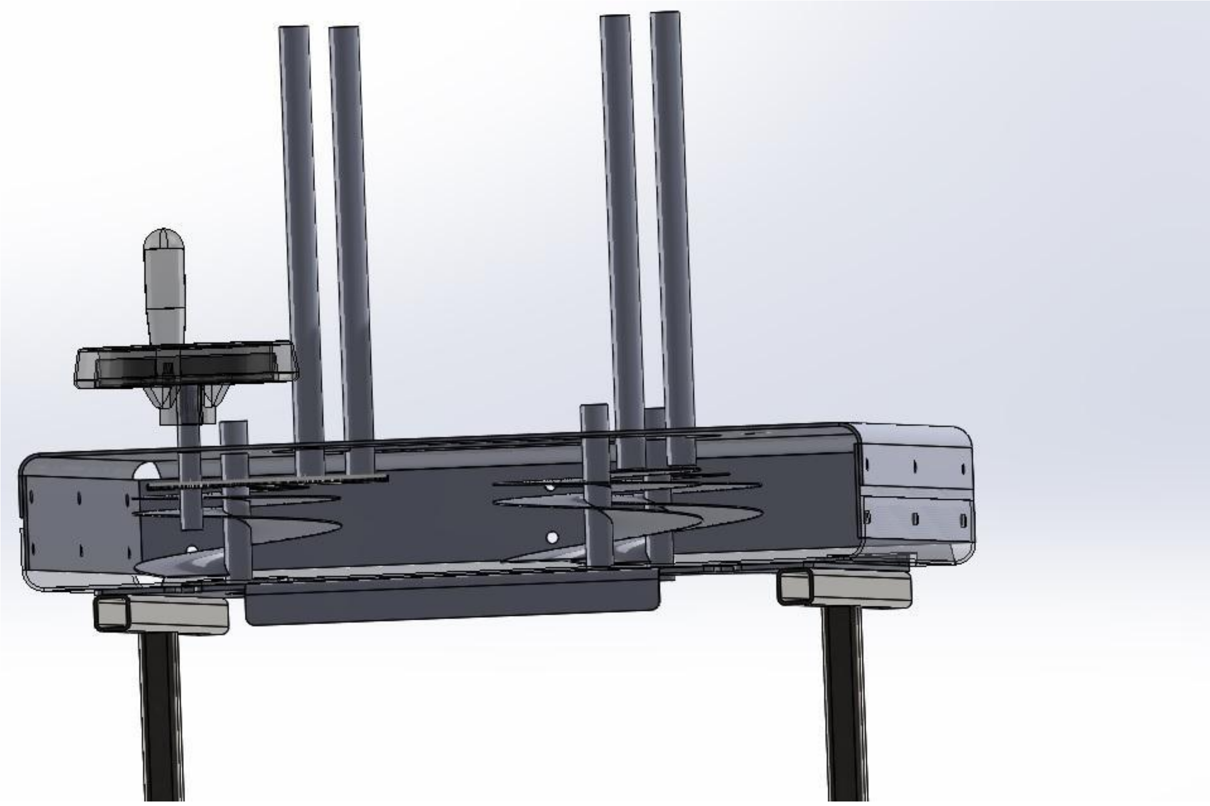

# PROJECT REPORT: DESIGN OF A MECHANICAL TOOL-GROUP 24

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# 1. Analysis

In order to have a smooth group collaboration, we drew up a group contract which can be found in Appendix A.

## Problem Analysis

The assignment is to make a plate dispenser. Until this moment there are a lot of plate dispenser, but they all work on the same idea of springs pushing the plates upwards. This concept does not work for us, because we have to make a plate dispenser that pushes plates downwards on a conveyor belt. We started by analysing the problem.

### Design topic

The topic of this problem is automating the process of plate dispensing on a conveyor belt in medium sized kitchens.

### Important Functions

The dispenser should be able to be filled with plates and should store those plates (at least 6). It needs to dispense the plates on the conveyor belt one by one with a distance of 40 centimetres between the plates +/- 5 centimetre. This should not break the plates and place them in the right position. The machine should also be able to be cleaned thoroughly.

### Design localization

The design will be placed in a medium sized kitchen. This is a place where it can get wet and where there is a lot of human movement. This place should be and stay clean and hygienic. The actual machine will be placed on the interface of the conveyor belt.

### Need

This machine will be needed to make the process of putting down plates and plating them go faster, smoother and easier.

### Timing

This project will be used when a reasonably large amount of plates needs to be plated and served. This could be for group dinners, lunches, breakfasts. For example, in hospitals when the same dinner needs to be prepared for and served to a lot of patients.

### Who

The people that will work with this dispenser will be employees that work in the catering business. The normal public won't have access to it.

### Duration

This product should last at least 5 years without breaking down.

### Weight

The design should be as light as possible so that it is easy to place, move and clean without losing any of its functionalities.

### Speed

The machine should be produced in such a way that it dispenses plates with a distance of 40 centimetres of each other (+/- 5 centimetre) on a belt that moves at 5 meters per minute. The motor that can be implemented will have a rotational speed of 25 revolutions per minute.

### Size

The maximum dimensions are (l x w x h) 600 x 600 x750 mm

### Interface

The machine needs to be placed on a certain interface. It needs to be stable and not fall off while working.

## Functions, Requirements & Wishes list

### Functions:

- Reloadable
    - Device can be opened
- Dispense plates 1 by 1
- Plates need to be equally placed with a range of 40 centimetres +/- 5 centimetre
- The plates must not break
- The plates must come on the right side up the belt conveyor (Top side up, bottom down)

### Requirements

- Completely automated process
    - Should be able to work by turning a handle with one hand
    - Hand driven but needs to be ready for a predefined motor that spins 25 revolutions/minutes
- User friendly
    - Operable by 1 person
    - Clearly marked instructions (reloading spot, turning way, max. Plates capacity)
    - Should display how dinner plates are left in the device
    - Parts easily accessible and cleanable
        - Without having to unscrew anything
        - Should be water resistant
- Not noisy (<40 dB)
- Safe
    - It should be a closed design, so that nothing can get stuck in the device
    - No sharp edges or points, so it doesn't cut the user
- Carefully place plates on conveyor
    - Plate should not break
    - Plates should be placed with a max (height) distance of 3 cm of the conveyer
    - Plates should be dispensed every 40 centimetres
- Machine should fit within the given dimensions max. (l x w x h) 600 x 600 x 750 mm
- Not more expensive than [will be decided later]
- Prototype should majorly consist of steel
- Machine should fit onto the interface
    - It should have a slit through which a metal part of (l x w x h) 20 x 50 x 3 mm can fit
    - Machine should not fall off the interface
    - Machine should not move on the interface

### Wishes

- Reload sign
- Adjustable settings / Workable with different plate sizes

## 2. Conceptual design

When discussing our ideas with each other in several meetings, we came up with different ideas. After a careful analysis it was decided that some of the ideas could not work in practice, and others sounded successful. A clearer and larger view is in Appendix B.

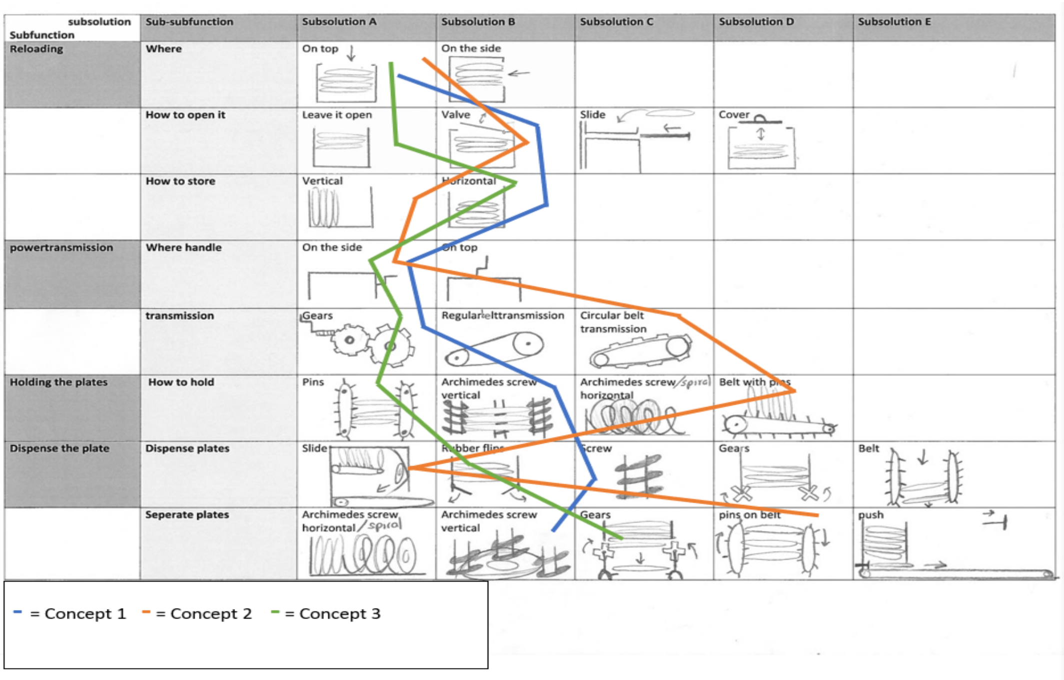



**Figure 1**

## Discarded ideas

a) Small conveyor belt design:

This design consists of a small conveyor belt which is located under the vertical storage, and this conveyor belt can be rotated by a handwheel placed on the side of it with a specific speed which allows the plates to be dispensed with a distance of 40 cm between each plate. One of the storage walls has a hole at the end of it and this hole has dimensions which only one plate can fit through it so it passes forward to the main conveyor belt.

Loadability: This function can be done easily by one person. Through the hole which is located on the top of the dispenser, the plates can be placed inside the storage vertically.

Dispensing the plates one by one: After our experiment, we found out that this function cannot be applied to our design because of the dimensions of the plates, so each plate has a cavity and while all of the plates are standing in the storage on the top of each other the bottom plate will not pass through the hole to the main conveyor belt because of the upper plate, and according to the hole dimensions only one plate can pass through. Therefore, we decided that this design does not meet the requirements we need, especially the essential function which is dispensing the plates one by one.

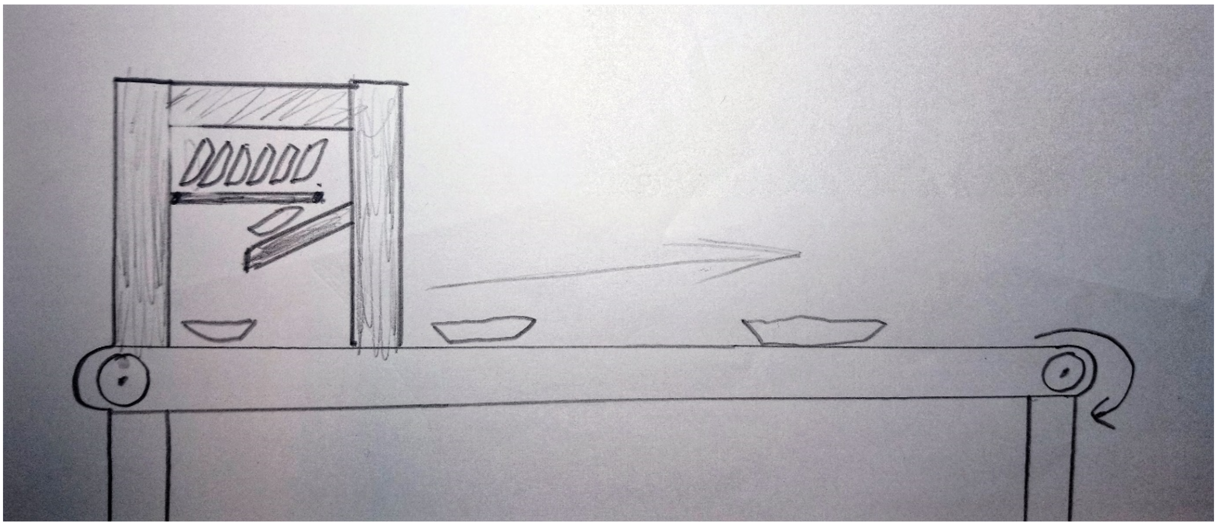


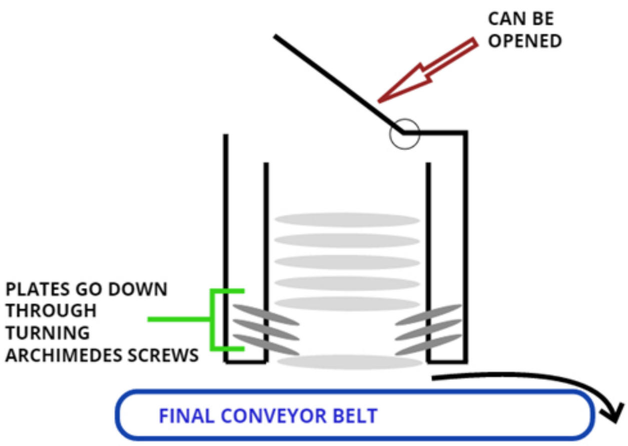
**Figure 2**

## Working ideas

**a) Vertical Archimedes Screw:**

One of the designs that are likely to work consists of two Archimedes screws located in front of each other vertically and attached to the conveyor belt. Both screws are supposed to rotate simultaneously and in opposite directions in order to bring the plates down from the top of the machine. The plates will be located on the top of the structure at once, making it easier to keep reloading plates for the employee and to keep the balance of the plates, a boxed structure will be implemented, thus making contact in 4 equidistant points around the outer surface of the plates. In other words, the loadability function is covered now. The helicoid has to be designed in a way that will catch the plates and, in the way downwards will automatically separate the plates 40cms between each other. The plates will reach the conveyor belt and will be dispensed one by one. It can be concluded that this machine accomplishes the 3 main functions indicated before and would probably work. For these reasons this idea has been selected for further development.

**Figure 3**




**b) Horizontal Rotating Band:**

Similar to a horizontal Archimedes screw, but instead of two Archimedes screws, just one toothed belt would be placed horizontally, in which the plates could be located vertically. The belt would be rotated to make the plates move forward until they fall on a sloping slide that will guide each plate to the conveyor belt. For this design we would have to face one problem that has to do with the reloadable function of the machine. It would be difficult to locate a great quantity of plates on the screw because the plates should be put one by one on the mechanism, which also means that more time would be needed for the employee, making the machine inefficient.

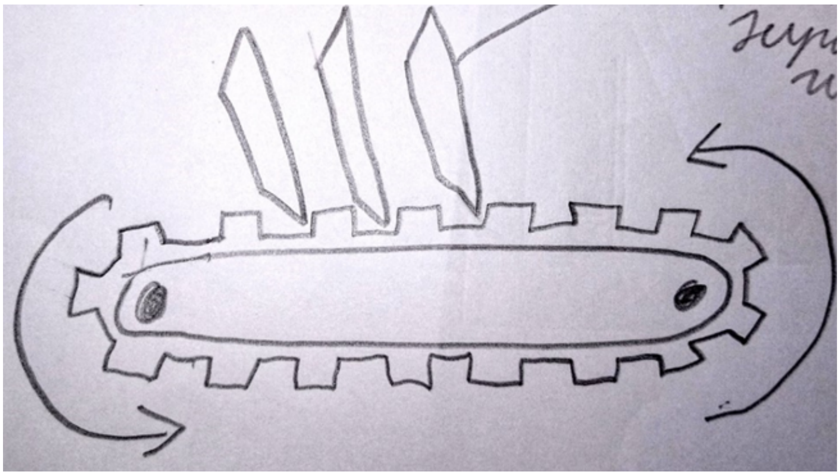


**Figure 4**

**c) Vertical Rotation Machine:**

One of the ideas we came up with consisted of a vertical structure capable of transporting the plates from the top of it to the conveyor belt located underneath. The main idea was to build two separated steel columns located in front of each other that would be covered by rubber and move the plates down by rotation. Analysing the functions the machine should have, we found that 2 of the 3 main functions would work.

