1. OBJECTIVES & STRATEGIES

GOAL
Gaining high market potential

option 1: HIGH COST
INJECTION MOULD
+
intended shape
2K colors of our choice
-
expensive even at a high production rate

Higher selling price per product
Sell supplementary products
Extend the market to foreign countries
Appropriate selling price
Sell supplementary products
Monopoly in Dutch market

Grabbers for other use
Replaceable blades
Replaceable grip
fruit, vegetables, etc.
color, size, material

option 2: MED-LOW COST
SILICON INJECTION MOULD
+
feastible cost
shape has to change into simpler form
integrate parts into a few
-

Replaceable blades

option 3: LOW COST
SHEET METAL BENDING
+
cheapest way to produce
shape has to entirely change into a basic form
integrate parts into a few
colour will be limited to ones that can be painted to metal
-

Replaceable blades

Figure 71 <Marketing strategy options>
The overall objective is to gain the most revenue by selling this new harvesting tool. We think there can be three possible options to achieve the goal. Different options will have different strategies to obtain the goal. The strategy for each option is introduced in the following sections.

Option 1: Make it as a high quality tool at an expensive price

Option 2: Make it as a medium price tool that is specific for pepper harvesting

Option 3: Make it as a very cheap tool for pepper harvesting

1.1. Business model
Business model for all the options should be a direct selling from a manufacturer. The reasons are listed below.

Advantages of direct selling from a manufacturer
- It allows a manufacturer to reach buyers directly and thereby shorten the distribution channel
- Based on efficiency, improved customer service and a better understanding of customer preferences can be achieved.
- This product is for a specific target segment which will spread by its word of mouth. Branding is not so necessary.

1.2. Option 1: Premium product for extensive use
This option requires higher investment money due to the injection molding method. Injection molding will produce a high quality design with the ergonomic shape that we designed, and also give a variety of colour choice without restriction.

High quality-high price
Since the product will have high quality, the strategy should be to gain profits by selling it at a high cost (approximately 20 euros or more).

Supplementary products
However, in order to regain the investment money it needs other sources of income as well. Therefore, we suggest providing supplementary products. This strategy can charge for associated products (blades, grip, and grabber) that are indispensably tied to the basic product.
Blades will need to be replaced frequently; therefore it can be sold as separate packs of blades (e.g. one pack holds 100 blades). Moreover, the grip part that has the most contact with the user can also be sold separately. It can even be sold in different colours, sizes, and material so that the user can adapt the tool to his preference.
We also think different kinds of grabbers (see figure below) can be introduced so that the tool can be used for other kinds of vegetables or fruits. The tool will then have the potential to extend to other vegetable markets in the future.

Figure 72 <Variation of the product>
Extend to foreign markets

To gain more market share, it needs to expand to foreign markets that have similar needs. For short-term, the objective would be to gain as much market potential within the Netherlands, and prepare launch of the product in other countries. However, for long-term, its objective should be to penetrate into other greenhouse pepper growers in other countries.

1.3. **Option 2: Quality tool specifically for pepper harvesting**

This option will use the silicon moulding method which will give a less end-quality for the product in comparison to injection moulding. Although it can give a free shape, it will not be as precise. Also, we will need to consider changing the complicated forms into a simpler shape, and combining parts to decrease the total number of components. However, the production cost will be a lot cheaper than the injection moulding.

**Right product for pepper harvest**

Since the production cost of this option will be less than option 1, it does not need to consider so many ways to regain the investment costs. Since we have designed this tool specifically for the use of pepper harvest, it should be introduced just for that market. Without introducing any additional supplementary products except for additional blades they can replace when it gets blunt, the selling price does not need to be high. This will be more attractive for the end users.

**Monopoly in Dutch market**

The strategy we suggest is to make a monopoly agreement with growers’ association so that this tool can be used by all the pepper pickers in the Netherlands. This can guarantee high return on investment.

1.4. **Option 3: Improved tool for pepper harvesting**

This option will use the sheet metal bending production. It will be the cheapest production method among all the options; however will have many restrictions to the choice of material and colour. Also, our design needs to change into a basic form which means most of the ergonomic aspects we have considered will not be visible. It will be a less comfortable tool, but cheaper.

**Cheapest solution for pepper harvest**

This option needs to emphasize the cheap price as the main advantage. It needs to emphasize the functional advantage against existing knife.

**Monopoly in Dutch market**

Similar to the second option, the best way to penetrate into Dutch market is to make a monopoly agreement.
2. ADVISED STRATEGY
Among three options, we want to advise option 2 (Quality tool specifically for pepper harvesting).

2.1. Why option 2
We advise options two for the following reasons.

Scope of research The scope of research of this project has mainly focused on the pepper industry in the Netherlands. While other foreign markets might be the potential users, it is risky to introduce the product at this point to foreign countries because of the lack of research. Countries with different climate and geography might need tools that are different from what we have developed. In such case, the product will need adjustments before they can be marketed to different markets. Therefore, the market introduction strategy for this tool should focus on the Dutch market first. If the product is penetrated into the Dutch market and brings certain amount of revenue to make up for the investment costs, then the company can invest in R&D for extending the market.

It’s a functional product This product is a functional product developed for solving a specific problem during the pepper harvest. Although supplementary products (such as different size grips and grabbers, etc.) can bring more benefits, we cannot be sure if the target users are willing to spend so much money on them. For the first introduction of this new product, it is better to focus on the main functions and produce just what is needed. Make it simple! The second option offers just what is needed specifically for the pepper growers.
2.2. Core strategy

The core strategy for option 2 is explained below.

