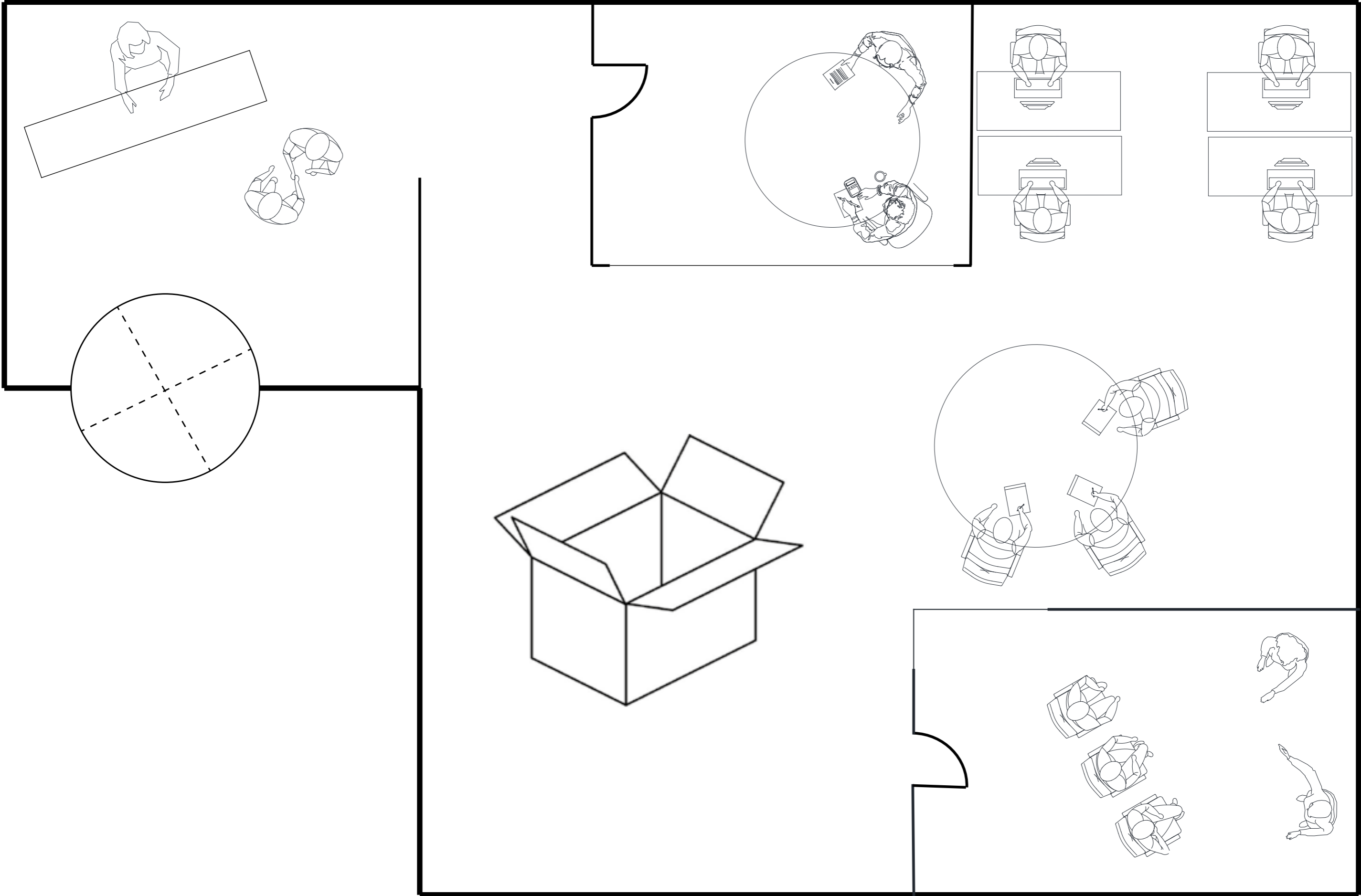


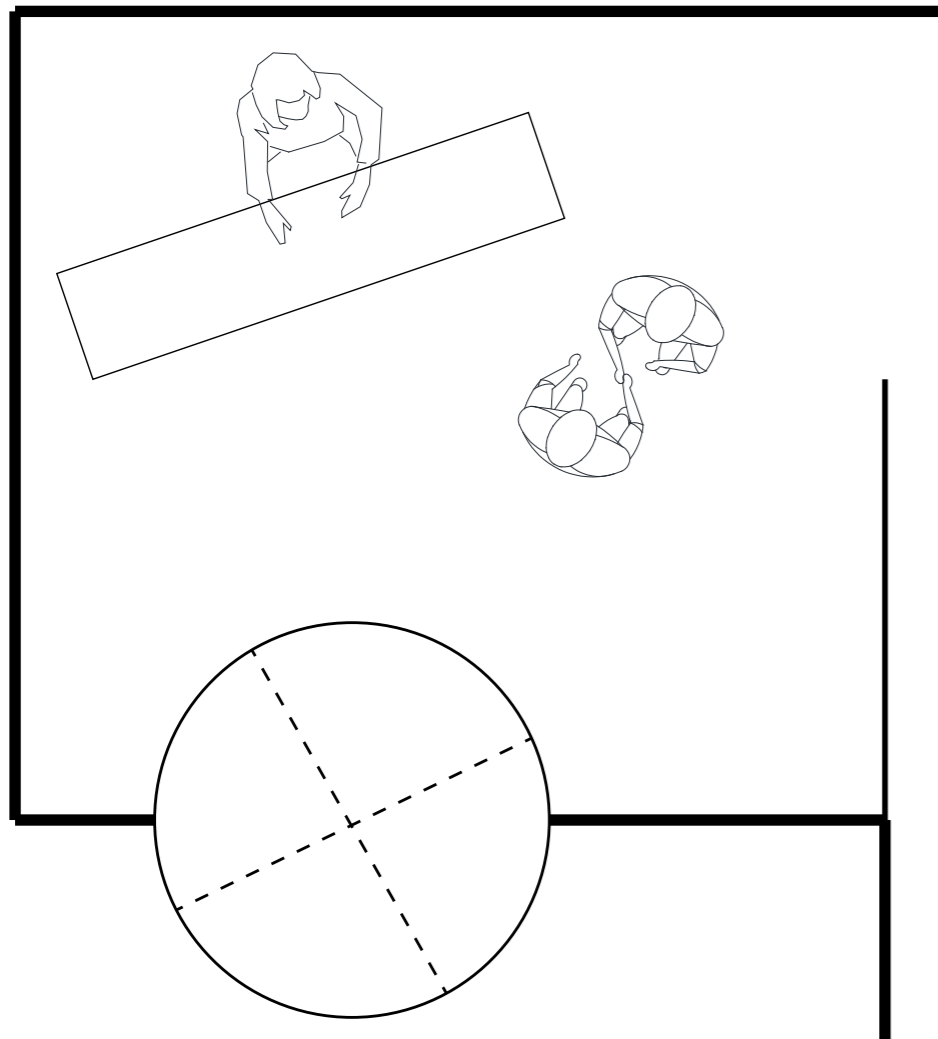


Welcome

Enjoy your journey through our designproces!







Welcome to our interactive document,

This document is made by project group 18, (module 6, University of Twente.)

Nine students of three different studies (Industrial Design, Mechanical Engineering and Industrial Engineering and Management) worked ten weeks on a project for the company ahrend. How we developed the final product you can see in this document.

Group members:

Industrial Design:

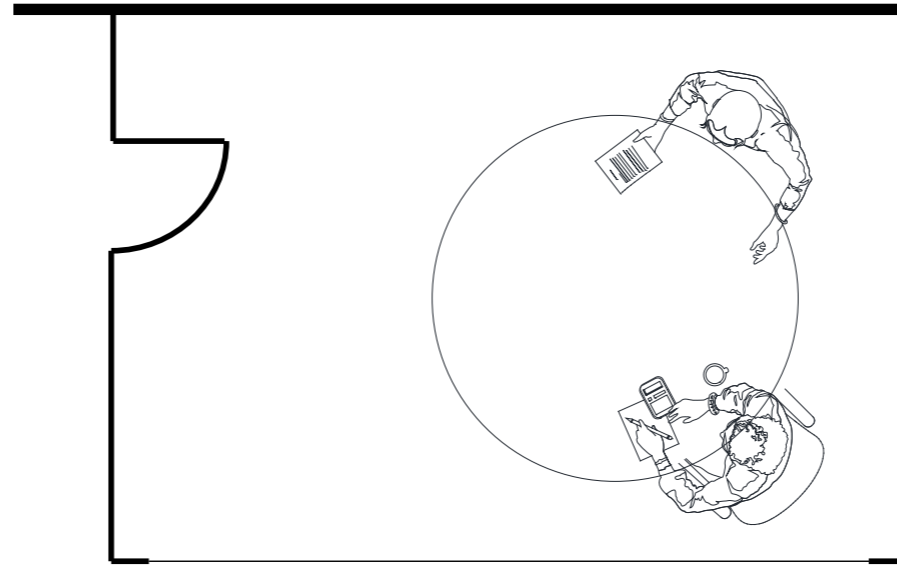
Judith Ditscherlein, Ellis van Steenis,  
Lisanne Verheij

Industrial Engineering and Management:

Fabian Pelgröm, Suzanne Wassenaar

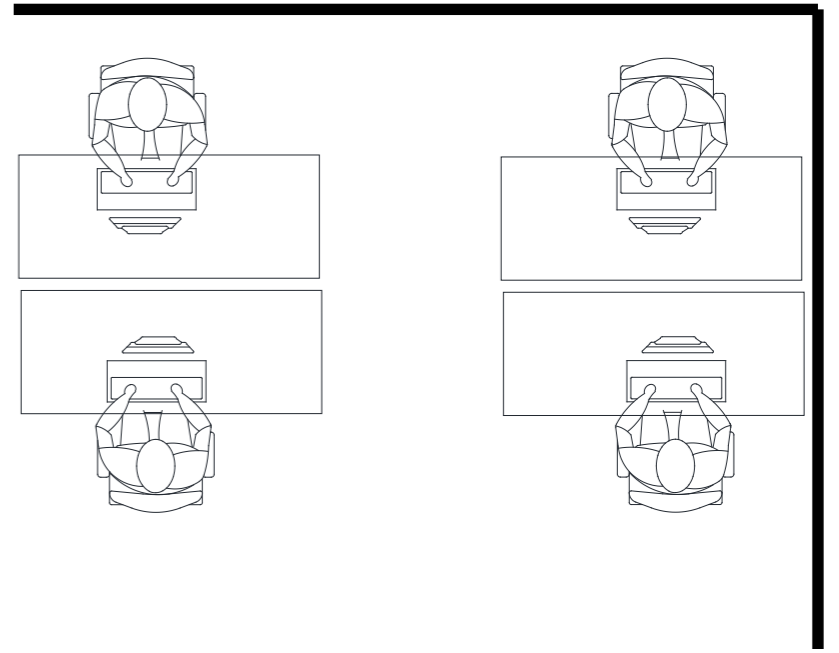
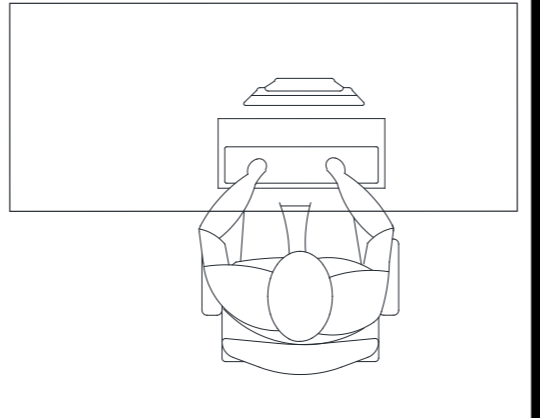
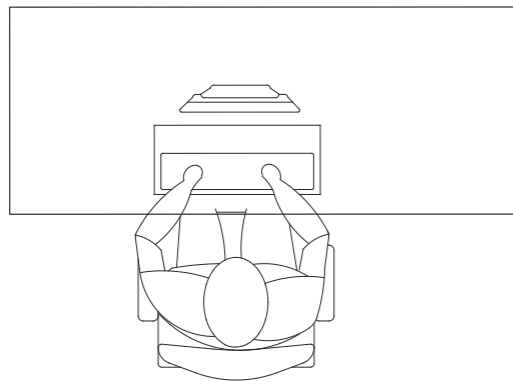
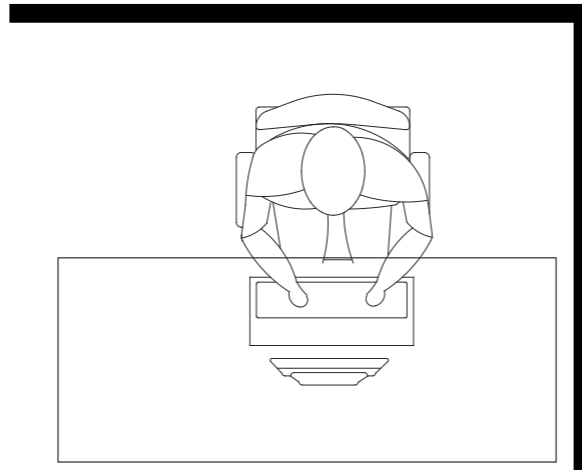
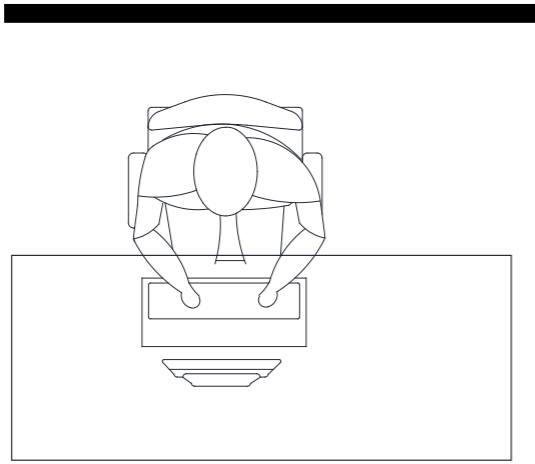
Mechanical Engineering:

Koen Busink, Jelmer Dijkstra,  
Lars Haarmeijer, Tristan Vlogman

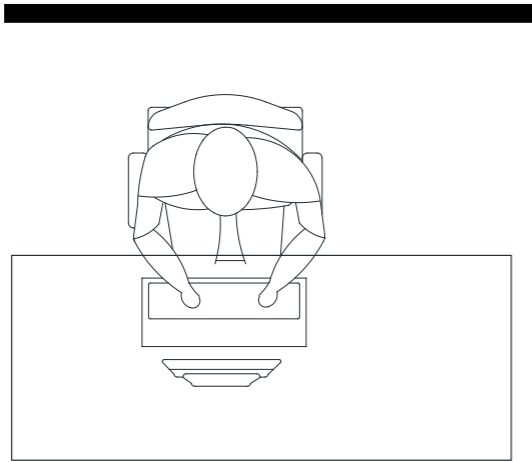


“Create a smart workplace that supports and stimulates both employer and employee in a healthy, productive, flexible and inspiring way of working. Keep an open eye for potentialities in the consumer market.”

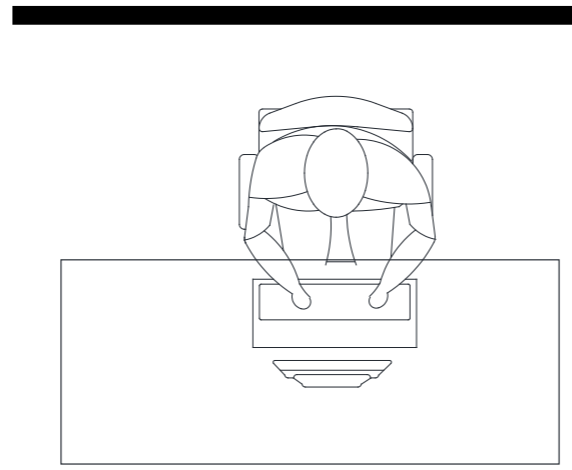
You can find our definition of a healthy, inspiring, productive and flexible workplace in the pdf, and that of a smart workplace in the chapter







We've conducted market research to see and understand in what market Ahrend is active. This is important for us, so that we know what to design and what market we should take into account when designing. To see the result of our market research,



To get a better picture of how the users think and behave there are made some personas and scenarios of the employees.

The target group that Ahrend operates in is that of companies that hire others to design their workspaces.

The people that hire Ahrend are the heads of the companies, while Ahrend designs for the employees that work in this company. So in this case the primary users are the employees and the secondary users are the heads of the company that make these kind of executive decisions.

Ahrend does a good job focusing on the primary users, even though they are not the ones directly speaking to Ahrend. They design for the people that will be working with their products, not just for the people that pay them.

Ahrend distinguishes themselves by not just creating interiors for companies, but focusing on some extra features and effects, like inspiring the employers and stimulation them to work more healthy.

Their target group would be the somewhat younger generation, that uses more flex spaces than ever and whom are open to new developments and new ways of working. So their target group will have an age of 21 – 45.

Apart from this, Ahrend also wishes to expand their target group by involving the home consumer, this is also a target group that we could expand to. The average age that we'd be designing for would remain the same, as we still want to attract the people that are open to new development and modern products. They would still use it while working, so we are targeting the group of people that works from their homes.