“Dispense 1 by 1 function” and “40cms Plates Separation”:

To cover these functions, both rotating columns would have small supports in the rubber band separated by 40cms. The plates would be placed above the structure and each plate should be allowed to lie on the supports, which would move until a maximum height of 3 cm from the belt before letting the plates fall on the conveyor belt, thus avoiding a sharp fall that would have broken the plates. The constant rotation velocity should be similar to the velocity of the conveyor belt, thus maintaining the distance of 40cms and also dispensing the plates 1 by one.

“Reloadability”

Continuing with the analysis, the group found a problem concerning the reloadable function of the machine. In order to put the plates on the structure, the separation should already be placed between the plates because, otherwise, if the plates are placed together, all the plates could fit between the supports distance and the other two functions wouldn’t work. One of the solutions was to put the plates together and incorporate a mechanism that only would allow the plates to fall one by one into the supports that in turn were placed every 40cms. Another option would have been to put them together, place the supports, not every 40cms but in order to fit the distance between plates and then find a way to stop the machine for 4,8 seconds after the falling of each plate into the conveyor belt, which would create the separation of 40cms.

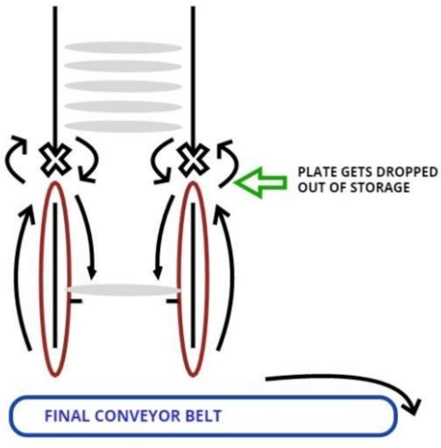



**Figure 5**

## Chosen design

In the end of week 38 and beginning of week 39 our chosen design was developed to work in the following process;

Firstly, the concept consists of three Archimedes screws located vertically in a way that they make a triangle shape to deliver enough balance and stability to the plates in order to go smoothly downwards to the conveyor belt; these screws are attached to the frame which will cover the design. All of the screws are supposed to rotate simultaneously and in order to bring the plates down from the top of the machine.

The plates will be located on the top of the structure at once, to make the function of reloading the plates easier and to keep the balance of the plates, to guarantee that the process of loading the plates into the dispenser is going as wished, there will be four shafts which are supposed to surround the plates from all sides while sliding towards the Archimedes screws and with this feature we can ensure that the plates can be loaded in a secure way.

Moving to the Archimedes screws, the screws have to be designed in a way that will catch the plates and, in the way downwards will automatically separate the plates 40cms between each other. The plates will reach the conveyor belt and will be dispensed one by one.

Moving forward to talk about the transmission process, six sprocket gears will be placed and these gears are going to be connected with the screws via a chain, a handle will be attached on the top of one of the screws and, as it is mentioned before that the screws will be connected to each other in order to be able to rotate all of the screws simultaneously via the handle.

Design sketches can be found in Appendix D and E. The list with advantages and disadvantages can be found below and the detailed table is in Appendix C.

| Functions Requirements | Concept 1 | Concept 2 | Concept 3 | Scale |
|---|---|---|---|---|
| | | | | |
| **Reloadable** | 3 | 2 | 3 | X1 |
| **Dispense plates 1 by 1** | 3 | 3 | 2 | X3 |
| **Plates need to be equally placed with a range of 40 cm +/- 5 cm** | 3 | 3 | 2 | X3 |
| **Completely automated process** | *3* | 3 | 2 | X2 |
| **User friendly** | 2 | 2 | 2 | X1 |
| **Not noisy (<40 dB)** | 3 | 3 | 3 | X1 |
| **Safe** | 3 | 3 | 3 | X2 |
| **Carefully place plates on conveyor** | 3 | 3 | 2 | X3 |
| **Machine should fit within given dimensions max. (l x w x h) 600 x 600 x 750 mm** | 3 | 3 | 3 | X3 |
| Total | 56/57 | 55/57 | 45/57 | |

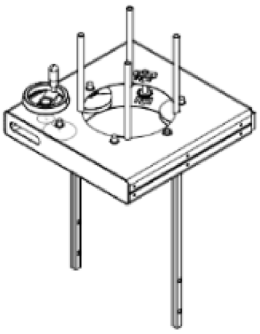
**Table 1**

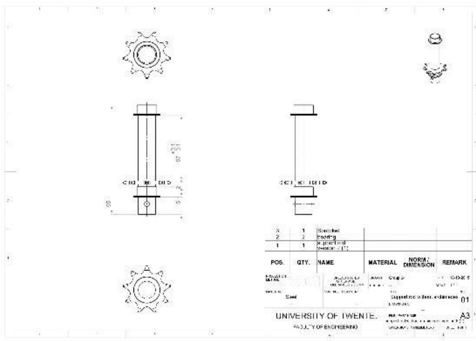
The difference between concept 1 and concept 2 is such that they both are good options. What made us decide for concept 1 over concept 2 is the stock and the reloadability. More plates can be stacked in concept 1 than in concept 2. Moreover,  one big stack of plates can be stacked one time from the top, whereas, for concept 2 the plates need to be put in one by one.

### Midway presentation: Led to changes

For the midway presentation, our main aim was to show the progress and process of our planning and thinking to explain how we arrived at our final design. For this presentation, half of the group was supposed to present. So, we selected the scheduled speakers to be Tsailung, Vincent, Aziz and Malli. We started off the presentation with how we analysed the whole problem given to us and how we came up with multiple solutions and sub solutions through a morphological diagram. We proceeded with the explanations of sketches of the chosen conceptual ideas and explained their advantages and disadvantages to justify our final concept selection. We even made a program of features to justify our arguments. We ended the presentation with the detailed sketches of our final chosen concept to provide a better overview and understanding to the audience. During the Q&A session, we were asked multiple questions. However, these questions were mainly based on wanting a more thorough explanation on the flaws of our failed concepts as well as wanting to understand our final concept better. This led us to understand that our sketches and drawings were not detailed enough and that our explanation along with the program of features were not sufficient. Towards the end of the presentation, as anticipated, we were asked to hand in more detailed technical drawings and were also asked to explore a few design changes to make the design more feasible, sturdy and efficient, given the limited resources available to us. The evaluation report for can be found in Appendix F.

## 3. Detailed Design





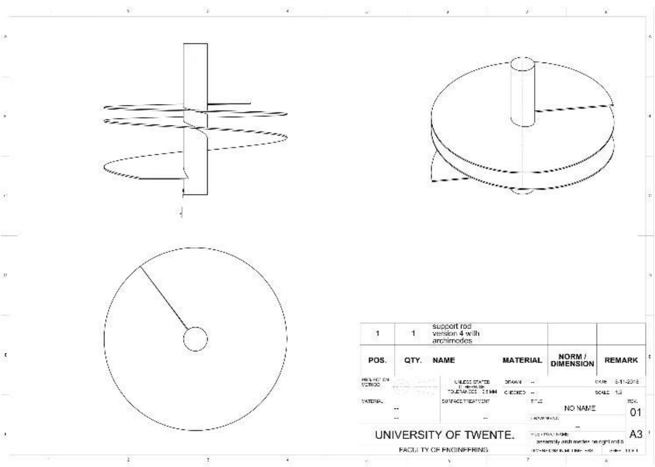



**Figure 6**

## Major Design Change justification:

Figure shows design sketches of the new design. After taking into account all the suggestions made at the midway presentation, we indulged into a couple of serious discussion sessions to explore other mechanisms and means of assembly to carry out the intended process of the chosen design. The following are the major changes made and their relevant explanations:

- Changing the internal gear into a chain and sprocket system
  One major problem we faced was figuring out how to support the internal gear we were going to be using. However, we realised that the chain and sprocket system could be used as an alternative. Furthermore, the chain and sprocket system would be easier to produce in the prototyping phase.

- The usage of bearings, circlips and adjustment rings.
  Initially, we had a solid rod and a hollow rod. Where the hollow rod was placed over the solid rod for the rotational ability of the mechanism. However, this would introduce large amounts of friction and is hard to produce. We replaced this with putting into use bearings, circlips and adjustment rings. These accomplish the same functions but with greater ease.

- Hexagonal structure to square
  Since we had eliminated the usage of most rods through our redesigning process, we realised that we did not need a coarse and complicated hexagonal structure to accomplish our task. We replaced this with a simple sheet metal structure, which helps in the ease of production and cost efficiency.

- Revolutions of Archimedes spirals
  We also realised that we did not need as many spirals as initially planned as we only needed to bring down one plate at a time. Hence we decreased the spirals in the design to 1.5. This allows for a more compact design and an ease in production.

## Product structure:

To dive deeper into the design, a product structure was made, showcasing all the possible parts and the approximate quantity required. The image of the product structure can be found in Appendix

The final prototype will consist of the following subassemblies and parts:

The frame which is the outer structure of the prototype consists of a hollow top plate and bottom plate, side walls, back wall and a front door to keep the design accessible and also safe. A square box shape was chosen, and the plates are supposed to go through the holes in the top and bottom plate.

The power transmission system plays a very important role for the successful operation of the prototype and consists of the handwheel which is fastened by means of a key to a rod which also has a gear on it. This is one of the 7 rods that complete the power transmission system. Each of these rods have sprockets and are connected to the top and bottom plate. A chain goes around the rods forming a circular shape, thus if the handwheel moves, the gears will rotate and so the sprockets.

For the dispensing mechanism, 3 of these rods consist of Archimedes screws and are located equidistant from each other. The plates will be placed on top of the screws and the rotation produced by the handwheels will rotate the spirals that are welded to the rods, thus moving the plates one by one downwards.

Four rods will be on top as a guide for the plates and these are welded to the top plate.

This prototype will be attached to a given interface and is supposed to accomplish all and each of the functions stated in the analysis phase of this project.

A project structure with the number of parts can be found in the appendix.

### Set of technical drawings:

A clearer, more detailed view of all the technical drawings are in Appendix J. Below only the important technical drawings of the assembly, gears and screws are given.

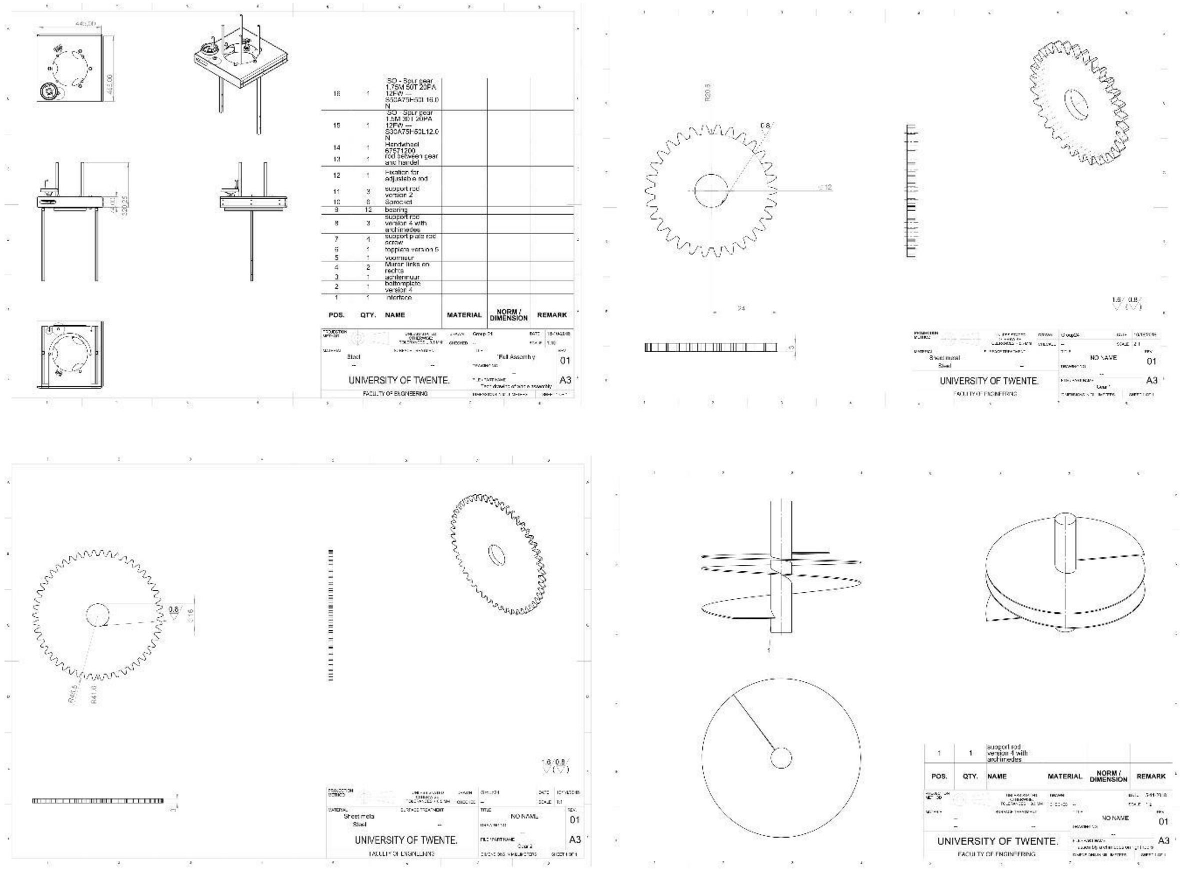


**Figure 7**

### Measurement plan:

For the prototype to be accurate, the theoretical measurements from the technical drawings and the real measurements of the important parts must be the same or within an acceptable tolerance. We anticipate that the important parts in the prototype for measurements are the two gears, the rods that would have sprockets, the screw disks that will be bent and attached to three rods with sprockets and the rod that attaches the hand wheel to the gearing mechanism. Therefore, a framework for the measurement plan was made, comparing the measurements of the real and theoretical values and the difference between them. The important parts in this measurement plan are: **Gears, pitch** of **Screw disks** and **hole alignment between top and bottom plates**. This is because a larger difference in these parts dimensions would be fatal for the prototype to function. Vernier callipers would mainly be used for the measurement of the real parts.

**Calculation of the gear ratio:**

Given values :

Motor = 25 rpm

Conveyor = 5 meters per minute

Considering that there has to be a space of 40cm between every plate, we can calculate that there are supposed to be 12.5 plates on the conveyor over the period of a minute.

Each revolution of the Archimedes screw dispenses one plate. This shows that the motor has the ability to dispense 25 plates per minute. However since we only need 12.5 plates per minute, we take the ratio between the two values which gives us a value of 2.

Hence the gear ratio would be 1:2.

However, for the purpose of the prototype, we realised that we cannot turn the handle as fast. Over a series of tests and estimations, we realised that our ideal rpm for a human hand would be around 9 rotations per minute, due to the heavy loads. This landed us with the gear ratio of 5:3.

**Calculation regarding the screw:**

The screws were made in solidworks and using the measuring tool the necessary measurements were taken. For the screws to fit properly onto the rods, the diameter of the hole in screw disks that would be attached to the rod cannot be the same as the diameter of the rod. This is because when the screw disks would be bent to achieve the desired shape and slope, the diameter of the hole on a flat plane would be different.