Focus on the potential benefit of using the knife

In order to make it easy to understand, we take van Dijk as our example to illustrate the potential revenue a pepper growers can gain form applying the new tool. For van Dijk, the average selling price for the pepper now is around €1.3/ per Kg (at the breakeven point), and the total production a year is around 5,300,000Kg. If the quality of the pepper can be insured, the selling price to the wholesalers can thus be possible to increase. In table 1, the calculation shows the potential revenue that can be generated due to this fact. With 1~1.5% increase of the selling price/ Kg, it can bring extra earnings from €70,000~100,000 per year. As Aad van Dijk mentioned in the meeting, 1 cent increase of selling price is very feasible especially for the retailers if the growers can guarantee higher quality of pepper. Besides this revenue, there is another potential one. According to the data from van Dijk, there is a 0.5% average damage rate of the total production, which is 5,300,000 Kg/ year. If the damage rate can be controlled, it means that this percentage of pepper can thus be able to sell. It shows in the table 2 that with the increase sale of the pepper, which before are being damaged and abandoned, the potential revenue van Dijk can gain form those extra sale. With even half of the increase of the amount of 2.5% sale, it yields a €17,225 increase in revenue a year.

<table>
<thead>
<tr>
<th>The average pepper selling price/ Kg (at the breakeven point)</th>
<th>The total production of the pepper/ year</th>
<th>The increase of the selling price</th>
<th>Increased revenue</th>
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Table 1 <The calculation under the situation of the increase selling price>

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<th>The increase sale of the total production</th>
<th>Increased revenue</th>
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<td>5,300,000 Kg</td>
<td>0.25%</td>
<td>€ 17,225</td>
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</table>

Table 2 <The calculation under the situation of the increase amount of pepper selling>

1 year product life cycle with replaceable blades

The strategy we suggest is to manufacture the tool as a product with 1 year life cycle, but sold with separate packs of blades. One pack can hold 100 blades which will allow approximately 3 months of use. Compared to the existing knife which was changed within 2-3 months, the new product has the image of a durable product.
Communication
message

The core value we intend to convey is by using the tool, both the quality of pepper the worker can be improved. The improvement of the quality which can result into the increase of the pepper selling price; the ease of the pain in continuous cutting and the motivation of the worker can facilitate higher quality and efficiency work.

2.3. Marketing mix

2.3.1. Product

Preventing damage during harvesting process

The blade of the tool is covered thoroughly within the cover, so during the harvesting process, it is nearly impossible to damage the peppers. This solves the main problem of using the existing knife, unintentionally cut the peppers, and most of the time without noticing.

Ergonomically designed

According to the result of our previous user test, a lot of pain in thumb was generated by using the existing knife. The new design can solve this problem by providing a different way to hold the tool and cut the pepper by stronger muscle.

Solves the specific problem of harvesting pepper

Due to the unique way to harvest pepper (to prevent rotting, the pepper should be cut in the middle of the knot). This new design is specially designed for the pepper harvesting, which is not seen in the market now.

Motivation design

The grip and the cover of the tool is designed to be changeable, which can be personalized and thus motivate people.

Affordable price

For the short term resolution for harvesting pepper (human power), this design is an affordable and a worth investment (€ 10/ per tool) for the growers. The analysis of the possible benefit it can bring can be found in 11.1 CORE STRATEGY.

2.3.2. Price

The total cost of the material, production, and assembly cost are in total around € 1 (detailed information can be found in chapter 2.9 Production cost estimation). And with 30~40% inbuilt profit, we expect the selling price of the new designed tool to be €10.

• Selling Price = Total Cost + Inbuilt Profit (%)
2.3.3. Place

Grower union: **Target group**: Dutch greenhouse pepper growers
Dutch pepper growers have their own union and share their knowledge through LTO Groeiservice, so the best way to penetrate this market is through the acceptance or agreement of this union or association during the regular meeting between these two parties. An example is shown in the figure 73. The promotion at a grower’s website can have a link leading to other websites that sell the product.

Websites and specialty tool stores: **Target group**: Amateur users
For our special designed tool for pepper harvesting, it is better to distribute it to some specialty websites or tool stores. For example, there is a company that owns a website called Brinkman Agro B.V. that sells a wide range of tools and some special tools for specific cutting and is able to shop online which is very suitable for selling our tool. Making the product available online is well-suited for this tool.
An example of the product being sold at Brinkman Agro B.V. is shown in figure 74, along with a pop-up window that will appear when the customer buys the product.

Figure 73 <Example of promotion at van Dijk’s website>
Special knife just for pepper harvest

Did you have to worry about blade cuts into the pepper?
Ever worried that unnoticed damage pepper will be in the box?
The new design pulls the stem and cuts it inside the knife to ensure that there is no blade cut into the pepper.

>> Invest in high quality of pepper!
   It can give you higher selling price per a box of pepper.

**Download onderdelen Vibri Vario**

<table>
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<td>pepper knife</td>
<td>1</td>
<td>zak</td>
</tr>
</tbody>
</table>

Figure 74<Example of product being sold at Brinkman website>
2.3.4. Promotion

Who
As mentioned before, our main target group will be the Dutch growers, so the promotion of the tool will be mainly focus on the Dutch pepper growing union.

What to communicate
The main message we planned to commute is: with the proper use of the tool, it will not damaged the pepper during cutting. Quality of the pepper is one of the most concerned issues of the greenhouse pepper growers. An example is shown in figure 75 and 76.

How
The first clients we will approach are van Dijk, and LTO Groeiservice, the problem owners of this project and have been collaborated with the development process throughout the project. Another possible and weighty stakeholder is Mr. Michel, the head of the Dutch pepper grower union, who also joined the development process and provided valuable suggestions. Since these three stakeholders understand most the value of this tool, they can be the first clients to accept this new developed product. After the acceptance of these three main stakeholders, the market penetration process will be easier with the system working inside the pepper grower union.

When
The new product can be presented during the regular meeting of the Dutch pepper growers and LTO Groeiservice. The reason is in this meeting, they share new knowledge or improvement in pepper growing, and the product can thus be fast spread during this knowledge sharing progress.
A knife specially designed for pepper harvesting

No more blade cuts into the pepper!
No more damage!

Increasing the quality of pepper increases the entire box of pepper
Increasing the quality of pepper can give us higher selling price

Interested?
Read more about the solution from the research at LTO Groeiservice!

