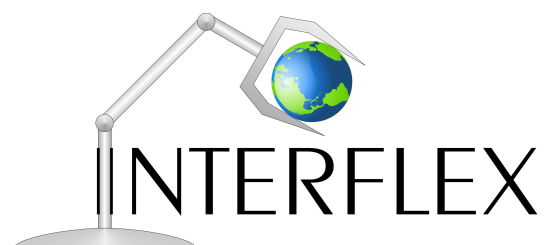


# Phase 1

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# 1 Collaboration

## 1.1 Belbin

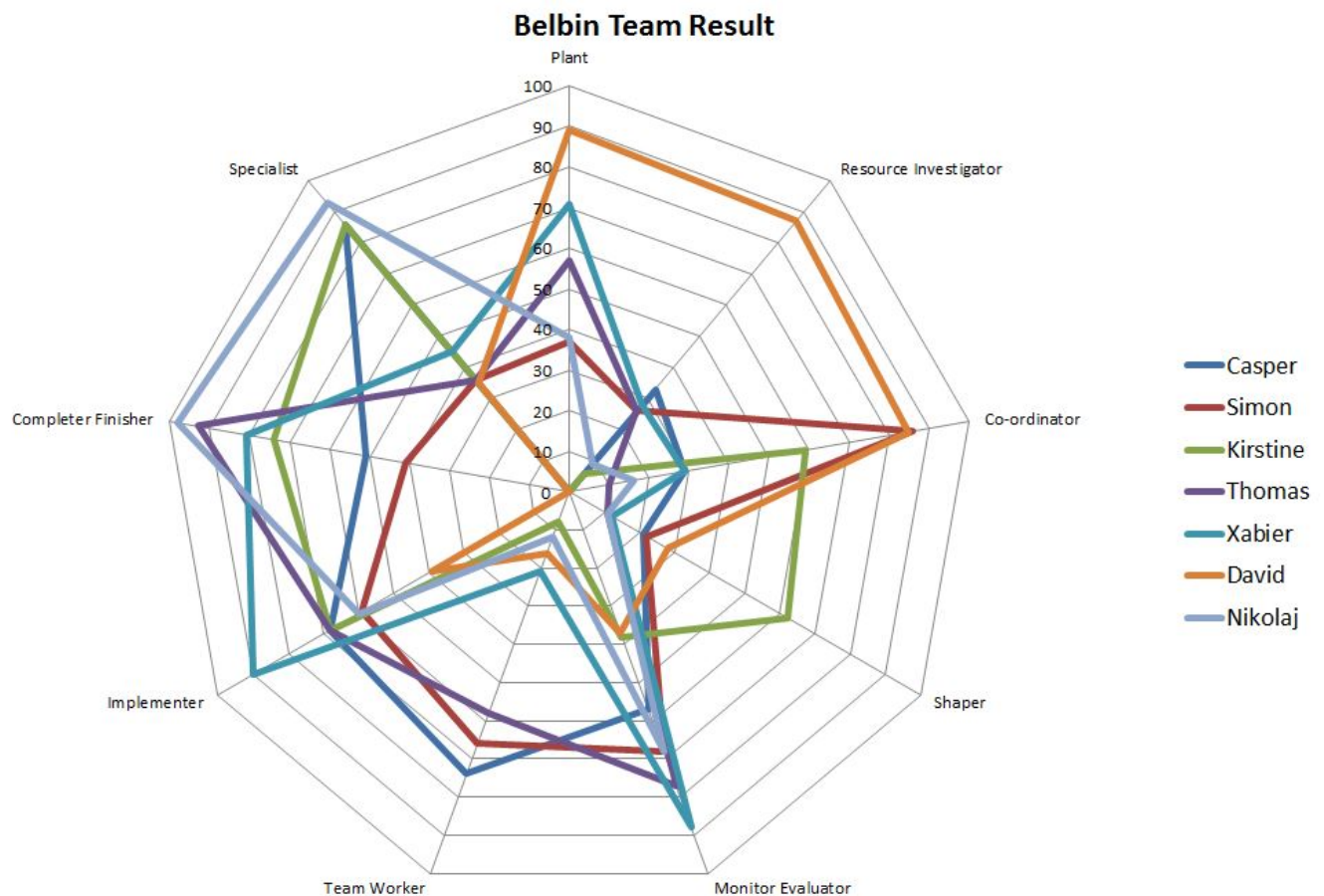


Figure 1.1: Belbin Self-perception "Spiderweb"

Table 1.1 is based on the results of the individual tests, which is also reflected by the spider web chart on figure 1.1. The table shows the strong and weak roles for the team profiles.