To obtain the right diameter or a diameter sufficient for the disks to bend and attach to the rods, the arc length of the holes were measured using the measuring tool in solidworks. Using the formula: **2.5*2*r=Arc length,** where 2.5 is the number of revolutions of the screw, with this we can find radius ***r*** . The arc length was measured at 133.2mm and so the radius was found to be 8.5mm.

## Work preparation sheet:

These are the work preparation sheets that were made according to the values in the textbook. 4 work preparation sheets were made for 4 parts. The rpm was calculated using the formula $N = \frac{v}{pi*d}$ Below only one is shown and the remaining 3 are in Appendix K.

| | | | |
|---|---|---|---|
| Part name: Collars | | Date: | Sheet number: |
| Part no: | Amount: 7 | Material: Steel | |
| Starting dimensions material:20mm Diameter, 400mm length. | | | |
| Machining sequence: Lathe, Milling and Tapping | | | |
| **Operation** | **Tool**<br>fixtures, tools and other aids | **Settings**<br>speed (V), number of revolutions (N), feed (f), depth of cut ($t_0$) etc. | **Remarks** |

| | | | |
|---|---|---|---|
| ***Mount to lathe or turning machine*** | | | |
| Drilling a center hole | Centerdrill | N= 1488 rpm | |
| Drilling a hole<br>Ø 15.2mm | Drill Ø 15.2mm and cutting<br>fluid | N= 768 rpm | The depth is not necessarily specified because more than one rings would be cut out so a little extra depth is fine |
| Cutting a ring<br>Length: 6mm | Cutting tool | N= 981 rpm | Cut as many rings as possible with the depth of hole drilled. If needed drill the hole again and cut the rings |
| ***Mount to milling machine*** | | | |
| Align the ring with the side of the milling machine clamp | | | This way all rings will have the drilled hole in the same position |
| Make center hole in the<br>middle | Centerdrill | N=1488 rpm | |
| Drill hole Ø 4 mm | Drill Ø4 mm and cutting fluid | N= 768 rpm | Drill only one hole on the ring. Do the same for all 7 rings. |
| Tap hole M4 | Tapping chuck with M4 tap<br>and cutting fluid | | Tap the holes manually with hands |

# 4. Implementation

## Test Program for prototype:

In order to test the prototype, several tests need to be performed. We need to test the functions and the requirements:

Functions:

- ***Reloadable***
    - ***Device can be opened:***

**Test 1.0 :** This can be tested by trying to open the machine and putting in plates. This should work smoothly. This should be done by one person. The machine should not fall from or move on the interface. The correct amount of plates should be displayed.

- ***Dispense plates 1 by 1:***

**Test 1.1 :** In order to test this, we need to place several plates in the machine and turn the handwheel around until plates get dispensed. The plates should be dispensed one by one. The plates should not break and should be dispensed with the top side up. This should be done by one person. The machine should not fall from or move on the interface. The distance between the plates should be 40 centimetres +/- 5 centimetre. The handwheel should be turned with one hand. The correct amount of plates should be displayed when plates are dispensed. This should be done in a quiet room. The machine should not make more noise than 40 dB.

- ***Plates need to be equally placed with a range of 40 centimetres +/- 5 centimetre:***

This should be tested during test 1.1.

- ***The plates must not break:***

This does not require an extra test. The plates should not break during test 1.1.

- ***The plates must come on the right side up the belt conveyor (Top side up, bottom down):***

For this function we can look at test 1.1 again. All the plates should be dispensed with the top side up.

Requirements

- ***Completely automated process:***
    - ***Should be able to work by turning a handle with one hand:***

This should be tested by trying to dispense plates by turning the handwheel with one hand during test 1.1

- ***User friendly***
    - ***Operable by 1 person:***

This does not require an extra test. Test 1.0 and test 1.1 should be performed by one person in order to see if this requirement is fulfilled.

- ***Should display how dinner plates are left in the device:***

This should be tested by putting a certain amount of plates in the device and seeing if the correct amount is displayed. An additional test could be dispensing several plates and checking if the displayed amount is still correct. This should be tested during test 1.0 and 1.1.

- o ***No sharp edges or points, so it doesn't cut the user***

**Test 2.2 :** This can be tested by going over all the edges of the machine with a sponge and feeling if there are any sharp edges.

- ***Carefully place plates on conveyor***
  - o ***Plate should not break:***

This does not require any extra test. We already check whether any of the plates break during test 1.1.

- o ***Plates should be dispensed every 40 centimetres:***

This will already be tested during test 1.2.

- ***Machine should fit within the given dimensions max. (l x w x h) 600 x 600 x 750 mm***

**Test 2.4 :** This can be done by simply measuring the machine.

- o ***Machine should not fall off the interface:***

This can be checked during test 1.0, 1.1 and 2.7.

- o ***Machine should not move on the interface:***

This can be tested during test 1.0, 1.1 and 2.7.

## Final measurement report and conclusion:

The detailed table of the measurements are in Appendix .For the power transmission system, the placing of the gears and supporting rods should correctly fit, that is the reason why the holes for the rods that will support the gears were measured from center to center in the top plate and also the bottom plate, because in the end this measures should coincide with the distance measured between both gear's centers. With these measurements we can assure the workability of the power transmission system.

The conclusion is that there is a small deviation outside the tolerance limit between gear's center and also in the holes located in the top plate, which finally do not agree with the drawings but both distances don't differ even a millimeter which is still positive. When measuring the holes in the bottom plate a serious problem was noticed, it was forgotten the design of the hole in the bottom plate, but a hole was made for the attachment with the interface. This distance was measured in the measurements report, and the conclusion is that another hole should be made, otherwise the operation of the prototype would be compromised.

The diameter of the inner hole of both gears were measured in order to show that the rods with standard diameter would fit. The result was positive with both gears.

-For the dispensing system the holes made in the bottom and top plate for the rods that will support the Archimedes screws are also important because this will be crucial in the dispensing function. The standard diameter of the rods should fit on top and bottom. The results were positive since the holes diameter lies between the general tolerance.

The pitch of the spirals is also important for the plate's transportation from top to the conveyor belt. As 2 discs form the spiral for the Archimedes screw, the pitch should be accurate in order to accomplish the function of taking just one plate and dispense it. As the spirals are bent, each spiral has a small variation but as the distance between plates also varies it can be concluded that big changes are not needed for these parts. The recommendation would be to make the spirals as the drawing indicates.

### Prototype-how it turned out:

The final prototype did not really turn out as we expected. This was because there is a difference between what solidworks presents in it’s drawings and the parts made in real life. One major change to the prototype after we received the laser cut parts was the top and bottom plate. The dimensions of the top and bottom plates remained the same but the flange in solidworks was different than in a real life bended part. The flange in solidworks was exaggerated and in real life the bend or the turning corner is minimal. This led to the overall height of the design to change and new rods were made, which were longer than the original planned ones.

### Final work preparation sheets:

These were the work preparation sheets used for the workshop. 4 work preparation sheets were made. Below only one form is shown and the remaining are in Appendix I.

| | | | |
|---|---|---|---|
| Part name: Support rod | | Date:26/10/2018 | Sheet number:3 |
| Amount: 6 | Material: Steel | | |
| Starting dimensions material: ⌀15mm X 120mm | | | |
| **Operation** | **Tool**<br>fixtures, tools and other aids | **Settings**<br>speed (V), number of revolutions (N), feed (f), depth of cut ($t_0$) etc. | **Remarks** |
| Smoothen the edges | Chamfering tool | N = 800 rpm | Both sides of the rod |
| Make a centre hole | Centre drill<br>and cutting fluid | N = 1500 rpm | 9mm from the edge |
| Drill hole Ø 4 mm | Drill Ø4 mm and cutting fluid | N = 800 rpm | Before drilling add oil to the contact surface of the drill |
| Tap hole M4 | cutting fluid | | Done manually by hand |

**Sheet 2**

# 5. Evaluation and redesign

### Test program results:

**_*This part of the report could not be added because in week 43, the parts we gave for laser cutting did not come into the workshop. Due to this we practically did nothing during that workshop session and therefore though we assembled the prototype, we could not test it because of the time constraint. If we could get time for testing it, then we could make it work. *_**

### Proposal for series production:

**Sand casting for the frame:**

To eliminate welding and unnecessary assembly processes, the frame could be made into one part. Sand casting would be a feasible option for this considering that all parts of the frame are of equal thickness (making it easy to produce without any errors), it is a cheap process (which helps in cost efficiency), could be made for mass production. Furthermore, this process also provides a smooth finish and will be produced in the desired structure. This leads to minimal or almost no further machining being required.

**Extrusion for the Archimedes Screw:**

Considering that the Archimedes screw is a uniform part and that it can be made out of billets, extrusion would be a feasible option. This would allow for the mass production of the screws, with low tolerance errors. Furthermore, the part will be produced as a single piece and will only require the cutting of equal lengths. This makes the process of assembly and manufacturing easier and quicker

### Proposal for series production-3design changes:

1- **Plate supporting rods**: a new design that makes use of plastic because it is light and simple to produce. It has a similar 4 rod design just as this prototype but the bottom part of the rods will have a circular platform with a hole in the centre for the plates to go through. This platform will turn and lock into place with the top plate of the dispenser. Unfortunately, we do not know what the turning into place and locking mechanism is called, so no picture can be provided. This design change makes the dispenser more practical.

2- **Removing the side walls**: instead of having side walls like in our prototype, a better way to make the design more aesthetic and easier to fix would be to increase the height of the flanged tom and bottom plates. This makes the design easier to fix and reduces the total number or parts in the dispenser.

3- **Reduce the overall height of the dispenser**: Due to misunderstanding between the dimensions of the flange in the top and bottom plates, the overall height could be reduced to give the original sleek design. This also reduces the drop height of the plates between the top plate and the first disk of the screw.

# 6. Appendix

- A

Group contract

## a. What do we want to achieve?

We want to have a smooth group collaboration. We want to try and get the best product of this module.

## b. What tasks and roles are needed for this?

We need a chairman to prepare every meeting and a secretary to take minutes.

## c. Who will take on what task/role?

We will make a rotating schedule for being the chair(wo)man and secretary so that everybody takes turns in this.

## d. Agreements on the meetings

• *Agenda and preparation*
The chairman will prepare the agenda. It is expected from everybody to do their action points and prepare everything for the meetings.

• *Decision making*
For important decisions we will have a voting.

• *Frequency, presence etc.*
We plan on meeting at least once a week. If we need more time, we will plan more meetings. It is expected from everyone that the attend the meetings on time. If for some reason this doesn't work, the group member should inform the group about this via WhatsApp. Excuses such as sleeping in and such will not be accepted.

## e. Agreements on the minutes

• *Who will make them?*
This will be different every week.

• *Template of the minutes*
Will be made by Adeline.

• *Deadline, spreading and archiving of the minutes*
We will try to finish the minutes the day after the meeting at max.
Afterwards they will be sent to everybody by mail.
We will make a google drive group and use that to archive the minutes and agenda.

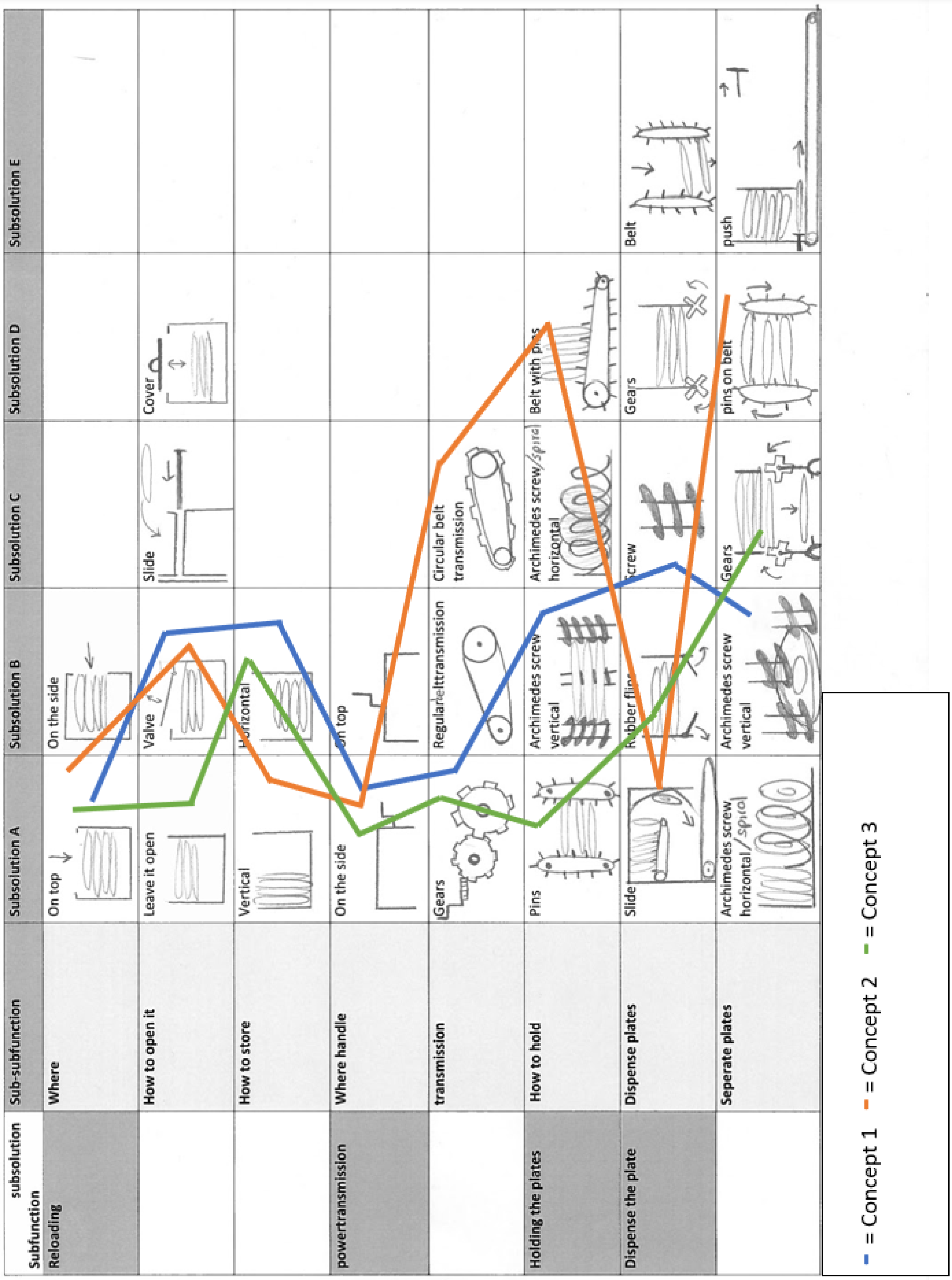
## f. How do we check if everything is going well (planning, collaboration, etc.)?

At the beginning of every meeting we will discuss what we have done and what still needs to be done etc.