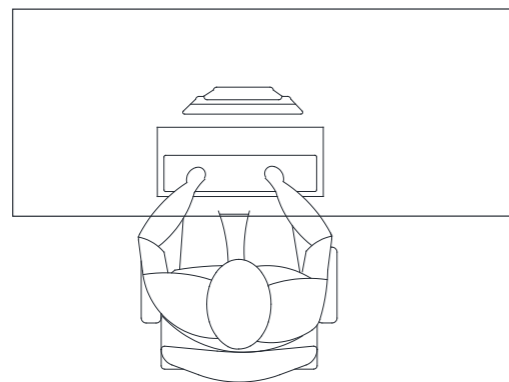
For us, this target group is more an expansion. In the first case we will just be designing for companies and their employees.

“The provision of a workplace infrastructure that empowers employees through self-regulation, engages employees through collaboration and communication, promotes a strong environmental ethic and sustains organisational agility, all of which are enabled through the adoption and implementation of new technology platforms.”

“The smart workplace”- Johnson Controls

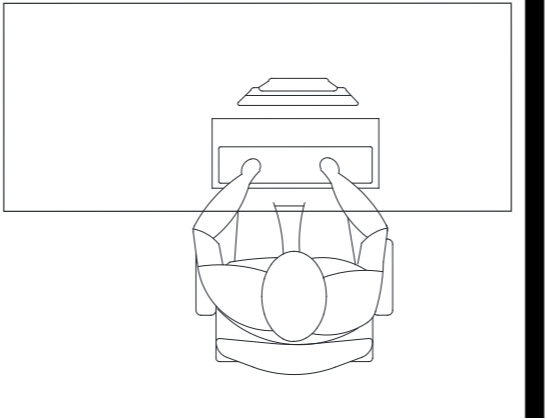
“The Smart Workplace of the future will see:

- A complex and competitive world focuses on collaboration, innovation and creativity.
- An industry focused on knowledge and co-creativity”





We have conducted a competitive analysis to find out what product are already available on the market. We have looked at products that creatively use light and we have also searched for products that share the same vision. We want to find out how they've handled some of the problems that we're facing as well.



CARRIERMAP

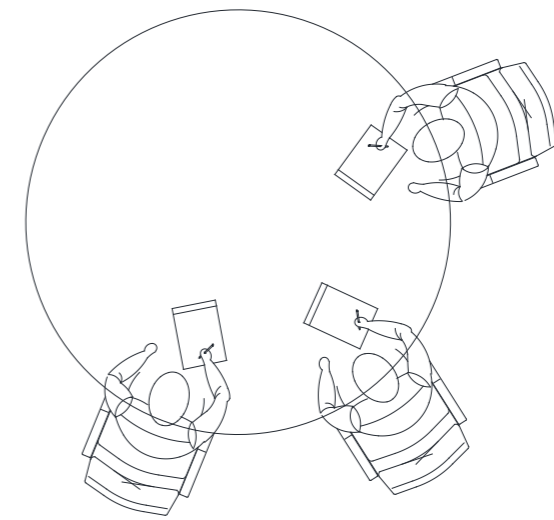
CARRIERCASE

EXTENDBOARD

WORKSTATION

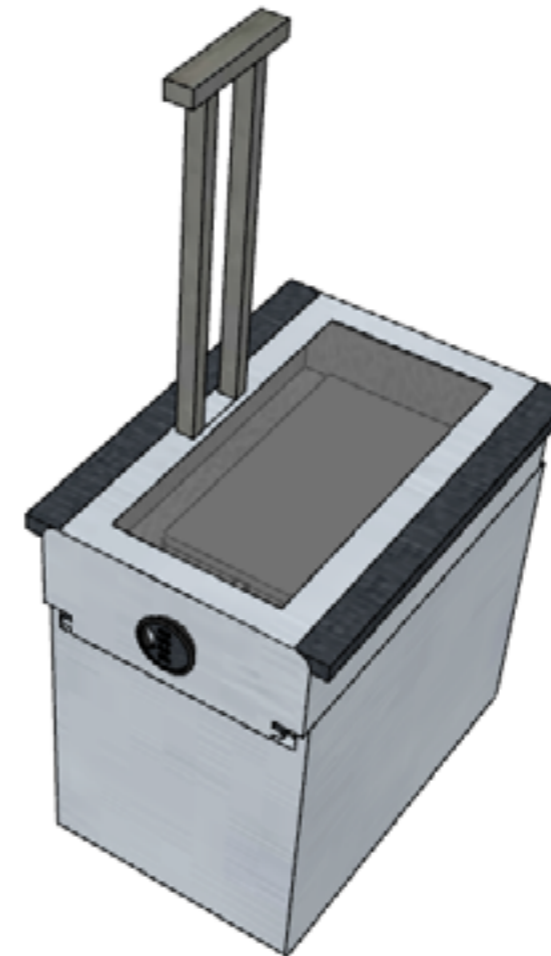
LIGHTWALL

FLEX BOARD





This family of products is designed to facilitate an effortless transition when switching between workplaces. It consists of two products, the carrier folder which is meant for employees carrying only a light laptop and documents and the carrier case which is designed to carry bulkier items.







The Extendboard can turn a cosy coffee corner into a conference room in seconds. Open rooms can be switched to more remote places. The flower containers in which the Extenboard is hidden give a warm and healthy ambience to the room.

The Extendboard is ideal for small companies who do not have space for a coffee corner and a conference room, but is also great for bigger companies with lots of open space.

assemble your workstation  
according to your needs



This concept makes use of an all existing table of Ahrend, the "Ahrend 314". A basis table with potential to more. With a little change on the table it could be possible to make your working place more personal/practical.



Our flexible whiteboard would allow for people to have a whiteboard ready-to-hand at their desk, enabling them to make quick sketches and concepts. The whiteboard is positioned in rails underneath the working tables. You can slide it towards you and then flip it over your table. This means that there will be no need for the employee to clear his desk before he can use the whiteboard. The whiteboard can then be positioned over the table in different angles, defined by what the employer likes best at that very moment.





This concept is a light which informs you about whether you have been sitting for too long. The target group for this concept is employees who work at a desk and have, or are interested in, a healthy lifestyle and a healthy workplace. This can also be used as a consumer product, for people who work at home and are interested in having a healthy lifestyle.

## Resume of feedback

### 1. Workstation

- a. Bad idea for flexplaces
- b. No clear cause for the concept

We decided, based on the feedback of Ahrend, not to continue with this concept.

### 2. Flexbord

- a. Nice idea, because you don't have to walk somewhere else to sketch something.
- b. You should make it digital
  - i. Make large drawing tablet of it
  - ii. Able to export sketches
- c. Eventually not that excited, because why not just use a tablet

We discussed this concept after the milestone meeting. Even though the feedback was quite positive, they eventually said you might as well use a tablet. So we decided not to continue with the Flexboard.

### 3. Extend board

- a. Nice idea for smaller companies
- b. A pro that you don't have large wall pieces left in a corner
- c. Solid base if you connect it to a planter
- d. Smartglass
- e. How expensive will it be

Ahrend was really positive, so we continued the discussion afterwards.

### 4. Lightwall

- a. Really easy to make (pro)
- b. Think of all the possibilities of the light
- c. Easy to make modular

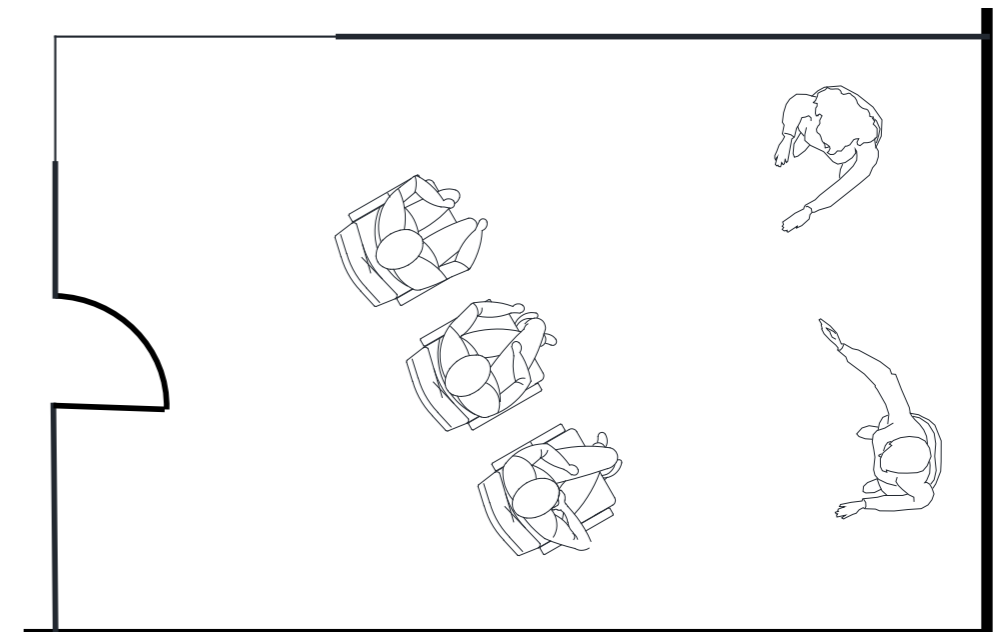
This concept was also discussed afterwards and we decided to make this our definitive idea.

### 5. Cariercase and map

- a. Not a big target group
- b. People mostly use only a laptop

This concept will not have a large enough target group to be profitable, so we scrapped the idea.

In the milestone meeting we presented our concepts to Ahrend and they gave us their opinion. The milestone meeting has greatly influenced the way we continued with our concepts.



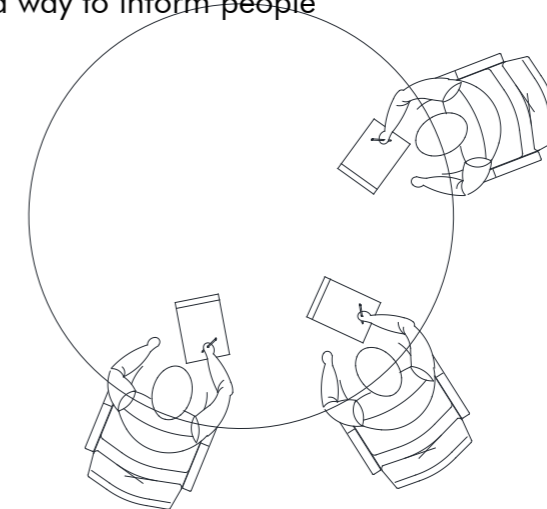


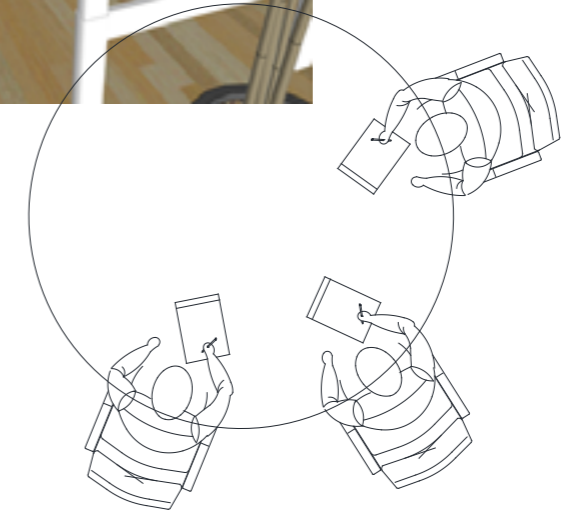
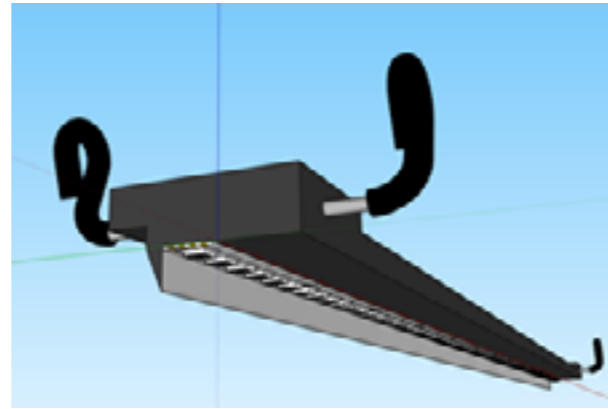
We have chosen the lightwall as the concept that we'll be developing further. Not only did the people from Ahrend respond well to this idea, but this is also an idea in which we see a lot of potential. We feel that it fits Ahrends visions as well. After we choose the lightwall, we started iterating this concept and adding new features.

Lightwall, a desk lighting system that tells you whether you have been sitting for too long. It is a minimalistic design which can be put on your desk. It does require minimal space because of its small and long design. The idea is that normally there is a productive color of light and when people have been sitting for too long, it changes to a red light. After a while the light will turn back to normal. This is a way to inform people about their behavior, not to push them to behave a certain way.

The "Lightwall" family of products uses smart LED lighting to make working at flexible workspaces more convenient, productive and enjoyable. Each of the products is designed to be used for a different type of workspace. All products fulfill a number of functions. Pressure sensors in the chairs register whether or not a chair (and thus a desk) is occupied. Available workspaces are illuminated by a green light. Once an employee sits down at one of the desks the light changes to blue. The color blue has been shown to promote concentration and calmness, both of which are desirable at the workspace. While an employee is working the pressure sensor registers how long said employee has been sitting at the desk. Prolonged sitting raises the risk of cardiovas

cular disease and musculoskeletal disorders. To encourage employees to take a break and get up from their chair frequently, the lighting changes from blue to red when employees have been seated for too long. The smart lighting can also be used to notify the employee of upcoming events such as meetings, conferences etc. This can be used in conjunction with the employee's electronic calendar. At a (user-defined) time before the event the LED strip produces a light effect to catch the user's attention and notify him/her of the upcoming event.





The first concept is especially made for the bureaus of Ahrend that have a wall, but some bureaus do not have a built in wall. Therefore the Lightwall compact is created. It is a version of the Lightwall with a small built in wall, so you do not need a wall behind your desk. Another variant of the Lightwall is the PCLightwall. This variant can clamp on to your computer screen, so the light will shine on your desk. The last idea was to combine the Lightwall with a flowerpot: The IllumiBonsai. The purpose of the Lightwall is to create a healthy lifestyle and because plants stimulate a healthy work environment, this is a good combination.





The final concept is a basic LED strip that can be combined with different parts so you can personalize your Lightwall. The LED strip itself contains a USB port, so other parts can be connected to the Lightwall. The following extra parts are created:

- Speakers
- Diffuser
- clasps

To turn on the light, you can touch the Lightwall at the touch part. In the light wall there will be a wifi-chip. When you touch the Lightwall for 10 seconds while sitting on a chair, the Lightwall will be connected to the closest chair where someone is sitting. When a chair is connected to a Lightwall it will not be disconnected unless you touch the Lightwall for 10 seconds again. It is also possible for the employer to reset all the systems, this could be used by flexible workplaces or when a lot of chairs are switched. When the Lightwall is turned on the light will be blue. This is a colour that promotes concentration and calmness, which are desirable at the workspace. While an employee is working, a pressure sensor in his chair registers how long the employee has been sitting at the desk.

After 28 minutes the blue light will gradually turn to red within two minutes. When the employee stands up, the light will gradually turn blue in two minutes. When the light is blue again and the pressure sensor in the chair is pressed, a new 28 minutes start. If the touch part of the Lightwall is touched a second time, the light will turn off.