Figure 75 <Example of promotion on van Dijk’s website>
Pepper knife

1. No more damaged pepper
Did you have to worry about blade cuts into the pepper?
Ever worried that unnoticed damage pepper will be in the box?
The new design pulls the stem and cuts it inside the knife to ensure that
there is no blade cut into the pepper.

>> Invest in high quality of pepper!
It can give you higher selling price
per a box of pepper.

2. Less pain in thumb and fingers
Did your workers complain about the
pain in thumb from using the knife?
Did you notice any long-term sick
leave caused by RSI?
The new design pepper knife uses the
bigger muscles of your arm and
provides a more ergonomic process of
cutting.

>> Invest in high quality of work place
and work process!
PART 5. FUTURE IDEAS

Since our goal was to develop a short term product (5-10 years) that can solve the problem of the existing knife, we developed a handheld mechanical tool which will bring higher quality of pepper and work. Also, we have suggested a wearable tube and other suggestions to improve the problems that one can face when using the wearable tube.

However, we had some ideas that are more future oriented which might be of interest for later use. They are shortly summarized below. We hope these future ideas can be used for other projects in the future.

1. FUTURE IDEAS

1.1. Use of Electricity for the tool

The essential way to solve the pain during harvesting is to replace the squeezing force form the muscle by electricity driven power. Another advantage of using electricity tool is that the process can be faster and be more stable. Thus, we suggest that in the future, with the improvement of the container or the overall greenhouse system, to include the possibility of electricity supply.

Robots and future use

The Pep can be used in the future as a robot extension: the grabbing part and the mechanism can be used unchanged, and instead of human power driven gears, the gears will be driven by electricity. On the robot arm will also be a detection device that is able to find the right spot to cut and to collect the right pepper. The right part to cut the stem is less wood-like than the total stem; here this part has a different density and colour (see the brown line on the stem in
the picture). Here for detection of the right location can be realized by the use of a density measuring sensor or light sensor. Important to mention is that even though these techniques are nowadays possible, a robot is much slower than a human in detecting a pepper and the cutting spot. It is unclear in what time-span a robot can actually be faster than a human, on this field.

1.2. Automatic glove

![Automatic glove illustration](Figure 79<Glove idea>)

The most natural way to get the fruit from the tree is to pick it. This is the main thought of this idea. This glove is designed to have cutting knives on it (the grey part on the glove) to make possible picking and cutting the pepper at the same time.

1.3. Cylinder greenhouse

![Cylinder greenhouse illustration](Figure 80 <Greenhouse container>)
Each paprika plant is covered by a cylinder glass tube, function as a small greenhouse, which the temperature and the humidity is controlled to be the best condition for the paprika plant to grow. The benefit of this concept is to save the heating energy and can also improve the overall environment in the greenhouse which now is more humid, and stuffy inside, etc.).

1.4. Pepper damage detector

One of the main troublesome for the pepper grower is to get rid of the damaged peppers in order to improve the overall quality. However, during the harvesting process, the unintentionally cut on the pepper is usually small and not easy to discovery. This idea is created to solve this problem by a built-in detecting device in the knife. When the knife cut into the pepper, the detector will show a warning signal (light, sound or smoked, etc.) to warn the user that the pepper has been damaged. This kind of detecting device can be a PH detector, which can distinguish the different PH value between the stem and the pepper (the result of the different PH value between the stem and the pepper can be found in the previous report).
1.5. Scanning device for sorting system

For now, there is around 0.5% damaged pepper in the harvested pepper. Although it is not much comparing to the whole product, damaged pepper will decrease the overall pepper quality, which make the growers have fewer bargaining power against the buyers. As a result, growers are eager to get rid of all the damaged pepper. There are now workers in charge of recognizing those damaged peppers, however, small damage is not easy visible by human eyes. The idea of the added on scanning device is than thought: during the sorting process, a scanning device can be added on to detect the damaged pepper, use for example the X-ray or other scanning techniques to detect and make a warning signal.
1.6. Automatic system in the greenhouse

The moving floor can make the transportation inside the greenhouse faster, thus improve the efficiency.

1.7. Motivating gadget

Motivation is an important aspect for workers, however it is not paid much attention. We thought it would motivate the workers if there is a product that creates some change in the greenhouse where it might be stuffy and mundane. The idea is to have a personal projector that can be attached in the container for each worker. They will be able to project pictures or images that motivate them.

This kind of projector can also be used in the resting place. The workers will relax and recharge during resting in this space. Integrating motivation design in the resting space, such as the natural environment background or soft background music, can relax the worker with both body and mind and can thus recharge with fresh energy and be motivated.
PART 6. REFLECTION

1. PRODUCT

We think the product is the closest we could get to the vision in this project. It's designed from a thorough research, combining knowledge on ergonomics, future scenario’s, pepper plants, tool markets and so on. We think we have clearly pointed out the necessity of quality improvement and our test show indications that this goal is reached with the new design. On some points the test were insufficient to be sure the product is ready for market introduction: The product is never tested on the real user and is never tested for a long period, making sure RSI problems can be discovered. After a longer period of use also the cleaning of the knife and the size of the product can be further analyzed. A better overview of cost reduction (increasing motivation, increasing harvesting speed, decreasing long term sickness) can then be established.

For the coming developments some decisions have to be made about production methods and further developing the product. Our advice is a reasonable possibility, but when different markets can be found a different solution might be more beneficial.

2. PROCESS

During the process we have noticed the importance of going to different growers, seeing different vegetables, speak to different experts. We saw specific expertise in different companies, all very related, but still good to hear from different sides. Some basic things (like the distance of the cutting spot to the stem) could have gotten a more prominent role within the project. Now this was only taken into account from pictures, where the distance seemed to differ a lot. Still we think during the process we were able to integrate this knowledge. Close contact with the growers helped us a lot to get useful information.

The project sometimes missed good structure. Idea generation was too messy for our opinion. A clearer idea generation might have been preferable. Although the most important ideas, also about the future are communicated, a lot of small ideas and sketches never made it to the report, just because they were snowed under by bigger ideas. In the end this resulted in a combination of products, mostly focused on a new harvesting knife.

