects, thus not evaluating after 6 months and improving the first trial of production. No use of gate 7 in project management.
 - "I didn't know there was a 7th gate in a project." - senior product engineer
 - "We'll transfer loose points from the project towards the IRB so we can close the project." - project manager
 - At the end realization of actual effect of product introduction becomes clear for production.
 - "People have a lot of cuts because they didn't make the edges smoother." - plant manager and supervisor
- Hero-culture: people are being appreciated by solving fires instead of deploying a sustainable solution
 - "We are a practical focused organization meaning we have a lot of problem solvers." - Current product engineer
 - "We lack the balance between more theoretical and practical people." - Maintenance
- Priority on a lot of things and not always on production problems. Non-tangible or low financial efficiency benefits.
 - "Willingness is there but they things unfortunately can't be finished." - supervisor
 - "We're working on too many things and therefore the little things become more complex." - process engineer

- Too much problems exists that need solving (IRB presently has over 100 issues)
 - Too much projects are run which doesn't leave a lot of room for resources to be spend on production (Little projects are put on hold, new projects still arise)
- It's easier and faster to hire more workers than to improve their work.
 - "Meeting the high demand is not achieved by creating more efficiency but by hiring more workers." - process engineer
 - "We need to design lines on 120%" - process engineer - "You lack the people and space to achieve efficiency" - manager
 - "We grow to utilizing lines over 80% which means there is little flexibility in capacity increase."

Strategic (MT level):

- Business as usual gave enough income to not make production more efficient. Present status is therefore accepted by MT.
 - See next points on strategy shift.
 - Seen in projects that are prioritized in project board.
- Shift from customer intimacy towards product leadership. Lagging operational excellence. No statement and/or misalignment in what the level should be on operational excellence.
 - Shared during introduction with HR.
- Focus on company is jump-the-curve (be ahead of upcoming (Asian) competition and remain market leader) resulting in innovative products, not primarily towards production.
 - Shared during introduction with HR
- Higher demand and limited (shop) floor space increases call for efficiency instead of output (by automation)
 - "We need to automate if we want to remain competitive." - automation engineer
 - "Presently 5% is automated, 95% manual." - automation engineer
 - "We need to start the Meet the Demand project." - CEO about short shift in present strategy. NPD projects were put on hold.
 - "The porta potti's remain profitable not because we outsourced its production to China but because they automated the lot. This is the same for older model cassette toilets like C200." - plant manager

One-step foaming related grouped statements

- Advantages for one-step foaming
 - "Time, money and space" - supervisor
- Start with the beaker
 - "We have high numbers of this product." - supervisor
 - "Get the one with the highest production quantity"
- Method to involve production/others
 - "We had a session where we went through each production step and identified waste and the influence of choices on next steps."
- What can already be automated with one-step foaming?
 - Fill-flap
 - Application of mastic to cooling unit

Automation

- At the moment Thetford is not prepared for automation

- Products are supplied in boxes that are difficult to handle by a machine
- Why choose for automation?
 - High quality specs and high precision
 - High quantities - high repeatability, dull work
 - Reduction impact for workers (heavy lifting, ergonomics)
- What are requirements for products (and assemblies) to better allow automation?
 - Parts
 - Rigid parts, flexible parts and wires are difficult to handle
 - Easy to keep apart, they shouldn't stick into each other
 - Assembly
 - DFA

Discussion

	Short term	Long term
External	High demand on market = increased output <ol style="list-style-type: none"> 1. More human resources = more production personnel 2. Increase efficiency lines (example is LF line efficiency increase) 	Increase in competition <ol style="list-style-type: none"> 1. Cost reduction present products = cost savings 2. Less dependency on human resources = automation 3. Introduce new products and lines
Internal	Limit factory space <ol style="list-style-type: none"> 1. Increase production capacity (executed by increasing shop floor space (example Pacman)) 2. Increase efficiency (example is LF line efficiency increase) 	Cannibalization new products <ol style="list-style-type: none"> 1. Efficient use of floor space of current portfolio

	Helpful	Harmful
Internal	Strengths <ul style="list-style-type: none"> • Making fridges: Designing, foaming and assembly • Human flexibility • Direct communication through departments and management levels 	Weaknesses <ul style="list-style-type: none"> • High amount rework • Old machinery and processes and its rigidity • Tacit knowledge • Lack of structure • Stuck efficiency • No more shop floor space in present factory
External/roadmap	Opportunities <ul style="list-style-type: none"> • One-step foaming • New products • Automation • Industry 4.0 • Continuous improvement = efficiency & quality increase • Cost savings 	Threats <ul style="list-style-type: none"> • Short term: <ul style="list-style-type: none"> • Sudden high demand • Difficulty to find production personnel on current market • Long term: <ul style="list-style-type: none"> • Uncertainty on sales quantities (present absorption is going to decline and future products rise) • Increase of competition (from China) that sell for lower price

Additional - Long list with interview questions

Introductions

People probably know the topics, so this is the time to let them speak out their mind shortly with the help of a short introduction.

Official things:

- Who are you
- What do you do?
- How were you involved in the one-step foaming project?

One-step foaming in general

Explain what I'm going to do the coming months and what my preferred outcome is.

- What do you think of that, anything to add? What are problems you immediately see?
- Why do they have these two steps?

I stated the following for my scope for my project

- What do you think? Anything to add? Was this the same

Thetford's vision and strategy

The think, feel, act of Thetford states its vision as "Creating the best memories through great leisure products" and "Bringing total peace of mind to every RV user in the world"

- Are you familiar with these visions?
- What do they mean to you and how do you apply them in your day to day work?

You are probably familiar with the strategy of Thetford to increase the level of 'product leadership' and deviate from the old strategy of 'customer intimacy' as from the model of Treacy and Wiersema.

- What does this mean to you and how do you apply them in your day to day work?
- What relation do you see to the vision?

With Treacy and Wiersema, the third strategy is 'operational excellence'.

- Could you describe the level we're currently at? Not in the sense as stated in the report of Alain.
- What level should we go to and why? *Think of specific assembly that fits automation well, standardization, cost of automation vs labor, losing flexibility, etc.*

Automation and industry 4.0

- Do you know the difference between industry 3.0 and 4.0 (and 1.0 and 2.0)?
- Where is the present fridge factory at? Where should it go to in your opinion?
- What do you value about automation and industry 4.0? What are the benefits and shortcoming? Start broad and then go to the situation of Thetford.

- What things should be changed right now related to automation? And what not? *When people are stuck on this question I want to give them specific location in the factory to think about.*
- Are you familiar with the manufacturing strategy? How would this add/change your view on the level of 'operational excellence'?
- Where should automation be implemented in the design process (of Thetford)? Why and what manner?
- How do you see the relation between automation and the manual production workers? Is it a strength/weakness as we do it now at Thetford?

Specific questions

- Dennie/Johan: At the moment the automation program is put on hold, what does this mean for the long run? How could it influence outcomes for one-step foaming automation?
- Dimitri: What interesting development do you see in the market on automation and industry 4.0? What could help with one-step foaming?

Internal customer

There are a lot of production workers at Thetford and one-step foaming is basically an internal production change. Focus on them and their involvement is therefore an important part of the process.

- What factors and methods are presently taken into consideration when designing products and production lines for production workers? (Safety, line balance, tooling DFMA, Poke Yoke, 5S, etc.) *This question is quite broad, but I will split this question during the interview*
 - Is there a handbook, is it embedded in the project management tool?
- How are production workers presently incorporated (thought of or involved) in: the design process, projects, small improvements, ...
- Could they be incorporated in a different way? What do you think?
- What do you think will come out if they are incorporated? What value do you see in that?

External customer

With each project you have an external customer you design for.

- How would you describe the external customer (in a sentence/ keywords)?
- What is the effect of 'customer intimacy' at the moment within Thetford (factory, products, etc.)?
- How would this change in the coming years in your opinion? What effect will this have on the products, factory, production workers, etc. in your opinion?