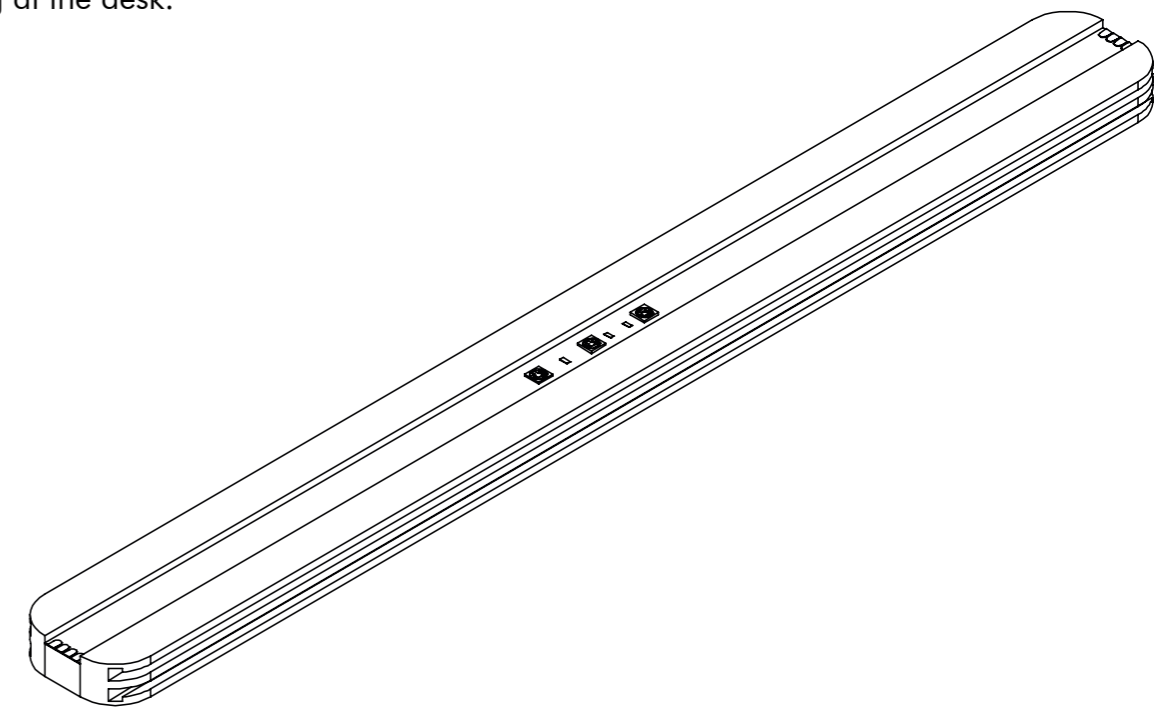
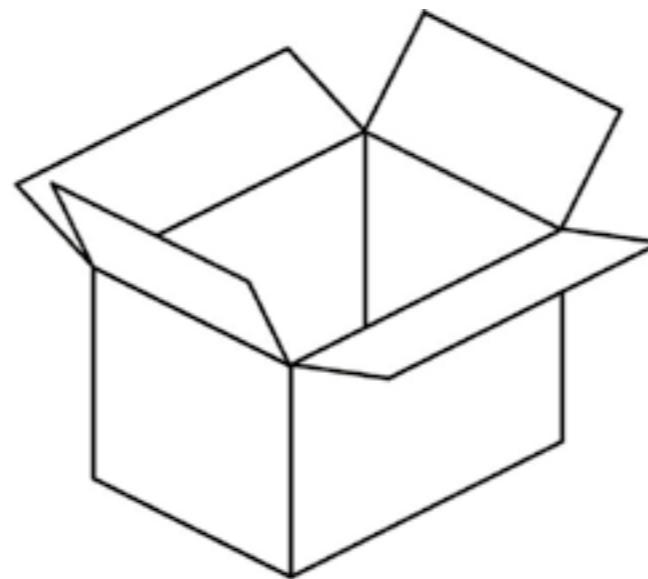
The product dimensions are 300mm by 30m by 10mm. It consists of a aluminium housing of 1 mm wall thickness. And an abs plastic cap with a thickness of 2,5mm. Furthermore the Lightwall will always be delivered with a diffuser.

The Lightwall consists of a several different parts. Including a housing, processor( chip), led strip, battery, wifi chip, usb port, diffuser and the cap.

How does the Lightwall work?

To turn on the light, you can touch the Lightwall at the touch part. The Light will be blue, because this is a color that promotes concentration and calmness, which are desirable at the workspace. An app can be linked to the Lightwall, so when the light is turned on, employees can see whether a workspace is occupied or not. While an employee is working, a pressure sensor in his chair registers how long the employee has been sitting at the desk.

After 28 minutes the blue light will gradually turn to red within two minutes. The light will gradually turn blue in two minutes. When the light is blue again and the pressure sensor in the chair is pressed, a new 28 start. If the touch part of the Lightwall is touched a second time, the light will turn off. If parts are connected via the USB port (projector), the light will automatically turn off. If other parts are connected, the light will not change.



### Influence of color

Blue stands for warmth in The Netherlands. But can be seen very differently in other countries. It also stands for high-quality and trustworthy here, but be careful when you want to export to other countries. For example, in Iran blue is the color of death. When associated with products, blue is often used for dairy products and healthy foods. This is the case in the USA and the Netherlands. Some suggest that blue is associated with passivity, because it lies towards the passive end. This also means that red lies towards the active end. This brings us to our second color: red.

We want people that stand up and do something with this color, which is why we

subtly gets hints about the sitting behavior. The color of the light will, also in 2 minutes, gradually change back. In this way, there will be indicated that you have to get up, for a total of four minutes. During this time, the employee can walk around.

choose a color that lies in the active end of the activity spectrum Red is also an exciting color, thus urging you to go and do something, whereas blue is a competent color, allowing you to work efficiently.

How long is it healthy to sit on a day?

According to health entrepreneur René Sielhorst, it's a matter of time before the World Health Organization sets a standard for the duration of sitting during your work. WHO: "People should not sit more than 30 minutes continuously for an hour. 'Sitting for four hours a day is unhealthy. That does not mean that you need to move continuously or run all day. The point is that you should alternate sitting with standing. And also al

ternate standing with moving. People with office jobs should try to not sit in a chair for more than a half hour. Why is sitting bad for you? "If you sit on a chair, your body goes into a shutdown mode," says Sielhorst: "All kinds of bodily functions are taken over by a chair. That seems good and healthy, but you can or develop all kinds of chronic ailments such as diabetes, cardiovascular disease and obesity."

Since the advice is to not sit for more than half an hour, the Lightwall gives a signal every half hour which ensures that employees are informed about their sitting behavior. After the pressure sensor in the seat is pressed for 28 minutes, the light gradually changes color. In this way, the employee



## Specialisations

During the development process of the Lightwall from concept to market-ready product special attention was paid to optimizing the injection molding process for a particular part within the product. Injection molding offers a cost-effective way to manufacture complex parts out of plastics without requiring extensive machining. The caps at the ends of the Lightwall product are an example of a part with relatively complex geometry where injection molding can significantly reduce the amount of steps in the production process.

A distinction was made between three main parts of this optimization process. Correspondingly, the different members

of the mechanical engineering part of the group each specialized in a different area of expertise:

Designing in plastics: focuses on optimizing the geometry and material of the injection-molded part.

Simulation of injection molding: simulates the injection molding process to optimize parameters for part quality and economic benefit.

Mold design: creates the final design for the mold, taking into account the results of the analysis as well as practical limitations.

All three specialisations have worked together in close collaboration to guarantee a quality product.

Simulations of the product

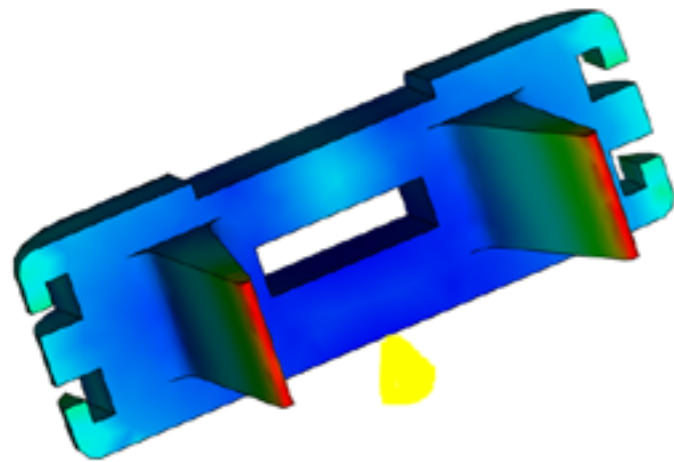
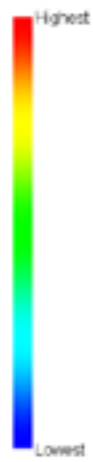
1) 3d representation



3) Part geometry



2) Gating location



Variation in cavity thickness causes hesitation  
Reducing thickness of front yields more balanced filling  
Short filling time results in low melt viscosity / temperature variations

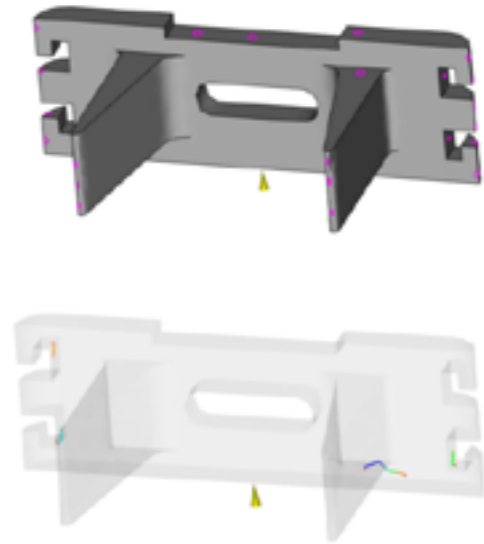


Gate must lie in parting plane  
Situating at location with low flow resistance



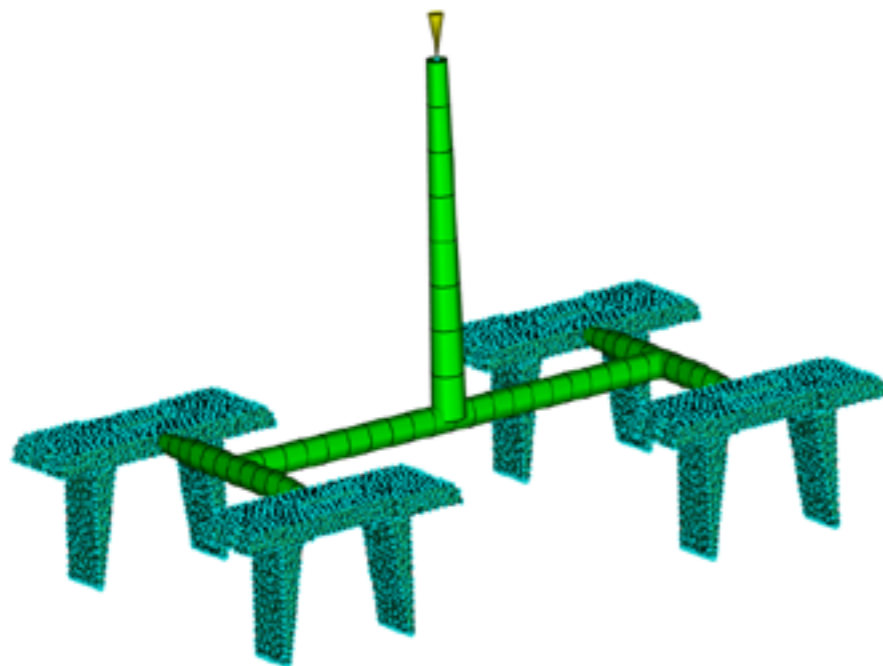
Simulations of the product

4) Weld lines and air traps  
 Plaatje: [weldlines\_airtraps.PNG]

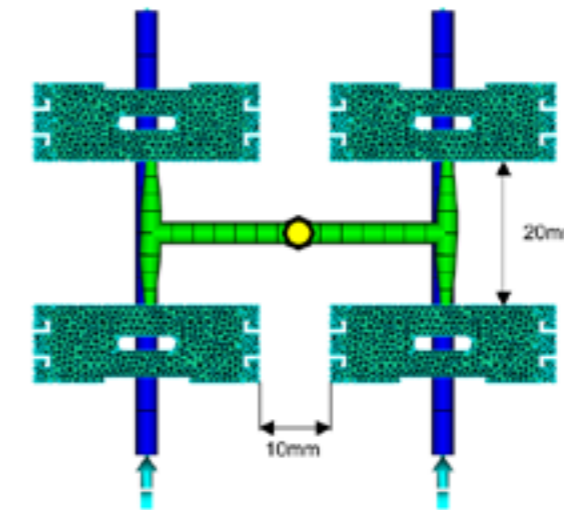
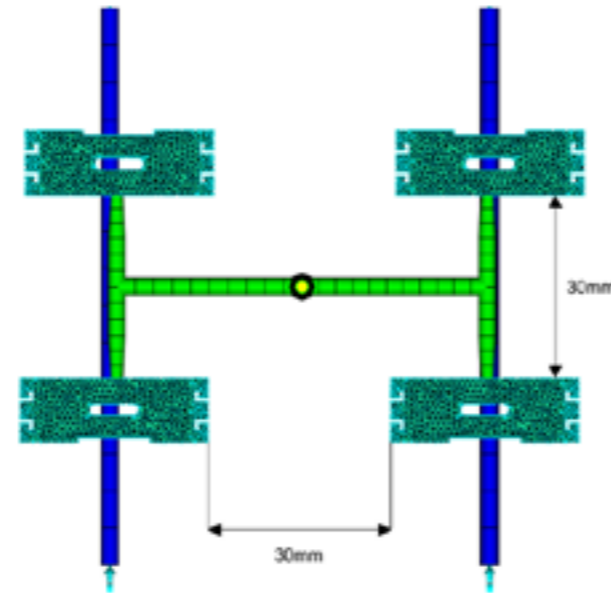


Air traps at ends of flow paths – application of vents  
 Weld lines shouldn't be a problem due to low melt viscosity as a result of high temperature

5) Multi-cavity molding



Increased production capacity  
 Material waste  
 More compact design – 20.6% less scrap



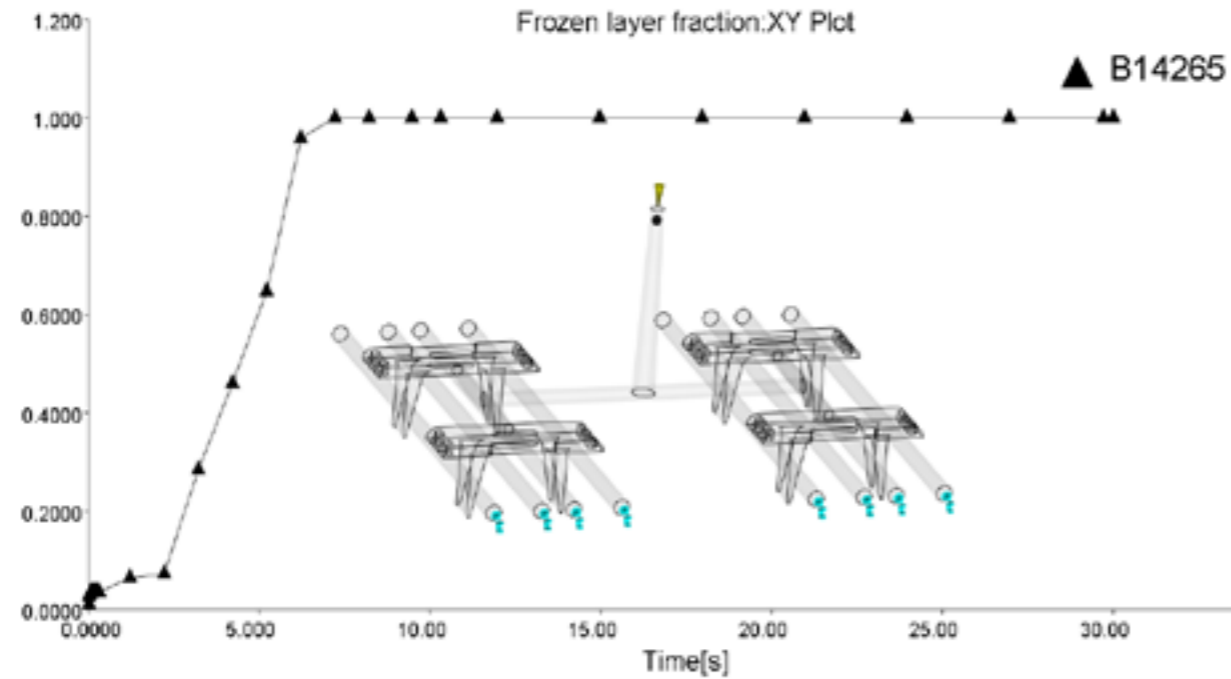
6) Optimizing filling time  
 Tabel:

Filling time (s)	Maximum pressure at injection location
2.00	42 MPa
1.00	37 MPa
0.50	36 MPa
0.25	36 MPa
0.10	42 MPa

"Sweet spot" between 0.25 and 0.5 seconds

Simulations of the product

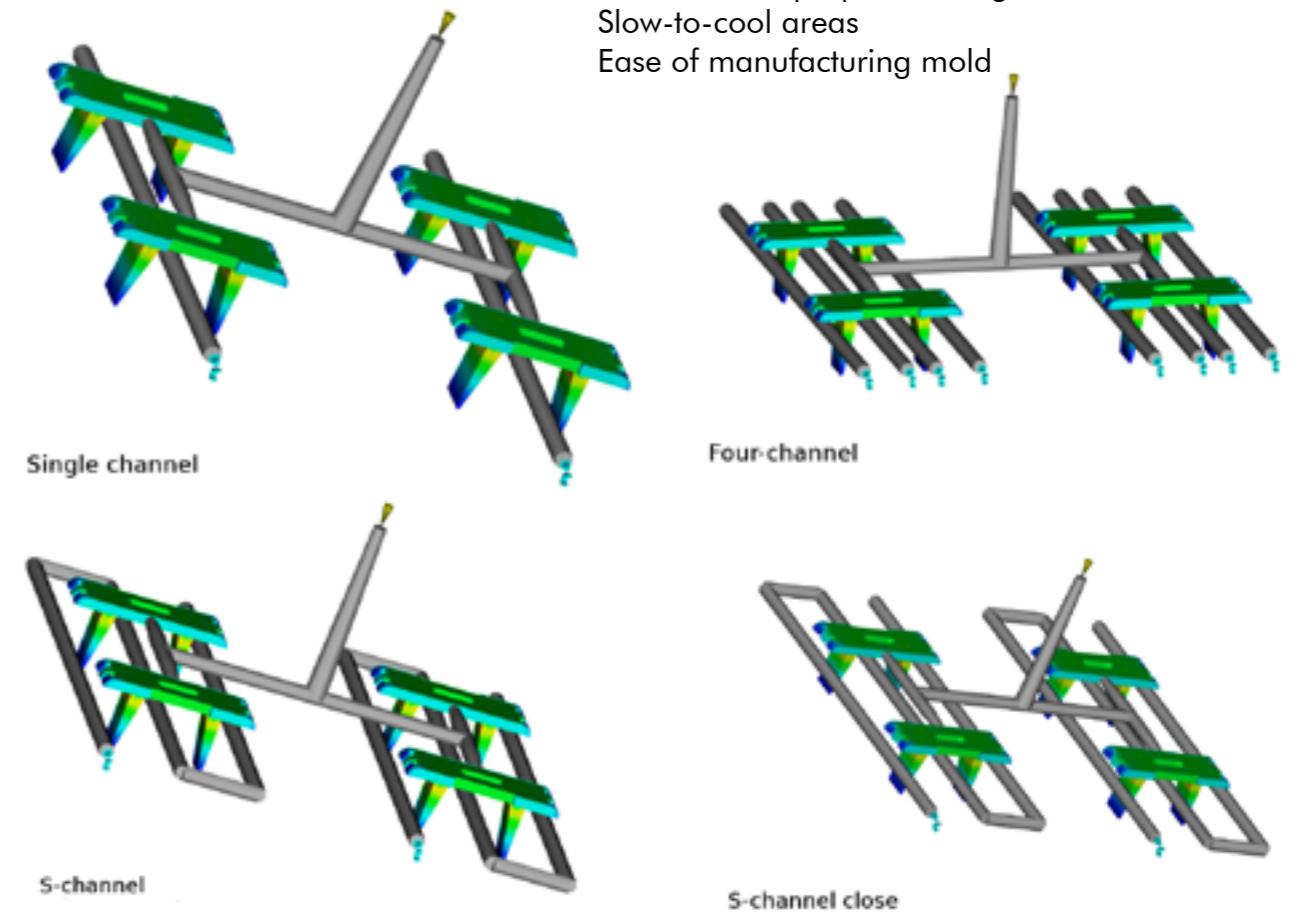
7) Packing analysis



Filling time - prue freezing time + 1 = 7.75 seconds  
 Packing pressure relatively little effect on shot weight  
 Shrinkage also not strongly affected by packing pressures  
 Warpage: max deflection 0.12mm