3. PRESENTATIONS

The last presentation we could finally show a prototype of the design. This was a moment everybody had been waiting for. Even though there was no real working model (time limit reached) we think this presentation was very useful in terms of a realistic final design and possible future scenario’s. During all presentation we liked the different input from the different guests, although sometimes they seemed to fall into the middle without knowing where our decisions were based on. This was also experienced as a motivation factor, since it made clear what we have gone through before showing up with this final design.
4. FURTHER DEVELOPMENT

To summarize future steps for development according to our opinion:

1. Finalize CAD for production, make test model with rapid prototyping experts, see appendix 8
2. Analyze basic shape (this is the master for the upcoming series)
3. Produce series through silicon molding with epoxy outside mould (amount depending on available time, costs, effort, in changing circumstances different production methods can be searched for), see chapter 1 (Part 2) and appendix 8

Then the product can be further evaluated and production can be further finalized.

- Evaluate the test series especially on
  - Usage complaints (RSI, grip, …)
  - Life span (How long could this product function before showing defects)
  - Assurance of quality of pepper
  - Speed of harvesting

- Continue market research on different, other vegetables that might be interested to use this product, maybe internationally

- Contact producer (could be same as the one making test series, or continue making silicon mould series).
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- http://www.firstmodel.nl
- http://www.gesilicones.com/
- http://www.imagine-3d.nl
- http://www.improvementcentre.com/
- http://www.intermould.nl/
- http://www.materialise.be/
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- http://www.pekago.nl/
- http://www.ptonline.com
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- http://www.rp2.nl
- http://www.smallparts.com/techinfo/
- http://www.sdp-si.com/
- http://www.uq-design.nl/
- http://www.vandermolendesign.nl
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APPENDICES
APPENDIX 1 <Cutting force analysis>

A research was performed to find out what force is needed to cut the stem of a pepper. Depending on the tools’ mechanism, the outcomes of this test can be calculated back to the force produced by the fingers/hand during cutting. This will determine efficiency of the tool and its physical comfort.

For the test stems of several (rep) peppers were cut off. Because the knob was already gone, the ‘normal’ part of the stem was used for cutting. This will provide us with a higher force, which will result in a more worse scenario. This could be a good assumption because the tool should steel function, even when the worker misses the right spot of the stem, without using too much force. The peppers that are used for this test came from a supermarket. This will also probably increase the cutting force because the stems are little dried, less crispy, and therefore harder to cut.

**Set up**
The test was performed in a lab of Industrial Design. The temperature was about 24 degrees and a normal indoor-humidity (less than glasshouse). For the cutting force measurement, the stem was places on top of a analogue force sensor (see picture). By applying stress on the sensor trough cutting, it would produce a specific voltage that is read on the multimeter. By setting the memory status of the meter to MAX, it would memorize the highest voltage produced during the cut. With a simple calculation the voltage could be linearly be converted to a force (5VDC=5KN).
In total three knives were tested: conventional harvesting knife, domestic potato knife and a stanley-knife (both sharp & blunt). It should be noted that the harvesting knife was already used by the worker, and therefore not fully sharp. All knives were tested with a downward movement, and slicing movement.

Harvesting knife

Potato knife

Stanley knife (sharp&blunt)
Results
The results were processed in Excel to get an overview of the forces in a more visual way. The horizontal axis indicates knife kind, while vertical axis is the force in Newton. Green bars stand for downward cut (light green=min value, dark green=max value). Blue bars are slicing cuts (light blue=min value, dark blue=max value). See legend. Every knife was tested in total 8 times, four times with downward movement, and four times slicing. In order to get a more accurate result, more tests per knife and kind of cut can be performed.
### APPEDIX 2 <Different plastic force test>

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<th>Grabber mouth width</th>
<th>Wooden cylinder diameter</th>
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<td>15</td>
<td>17.5</td>
</tr>
<tr>
<td></td>
<td>10mm</td>
<td>10mm</td>
<td>8</td>
<td>10.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15mm</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20mm</td>
<td>21</td>
<td>19</td>
</tr>
<tr>
<td>3mm</td>
<td>8mm</td>
<td>10mm</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15mm</td>
<td>29</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20mm</td>
<td>33</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>10mm</td>
<td>10mm</td>
<td>22</td>
<td>27.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15mm</td>
<td>29</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20mm</td>
<td>42</td>
<td>50</td>
</tr>
</tbody>
</table>

*<The average testing results >*
In order to find out the ideal shape of the grabber, a research was launched to test the relationship between the following four factors: the thickness of the grabber, the width of the grabber mouth, the size of the stem, and the pushing and pulling forces.
Set up
The test was performed in a lab of Industrial Design. For the thickness of the grabber, three kinds of plastic (PVC, VIC and PETG) with two different thicknesses were used to make the body of the grabber (see <Three kinds of plastic, from left to right: PVC, PETG, VIC>). For the width of the grabber mouth, we made two mouths with widths of 8mm and 10 mm (see <The testing grabber>). Three wooden cylinders (10mm, 15mm, and 20 in diameters) were made to represent the different stem size. These three wooden cylinders were screwed onto a same board and attached to a steady testing table (see <Different size of the wooden cylinders>). Together with a dynamometer, difference in pulling and pushing force were tested. The set up of the experiment can be found in the last figure <Set up for the experiment>.

Result
The test was performed twice, and the average testing results are shown in the table in the previous page. In general, the average force needed to pull is higher than pushing. Based on the result, we did a calculation of the average ration of pulling force/ pushing force of the three materials. From this calculation, we concluded that PVC has the highest ration for pulling force/ pushing force which means that the stem can be pushed into the grabber with less force and when cutting, the stem is less inclined to come out.

Blades & grip life cycle
In nowadays usage, the picker in van Dijk has to sharpen their knife everyday. For the new designed tool, although it is possible to use cheaper blade, and sharpen it everyday, we would rather recommend using a higher quality blade material, even though the price will be a bit higher. The main reason is in that the new mechanism of the tool covers the blade, so the blade cannot be sharpen as easy as the existing cutting knife. With better quality steel blade, we assumed that the blade can be sharp after two day use. The blade we found is now available for €0.30 per piece in retail store. However, in the future with mass production and wholesale directly from the producer, we can imagine the price can be drop down to lower than €0.30 per piece.

