ENGINEERS
WITHOUT BORDERS
DENMARK

Oil press solution

EWB DK / SDU student project

Process report

4. Semester - Integrated Design, ID 403

Title page

4. Semester project

University of Southern Denmark

The Technical Faculty

Graduate Engineer in Integrated Design

Process report - ID 403

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Number of words: 1077

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THE PRE PROJECT

Introduction

Palm oil farming is one of the most important industries in the world. It produces palm oil, which is heavily used in the food and cosmetics industries.

Many Sierra Leoneans consume palm oil as part of their diet. However, there is a lack of industrialization and development, efficient machinery and processes. This makes the extraction of palm oil labour intensive, under-developed and under-utilised. Many small scale farms are still using very primitive technology in extracting oil, which can be inefficient and labour intensive. As such, the group will be working with Engineers without Borders to develop an efficient oil press solution for smaller scale farmers in the palm oil industry in Sierra Leone.

The Project Group

Fatama Al-Zahraa
22 years old

Strengths

- Sketching
- Adaptable
- Optimistic

James Chan
23 years old

Strengths

- Creative
- Determined
- Resourceful

Kasper Knudsen
23 years old

Strengths

- Dutiful
- Mood spreader
- Creative

Pelle Carlsson
25 years old

Strengths

- Analytical
- Logical
- Adaptable

Sandy Hoang
21 years old

Strengths

- Enthusiastic
- Brave
- Delegation

Zine Göncü
24 years old

Strengths

- Structured
- Good at completion
- Drawing/Creative

Group Profile

There has been made a Group Profile of the project group with the use of Belbin, the Group Contract, Team Canvas and Risk Analysis (Appendix 1, 2, 3 and 4).

Belbin

From what the group's Belbin report shows, the team can generate many ideas due to many Plants present. The team is likely to be receptive to feed-back and new ideas, and many will also step up to contribute. However, some of the best ideas will li-kely come from those who are quiet by nature and thus the group would need to listen well.

This could be solved with a method to make sure everyone gets their say, for instance a pen that a group member could hold, to make everyone else quiet down.

The Group Contract

The Group Contract contains different things such as: Decision making, level of ambition for the pro-ject, work hours and how to handle sickness in the group.

The project group will be using it as a guideline to set the standards expected of each member th-roughout the project.

Team Canvas

Team Canvas is used to set attainable goals, to understand the team's performance better and make necessary changes.

The framework will be a part of the process to make sure every team member is brought together and motivated. This is to ensure that the workload is shared equally among everyone, and that things will get done efficiently and within the deadline.

Risk Analysis

A risk analysis was conducted to help the team identify possible problems and take steps to prevent or rectify them to increase efficacy while working together.

As an example, the group have to be aware of the project being delayed because of sickness, and to get enough information about the user. The solutions to these would be good planning, communication and online working.

Mission Statement

Engineers without Borders (EWB) is an organization of volunteers and committed members with technical skills. It is a goal for EWB to collaborate with local and international aid organizations to help those in need, in poor countries as well as ensuring change[1].

Besides that, Engineers without Borders helps provide basic survival opportunities to build a better future for people affected by disasters and poverty. Based on the “Sustainable Development Goals” (SDGs), EWB will engage and move towards the goals.
The needs further down are supported by these SDGs[2]: ”7. Sustainable Energy” and ”11. Sustainable Cities and Local Communities” (Figure 1 and 2).

Figure 1

Figure 2

1 EWB: https://iug.dk/about
2 Sustainable Development Goals: https://www.verdensmaalene.dk/maal

Needs and Problems

With the current process of extracting the oil from the palm seeds, it is demanding and physically hard. A solution is therefore needed to develop new extraction methods. The needs and problems are given by Engineers without Borders[1] and a brainstorming in the group is set up to generate a number of issues for the case (Appendix 5). Possible answers for the issues can be found during the process, which in return helps generate possible answers to the problem formulation.

Figure 3

1 EWB DK - Oil Press Solution: https://iug.dk/media/116009/iug-projekt-hybrid-flexible-oil-press.pdf)

Needs

- The system can be built locally.
- The system can be operated and serviced by the local producers/users and or local service providers.
- The system can both be driven by solar power and with manual power (without external power supply).

Other questions to look into

- What are the processes in harvesting oil palm seeds and extracting oil from the seeds?
- Could a system be shared between several villages (business model)?
- Can the system be designed for easy transportation and set-up?
- Is there any operational (business) value gained in the introduction and electrical power?

Problem Screening

There is a need for improving the utilization of harvested oil palm seeds in Sierra Leone. Based on the above needs and problems, the problem statement is shown down below. In order to solve the problem statement, there are three other questions. For more details about the problems, see appendix 5.

How can a system/process be developed that provides efficient utilization of oil contained in harvested Oil Palm seeds?

- What material is best suited for oil pressing and is accessible in Sierra Leone?
- How can the process of extracting oil from harvested oil palm seeds be improved to maximize the amount of oil obtained, while minimizing waste and reducing the amount of resources required?
- What are the challenges the user might face during the harvesting and extraction process?

Project Management

Flow Chart

A temporary Flow Chart has been made to give a view of the expected workflow through the problem screening stage (Figure 4).

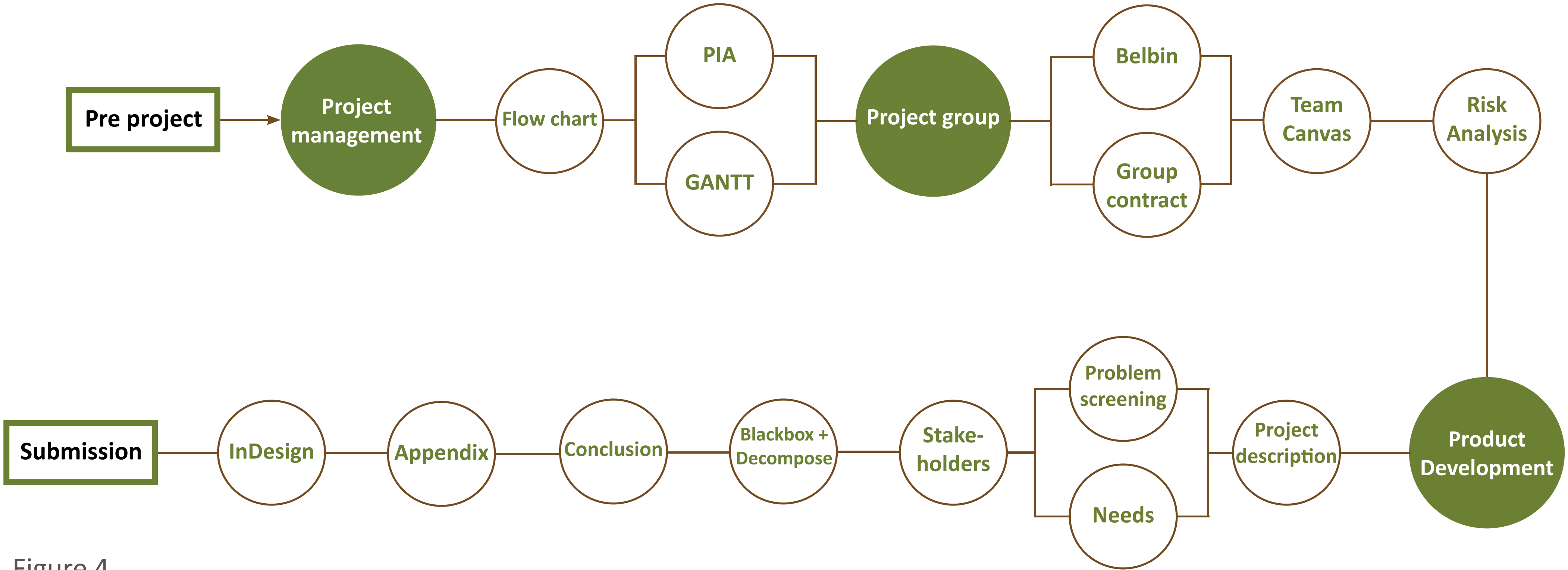


Figure 4

GANTT and PIA

For further view of the project, GANTT and PIA charts will be used. This is to schedule and follow the process through the project. See appendix 6 and 7.

Development Model

A Stage Gate is used to ensure a proper buildup of a concept. In each phase, the project group will reflect on the work that has been done, to make sure the project phase has been done well. (Figure 5).

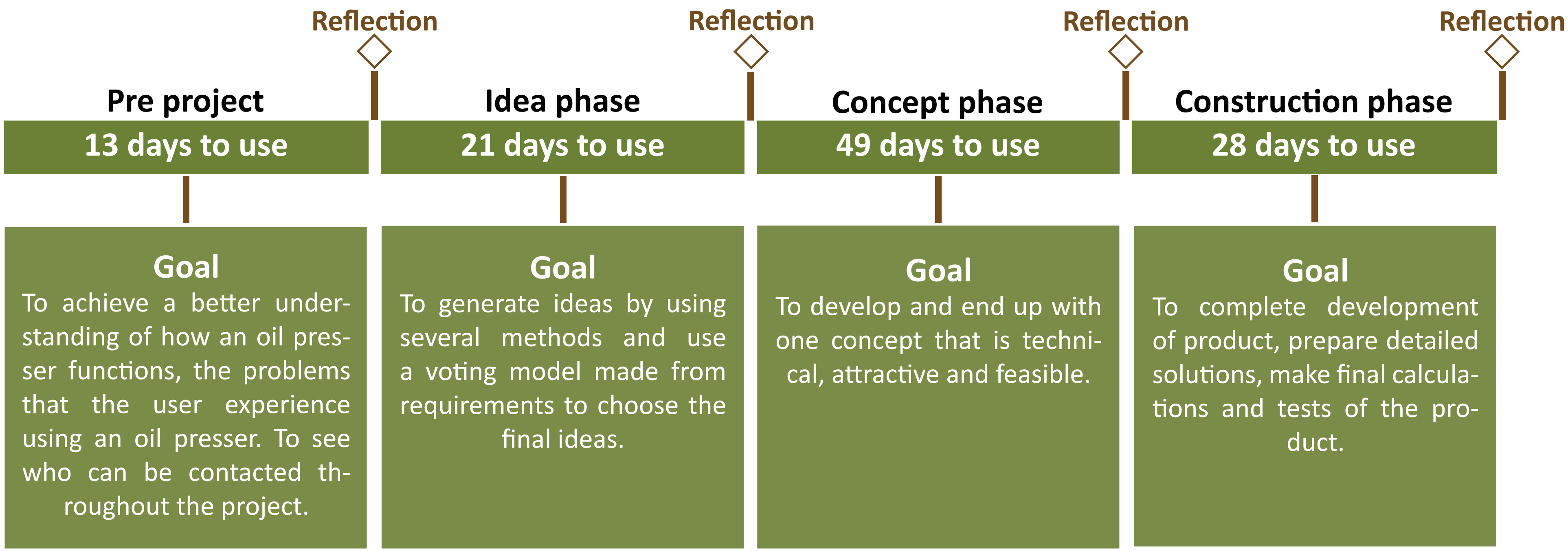


Figure 5

Stakeholders

The stakeholder analysis is made so the project group will have a view of important stakeholders. With that, it will help the group to contact those who are part of the project.

The main stakeholder the team will work with is Engineers without Borders (EWB). The organization has extensive links and can provide information about the end users in Sierra Leone as well as some possible constraints.

Next, the team will be liaising with their supervisors and other lecturers from SDU for their technical expertise as well as possible networks and contacts for any future stakeholders (Table 1).

Who	Importance	When	How	Responsible
Product commitee	Big importance	As soon as there is need for further information about the project and in the end of the project	By E-mail	Sandy Hoang
Christian Hammerich	Important	When there is need for information about the environment, life, user, and material available down in Sierra Leone.	By E-mail + Interview	Kasper Knudsen
Arne Palsbirk	Important	When there is need for information about the environment, life, user, and material available down in Sierra Leone.	By E-mail	Sandy Hoang
Edward Renner	Important	When there is need for information about the environment, life, user, and material available down in Sierra Leone.	By E-mail	Kasper Knudsen

Table 1: Stakeholder Analysis

The placement of the dots was based on initial perception and have been updated throughout the project once the group has sufficient interaction with the relevant parties (Figure 6).

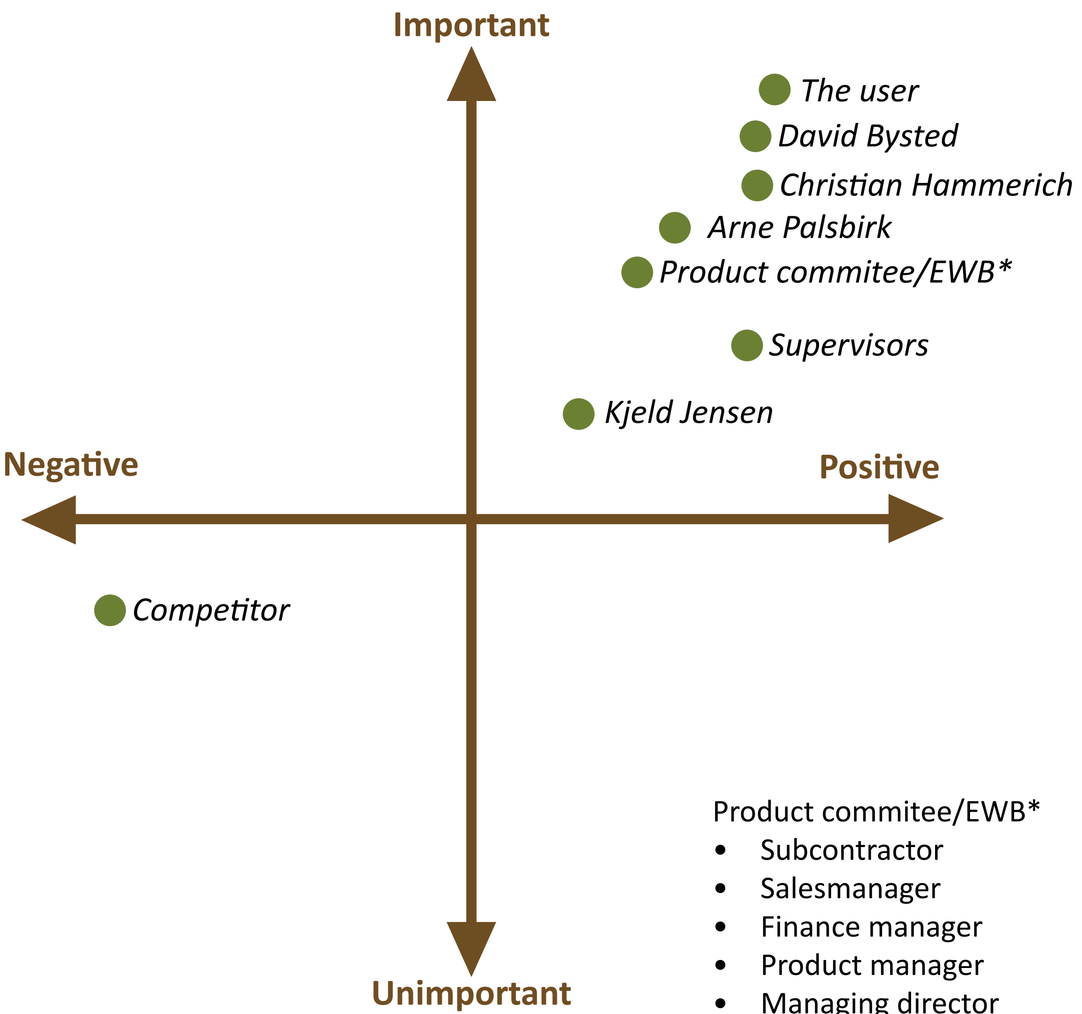


Figure 6

Product commitee/EWB*

- Subcontractor
- Salesmanager
- Finance manager
- Product manager
- Managing director
- Naja Mammen Nielsen (Communications officer)

Blackbox and Decompose

A black box and a decompose has been made to visualize the users' process whenever oil is produced. It is used to see the outcome and understand the effort that is needed (Figure 7 og 8).

Blackbox

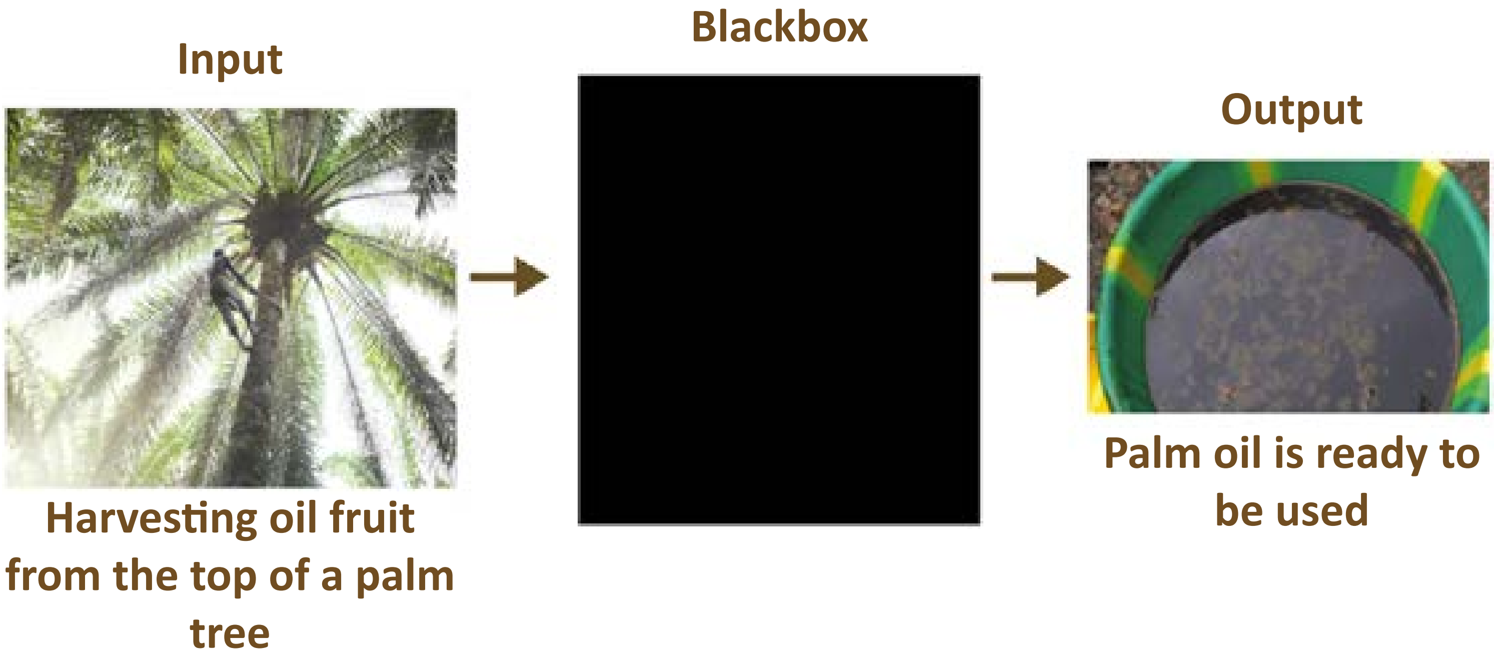


Figure 7

Decompose

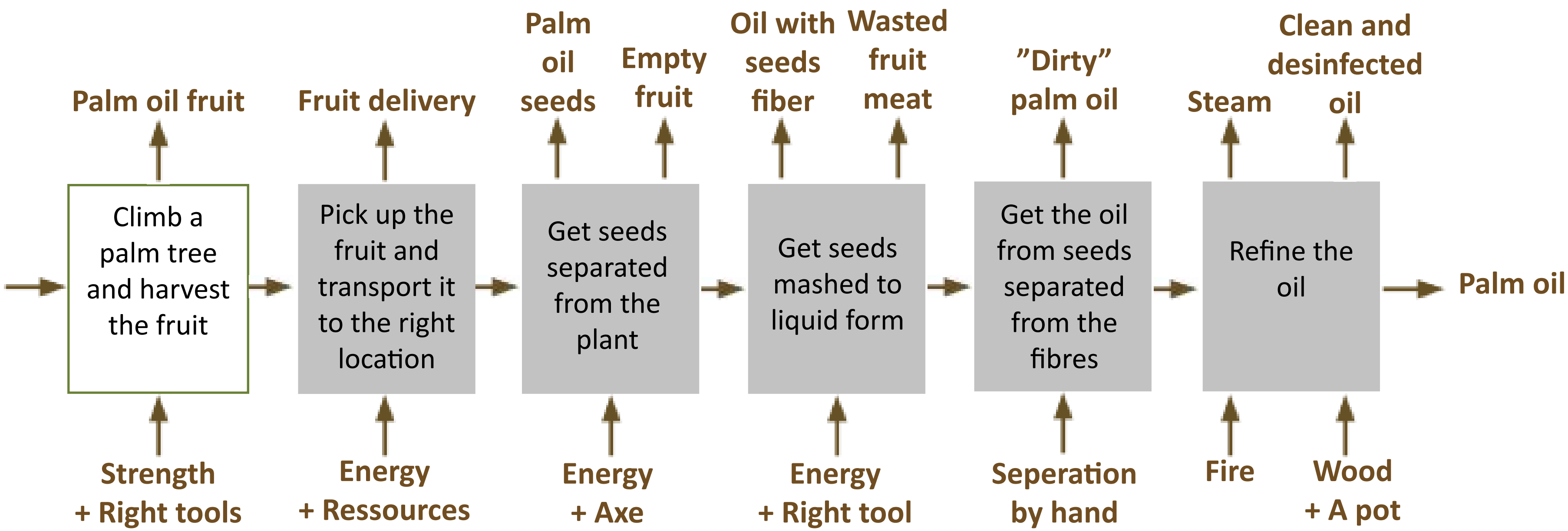


Figure 8

The decompose shows that there are opportunities to solve problems in the process. The grey boxes are characterized by physically demanding work. Herefore, the boxes are possibilities to find solutions that increases value for the user and opportunities to use the FINIC machinery[1].

1 Palm Oil Process: Palm Oil Processing - FINIC Generation 4 (G4) Palm Oil Mill Equipment - YouTube

Project Status

Currently, the team has established clear roles, the main problems and responsibilities and has developed a clear structure for how future work would be done. The team has also initiated contact with several stakeholders and looks forward to working with them in the coming months.

THE IDEA PHASE

Introduction

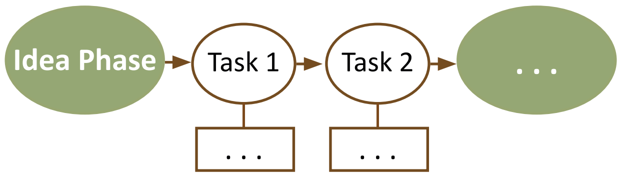
In the Idea phase of the project, the group intends to generate ideas for the project. To do this, the group will rely on information from stakeholders and its own research to generate a list of needs and requirements for the oil press. With the relevant information, the group can then brainstorm ideas and refine them, using a voting system to narrow down to the final few ideas. The end goal will be for the group to agree on a final idea to develop.

Project Management

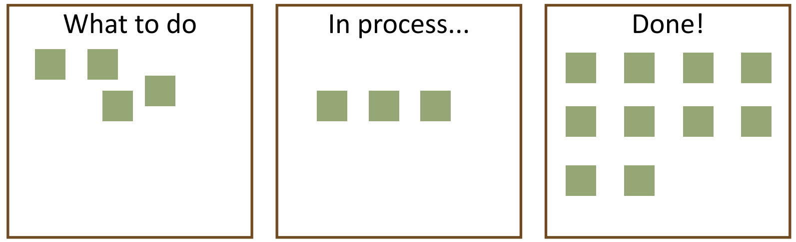
Flow Chart, GANTT and PIA

To manage the project, the group uses tools such as Flow Chart, PIA and GANTT. The Flow Chart is made to have a view of the work-flow in the Idea phase and is seen on page 25. Furthermore, GANTT and PIA are used as well to organise and have a follow up on process throughout the phase (Appendix 8 and 9).