Packing pressure (% of filling pressure)	Part weight of the four parts (g)	Maximum volumetric shrinkage
80	2.7429	6.889%
120	2.7481	6.824%
200	2.7551	6.7136%

8) Cooling



9) Summary of most important parameters

Material	Generic ABS
Mesh size	0.99mm
Filling time	0.25 seconds
Packing time	7.75 seconds
Packing pressure	80% of fill pressure
Max pressure at injection location	36 MPa
Time to reach injection temperature (part)	0.9 seconds
Total cycle time	13 seconds
Max volumetric shrinkage	6.889%
Max warpage	0.12mm

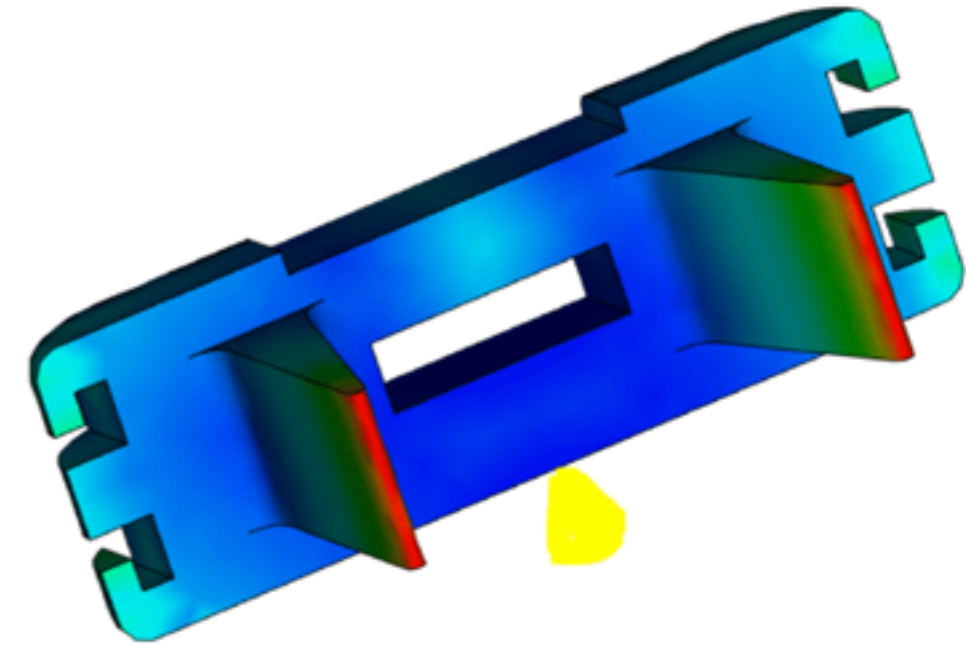
### 3D model and meshing



First the molding of a single part was simulated to get a general idea of the problems that might be encountered during molding. The part is made of medium ABS and a visual representation can be seen in the image above.

In order to perform an analysis, the STL file exported from the CAD model needs to be meshed. To guarantee the accuracy of the following simulations a suitable mesh size needs to be determined. For this part the default mesh size of 0.99mm provided a reasonable representation of the model. The maximum aspect ratio is 18, which is towards the higher end of what the Moldflow documentation recommends. However, these high-aspect ratio triangles occur only at the ends of the two protrusions from the part and do not lie in the direction of the flow, which significantly reduces their impact on the results. Performing one analysis with a finer (0.50mm) mesh took significantly longer and the results did not differ from those using the 0.99mm mesh. Hence, all further analyses were carried out using the 0.99mm mesh.

### Gating location

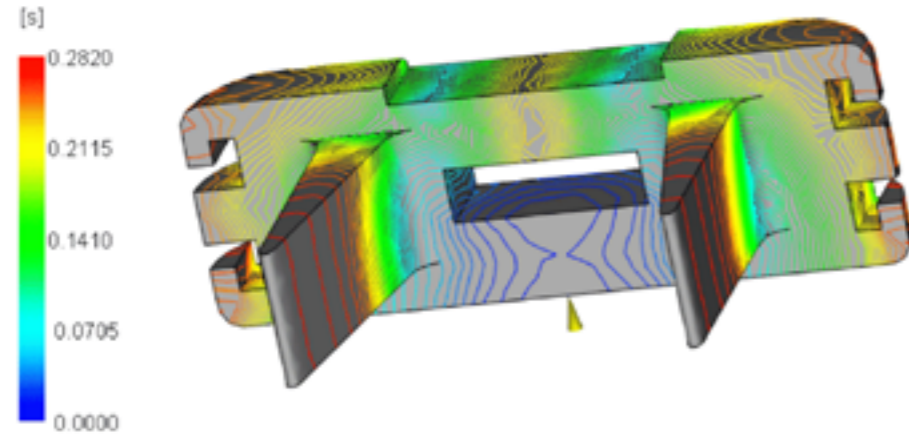


The first step in the simulation process was to find a suitable gate location. A good gate location should be at a location within the part where flow resistance is low and where the gate vestige causes no aesthetic or functional problems. Also, the gate should lie in the parting plane in order to be able to remove the solidified melt in the runners, which for this part limits the choice of gating locations considerably. Keeping this in mind and using the flow resistance result of the gate location analysis leads to a choice of gate location at the bottom middle section of the part shown in the image above as a yellow cone.

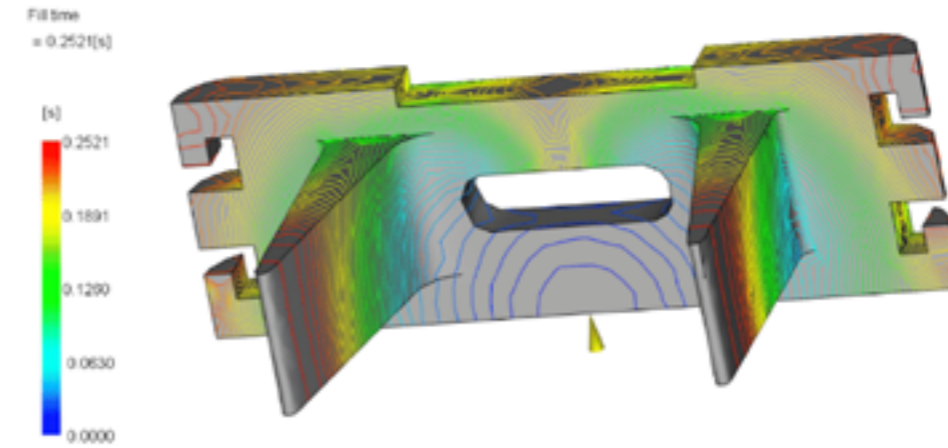


### Part geometry

The images below show the results of the fill analysis for a single part. Ideally, the mold cavity will be filled in a balanced and uniform manner as this leads to less variations in density and other relevant properties which is critical in ensuring consistent quality of the products.

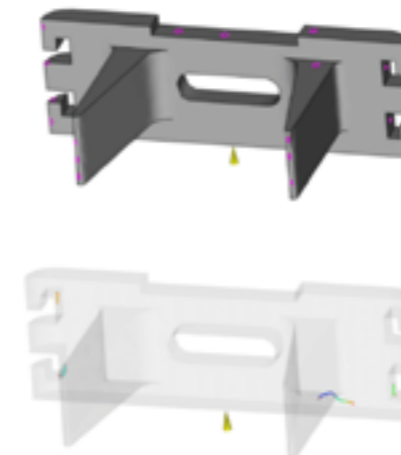


It can be seen that in this analysis the fill time contours are not evenly spaced, indicating unbalanced filling. Especially the transition from the cap body to the two supports shows contours very close to one another signifying that hesitation occurs. This problem is most likely caused by the difference in cavity thickness between the support and the cap body: the melt tends to flow more easily in the thicker sections of the product and hence hesitates when entering the thin support sections. A possible solution to this problem is to reduce the wall thickness of the cap body so that the difference between wall thicknesses in the product is smaller. Reducing the original 4mm thick cap body to 2mm and also rounding off the corners of around the hole for the USB port (to facilitate a smoother flow around these edges) yields the image shown below.



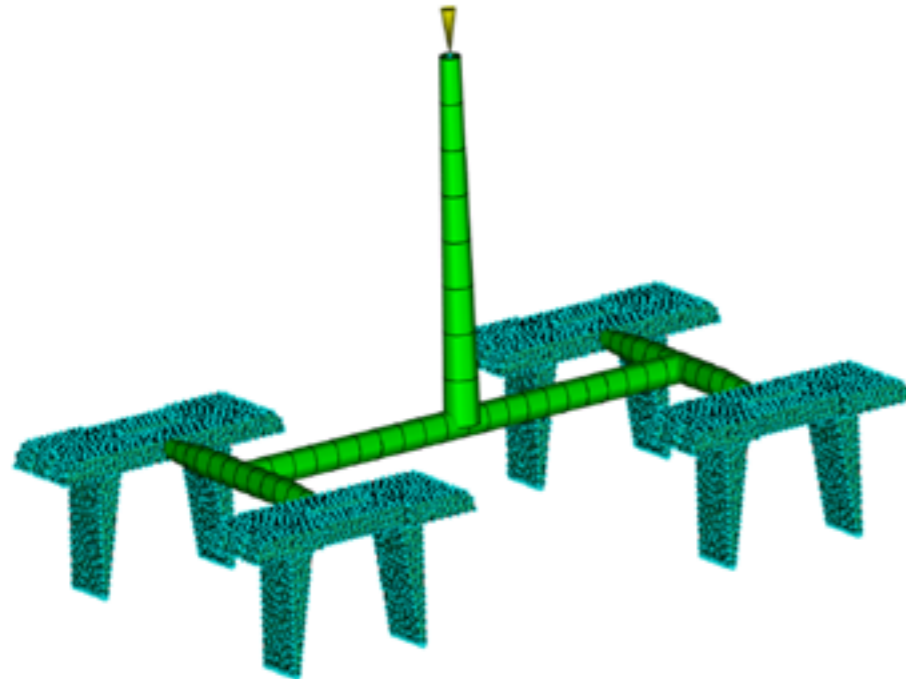
It can be seen that hesitation at the transition from cap body to support has been reduced. The overall pattern of contour lines has also become a bit more uniform. Though there are still clear differences in the distances between contour lines, one has to take into account that the short filling time (as this is a small part) means that the melt temperature (and thus viscosity) will not vary much during filling of the different parts of the mold cavity. This observation is verified by the temperature at flow front result which states that there is less than a 1 degree difference in temperature at flow front between the first- and last-filled sections.

### Weld lines and air traps



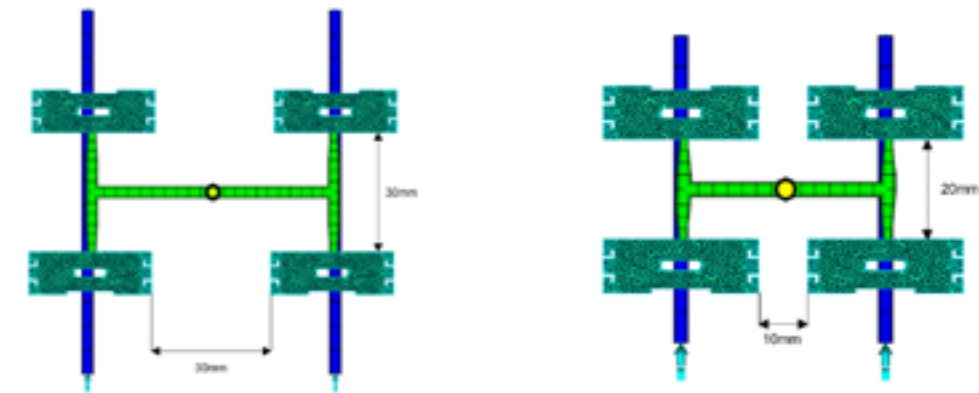
Some other things to look out for during the filling analysis are air traps and weld lines. In this case the locations where Moldflow indicates a risk of air traps are as expected at the last-to-fill parts of the mold cavity. Moldflow shows that weld lines are likely to show up in a number of places where two melt fronts meet. However, it should be noted that as mentioned, the temperature of the melt is still quite high when the melt fronts meet which suggests that the melt fronts will mix easily and in reality, weld lines shouldn't be much of a problem.

### Multi-cavity molding



A common way to increase production capacity and reduce costs for small injection-molded parts such as this one is to use molds with multiple cavities, allowing multiple parts to be produced with each shot. This requires the design of a runner system to supply melt to each cavity. A downside of this way of molding is that some material is wasted as it solidifies in the (cold) runners and has to be removed. The longer the runners are, the more material is wasted and hence it is important to strike a balance between the number of products per shot and the length and complexity of the runner system. For this product, a four-cavity mold was chosen with the runner system shown above.

One disadvantage of a multi-cavity design using cold runners is that the material in the runners must be discarded. This obviously has economic consequences and hence it is worth exploring whether a runner design with shorter runner paths is possible without detrimental effects on the rest of the injection molding process. To that end, the effect of using a more compact arrangement of cavities (and hence, a shorter runner system) was investigated. For reasons related to mold design, there is a limit to how small the gate and runner system can be made. In this particular scenario, the space between the mold cavities was kept to 10mm in the length direction and 20mm in the width direction as shown in the image below.



links [layout\_size.PNG] en rechts [layout\_size\_compact.PNG]

First of all the material savings were considered when switching from the original runner layout depicted above to the left to the more compact arrangement on the right. The weight of the sprue, runner and gates for the original situation is 1.14g whereas in the compact arrangement these parts have a weight of 0.91g. This translates to 20.6% less material that has to be discarded when using the compact layout. The compact layout does have a small negative effect on the time to reach ejection temperature, which is prolonged by 0.3 seconds. However, the material savings gained by using this layout outweigh this small disadvantage. The more compact cavity arrangement had no substantial influence on any of the other parameters of interest.