It is very clear that the group has a major potential when it comes to developing solutions to perfection, while being able to investigate the different possibilities. This could be explained by the amount of specialists in the group.

It is also very clear that the group lacks drive and a key person to set the pace of the work processes. The group has to be aware that the beginning of project can potentially cause issues. This is due to the lack of Plants and Resource Investigators. The Plants provide creativity and innovation, while the Resource Investigators validates the possibility of and idea.

<i>Contribution:</i>	<i>Allowable Weaknesses:</i>
<b>Top 3 roles:</b>	
<b>Monitor Evaluator</b>	
Sober, strategic and discerning. Sees all options and judges accurately.	Lacks drive and ability to inspire others. Can be overly critical to others.
<b>Implementer</b>	
Practical, reliable, efficient. Turns ideas into actions and organizes work that needs to be done.	Somewhat inflexible. Slow to respond to new possibilities.
<b>Completer Finisher</b>	
Painstaking, conscientious, anxious. Searches out errors. Polishes and perfects.	Inclined to worry unduly. Reluctant to delegate.
<b>Bottom 3 Roles:</b>	
<b>Shaper</b>	
Challenging, dynamic, thrives on pressure. Has the drive and courage to overcome obstacles.	Prone to provocation. Offends people's feelings.
<b>Plant</b>	
Creative, imaginative, free-thinking. Generates ideas and solves difficult problems.	Ignores incidentals. Too preoccupied to communicate effectively.
<b>Resource Investigator</b>	
Outgoing, enthusiastic, communicative. Explores opportunities and develops contacts.	Over-optimistic. Loses interest once initial enthusiasm has passed.

Table 1.1: Top/Bottom 3 Belbin Self-perception for the group

## 1.2 SWOT

Table 1.2 shows the combination of the SWOT-analysis of the individual members. By combining each SWOT-analysis into one, we get a very good overview of the strengths and weaknesses for the group.

By looking at the two boxes with strengths and opportunities we see that there are a lot of words and sentences that indicate that our team can solve and work with problems, as well as being structured. The two boxes that contain weaknesses and threats indicates that the team is marked by stubbornness, non-shapers and non-innovative members. This implies that the team will probably have a hard time generating ideas and to start work on a problem.

It is a kind of a paradox when we take a look at the strengths and weaknesses of the team. We are very good at solving and working with problems, but at the same time we are having difficulties finding and or creating these problems. This means that the team should be aware of difficulties especially in the beginning of the project.

## 1.3 Competence triangle

In order to learn more about each group member a competence triangle was created (figure 1.2). The competence triangle separates competences that are on a personal, theoretical and experience level. This is done to get a better understanding of how people view themselves and what their education involves. Each member wrote down 2-3 things about themselves and each item and its relation to the project was discussed. The group has a lot of math and programming focused people, but lacks business oriented people.

## 1.4 Conclusion

The team has had a lot of difficulties finding a problem that we wanted to work with. We have been using innovative tools including brainstorming to come up with ideas particularly around e-waste but we never got anything useful. After a meeting with the supervisors, we decided to work with an idea that was mentioned in the introduction of the project.

By looking at the results from the Belbin and SWOT-analysis it is not surprising that the team ended in the situation that we did. It is very clear that the team has a weakness when it comes to idea generation and as well a strength in problem solving. Prospectively it would be a good idea to look at the results from the team tests so we don't end up in the same situation as we already have.