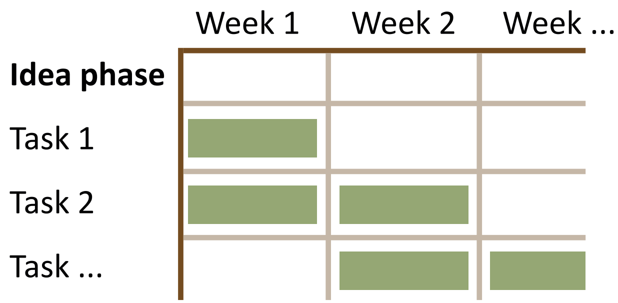
Flow Chart



PIA



GANTT



Flow Chart

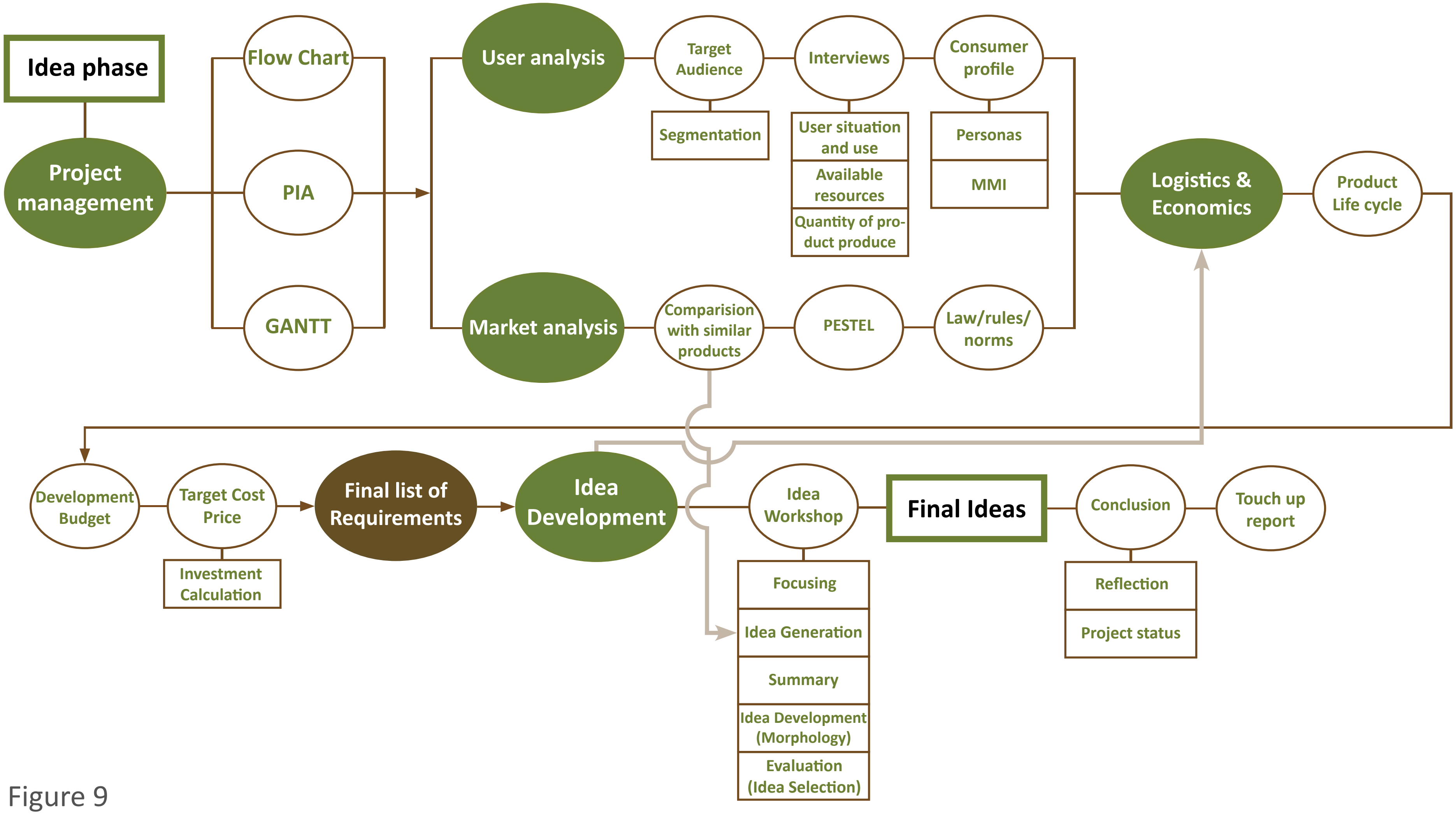


Figure 9

Research and Analysis

Introduction

The group will be researching on the market and users of oil pressers in Sierra Leone. The information obtained will later be used to aid the development process of the final idea.

To gain more insights on the user, the group first carries out Segmentation to further separate and classify the target audience. With the distinction drawn, the group can then proceed to interview the stakeholders to obtain the relevant information on the User Situation and Use, Available Resources in Sierra Leone and the Quantity of Product Produced. With this, the group can then summarise the information to create a Consumer Profile using Personas and MMI.

On the market aspect, the group will research on Similar Products in the market, conduct PESTEL analysis, and identify the Laws, Rules and Norms in Sierra Leone.

From these, the group can obtain a final set of requirements derived from the user and the market to progress on to the next phase.

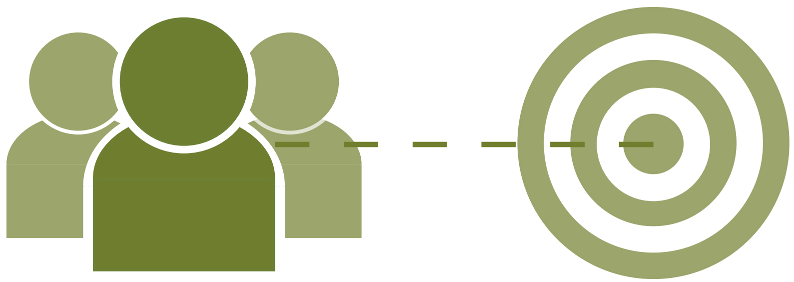
User Analysis

Target Audience

From interviewing stakeholders, the primary users of the oil presser are identified to be farmers from the villages. They use primitive tools and sometimes inefficient hand-powered machines, making their work physically demanding. Occasionally, their family members, even their children, are involved.

However, the target audience are the community leaders and farm owners. This is because the community leaders are the ones who have influence and power to make decisions in the community. They are responsible for passing on information about the use of the machine to the users.

As such, it can be assumed that the profile of the average palm oil press operator would be an able bodied adult male in Sierra Leone. The machine should hence be designed with that consideration in mind.



Since the country is fighting severe poverty, there is no easy way to contact the target audience or users. Therefore, the group is seeking the experience of workers and experts from EWB and people who have been in Sierra Leone to gain more information on the target audience.

Segmentation

This project will be working with two different segments, within the target audience, that are based off the information gathered in the project group's research.

The first segment consists of the reclusive farmers. These people are the ones who own small farms deep in the jungle. They only have the bare minimum of necessities, little to no electricity and produce palm oil using primitive methods. They are the most difficult segment to reach, as they cannot use the internet to communicate, and are less likely to be able to read and write.

The second segment consists of the community farmers. They are the ones who live in villages of up to 1000 people, and have access to some technology, such as motorcycles, cars, phones, and combustion engines. They can also band together to buy more advanced machinery for oil processing, with some even having access to FINIC machines. These are easier to reach as they can both use the internet and have a higher chance of having some education that allows them to read and write. They have community leaders that can reach many people at once to relay information like how to operate new machinery.

Interviews

To gain a better understanding of the users, the group set-out to interview a number of stakeholders who have experience working in Sierra Leone (Table 2). For the interview questions and transcript, see appendix 10.

Name	Position	Work Experience
Chrisian Hammerich	Civil Engineer, Lecturer SDU	Invovled in water project in Sierra Leone.
Arne Palsbirk	Project Engineer EWB	Invovled in water project in Sierra Leone.
Dorte Madsen	General Secretray EWB	Visited Sierra Leone to understand oil palm farmning and extraction.
David Bysted	Intern EWB	Interning with EWB in Sierra Leone as a teacher for the local students.
Søren Borg & Steffen Sørensen	Project Supervisors SDU	Søren has worked in Tanzania.

Table 2: Stakeholders

Key points that have been extracted from the interviews, about society and the living circumstances in Sierra Leone are: They have low education, limited available tools and an income of around 1.5 USD per day. This information will be converted into needs.

User Situation and Use

Identification of the process is built from the decomposition, and based on relevant observations[1]. A description of alternative methods in the process of producing palm oil has been written. The setup below shows the possible steps that the users will go through during the production of palm oil (Table 3). The project group has chosen to focus on the main functions of the oil press where each step has some variations. To see the full table, see appendix 11.

Alternatives for the use of machines and primitive tools

- **The seeds need to be mashed to produce unrefined oil.**
  - a. They will be mashed by a thick stick in a stone bowl (This will not sort out the fibers from the liquid).
  - b. They will be mashed by a machine that will sort out the fiber from liquid.
- **The unrefined Palm Oil needs to be refined.**
  - a. The barrel with open fire heats up the oil.
  - b. A big container gets heated up with a closed fire.

Table 3: Steps for oil presser with variations

This setup will be used in the making of personas, that would give a better understanding of the users' different work processes and will be used as an inspiration for generating ideas.

1 Palm Oil Processing - FINIC Generation 4

Storyboards

The steps that the users go through during oil pressing, using the machines or primitive tool has been outlined in appendix 12.
From this, two storyboards have been made to get a better overview of the two processes:
One for machines from FINIC and one for primitive tools (Figure 10 & figure 11, seen on page 33 and 34). The storyboards are inspired by pictures showing the two different ways of producing palm oil.

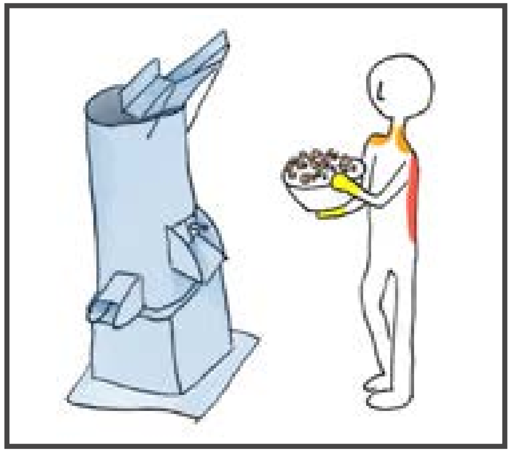
The FINIC machine is chosen as a general way of understanding the user situation during the machinery process. Likewise, there is shown another more complicated and physically demanding method, using primitive tools.

The storyboards visualize how the users interact with the seeds, step by step. In addition, it shows how the users are physically affected while working. The colors on their bodies rate their pain during their work:

Yellow is mild pain **Orange** is moderate pain **Red** is severe pain

After looking at the storyboards and to sum up everything that has been stated so far:
The use of primitive tools results in the most pain for the users. Meanwhile the use of FINIC machinery has fewer, and less physically demanding steps and therefore less pain occurs. This gives a general view of their work.

FINIC MACHINE



The Finic Machine is ready to go but the bowls of palm seeds are heavy:

- Mild pain in their wrists and hands.
- Moderate pain in the shoulders.
- Severe pain in the back.

The users pour down the seeds:

- Moderate pain in the shoulders.
- Also, moderate pain in the hands and wrists.
- Severe pain in the back.

The users pour down water:

- Moderate pain in the shoulders.
- Also, moderate pain in the hands and wrists.
- Severe pain in the back.

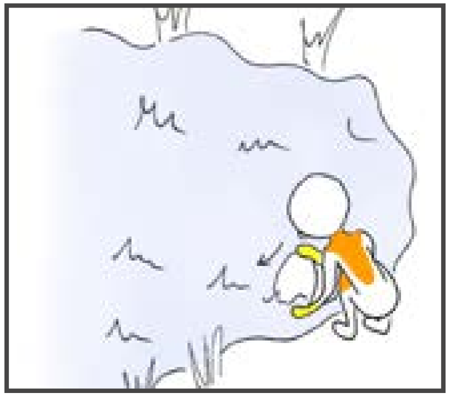
The Finic Machine does the job and produces the palm oil. It drips a little in the other bowl. To avoid waste the users will make sure to pour it over the bowl with the oil.

The user opens the small gate to let out the fruit that is leftover in the machine.

Figure 10

The palm seeds are being chopped off the bushes:
- Mild pain in the wrists and hands.
- Moderate pain in the arms and shoulders.
- Severe pain in the back.

The user pours down the seeds:
- Moderate pain in the shoulders.
- Also, moderate pain in the hands and wrists.
- Severe pain in the back.



The user scoops up water:
- Moderate pain in the shoulders, back and knees.
- Mild pain in the hands and wrists when scooping up the water.

The users pour down water:
- Moderate pain in the shoulders
- Also, moderate pain in the hands and wrists.
- Severe pain in the back.

The user stirs and boils the seeds until they are soft and ready to get mashed:
- Moderate pain in the shoulder, biceps, forams, wrists and hands.

The users are mashing the palm se-eds so the oil can be made:
- Severe pain in the arms, shoul-ders and back.

The oil is ready and the user pours down the oil in several plastic cans.
- Mild pain in the arms.
- Moderate pain in the wrists and hands.

Figure 11

Available Resources

In order to construct a product that would be easy for Sierra Leoneans to make and maintain, it is necessary to observe the kinds of materials that they have at their disposal. The information has been obtained from interviews with stakeholders (appendix 10):

- Many of the products users would be farmers, that have hand ***tools readily available***, although not necessarily in large number. ***Machetes*** would be a common sight. ***The bladed ends*** of such tools could be of use in the product.

- ***Air conditioners*** can be found in some less rural villages, and could provide casings, tubing and other parts for transporting and handling fluid.

- ***Combustion engines*** could provide similar parts and could likewise be used for operating machinery.

- ***Solar panels*** are increasingly common and could be used to ***obtain electrical power*** for the product.

- The most common type of vehicle in rural Sierra Leone is the ***Toyota Landcruiser***, which of course contains many smaller parts, a ***combustion engine***, ***tubing***, ***filters*** as well as additional equipment such as a ***hydraulic car jack***.

- Some villages have ***blacksmiths***, that can shape and process metal in relatively simple ways.

In short, many materials are available, although anything custom fitted would have to be something a blacksmith with simple tools could handle or be bought from other sources.

Quantity of Product Processed

A calculation of oil produced has been made to determine the quantity of oil produced per cycle, day, year, and decade.

These figures can be utilized to determine the necessary requirements for the oilpresser, as well as given an idea of the right volume.

As shown, this (Table 4) is data for the production, taken from the section “Product Life Cycle”.

Time used per day	5	times
Time used per year	182	times
Product Lifetime	10	years

Table 4: Operational plan of produced oil

Furthermore, this is data on the different types of seeds construction and their different characteristics (Figure 12 and table 5). Arne Palsbirk also mentioned that they are the same size as grapes, and the seeds are a bit stronger on the outer side. 1/3 of the seeds is a stone.

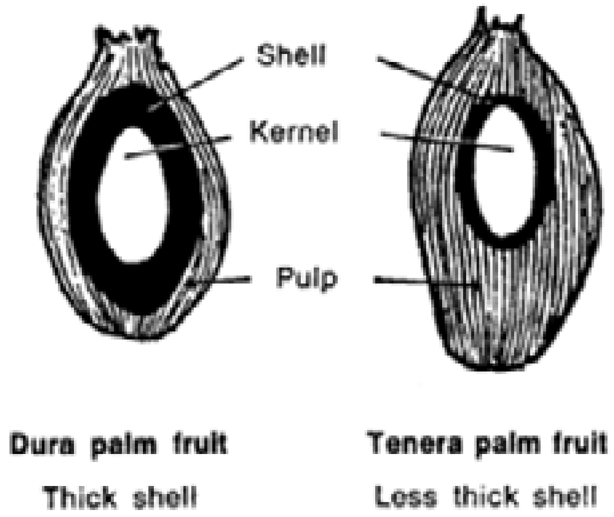


Figure 12

Type of seed	Dura seed	Tenera seed	
Weight	12,5	11,5	g
Contains on average about	23	27,5	% oil
Oil in seed	2,875	3,163	g
Average oil extraction in presser	22-25	22-25	%
Produced oil from seed	0,676	0,743	g
Forced to crack the seed	5,79	2	N/ mm^2

Table 5: Differences between Dura & Tenera seeds

In addition, to understand the general information about Dura and Tenera seeds, tables has been made in appendix 13. From what is seen it turns out that the palm seed/water ratio in production is 1/1 or usually 1/2 ratio[1]. This means a medium scale oilpresser can hold about 15 kg[2] which is likewise informed by Christian Hammerich.

It can be concluded that the Tenera seed yields more but is likely to crack at around 2 N/mm, while the Dura seed produces less and is harder to crack at 5.79 N/mm. Scaling up the construction will increase wastewater production at a 1:2 ratio. The yearly oil production of both seeds will be used in the simple investment calculation.

1 Small-Scale Palm Oil Processing in Africa
2 Wooden Rotary Oil Press

Consumer Profile

Personas

To understand the users' use case better, the project group has created three personas. They are fictional characters representing different user groups, based on previous research by the group.
For more detailed despriction of each persona, see appendix 14.

Abdul, M, 25 years old

- Lives in the jungle
- Works for his father's palm oil plantation
- Limited electricity and tools
- Strong physique because of physical work
- No education; cannot read or write
- Has never operated a machine
- Carries and walk with the oil to the market

Tenneh, F, 35 years old

- Lives in the village
- Owner of a small communal palm oil plantation
- Owns two mechanical, hand-powered oil presses
- Access to electricity
- Owns a cellphone for social media
- Knows how to write and read
- Uses a motorcycle to transport the oil to the market

Mariama, F, 46 years old

- Lives in the jungle
- Does household chores and takes care of her baby
- Helps carry water from lake
- She is busy, but wishes to have more time with her baby
- Physically strong because of physical work

MMI

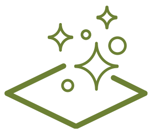
MMI is made to show different parameters of what the product should focus on, so that the user will operate the product as intended. So far, it has not been decided whether to work on a machine- or human-powered solution. Some of the parameters can only affect certain types of machines (Appendix 15).
Based on the MMI, the most important parameters have been ranked from top to bottom. Readability is the most important, while cleaning is the least important.

Readability is the most important parameter, based on the interview with Christian. If the users do not know how to use the machine/tool, it will be abandoned.

Servicing is the second most important parameter. If they get a machine/tool and it brakes, and they cannot fix it, it is going to be abandoned.

Ergonomics and perception in combination. Surfaces their human interaction are needed, mostly to be obvious, as it will help understanding the machine/tool.

Safety. Moving parts should be shielded and emergency stops should be a part of the construction.



Cleaning. To get the machine/tool to last longer, and therefore make it worth the investment.

Market Research

PESTEL

To better understand the culture, society, and general macro-climate in Sierra Leone, the project group will create a PESTEL analysis (Table 6). The information in PESTEL is obtained from sources like Wikipedia[1] and the stakeholders. A full analysis including sources are available in appendix 16.

P	E	S	T	E	L
• Republic • Large agricultural sector • Corruption	• GDP Total: 26,77 bio. kr. • Cost of living in villages: 10 kr. per day	• Low education level • Most people are fit • People are curious and cooperative	• Low tech • Little infrastructure in villages • Toyota Landcruiser is common vehicle	• Tropical climate	• Small farms often outside law enforcement

Table 6: PESTEL

Based on the PESTEL analysis, the project group will prioritize the Social, Environmental and Technological aspects of Sierra Leonean society. The Social and Technological aspects are important because of how much they differ from the group's home environment, and the Environmental aspect is important as most oil presser is exposed to the outdoors environment. Therefore, the group will primarily focus on these, while of course keeping other aspects in mind.

1 Wikipedia - Sierra Leone

Comparison with Similar Products

In this section[1], the project group will look at traditional and modern methods that can be used to extract juices and oils from various products. This comparison gives an opportunity to discover how existing products function and can give inspiration for the Idea Generation.

A list of different oil/juice extraction methods is made, which is shown down below (Appendix 17).

1. FINIC Palm oil processing machine
2. DOING Palm oil processing machine
3. Homemade palm oil press
4. Hand pressed juicer 1
5. Hand pressed juicer 2
6. Sugarcane juicer
7. Hand cranked juicer 1
8. Hand cranked juicer 2
9. Centrifugal juicer
10. Sunflower seed oil press
11. Home oil press machine
12. Mustard seed wood oil press
13. Olive oil press

1 Several videos of similar products

To understand these methods, it is necessary to analyse the form of juice/oil extraction, which has been categorised in the list below:

Pressing

- o Grindstone
- o Auger against filter
- o Roller press
- o Screw action press
- o Pressure against filter

Blending

- o Blending and washing
- o Centrifugal juicer

Further observation reveals that the main method for oil extraction involves some form of pressure on a filter surface. The high pressure forces the fluids out through the filter while retaining the fibres and other solids. The amount of pressure and size of filter holes depends on the substance that is being crushed.

Palm seeds require a higher pressure to extract oils, due to its strong fibres, compared to fruits. Because of the size of the fibres, plam seeds require less fine filter sizes to keep the solids out.

Pressure/Pressing Methods	Filter Design
Hydraulic press	Rebars welded close to each other
Auger	Perforated metal sheets
Screw action press	
Roller press	

Table 7: Pressure/Pressing methods & filter design.

With that, it shows some possible methods that could be used for Idea Generation of the final design (Table 7).

Laws, Rules and Norms

A research of Laws, Rules and Norms have been made, to learn more about the living situation and circumstances in Sierra Leone.

Laws and Rules

From the interview with Hammerich and Palsbirk, Sierra Leone does not have any relevant laws and rules. They do not have rules regulating the usage of oil pressers, farming, selling or safety, which were initially areas of concern for the group.

Therefore, it is important to go into the culture and norms of Sierra Leone, which could influence the perspective on the project.

Norms

According to Hammerich, Sierre Leone is a male-dominant environment. This indicates that the Sierra Leoneans are quite traditional, and they divide the tasks between males and females.
Hammerich explains that the females are quite systematic and structured. They do traditional work by collecting water, cooking and so on. Meanwhile the males carry out most of the physical labour outside of the household. As such, they are most likely vaccinated with the COVID-19 vaccine.

In context of the palm oil presser, it is clear from said norms that the females will provide the water for boiling, while the males will operate the machine.

Logistics and Economics

Logistic and Economics

Introduction

In this section, the project group will first investigate the ideal target lifespan of the oil press, as well as the finances allocated for it. This is essential as it allows the greatest return of investment while still being affordable for the target users. This section will act as the final reference point before beginning Idea Generation.

The Analysis

Some of the bigger challenges of the project is how to manage the resources available to the target group, as well as the economic situation. The availability of materials is limited, not everyone has transportation, electricity is not available in some places and money doesn't come from nowhere.

After reaching out to the stakeholders, Christian Hammerich and Arne Palbirk, it is now known that EWG can help (appendix 18). CISU or companies will donate money or expertise to establishing projects, that will be proceeded with help of a local partner. EWG strive to buy and use local materials. If certain materials are not available and is necessary for the project, EWG will ship the materials and tools to Sierra Leone. After a project is up and running in the community, either it will operate on its own or locals will be teached to operate and maintain the project.

Product Lifecycle

It is important for the project group to determine the products' lifecycle, to ascertain that the machine development is efficient and cost effective. This will help finding the balance between minimizing the cost while maximizing the oil production.

To determine the lifecycle, research has been done to get data for the calculation. The oil presser is used under the harvesting season for palm fruit, between October and April[1], where they will be used around 5 times a day and has a lifetime of 10 years.
The oil presser can be used around:

5 times * 182 days * 10 year = 9200 times

The project group aim to discover how much a machine should cost and therefore estimate the product´s lifecycle from the potential designs that can fit within the cost range. With this data, it is also possible to estimate the returns to investment ratio based off the amount of oil it can press over its lifetime.

1 Department of Agricultural Economics

Development Budget

From the interview with Christian Hammerich and Arne Palsbirk, the project group seek to determine the estimated budget for the oil press.

To produce an oil press, it is usually the local blacksmith who will use materials that they can get their hands on in Sierra Leone. Prices on materials and similar oil pressers in Sierra Leone has been hard to find.

Therefore, it will not make sense to make a development budget from materials price based on Danish prices, as costs would be different in Sierra Leone.

Target Cost Price

To determine the target cost price, a multitude of factors needs to be considered.
This would include the average wage of palm oil farmers in Sierra Leone, the cost of similar machines in Sierra Leone, as well as material and labour costs. These would guide a decision in setting a plausible range for the cost price, so that an efficient, yet affordable machine can be built.

Based on the interview with Christian Hammerich, most Sierra Leoneans in the target audience is living on **1.5 USD (10 DKK)** a day. Additionally, the minimum wage for Sierra Leoneans is around **211 USD (1462,95 DKK)**[1] a year. However, Sierra Leone ranks low on rule of law and regulatory efficiency and thus many people are in the informal labour force[2]. This means that the data above should be taken as a rough guideline.

1 Minimum wage - Sierra Leone
2 Heritage - Facts about Sierra Leone

In terms of machines, there are two reference points: The hand powered one from Arne Palsbirk's [1]video , and the FINIC machinery from 3rd and 4th generation. The 4th generation is said to have a longer working lifespan than the 3rd[2].

For an overview of the data, table 8 has been created.

The Target Audience		Cost of Machines		
How much they live on (Per day)	**Minimum wage (Per year)**	**Hand powered Machine**	**FINIC (3rd generation)**	**FINIC (4th generation)**
1,5 USD (10 DKK)	211 USD (1462,95 DKK)	354 USD (2454,42 DKK)	1800 USD (12402 DKK)	3600 USD (24804DKK)

Table 8: Price/Wage comparision

From the table above, it is clear that the average Sierra Leonean that does not have a job, would find it difficult to afford a machine after factoring in living expenses. As such, as Arne Palsbirk states, a village of 1000 people will work together to buy an oil presser from the local blacksmith.