I state "the external customer (OEM and end-user) shouldn't notice the internal manufacturing change":

- What is your thought on that?
- What shouldn't the customer notice?
- What is 'ok' for the customer to notice? Is there some space and what is this space?

Feasibility study

The feasibility consists of different parts that are related to each other (project, product, production process, foaming, assembly, ...) *There are some very specific questions here, but these are important in the long run but maybe not at this phase. Not stating them could be a miss, not asking them now not.*

Project

- How did the project go?
- How were the internal customer and automation incorporated in the project? Were there other values?
- Where did it end? Year, what points were left out or not finished, ...?
- What requirements were stated (at the beginning)?
- Why was the direction chosen as stated in the report? What were your thoughts on that?

Product

- What aspects of the design were influenced the most? Why and how did you cope with that change?
- A metal wrapper was used at the back? How did that go? Big deformations, good flow, etc.?
- Why did you choose for the beaker as a starter?

Production process

- What could you say about the influence the change had/has on the overall process?
- What key things were learned from the feasibility study in that aspect?
- Was there a big influence on the process of final assembly?

Foaming and the machine

- The back of the fridge was made out of metal, how did this go in the machine?
- What is the impact on the foaming machine? Is this big/small, what problems do you see?

Assembly

- How did the difficulty/complexity increase of the assembly process?
- What did production workers think of this? Did you already see automation possibilities?

Other

- Any good (other) advise?

Implementation hurdles

If you think of implementing one-step foaming:

- Choice to start with
 - What product? (Small, large, beaker)
 - What line/ location in factory? (OMS 1 (automatic), OMS2 (new manual), Cannon (old manual))
 - Why would you say that? (Think of factors like production/sales numbers, prospects on new products and where they will be produced, biggest gain in specific line, use of machines (automatic vs manual line).
- Possible challenges
 - What are the biggest challenges you can think of for this project?
 - Related to the design
 - Related to the production steps
 - Related to the external customer
 - Is there advice you want to give me?

Rules and regulations

There are rules and regulations we have to apply to concerning fridges:

- What are the rules (you know of) that are relevant for one-step foaming?
- How are these related to specific norms and regulations?
- How are these related to requirements from the external customer?

Other

- Factory and production process
 - o Maybe later? As this can be a part of the ideas and conceptualization phase and I have
- Product

Appendix 3: DFMA analysis present production

Appendix 4: IKEA fridge analysis

Analysis foaming related design IKEA fridge VINTERKALL

For the T-rex project an IKEA VINTERKALL fridge was bought for design study. This reports describes the foaming related study to this fridge.



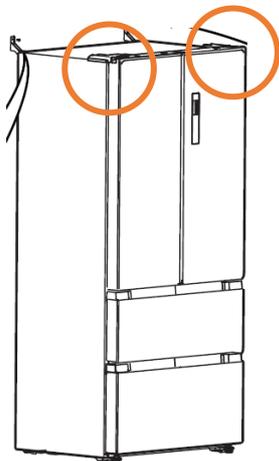
Figure 4: IKEA VINTERKALL³

- Connections various parts to make it foam tight
- Isolation methods
- Other discoveries

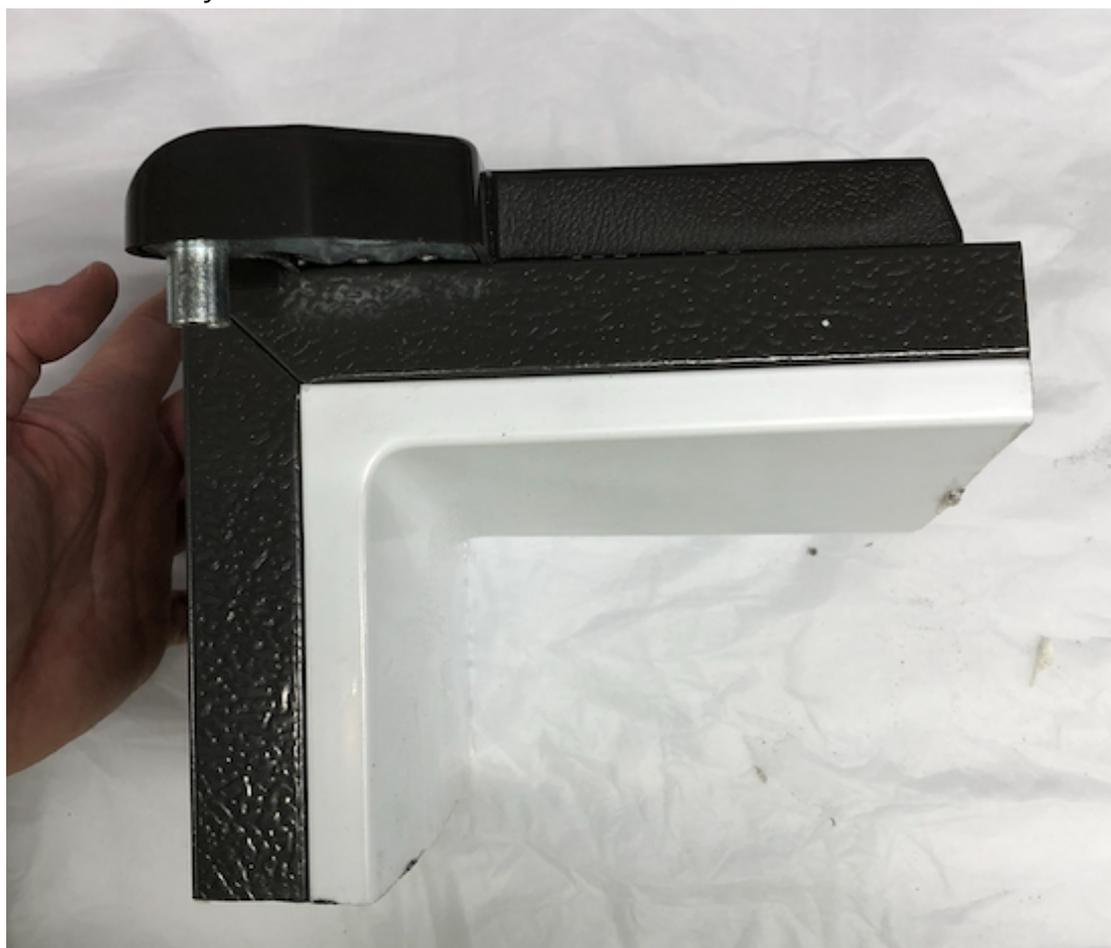
³ <https://www.ikea.com/nl/nl/p/vinterkall-dubbeldeurs-koel-vriestkast-ikea-700-losstaand-roestvrij-staal-60490128/>