Strength	Opportunities
Patient(2) Tolerant Open minded Working with others Communicative Strong work ethics (2) Adaptable Team player Open minded Communicating On time Social  Experience (work) Effective Technically skilled Clever Logic thinking Able to prioritize Well organized Decisive(2) Ambitious Thorough Decisive Dedicated to solving issues/problem Comprehensive Discipline on my own Creativity and innovation	Problem solving(3) Good presenter Broad contacts Interested in management Solve problems on time Able to structure the report Can finish a project. Can work from somebody's schedule Can work late Not afraid to delegate and face impacts Mindful of others and open for communication for instance the workload Can work in different areas Idea generation Technical skills Easily can learn other subjects Team worker
Weaknesses	Threats
Stubborn(2) Impatient Inflexible Being on time Express my ideas Unwilling to recognize the value of my work  Not starter (If goal is unclear)(2) Loses focus easily(3) Not very innovative/creative (2) Overview Working fully on my own Skeptical within my area Not a perfectionist Bad at keeping track of who knows what Meeting deadlines Uncomfortable with uncertainty	Not a specialist Easily get stressed Impatient, if others don't understand Might be difficult to understand Bad at solving problems myself Bad at remembering details Might ignore good suggestions when focused on other/own ideas The development phase might be slowed down Reduced working time I like parties and going out/I prefer fun over work Focus on too many areas We might never get started Bad at getting ideas to startup a project Losing focus Need things planned in good time Get stalled in some point of the project Don't finish on time

Table 1.2: SWOT-analysis



Figure 1.2: Competence triangle

## 2 Innovation and business

### 2.1 Pictures

For an idea generation process we all sat around the same table and passed around pictures. We started with the pictures face down so we would pick them at random. When passing the pictures around, each of us said what came to mind when looking at the pictures, always keeping in mind that we were to make a creative functional robot. We made sure not to comment on each others thoughts so all thoughts were allowed.

It was very interesting to see how different pictures generated different thoughts. There was a picture of an opera singer, and the thoughts there were: "Loud", "Hard work", "Love for your work", "Human interaction", "Service provider", "Sound recognition" and "Training algorithms". Another picture was of a cellphone and the thoughts there were: "Interface", "Monitoring", "Portability", "Connectivity", "Extension/Multi-functional", "Compact", "User experience", "New experience", and "Awareness/focus".

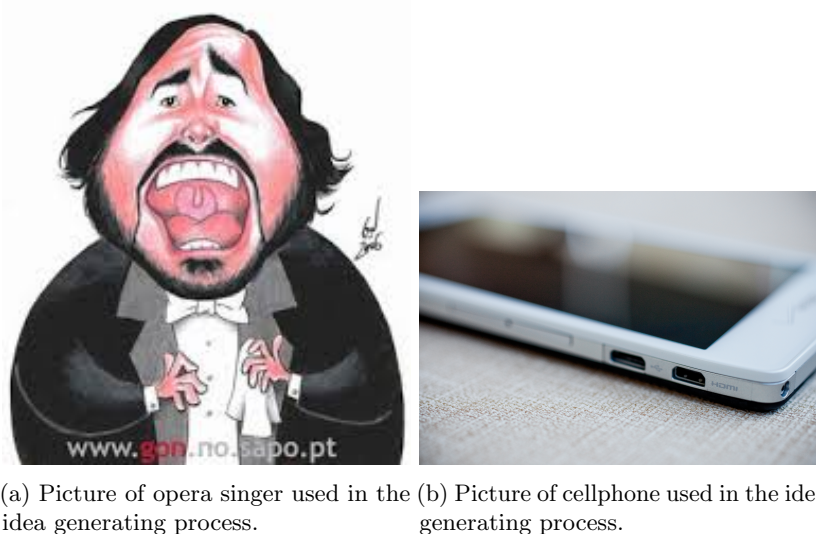


Figure 2.1: Pictures used in the idea generating process

In the beginning of this process several of us found it to be somewhat a waste of time. It was difficult to see how a picture of an opera singer should help us design a robot. After the process, however, we all agreed that we had come up with some really good words, and a lot of them were words that we would like to describe our product, e.g.: "Mobility", "Safety", "Combined knowledge", "Service provider" and "Precision". Other words we would have to make sure would not end up describing our product, e.g.: "Loud", "Danger", and "Legal issues".