A plausible idea would then be to create a machine with upgradable and customisable components to fit different price ranges and production capacities.

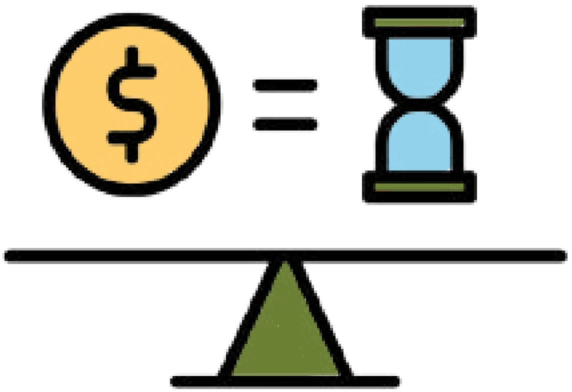
1 Arne Palsbirk's video of Oil Presser
2 Youtube: Palm Oil Processing - The FINIC G3 & G4 Palm Fruits Gigesters in action

Investment Calculation

A simple Investment Calculation has been made to find out how long the machine need to last and to reach the breakeven point. Furthermore, documentation has been made about the palm oil selling's prices via WACOMP[1] and asking one of the stakeholders currently in Sierra Leone. To understand and get more information about the different types of palm oil, which is Dura and Tenera, it is explained and researched in the section "Quantity of Product Produced".

It appears that the price will be negotiated and most likely be low because of the big competition on the domestic local market.

It was announced that the local cooking oil price was 1,24 USD pr. liter. The density of palm oil is around 904 kg/m^3,[2] which means the price is 1370 USD pr. ton. Compared to other prices, this product is a premium price, and almost nine times more expensive than other prices.



1 Palm oil production and markets in Sierra Leone
2 Analysis & comparison of olive cooking oil & palm cooking oil properties

Case: If a village of 1000 people invest 0,1 USD each, to buy a machine worth 300 USD.	**Breakeven Wholesale price (Low): 154 USD/ton**	**Breakeven Wholesale price (High): 729 USD/ton**	**Breakeven World export price: 644 USD/ton**	**Breakeven ECOWAS export price: 807 USD/ton**	**Breakeven Stakeholder price local: 1370 USD/ton**
Dura (Best case) (1:1 water ratio)	Year 4,5	Year 0,5	Year 0,5	Year 0,5	Year 0,2
Dura (Worst case) (1:2) water ratio)	Year 5,5	Year 1	Year 1	Year 1	Year 0,3
Tenera (Best case) (1:1 water ratio)	Year 3	Year 0,5	Year 0,5	Year 1	Year 0,2
Tenera (Worst case) (1:2) water ratio)	Year 4,5	Year 0,5	Year 1	Year 1	Year 0,3

Table 9: X-axes of table shows different prices - Y-axes shows breakeven for each scenario

Table 9[1,2] will compare the different prices in their respective markets. Likewise, the table shows the breakeven can be achieved in the interval of 0,2 – 5,5 years. For the full table, see appendix 19. The earlier breakeven indicates a better quality, by using less water to extract the oil. If the palm oil quality gets better, exporting will be a future option as it can be sold for a higher price.

The investment price at 300 USD seems realistic at this point to achieve a breakeven, but if the machine cannot last at least 5,5 years in the production cycle of 9200 over ten years, it could be a problem. However, if the daily production of 5 cycles is raised the breakeven can be obtained faster. Luckily, EWG can help the locals by starting projects that can improved oil pressers.

1 Palm Oil price in Sierra Leone
2 Palm oil production and markets in Sierra Leone - May 2023

List of Needs

The content from this paragraph is a summary of the research done in the previous section and have the needs clearly listed out (Table 10).

One need from each section is picked out to understand how the project group converted the quotes from each section to extracted needs. Each need is numbered according to the full list of needs (Appendix 20).

Section	Quoted text	Extracted Needs	Needs No.
Interview	”People living below 1.5 dollars a day”.	The oil presser is affordable for people in Sierra Leone.	1
MMI	”For the oil not to be contaminated”. (Cleaning)	The oil presser can be easily disassembled of certain outer parts for easy access to cleaning.	15
Personas	“Has never received any education to teach him to read or write”.	The oil presser of the oil-presser can be understood without reading.	19
Quantity of product produced	“Make the production of palm oil on farms more efficient”.	The oil presser minimizes drops of valuable resources.	28
Similar products	”Fluid from seeds needs to separate from the fibres“.	The oil presser can separate the fluid from the fibre.	30
PESTEL	“Tropical climate”.	The oil presser is not affected by the tropical climate.	31

Section	Quoted text	Extracted Needs	Needs No.
Storyboard	"...the use of the primary tool results in the most pain for the users".	Less physically demanding using primitive tools.	32
Laws/rules	" Sierre Leone is a male-dominant environment." "males are hard workers outside of the household".	"The height of the oil presser is adjusted to suit the comfort of male users.	35
Project Description		The system improves the utilization of harvesting oil palm seeds.	36
Target Cost Price	"Could have an option to upgrade to a motorised version by installing other components in the future, perhaps an electronic motor."	Oil presser should be mechanical, but designed to be able to attach to a motor in the future.	40
FN	"Sustainable Cities and Local Communities".	The oil presser helps provide sustainable Cities and Local Communities.	43

Table 10: List of needs

List of Requirements

The extracted needs from the earlier section are converted into requirements for the final idea (Table 11).

The importance of each need is rated in the “importance” column.
The higher the number, the more important the requirement.

The requirements marked with red will be further investigated in the Concept Phase. All in all, the requirements will proceed to brainstorm and develop ideas of the oil presser.

Needs No.	Requirements	Units	Importance (1-5)
1, 7	The oil presser costs less than 345 dol-lars.	USD	5
2, 4, 39, 29	The machine can apply 6 MPa.	MPa	5
3, 18	The oil presser can be built with x of tools.	Number of tools	4
6, 12	Minimum two colours will be used for the oilpresser to indicate use.	Number of colors	3
8, 10, 11, 16 37 43	The oil presser consists of At least 70% of the materials used in the construc-tion of the machine should be sourced locally.	Number of familiar parts	4
9, 31	The lifecycles of the oil presser should remain over 9200 cycles during rain and in 40 degrees Celsius.	Cycles	4
13, 35	The height of the installation of interfa-ces is around 1-1,5 meter.	cm	3

Needs No.	Requirements	Units	Importance (1-5)
14	Time used to stop the oil process is less than 3 seconds.	Seconds	3
15	Time for disassembling. The oil presser is maximum 20 min.	Minutes	3
17, 38	It takes 20 min to figure out how to maintain the oil presser when first intro-duced.	Minutes	3
19, 21, 5, 36, 37	It takes 10 min to understand how the oil presser works without a manual.	Minutes	5
20	The oil presser can be transported by 2 average men, with the speed of 15 m per min. during the first min.	Minutes	3
24	The maximum numbers of needed wor-kers to use the oil presser is 2	Numbers of workers	3
25, 26	The time used on the oil presser will be less than X min.	Minutes	4

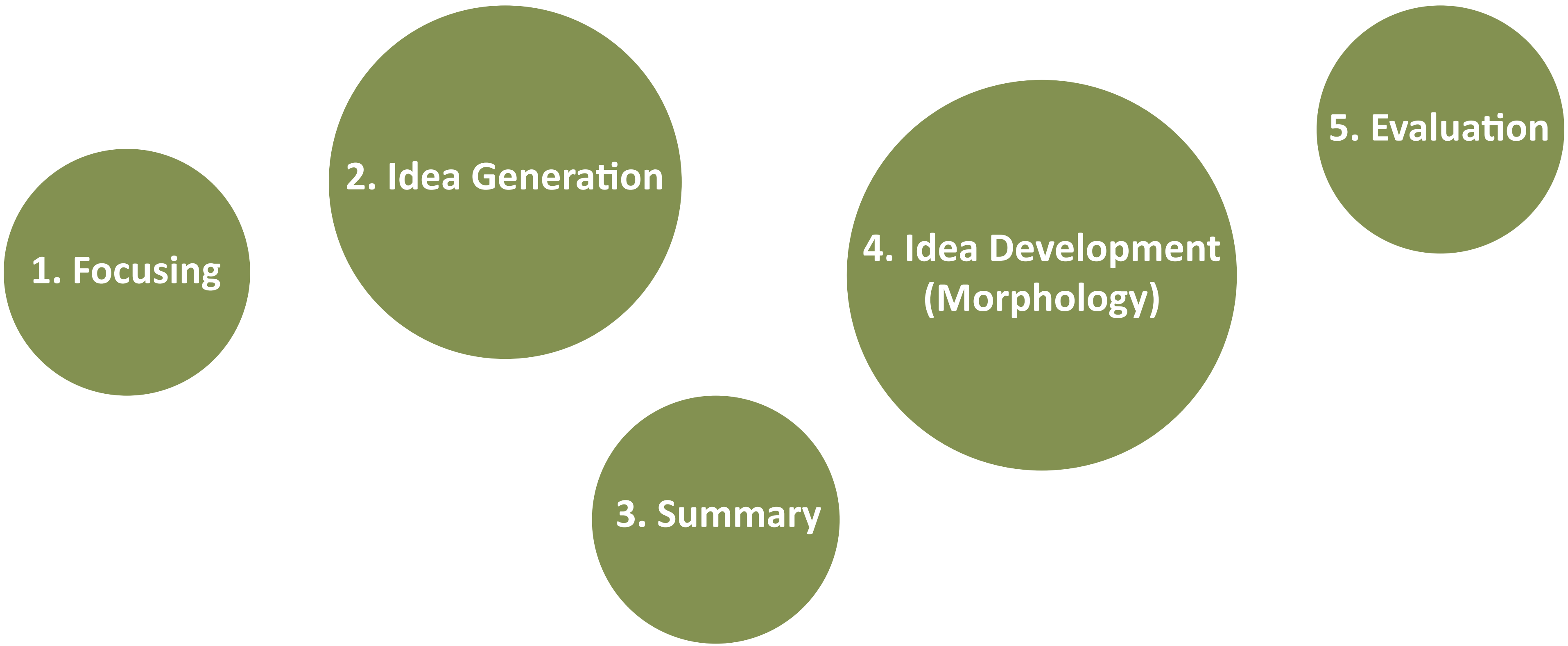
Needs No.	Requirements	Units	Importance (1-5)
27	The time used on to supply water to the oil presser is less than 10 min	Minutes	4
28, 30, 36	The oil pressers oil waste is less than 5 %.	%	3
31, 36	The material hardness will remain minimum 95% the same during rain and 40 degrees heat.	HV	4
34	The load on the shoulder, arm and back should be less than x N	Newton	5
40	The oil presser should be a mechanical device capable of manual operation. But designed for future motorization. It should be able to process at least 20 kilograms of raw material per hour and exert a minimum pressure of 0.7 megapascals (MPa) for efficient oil extraction.	MPa	3
36, 31	The oil produced is over 95% pure	%	5
43	The oil presser uses a sustainable energy source, such as solar, wind, or hydropower, to power the machine.	Choice of power	4

Table 11: List of requirements

Idea Development

Idea Workshop

The purpose of this workshop is to generate a diverse range of ideas that will then end up with 3 ideas with the best solutions for requirements and needs. The final idea will then be worked into a concept further developed in the Concept Phase. This workshop has been made by a model from "Creative problem solving and practical Idea Development", that consist of 5 steps:



Focusing

The focus of this workshop will be based on the problem statement:

"How can a system/process be developed that provides efficient utilization of oil contained in harvested Oil Palm seeds?"

Idea Generation

As shown on the next page, the methods that are used in Idea Generation are the ***Visual Technique and 6-3-5 Technique.*** It is used generate many ideas in a relatively short period of time.

Summary

Afterwards, the project group reviewed and summarized the ideas generated during the Idea Generation. The project group engaged in a productive discussion to determine which ideas showed the most promise for further development and sorted the ideas out that were not realistic.

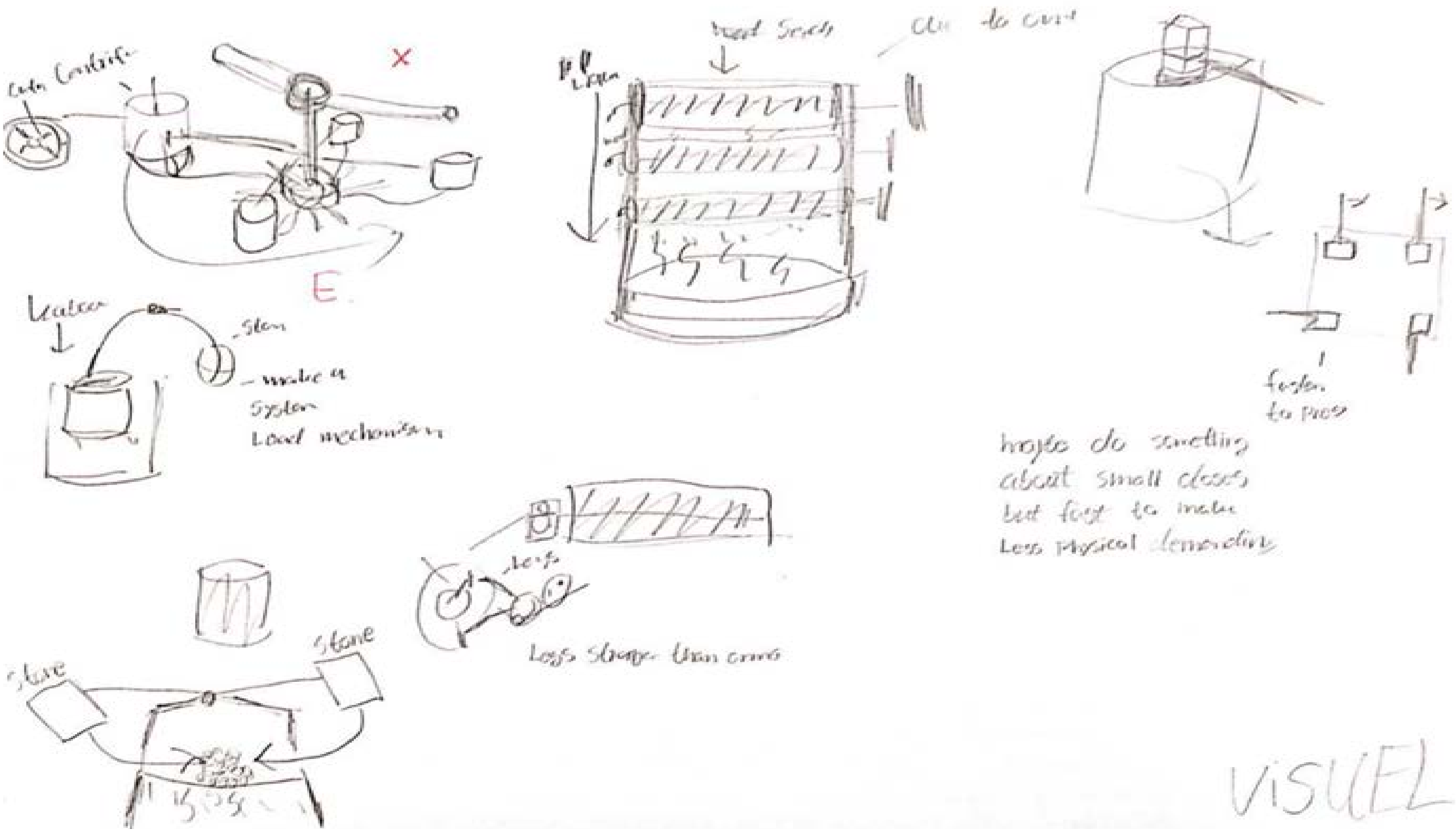


Figure 13

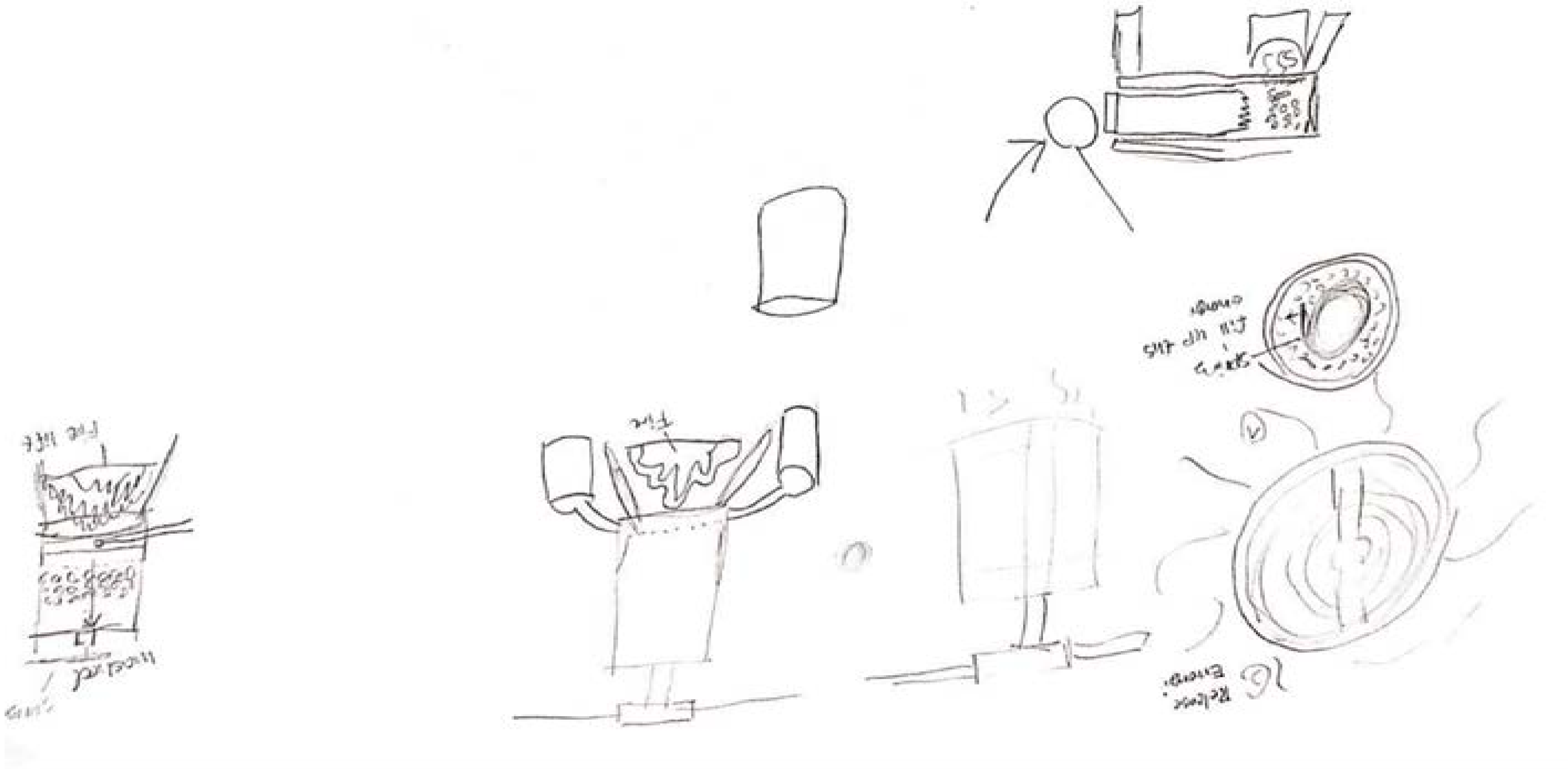


Figure 14

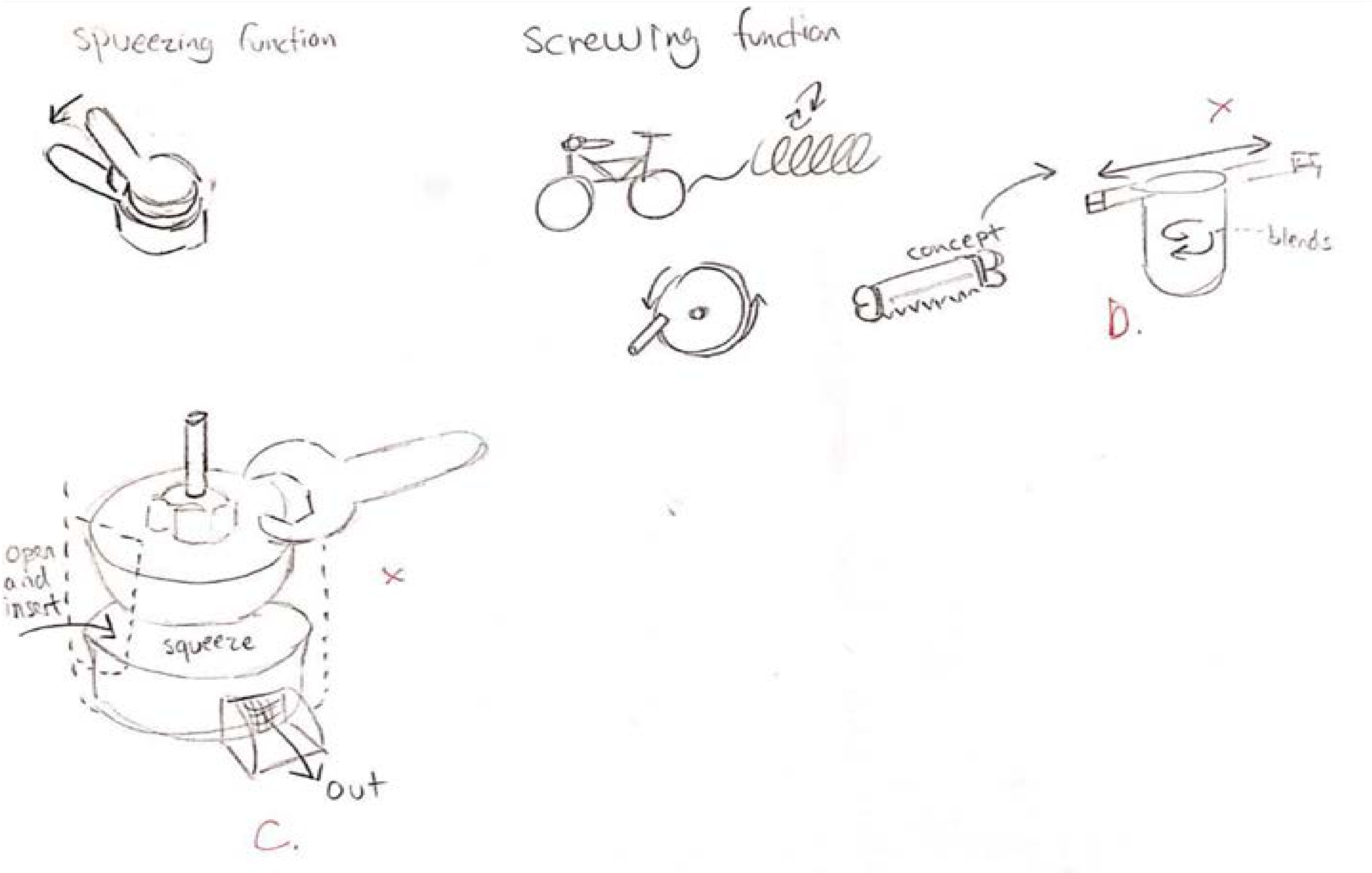

spueezing function
screwing function
concept
blends
D.
open and insert
squeeze
out
C.