Foam tight connections cabinet

Top corner front



Total assembly

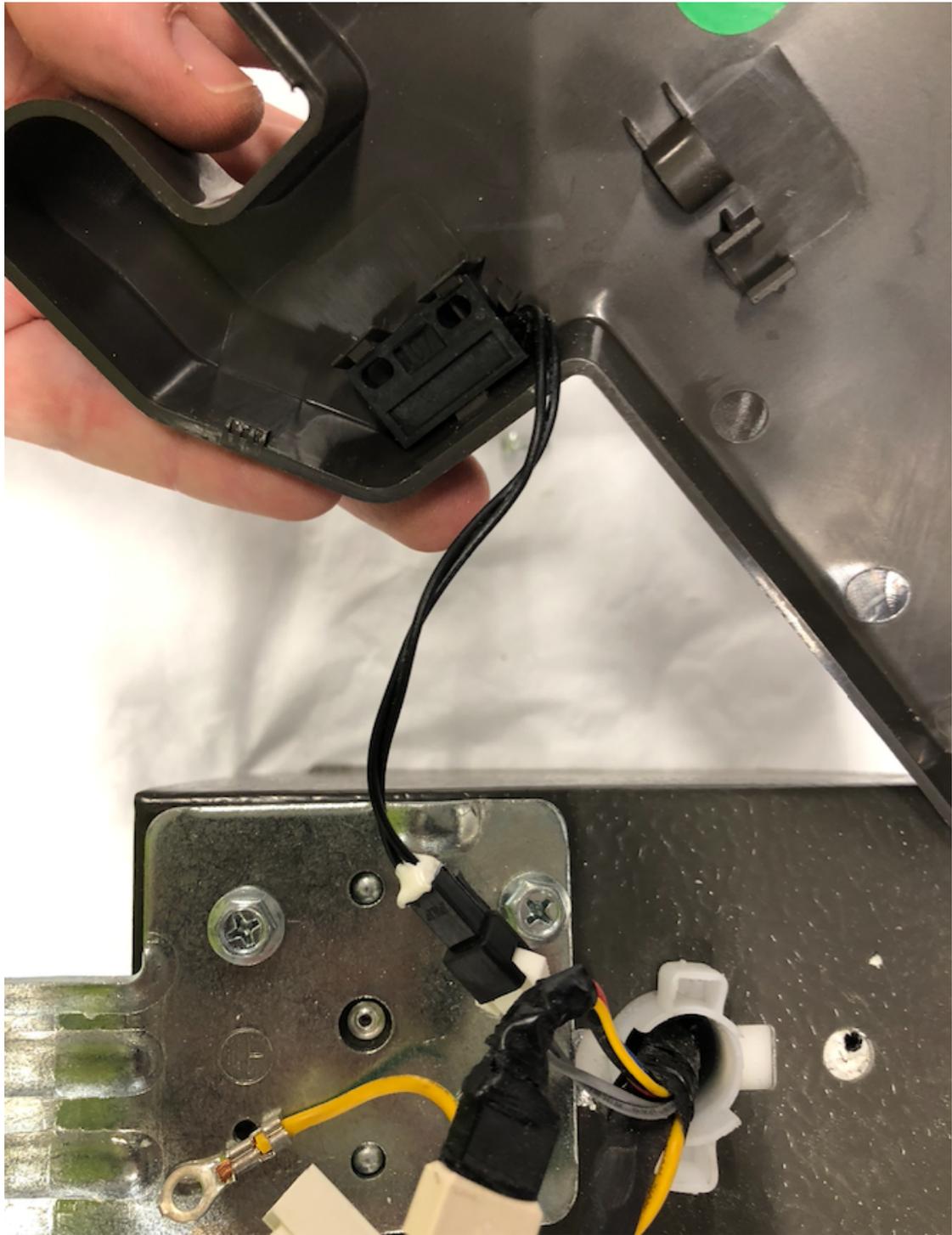




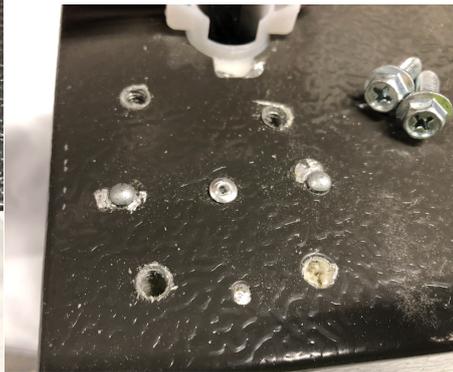
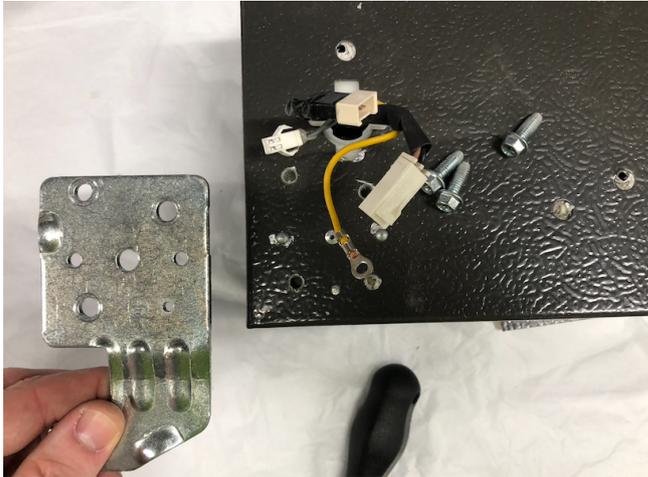
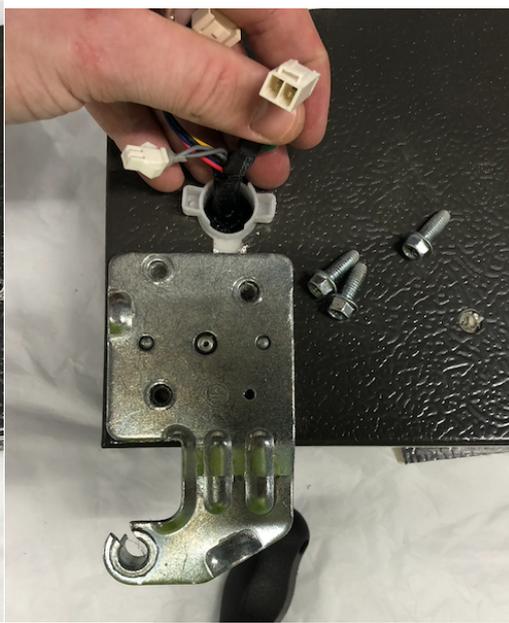
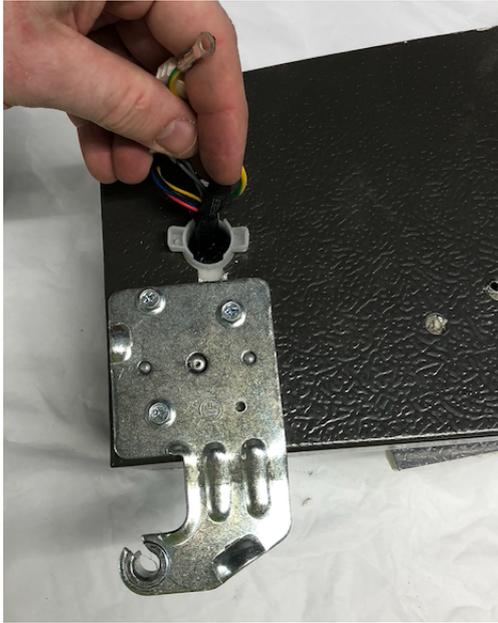
Top plate + magnet sensor connection