### 2.2 Business Model Creator (IDEA - BMC)

After defining the business idea we wanted to specify problems that our idea could solve. To get the maximum from our idea, we decided to make a business plan. The question was how to generate cash flow and to create value for the customers and this helped us answer it. It helped us to better define the situation in which we found ourselves and the direction we should take.

We started with "Value Proposition", which should help us define the services we would like to provide and the products we will develop the business model for. We saw this step as very important and that it will define the course of our business plan, so we decided to spend some time thinking about how we could define what we are going to do and the value we want to create for potential customers.

In the end, we defined our customers as the companies in the welding industry. Companies working on improving the welding technology and companies with non-mass production. We expect the first to be interested in acquiring the technology to implement it to their own system to gain a competitive advantage and the latter one can use it to improve their production and facilitate flexibility of the production, making it possible for further customization of their products and reduction of costs and time.

In the next step, we began to define ideas related to the product. We saw an opportunity in creating value from our product as an innovation in areas, where the competitors failed to achieve it. We decided that the best option in terms of price of the final product would be to suit the current market price, as it would be almost impossible to sell it under the price and selling it with a high price would not be profitable for our customers as the value it creates for them is not crucial for their production.

Will have to make the following comments in reference to the product configuration:

- We are trusted partner in a highly integrated value chain. We focus on adding value in a very specific chain.
- As we focus on developing the technology necessary for the development of sensing system lines for automation of welding, a strong relation with our partners will be necessary, as we need the rest of the technology and components, in order to create the full product.
- Our processes will be quite the same as the industrial production in general:
  - Inbound logistics
  - Production
  - Outgoing logistics
  - Sales and marketing

There is also the financial part. Our prices depend on the product features. The more or the better the features, the higher the price, so it will be more expensive if we had to develop a new type of product with different specifications than if they buy the standard product. We will try to make a price list suitable to all kinds of potential customer's production.

Finally, we have the customer configuration table 2.1. We have an extremely narrow area of focus, but we can develop the product in response to the customer needs, which we know. As this is not a cheap product and the market is not that big, we will try to keep our customers through loyalty programs, where customers are rewarded for remaining loyal to our product. This is also a good way to acquire new customers, because if they are happy with the service/product we provide them, it is very likely that they will provide positive references and recommendations and spread the message about our product.

Customer Configuration				
Channel				
Channel	Awareness	Evaluation	Purchase	After Sales
Internet	✓	✓	✓	✓
Product brochures		✓		
Journals	✓			

Table 2.1: Customer configuration

## 2.3 Brainstorm

One of the main techniques applied in the ideation process was brainstorming. In order to get the best outcome from this technique it is important that any idea, no matter the absurdity, is allowed on the drawing. Others may benefit from these seemingly absurd ideas. Early on in the ideation process there was a strong consensus in the group that we find our project in the waste recycling domain. Figure 2.5 shows the first brainstorm the group made.

As can be seen, the two fields of metals and E-waste received the most interest. A vote was held to decide which of the two fields we were going to continue our research on. E-waste was chosen. To further specify the problem of our project another brainstorm was started, this time on different problems within the field of E-waste. The result can be seen in figure 2.6.

No real result came from the brainstorm on E-Waste, and we came to the realisation that more research was needed for us to finalize our project idea. A list of questions was devised and each member assigned to do research on some of these questions.

At this point we were advised by the supervisors to either make a choice based on the research we had already