Figure 15

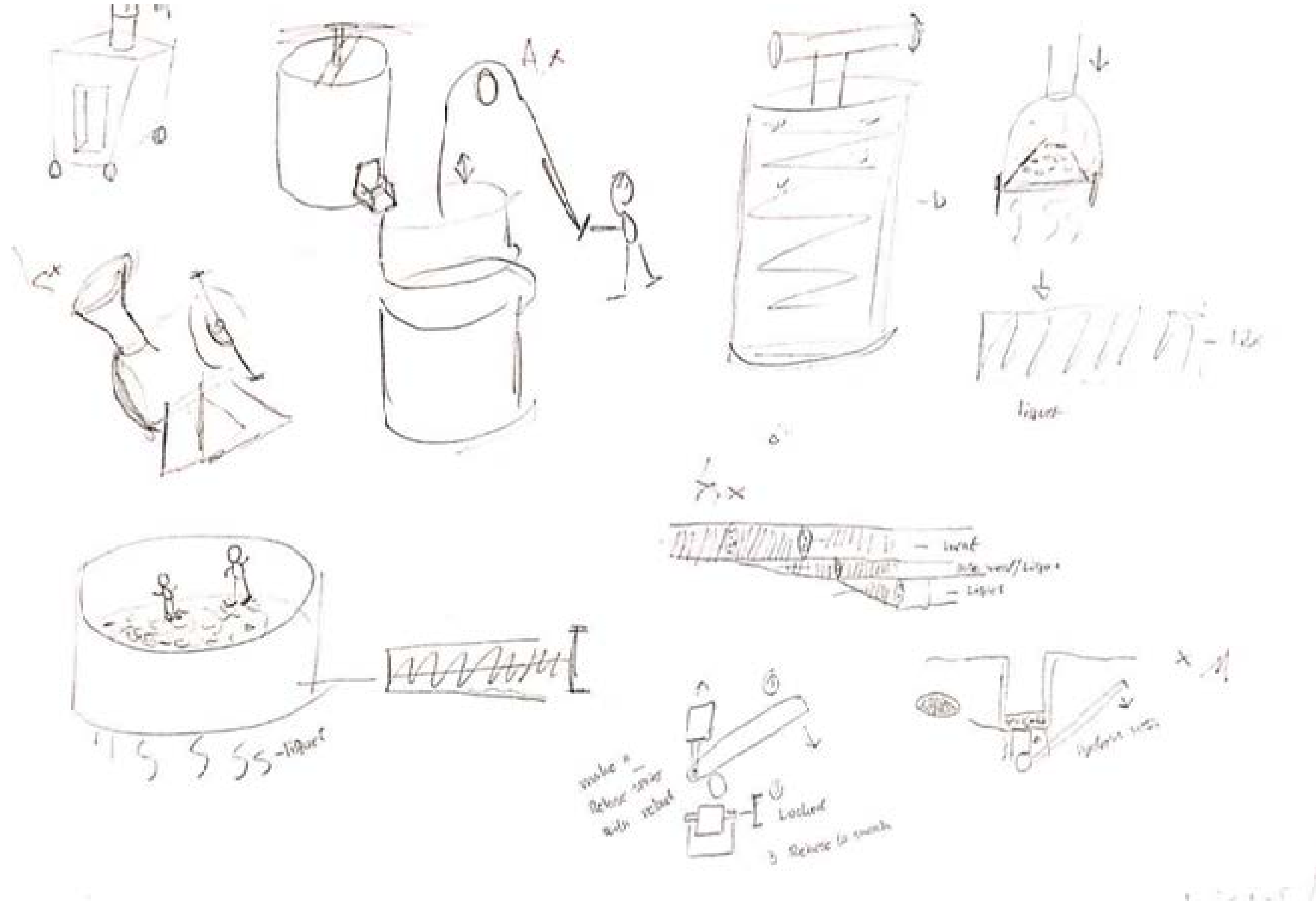


Figure 16

Categorising

To provide an organized overview of the ideas left, the ideas were grouped into different parts/sub-categories: Operating, Processing, and Refining/Heating (Table 12).

Operating (Mechanical motion to operate the processing step)	
• Pulley • Hydraulic • Rack & pinion	• Seesaw • Vertical rotation • Pull start
Processing (Putting work into the seeds to extract the oil)	
• Stone smashing • Lever crushing • Archimedes screw • Rotary crushers	• Torsion squeeze • Centrifuge filter • Screw press • Shredding
Refining/Heating (Purifying the extracted filtrate)	
• Multistage system • Oil heating	• Pressure cooking • Waste Removal System

Table 12: Part categorising

Idea Development (Morphology)

For the Idea Development, the Morphology technique is utilized to explore a diverse range of potential solutions and ideas. The remaining ideas from the initial filtering, from appendix 21, and each subcategory are then paired together to generate new and innovative ideas that may offer better solutions for the problem statement. The ideas are seen down below and on the next page.

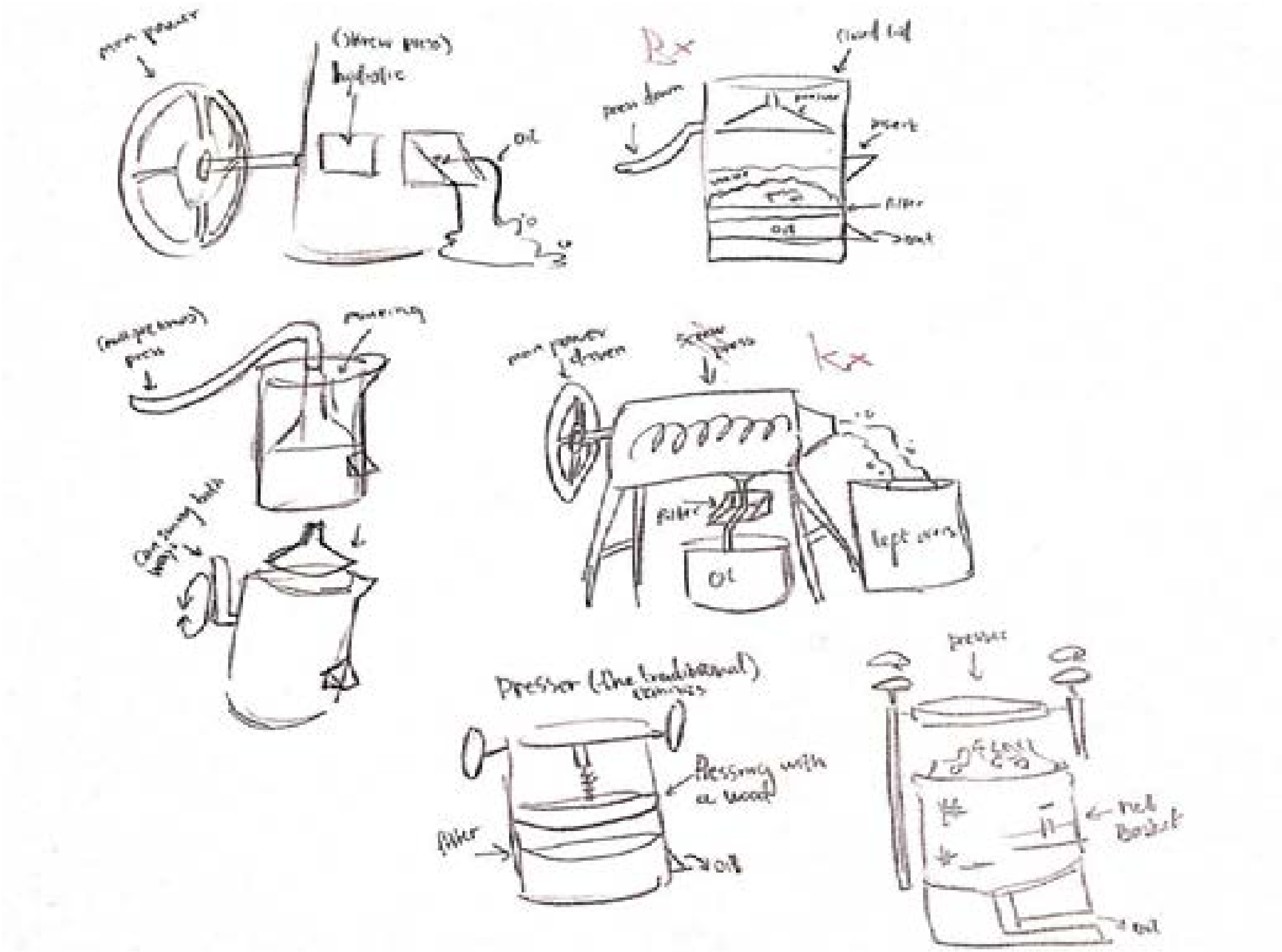


Figure 17

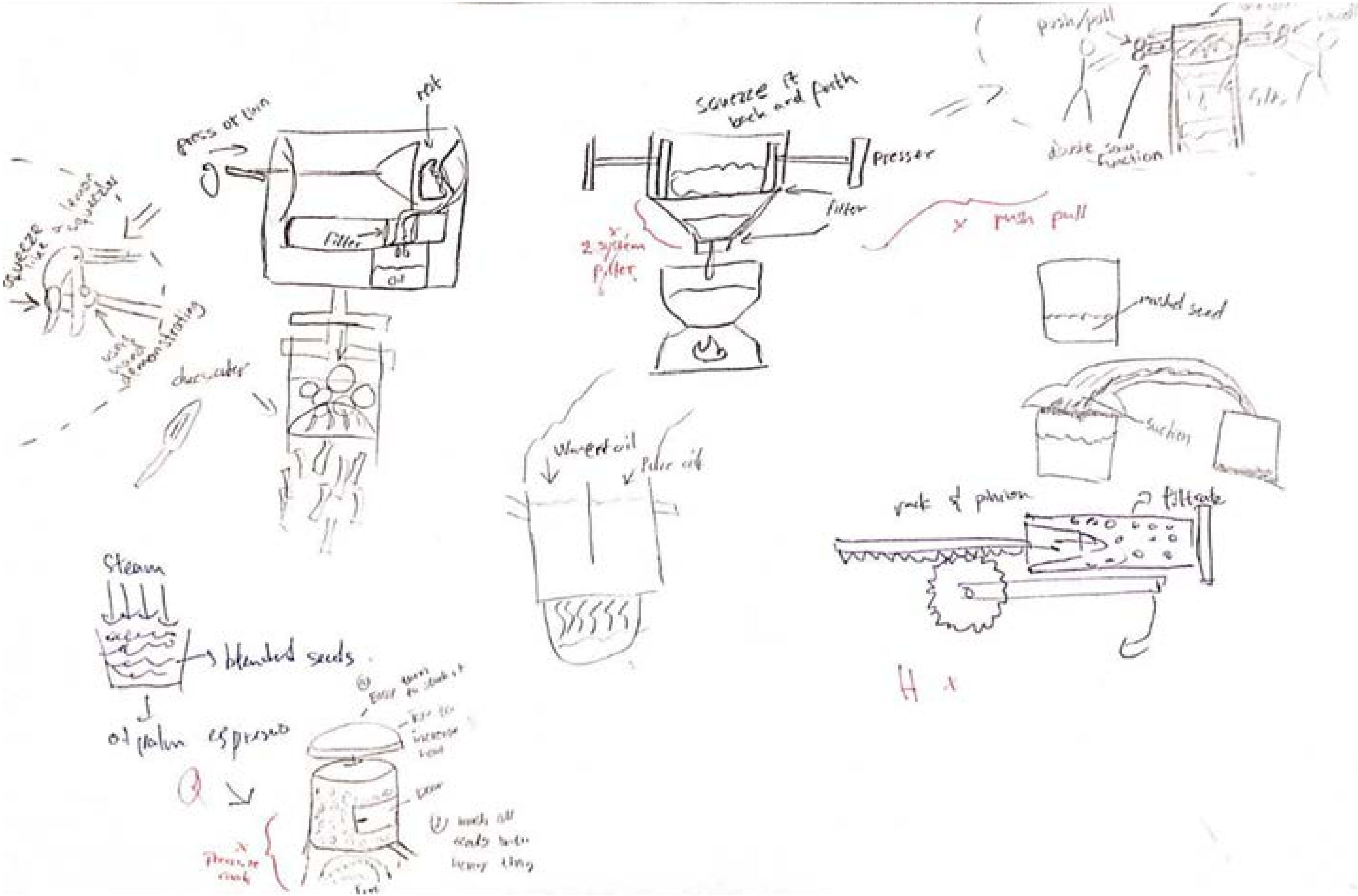

press or turn
rack
filter
oil
squeeze it back and forth
presser
filter
2 system filter
push/pull
x push pull
mashed seed
suction
rack & pinion
Steam
blended seeds
oil palm espresso

Figure 18

Evaluation (Idea Selection)

After generating a list of ideas from the Morphology phase, the group now proceeds to filter them further by using the methods "Traffic Light Method" and "PV Scheme" described in the next few paragraphs.

Traffic Light Method

The Traffic Light Method is utilized to evaluate and compare various ideas based on the feasibility of construction in the colors red, yellow and green (Table 13).

Red: "stop/problem"

Yellow: "caution/warning"

Green: "go/progress"

Ideas listed in the green and yellow categories are given further consideration and scored using the PV Scheme, while those categorized as red are excluded from further consideration.

Red	Yellow	Green
1) Pulley lever crusher		
2) Pulley stone smash		
3) Hydrualic car jack squeeze		
	4) Rack and pinion shredder	
	5) Seesaw lever crushing, legs	
6) Seesaw lever crushing, upper body		
	7) Waterlock	
	8) "Book" crusher	
	9) Bicycle system	
10) Squeeze		
11) Hydrualic crusher		
	12) Washing machine	
	13) Rotary crusher	
	14) Pulley stone smash (similar to idea 2)	
		15) Screw press car jack (similar to idea 3)
		16) Rack and pinion piston
		17) Pulley piston
18) Hydrualic squeeze		
19) Screw press squeeze		
	20) Lemon squeeze	

Table 13: Traffic Light Method

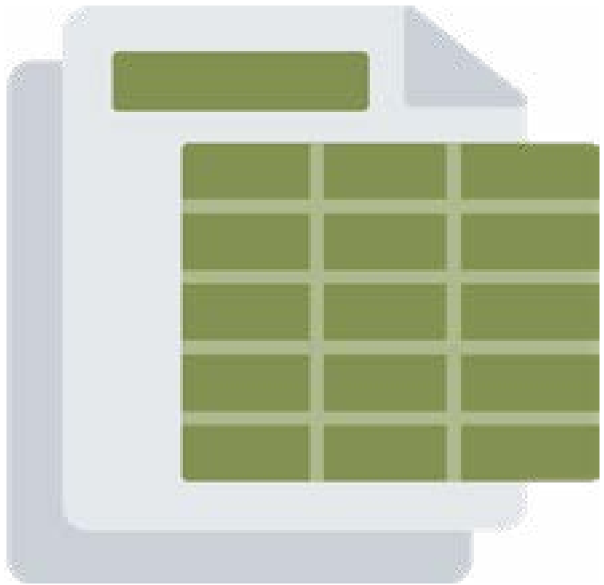
PV Scheme

To perform the final evaluation, the ideas are evaluated using a PV Scheme (Appendix 22).

The top row of the table lists the names and numbers of the ideas. The first column (row A) displays the nine most important and relevant selection requirements.

The **weightage** reflects the **importance of each requirement**, and the **points**, which range from **1, 5 and 10**, indicate **how well each idea fulfills the requirements (10=excellent, 5=average, 1=poor)**.

The weightage and points are multiplied and added together, and the total score for each idea is shown in the bottom row. From what it shows, these are the three ideas with the highest scores and will be selected for concept development during the next phase.



- **15 Screw press car jack**
- **16 Rack and pinion piston**
- **20 Lemon squeeze**

Final ideas

The final ideas revolve around the concept of applying large amounts of pressure directly to the oil palms against a filter. This will separate the oil from the fibers.

All three ideas, seen on the next few pages, are easy to understand and leverage on simple mechanics/ready-made parts. They are likewise generally affordable to construct and hence have been chosen.

Screw Press Car Jack

The Screw Press Car Jack uses a hydraulic car jack to apply huge amounts of force to the product. The hydraulic press multiplies the force and makes it easier for the user to produce that amount of force. This idea scored 355 out of 370 points from the PV Scheme.

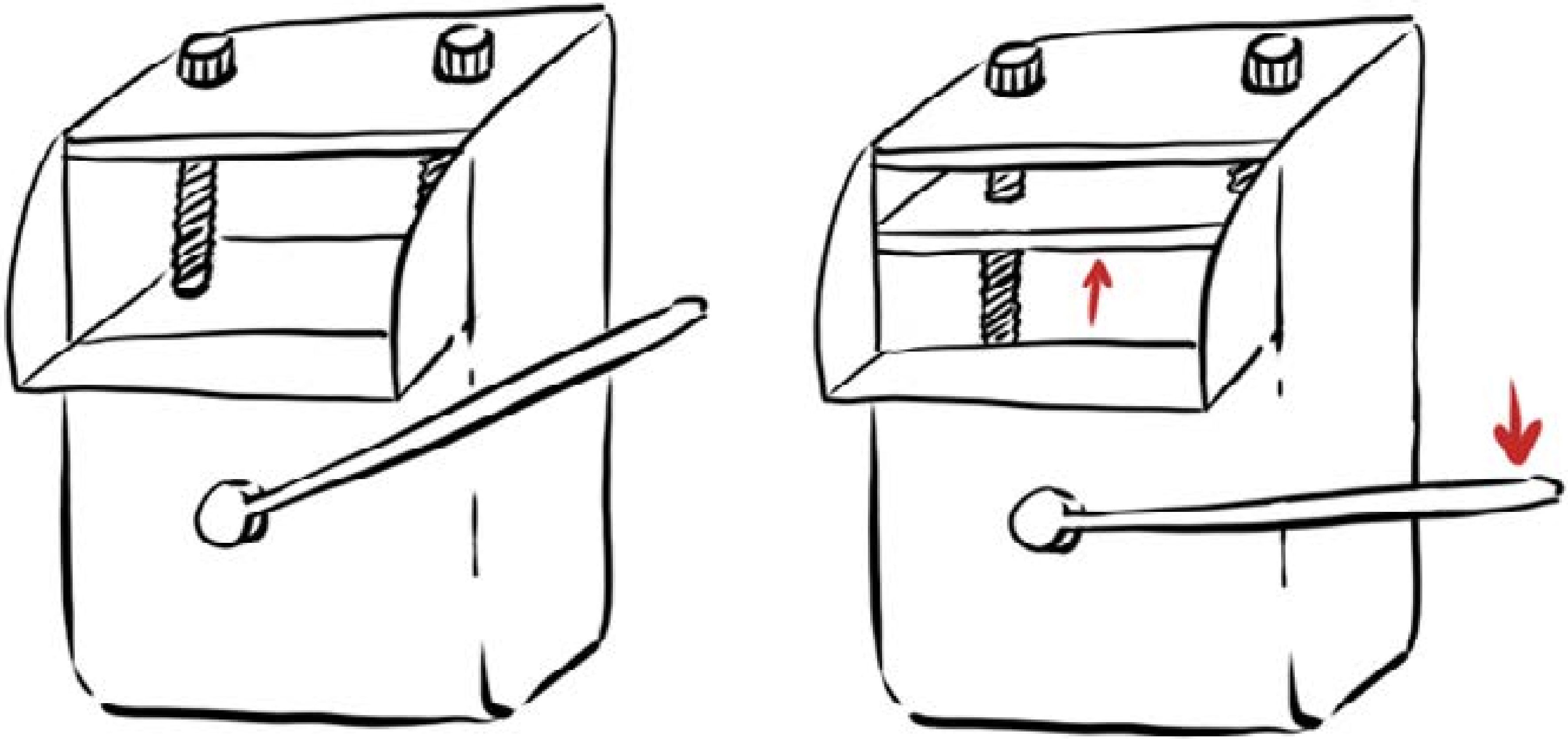


Figure 19

Rack and Pinion Piston

Next, the Rack and Pinion Piston uses and rack and pinion gear system to translate rotational movement to vertical movement. The large size of the turning wheel makes it easier for the user to produce large amounts of downward force to crush the seeds.
This idea scored 345 out of 370 points from the PV Scheme.

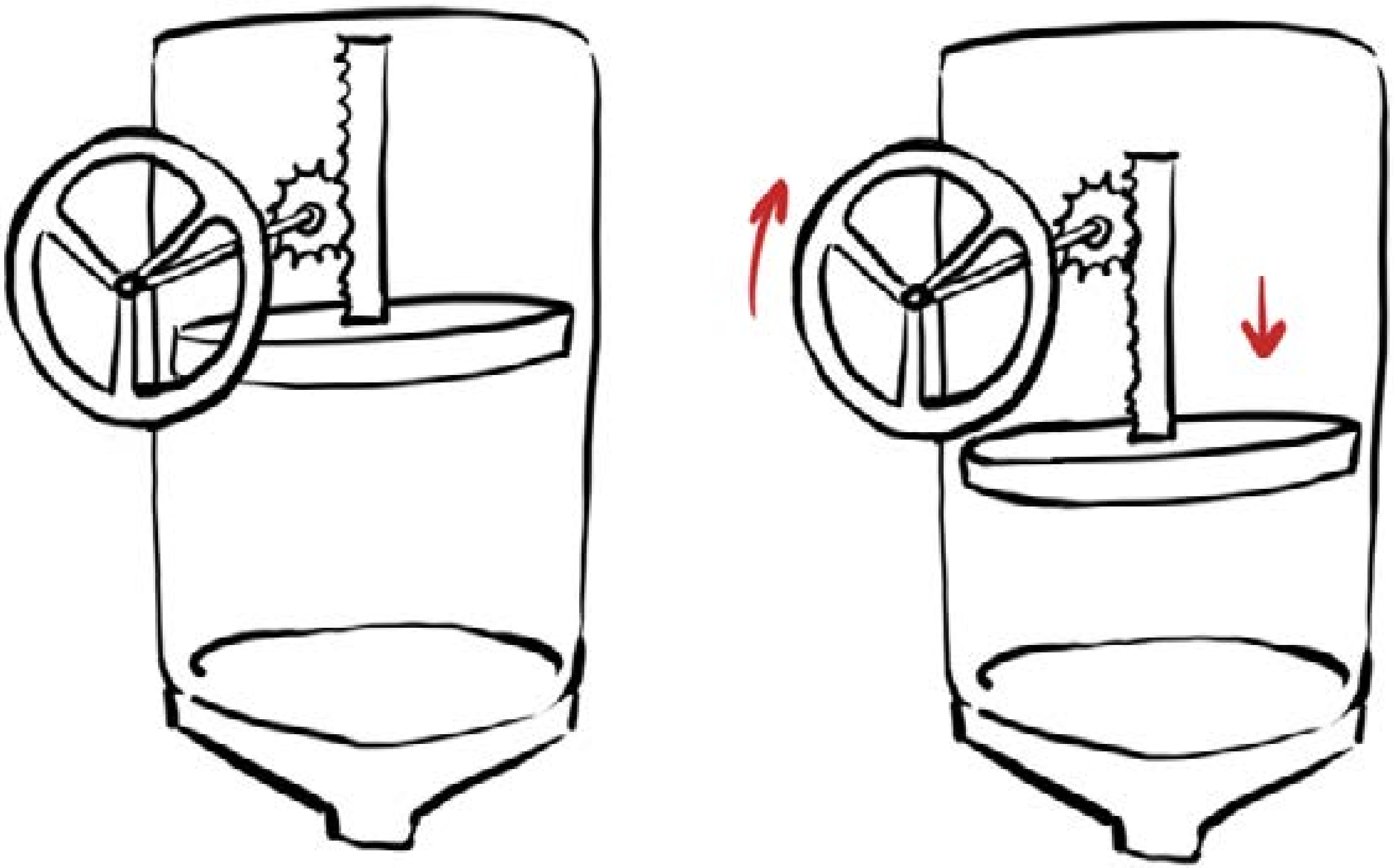


Figure 20

Lemon Squeezer

Lastly, the Lemon Squeezer uses a long lever attached to a piston to squeeze the seeds. The long lever multiplies the force on the piston which is closer to the fulcrum.
This idea scored 330 out of 370 points from the PV Scheme.

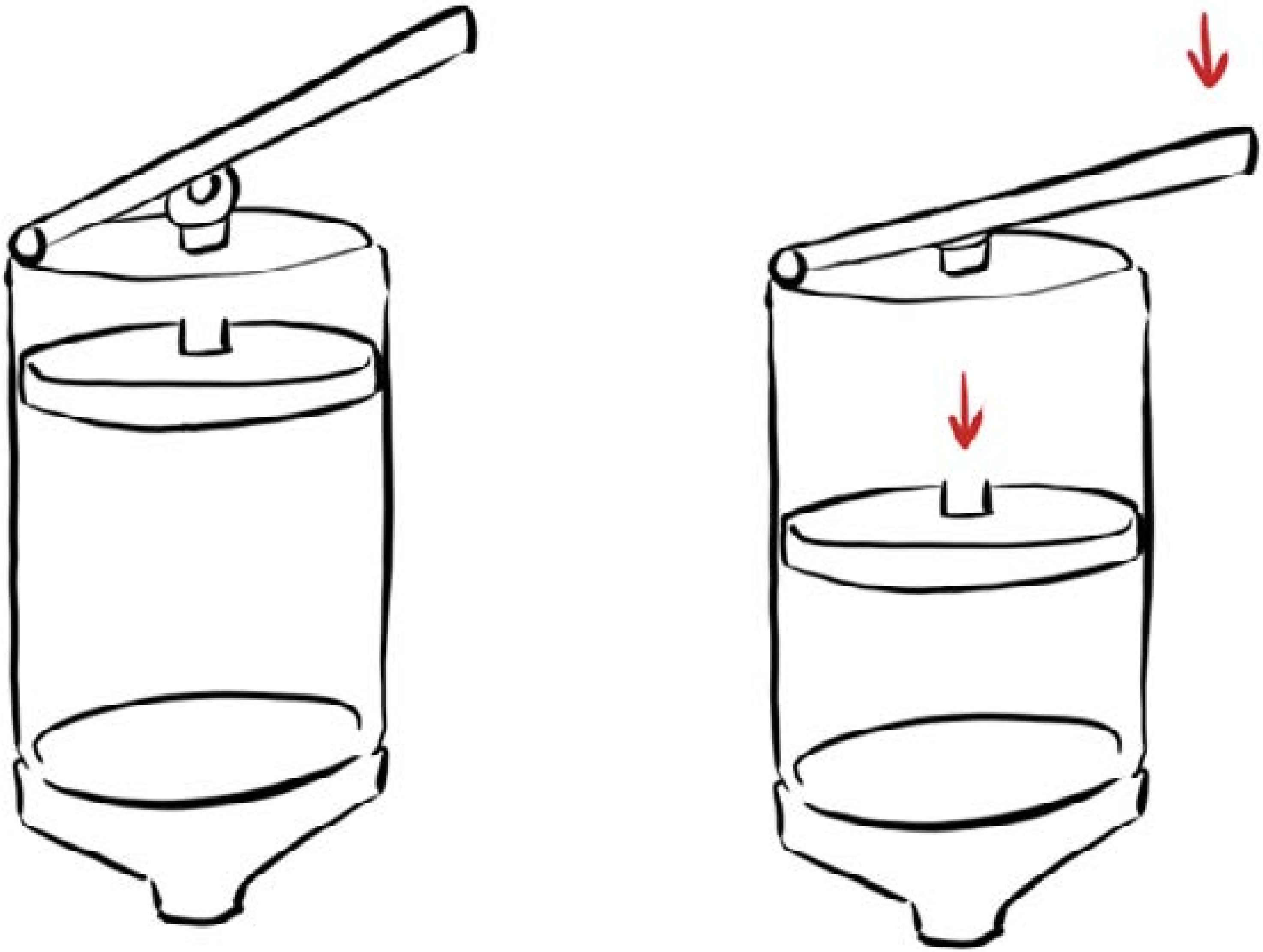


Figure 21

Conclusion

Conclusion

To conclude the Idea Phase, the group has taken some time to reflect on the work done.