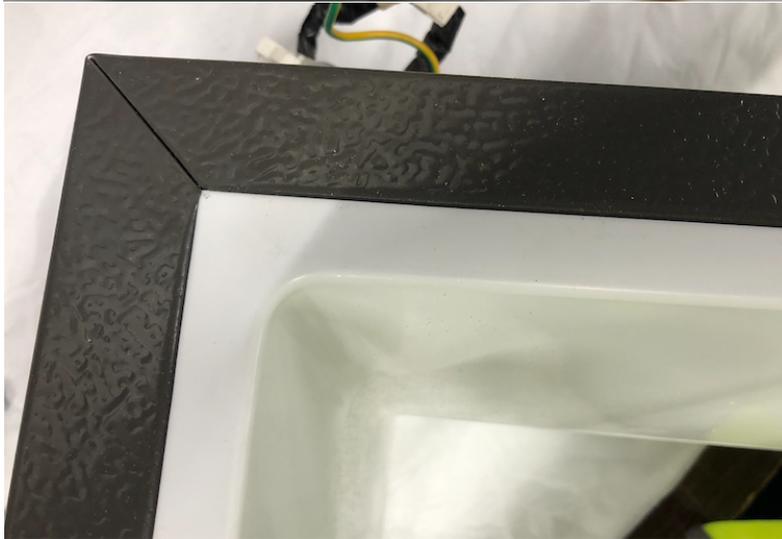


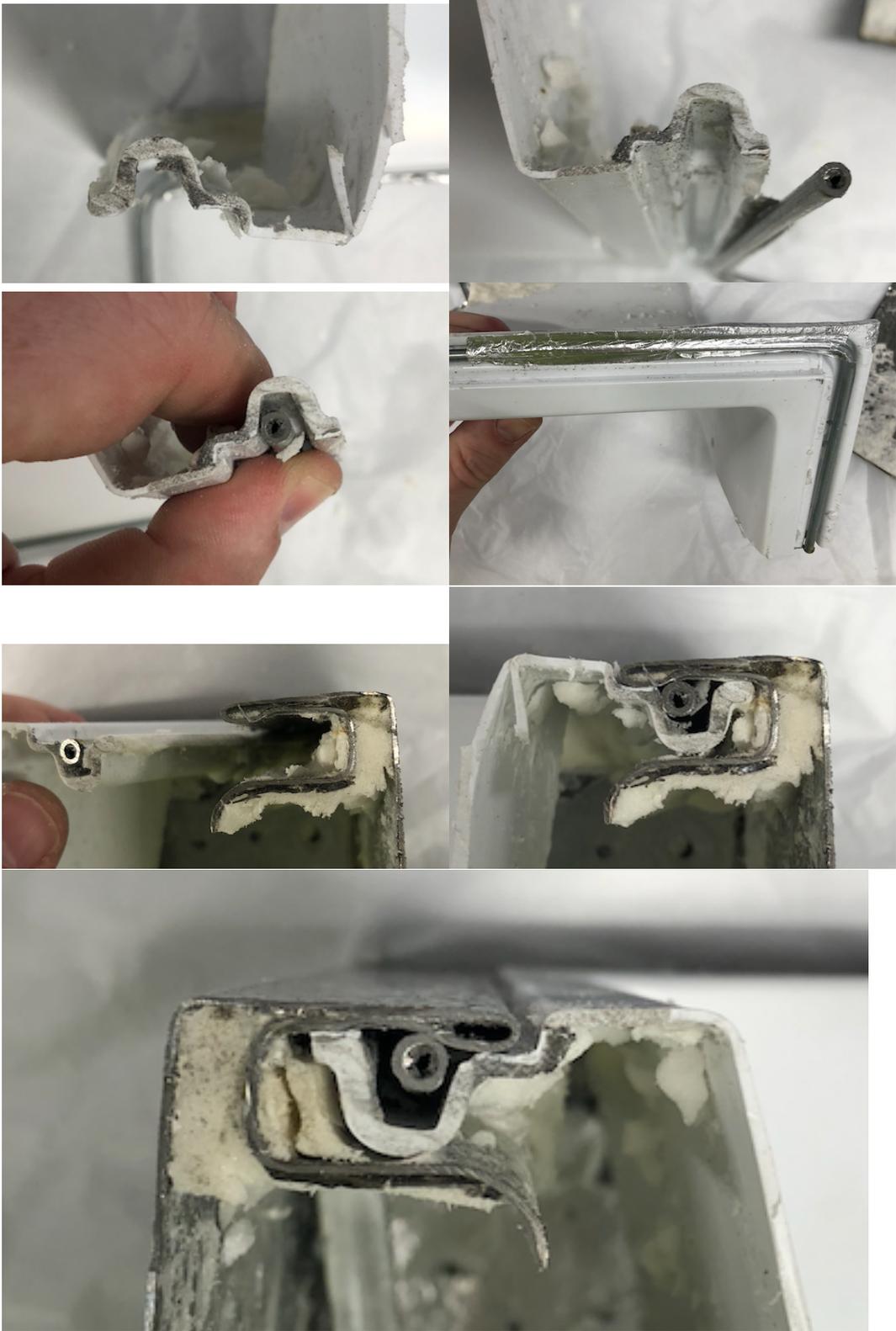


Hinge connection



Connection liner and wrapping/breaker

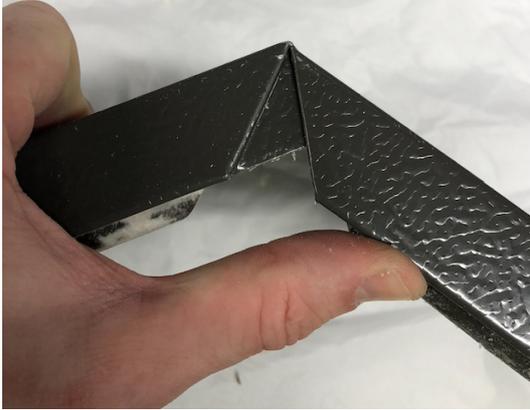
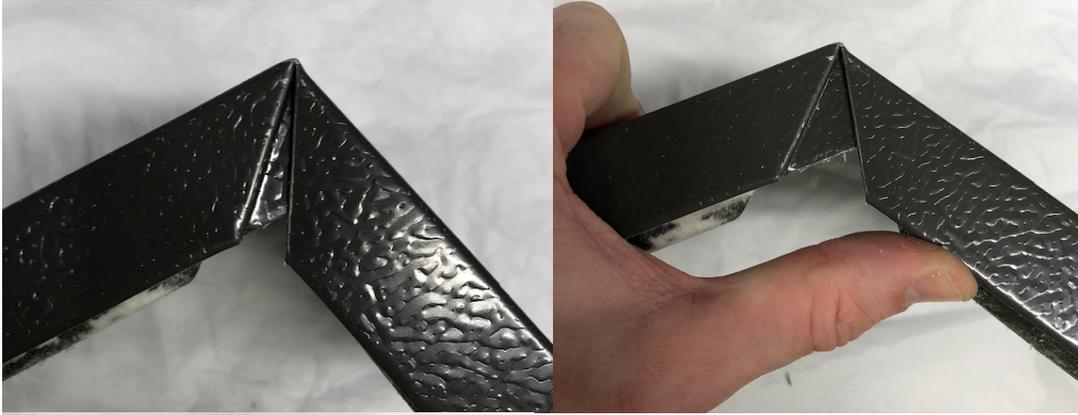




All parts



Connection corner metal wrapping

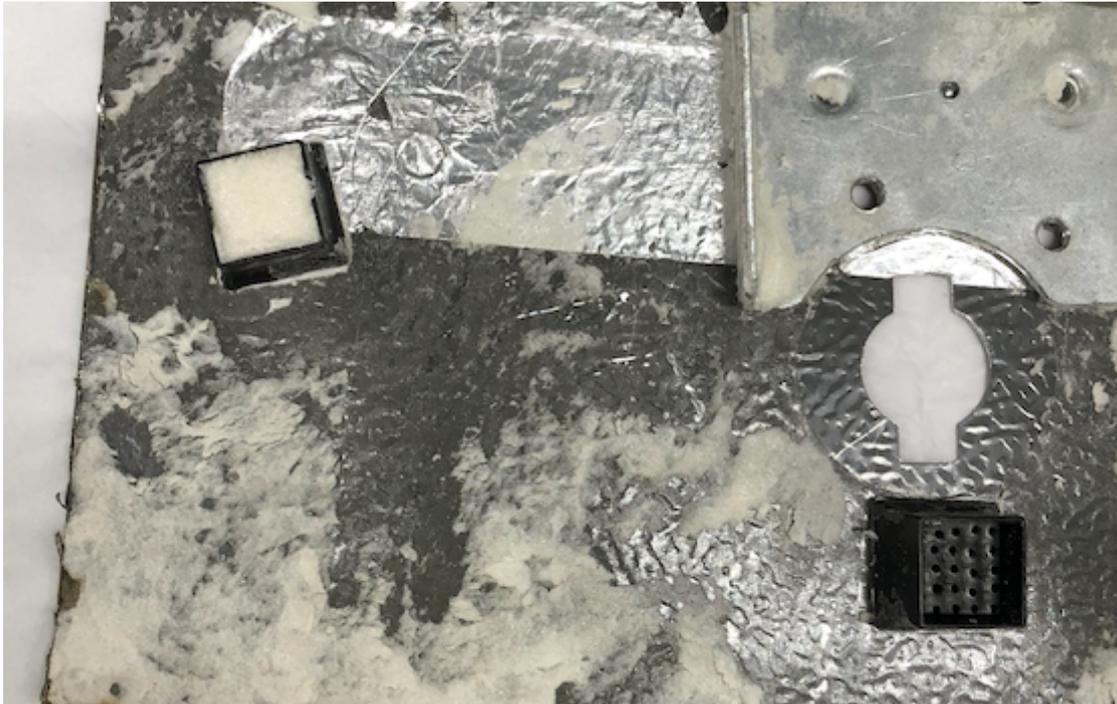
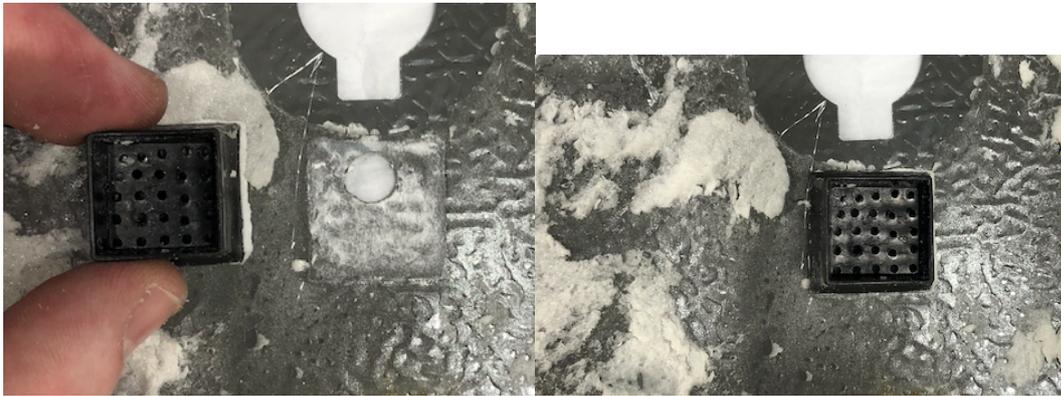