### Optimizing filling time

Filling time (s)	Maximum pressure at injection location
2.00	42 MPa
1.00	37 MPa
0.50	36 MPa
0.25	36 MPa
0.10	42 MPa

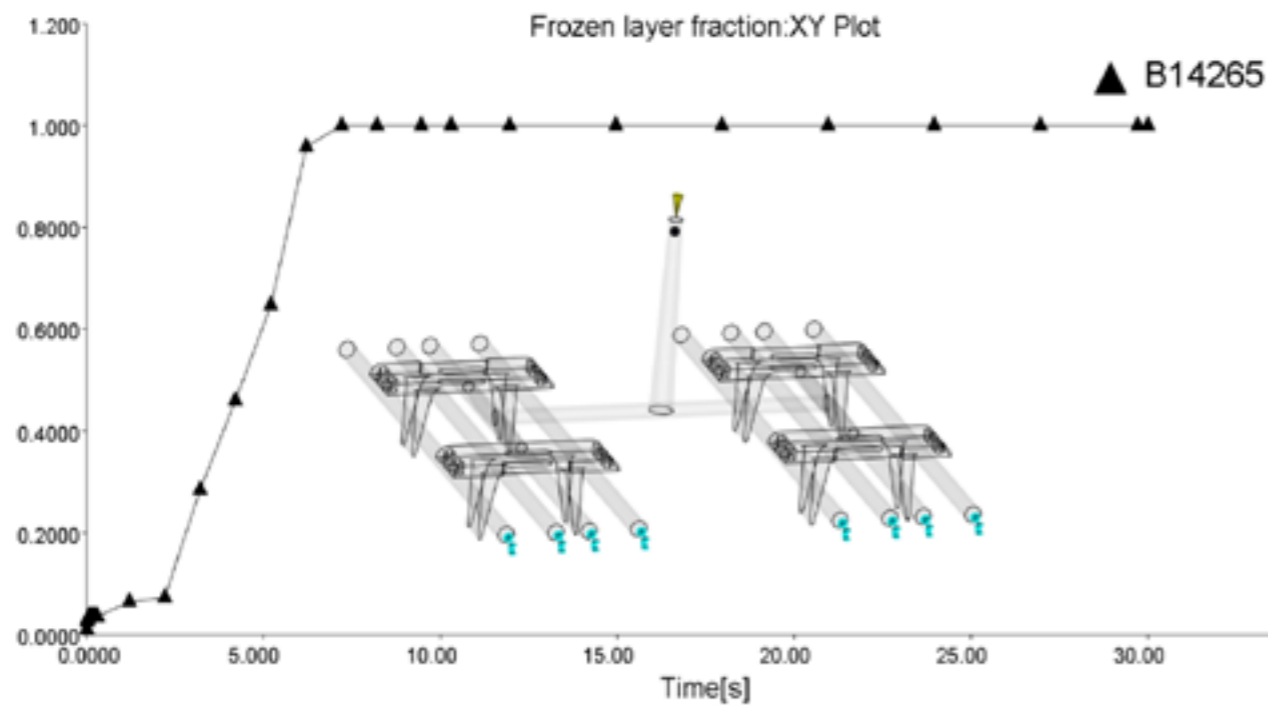
To decide on a suitable filling time a number of options and their effect on the maximum pressure at the injection location were investigated. A lower pressure at the injection location is advantageous as this means that a lower-specced machine can be used. The filling times investigated and the maximum pressure at the injection location are shown in the table above.

It seems that a minimum is reached for filling times between 0.5 and 0.25 seconds. After making sure that a filling time in this range does not cause unbalanced filling or cause any other problems (i.e. air traps or weld lines) other than those already mentioned in the single-part analysis, a filling time of approximately 0.25 seconds was decided upon.



### Packing analysis

The packing phase serves to compensate for the shrinkage that will occur as the part cools down, as well as to ensure that the melt will remain in contact with the cavity wall as it cools down, facilitating heat transfer and shortening cycle times. As a general rule the packing time should be equal to the freezing time of the gate plus a one second margin. Using this rule and the frozen layer fraction result of the Moldflow analysis a packing time of  $7 - 0.25 + 1 = 7.75$  seconds was decided upon. The packing pressure can be of influence on the shot weight (i.e. density of the final product) and shrinkage. However, when comparing the part weight results for a variety of packing pressures (all packing times kept at 7.75 seconds) very little effect on part weight can be observed.

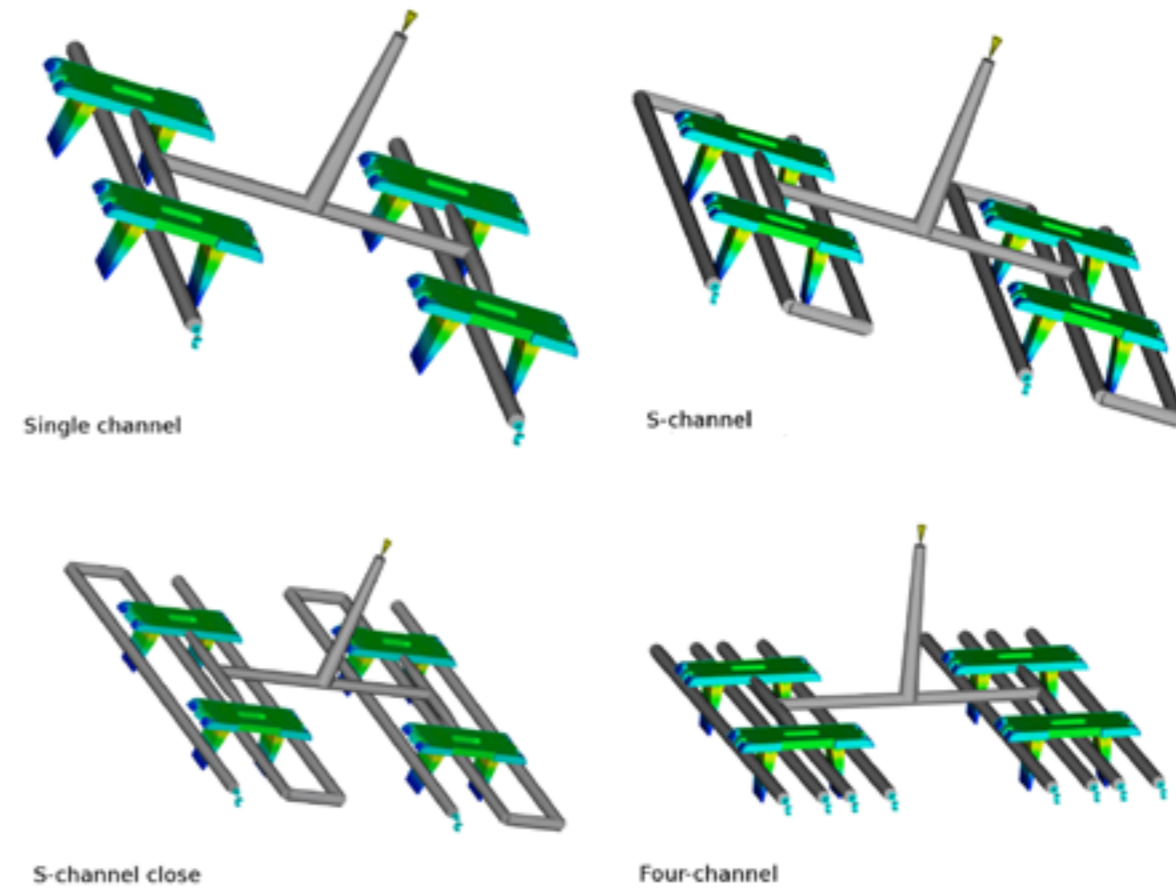


Based on the negligible effect of the different packing pressures on shot weight a similarly small influence on part shrinkage is expected. The volumetric shrinkage results for the different packing pressures confirm this hypothesis: changing the packing pressure from 80% of the filling pressure to 120% and the maximum 200% of filling pressure yields a change of volumetric shrinkage of only 0.07% and 0.18% respectively. Warpage doesn't seem to pose much of a problem: for all packing pressures the maximum deflection is only 0.12mm. The results of the packing pressure analysis are summarised in the table below.

Packing pressure (% of filling pressure)	Part weight of the four parts (g)	Maximum volumetric shrinkage
80	2.7429	6.889%
120	2.7481	6.824%
200	2.7551	6.7136%

### Cooling

Cycle times can be shortened even further by making use of a liquid cooling system. The influence of different configurations of cooling channels was investigated. A line-up of four designs was analyzed: one very simple design utilizing two straight channels, a more complex S-shaped channel system the same S-shaped channel system brought closer to the part and a design using four straight channels. The S-shaped configurations require a more complex (and hence, more expensive) mold and especially the close S-shaped design requires more precise machining.



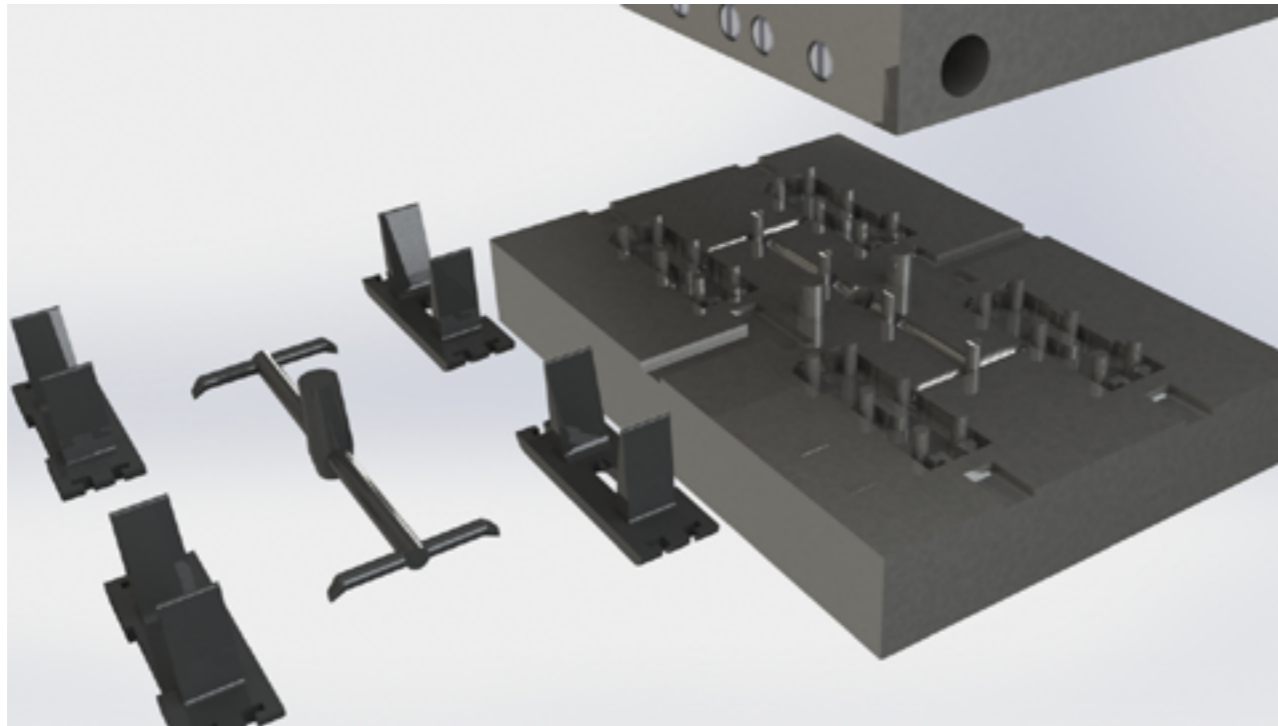
Comparing the results of the cooling analysis for these four configurations and also comparing to a scenario with no liquid cooling system shows that employing a basic cooling system reduces the time to reach injection temperature for the part from 15 to 11.4 seconds. Using the S-shaped cooling system yields a time to reach injection temperature of 11.0 seconds and bringing the S-shaped cooling system closer to the part doesn't have any significant effect. The four-channel cooling system results in a time to reach ejection temperature of 10.9 seconds and is hence the most preferable option. Another advantage of this design is that, like the two-channel design, it is relatively easy to manufacture.

**Summary of most important parameters**

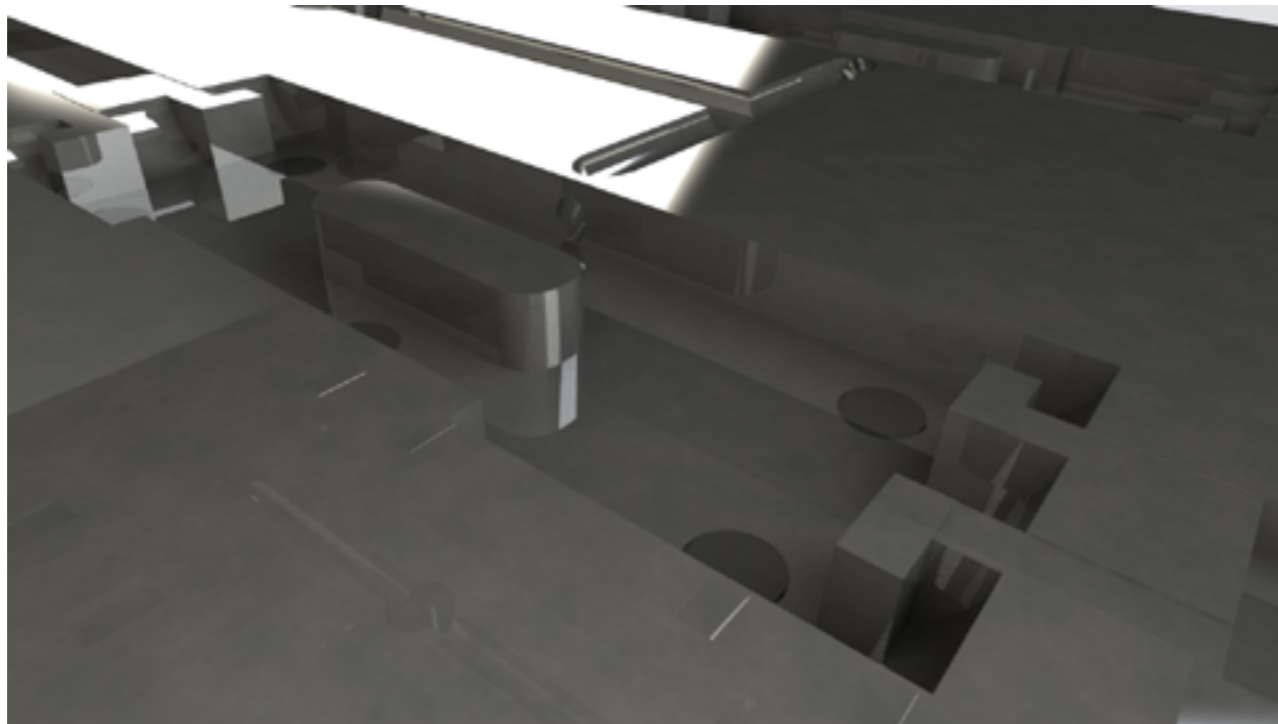
To conclude the analysis, some of the most important parameters have been summarised in the table below.

<b>Material</b>	Generic ABS
<b>Mesh size</b>	0.99mm
<b>Filling time</b>	0.25 seconds
<b>Packing time</b>	7.75 seconds
<b>Packing pressure</b>	80% of fill pressure
<b>Max pressure at injection location</b>	36 MPa
<b>Time to reach injection temperature (part)</b>	10.9 seconds
<b>Total cycle time</b>	13 seconds
<b>Max volumetric shrinkage</b>	6.889%
<b>Max warpage</b>	0.12mm

## Mold Design

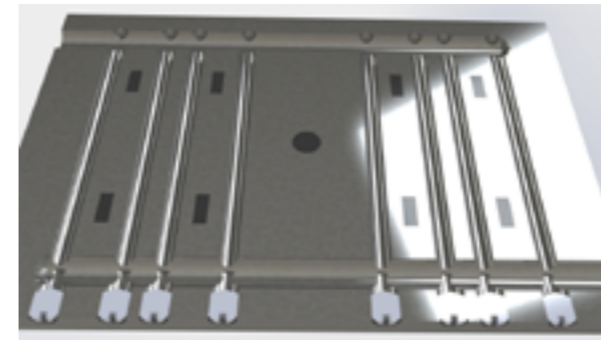


Overview: Each component has six ejection pins: four in the corners because it will clamp itself there, and two in the middle, one for cutting the product from the tree and the other to ensure a force of equal magnitude on both halves of the product. The tree has four ejection pins, because a certain force is needed to cut the tree from the component.

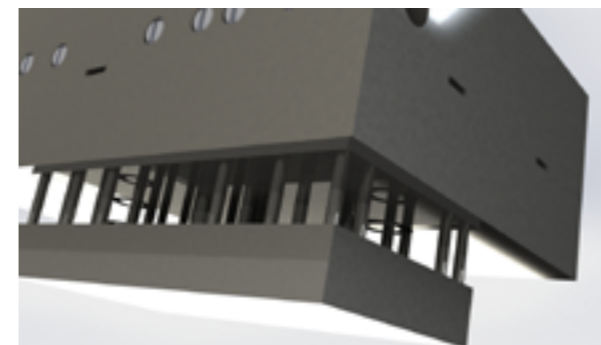


Detail: A draft angle of two degrees is applied to all the planes directed to the outside of the product. In the corners four venting holes are placed to prevent the air from being trapped in the corners of the product. The six ejection pins also have two flat sides to create more venting holes, this is to make sure that the mould can be filled in half a second.

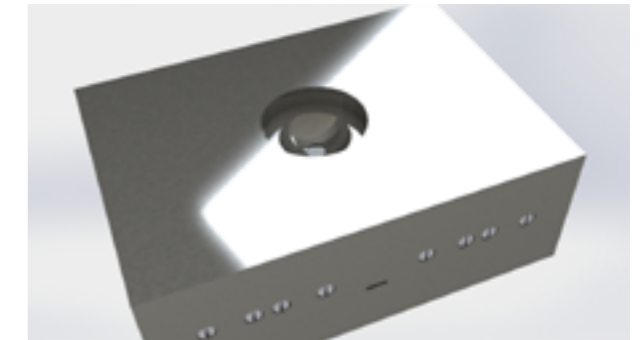
The diver incorporates a sharp edge which will cut the product from the tree when it is ejected.



Cooling channels: To make sure the components are properly and equally cooled, each component will have four cooling pipes of 4mm in diameter, these can be drilled into the core from the outside. The feed and exit pipes are two pipes of 6mm in diameter also drilled from the outside of the core. With this design, all possible flow paths through the pipes have the same length and resistance and therefore have an equal flow. The eighth 4mm holes are closed with small M5 screws.



Ejection pins: all the ejection pins are connected to a plate at the end of the cavity to guarantee a uniform ejection of the tree and components. A hole is milled on the back of the cavity and on the ejection-pins-plate for a spring to push the pins back before clamping the cavity back against the core.