Reflection

In the past few weeks, the team has been working hard to complete Idea Phase. From obtaining the requirements to brainstorming design solutions, the team has made significant progress. Before moving on to the Concept Phase, the team would like to reflect on the past weeks. This would allow the team to acknowledge the good work done and identify areas for improvement.

Stage Gate

Referring to the Stage Gate made in the Pre Project, the group was supposed to finish Idea Phase in 21 days on the 8th of March. However, the group took way longer than expected and ended Idea Phase in mid-April.

Nevertheless, the group has managed to achieve the objectives for Idea Phase by coming up with 3 final designs to move on into Concept Phase.

Idea Generation

The project group have used more time than expected on the Idea Generation. One of the reasons might be due to the group not using the Black Box and Decompose from the Pre Project.
This resulted in us spending time on trying to figure out the different functions on the oil presser even though we already figured it out from the Decompose. After that we had to sort the different functions part of the already created ideas rather than using the Decompose to idea generate on the different functions in the beginning.

The Good

In general, the team feels that it has done well overall. Progress was made at a steady pace and disagreements were often minor and sorted out quickly. The work done was mostly thorough and of standard.

The team was also very creative in the workshop which resulted in many ideas formed and discussed.
The team is also very motivated and is very willing to work together and accommodate each other.

The Bad

However, on certain occasions, the team had to spend extra time working on the project. This was often due to members taking more time to complete tasks. While this was not necessarily due to poor work ethic, it resulted in tightened schedules and stress on the project timeline.

The group feels that it could have stopped itself from digressing during meetings as members would lose focus on the main task and fixate on smaller, less important details. This caused a lot of unnecessary time wastage and caused many tasks to be pushed to homework instead.

The Future

The group is aware of its potential to digress and has taken steps to ensure that every member calls the discussion back whenever they notice it has strayed from the main topic.

The group is also confident that although more time was spent on Idea phase than planned, the groundwork done here would make the Concept Phase much faster.

THE CONCEPT PHASE

Introduction

After finishing the Idea Phase, the group has narrowed down the many different ideas to three. During the concept phase, this number will be narrowed down to one, which will then be developed to a final concept and by the end of the phase will be constructed a mock-up of.

Project Management

The methods, Flow Chart and GANTT, that have been used in Idea Phase, have been used continuously in in Concept Phase for the same reasons as in previous phase. See Flow Chart in figure (22) and GANTT in appendix (24).

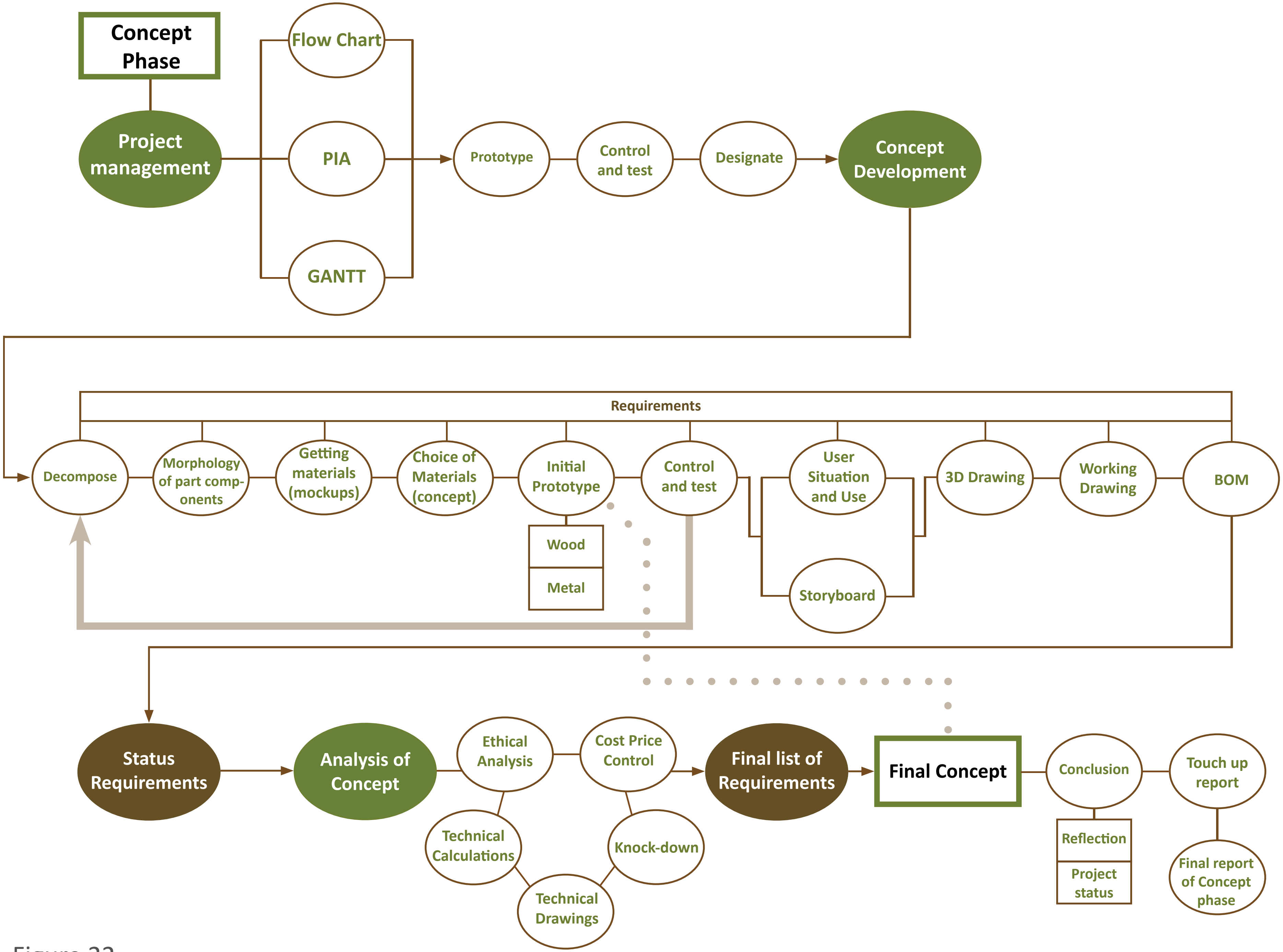

Concept Phase
Flow Chart
Project management
PIA
Prototype
Control and test
Designate
Concept Development
GANTT
Requirements
Decompose
Morphology of part comp-onents
Getting materials (mockups)
Choice of Materials (concept)
Initial Prototype
Control and test
User Situation and Use
3D Drawing
Working Drawing
BOM
Wood
Metal
Storyboard
Status Requirements
Analysis of Concept
Ethical Analysis
Cost Price Control
Final list of Requirements
Final Concept
Conclusion
Touch up report
Technical Calculations
Knock-down
Technical Drawings
Reflection
Project status
Final report of Concept phase

Figure 22

Product Development

Control & tests

To find the idea to further develop, a development workshop was made to get feedback on the 3 ideas/prototypes from supervisors and stakeholders, as they either have a mechanical background or worked in Sierra Leone. The 3 prototypes will be working as a demonstration of their mechanism in the workshop. The workshop will achieve feedback by getting comments and making a short idea generation on certain parts of the prototype.

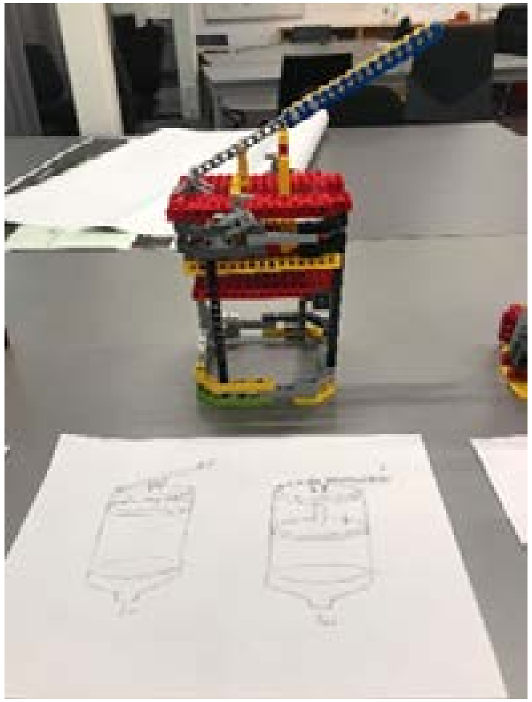


Figure 23

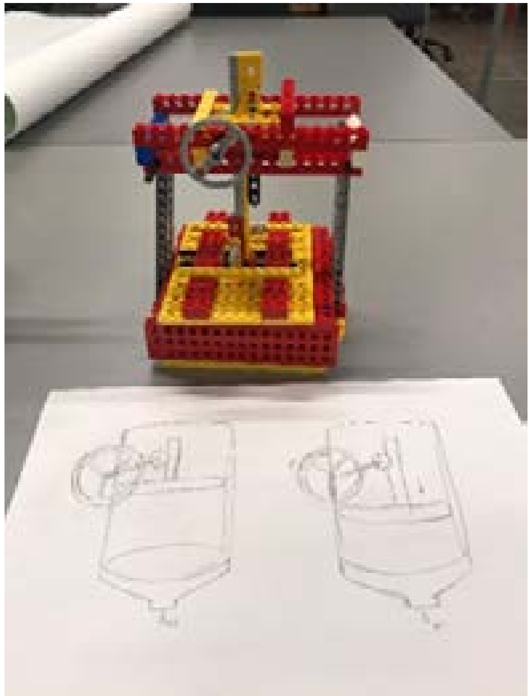


Figure 24

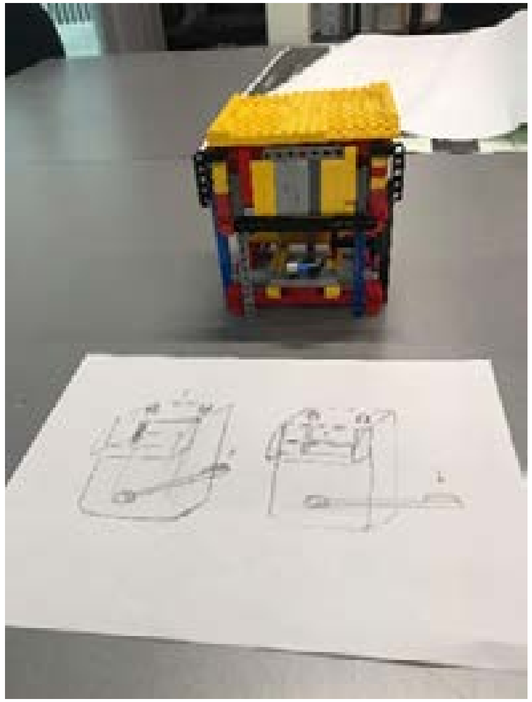


Figure 24

Feedback

After recieving feedback, the group has made a list of mechanical parts that must be looked at:

Consider the form of the construction

Pressure mechanism (Find out how much force is needed)
- Inside mechanism
- Lock mechanism (To maintain pressure)
- Gear ratio (If necessary)

Input of water/seeds and output of oil and waste
- How to get waste out?

Filter system (Waste and liquids gets separated)

Can it be built with simple tools?
- How to minimize failure points

Should it have a support structure?

With feedback from the Control and Test, as well as the PV Scheme, the project group will continue working on the Car Jack idea. It can be further developed with the use of Morphology.

Concept Development

Black Box

A new Black Box and Decompose have been made in the Concept Phase, to focus on pressing the seeds with an oil presser, rather than focusing on the whole process, like in the Pre Project.

Black Box shows the input and output in the process of using the oil presser without being restricted to the functional aspect of the oil presser. The functions will be looked further into in Decompose. See figure (25).

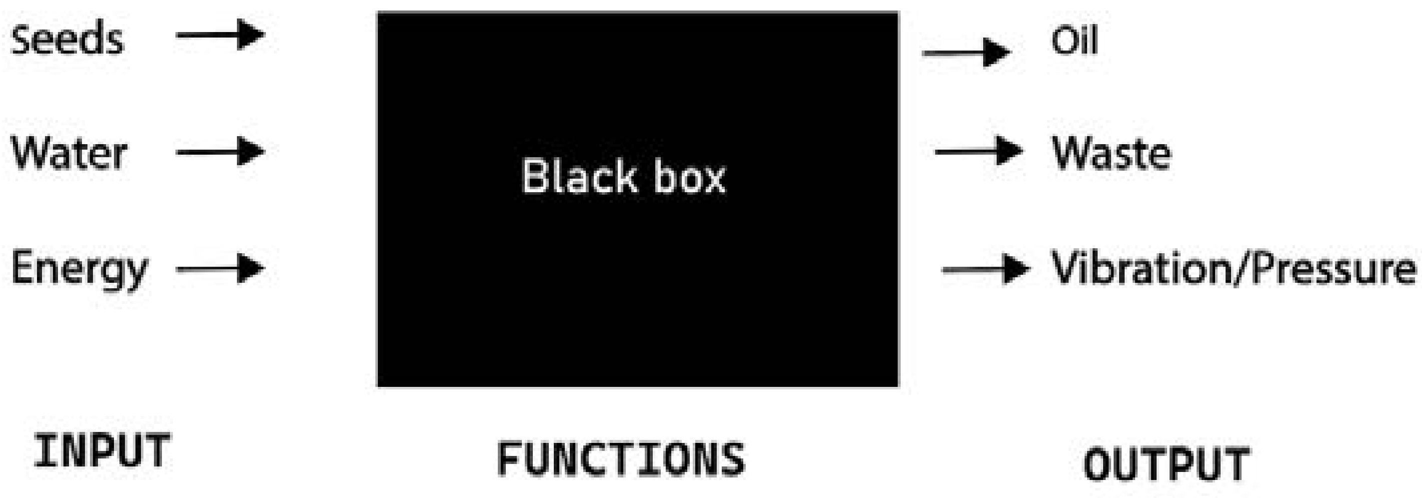


Figure 25

Decompose and Morphology

Decompose breaks down the system of the oil presser into smaller functions, but also sets question mark on which direction the element should function. By using this method, a better understanding of the oil presser can be created and will help develop the idea further into a concept by also using Morphology in the Concept Phase. See figure (26).

1. **Seeds and maybe water are put into the oilpresser.**
2. **A car jack is used to get the oil out from the seeds.**
3. **Waste is removed.**

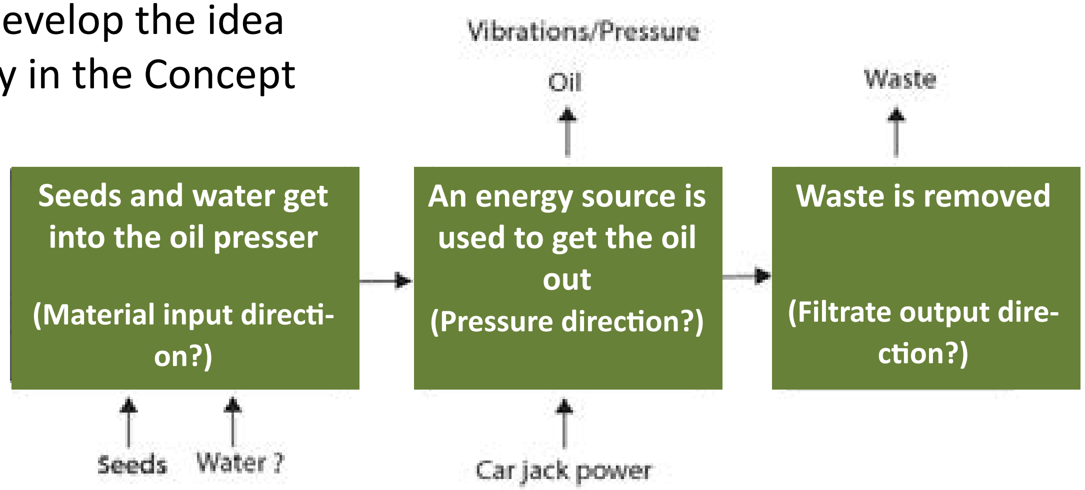


Figure 26

Since the project group has already decided on using a car jack as the primary means of pressing the oil, it was decided that instead of getting the members to make designs from scratch, existing DIY projects on the internet would be researched. These machines will then undergo decomposition before proceeding on to the Morphology.

The various presses underwent a decomposition, where the various key functions were categorized and differentiated. A table has been made to show the detailed decomposition for the 6 machines. See appendix 25. After discussion during groupwork, the following result was generated. The functions marked with yellow are the chosen functions.

Design Choice and Reasoning

The final concept consists of using a Scissor Jack to press the seeds downwards into a filter. The design is such that the seeds will be loaded from the top and then pushed into place before being pressed. Once pressing is completed, unscrewing the jack returns it to the original height and the seed waste can be discarded. There are three main components to the press. A rough sketch of the concept is shown below to understand better and is shown in the colours red, green and blue:

The main frame is what the jack is attached to. A central reinforced metal structure will bear most of the pressure from the jack. Below it, there is a perforated metal sheet, which acts as a filter for the seeds. The main frame is long to allow the pressing frame to move along it.

The pressing frame is where the seeds will be poured into. It moves along the base of the main frame from the loading area to the pressing area. After the pressing, it can be pushed further to empty its contents.

The pressing block fits into the pressing frame where it can be moved into place and pressed by the car jack. The design of the prototype is done in a way to ensure the ease of human operation of the different steps. Hence the moving frame as well as the waste removal function.

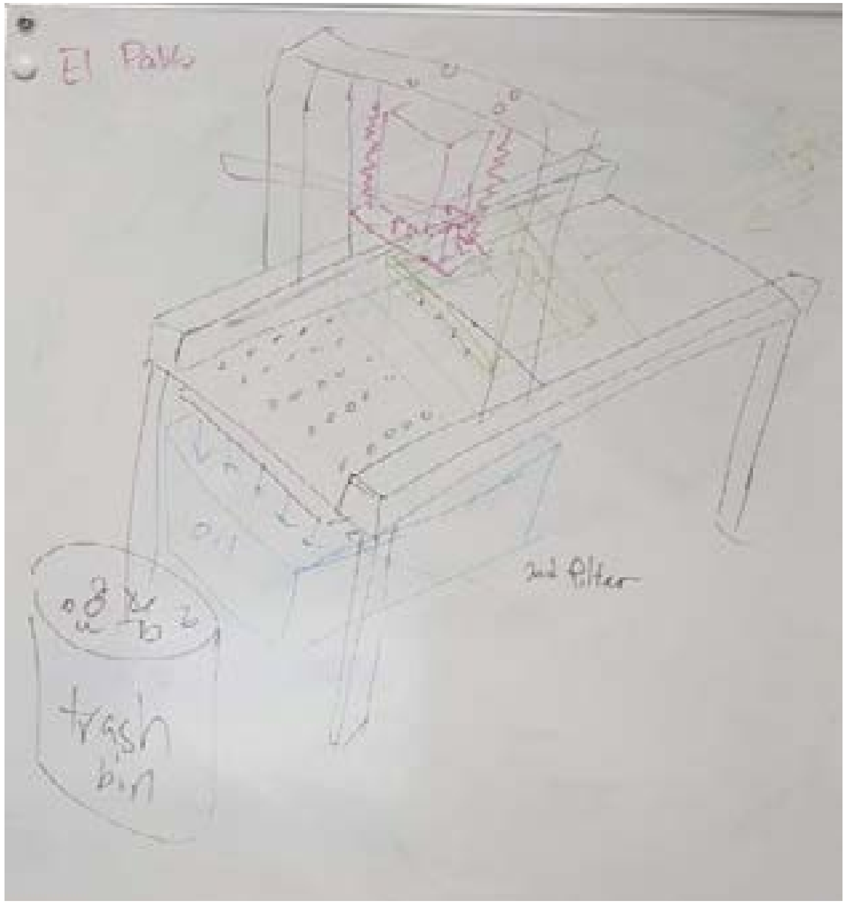


Figure 27

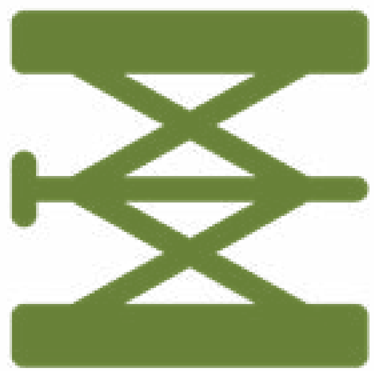
Mechanics

In general, the choice of using a vertical downward pressure direction, a horizontal filter and a top material filling input is down to ergonomics and the usage of gravity. By having the whole pressing and filtering functions in the vertical downwards direction, the machine can make use of gravity to extract the oil efficiently at the base of the machine.

It is likewise convenient, as the machine would have room below to house an oil collection bin. Oil collection would be much more complex had the filter been placed on the top or the sides, as slopes and pipes would have to be constructed to collect the oil.
Putting the seeds in via the top is also much easier than using the sides and the bottom as there is no worry of seeds falling out of the intended location.

Scissor Jack

This jack was chosen as among all the available car jacks, it is one of the simplest mechanically. It is also the most affordable and can output comparable force to the rest of the car jacks.



Resetting of Pressing Plate

The plate must be able to reset to the original position easily to facilitate multiple pressing processes in succession. Since the jack chosen is a scissor jack, the only way it can be reset is by unwinding it by hand.

Volume Calculation

It is needed to find the volume of palm seeds that a **1 ton** car jack can crush. By knowing that a seed needs a peak pressure of **6 MPa to be cracked**, the amount of force needed can be calculated by dividing the necessary pressure:

Force from the Car Jack

$$1ton = 9806.65N$$

Pressure needed to crack a seed

$$6Mpa = 6N/mm^2$$

Calculated Pressing Area

$$9806.65N \div 6N/mm^2 = 1634mm^2$$

$$\sqrt[3]{82408mm^2} \sim 287mm \quad \sqrt[3]{1634} \sim 40mm$$

This means that a box with base area of **4 cm by 4 cm** would be the maximum capacity.

These dimensions seemed too small as compared to oil press videos that the project group has referred to. So the group thought of boiling the seeds to soften them like in the videos. By watching a video of a woman boiling palm oil seeds, it was observed that the seeds became soft, and could be crushed by hand[1]. Therefore, a rough estimate has been made.

The average strength of a woman's grip is **195,1 N[2]**. It is likewise estimated that the area of seeds that she pressed in her hand was **16 cm²**. The number of hands that needs to be used is: **9806 N/195,1 N = 50 hands**. So the maximum pressure area from a **1 ton** car jack is:

Pressure generated (Woman squeezing boiled palm seeds):

$$195,1N \div 1600mm^2 = 0.119N/mm^2$$

Pressing area using a 1 ton Car Jack:

$$9806.65N \div 0.119N/mm^2 = 82408mm^2$$

$$\sqrt[3]{82408mm^2} \sim 280mm$$

1 How to Extract Pure Palm Oil at Home

Based off the above calculations, the maximum pressing area would be a box with a base of **28 x 28 cm**.

Given an estimate of **28 cm** for the maximum extension of a car jack, the maximum pressing volume at one time is:

Maximum Pressing Volume

$$28cm \times 28cm \times 28cm = 21952cm^3$$

To learn how many seeds can be crushed per cycle, a rough calculation of the volume of the seeds is necessary. By looking at figure 28 and using information from the stakeholder Arne Palsbirk, it is estimated that the seeds are roughly the size of grapes.