Placement inside piece hinge

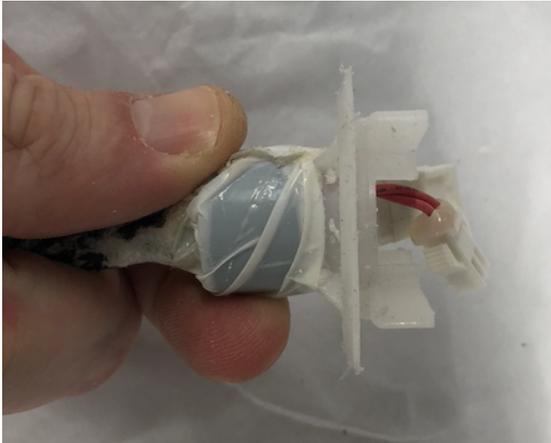


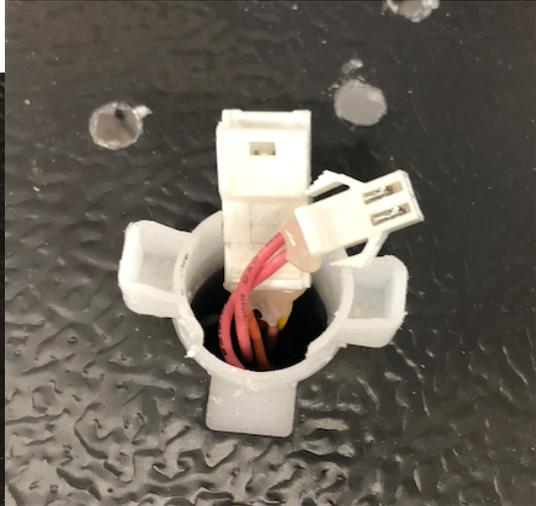
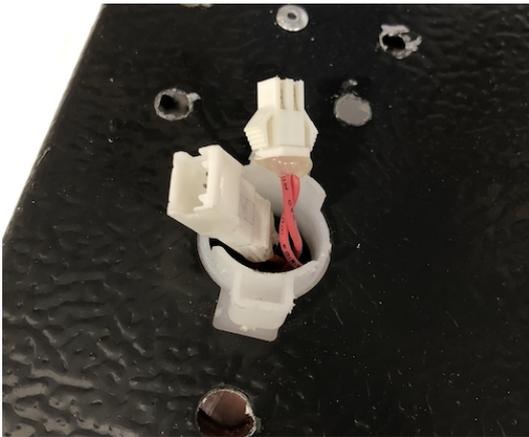
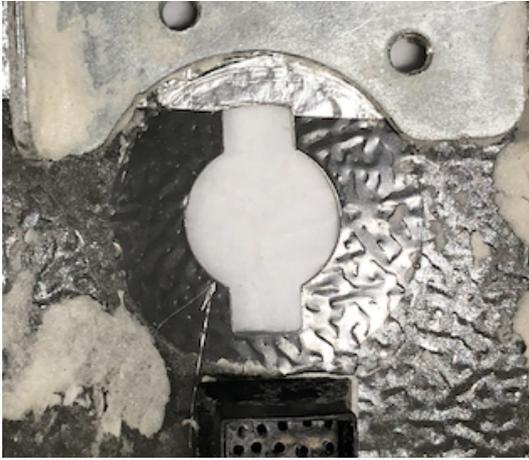
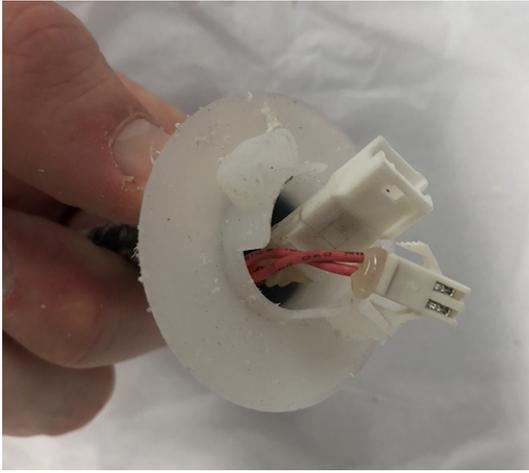
Nutplate or cable pot placement