Nozzle: the nozzle of the mould is designed according to the Bayer Mold Design Document. The diameter of the nozzle is read out of a graph with the filling volume and the filling time as parameters.





## Marketing plan

Naturally, with the creation of a new product, there was also a marketing plan developed. The segmented target has been chosen and a fitting promotional and pricing strategy have been decided. A cost estimation has been made and elaborated. To see the entire marketing plan,

## Segmentation

The similar set of needs and wants of the consumers in this market generates the demand for a business that will design their workspaces.

So, the traditional market that Ahrend operates in is the market that designs workplaces for businesses. Businesses often don't really have the time and/or the skills to design their own offices. Therefore they hire companies to design their workspaces and business interiors.

We will now look at different segmentations we could use to segment the market.

**Geographical Segmentation:** We could make a segmentation between the businesses that operate on a national scale and those who keep their businesses within one area. Another option is to operate nationally, but concentrate on the local businesses and adapt them to the area that they're in.

**Demographic Segmentation:** We can make demographical segmentations based on things like age, family size, family life, gender, religion, income etc. A lot of these segmentations have an influence on consumers' wants and needs. In our case some interesting segmentations would be income, family life and age. We will segment the market with these characteristics.

**Psychographic Segmentation:** With psychographic segmentation we divide the market by psychological/personality traits, lifestyles or values. We will divide our market in personality, lifestyles and values.

**Behavioral Segmentation:** Here we divide buyers

into groups on the basis of their knowledge of, attitude towards, use of or response to a product.

**Geographical Segmentation:** When a company either operates in just one or a few areas, or operates in multiple areas but pays attention to local variations, we call it grassroots marketing. Grassroots marketing is already pretty popular in for example America, but not a lot use it in the Netherlands. Grassroots marketing is used to make people more involved in your cause, making it more attractive for different individuals to join you.

**Demographical Segmentation:** These segmentations are important and help define your consumers. They describe the lives of the consumer. There are almost no companies that do not look at the demographical characteristics of their consumers.

**Psychographic Segmentation:** These segmentations are more specifically used. You can use these segmentations to add an extra dimension to your product. It makes your product align with your consumers lifestyle and values.

**Behavioral Segmentation:** With behavioral segmentation you would really adapt your product to your consumers capabilities. This is very important when developing a new product. Often designers find it hard to imagine that consumers might not understand how to use their product. Or the designer is not able to anticipate how consumers will respond to their product. This aspect is very important and greatly influences the effectiveness a product will have in a specific market.

## Targeting

The advantages of grassroots marketing are that it's a good way to really reach people. People feel more involved and personally spoken to. You will also have a better view into your different consumers, which allows you to develop very specifically enhanced product for a particular group of people. In Ahrends case this would be more fitting than operating on a national scale, because Ahrend is already focusing on their consumers and fitting their designs to different people.

As for the demographic segmentation, it might be interesting for Ahrend to look at age, income and family life. Age is always an important segmentation, because it defines a lot of the wants and needs of your consumer. Ahrend now focusses on the employer, thus on people with an age of about 21 – 45. They seem to develop for the somewhat younger generation of employers, looking at their modern products.

Income could also be important. Of course it is always important for a designer to design to the income of the client.

Family life could also be an interesting aspect for a company like Ahrend. They seem to be concentrating on the personal ways of living of their clients, and implementing this in their designs. If they have the desire to expand to another market and designing for living rooms, they could take family life into account, as they account for the employers working life now.

A plus from these demographic segmentations is that they are easy to measure, guaranteeing that you will have the right data.

Ahrend is already very invested in some of the psychographic segmentations. They focus on the healthiness of the employers they design for, and they wish to improve their lifestyles with their products. They want their workplaces to stimulate its employers and the way to achieve this is by focusing on the psychographic segment.

Behavioral segmentations could possibly be interesting if you wish to adapt your product to a very specific user.

The target segment for our product would be psychographic. With our lightwall we want to influence how the employer's work. We could also look at the Behavioral Segment if we wish to implement somewhat more difficult technology. In this case it might be profitable to look at your consumers and how they would react to and use our product.

Ahrend offers multiple products for one market and therefore they can be put in number three (see figure below). Our product will be put in number one, because we will design one product for one market.

With the psychographic characteristics we could find out how to influence employers work lives. We could use a pressure sensor to monitor how long employers have been sitting at their desk. When an employer has been sitting for too long we can alert him of this, by showing a different light color. They can now choose to stand or walk for a while, now that they know that sitting for such a long time is not healthy. It will now be easier for the employers to work healthy.

With our beamer and perhaps interactive beamer function it would be beneficial to make sure that our consumer actually know how to use these functions.

The four P's of the marketing mix: Product, Place, Promotion, Price.

Product:

Our product is the Lightwall. This product has some specific characteristics that will define its place in the market. For example, our product will have a lot of variety. You can buy different units that will extend the bought products and you can also choose between a variety of product versions when buying it.

We will make sure that the quality of the Lightwall is high, because this reinforces the idea of a luxury product. The design will also have to support this, which is why we strived for a sophisticated look.

Our brand name and our packaging and service will also be well thought and organized. To show our confidence in our product and to reassure people that it is indeed of high quality, we will be working with warranties.

Place:

Our distribution channel will only be Ahrend. Ahrend transports all their products themselves, and so our Lightwall will not be too heavy. In the inventory we will not only display our standard packages, but also their extensions and extra features.

Price:

Since we are introducing a new product to the market, the main pricing objective would often be survival. But as we are working for Ahrend, a business that sells their luxury product at a luxury price, we could also choose to base our pricing strategies on this, and price our project above the survival objective. Our pricing decisions will be set and discussed in a further section.

Promotion:

The promotion of our product will also have to be adjusted to the fact that it's a new product. At the same time we will have to keep Ahrend and their style in mind and stress our important and unique product point. Promotion will also be thoroughly discussed in a further section of this document.

## Marketing

If you want to sell a product you need a lot of marketing. People need to know that the product exists. Customers must be informed, persuaded and reminded, this can happen in direct and in indirect way. For Ahrend it is more important to start with personal selling. Ahrend has a lot of loyal customers and you can inform them with sales presentations and sales meetings. If we want to sell it to other customers we also can use telemarketing and TV shopping.

## Inbound and Outbound

There are a lot of options for Ahrend to use in marketing. You can divide this in inbound and outbound. At this moment outbound is more important because potential customers do not know anything about the product. Ahrend has to push the product to the customer. Ahrend can choose on which customers they want to focus. For now it is important to focus on small companies where there are ergonomic problems. Inbound marketing is not really an option except when there are coming companies with ergonomic problems.

## Communications

To select effective communications, you need 7 steps, this are the following:

### 1. Identify target audience

Target audience is the companies with ergonomic problems

### 2. Determine objectives

The objective is to make companies aware that the product exists and that it could be a high tech solution for some ergonomic problems

### 3. Design communications

Healthy lifestyle and better for your back

### 4. Select channels

The channel you use the most is advertising on the internet and using the contacts Ahrend already has

### 5. Establish budget

We will know the exact budget for marketing later when we have all the costs together

### 6. Decide on media mix

We only want to sell by internet because at this moment Ahrend does not have shops and that is also not necessary for product. In compare to other internet shops the difference for Ahrend is that they have direct contact with their customers.

### 7. Manage IMC

## Marketing channels

Advertising on the internet is the most effective way to reach Ahrends customers so they will buy the Lightwall. Because Ahrend already advertises via the internet. They also have direct customers. The advertisement on the internet should focus on companies with ergonomic problems. It should show customers how the Lightwall can be a high tech solution for ergonomic problems, so it is a healthy choice.

Advertising via the website of Ahrend is very cheap. The only investment is the domain name of the website and the required employees to maintain the web page. Thereby you can reach a lot of people via the internet.

## Product Strategy

Product levels:

Core benefit: Healthy workspace

Basic product: Light

Expected product: Different colors, different customized accessories

Augmented product: brand(Ahrend), installation, delivery, consultancy

Potential Product: agenda function, projector, inform about sitting behavior

### Product classification

If you want to sell a product you need a lot of marketing. People need to know that the product exists. Customers must be informed, persuaded and reminded, this can happen in direct and in indirect way. For Ahrend it is more important to start with personal selling. Ahrend has a lot of loyal customers and you can inform them with sales presentations and sales meetings. If we want to sell it to other customers we also can use telemarketing and TV shopping.

#### Unique Selling Point:

-Form: small and 35 long so it will fit on your desk without distracting you. Thereby it can be combined with your computer screen.

-Features: Inform you about your sitting behavior. Extra features: Agenda, projector.

-Customization: There is a basic design and you can add your own accessories.

-Style: Minimalistic and luxurious.

Service differentiation: easy ordering, delivery, installation, customer training and consulting (how should they use the Lightwall), the Lightwall will be repaired by Ahrend when it is broken.

3C's: Customer, Company and Competition

Does the customer perceive our product as different from the competitor?

-Yes because this light also informs you about your sitting behavior. Besides the LED strip is the basic design. All kinds of components can be added to the basic design to customize it.

### Communications

Marketing mix: 4p's

Product: Lightwall

Price: about €75,-

Place: office

Promotion: make sure businesses will find Ahrend on Google and talk to businesses in person

Offerings (what): Lightwall

Customers (who): (Flexibel) officeworkers

Processes (how): Extruding techniques, Injection moulding, apply light in a healthy and functional way

Presence (where): office

Market activities we still need to do: concept/product testing/prototype/ test customers/ test market/ launch

### Conjoint analysis

Product attributes	Levels
Design	Simple Average Luxurios
Weight	200 g 300 g 400 g
Price	€75 €100 €200
Lenght	35 cm 100 cm 200 cm
Amount of colours	1 2 5
Intensity of light	Not intense Medium intense Intense

### What do we choose:

Design: Luxurious but minimalistic, which fits best in the style of Ahrend

Weight: 300g, the lamp serves different needs, this means that the lamp should be easily moved. Therefore is should be as light as possible

Price: €75,-, Because Ahrend is a high end Business, so a high price fits their profile

Length: 35cm, because the lamp should be attachable to a computer screen and this is about the length of a computer screen.

Amount of colors: 2, In this way the office will not be full of all sorts of distracting colors of light, but people will still be informed about their sitting behavior with different colors of light.

Intensity of light, Medium intense, so it will not distract others, but you will have enough intensity of light to notice the change in color, or if the light is flickering.

When the new product is Launched, a new category should be adopted and a primary demand should be created for the Lightwall.

A product mix is developed: an assortment of different accessories to combine with the basis Lightwall LED strip.

The Lightwall fills the product line: we add new items in a product range. The market need should be served, not the internal need. The Lightwall serves the market need by informing employees about their sitting behavior to create a healthy lifestyle.

Price management

### Select the price objective

The main goal of the lightwall is to remember the employee to certain things, like appointments, sitting two hours in a row etcetera. Product-quality leadership is the pricing objective, because the ergonomics are very important for businesses, otherwise employees forget things, time to take a break for example.

### Determine demand

It is almost impossible to calculate an exact number of the products that will be sold. This is because there is no information about the demand of product is, because it is a new product in the market so there is no information about competitors or customers. Furthermore the product can be sold to the companies where Ahrend is already selling to but also to other companies or private consumers. The influence of the different features will not be taken into account, but it will only have a positive effect on the demand. But when there is a really good marketing campaign, the demand could be 30.000 products. In the rest of the product we used therefore this number of products that we can sell.

Now there is a demand we can calculate the costs of this batch. The costs can be divided into four different groups, namely material cost, injection molding cost, mold costs and overhead costs. All these costs will be explained below.

### Estimate costs

#### Material costs

For the material costs you need plastics and aluminium

Plastics : price \* needed material \* scrap =  
 $€1,10 * (169,9 * 1,04 / 1000) * 1,25 = 0,24$

Aluminium: price \* needed material =  
 $€1,6856 * (169,9 * 2,7 / 1000) = 0,77$

Furthermore you need an usb- c port and a led strip, for the usb c port you need a number of products.

Plug through hole[1]	€1,28
A battery[2]	€6,28
A Chip	€5,00
Some cables	€5,00
Total for USB Port	€17,56

It is also important to put a wifi-connector in the product, this connector can than be connected with the chair. Furthermore a led strip will costs €7,83[3]. The products will also be delivered with a diffuser, this will cost an extra of 6,69[4] for each product. In total this means that the material costs for each product are around the €30,00. This means that for 35.000 products the total material costs will be €1.050.000

#### Injection molding costs

Computer simulation shows we need a closing force 3 Ton. Therefore we need an available machine, in this case we will use machine of €150.000 with a total power of 60kW. The machine will amortize in 5 years, so it costs €600 each week. The interest will be 120 each week (interest percentage 8%, average investment 75.000)

The same simulation shows that cycle time is 13 seconds. And we use a multi-runner system of 4 products. There are only daily shifts, and there are 40 production hours in a week.

Thereby the production will be around the 44.000 products in a week. There will be a total of 30.000 products and the scrap will be around the 25%, this means that total production must be 37.500. This means that there is only 1 week needed. This means that the total injection moulding costs are:

Amortization	1 week * €600
€ 600	
Interest	1 week * €120
€ 120	
Energy	1 week * 40 * 60 * 0,30
€ 720	
Man Power	1 week * 40 * 40
€1.600	
Total Injection Molding Costs of this badge±	€3.000

#### Mold costs

The mold itself will cost around the €40.000. With this mold it is possible to make around the 120.000 products[5](depends on surface quality). So only one fourth of the mold is used, this means that that the real cost of the mold of this badge are 10.000.

#### Overhead costs

The overhead consists of all the other costs. For example marketing, administration and transport are costs who are defined by the overhead costs. For our product it is very important to have a good marketing campaign. Furthermore we would like to have good packaging material. The administration would not be much more than Ahrend is doing right now.

For the transportation costs it is possible to put all the products in one truck.

This means that the transportation costs will be 200 euros for each badge. Now there are made 30,000 products in one badge. So the transportation will not make a big difference.

For the marketing campaign there will be 300.000 euros spend, 200.000 of this will be spend to advertisements like commercials, billboards and in magazines. The other 100.000 will be spend on marketing on the internet, on the site of Ahrend and beyond. This altogether means that the total overhead costs will be 350.000

Total costs

So the total costs will be:

Material costs	€1.050.000
Injection Molding costs	€ 3.000
Mould costs	€10.000
Overhead costs	€ 3 5 0 . 0 0 0
Total costs of 30.000 products	€1.413.000

This means that the costs of each product will be 47,10 . A part of this cost is variable. The materials are of course all variable, the more products you make the more material cost you have. The total injection molding costs are 3.000 for every 44.000 products. The mold costs are 40.000 for every 100.000 products. And the overhead costs are for 5.000 variable.

### Select pricing method

Value based pricing

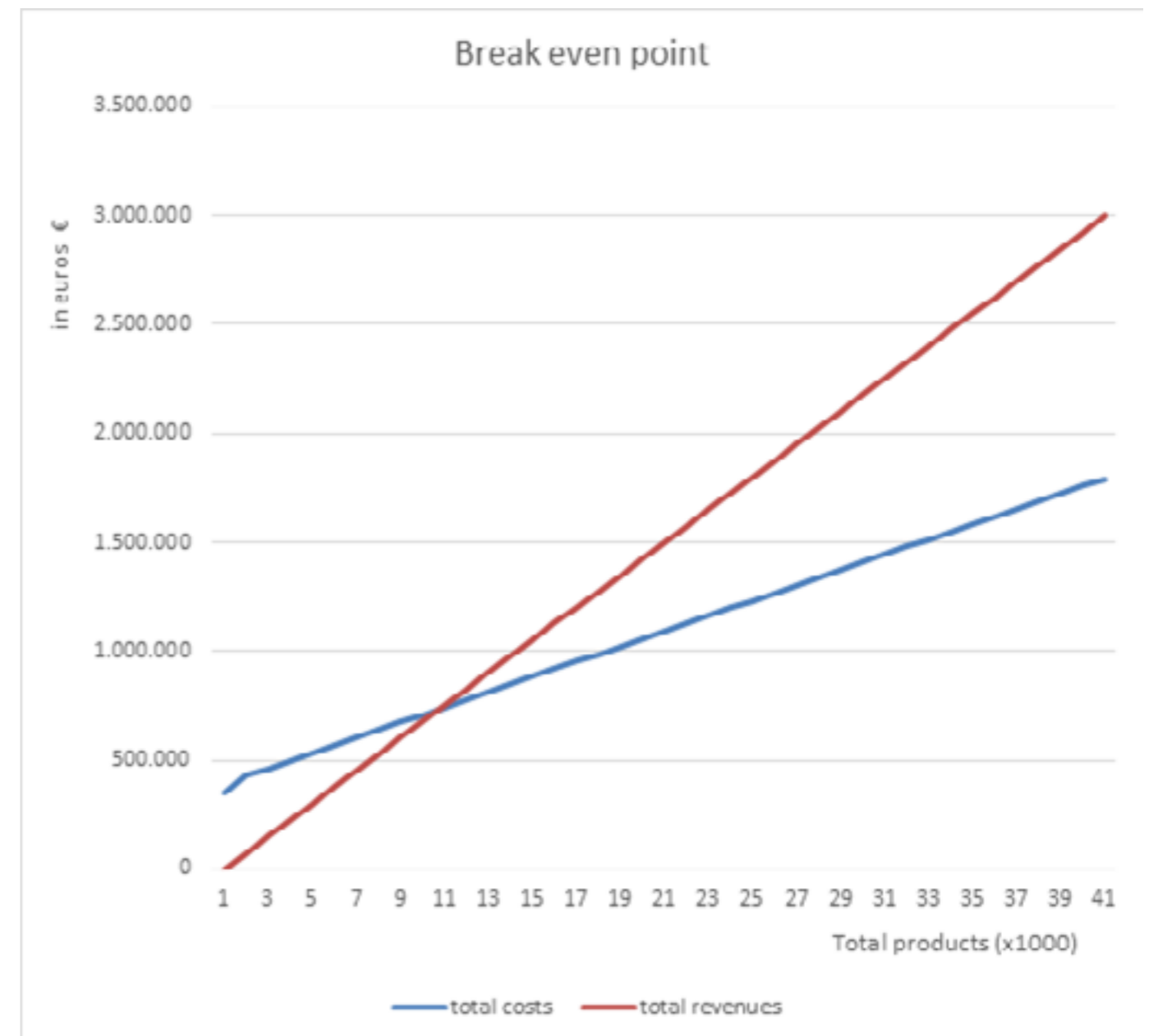
Because it is a luxury product we used value based pricing as our strategy. This means that the price will be defined as an extra of what the customer is willing to pay on top of the cost price. The cost price is €47,10. The possible prices for this product are €75, €100 or €200. The selling will be the highest with the lowest price, so the price will be €75. this is a profit margin Of 59%.