Figure 28

Correct dimensions of the seeds are found, as the advice from Palsbirk is merely a rough guide. It is likewise to note that a fresh Dura seed is smaller than a fresh Tenera seed[1]. The volume is then calculated by an egg shape formular[2], and the calculations are showcased in a table (Appendix 26).

As seen in table 14, theoretically there can be **3485 seeds** in the **28 cm x 28 cm x 28 cm** pressing volume. To be sure only **80 %** volume will be used in the calculation, to ensure that the estimate holds. This means that around **2788 seeds** of Dura and **2297 seeds** of Tenera can be there with a total weight of around **34 kg** of dura and **26 kg** of Tenera. This density is around twice as high as first estimated **(15 kg)** in the quantity of product processed. It is also estimated that additional water in the extraction process will not be necessary, though this should be tested.

Oil produced over 10 years (product life) interval

Oil produced over 10 years (product life) interval	2,46 - 3,69	2,94 - 4,41	Ton
Water waste usage	3,69 - 4,92	4,41 - 5,88	Ton

Difference with 15 kg volume

Oil produced over 10 years (product life) 15 kg	3,21 - 4,44	3,85 - 5,31	Ton more oil produced
Water waste usage	3,69 - 4,92	4,41 - 5,88	Ton less water usage

Difference with estimate full capacity (80%)	16,1	14,5	Ton
Oil produced over 10 years (product life) interval	12,4 - 13,6	10,1 - 11,6	More oil produced
Water waste usage	8,6 - 11,4	7,8 -10,4	Ton less water usage

Table 14: Comparison between concept and Quantity of Product Processed (QOPP)

1 Physical and Machanical Properties of Palm Oil Seeds
2 Egg Surface Area and Volume Calculator

The project group's conceptual oil presser should last **10 years** of usage.
The project group’s oil presser is loaded at **80 % volume, it can produce 14,5–16,1 tons palm oil, which is 10,1– 3,6 ton more oil and uses 7,8–11,4 ton** less water compared to the QOPP version. This is a good thing as the water waste carry load possibly be lower and with better oil quality. Thus, theoretically it can get breakeven twice as fast as the oilpresser calculates in QOPP section the oilpresser volume, locals are using at **15 kg volume**.

Compared to other farms the average quantity of palm oil is **1,07–2,24 tons sold yearly**; the concept will theoretically produce **1,4–1,6 ton of oil yearly**. As it showcases that the concept can compete with other farms' oil pressures.

If the daily production needs to be bigger, the **5 days usage** could be increased, as the machine is not as physically demanding as it used to be. The real-life on average production of **22-25 %** could likewise increase.

Requirement

- The construction can withstand 40 kg seeds and a pressure of 1 ton over 280 mm x 280 mm area.

- The oil presser can as a minimum be used 5 times a day, 182 days a year over 10 years span.

Choice of Materials

It is necessary to investigate what materials work best with the environmental and economic situation, in order to make a proper choice of materials. These materials have since been analyzed using Granta EduPack by using different graphs showing how well each material performs in the Attributes, Weldability, Tensile Strength, Yield Strength, Oil Durability and Water Durability. See appendix (27, 28 and 29). A table has been made based of the graphs and the 6 materials that has the best attributes (Appendix 30). From what is show down below, a list of materials available in Sierra Leone is made:

- Steel
  - *Carbon steel*
  - *Stainless steel*
  - *High strength steel*
- Iron
- Limonite
- Aluminium
- Titanium
- Copper
- Rubber
- Wood
- Plastic *(PC, ABS)*
- Metal
- Zinc
- Concrete

The top 6 materials for the oil presser have been put into the PV Scheme below, to see which ones have the best attributes. The first row showcases the attributes and the next their importance on a scale of 1-5, where 5 is the most important. The first column displays the top 6 material names, while the following columns are the material's individual scores for the different attributes, on a scale of 1 to 6, where 6 is the best. The individual rankings are then multiplied with the importance of the attribute, and summarized in the final column, "Results". The material with the highest cumulative score will be recommended as the best choice (References: Appendix 31).
Ranking of recommended materials for use in the oil press, where 1 is the most recommended:

1. Stainless steel
2. Low alloy steel
3. Cast iron
4. Low carbon steel
5. High carbon steel
6. Medium carbon steel

3D drawing

Shown below is the concept that the group is developing. The Mk1 is the initial concept, developed primarily through morphology. The concept is developing thought the next section.

Mk1 *(Made from a rough initial drawing of a concept. See figure 27)*

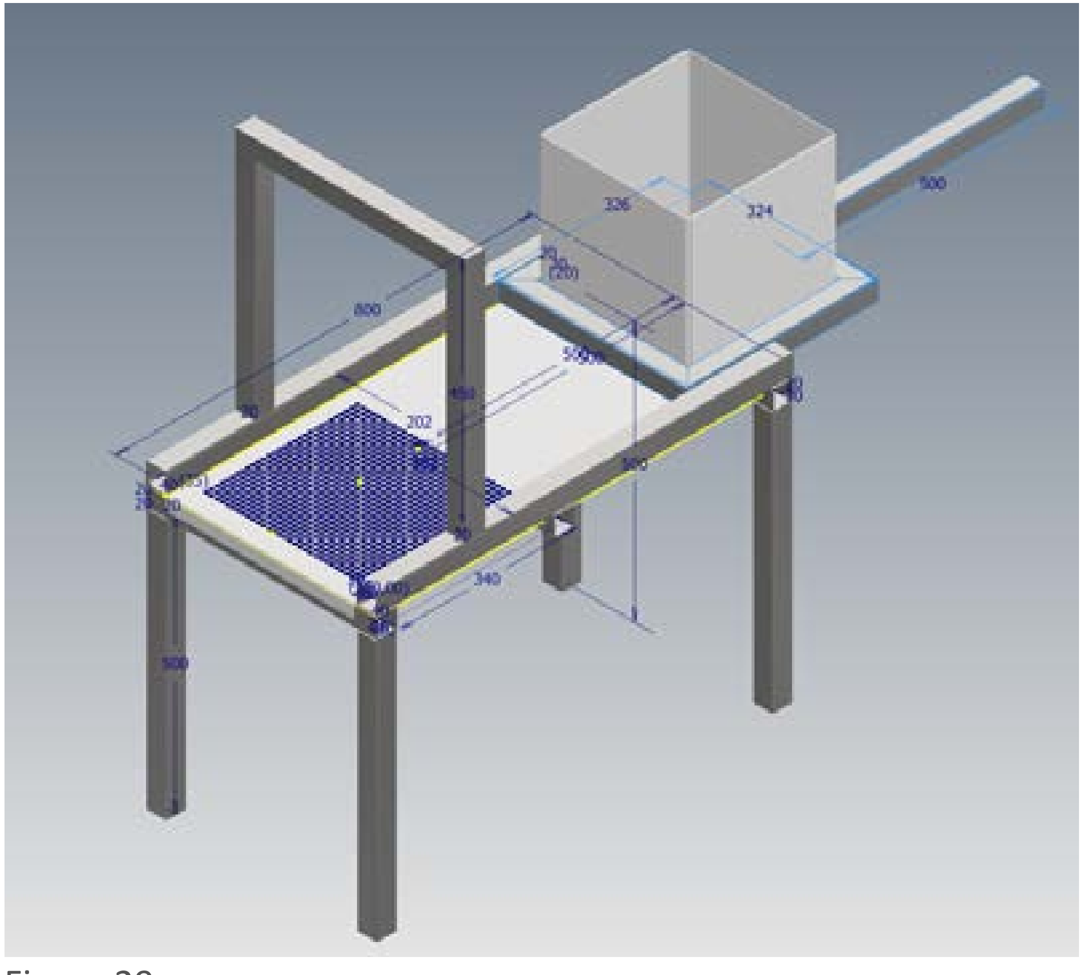


Figure 29

Considerations

- Mounting points: Welding or bolts.
- The floor needs to be strong enough to withstand pressure from the car jack.
- General tolerances.
- General size (Width, height, length).
- Which car jack will be used in the drawings.

Mk2

Changes from previous version

- Reinforcing the construction for the normal force with reinforced steel, which needs to be welded on.
- A wood plate to stabilize the scissor jack and prevent damage to the steel. It will also help distribute the stress unto the pressing area.
- Wood parts to stop the box from moving while pressing seeds in case the seeds are not lying flat.
- Scissor jack is not attached to the wood plate, allowing the user to take it home for security.
- A scissor jack (Biltema1) with an interval of min. height 95mm, max height 390mm and pressing with 1,5 tones of force. This one was chosen over the hydraulic, as lever on hydraulic jacks would descend, making the process more awkward. The pressing interval length is also only 116mm, in comparison to the scissor car jack's 295mm

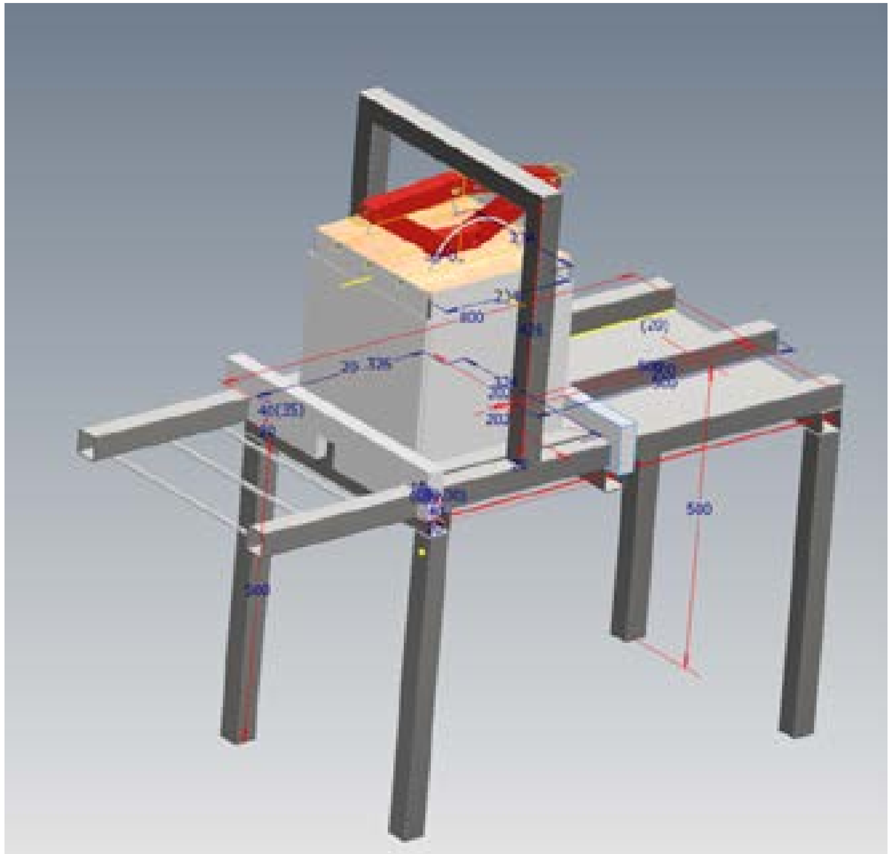


Figure 30

Considerations

- Is the pressure on the reinforced steel at the joint a structural concern?
- Which direction should the car jack face?
- As the slide weighs 25-35 kg, and moves on a solid floor, should there be any kind of system to make it easier to move.

Mk3

Changes from previous version

- Brackets have been added to distribute the load to the long lower beams.

- Car jack rotated to distribute the load to the top beam.

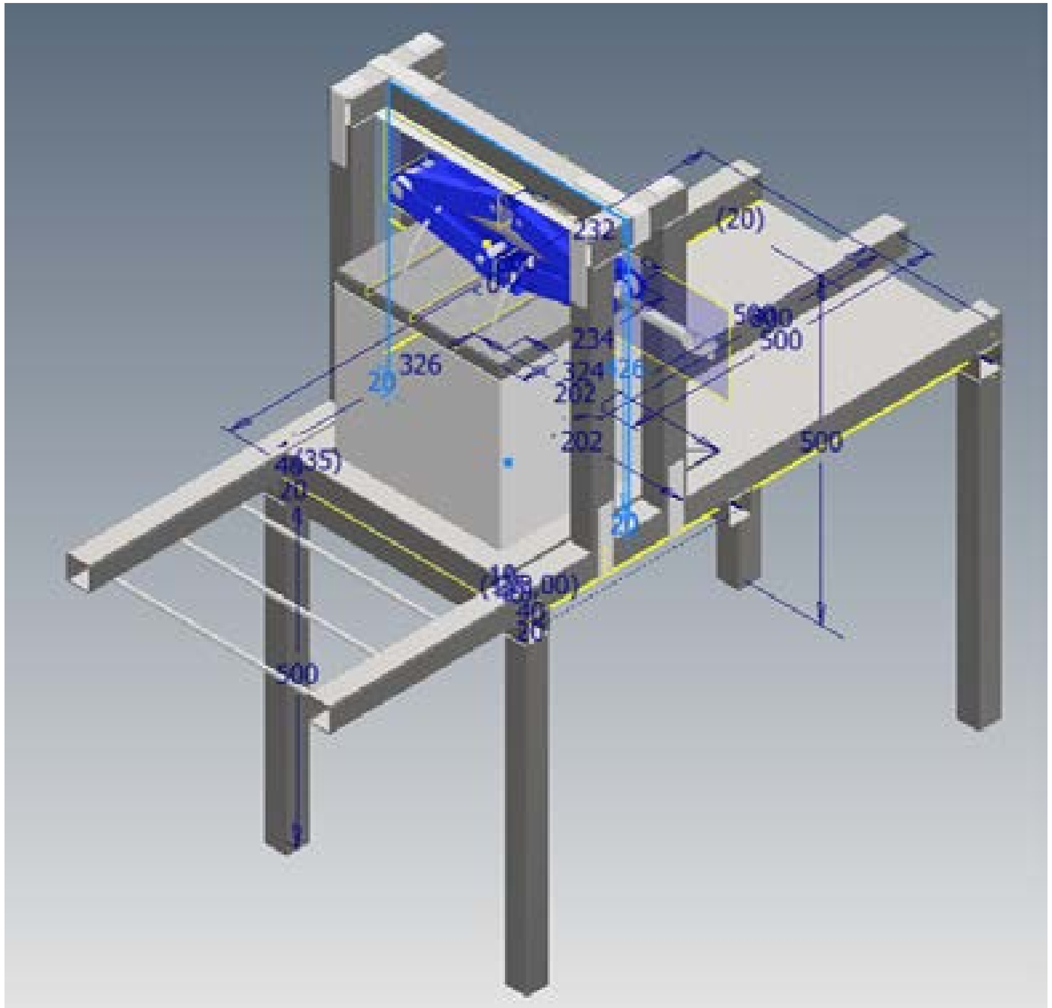


Figure 31

Mockup & Construction Process

Blueprint and obtaining materials

Before the start of the workshop, a prototype was needed. It was decided that the initial prototype would be made with wood, due it is easier to build. Hence, the project group required a construction plan. A blueprint based on the **CAD Mk2 construction** was made as the first step as the MK3 was not developed yet:

Adjustments to the design were needed, as wood constructions differ greatly from metal. Parts were assembled with joints, glue screws, nails, and many dowels instead of welds.

By building the prototype, the group can test out the concept and have a proof of workability before moving on to create the metal version as intended.

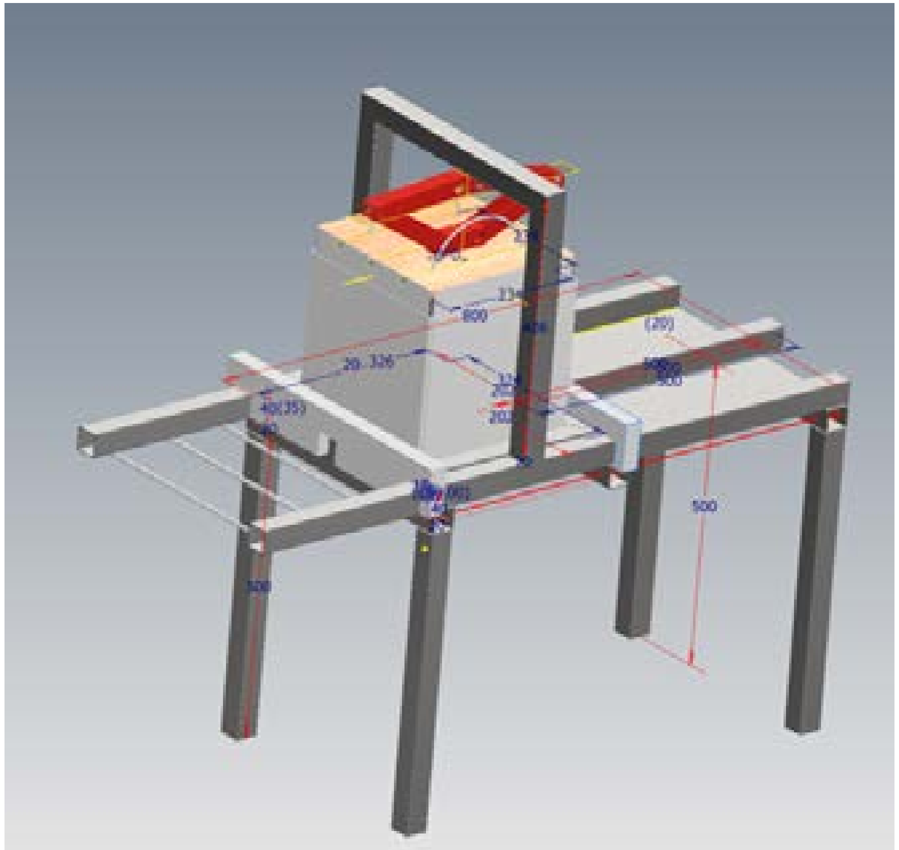


Figure 32

Blueprint/principle sketches

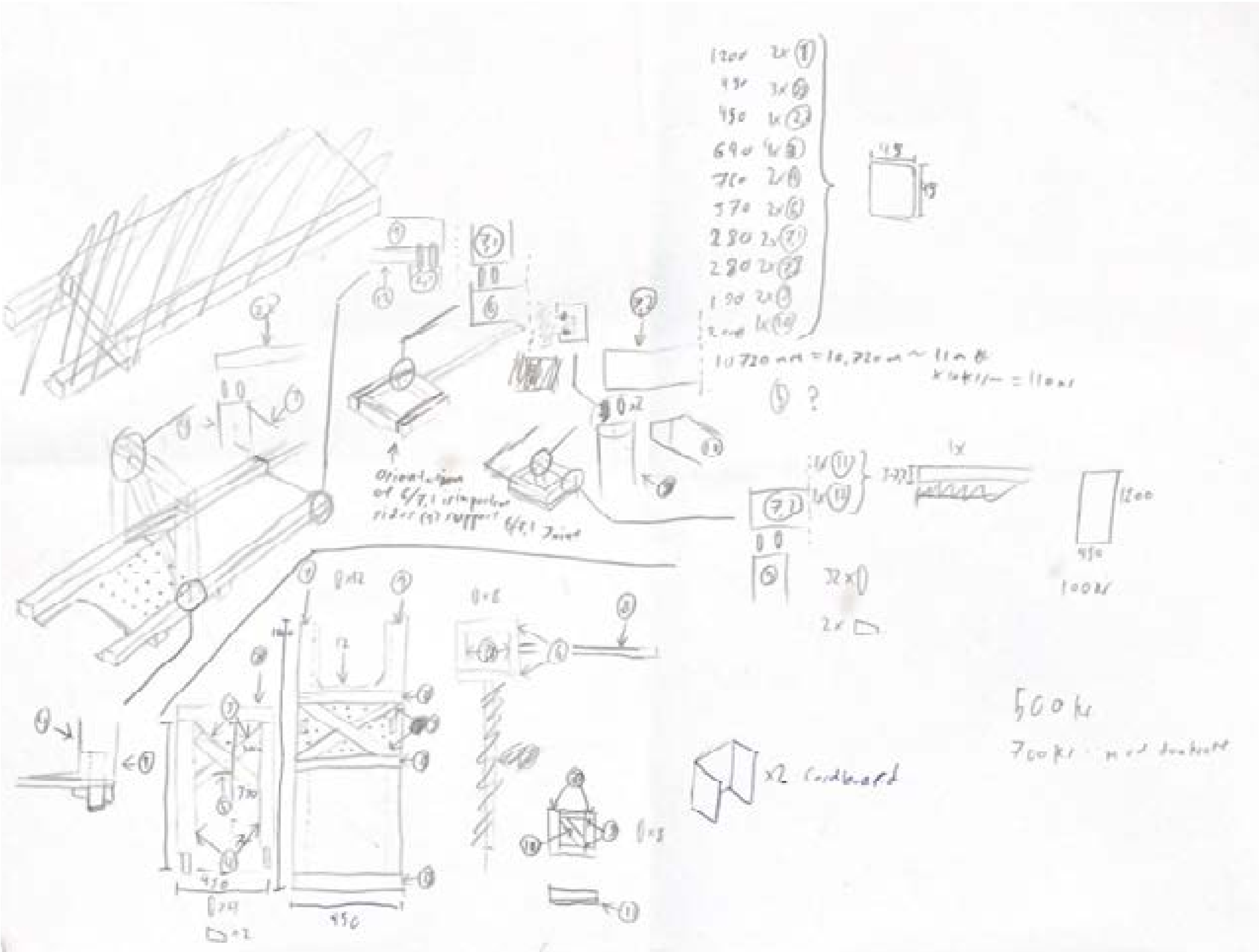


Figure 33

Main Beam Construction

For the main beams that brace the jack, the pinned mortise and tenon joint was chosen as it would give sufficient support for a structure in tension. Wood joints are cut out, and holes pre-drilled and then chiseled. Interference fit tolerances help the construction stick together. The over beam is hammered on and dowels are used to make the construction stronger. There were some angle adjustments as the "legs" went inwards.

Figure 34

Pressing Floor Construction

A sheet of plywood was nailed to the bottom of the two beams to form the base of the pressing floor. The sheet also has a cutout on the other end to allow the waste from the pressed seeds to fall out when pressing is completed.

Reinforcement of the Pressing Floor

Initially, the pressing floor was nailed into the base beams, but it was thought to have insufficient strength to withstand the pressure from the jack. Thus, wood pieces were attached to hold the base beam and pressing floor together with inserted dowels. This increases the allowable pressure as the force needed to shear the dowels is far greater than that needed to overcome the friction holding the nails in the wood.

Figure 35

Pressing Frame and Pressing Plate Construction

The initial idea for the prototype was first to use carboard as walls to hold the seeds, but it seemed like it would bend. On the CAD version, the walls were meant to be 2mm metal plates. Wood plates found in the trash basket were used instead. It was also discovered that tolerance made it difficult to make.

The walls were nailed into the pressing frame, which is made of 5 wood pieces and assembled by dowels and glue.

After initial testing, the group realized that the wood pieces would still bend outwards if the object pressed was higher than the bottom beam. Thus, more reinforcement of the wooden structure was needed. While this is a problem with the wooden design, it might not be when constructed out of metal.

Mount for Car Jack

The jack needs to be attached to the beam, as it should still be fixed when there is no pressing. Since the top beam is the main force bearing unit, any drilling done into it would weaken its load capacity. Thus, the idea was to clamp the jack around the beam using two bent metal pieces stuck to a wooden base which was bolted on to the jack. This removed the need for any bolting into the main beam.

Holes for the liquid output

Holes were drilled on the base of the presser to allow the liquid to be collected at the bottom. Ideally, there should be a higher density of holes but due to the nature of the wood used in the mockup, less holes had to be drilled to preserve the structural integrity of the machine. In the metal version, more holes will be drilled to allow liquid to pass through more easily.

Figure 36

Preliminary testing

To ensure that the construction works as intended, an empty soda can was pressed using the setup. It managed to crush the can into a disc less than 1 cm in height. This proved that the construction is sturdy enough to withstand a test to show a proof of concept.

Figure 37

Readability Workshop

After putting together, the machine, the group ran a readability workshop as described in a separate section. After this, changes in the design based on the feedback were made, which will be discussed in the next few sections.

Reinforcement to Pressing Frame

Since the wooden boards were often bent outwards during pressing, an additional frame similar to the bottom one was built around the top surface. Plywood rectangles were also added to the sides to support the frame vertically.

Figure 38

Guide Rails

To prevent the pressing frame from being pushed upwards by seeds, two pieces of plywood was nailed on the top of the bottom beam to hold down the frame when it is put into the pressing position.

Miscellaneous Changes

Sanding of the pressing frame as well as the main frame was carried out to remove as many warps as possible. This allowed significantly smoother operation of the setup.

Figure 39

Analysis of Concept

Readability Workshop

As the target group is not assumed to be able to read, the project group will test out the concept's readability and the operating height on random people, that do not know about the project. This will give the best indication of if the concept lives up to the one requirement:

"It takes 10 minutes maximum to understand how the oilpresser works without a manual".