## g. What do we do when this is not the case (how do we address this to each other)?

We will talk to each other during the meeting and discuss together how we should solve this

- B



| Subfunction / subsolution | Sub-subfunction | Subsolution A | Subsolution B | Subsolution C | Subsolution D | Subsolution E |
|---|---|---|---|---|---|---|
| Reloading | Where | On top | On the side | | | |
| | How to open it | Leave it open | Valve | Slide | Cover | |
| | How to store | Vertical | Horizontal | | | |
| powertransmission | Where handle | On the side | On top | | | |
| | transmission | Gears | Regularbelttransmission | Circular belt transmission | | |
| Holding the plates | How to hold | Pins | Archimedes screw vertical | Archimedes screw/spiral horizontal | Belt with pins | |
| Dispense the plate | Dispense plates | Slide | Rubber flip | Screw | Gears | Belt |
| | Seperate plates | Archimedes screw horizontal/spiral | Archimedes screw vertical | Gears | pins on belt | push |

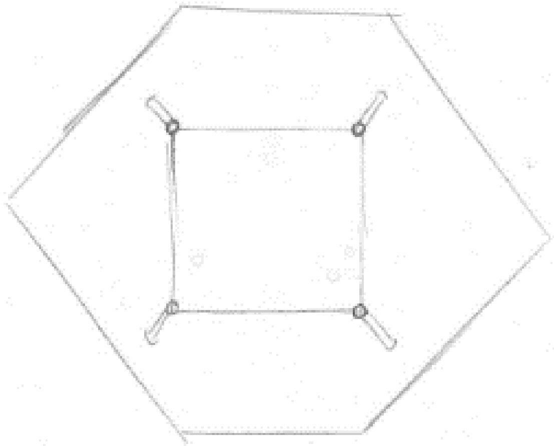
- C

| Functions<br>Requirements | Concept 1 | Concept 2 | Concept 3 | Scale |
|---|---|---|---|---|
| | | | | |
| **Reloadable**<br>- Device can be opened, so that 6 new dinner plates can be placed<br>- Store at least 6 dinner plates | 3 | 2 | 3 | X1 |
| **Dispense plates 1 by 1** | 3 | 3 | 2 | X3 |
| **Plates need to be equally placed with a range of 40 cm +/- 5 cm**<br>- The plates must not break<br>- The plates must come on the right side up the belt conveyor (Top side up, bottom down) | 3 | 3 | 2 | X3 |
| **Completely automated process**<br>- Should be able to work by turning a handle with one hand<br>- Hand driven but needs to be ready for a predefined motor that spins 25 revolutions/minutes | *3* | 3 | 2 | X2 |
| **User friendly**<br>- Operable by 1 person<br>- Clearly marked instructions (reloading spot, turning way, max. Plates capacity) S<br>- Should display how dinner plates are left in the device<br>- Parts easily accessible and cleanable Without having to unscrew anything | 2 | 2 | 2 | X1 |

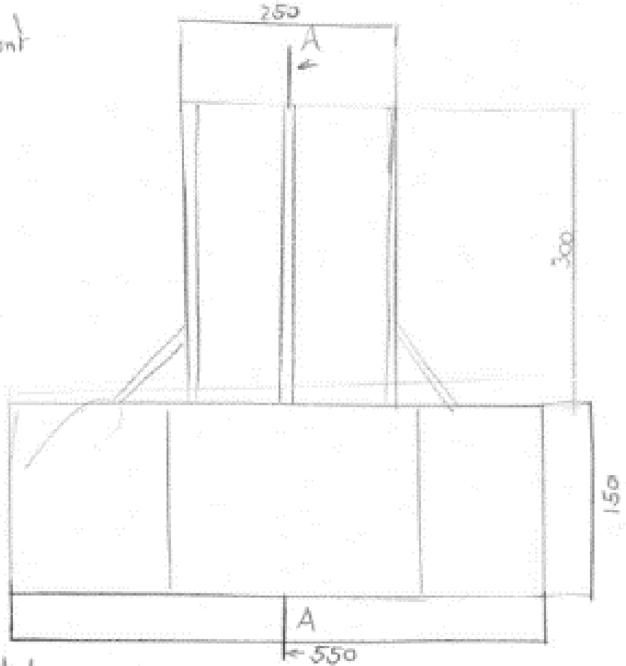
| | | | | |
|---|---|---|---|---|
| - Should be water resistant | | | | |
| **Not noisy (<40 dB)** | 3 | 3 | 3 | X1 |
| **Safe**<br>- It should be a closed design, so that nothing can get stuck in the device<br>- No sharp edges or points, so it doesn't cut the user | 3 | 3 | 3 | X2 |
| **Carefully place plates on conveyor**<br>- Plate should not break<br>- Plates should be placed with a max (height) distance of 3 cm of the conveyer<br>- Plates should be dispensed every 40 centimetres | 3 | 3 | 2 | X3 |
| **Machine should fit within given dimensions max. (l x w x h) 600 x 600 x 750 mm** | 3 | 3 | 3 | X3 |
| Total | 56/57 | 55/57 | 45/57 | |

- D

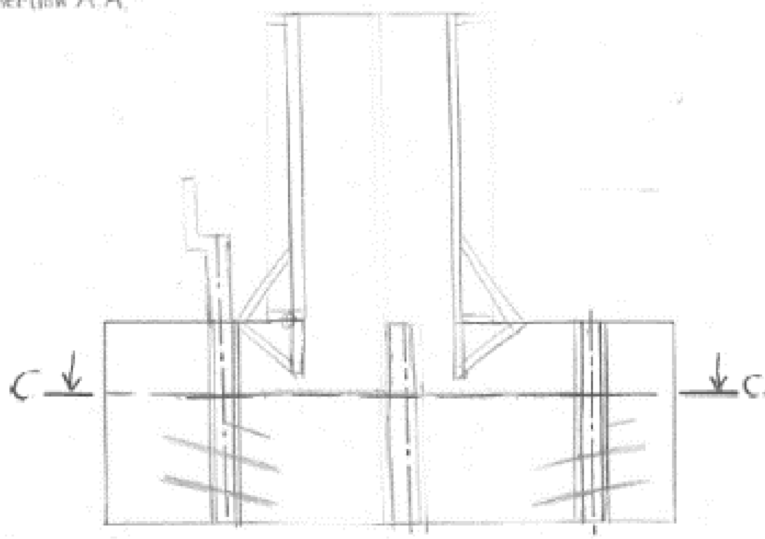
Top



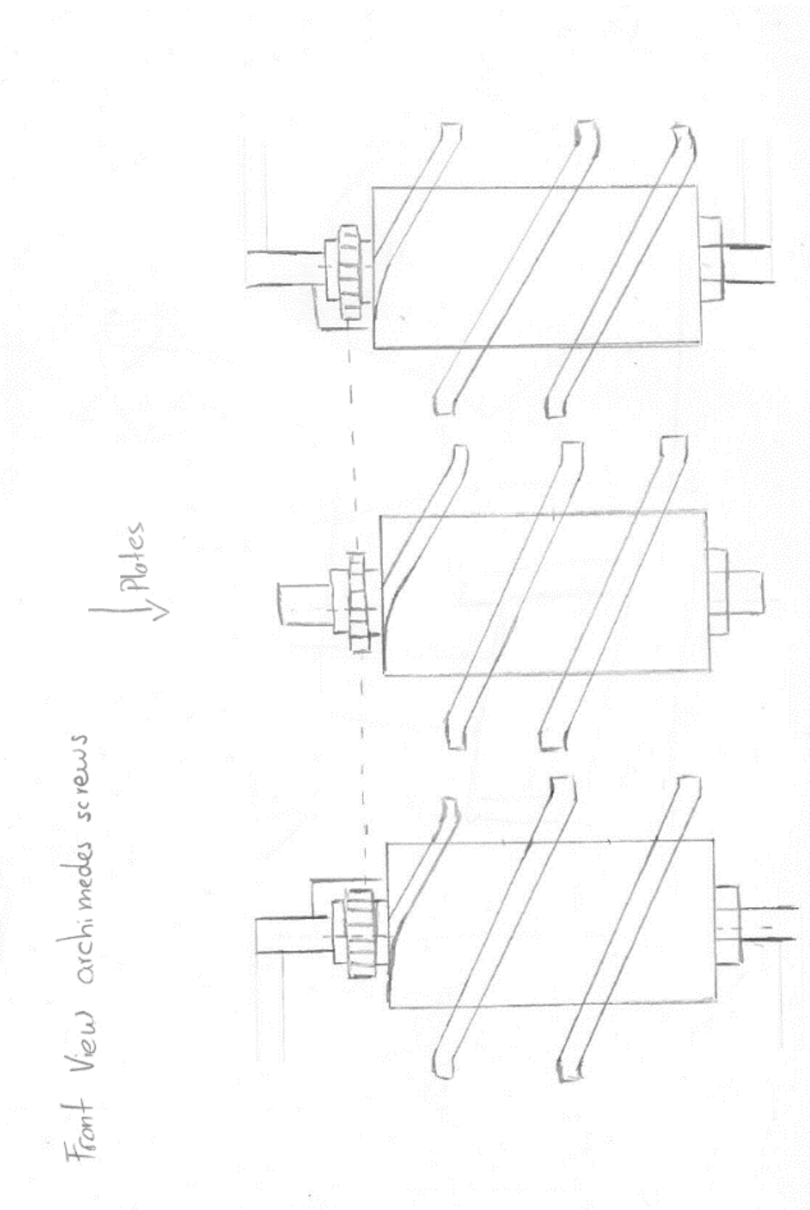
Front




section A.A.



- E



- F

## Evaluation Report

***Group 12 to 24 - written by Sven Terhorst & Bas van der Boom***

First of all, we would like to tell you that the presentation in general was very good. You guys did a very good job! The slideshow you used was a good addition to the presentation and was a good manner to clarify the things that you were saying. We admire the attention to details such as clothing, PowerPoint and use of words. Besides the nerves, the speed of some individuals were typically slow whereas others were too fast to follow. Noticeable was that a lot of the time, their backs were towards the client(s).

During the presentation, you presented the required parts; analysis, morphological diagram, structural sketches etcetera, but we did not however, got the feeling that it was all related to each other. Thus, maybe you can refer more often to analysis for example, the part you already described and making the story feel more complete.

Concerning the concept itself:
(Was later mentioned by the client itself:) The slope of the compartment where the plates are meant to be stored, is unnecessarily and makes the concept more difficult to produce. The drive chain-will give an uncontrollable force that might cause for more maintenance in the long terms.

An option would be to use simple-to-produce shapes. The wasted space is not taken into consideration when grading the assignment, the idea of such a concept is always good to thing about, but not to actually produce in this module. Furthermore, the use of pulleys or an external drive-chain that will hold the three screws in place will terminate the critical forces on the screws.

The idea of using screws to lower the plates down from the storing-compartment to the conveyor-belt uses critical contact-points with the plates that may cause wear on the rims of the plates, a solution for this would to maybe use some softer material when parts come into contact with the plates.

| ***Overall score of presentees*** | ***Vincent*** | ***Aziz*** | ***Tsailung*** | ***Ajitesh Malli*** |
|---|---|---|---|---|
| ***Use of voice*** | *4* | *4* | *3* | *5* |
| ***Use of body-language*** | *3* | *3* | *3* | *4* |
| ***Use of interaction towards the client*** | *4* | *3* | *4* | *3* |
| ***Use of visual and audio support*** | *4* | *3* | *3* | *4* |

## - G

**Plate Dispenser**

1. Frame
    a) Top Plate
    b) Bottom Plate
    c) Side Walls (x2)
    d) Back Wall
    e) Door
2. Power Transmission
    a) Hand wheel
        i. Rod
    b) Gears(x2)
    c) Chain
    d) Sprockets (x3)
    e) Rods (x3)
3. Dispensing Mechanism
    a) Archimedes Screws(x3)
        i. Rods(x3)
        ii. Sprockets (3)
4. Plate Supporting
    a) Rods (4)
5. Fixation for adjustable rod
6. Sleeve bearings(x2)
7. Adjustment rings(x7)
8. Interface

- H

***Gear 1***

| Dim.ID | According to drawing | Measured | Measuring tool used | Conclusion |
|---|---|---|---|---|
| Thickness | 3mm | | | |
| Central hole diameter | 12 +0.05 | | | |
| Circumference diameter without teeth | R20.6 | | | |
| Circumference diameter with teeth | 24 | | | |

***Gear 2***

| Dim.ID | According to drawing | Measured | Measuring tool used | Conclusion |
|---|---|---|---|---|
| Thickness | 3 | | | |
| Central hole diameter | 16 +0.05 | | | |
| Circumference diameter without teeth | R41.6 | | | |
| Circumference diameter with teeth | R45.5 | | | |

***Rod with sprockets***

| Serial No. | Dim.ID | According to drawing | Measured | Measuring tool used | Conclusion |
|---|---|---|---|---|---|
| 1 | Length | 95mm | | | |
| 1 | Thread hole | M4 | | | |
| 1 | Distance hole to side | 9mm | | | |
| 1 | Diameter | 15mm | | | |

***Rod between Gear and Handel***

| Dim.ID | According to drawing | Measured | Measuring tool used | Conclusion |
|---|---|---|---|---|
| Diameter | 12mm | | | |
| Length | 80 | | | |

***Screw Plate***

| Serial No. | Dim.ID | According to drawing | Measured | Measuring tool used | Conclusion |
|---|---|---|---|---|---|
| 1 | Thickness | 1.50mm | | | |
| 1 | Radius | 65mm | | | |
| 1 | Inner hole radius | 8.29mm | | | |
| 1 | Distance inner hole outer diameter | 56.72mm | | | |
| 1 | Opening separation | 0.50mm | | | |

- |

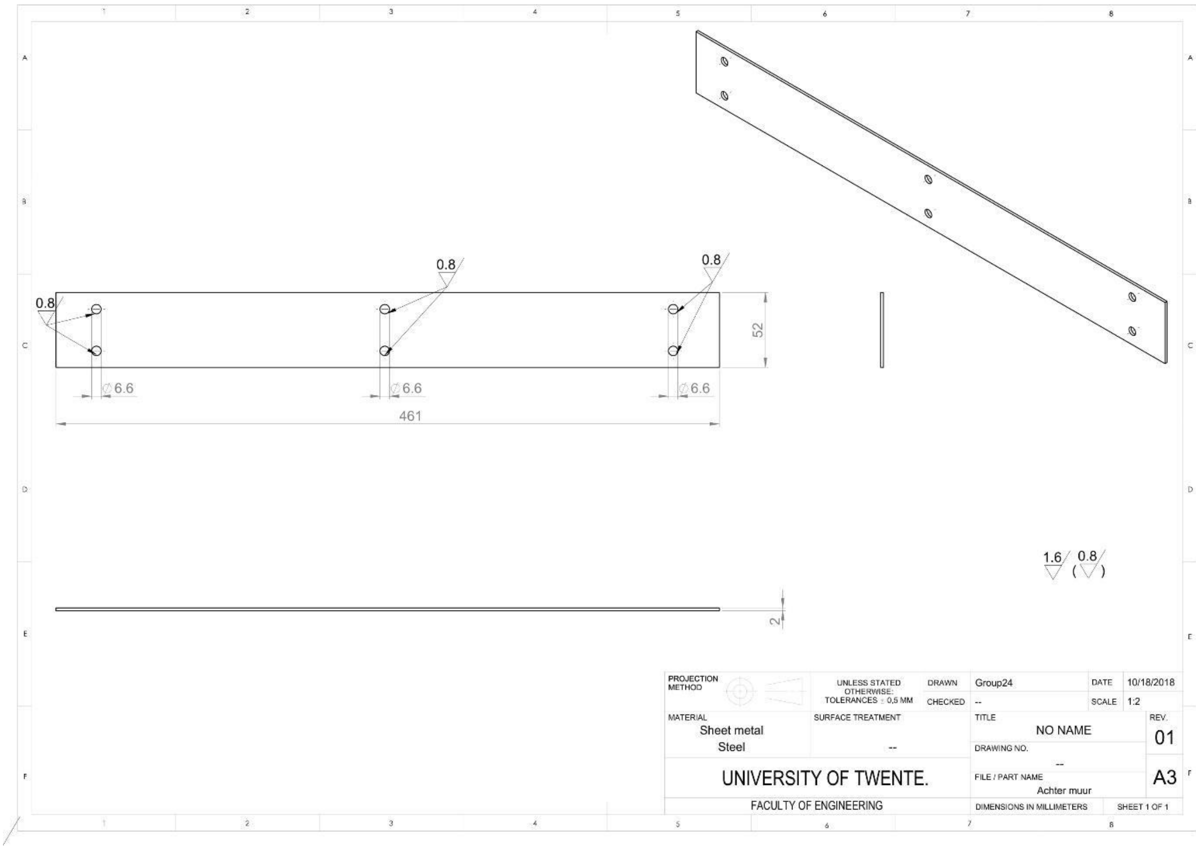
| Part name: Rod for Handwheel | | Date: 26/10/2018 | Sheet number:1 |
|---|---|---|---|
| Amount: 6 | Material: Steel | | |
| Starting dimensions material: ⦰15mm X 120mm | | | |
| **Operation** | **Tool**<br>fixtures, tools and other aids | **Settings**<br>speed (V), number of revolutions (N), feed (f), depth of cut ($t_0$) etc. | **Remarks** |
| Chamfer the edges | Chamfering tool | N = 800 rpm | Both sides of the rod |
| Make centre hole | centre drill | N=1500 rpm | Only on the flat face of one end of |
| Drilling a hole Ø 6mm | Drill Ø 6mm and cutting fluid | N=800 rpm | |
| Tap M6 hole | Tapping chuck with M6 tap and cutting fluid | N=50 rpm | |
| Drill keyseat Width: 4mm Length: 20mm | Drill Ø 4mm and cutting fluid | N=800rpm | Move the mill in the x axis for 20mm |
| Saw 4mm*4mm square rod to 20mm for key | Sawing machine | | |
| Shape the key | Sanding machine | | Shape till the key sits perfectly into the keyseat |