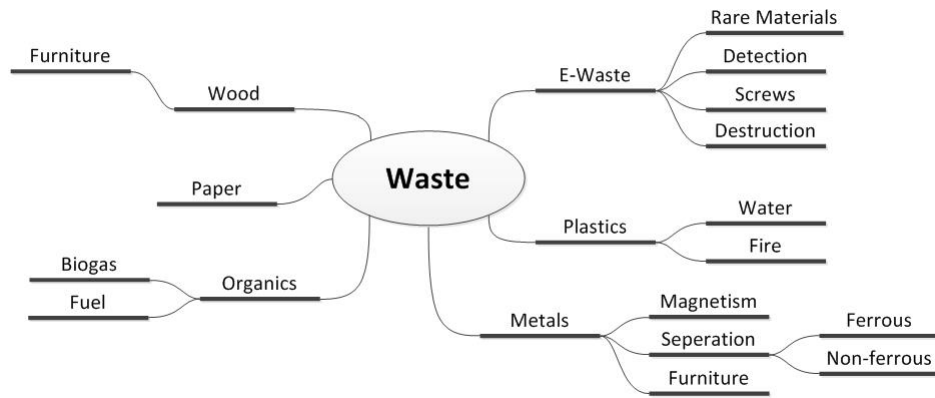


Figure 2.2: Brainstorm on different areas of waste recycling and possible ways of sorting

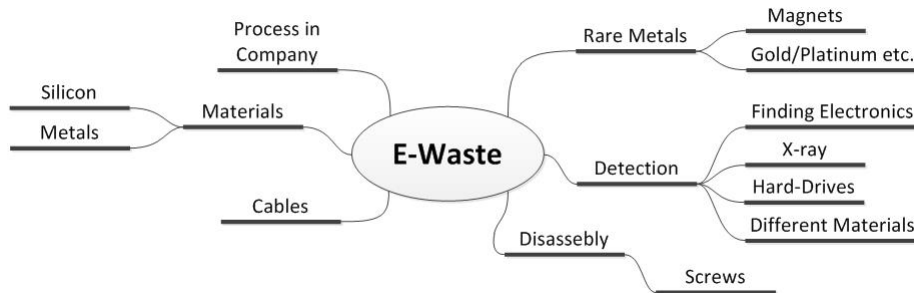


Figure 2.3: Brainstorm on problems within the field of E-Waste

done, or to go in another direction entirely. It was decided to do a brainstorm entirely focused on concepts, this can be seen in figure 2.7.

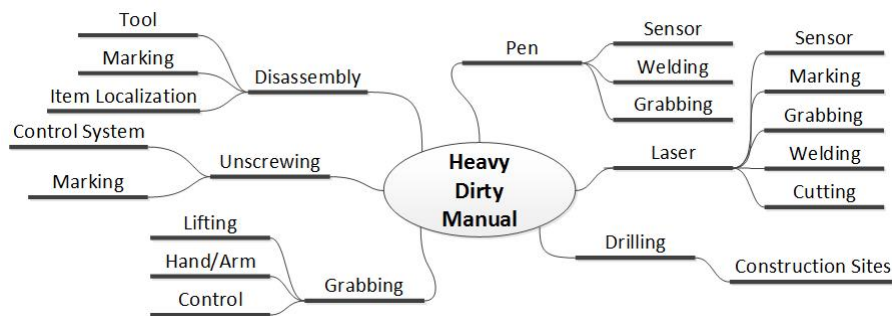


Figure 2.4: Brainstorm on possible concepts

Upon finishing the brainstorm the team split into two groups, each group discussing applications for each concept. Ultimately, we decided to focus our project on the development of a flexible welding robot, using a derivation of the pen principle.



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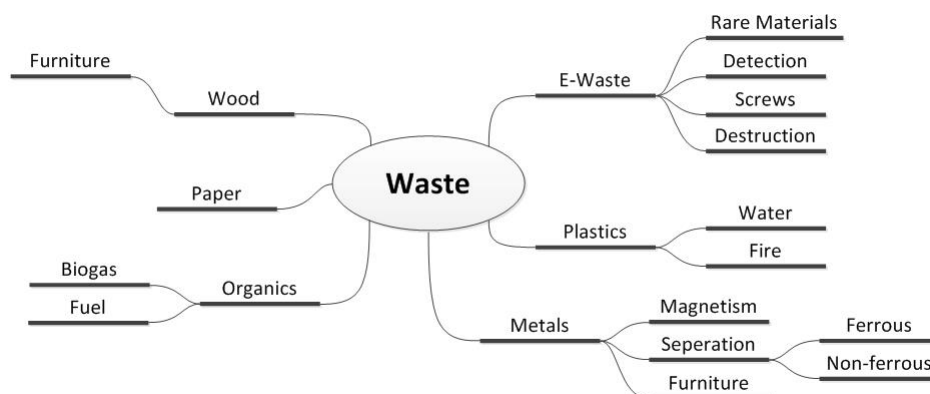


Figure 2.5: Brainstorm on different areas of waste recycling and possible ways of sorting

As can be seen, the two fields of metals and E-waste received the most interest. A vote was held to decide which of the two fields we were going to continue our research on. E-waste was chosen. To further specify the problem of our project another brainstorm was started, this time on different problems within the field of E-waste. The result can be seen in figure 2.6.