With the current state of the prototype and other limitations, the experimental setup was not 100% representative of the actual user situation. For example, chairs roughly 60cm heigh, were used to prop up the machine which did not give the ideal height, and since the group is unable to obtain oil palm seeds, a wet towel was pressed instead. However, to test out user experience with the machine, this setup is sufficient For results, see appendix 32.

Figure 40

Take aways from the Workshop

Positives	Negatives	Suggestions
Physically easy to operate the machine.	Car jack was confusing to operate without any instruction.	Connect the vertical block to the pressing block.
All participants managed to successfully extract the water using the machine in under 5 minutes with minimal guidance. This is much lower than the target that has been set in the Idea phase of 10 minutes.	Wood concept tolerances at pushing motion were tight. Also, the towel got stuck under the frame on certain occasions. Thus, people thought it was not meant to be used like that.	Make the presser walls stronger to withstand pressure.
Generally easy to understand the purpose of the components of the machine.	The hole for waste material at the back of the machine was confusing.	
Design is simple.	Some users did not know they had to center the press.	
	Not clear on the range of motion of the jack.	

Tabel 15: Feedback from Readability Workshop

Looking at the feedback, there were certain issues with the machine that were not necessarily due to the design of the machine but rather the setup (Table 15). For example, the wood model had warps and imperfections, which resulted in the components getting stuck to each other. The hole at the back of the machine was intended for waste removal but due to the placement of the stool right under it, it appeared as an unnecessary component.

Given that there were minimal instructions, the design of the machine performed well in general, but some changes were required after going through the Readability Workshop, the BCD Workshop as well as collecting the project group's own internal feedback on the machine.

Changes to be reflected on the machine

1. Connect vertical block to pressing block (from Readability Workshop)

The connection will solve a couple of issues raised during the workshop. Firstly, there are fewer free parts such that it is less confusing as to the number of possible ways to use the machine incorrectly. Secondly, it ensures that the user must center the press to be able to use it. Lastly, it makes it such that the user does not need to guess the range of motion of the car jack.

2. Reinforce the walls (from Readability Workshop + Supervisors + Project Group)

The wood design has four plates nailed to the frame at the base which means it is relatively weak at the top. This results in the walls splaying outwards if there is an off-centered distribution of force in the presser. By reinforcing the walls with another frame on the top, it forces the press and material to go in one single direction. It was observed during the workshop that the walls would bend outwards when the user did not place the towel flat on the pressing surface, forcing the pressing block to tilt and press outwards on the boards.

3. Guiderails: Prevent frame from moving upwards during pressing (from Supervisors)

When the presser is in action, the pressed material would find gaps to escape due to the pressure. This might result in the pressing frame being pushed up by fibers escaping through the bottom slots. Hence a guiderail is built into the frame to prevent the frame from moving upwards in its pressing position. This change was suggested by the supervisors as a potential issue when pressing actual oil palm seeds.

4. Drill holes under the pressing floor: better flow of liquid (from the Project Group)

This change is more for redundancy, as it is predicted that when the presser is in action, the liquid might escape through the gaps between the presser and the frame. Thus, with extra holes on the board under the frame, these extra liquids can be captured into the collector beneath it.

3D Model Development post Readability Workshop

MK4

Based on the Readability Workshop and a supervisor meeting the following changes has been made:

- Longer pushing bar with an elevated handle, and stop beams, so the slide can only move in the desired space.
- Reinforced seed walls, to ensure the walls will not bend from the seeds getting pressed in the 280mm x 280mm area. An extra support beam under the pressing area.
- A longer floor to support the pressing box when ejecting of the waste.
- Added more holes, so the liquid will not escape to the side or push the box upwards, frame rails are added, so the pressing box will not be pushed upwards by seeds, while pressing
- Added a block element to the pressing plate, to be able to reach the bottom with the car jack, and to ensure that the legs of a scissor jack will not hit the walls of the pressing box.
- Screws and bolts are avoided in the chassie to minimize corrosion, given the humid environment.

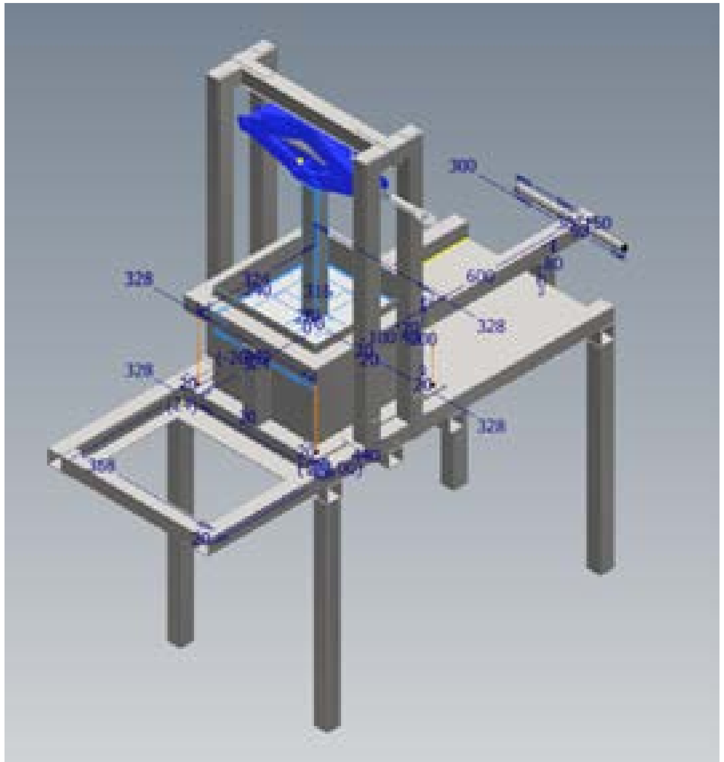


Figure 41

3D Model Development post Readability Workshop

MK5

This version is solving the question of how to attach the car jack to the beam. Without knowing what material, the car jack is made of, it was uncertain if it would be possible to weld it on the top beam. The thought was to either use bimetal to weld or use wood for clamping. But the bimetal will have a high chance of corroding in the humid weather, and the wood will splinter under stress. Therefore, it was decided that one clamp of metal will be screwed together with a metal plate, to hold the car jack. The plate and clamp will be painted, to eliminate electrical connections to the rest of the construction.

- Changes from previous version:
- Locking tabs for the slide changed to beams, for ease of manufacturing.
- Car jack plate is widened to distribute the stress to the top beam.
- Beam height adjusted to make the car jack able to press in the maximal pressing range for a longer duration.

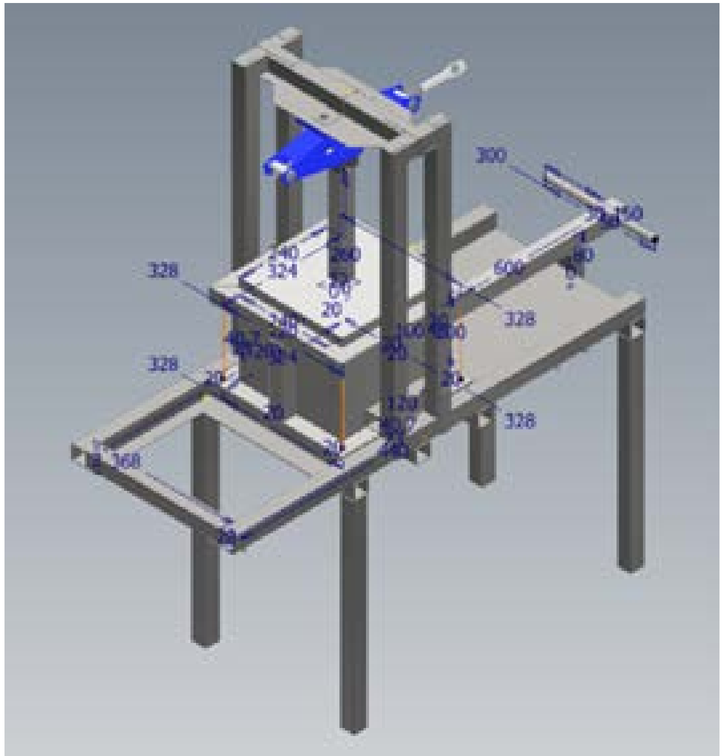
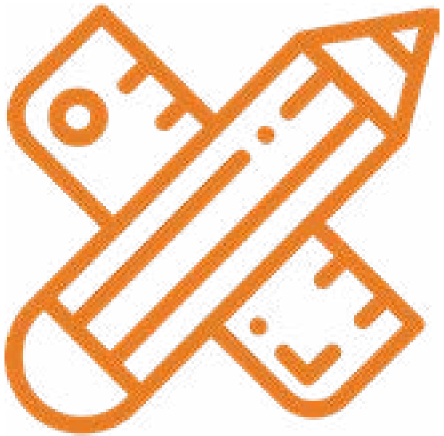
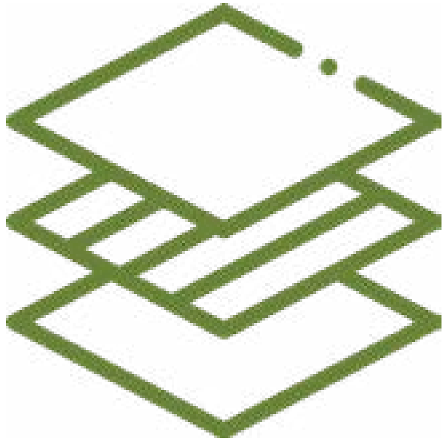


Figure 42

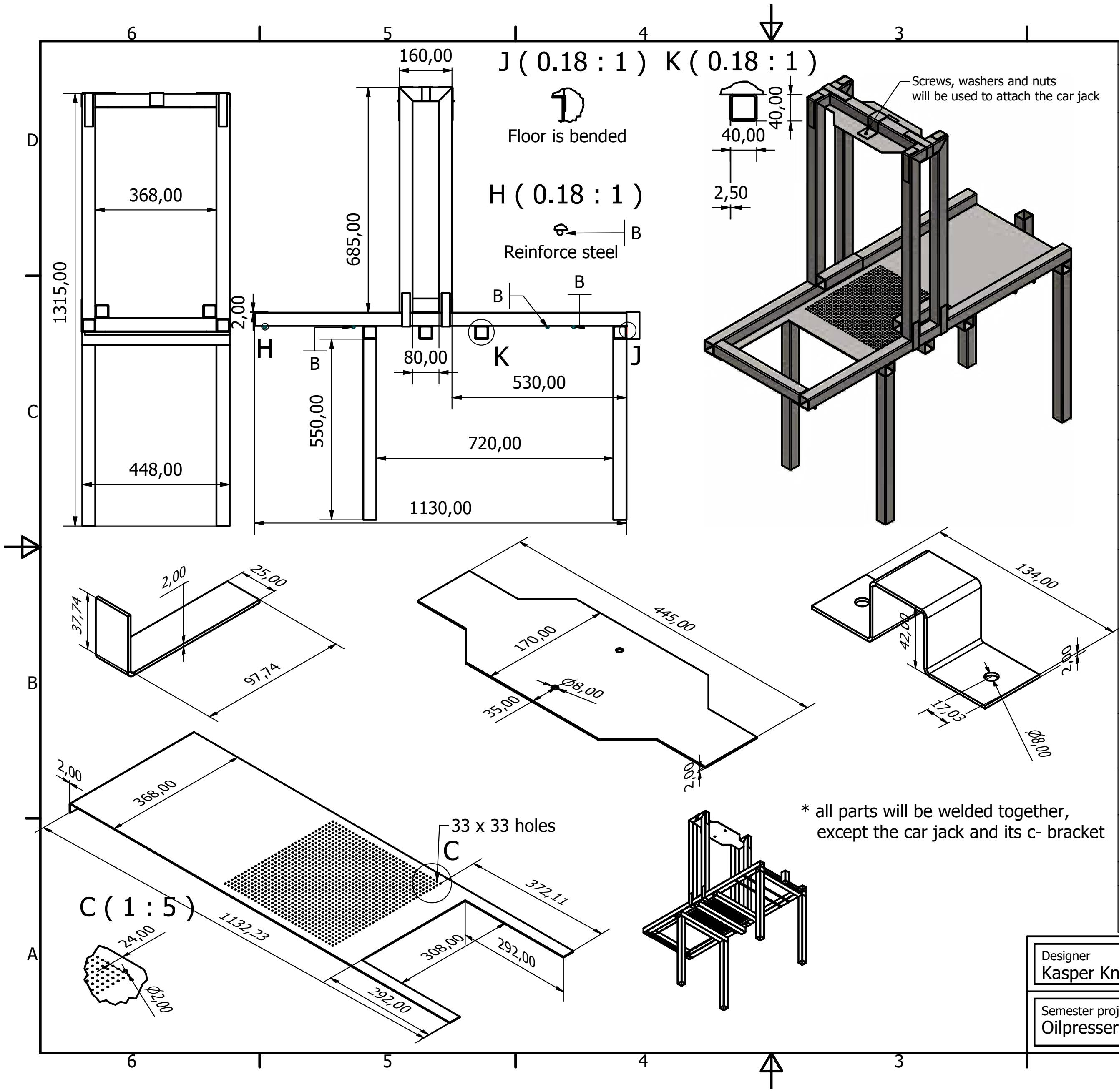
Working Drawings and BOM

The Working Drawing is made to show the dimensions of the metal concept version. There are no tolerances on the Working Drawing, as the idea is that the locals/EWB could look at the drawing and be inspired on how to build the concept. Firstly, to see if there are any issues to work on, the concept needs to be tested out before it can be produced.





Chassie, Floor, Top Plate and Brackets



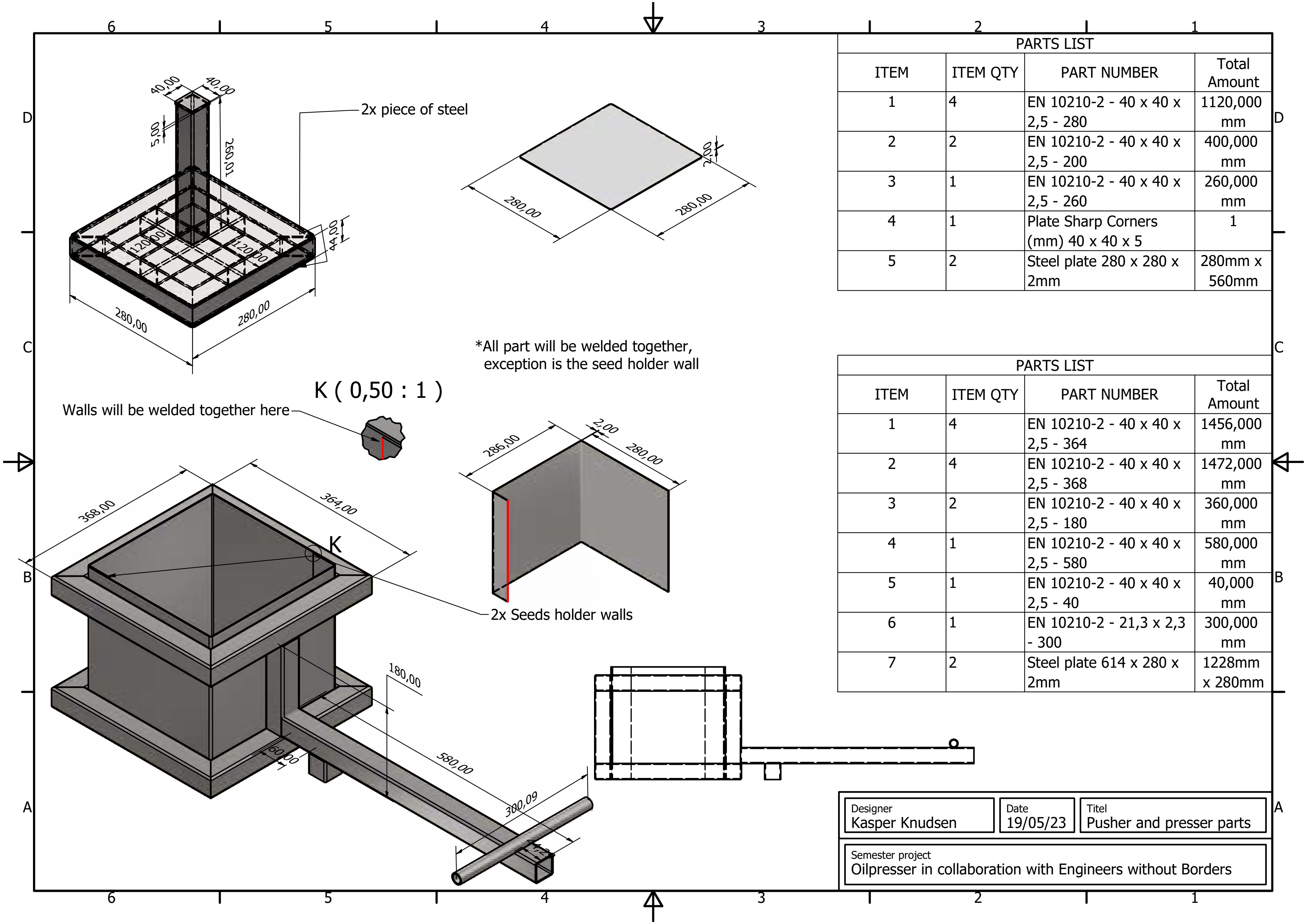
PARTS LIST			
ITEM	ITEM QTY	PART NUMBER	Total Amount
1	4	EN 10210-2 - 40 x 40 x 2,5 - 550	2200,000 mm
2	2	EN 10210-2 - 40 x 40 x 2,5 - 1130	2260,000 mm
3	4	EN 10210-2 - 40 x 40 x 2,5 - 685	2740,000 mm
4	4	EN 10210-2 - 40 x 40 x 2,5 - 160	640,000 mm
5	2	EN 10210-2 - 40 x 40 x 2,5 - 368	736,000 mm
6	4	EN 10210-2 - 40 x 40 x 2,5 - 448	1792,000 mm
7	1	EN 10210-2 - 40 x 40 x 2,5 - 81,89	81,890 mm
8	1	Floor Steel plate 2mm	368 mm x 1153mm
9	10	L-bracket steel plate 2mm(Remember to add extra material to cutting)	1400mm x 250mm
10	1	Top plate to divide stress steel plate 2mm	445mm x 170mm
11	4	Rebar (Reinforce steel)	4
12	1	C-bracket steel plate 2mm	208mm x 42mm
13	4	ISO 7091 st 8 - 100 hv	
14	2	ISO 4017 M8	
15	2	ANSI B18.2.4.2m M8 x 1,25	

Designer	Date	Titel
Kasper Knudsen	19/05/23	Chassie and floor

Semester project
Oilpresser in collaboration with Engineers without Borders

Figure 43

Pusher Beam and Stemple



PARTS LIST			
ITEM	ITEM QTY	PART NUMBER	Total Amount
1	4	EN 10210-2 - 40 x 40 x 2,5 - 280	1120,000 mm
2	2	EN 10210-2 - 40 x 40 x 2,5 - 200	400,000 mm
3	1	EN 10210-2 - 40 x 40 x 2,5 - 260	260,000 mm
4	1	Plate Sharp Corners (mm) 40 x 40 x 5	1
5	2	Steel plate 280 x 280 x 2mm	280mm x 560mm

PARTS LIST			
ITEM	ITEM QTY	PART NUMBER	Total Amount
1	4	EN 10210-2 - 40 x 40 x 2,5 - 364	1456,000 mm
2	4	EN 10210-2 - 40 x 40 x 2,5 - 368	1472,000 mm
3	2	EN 10210-2 - 40 x 40 x 2,5 - 180	360,000 mm
4	1	EN 10210-2 - 40 x 40 x 2,5 - 580	580,000 mm
5	1	EN 10210-2 - 40 x 40 x 2,5 - 40	40,000 mm
6	1	EN 10210-2 - 21,3 x 2,3 - 300	300,000 mm
7	2	Steel plate 614 x 280 x 2mm	1228mm x 280mm

Designer	Date	Titel
Kasper Knudsen	19/05/23	Pusher and presser parts

Semester project
Oilpresser in collaboration with Engineers without Borders

Figure 44

User Situation and Use

Construction Presentation

This section will present the current construction, and its elements and functionality.

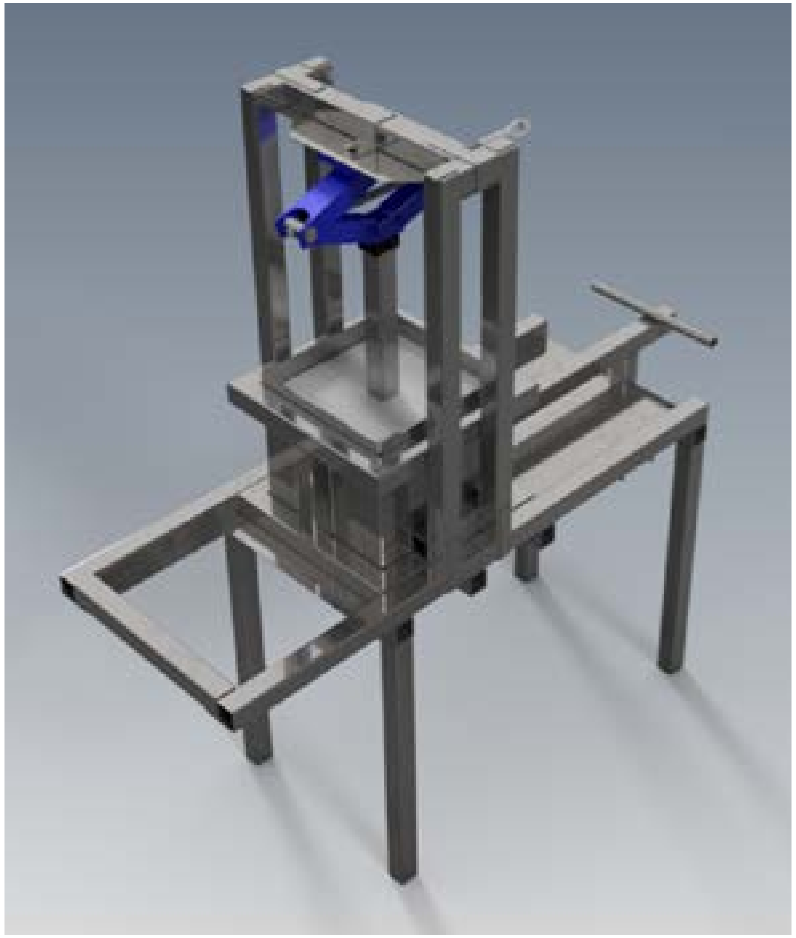


Figure 45

Car Jack Function

To prevent the pressing frame from being pushed upwards by seeds, two pieces of plywood was nailed on the top of the bottom beam to hold down the frame when it is put into the pressing position.

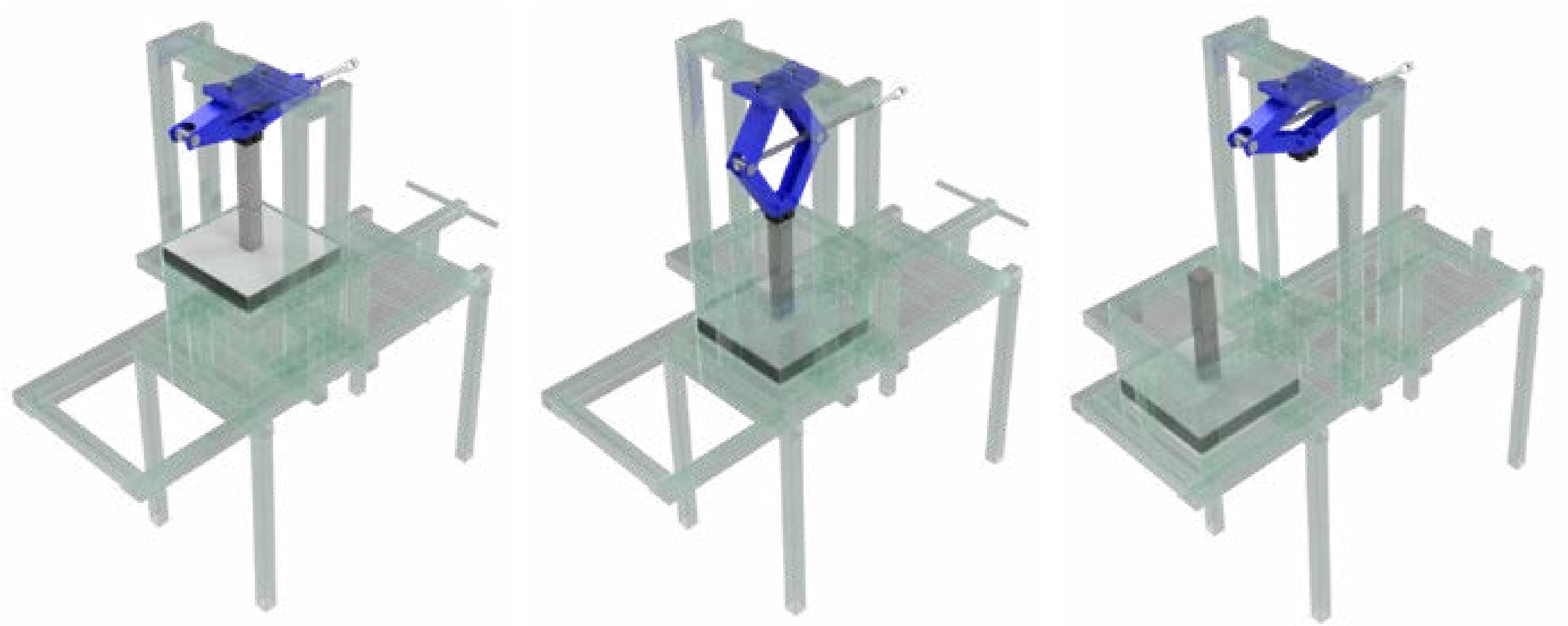


Figure 46

Presser Plate Function (Stamp)

Place the presser plate on top of seeds, and then move it under the car jack to press it down. To maximize output and ensure a longer lifespan of the press, even out the seeds first.