| Part name: Collars | | Date: 26/10/2018 | Sheet number:2 |
|---|---|---|---|
| Amount: 7 | Material: Steel | | |
| Starting dimensions material:20mm Diameter, 400mm length. | | | |
| Machining sequence: Lathe, Milling and Tapping | | | |
| **Operation** | **Tool**<br>fixtures, tools and other aids | **Settings**<br>speed (V), number of revolutions (N), feed (f), depth of cut ($t_0$) etc. | **Remarks** |
| ***Mount to lathe or turning machine*** | | | |
| Drilling a centre hole | Centre drill | N= 1500 rpm | |

| | | | |
|---|---|---|---|
| Drilling a hole Ø 15.2mm | Drill Ø 15.2mm and cutting fluid | N= 800 rpm | The depth is not necessarily specified because more than one rings would be cut out so a little extra depth is fine |
| Cutting a ring Length: 6mm | Cutting tool | N= rpm | Cut as many rings possible with the depth of hole drilled. If needed drill the hole again and cut the rings |
| ***Mount to milling machine*** | | | |
| Align the ring with the side of the milling machine clamp | | | This way all rings will have the drilled hole in the same position |
| Make centre hole in the middle | Centre drill | N=1500 rpm | |
| Drill hole Ø 4 mm | Drill Ø4 mm and cutting fluid | N= 800 rpm | Drill only one hole on the ring. Do the same for all 7 rings. |
| Tap hole M4 | Tapping chuck with M4 tap and cutting fluid | | Tap the holes manually with hands |

| | | | |
|---|---|---|---|
| Part name: Support rod for plates | | Date: 26/11/2018 | Sheet number: 4 |
| Amount: 4 | Material: Steel | | |
| Starting dimensions material: ⦰16 X 250 | | | |
| **Operation** | **Tool**<br>fixtures, tools and other aids | **Settings**<br>speed (V), number of revolutions (N), feed (f), depth of cut ($t_0$) etc. | **Remarks** |
| Smooth the edges of the rods | Sanding tool | Use the sanding machine | Do this by hand till there are no more sharp edges |

- J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0.8
52
⌀6.6
⌀6.6
⌀6.6
461
1.6 0.8
2
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UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM
DRAWN Group24
DATE 10/18/2018
CHECKED --
SCALE 1:2
MATERIAL
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Steel
SURFACE TREATMENT
--
TITLE
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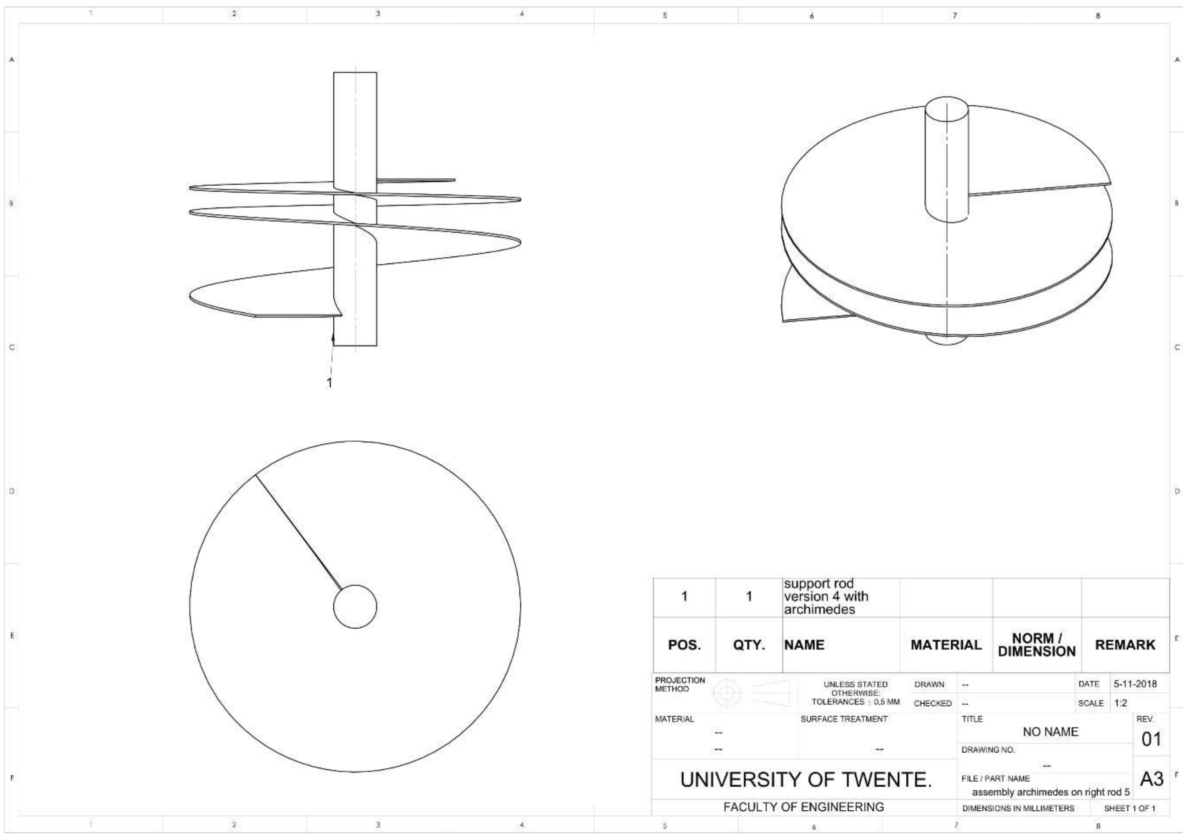
REV.
01
DRAWING NO.
--
UNIVERSITY OF TWENTE.
FILE / PART NAME
Achter muur
A3
FACULTY OF ENGINEERING
DIMENSIONS IN MILLIMETERS
SHEET 1 OF 1


1
1
1
support rod version 4 with archimedes
POS.
QTY.
NAME
MATERIAL
NORM / DIMENSION
REMARK
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DRAWN --
DATE 5-11-2018
CHECKED --
SCALE 1:2
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REV.
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UNIVERSITY OF TWENTE.
FILE / PART NAME
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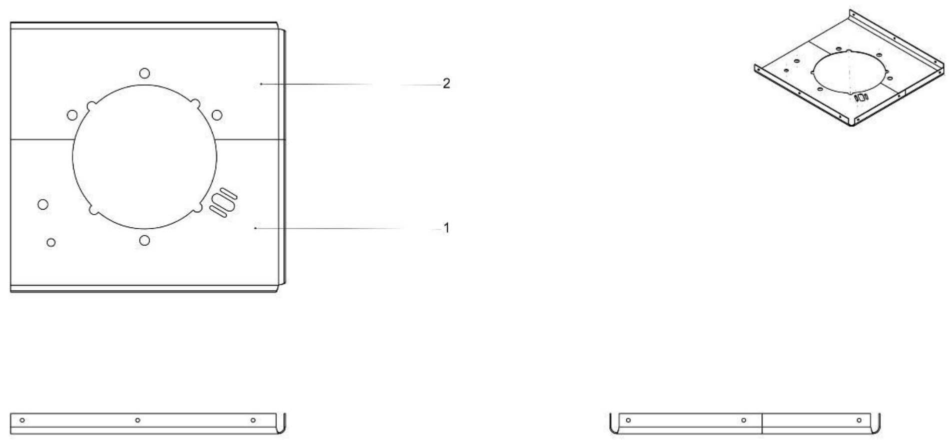
A3
FACULTY OF ENGINEERING
DIMENSIONS IN MILLIMETERS
SHEET 1 OF 1




| POS. | QTY. | NAME | MATERIAL | NORM / DIMENSION | REMARK |
|---|---|---|---|---|---|
| 2 | 1 | topplate part 2 | | | |
| 1 | 1 | topplate part 1 | | | |

| | | | | | |
|---|---|---|---|---|---|
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| | | DRAWING NO. -- | | | |
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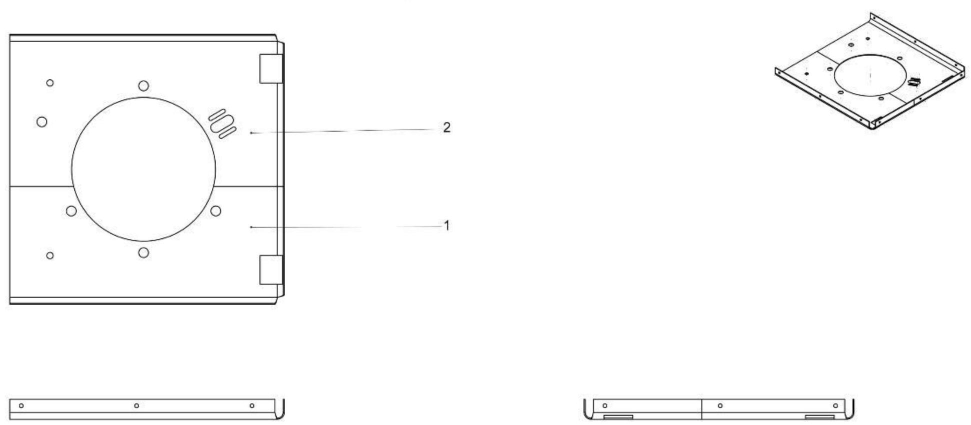
| FACULTY OF ENGINEERING | | DIMENSIONS IN MILLIMETERS | | SHEET 1 OF 1 | |




| POS. | QTY. | NAME | MATERIAL | NORM / DIMENSION | REMARK |
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| 1 | 1 | bottomplate part 1 | | | |

| | | | | | |
|---|---|---|---|---|---|
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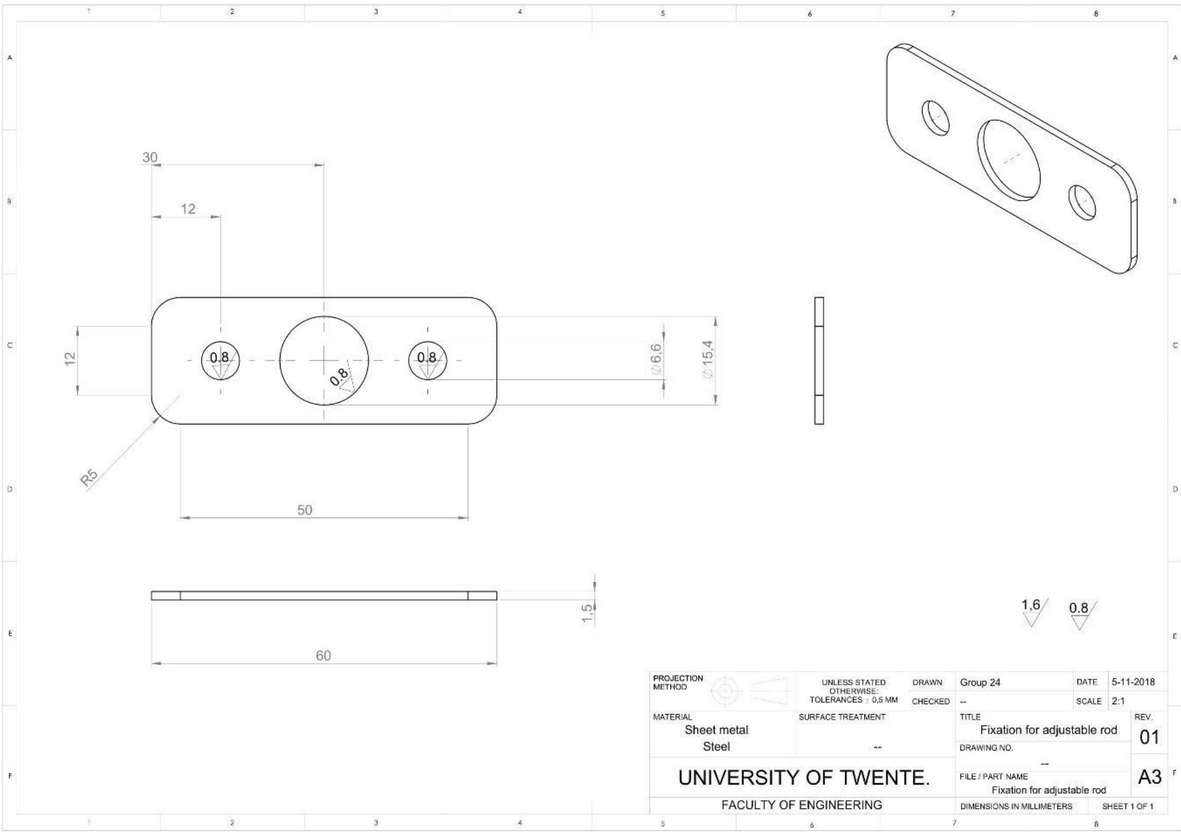
| FACULTY OF ENGINEERING | | DIMENSIONS IN MILLIMETERS | | SHEET 1 OF 1 | |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12
12
0.8
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0.8
∅6,6
∅15,4
R5
50
1,5
60
1,6
0.8
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DRAWN
Group 24
DATE
5-11-2018
CHECKED
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Fixation for adjustable rod
REV.
01
DRAWING NO.
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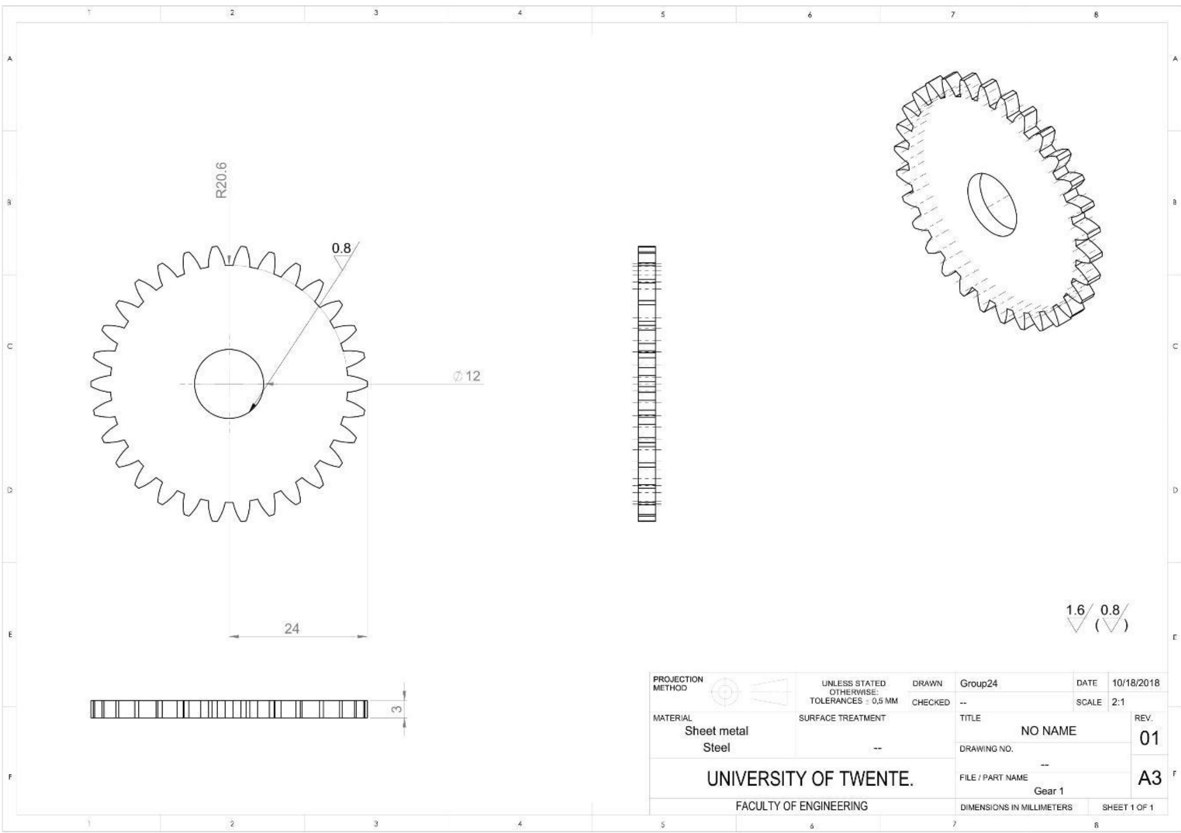
UNIVERSITY OF TWENTE.
FILE / PART NAME
Fixation for adjustable rod
A3
FACULTY OF ENGINEERING
DIMENSIONS IN MILLIMETERS
SHEET 1 OF 1