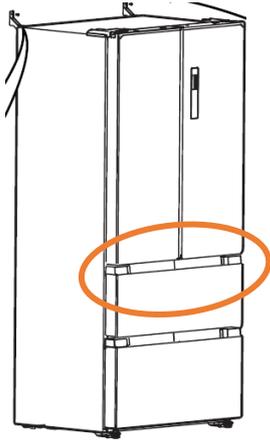


Cable grommet





Divider between FF and FR



Connection hinge



Foam tightness

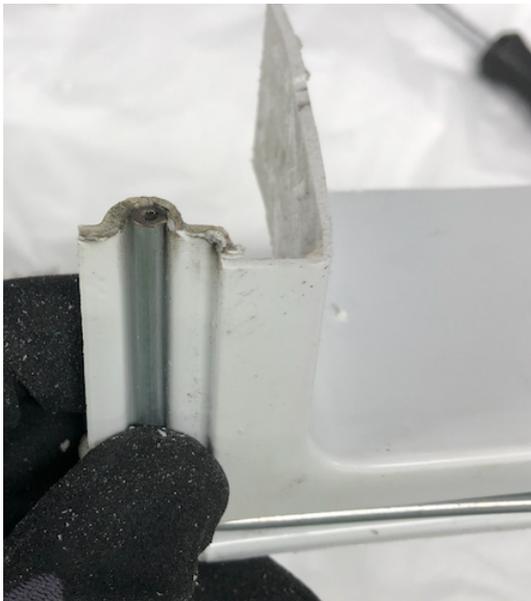


Connection divider





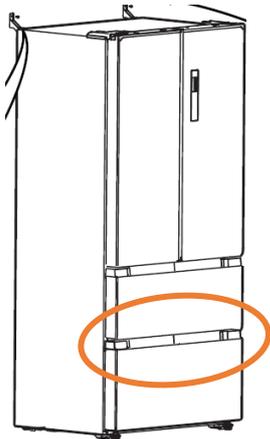
Connecting liner to divider assy







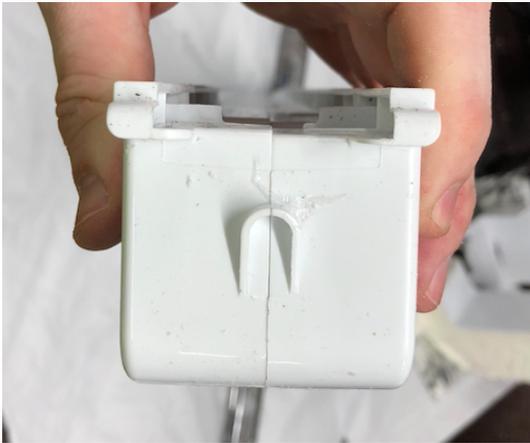
Divider additional in freezer





Connection right divider bar to cabinet





Inside divider bar







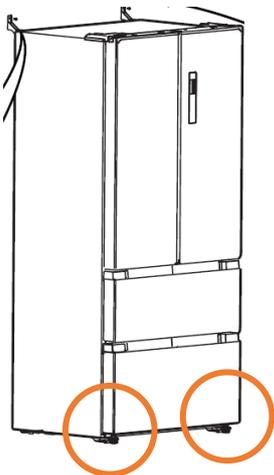
Divider bar connection left



Divider bar assy



Bottom front feet



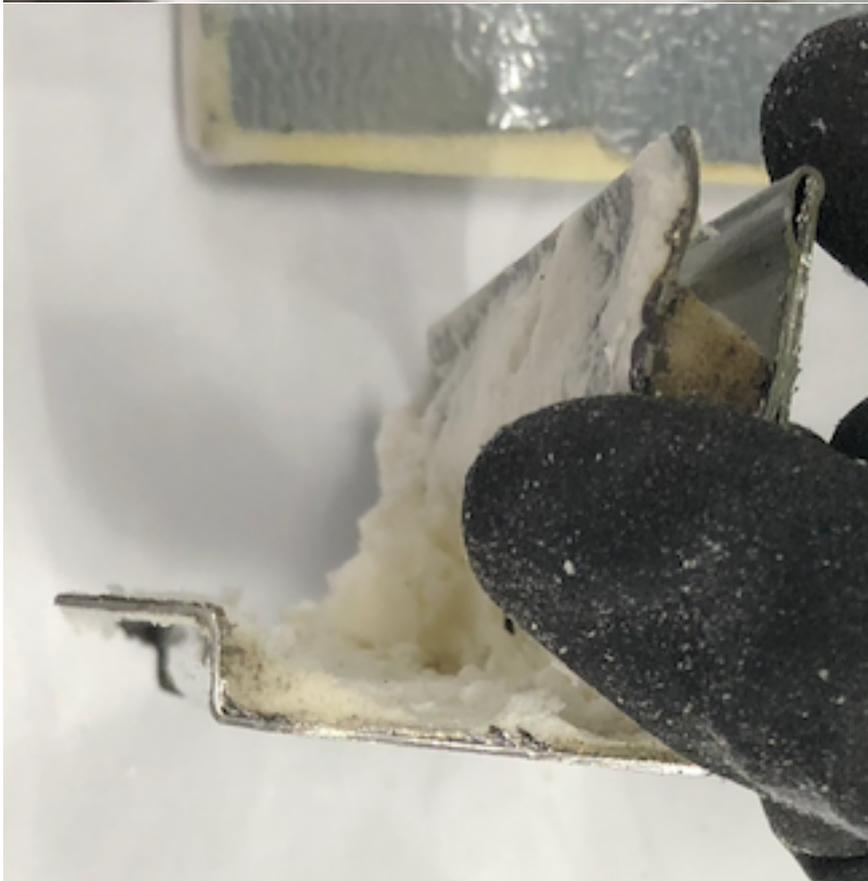


Foaming connection





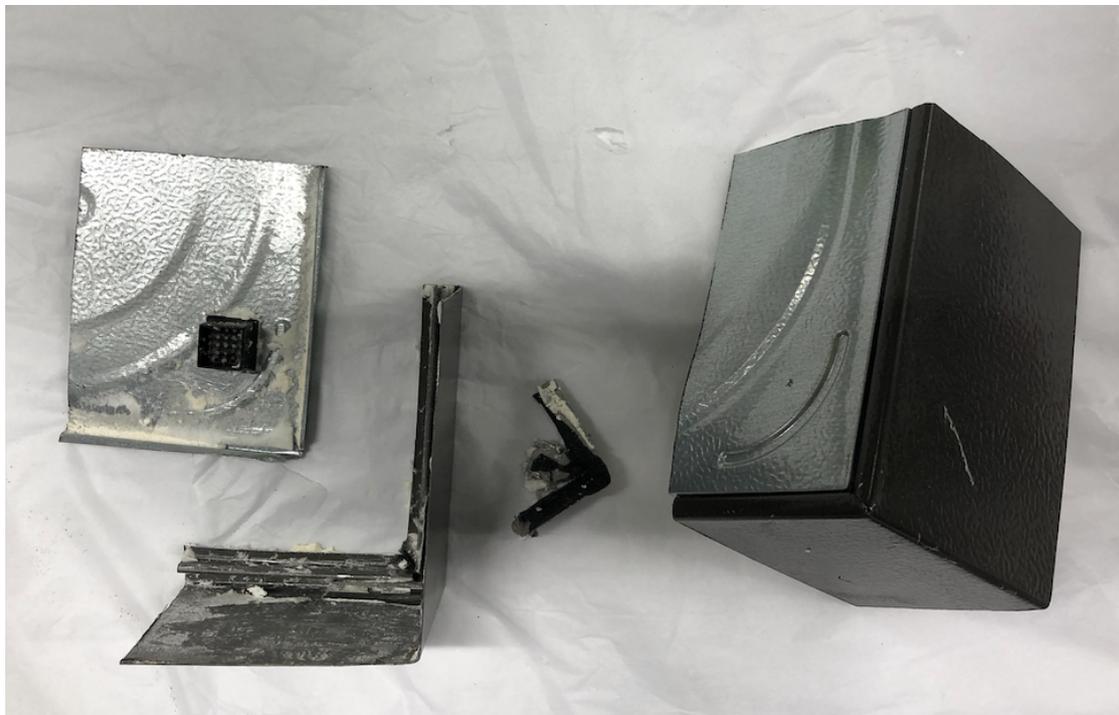
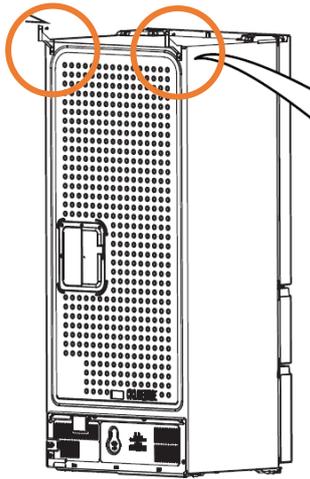
Loose parts