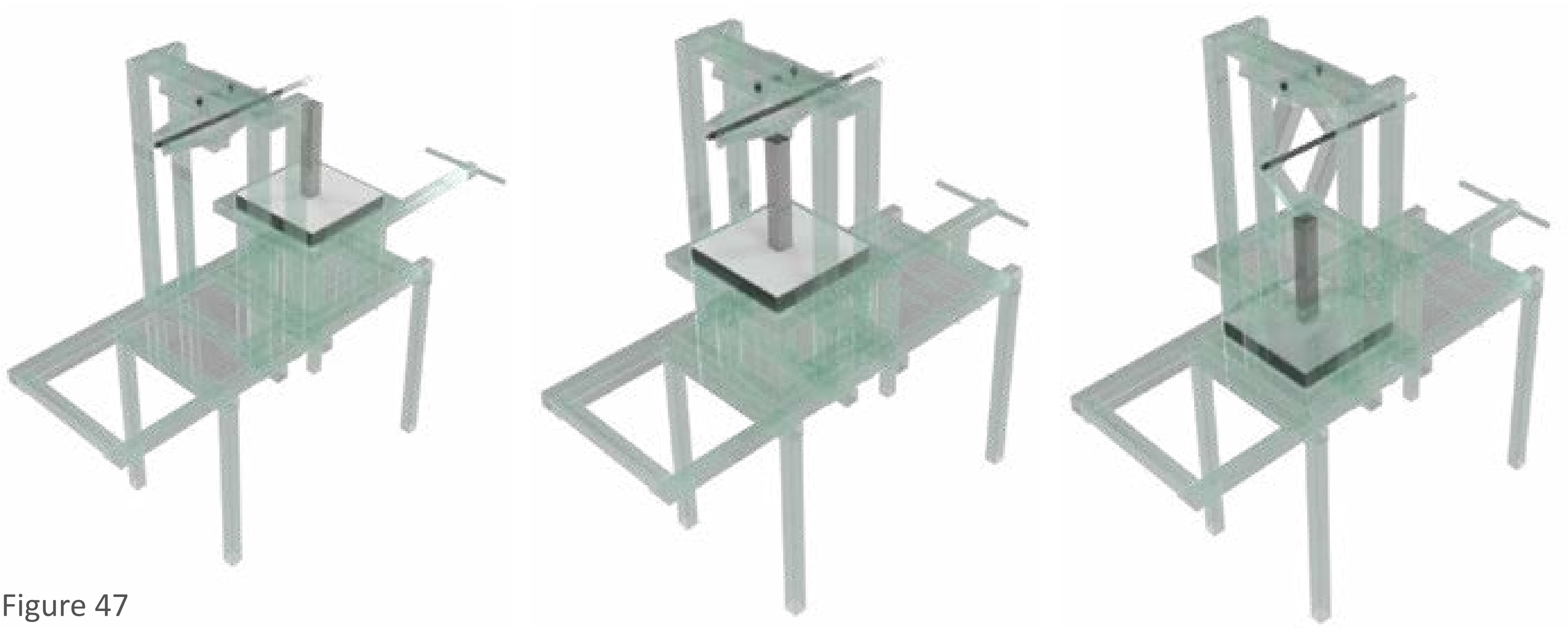


Figure 47

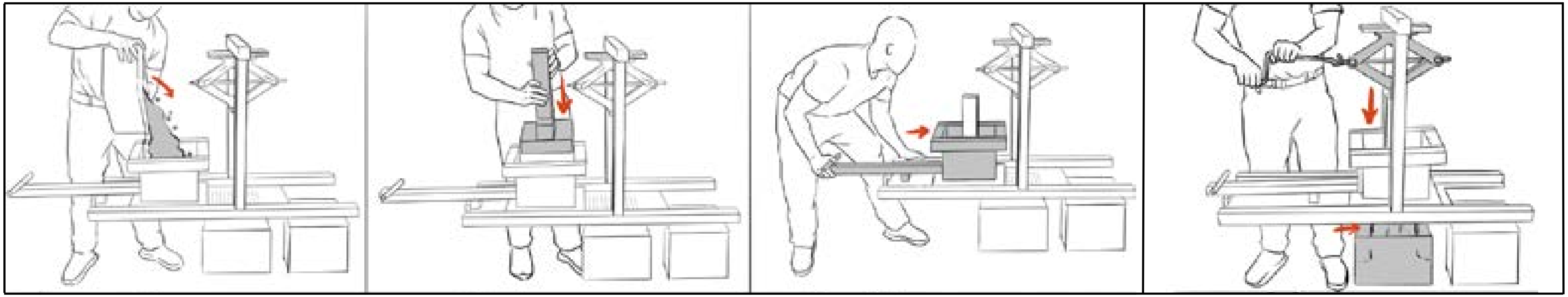
Pusher Function (BOX)

Fill up the seeds to 80% volume, then move it under the car jack and so the seeds can be pressed. Afterwards, move it to the back to remove waste.

Figure 48

Storyboard

A storyboard is showcasing how the user should operate the oilpresser.

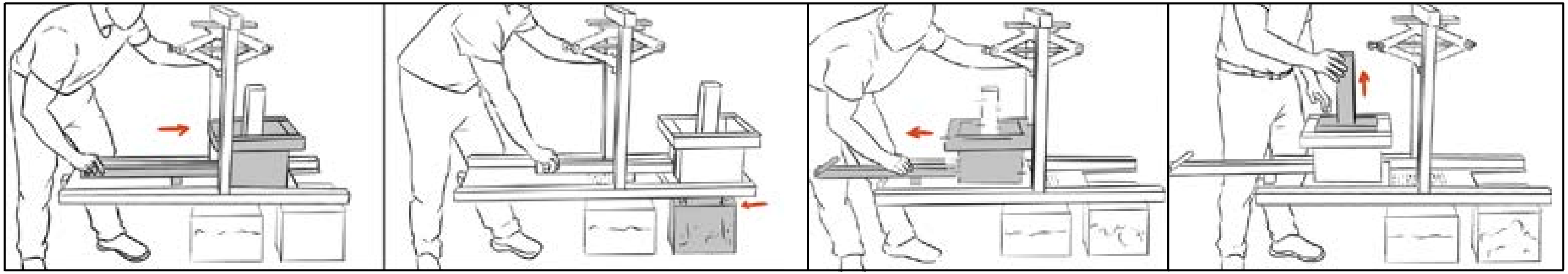


1.
The user is pouring the palm seeds in the box.

2.
The user places the stemple in the box, on top of the palm seeds.

3.
The user moves the box and places it right under the car jack, on top of the filter.

4.
The user then uses the car jack, to press the stemple down, so the oil will be pressed out through the filter.



5.
The user continues sliding the box to the next step, which is the opening.

6.
When the box is placed on the ope-ning, the rest of the palm seeds will fall through the opening and directly down to the bucket.

7.
The user slides the box back to the start point.

8.
Lastly the user takes the stemple out of the box and the process repeates.

Figure 49

Ethical Analysis

In order to ensure that no unforeseen consequences occur and that any positive outcomes can be accounted for, a speculative ethical analysis of the product has been conducted. A table has been made to evaluate whether the project should be continued. The table below consists of positive and negative outcomes. The different outcomes will be rated by importance from (2, 4, 5, 8, 10), where 10 is most important and 2 is least important. The likelihood of each outcome will be rated from 1-5 where 5 is most likely and 1 is least likely. The rating of importance and likelihood will then be multiplied and the totals from the positive outcomes and negative outcomes will then be compared (Appendix 33).

Overall, the **positives** that the press could provide outweigh the negatives with **92 points**, which is almost double the points of the **negative** outcome with **44 points**, with the reason being, that **most negative outcomes are unlikely to happen**.

It can be concluded that this project has the potential to contribute social benefits and is in accordance with ethical principles.

Cost Price Control

Given the nature of the project, the cost price will in this case describe the cost of materials to assemble one press, as the labour of assembly and transport of materials are assumed to be provided by the users themselves.

Furthermore, the press can be assembled by different types of steel, and the acquisition of parts are also carried out by the user (Table 16). As such, the price is highly variable, so the provided cost price is rough in the high-end estimate. For a reasoning of the estimates, see appendix 34.

Car Jack	Stainless steel (67,5 kg)	Total Price
500 DKK (72,5 USD)	1248 DKK (180,8 USD)	1728 DKK (233USD)

Table 16: Cost Price Estimate

As stated before, this is a high-end estimate, and the actual price should be comparable to or less than this estimate.

Frame Analysis

To find out if the top and bottom beams can withstand the pressure from the car jack, and identify any weak points, a frame simulation of the oil presser chassis has been conducted in CAD.

A force of 15 ton or 15000 N, is the maximum pressure the chosen car jack can apply (Table 17).

	Car Jack Press	Beam width	Distributed load length	Area of load distribution	Max. stress on beam
Top beam	1500 N	40 mm	70 mm	5,357 N/mm^2	232,4 MPa
Bottom beam	1500 N	40 mm	280 mm	1,33 N/mm^2	149,2 MPa

Table 17: Table of Frame Analysis

Given the results, an argument could be made that the longevity of the top beam could be a problem, as the pressure of 234MPa is close to stainless steel's lower yield strength interval of 257MPa.

It is also possible to identify which parts of the chassis should be further analyzed. As shown, the top and bottom beam are subject to the most stress. The top side beams, as well as the welded connections, are stressed more than the bottoms side beams.

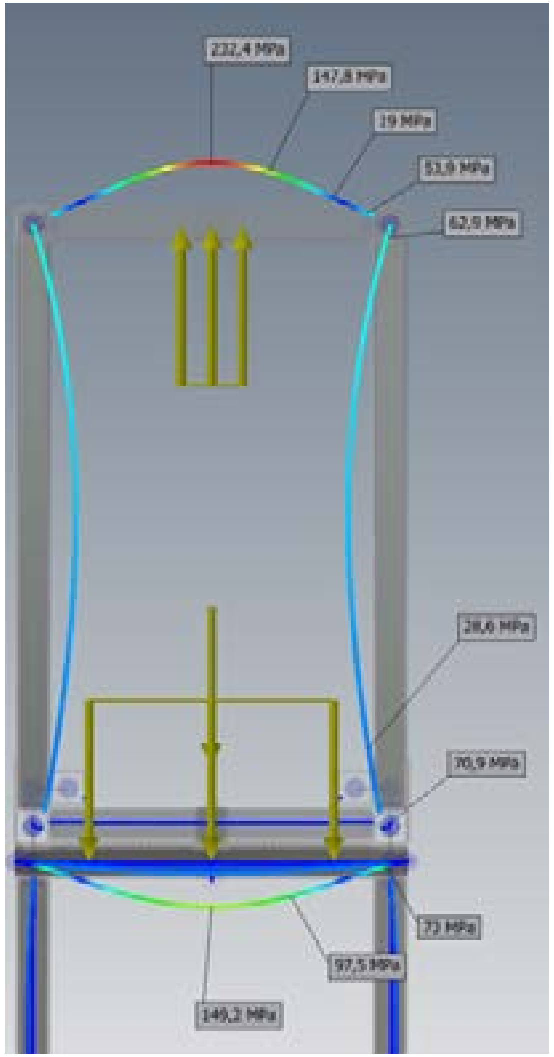


Figure 50

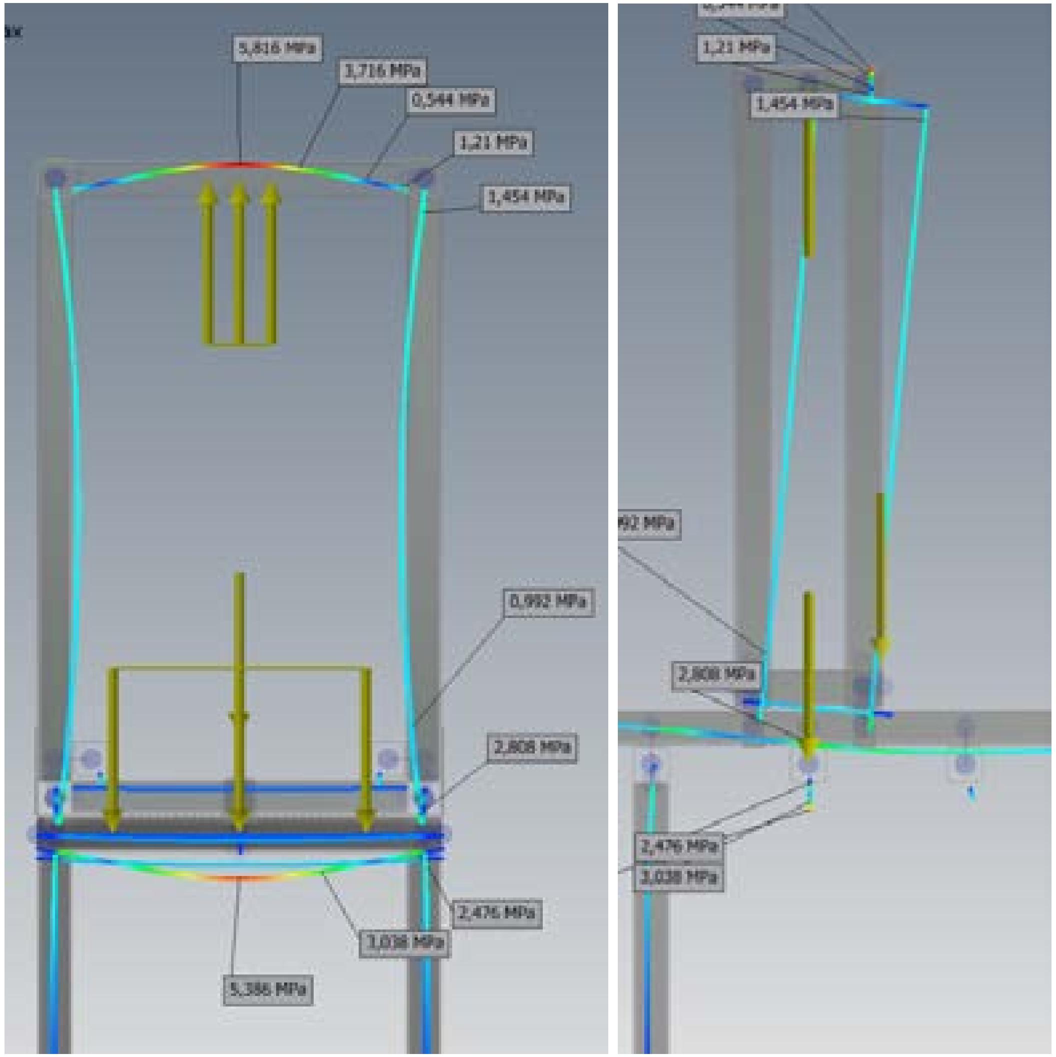


Figure 51

Technical Calculations

To further ensure that the construction of the press can withstand the force of the car jack, basic calculations are made to complement the CAD frame analysis.

The cross section of each beam is 40mm x 40mm, with 2,5 mm thickness, giving a cross sectional area of 375 mm^2.

Failure Point Determination

To determine the potential failure points, the project group look at the design of the main frame and the CAD simulation.

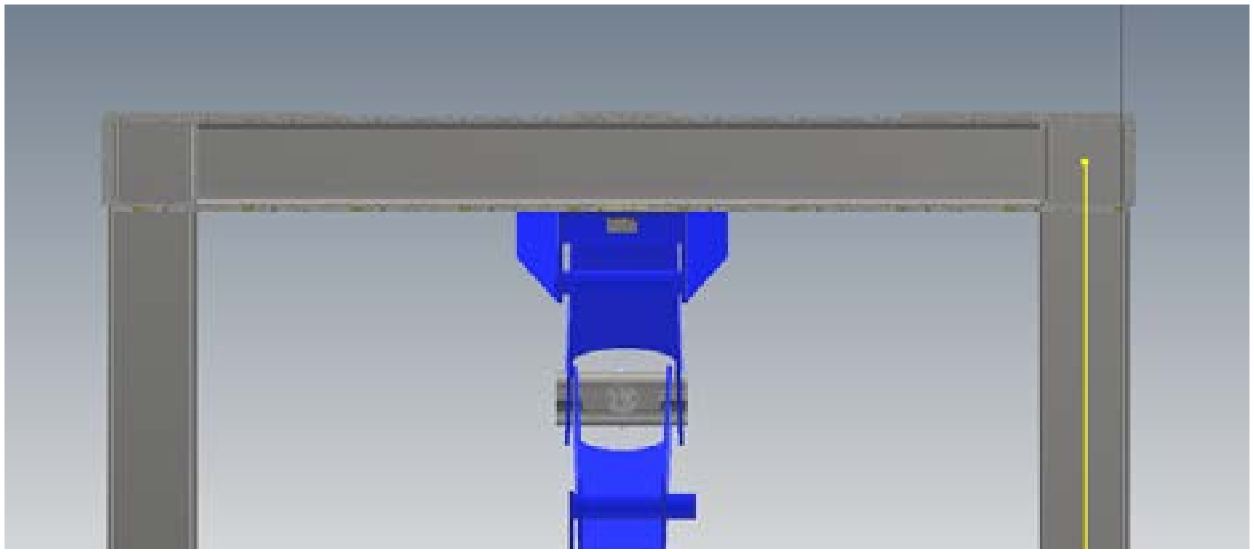


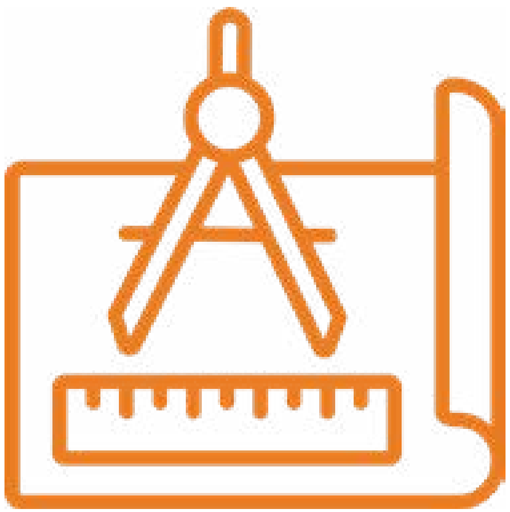
Figure 52

Based on the design, the Top Beam is identified as the potential failure point, as the bottom beams experience the same force, but spread out over a greater area. Hence there are two main modes of failure in the top beam that need to be calculated:

1. Failure at the end joint of Beam
    a. Weld Failure
    b. Beam Failure

2. Plastic Deformation of Beam

Calculation will be done next to ensure that forces experienced by the frame are insufficient to cause such modes of failure. Kindly refer to appendix 35 for the full set of calculations.



Summary

The calculations have shown that when loaded to the theoretical maximum of a 1.5 ton car jack, the frame of the oil press is able to function without damage or deformation (Table 18). They have also shown that the potential key failure points generally have a high safety factor, the lowest of which being 2.5. Since there is no standard to the safety factor, a rough approach was taken based on online research.

Applications	Factor of Safety - *FOS* -
For use with highly reliable materials where loading and environmental conditions are not severe and where weight is an important consideration	1.3 - 1.5
For use with reliable materials where loading and environmental conditions are not severe	1.5 - 2
For use with ordinary materials where loading and environmental conditions are not severe	2 - 2.5
For use with less tried and for brittle materials where loading and environmental conditions are not severe	2.5 - 3
For use with materials where properties are not reliable and where loading and environmental conditions are not severe, or where reliable materials are used under difficult and environmental conditions	3 - 4

Table 18: Factor of Safety Guidelines

The machine is not perpetually loaded for long periods at maximum load, and there is currently no empirical evidence that the maximum pressing force is needed to fully extract the oil from the seeds. Hence, it is then safe to conclude that the safety factor is sufficient until further testing is conducted.

Knock Down

The oil presser that the project group chose to develop is a Knock Down product. This is due to the fact that the expenses of transporting a whole oil presser to Sierra Leone would be very high. The product will be assembled from several elements by the local Sierra Leonean blacksmith. Through Engineers without Borders, the Sierra Leoneans blacksmith will receive working drawings of the oil presser. Thus, make it possible for the blacksmith to see what materials to use.

The materials are available resources that they have access to. Furthermore, the project group has done proper research on the materials, to see what is highly recommended to use and if it is not possible, then good alternatives can be used.

All Requirements

Needs No.	Requirements	Units	Importance (1-5)	Fufil-ment	Oilpresser results
1, 7	The oil presser cost less than 345 dollars.	USD	5	3	The oil presser costs 250 USD
2, 4, 39, 29	The oil presser can apply 6 MPa	MPa	5	2	The oil presser can ap-ply 6 N on a 40x40 mm area
3, 18	The oil presser can be built without precision fabrication tools	No. of precision fabricati-on tools	4	3	The oil presser mockup, has been made by using basic hand tools like: Hand-saws, chisels & drills
12	Minimum 2 colours will be used for the oil presser to indicate use	No. of colours	3	1	The oil pressers consist of more than 2 colou-rs, but it's not used to indicate use
8, 10, 11, 16, 37, 43	The oil presser consists of At least 90% of the materials available in Sierra Leone	No. of familiar parts	4	3	The oil presser is desig-ned to be created with the available materials in SL: where it will be built and where the parts come from
13, 35	The height of the interface is around 1-1,5 meters	cm	3	3	The height of the inter-face on the oil presser is around 1,2 m

Needs No.	Requirements	Units	Importance (1-5)	Fufil-ment	Oilpresser results
14	Time used to stop the pressing process is less than 3 seconds.	Sec.	3	3	The carjack requires manual power to operate. Removing the manual power will take less than 3 sec.
6, 19, 21, 5, 36, 37	It takes 10 minutes to understand how the oil presser works without a manual.	Min.	5	3	Based on the readability workshop results, the average time to understand how the oil presser works is 2,2 min
20	The oil presser can be transported by 2 average men, with the speed of 15 m/min. during the first minute.	Min.	3	2	The 3 mockup could be transported 400 m by one man within 12 min. The metal oil presser in SL would weigh over twice as much (steel is mostly recommended), therefore making the transport time longer
24	The maximum numbers of workers needed to use the oil presser is 2	No. of workers	3	3	The oil presser could be used by one person during the readability workshop

Needs No.	Requirements	Units	Importance (1-5)	Fufil-ment	Oilpresser results
31, 36	The material hardness will remain minimum 95% the same during rain and 40 degrees heat before 5 years	HV	4	2	A hardness test will be conducted using a water spray and a blow dryer to test the oil presser' results adherence to the requirements
40	The oil presser should be a mechanical device capable of manual operation but designed for future motorization.	Subj.	3	3	It is possible to add a motorized car jack in the future
43	The oil presser uses a sustainable energy source, such as solar, wind, or hydropower, to power the machine.	Choice of power	4	1	The oil presser uses manual power
From volume calculation	The construction can withstand 40kg of seeds and a pressure of 1.5 tons over a 280x280 mm area.	Withstandable	5	2	The CAD frame analysis showcased that the oilpresser withstands the pressure, but a physical model needs to be tested on as well

Table 19: Fulfilment of Requirements

Conclusion

Conclusion

Project Status

The project is currently in the last part of the concept phase, with the wooden prototype serving as a capstone to the process. The use of the oil press, the user and the general circumstance is well understood by the group, and the functions have been fully agreed upon.

Reflection

At the end of the Concept Phase, the group reflected on the process of the project. Some of the key findings are as follows:
Most of the report was written without a clear image of who it was for, which could have had a negative impact on the writing. This could be solved by making a decision early on in the project.

Workshops for Idea Generation should be very well planned, with a clear goal in mind, to prevent the workshop from going off on a tangent and lasting much longer.

With information being as hard to obtain as it has been, it is important to double check and cross reference all sources, to ensure that, as happened with the group, small errors are not overlooked.

If there was time, the loop of constructing mockups from feedback to get more feedback should have continued, as just having the wooden prototype proved invaluable to the group.
For the full list reflection points, see appendix 35.

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