Break Even Point

The graph on the right shows the total costs and the total revenues. The break-even-point is the point where the revenues and the costs are similar. In this case this means the break-even-point is 9,825. So there need to be sold 9,825 products for making profit.

### Summary

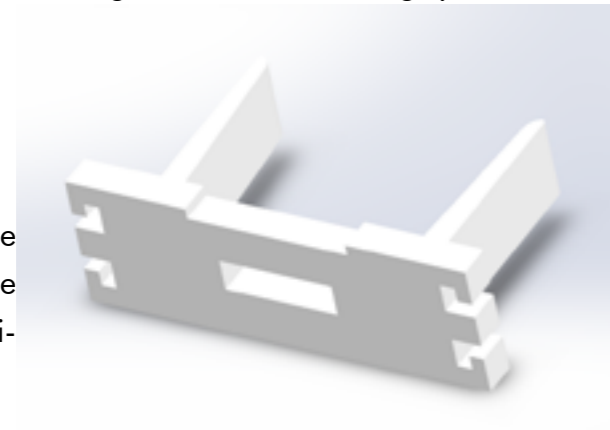
The lightwall is a product which increases the ergonomics in the workplace. This lightwall will be sold in the Ahrend store and webshop. Thanks to basic design the customer can add accessories to customize the product. The (basic) lightwall will be 30 cm long, 300 gram and it will deliver two colors. The price which is value-based is € 75,-.





## Designing in plastics

The best production process for the housing is extrusion. Therefore the cap on the end of the housing has been chosen to optimize for injection moulding. By using injection moulding it is possible to create a complex product which includes multiple functions like the hole for a USB-port, a cover for the housing and a self mounting system.



This design shows the cap which needs to be optimised for injection moulding.

## Requirements

Product: Cap made by injection molding

- Shape and dimensions
- Connection to another construction
- Material requirements and choice

Function		Specification
Dimensions	Length	30mm
	Height	2.5mm
	Width	10mm
	hole	Hole for usb-c
Mounting		Clamps
Production	Injection molding	Excelent
Thermal properties	User temperature	Between 0° and 60°
	Thermal expansion	Close to the range of aluminum
Load	Point in the middle	20N
Visual	Scratch proof	High hardness
Safety	Safety factor	2
Objectives	Weight	As light as possible
	Price	As cheap as possible

## Material choice CES

The temperature range is suitable for transportation during the winter and the heat from the LED or a cup of coffee.

The material should be recyclable, in accordance to Ahrends vision on sustainability. The product doesn't require a high tensile strength, so a fiber reinforced material is not needed for the product.

Properties	Value
Injection moldability	Excellent
Maximum minimal service temperature	0°
Minimal maximum service temperature	60°
Recyclable	Yes
Material family	Plastic(thermoplastic, amorphous)
Fiber reinforced	No
Maximum price	€4/kg
Minimum Elongation	10%

This leads to ABS(medium impact) which properties can be seen in this table.

Properties	Lower value	Uppervalue	Unit
Price	2.29	2.75	€/kg
Density	1.03e3	1.06e3	Kg/m <sup>3</sup>
Yield Strength	37.9	51.7	MPa
Elongation	5	60	%
Hardness-Vickers	10.4	14.9	HV
Max. service Temp.	63	77	°C
Min. service Temp.	-45	-35	°C
Thermal expansion	74	123	µstrain/°C
Injection molding	Excellent		
recyclable	Yes		

Narrowing the selection

-Thermal expansion close to the range of aluminium.

-The price of PC is twice as high.

- SMA, ASA+PC and ABS(heat resistant) have a very high thermal expansion, which is not favourable in combination with aluminium.

- ABS medium impact and flame retarded are left. - - The pro of the flame retarded is the flammability, but that is not that of an issue at our product.

-Therefore ABS(medium impact) has been chosen.

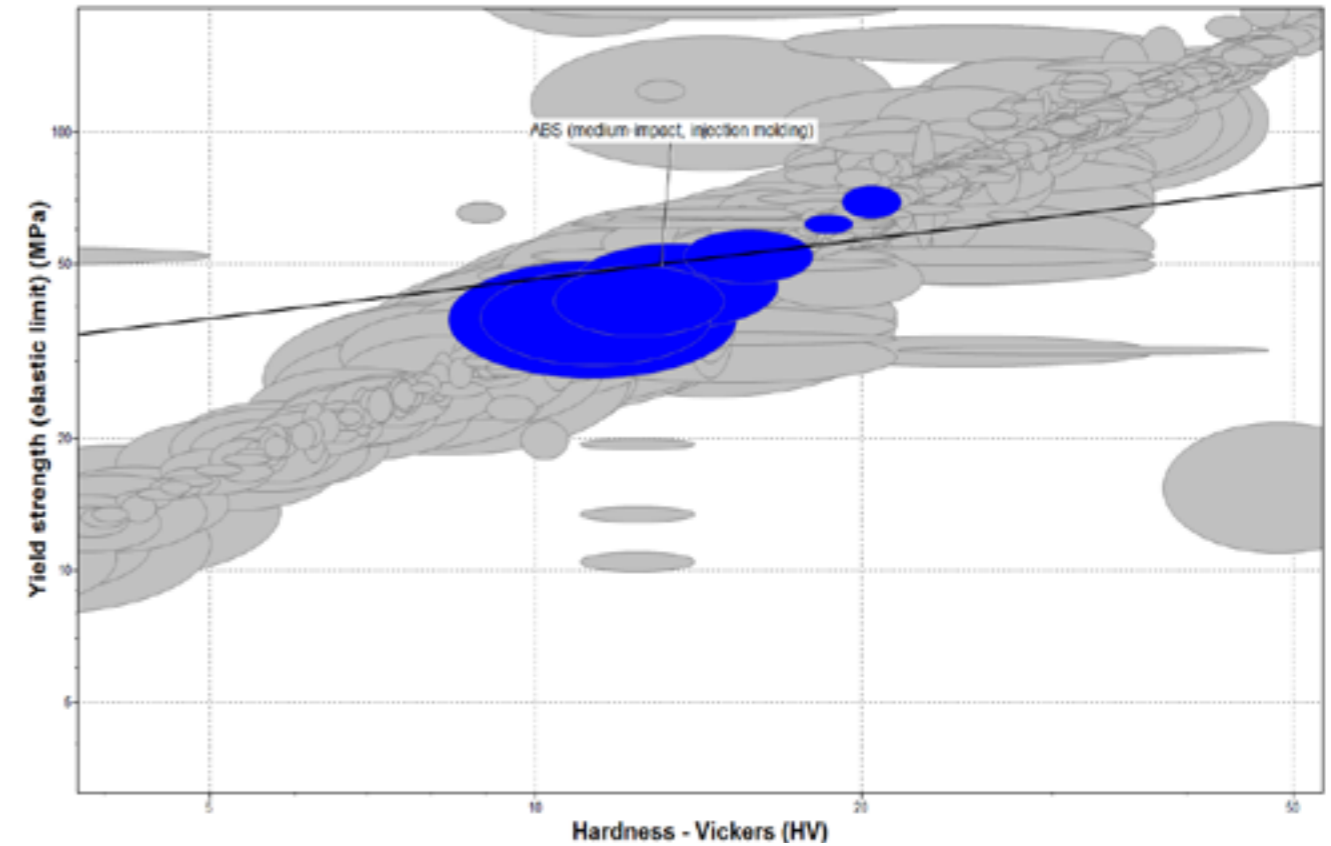
### 3. Results: 7 of 696 pass

Show: Pass all Stages

Rank by: Stage 2: Yield strength (elastic limit) (MPa)

Name	Yield strength (elastic limit...)
ABS (flame retarded, molding and e...	27.6 - 51
ABS (heat resistant, injection molding)	29.6 - 48.3
ABS (medium-impact, injection mold...	34.5 - 49.6
SMA (molding and extrusion)	35.9 - 55.0
ASA+PC (unfilled)	45.5 - 60
PC (high viscosity, molding and extru...	59.1 - 65.2
PC (copolymer, high-heat)	64.1 - 76

The material needs to have a high yield strength and a sufficient hardness. The yield strength is more important, so the performance index is 0,3. This leads to the materials which can be seen below.



## Mechanical

A possible load case is when someone misuses the USB port, which leads to a force on the middle of the cap.

As a worst case scenario this has been modelled using the following equations:

The estimated force is 20 N, which is submitted at the tip of the arrow.

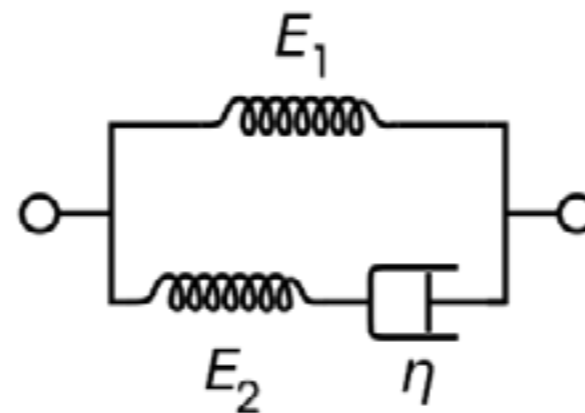
The minimal wall thickness is 2,28 mm.  
The maximum deformation is 0,55 mm.  
The maximum shear stress is 0,07 MPa.

For more details and calculations, click [here](#).

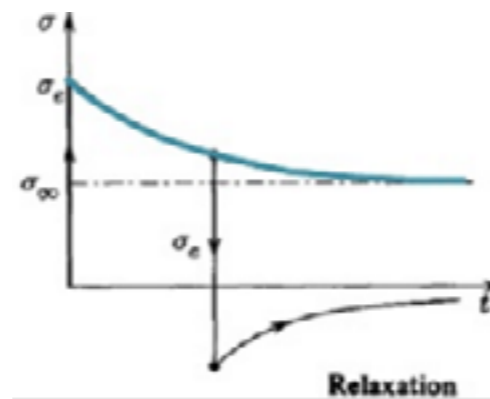


## Relaxation

It is better to prevent the cap from falling out of the product than to postpone it. Therefore the needed pressfit has been determined. By using this pressfit the cap will never fall out of the product, even when stress decreases due to relaxation.



The system can be described by the standard linear solid model, which is illustrated above.



There will be residual stress in the product, due to the parallel damper, as can be seen in the SLS model above.

The calculated fit is a -16 nm. Since this is not possible to manufacture the fitting will be between -24 and -15 $\mu$ .

To see the calculations, click [here](#).

## Collaboration

-The calculated wall thickness is 2,28 mm. It is not possible to injection mould this precisely. Therefore it has been normalized to 2,5 mm.

- The chosen material is amorphous, which has a slightly higher viscosity than semi-crystalline materials. That leads to smaller air vents in the mould.

- The wall thickness are roughly normalized for better injection mouldability.

- The draft angle is two percent, so the part can be easily removed from the mould.

## Final choice

Evaluation:

- Thermal expansion is still higher than aluminium, but as close as possible

- The maximum and minimum service temperature are sufficient for the product.

- The price is 2,29-2,75 EUR/kg

- Scratch resistance: relatively high scratch resistance

- The wall thickness is 2,5 mm

## COMPETITIVE ANALYSES



Led lights in a working office, dimmable but not able to change in color (different with our concept). This lamp is comparable to our concept; the differences can be found in the place. Because our concepts are below the monitor.

Dimmable LED based desk lamp.

Material: coated stainless steel.

Size: width 80 cm x height 52 cm

Price: €300 ex VAT



256-COLOR LED LIVING COLORS PROJECTION LAMP, ATMOSPHERE LAMP - WHITE

This compact Living Color Mood Light can create the right atmosphere at the right place. By using the slider on the back of the lamp you can choose from 256 colors, or you can make it change colors automatically.

€ 22, 95

This mood light is similar to our idea, only we will implement it into led strips. We also want to use the function of changing the function automatically, for example when you sit too long.



ELGATO AVEA DYNAMIC MOOD LIGHT

SPECS

iOS, Bluetooth, dimmable, 7 Watt, white and color light, € 42,99

This lamp has natural lights, which stimulates the employees. Science had shown that as workday nature contact increased, perceived stress and generalized health complaints decreased. Our concept is a different kind of lamp, but the natural lights we also want to implement.



Because employees sit too long behind their desks they invented a Sit-Stand Desktop Workstation Riser. Our concept indicates that you reached for example two hours in your chair. The led strip will give a sign which draws attention to take a break and walk for a few minutes.

\$299.99

## TARGET GROUP ANALYSIS



Employee that works individually

Tara, 24

Tara has a function within the company that allows her to work mostly individual behind her laptop. She's working on developing a program that reinforces and predicts project schedules. So she individually contributes to the company. Since she very often works on the same place for entire days, it's important for her to have an ergonomic workplace. And because she works for herself it's also important that she can concentrate well for long time. Tara doesn't like to have too much fuss surrounding her. What's also important is that she works in a 'healthy' place, considering the time she spends there. She should feel comfortable there, as this makes her more productive and it allows her to begin and end her day on a good note.



Employee that experiences stress

Gerard, 36

Gerard has a successful job where he is supposed to take some important decisions and sometimes deals with a lot of deadlines all at once. In the mornings he starts with a team meeting, after that he is called to another meeting. At noon Gerard has a break of an hour, which he uses to lunch, relax and chat with his coworkers. After that he spends a couple of hours working on his individual deadlines and he ends the day with giving a presentation about the company he's employed at.

Obviously, Gerard has a busy schedule and needs to perform a number of different tasks within one day. This causes him to stress faster. Between all these different chores Gerard has some short breaks. He often barely has time to get some coffee,



before he has to worry about the new task again. What Gerard would like is a way to clear his head between his assignments. This would reduce his stress and it would allow him to concentrate on his assignments better. This works because happier people are more effective in their work and in the end this yield a better result.



## TARGET GROUP ANALYSIS



Employee that works in groups

Leo, 26

Leo works in a designing company. Here he often works with others and this is also what he like about his work. In this way he connects with a lot of people and it makes his work dynamic. Leo often has meetings to attend. These can be meetings with colleagues to generate and present ideas. And these can be meetings with other parties where he has to represent his company and present their results. All these meetings cause him to sometimes stand for a long time and sometimes sit for a long time, depending on whether he has to present or listen to others. After his meetings he headsto the cafeteria to relax. Here he often searches for the company of his colleagues, but sometimes he just wants some time for himself in these breaks. What Leo needs is a place where he can be social, but also choose to relax on his own. A place where he can help others with their works, but where he can also sit in silence. Because of his varying work, it his needs for either a chair or just a place to stand varies as well.



After a long meeting where he's had to stand, he would like to sit down for a while. And after a long sitting of listening to others, he would like the chance to stretch his legs.