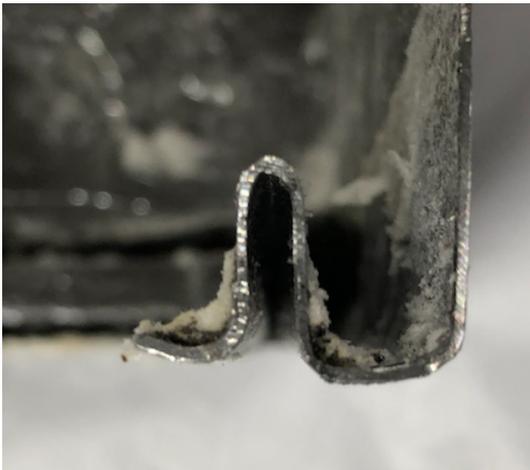


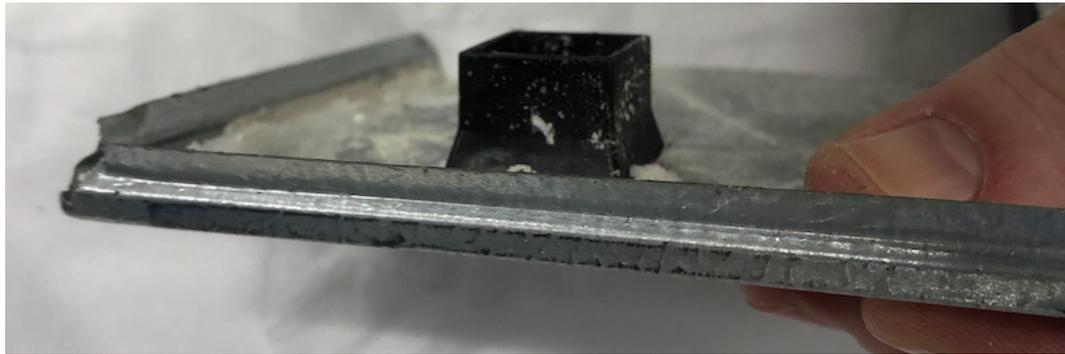
Top back corners



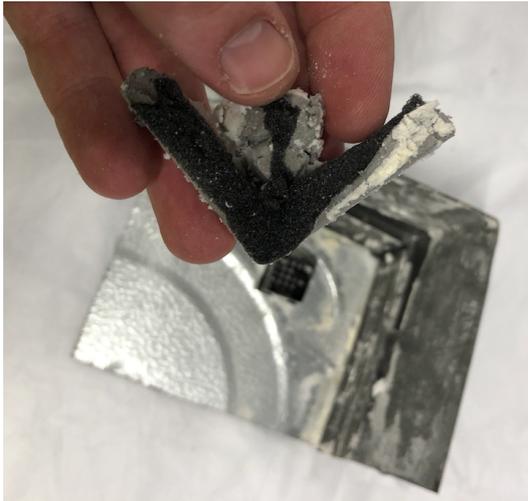


Connection plates





Placing foamtape in corner



Door

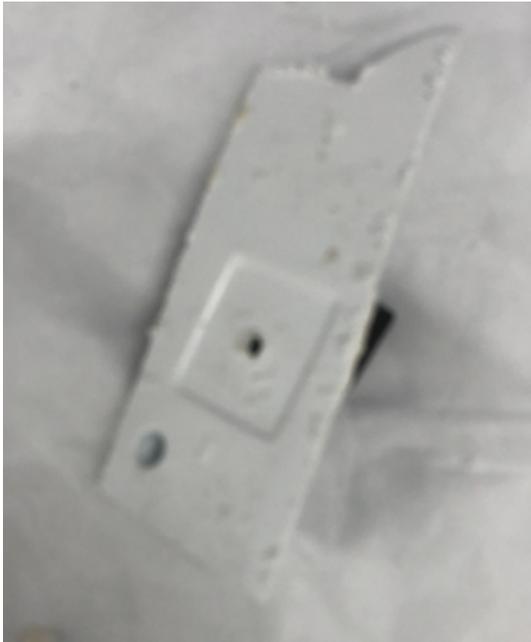




Special part connections

Nutplate

At random in the fridge



Drawer guides

Eu

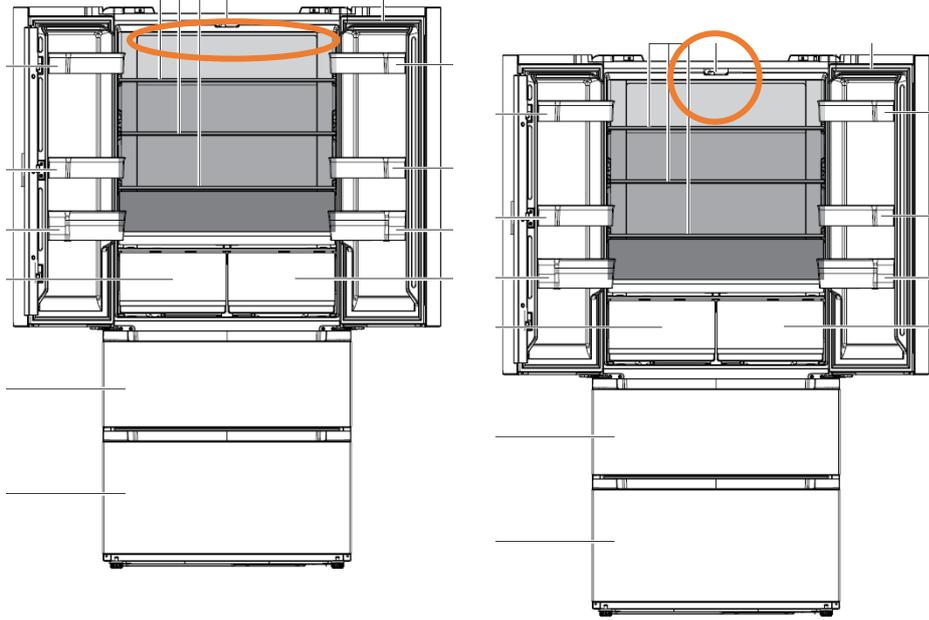
Drawer magnet freezer

Eu

Cable connections

eu

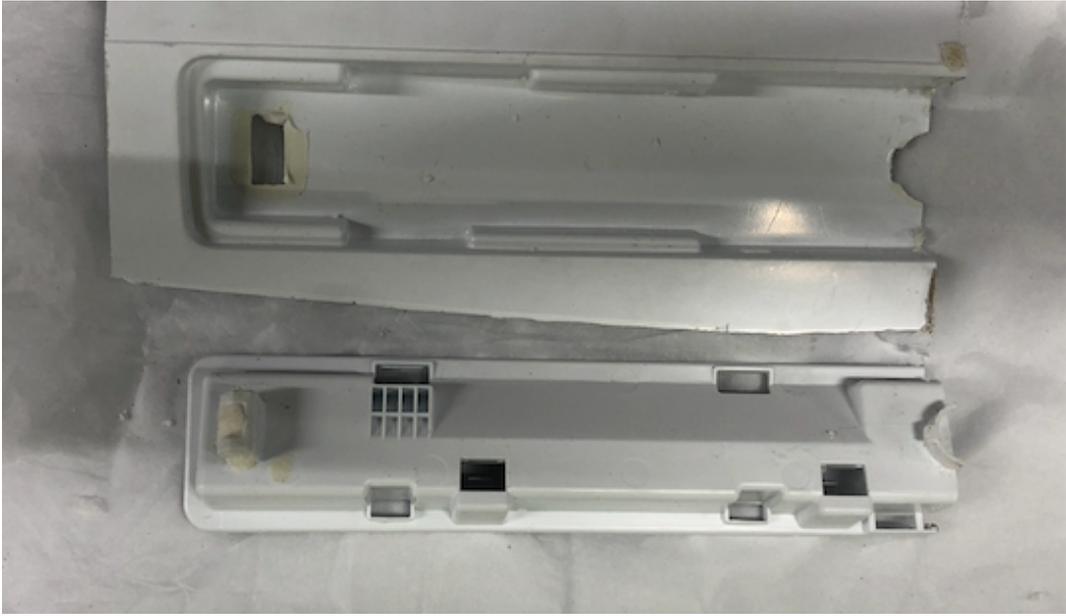