For the aubergine grower, they change their cutting scissor for 2~3 months. We obtained one used scissor from the grower and found out that after 2~3 months of using, the cover of the tool, the soft blue plastic part, is broken at the end point. Since the usage of this part, for better holding, and the material it used is similar to our designed tool, we took it as an analogy to estimate the life cycle of our grip. Therefore, we suggest that the cover of our grip might have to be changed every three month.
APPENDIX 3 <Technical drawing of the earlier prototype>
Vragenlijst
22 januari 2008

Wij willen u vragen deze korte vragenlijst in te vullen. Met de antwoorden helpt u ons, Industrieel Ontwerpen aan de TUDelft, met het onderzoek naar - en de mogelijke ontwikkeling van - een betere paprika oogst methode. Uw antwoorden zijn geheel anoniem.

Ik ben een
□ Man
□ Vrouw

Mijn nationaliteit is
□ Nederlands
□ Anders, nl ...

Ik ben
□ Links handig
□ Rechts handig

Hoe oud bent u?
□ Jonger dan 20 jaar
□ 20 - 29 jaar
□ 30 - 39 jaar
□ 40 - 49 jaar
□ 50 jaar of ouder

Heeft u enige ervaring met het telen en oogsten van groente of fruit?
□ Nee
□ Ja

Indien ja, op welke manier heeft u de ervaring opgedaan?
□ Beroepsmatig
□ Eigen tuin
□ Volkstuin
□ Anders, nl. ...

Welke groenten heeft u wel eens geoogst?
□ Paprika
□ Aubergine
□ Komkommer
□ Tomaat
□ Pepers
□ Courgette
□ Sla
□ Worteltjes
□ Ui
Hoe denkt u over de volgende punten?

<table>
<thead>
<tr>
<th>zeer ontvreden</th>
<th>ontvreden</th>
<th>neutraal</th>
<th>tevreden</th>
<th>zeer tevreden</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) De eerste impressie van het mes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) De vorm van het mes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Het gewicht van het mes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) De kleur van het mes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) Het gemak om te bedienen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f) Het beschadigen van de paprika door het mes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) Veiligheid van het mes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h) De snelheid van het oogsten met dit mes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i) Het bereiken van de paprika’s die op een lastige plek hangen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hoe denkt u over de volgende punten (ten aanzien van de ring om paprika’s weg te leggen)?

<table>
<thead>
<tr>
<th>zeer ontvreden</th>
<th>ontvreden</th>
<th>neutraal</th>
<th>tevreden</th>
<th>zeer tevreden</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) De eerste impressie van de ring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Het gebruiksgemak van de ring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) De efficiëntie van het werken met deze ring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) De comfort van deze ring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) De hoogte van de ring voor u</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Heeft u tijdens het gebruik van het mes of de ring last van bepaalde lichaamsdelen, of denkt u hier na verloop van tijd last van te krijgen? (Geef aan in de figuren hiernaast)

Welke kleur is een motiverende kleur voor u, welke kleur spreekt u aan voor dit mes?

Als je een kleur moet kiezen voor het product uit onderstaande nummers, welke zou u kiezen?

Heeft u nog verdere opmerkingen? Bijvoorbeeld mogelijke verbeteringen aan het mesje, de ring of de werkmethode?

Dit is het einde van deze vragenlijst, hartelijk dank voor uw medewerking!
Tested people consisted of:
6 participants

5 man, 1 woman
Remarks: woman overall very interested in the colour

5 Dutch, 1 Iranian

4 right handed (2 missing)
Remarks: one said it did not matter which hand, he was both handed: he used it with his right hand

1 participant: age was below 20 (19 years old)
1 participant: age between 30 and 39
2 participants were older than 50

Four people had no experience (except for a brother working with flowers and a father that was in this business). Two did have experience; one worked with peppers, cucumbers and tomatoes, other worked with peppers and now grew a lot in his ‘volkstuin’.
Remarks: The experienced people were less optimistic about being sure no pepper was damaged, the rest did not really differ

Results for topics concerning knife:

<table>
<thead>
<tr>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>First impression</td>
</tr>
<tr>
<td>Shape</td>
</tr>
<tr>
<td>Weight</td>
</tr>
<tr>
<td>Colour</td>
</tr>
<tr>
<td>Ease to use</td>
</tr>
<tr>
<td>Damaging pepper</td>
</tr>
<tr>
<td>Safety</td>
</tr>
<tr>
<td>Speed</td>
</tr>
<tr>
<td>Reaching peppers</td>
</tr>
</tbody>
</table>

Results for topics concerning tube:

<table>
<thead>
<tr>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>First impression</td>
</tr>
<tr>
<td>Easy to use</td>
</tr>
<tr>
<td>Efficiency</td>
</tr>
<tr>
<td>Comfort</td>
</tr>
<tr>
<td>Height ring</td>
</tr>
</tbody>
</table>
Places that could hurt after a while
4 out of 6 thought of no hurting places

Favourite colour

Remarks: light colour was scored by woman.

Further remarks:
Maybe a special sack on your belt that you can store your knife in
Colour does not matter because it will get dirty and if it falls the colour will scrape off
You have to make a very big movement
The tube should be placed somewhat aside of you, under your armpit.
Yellow was in 3 cases mentioned as a nice, motivating colour.
APPENDIX 6 <Materials>

Steel kinds

**Carbon Steel** - The predominant elements in Carbon Steels are Iron and Carbon, of which Carbon content ranges from a few hundredths to just over 1%. (Low Carbon Steel - up to 0.30%; Medium Carbon Steel - up to 0.70%; High Carbon Steel - up to 1.3%). Carbon Steel in its various forms represents more than three-quarters of steel production. Carbon Steel is generally fine grain, fully killed (deoxidized) basic steel with no alloying agent. It may be classified as hot rolled or cold drawn, (cold rolled when referring to sheets) and is produced as bar, sheet, wire, tubing and structural shapes. Density is .28 lbs/in³.