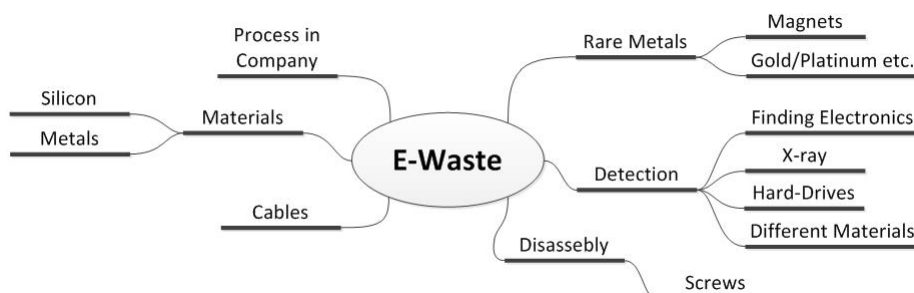


Figure 2.6: Brainstorm on problems within the field of E-Waste

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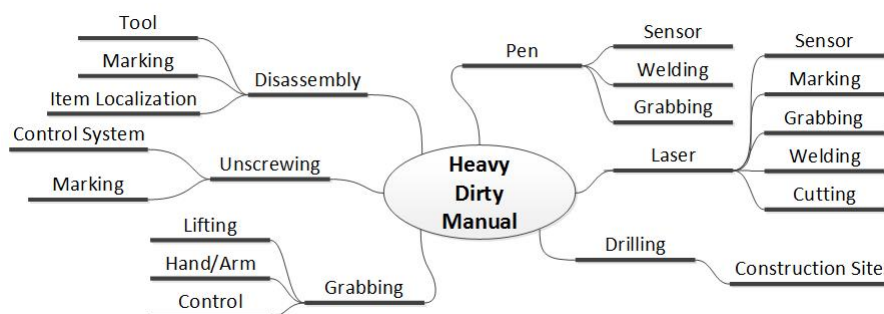


Figure 2.7: Brainstorm on possible concepts

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### 3 Expert skills

#### 3.1 Technology description

The idea consists of a welding robot, which is able to recognize a line prepared for welding. To be able to do this, we have to use different technology, as it is a complex case that requires a variety of components to carry out this project.

It is necessary to have a welding robot with a lot of sensors to allow the robot to be more independent. Standard welding robot, which can support up to 6kg with a range of 810mm (to 5 axis) would be used. These robots are perfect for arc welding, assembly, cleaning etc. so it is ideal to use this type of robot.

We also have to take into account all types of protection needed for the implementation of these robots, in this case the following would be used:

- Foundry Plus
- Wash
- Clean Room ISO Class 6

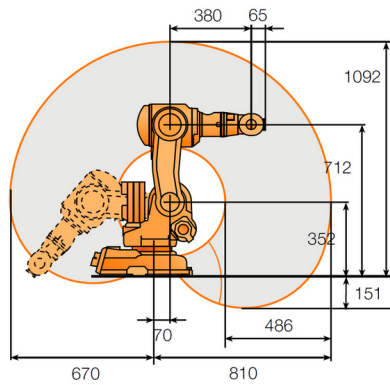


Figure 3.1: Possible type of robotic arm used

We would like the robot to be able to precisely weld holes, which can be as small as 0,1 mm. Precision of the robot is a key component for this task so we have to use a measuring tool.

The decision fell on a laser sensor capable of measuring the distance between the laser and the item prepared for welding, so knowing the position of the laser, we are able to calculate the position of the tool tip, in this case a welding pen. This will serve to correct deviations and obtain a uniform weld, because welding is performed at the same distance.