Employer that oversees the work of other employees

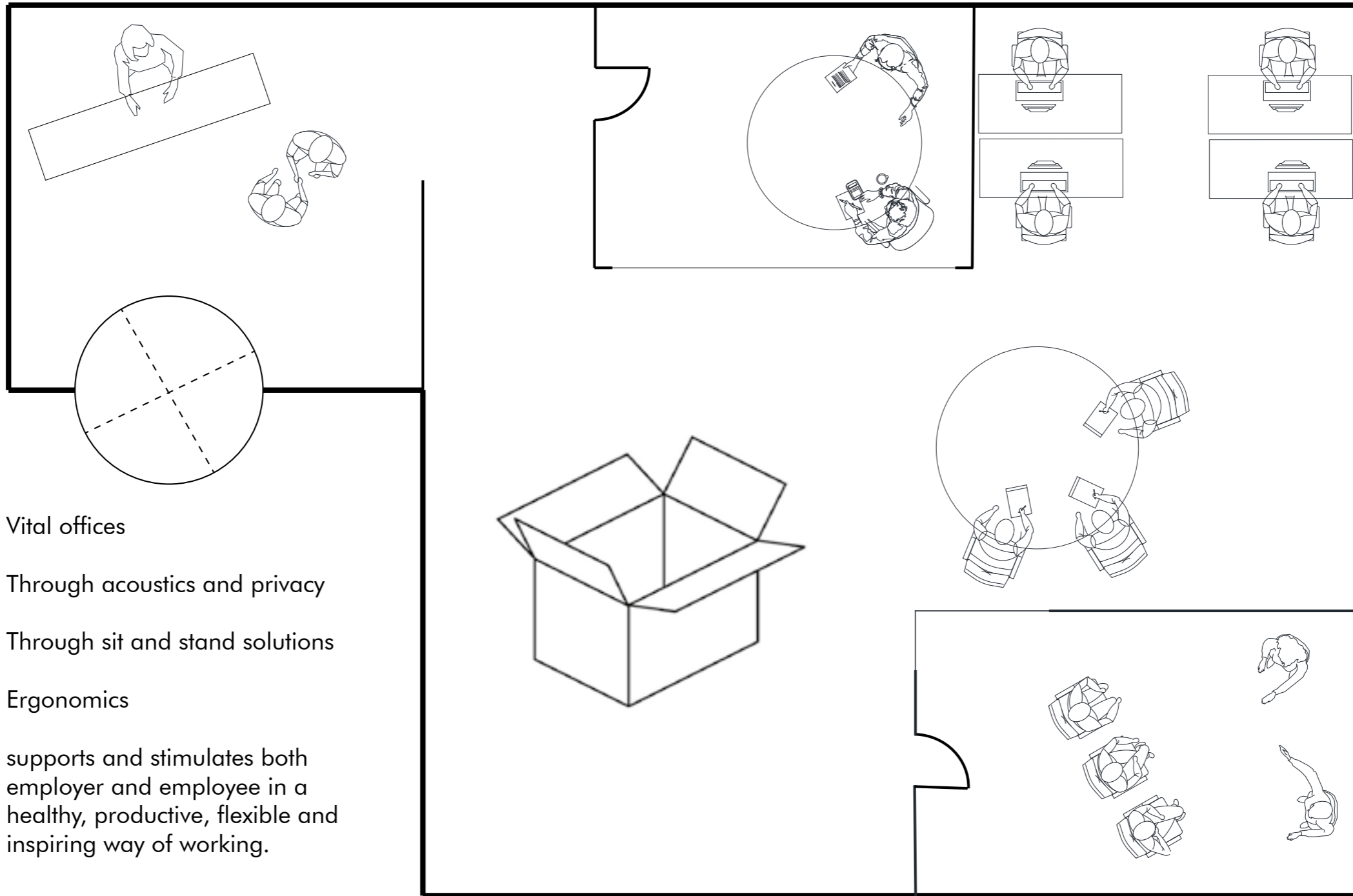
Stella, 41

Stella has a function where she directs others. She has to keep track of everything that happens in her company and make sure that everyone is able to do their jobs. For Stella it is very important that the work of her employees is being made as easy as it can be. She is always invested in her employees and listens to their wants and needs. When an employee comes to her with an innovating solution that will help the employees to work more efficiently. She also tries really hard to get this point across to the head of her company, whom makes the executive decisions. She firmly believes that small changes can help their employees work more efficiently, whether it is by helping them concentrate or by simplifying their work.

SMART WORKPLACE

The Internet Of Things

Digital innovation



Flexible workspaces

Vital offices

Through acoustics and privacy

Through sit and stand solutions

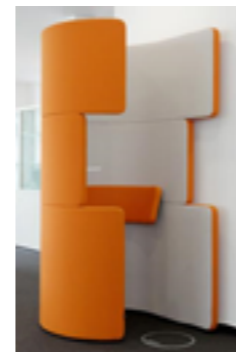
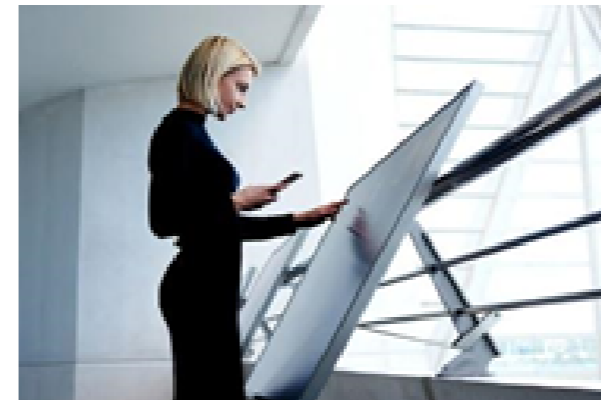
Ergonomics

supports and stimulates both employer and employee in a healthy, productive, flexible and inspiring way of working.

people to come together for learning, collaborating and social interactions

international availability of comprehensive workspace

## MARKET RESEARCH



The goal of this design process is to create a smart workplace for employees. Several smart workplaces have already been created. Therefore it is important to do a market research in order to gain insight into the spectrum of products on the market. In this market research the accessories are pointed out.

There are several accessories in common use at working places. Green/nature and light is an aspect which you can see a lot in workplaces.



Healthy, productive, flexible and inspiring way of working

### Inspiring

An employer should strive to make work enjoyable and satisfying for employees for other reasons than their paycheck as this increases the quality of work done, reduces employee stress and increases loyalty to the company. Various notions exist on what makes a job inspiring and motivates employees. Some factors that frequently show up:

- Autonomy
- Empowerment of employees
- Trust in and respect towards employees
- Varied tasks

### Productive

Productivity of a company or organisation relies on many factors, of which a selection will weigh most heavily depending on the situation. Some important aspects to keep in mind: <https://www.clearbooks.co.uk/themes/revo/media/white-paper/improve-productivity-in-workplace.pdf>

- Theory of constraints / limiting factor <http://www.leanproduction.com/theory-of-constraints.html>
- Successful communication
- Task-switching for employees
- Frequent breaks (ex: pomodoro technique)
- Clean, tidy workspace
- Workspace suited to type of work
- Progress tracking & management
- Minimum amount of meetings

### Psychological health

In general:

[https://oshwiki.eu/wiki/Psychosocial\\_risks\\_and\\_workers\\_health](https://oshwiki.eu/wiki/Psychosocial_risks_and_workers_health)

- Stress

[https://oshwiki.eu/wiki/Work-related\\_stress:\\_Nature\\_and\\_management](https://oshwiki.eu/wiki/Work-related_stress:_Nature_and_management)

- Balance challenge - perceived capacity of employee

- Several theories:

Person-Environment theory: bad match employee - task/workload

Job Demand - Control theory: employee perceives lack of control

Effort-Reward theory: (perceived) disturbed work / reward balance

### Social health

Bullying

Hierarchy: Leadership: [https://oshwiki.eu/wiki/The\\_importance\\_of\\_good\\_leadership\\_in\\_occupational\\_safety\\_and\\_health](https://oshwiki.eu/wiki/The_importance_of_good_leadership_in_occupational_safety_and_health)

- "Ten Platinum Rules for Better Management"
- Remember you are working with people (Do not exhaust them, People are not machines, Treat them with dignity and respect)
- Listen to and talk with your people (Be inclusive, Do it frequently, Value and develop people skills in supervisors and managers)
- Fix things promptly (Don not let issues fester, Keep people informed of progress)
- Make sure your paper work is worth having (Keep it current, Make sure it is meaningful)
- Improve competency in OSH (Particularly at management level)
- Encourage people to give you bad news
- Fix your workplace first
- Measure and monitor risks, that people are exposed to (Don not just react to incidents: fix things before they happen, Control risks at their source)
- Keep checking that what you are doing is working effectively (Are you achieving what you think you are?)
- Apply adequate resources in time and money

Exclusion

### Physical health

- Prolonged sitting / standing

[http://revdesportiva.pt/files/form\\_cont/Sitting\\_Time\\_and\\_Mortality\\_from\\_All\\_Causes.pdf](http://revdesportiva.pt/files/form_cont/Sitting_Time_and_Mortality_from_All_Causes.pdf)

(Increased mortality, Standing/sitting desks, Frequent active breaks)

- Bad posture (Ergonomics)
- Nutrition (Healthy lunches)

Daylight / lighting

<http://www.aasmnet.org/jcsm/acceptedpapers/jc-274-13.pdf>

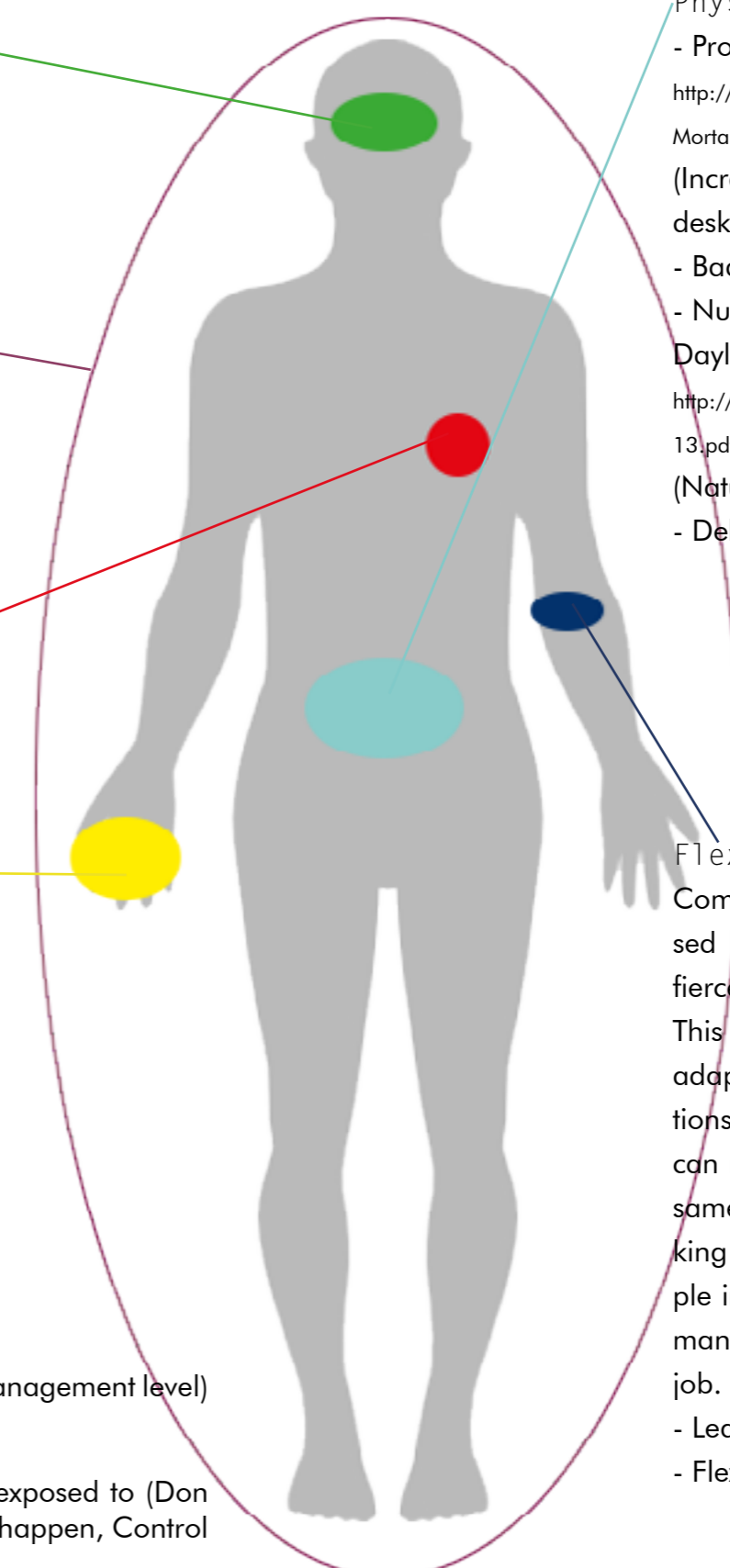
(Natural light, Sleep quality)

- Dehydration

### Flexible

Competition within markets is, with increased (and ever increasing) globalization, fiercer now than it has ever been before. This means companies need to be able to adapt quickly to new strategies and situations. That, in turn, means that employees can no longer expect to be performing the same sorts of tasks every day of their working lives. This entails quitting to put people in boxes and adopting the attitude that many skills will (need to be) learned on the job.

- Learn on the job
- Flexible breaks



SPECIALISATION (1)  
 DESIGNING IN PLASTICS  
 Mechanical calculations

Assuming  $F = 20\text{N}$ ,  
 $M = \frac{1}{4} F \cdot L = \frac{1}{4} \cdot 20 \cdot 30 = 150 \text{ N/mm}^2$

$$\sigma = \frac{My}{I} \rightarrow I = \frac{My}{\sigma}$$

$$\frac{1}{12} \cdot 10 \cdot x^3 = \frac{150 \cdot 0.5x}{17,25}$$

$$x^2 = 450/86,25 \rightarrow x = \sqrt{450/86,25} = 2,28 \text{ mm}$$

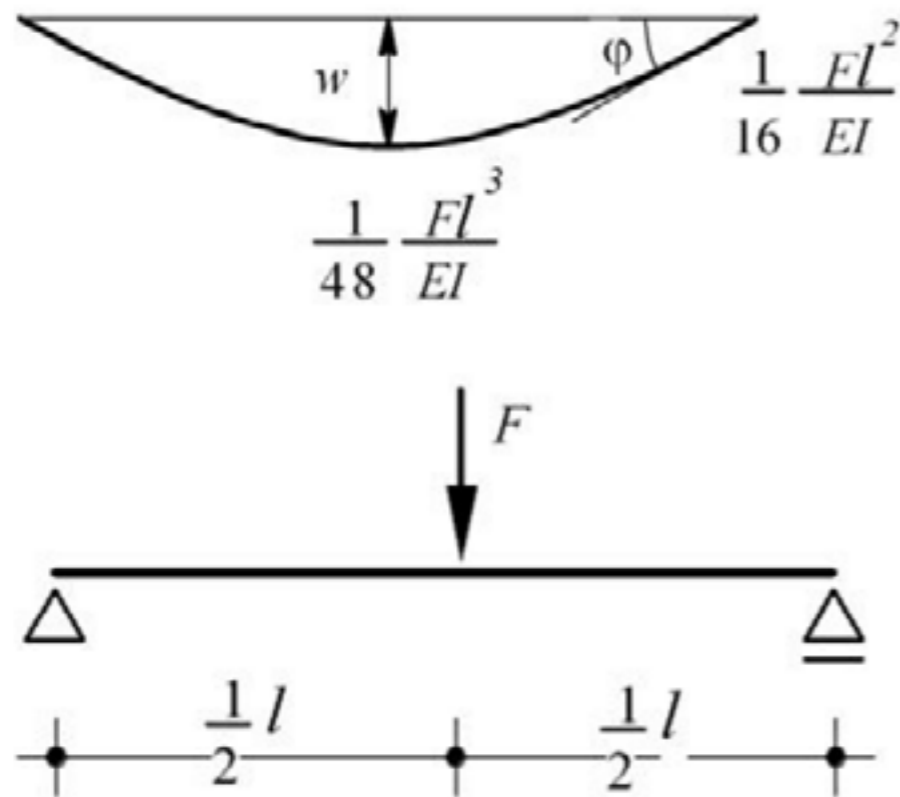
$$I = \frac{1}{12} \cdot 10 \cdot 2,28^3 = 9,879$$

$$v = \frac{\Gamma \cdot L^3}{48EI}$$

$$= \frac{20 \cdot 30^3}{48 \cdot 9,879 \cdot 2,07 \cdot 10^3}$$

$$= 0,55 \text{ mm}$$

Shear stress  $= F/A$   
 $A$  = the cross-sectional area and  $F$  the applied force  
 $A = 150 \cdot 2 = 300 \text{ mm}^2$   
 $\tau = F/A = 20/300 = 0,07 \text{ Mpa}$



Relaxation calculations

Assumed  $E1 = E2 = 1/2E$   
 $E = 2 \text{ Gpa} \rightarrow E1 = E2 = 1 \text{ Gpa}$

The maximum acceleration is  $10 \text{ m/s}^2$   
 $F = m \cdot a = 0,7 \cdot 10^{-3} \cdot 10 = 0,7 \cdot 10^{-2} \text{ N}$

$F = 2 F_w \rightarrow F_w = 1/2 F$   
 $F_w = \mu \cdot F_n$  ( $\mu$  for aluminium/ABS(plastic) is around 0,25)  
 $0,35 \cdot 10^{-2} = 0,25 \cdot F_n$   
 $F_n = 1,4 \cdot 10^{-2}$

Considering the contact area is  $1/4$  of the total area.  
 $A = 1/4 \cdot 70 \text{ mm}^2 = 17,5 \text{ mm}^2$

$$\sigma = F/A = 1,4 \cdot 10^{-2} / 17,5 \cdot 10^{-6} = 800 \text{ Pa}$$

$$E \cdot \epsilon = \sigma \rightarrow \epsilon = \sigma/E = 800 / 1 \cdot 10^9 = 8 \cdot 10^{-6} \text{ mm}$$

$$L = 2 \text{ mm}$$

$$\delta L = 8 \cdot 10^{-6} \cdot 2 = 1,6 \cdot 10^{-5} \text{ mm}$$

Documentation

Databases:  
 CES Edupack  
 Rolof Matek tabellenboek  
<http://www.altmedsales.com/bags-viscoelastic-polymer-relaxation-time.html> (relaxation curve)  
<http://www.werktuigbouw.nl/calculators/image/vergeetmenietjes.jpg>  
 (vergeet-me-nietjes)