R20.6
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24
3
1.6
0.8
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DRAWN
Group24
DATE
10/18/2018
CHECKED
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SCALE
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Steel
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TITLE
NO NAME
REV.
01
DRAWING NO.
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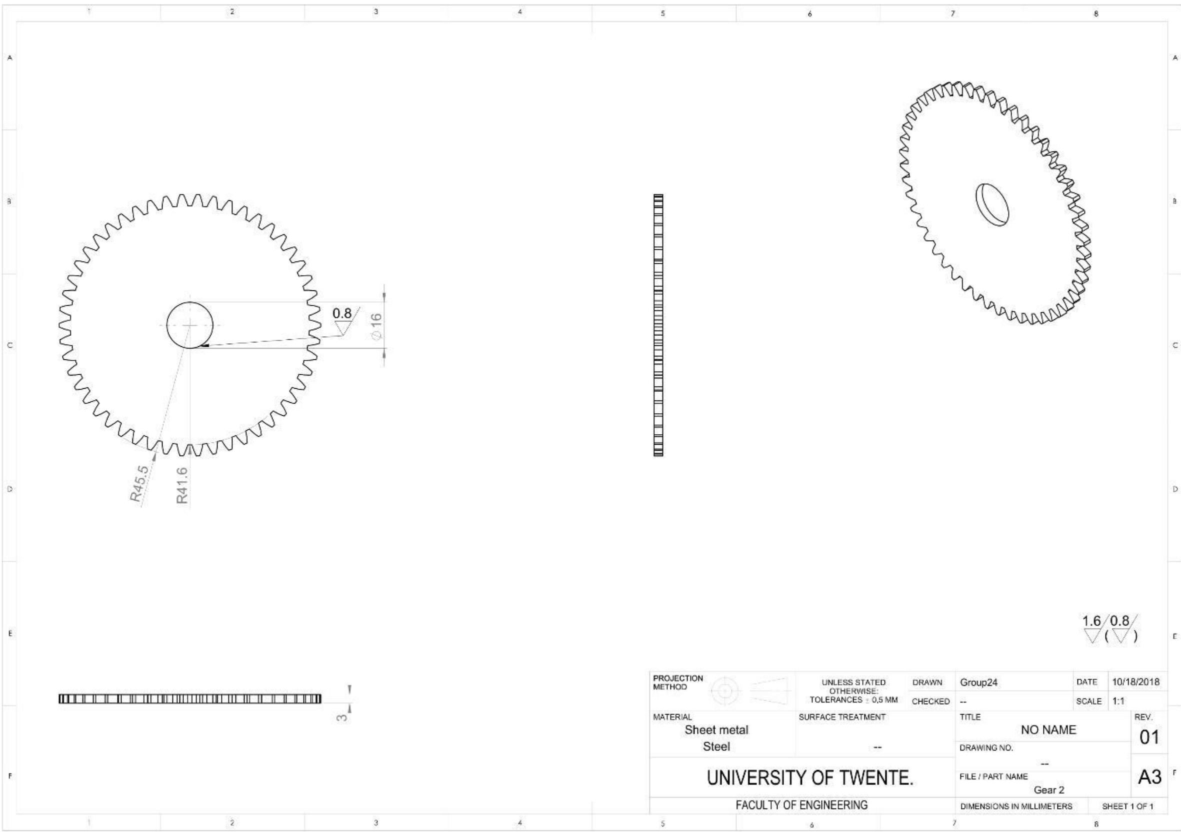
UNIVERSITY OF TWENTE.
FILE / PART NAME
Gear 1
A3
FACULTY OF ENGINEERING
DIMENSIONS IN MILLIMETERS
SHEET 1 OF 1



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R45.5
R41.6
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Group24
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10/18/2018
CHECKED
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REV.
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DRAWING NO.
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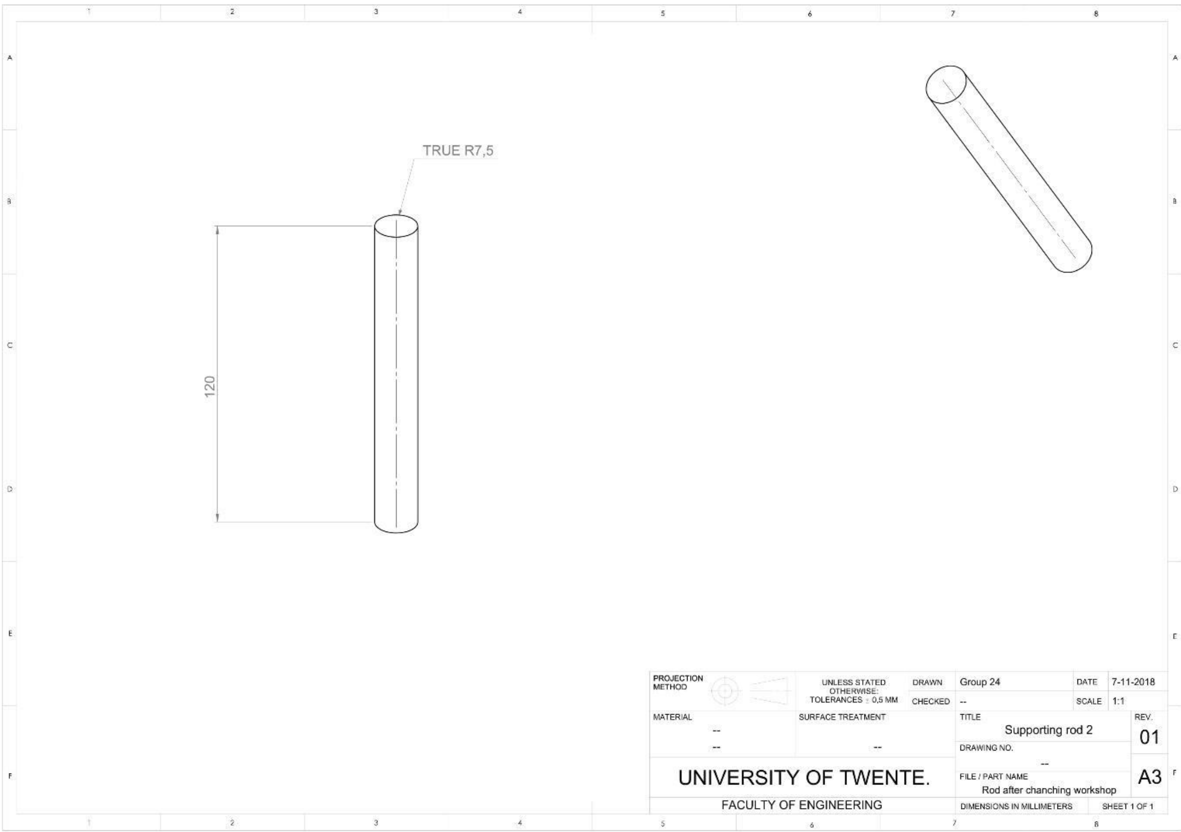
UNIVERSITY OF TWENTE.
FILE / PART NAME
Gear 2
A3
FACULTY OF ENGINEERING
DIMENSIONS IN MILLIMETERS
SHEET 1 OF 1


TRUE R7,5
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Group 24
DATE
7-11-2018
CHECKED
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MATERIAL
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SURFACE TREATMENT
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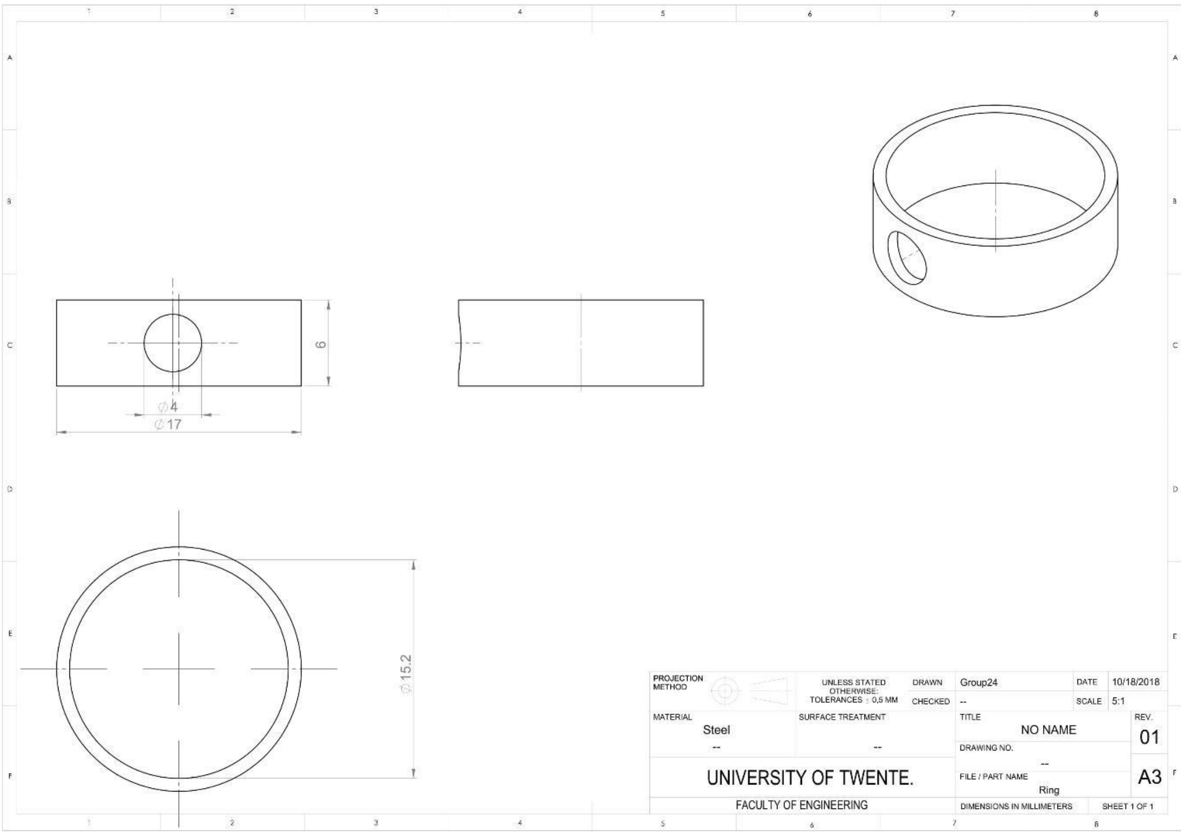
TITLE
Supporting rod 2
REV.
01
DRAWING NO.
--
UNIVERSITY OF TWENTE.
FILE / PART NAME
Rod after chanching workshop
A3
FACULTY OF ENGINEERING
DIMENSIONS IN MILLIMETERS
SHEET 1 OF 1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⌀4
⌀17
⌀15,2
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10/18/2018
CHECKED
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REV.
01
DRAWING NO.
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FILE / PART NAME
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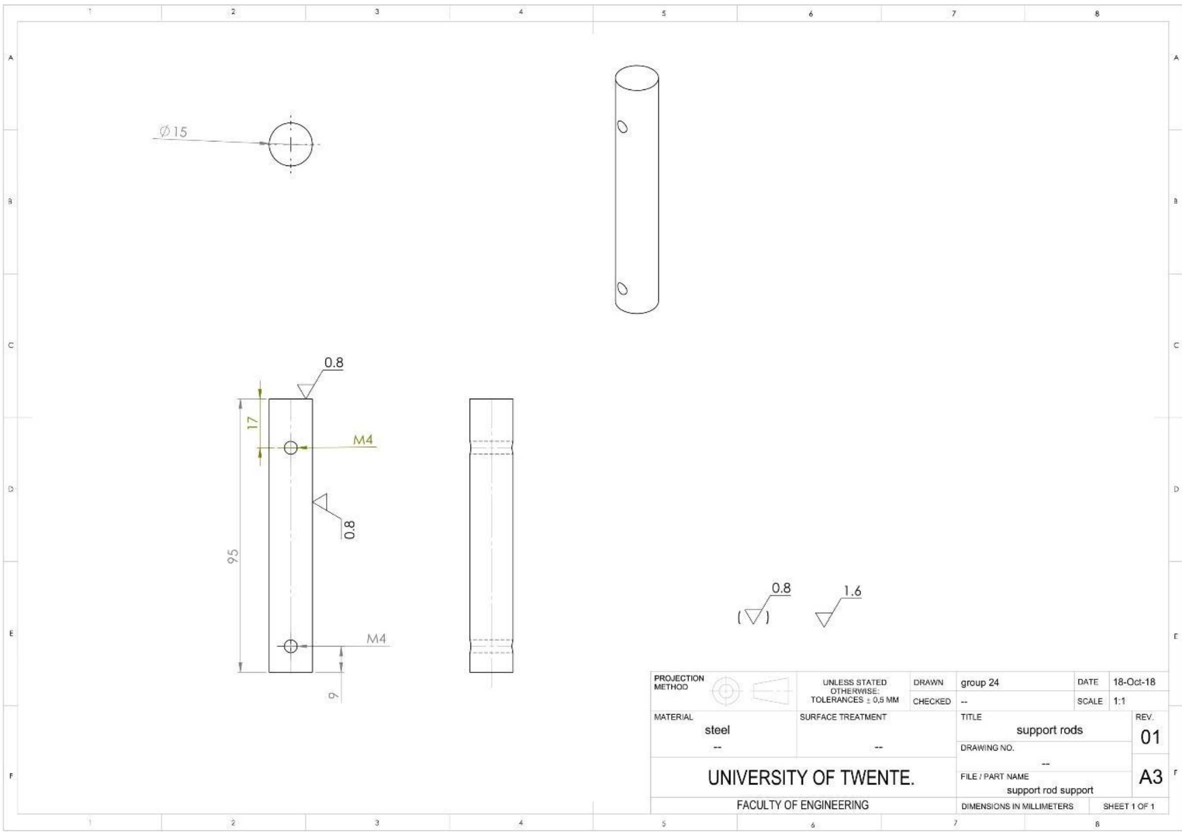
A3
FACULTY OF ENGINEERING
DIMENSIONS IN MILLIMETERS
SHEET 1 OF 1