**Chrom-Moly 4130** - Steel Alloy 4130 is a high strength steel with Chromium and Molybdenum. It is specified when strong, lightweight structural integrity is required. Frequently used in the aircraft industry, for racecars, motorcycles, bicycles, and for industrial equipment, this high-strength steel is easily fabricated and has excellent weldability. It can be subjected to mild hardening and nitriding for additional wear and abrasion resistance.

**Cold Rolled Type C1018** - A high quality, low carbon, smooth finished mild steel has good machining characteristics. It is easy to weld, braze and solder, making it a great material for models or prototypes.

**Cold Rolled Type C1008 / C1010** - This is a moderately stiff, half-hard temper cold rolled strip suitable for limited bending. Strips of this temper may be bent in the longitudinal direction. The minimum bending radius is the material thickness. Often used for decorative artwork as in grills, screens and gates. Its round edge gives a fine, finished appearance with no further work.

**Spring Steel SAE 1095** - Spring Steel is blue tempered and hardened to meet the most exacting requirements. Carbon content is in the range of 0.90 to 1.05%. Rockwell hardness -C 48/51. This material has the highest elastic limit and fatigue values of commonly used spring steel. Recommended for coiled and flat mechanical springs such as: ignition vibrator springs, springs for timing devices, springs for the electrical and electronic fields, steel tapes and rules.

**Tool Steel D2** - Characterized by superior wear and abrasion resistance, air-hardening D-2 Tool Steel has high carbon and chromium content, and is decarburization-free. This tough tool steel can be heat treated to achieve maximum performance. Due to its low sulphur content, it is not free-machining. Used primarily as a die material, it also holds a very sharp edge, giving it wide acceptance for use...
in cutlery and industrial trimmer blades.

**Tool Steel SAE 0-1** - This ground tool steel is an oil hardenable steel alloy recommended for dies, punches, gauges and tools. It should be used where a greater degree of accuracy is desired in hardening. Its precise diameter and smooth finish make it excellent for use as steel shafting. Also referred to as "Silver Steel" in England

### Properties

<table>
<thead>
<tr>
<th>Property Tested</th>
<th>Test Units</th>
<th>1018</th>
<th>4130</th>
<th>1095</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>lb/in³</td>
<td>.28</td>
<td>.28</td>
<td>.28</td>
</tr>
<tr>
<td>Tensile Strength - Ultimate</td>
<td>ksi</td>
<td>63</td>
<td>97</td>
<td>160</td>
</tr>
<tr>
<td>Tensile Strength - Yield</td>
<td>ksi</td>
<td>53</td>
<td>63</td>
<td>98</td>
</tr>
<tr>
<td>Elongation</td>
<td>% in 2in</td>
<td>15</td>
<td>25</td>
<td>14</td>
</tr>
<tr>
<td>Brinell Hardness</td>
<td>-</td>
<td>126</td>
<td>197</td>
<td>321</td>
</tr>
<tr>
<td>Machinability</td>
<td>1212=100</td>
<td>703</td>
<td>70</td>
<td>-</td>
</tr>
</tbody>
</table>

*ksi: kips per square inch = 1000's pounds per square inch

**Note:** Typical values "Not For Design Purposes"

Plastic gear material

20.2 Properties of Plastic Gear Materials

Popular materials for Plastic Gears are acetal resins such as DELRIN*, nylon resins such as ZYTEL* and NYLATRON** and acetal copolymers such as CELCON***. The physical and mechanical properties of these materials vary with regard to strength, rigidity, dimensional resistance, fabrication requirements, moisture absorption etc. Standardized tabular data is available from various manufacturers catalogs. In general, the information and data is less simplified and fixed than for the metals. This is because plastics are subject to wider formulation variations and are often regarded as proprietary compounds and mixtures. Tables 1.38 through 1.43A are representative listings of physical and mechanical properties of gear plastics taken from a variety of sources.

It is common practice to use plastics in combination with different metals and materials other than plastics. Such is the case when gears have metal hubs, inserts, rims, spokes, etc. In these cases one must be cognizant of the fact that plastics have an order of magnitude different Coefficients of Thermal Expansion as well as Density and Modulus of Elasticity. For this reason Table 1.43A is presented. Other properties and features that enter into considerations for gearing are given in Table 1.44 (Wear) and Table 1.45 (Poisson’s Ratio). Moisture has a significant impact on plastic properties as can be seen in Tables 1.38 thru 1.43. Ranking of plastics is given in Table 1.46. In this table, rate refers to expansion from dry to full moist condition. Thus, a 0.20% rating means a dimensional increase of 0.002 inch per inch. Note that this is only a rough guide as exact values depend upon factors of composition and processing, both the raw material and gear molding. For example, it can be seen that the various types and grades of nylon can range from 0.07% to 2.0%.

Table 1.47 lists safe stress values for a few basic plastics and the effect of glass fiber reinforcement