LED housing and double door guide





Parts on liner





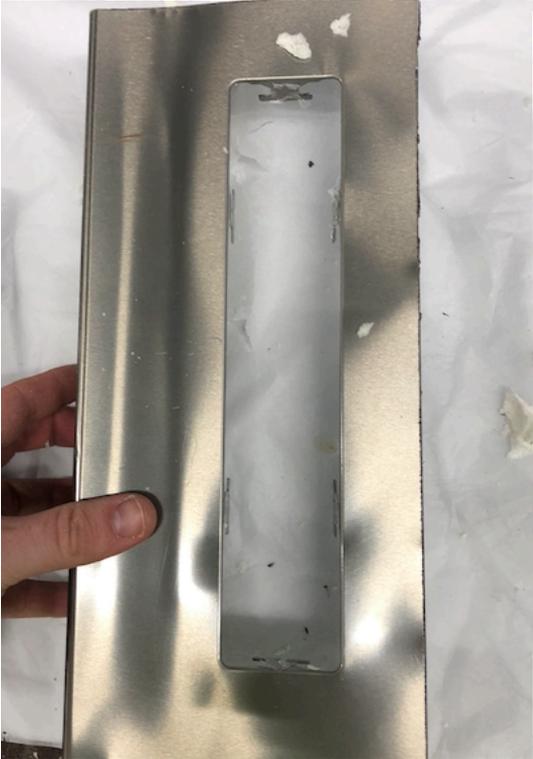


Door display







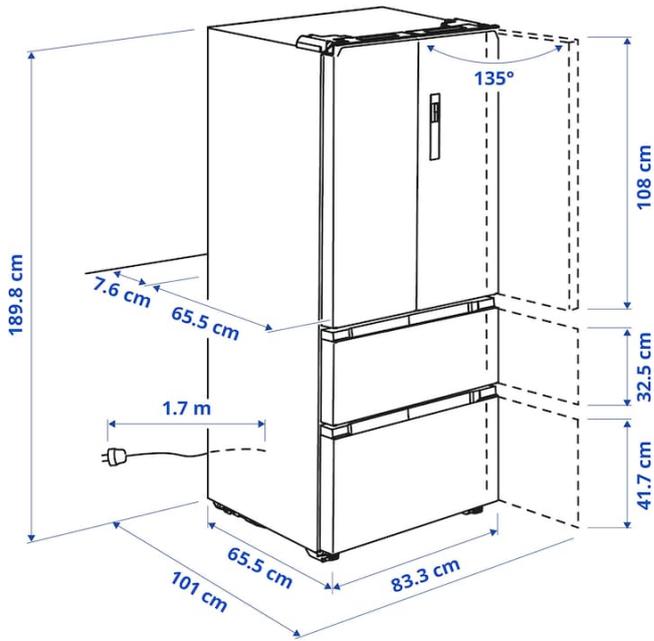


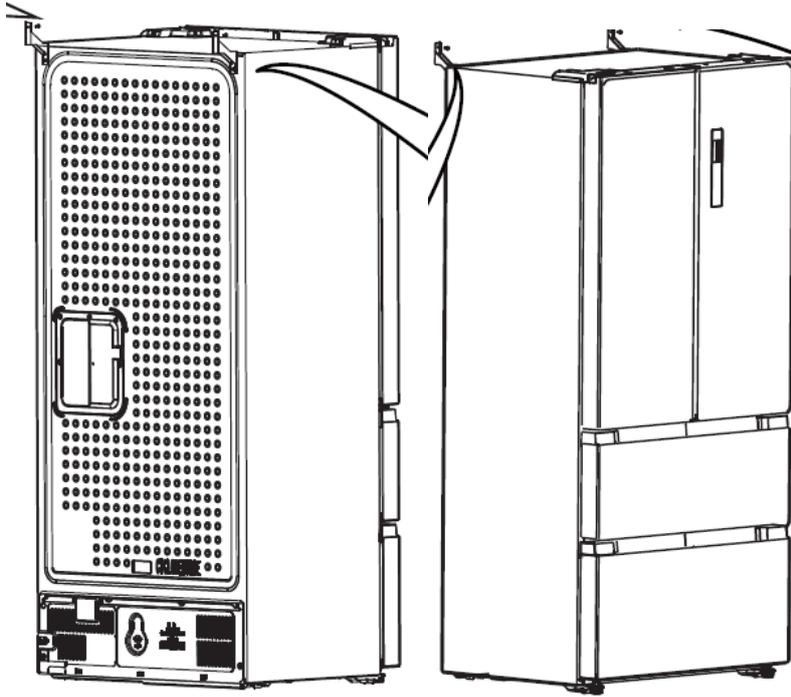


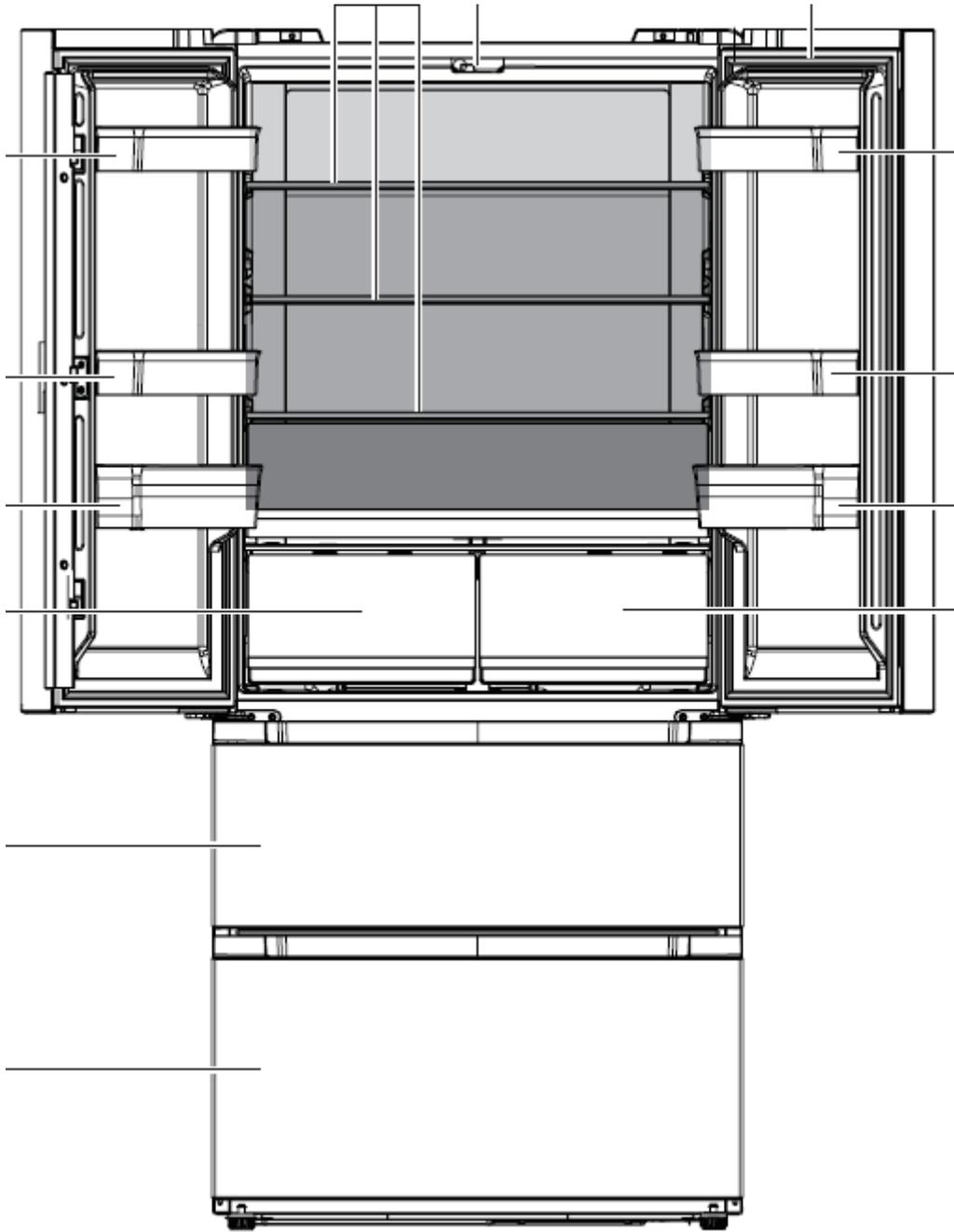




Appendix: images fridge VINTERKALL







Appendix 5:

Competitor analysis

Appendix 6: Detailed production flow including parts

Appendix 7: List of requirements (operational level)

Appendix 8: Business case