Ø15
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M4
95
9
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DRAWN
group 24
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18-Oct-18
CHECKED
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support rods
REV.
01
DRAWING NO.
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FILE / PART NAME
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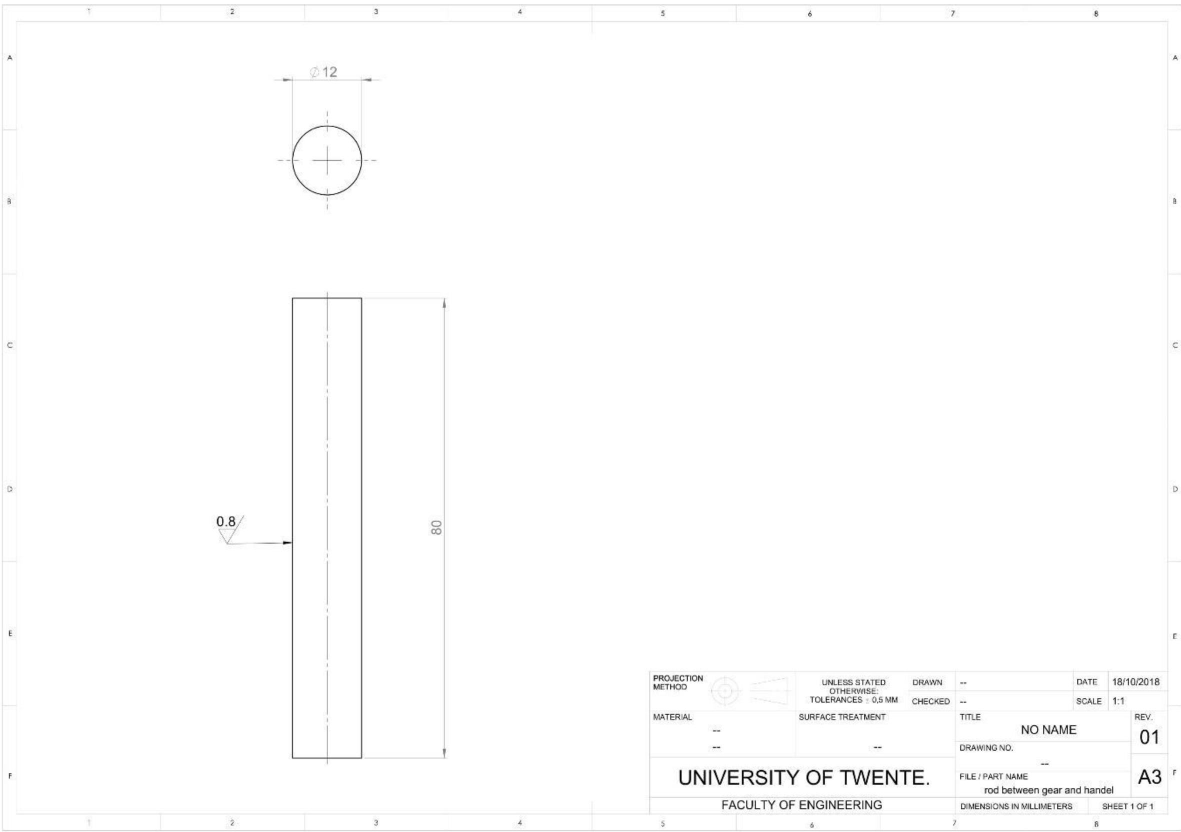
A3
FACULTY OF ENGINEERING
DIMENSIONS IN MILLIMETERS
SHEET 1 OF 1

Ø12
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PROJECTION METHOD
UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM
DRAWN
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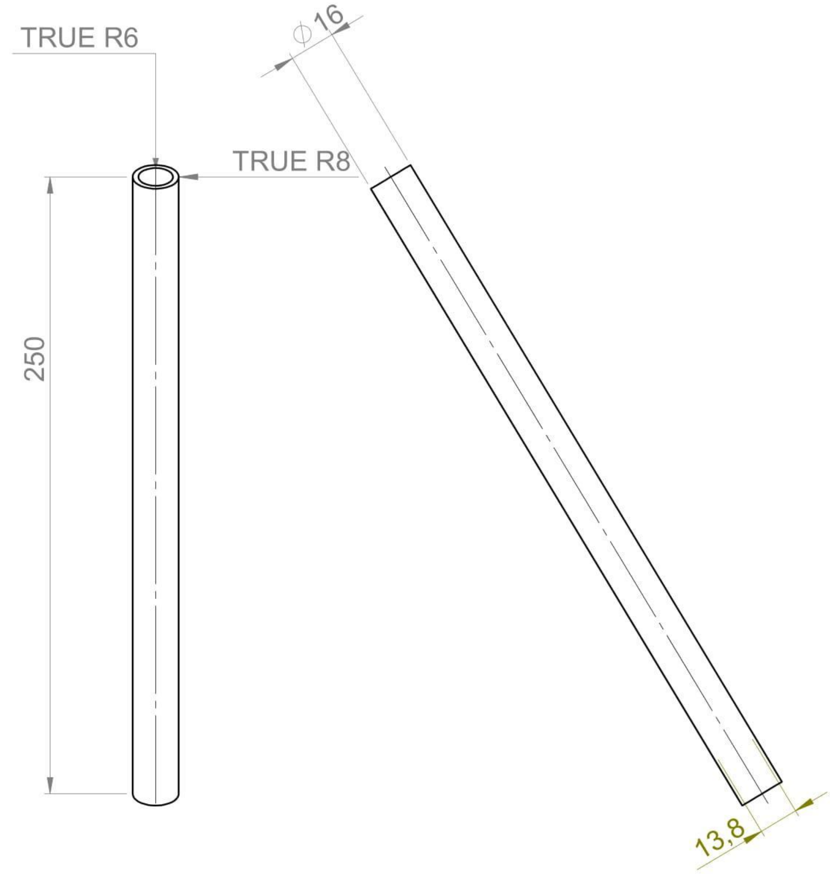
DATE
18/10/2018
CHECKED
--
SCALE
1:1
MATERIAL
--
--
SURFACE TREATMENT
--
TITLE
NO NAME
REV.
01
DRAWING NO.
--
UNIVERSITY OF TWENTE.
FILE / PART NAME
rod between gear and handel
A3
FACULTY OF ENGINEERING
DIMENSIONS IN MILLIMETERS
SHEET 1 OF 1




| | | | | | |
|---|---|---|---|---|---|
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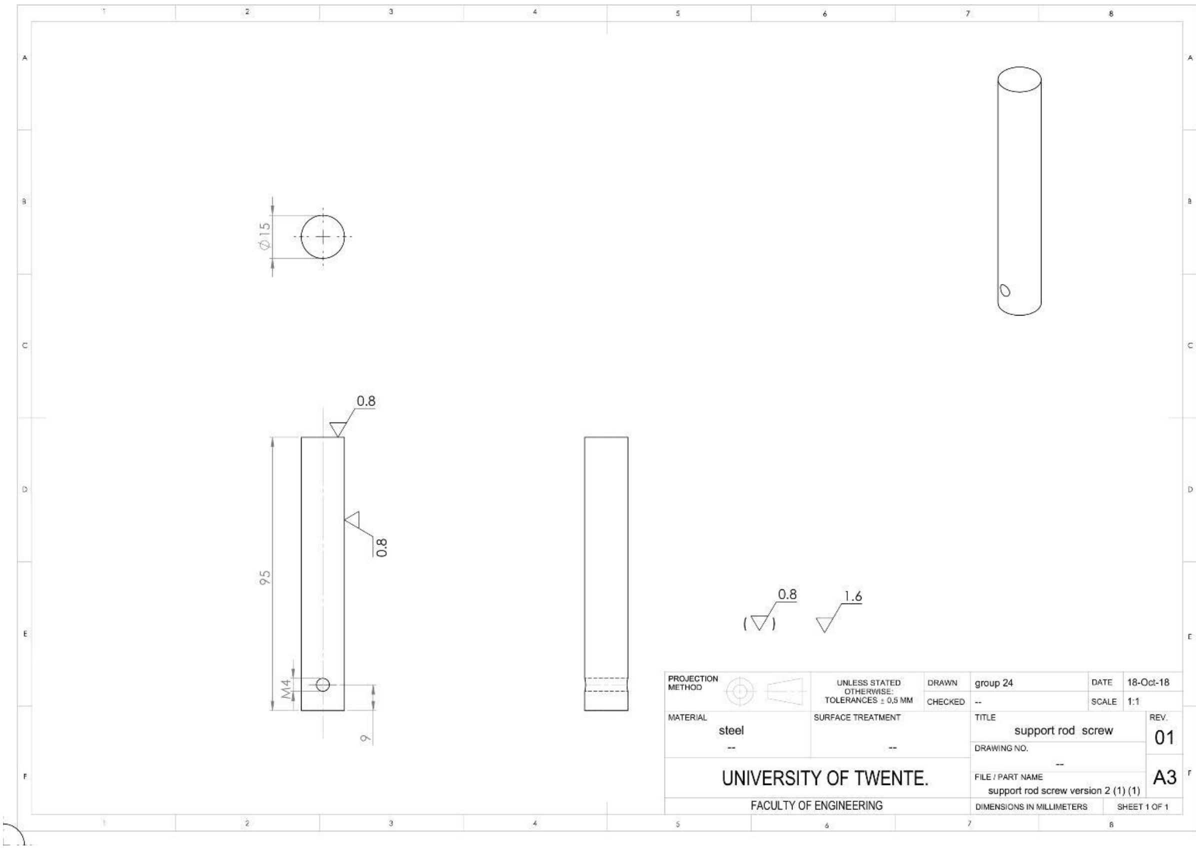
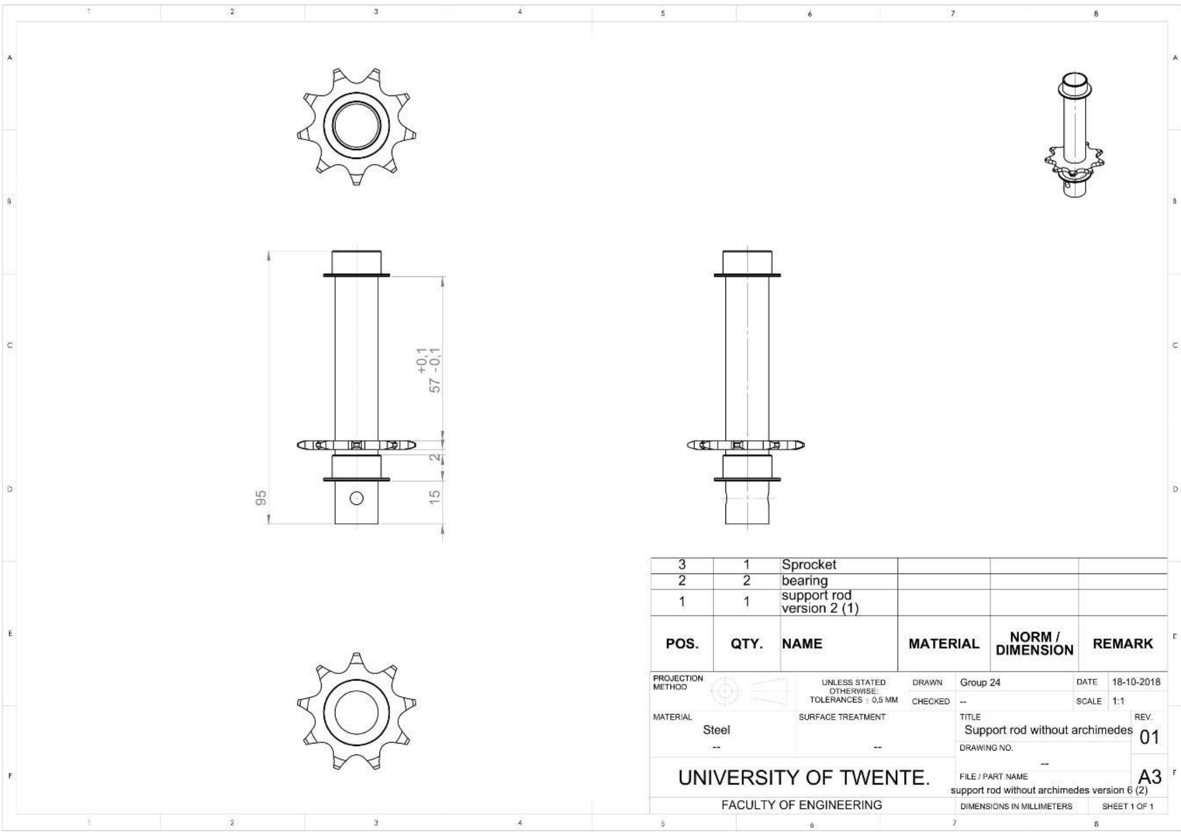
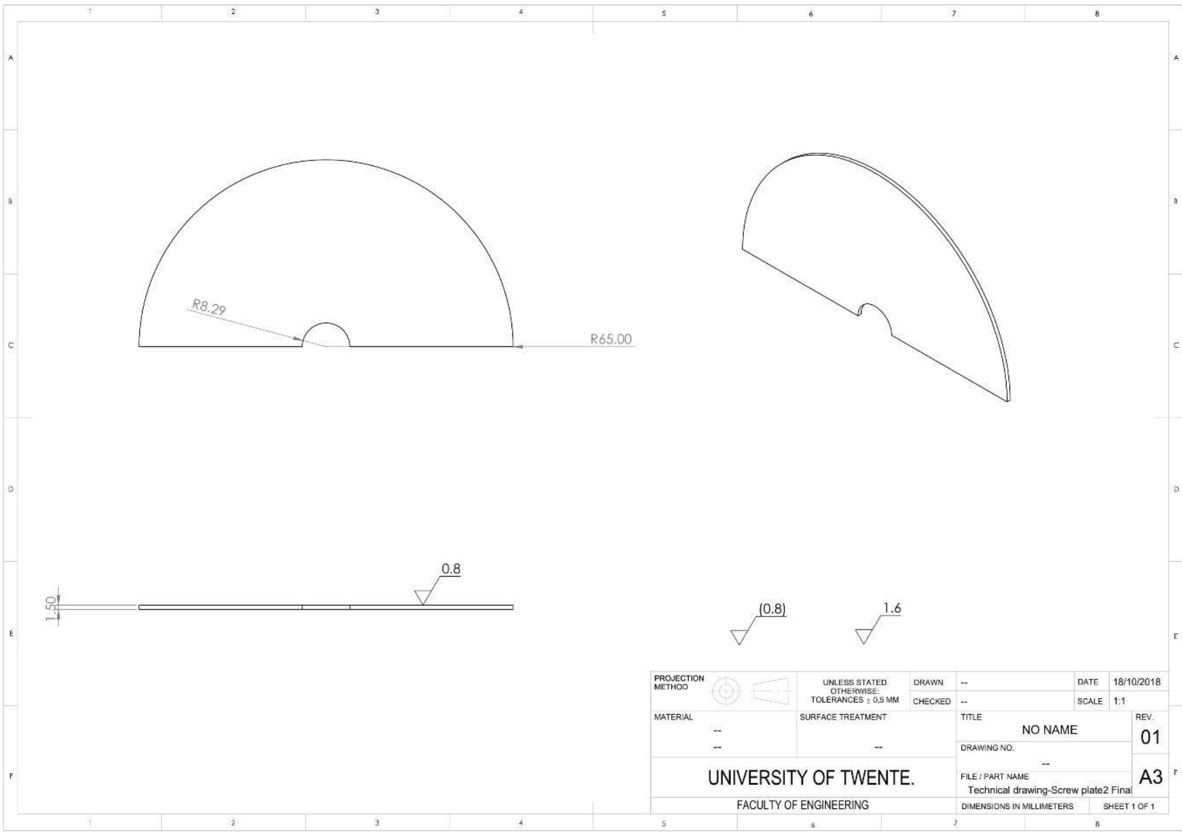
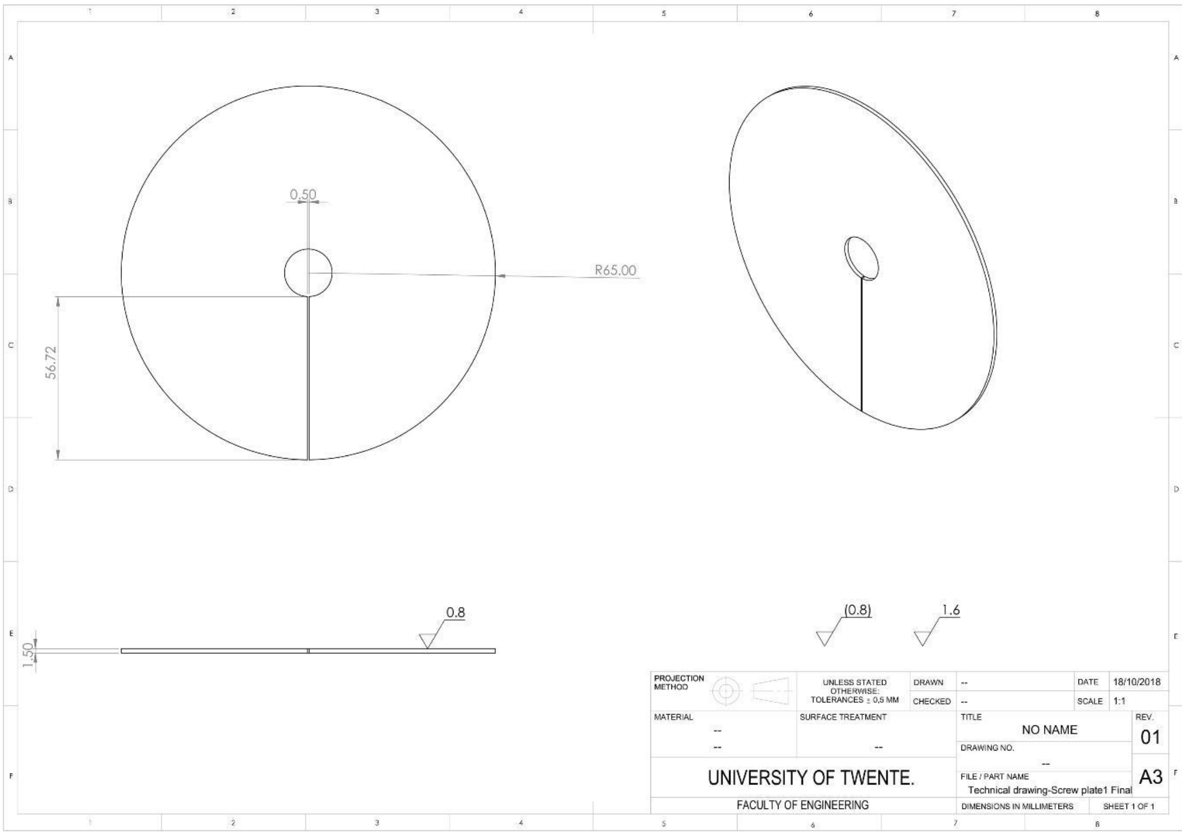
| | | CHECKED | -- | SCALE | 1:2 |
| MATERIAL Steel -- | SURFACE TREATMENT 1.6 | TITLE Support plate rod screw | | REV. 01 | |
| UNIVERSITY OF TWENTE. | | DRAWING NO. 1/1 | | A4 | |
| | | FILE / PART NAME support plate rod screw (2) | | | |
| FACULTY OF ENGINEERING | | DIMENSIONS IN MILLIMETERS | | SHEET 1 OF 1 | |