<table>
<thead>
<tr>
<th>Material</th>
<th>Tensile Strength (psi x 10^7)</th>
<th>Flexural Strength (psi x 10^7)</th>
<th>Compressive Modulus (psi x 10^7)</th>
<th>Heat Distortion Temperature (°F @ 264 psi)</th>
<th>Water Absorption (% 24 hr)</th>
<th>Rockwell Hardness</th>
<th>Mold Shrinkage (in./in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetal</td>
<td>8.8-10</td>
<td>12-14</td>
<td>1300</td>
<td>230-255</td>
<td>0.25</td>
<td>M94 R120</td>
<td>0.022/0.003</td>
</tr>
<tr>
<td>Styrene</td>
<td>4.5-8.5</td>
<td>5-13.5</td>
<td>120-200</td>
<td>190-245</td>
<td>0.2-0.5</td>
<td>R80-120</td>
<td>0.007/0.007</td>
</tr>
<tr>
<td>Nylon 6/6</td>
<td>11.2-13.1</td>
<td>14.6</td>
<td>140-200</td>
<td>200</td>
<td>1.3</td>
<td>R15-123</td>
<td>0.015</td>
</tr>
<tr>
<td>Nylon 6/10</td>
<td>7-8.5</td>
<td>10.5</td>
<td>400</td>
<td>145</td>
<td>0.7</td>
<td>R111 M70</td>
<td>0.015/0.005</td>
</tr>
<tr>
<td>Polycarbonate</td>
<td>8-9.5</td>
<td>11-13</td>
<td>350</td>
<td>285-290</td>
<td>0.15</td>
<td>R112</td>
<td>0.007/0.003</td>
</tr>
<tr>
<td>High Impact</td>
<td>1.9-4</td>
<td>5.5-12.5</td>
<td>300-580</td>
<td>160-205</td>
<td>0.15</td>
<td>M25-69</td>
<td>0.05</td>
</tr>
<tr>
<td>Polystyrene</td>
<td>4.5-8</td>
<td>7.1</td>
<td>85</td>
<td>180-205</td>
<td>0.60-0.80</td>
<td>M29 R90</td>
<td>0.009/0.002</td>
</tr>
<tr>
<td>Polyurethane</td>
<td>6-9</td>
<td>8-15</td>
<td>300-400</td>
<td>140-175</td>
<td>0.07-0.40</td>
<td>R100-120</td>
<td>0.004</td>
</tr>
<tr>
<td>Polyvinyl</td>
<td>10.2</td>
<td>16.4</td>
<td>370</td>
<td>345</td>
<td>0.22</td>
<td>M69-R120</td>
<td>0.0076</td>
</tr>
<tr>
<td>Chloride</td>
<td>10.2</td>
<td>10</td>
<td>330</td>
<td>140</td>
<td>0.4</td>
<td>D785</td>
<td>0.012</td>
</tr>
</tbody>
</table>

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*Registered trademark. E.I. du Pont de Nemours and Co., Wilmington, Delaware 19898.
**Registered trademark, The Polymer Corporation, P.O. Box 422, Reading Pennsylvania, 19603
***Registered trademark, Celanese Corporation, 26 Msn St., Chalkham, N.J. 07928

APPENDIX 7 <Cost esimation>

Resin grade | $/LB
---|---
Acetal copolymer | 144-160
Polyurethane (PUR) | 125-145
PVC copolymer | 86-90

www.ptonline.com
Jan 25th: 1 euro = 1.47 US dollar
1 pound = 453.6 grams

Bron: MCB, 2004 NB gemiddelde prijzen bij afname van 100 kg. (boven 500 kg ca. 30% korting)

<table>
<thead>
<tr>
<th>materiaal</th>
<th>euro/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warmgewalste plaat S355J2G3</td>
<td>1.29</td>
</tr>
<tr>
<td>Warmgewalste plaat C45+N</td>
<td>1.35</td>
</tr>
<tr>
<td>Warmgewalste plaat S235JR 3 t/m 10 mm</td>
<td>1.35</td>
</tr>
<tr>
<td>Warmgewalste plaat CorTen A</td>
<td>1.39</td>
</tr>
<tr>
<td>Warmgewalste plaat CorTen B</td>
<td>1.39</td>
</tr>
<tr>
<td>Koudgewalste blanke plaat DC01-A-m geolied</td>
<td>1.48</td>
</tr>
<tr>
<td>Koudgewalste blanke plaat DC04-A-m geolied dieptrek</td>
<td>1.55</td>
</tr>
<tr>
<td>staalplaat, vlak, aluzink</td>
<td>1.57</td>
</tr>
<tr>
<td>Sendzimir verzinkte plaat DX51D+Z275-MBC</td>
<td>1.57</td>
</tr>
<tr>
<td>staalplaat, vlak, elektroytisch verzinkt</td>
<td>1.60</td>
</tr>
<tr>
<td>Koudgewalste plaat CorTen A</td>
<td>1.63</td>
</tr>
<tr>
<td>Gealuminiseerde plaat DX51D+AS120-A-O geolied mat</td>
<td>1.70</td>
</tr>
<tr>
<td>staalplaat, vlak, gelakt</td>
<td>2.53</td>
</tr>
<tr>
<td>staal profiel vierkant, blank C45+C / C45K</td>
<td>2.60</td>
</tr>
<tr>
<td>staal, ronde buis (div.)</td>
<td>7.00</td>
</tr>
<tr>
<td>RVS</td>
<td></td>
</tr>
<tr>
<td>Rvs plaat 1.4003 koudgewalst finish 2B</td>
<td>3.20</td>
</tr>
<tr>
<td>Rvs plaat type 304 kgw finish 2B eenzijdig beschermfolie 90 Mu</td>
<td>4.50</td>
</tr>
<tr>
<td>RVS, ronde buis (div.)</td>
<td>10.00</td>
</tr>
<tr>
<td>Rvs profiel 1.4404 (316L) warmgewalst vierkant</td>
<td>6.25</td>
</tr>
<tr>
<td>Aluminium</td>
<td></td>
</tr>
<tr>
<td>Aluminium plaat EN AW-1050A O dieptrekkwaliteit</td>
<td>4.90</td>
</tr>
<tr>
<td>Aluminium plaat EN AW-5005 H14/H24 anodiseerkwaliteit 1 Z folie 90 Mu</td>
<td>5.40</td>
</tr>
<tr>
<td>Aluminium profiel 51St AlMgSi1 F28/F31 vierkant</td>
<td>4.65</td>
</tr>
<tr>
<td>Aluminium profiel AlMgSi0.7-F27 vierkant</td>
<td>8.70</td>
</tr>
</tbody>
</table>
The production process is described below and some example-products can be seen:

**Molding Processes**

**Seamless Simple Mold**

**Step 1:** Place the master model on the mold board, and enclose on all four sides with a frame. Clay may be applied on the bottom of the master to securely attach it to the mold board.

**Step 2:** Measure the base material and catalyst by weight as specified for the silicone grade selected. Thoroughly mix the components.

**Step 3:** Vacuum-degas the silicone mixture to remove air that become entrapped during mixing. The mixture will rise while degassing, and therefore, a container with an adequate size (4 to 5 times) is required.

**Step 4:** Begin pouring the material, starting first at a low point in the mold. Allow the silicone to cure for the specified time.

**Step 5:** After the silicone has cured, remove the mold walls, and gently release the mold from the mold board. Release the master model from the silicone mold, and remove any flash that may have developed on the edges of the mold.

**Step 6:** Prepare the casting resin as specified by the manufacturer, pour into the silicone mold, and allow to cure.

The company Pekago produces silicon moulds to create functional prototypes. Next to this they can offer RMT (Rapid Modular Tooling) with which a market introduction can be realized without making use already of the production ‘hard tooling’. The product design can be further developed into the later planned production method, so the 3D data does not need to change when the production of the test series is changed into the real series. RMT is, depending on the mould-material choice, usable for up to 500 products a series. [http://www.pekago.nl/site/index.php?id=17](http://www.pekago.nl/site/index.php?id=17)

Intermould emphasizes that with silicon moulding, the moulds can be made in such a geometry that regular product would not be able to come out of the mould. For this product this does not seem to be an extra advantage. [http://www.intermould.nl/nederlands/matrijzen_nl.htm](http://www.intermould.nl/nederlands/matrijzen_nl.htm)

Some examples of products that are made with the silicon mould technique are shown below.


The general technique is described as RIM (Reaction Injection Moulding). Two components are mixed together and hardens in the mould because of a chemical reaction. For relative small series (as seems the case for a test series of the pepper snapper) silicon moulds are used, but also aluminium moulds can be used to extend the series. Materialise NV in Belgium gives information on this aspect on their website. They can produce small series from 10 products to some thousand pieces. Materials that can be used are different sorts of PUR, characteristics comparable to PA, PBT, PE, PP, ABS. PP in this case seems to come closest to our specifications.

More information on R.I.M. (Reaction Injection Moulding) on Materialise website is shown below:

*RIM is a technique to produce plastic parts by low pressure injection of thermoset resins in moulds. Different types of moulds are applicable, among which resin moulds are the most frequently used. Materialise focuses on small series moulds, built around a master part produced by rapid prototyping methods such as stereolithography or HSM. Different moulds are used, depending on trade off series, size of the part and speed. We offer the following approaches in function of quantity.*

1. Directly machined tools; no master needed
• **Ureol tools (100-200 mouldings)**

2. **Master based tools**

• Silicone tools (up to 25-50 shots)
• Hybrid tools (50-100 shots)
• Resin tools with fibre reinforcement (200-300 parts)
• Resin tools with aluminium backing (up to 300-1000 parts), dependent on part complexity, R.I.M. material

http://www.productionnavigator.com/ace/engine.php?Cmd=see&P_site=51&P_self=68&PMax=1&PSkip=0

Further information on this material to use in these prototyping techniques is shown below.

Lage opstartkosten, kleine en grote series en technische mogelijkheden maken polyurethaan aantrekkelijk

**Snel en tegen lage kosten** In tegenstelling tot veel andere kunststofverwerkende technieken zijn bij polyurethaan productie doorgaans de matrijzen veel eenvoudiger van opzet. De hoge drukken, temperaturen en belasting zoals bij spuitgieten en rubber verwerking zijn niet van toepassing. Het voordeel uit zich in lagere matrijks kosten en snellere doorlooptijden. Het inzetten van matrijzen uit epoxy, polyurethaan of siliconen is mogelijk, deze zijn zeer voordelig en zeer snel te produceren. Deze doen overigens niet af aan de kwaliteit van het eindproduct.

**Seriegroottes**

Door de lage opstartkosten van de gereedschappen komen onderdelen sneller in aanmerking om in polyurethaan geproduceerd te worden. Delen die in kleine oplage gemaakt worden door bijvoorbeeld halffabrikaten mechanisch te bewerken kunnen vaak mooier en goedkoper in polyurethaan gemaakt worden. Series vanaf enkele stuks tot series van duizenden stuks zijn bij ons mogelijk.

**Extra mogelijkheden**

Naast de mogelijkheden van kleine series zijn er technisch ook meer mogelijkheden dan met andere kunststoffen. Zo is bijvoorbeeld in tegenstelling tot thermoplastische verwerkings technieken het produceren van dikwandige, grote of geheel massieve onderdelen geen enkel probleem. Het verwerken zonder hoge temperaturen en druk is mogelijk, hierdoor kunnen ook kwetsbare delen geïntegreerd worden in een product (bijv. elektronica).
Als alternatief voor producten die in integraal hardschuim geproduceerd worden is dit interessant. Ons oudste product, de vlaggenmastknoppen, worden tegenwoordig met deze techniek geproduceerd. Vroeger werden deze van een integraal hardschuim gemaakt.

**Integreren van vreemde delen**
Er is waarschijnlijk geen kunststof die zich zo goed leent voor het integreren van vreemde delen. Van schroefdraad inserts tot en met complete mechanische constructies met bewegende delen, het is allemaal mogelijk. De delen kunnen dienen als versterking, vooral bij flexibele materialen, of maken montage op ander delen mogelijk.

In de meeste gevallen zijn de delen die worden meegenomen gemaakt uit metaal. Aangezien in heel veel gevallen sprake is van dit soort onderdelen werken wij nauw samen met een metaalbedrijf.

http://www.purtec.nl/b_verwerking.htm

**company list rapid prototyping**

List of companies focusing on (direct) rapid prototyping techniques.

http://www.vandermolendesign.nl
http://www.firstmodel.nl
http://www.3D-Printexpert.nl
http://www.imagine-3d.nl
http://www.rapidprototyping.nl
http://www.rapidprototyping.nl
http://www.protometals.com/

http://www.rp2.nl
http://www.combi-pack.nl
http://www.vrt.nl
http://www.dimarco.nl/
http://www.minid.nl
http://www.uq-design.nl/
http://www.proproduct.nl
APPENDIX 9 < Final technical drawings>