Ø15
0.8
0.8
95
M4
9
0.8
1.6
PROJECTION METHOD
UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM
DRAWN group 24
DATE 18-Oct-18
CHECKED --
SCALE 1:1
MATERIAL steel
SURFACE TREATMENT --
TITLE support rod screw
REV. 01
DRAWING NO. --
UNIVERSITY OF TWENTE.
FILE / PART NAME support rod screw version 2 (1) (1)
A3
FACULTY OF ENGINEERING
DIMENSIONS IN MILLIMETERS
SHEET 1 OF 1

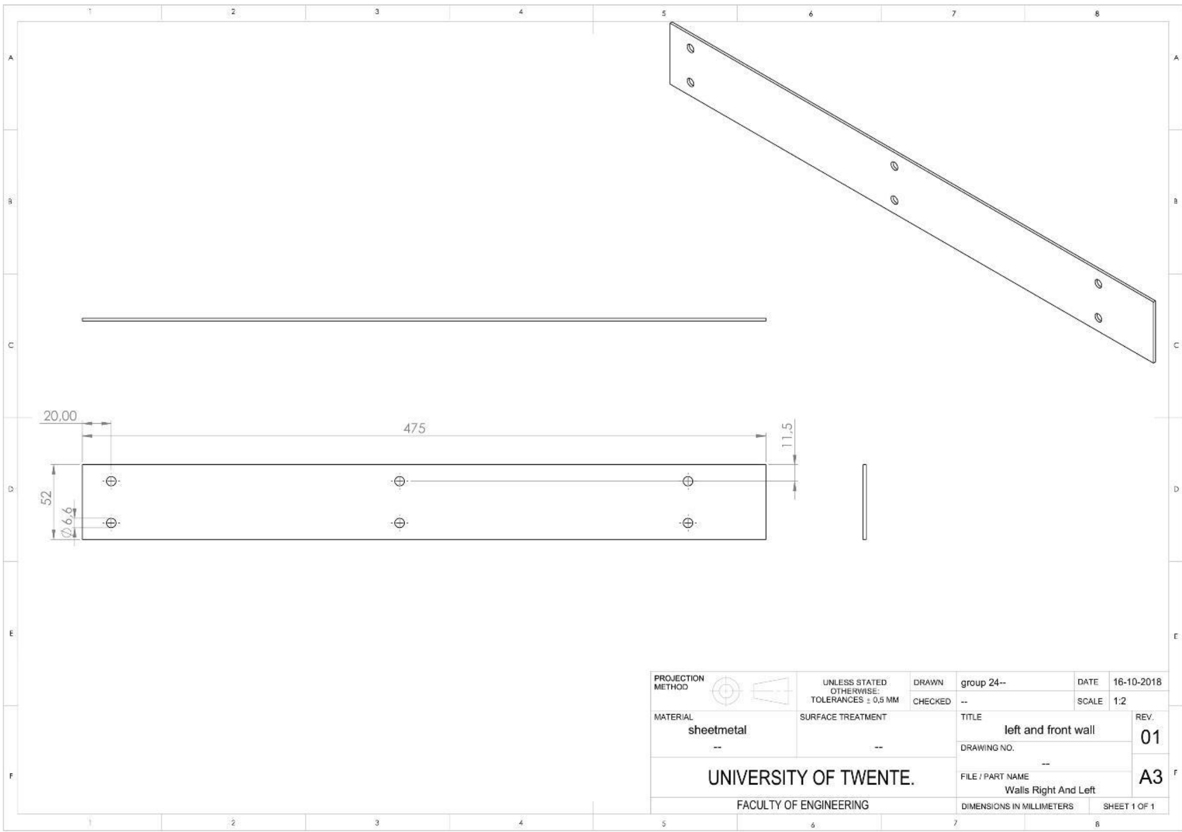

+0,1
57 -0,1
2
15
95
3 1 Sprocket
2 2 bearing
1 1 support rod version 2 (1)
POS. QTY. NAME MATERIAL NORM / DIMENSION REMARK
PROJECTION METHOD
UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM
DRAWN Group 24
DATE 18-10-2018
CHECKED --
SCALE 1:1
MATERIAL Steel
SURFACE TREATMENT --
TITLE Support rod without archimedes
REV. 01
DRAWING NO. --
UNIVERSITY OF TWENTE.
FILE / PART NAME support rod without archimedes version 6 (2)
A3
FACULTY OF ENGINEERING
DIMENSIONS IN MILLIMETERS
SHEET 1 OF 1



R8.29
R65.00
1.50
0.8
(0.8)
1.6
PROJECTION METHOD
UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM
DRAWN --
CHECKED --
DATE 18/10/2018
SCALE 1:1
MATERIAL --
SURFACE TREATMENT --
TITLE NO NAME
REV. 01
DRAWING NO. --
UNIVERSITY OF TWENTE.
FILE / PART NAME Technical drawing-Screw plate2 Final
A3
FACULTY OF ENGINEERING
DIMENSIONS IN MILLIMETERS
SHEET 1 OF 1

0.50
R65.00
56.72
1.50
0.8
(0.8)
1.6
PROJECTION METHOD
UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM
DRAWN --
CHECKED --
DATE 18/10/2018
SCALE 1:1
MATERIAL --
SURFACE TREATMENT --
TITLE NO NAME
REV. 01
DRAWING NO. --
UNIVERSITY OF TWENTE.
FILE / PART NAME Technical drawing-Screw plate1 Final
A3
FACULTY OF ENGINEERING
DIMENSIONS IN MILLIMETERS
SHEET 1 OF 1


20,00
475
11,5
52
⌀6,6
PROJECTION METHOD
UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM
DRAWN
group 24--
DATE
16-10-2018
CHECKED
--
SCALE
1:2
MATERIAL
sheetmetal
--
SURFACE TREATMENT
--
TITLE
left and front wall
REV.
01
DRAWING NO.
--
UNIVERSITY OF TWENTE.
FILE / PART NAME
Walls Right And Left
A3
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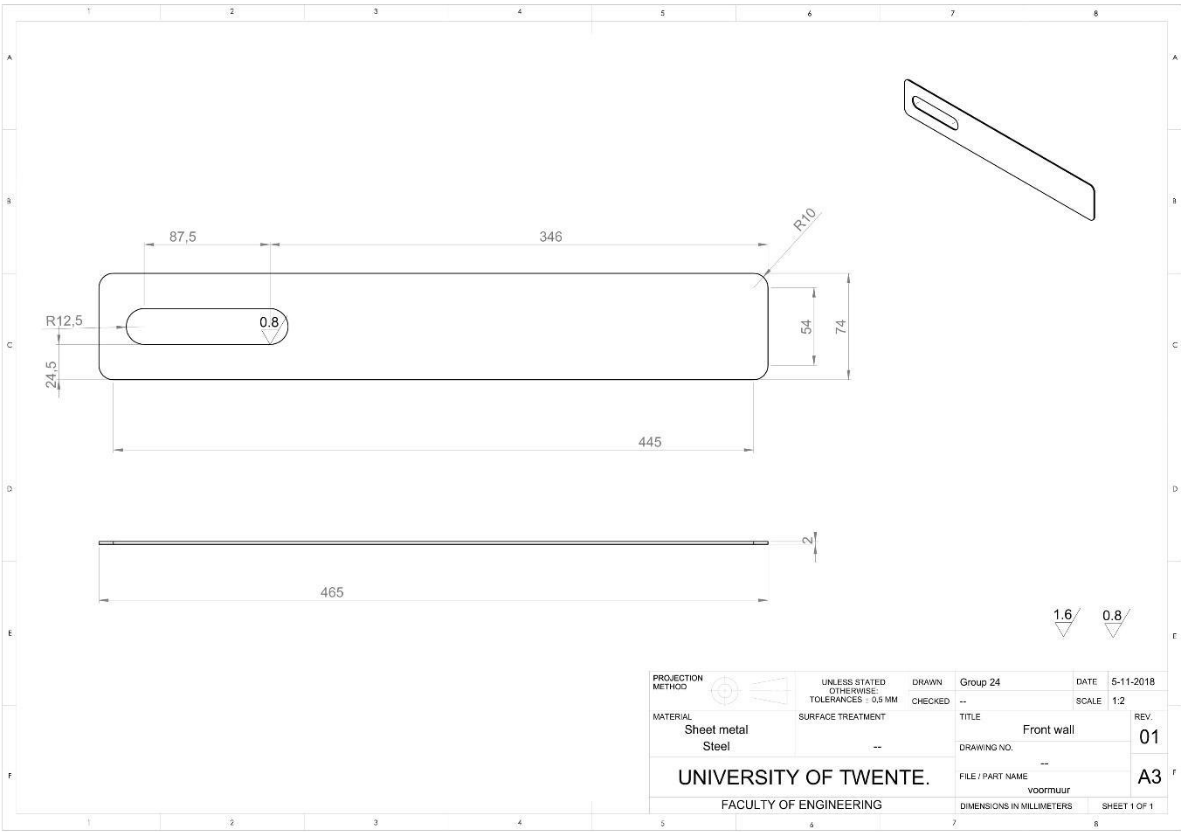
DIMENSIONS IN MILLIMETERS
SHEET 1 OF 1


87,5
346
R10
R12,5
0.8
54
74
24,5
445
2
465
1.6
0.8
PROJECTION METHOD
UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM
DRAWN
Group 24
DATE
5-11-2018
CHECKED
--
SCALE
1:2
MATERIAL
Sheet metal
Steel
SURFACE TREATMENT
--
TITLE
Front wall
REV.
01
DRAWING NO.
--
UNIVERSITY OF TWENTE.
FILE / PART NAME
voormuur
A3
FACULTY OF ENGINEERING
DIMENSIONS IN MILLIMETERS
SHEET 1 OF 1

- K
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| Part name: Rod for Handwheel | | Date:……………. | Sheet number:….. |
|---|---|---|---|
| Amount: 6 | Material:……………………………… | | |
| Starting dimensions material: ⦰15mm X 120mm | | | |
| **Operation** | **Tool**<br>fixtures, tools and other aids | **Settings**<br>speed (V), number of revolutions (N), feed (f), depth of cut ($t_0$) etc. | **Remarks** |
| Chamfer the edges | Chamfering tool | N = 768 rpm | Both sides of the rod |
| Make center hole | center drill | N=1488 rpm | Only on the flat face of one end of |
| Drilling a hole Ø 6.mm | Drill Ø 6mm and cutting fluid | N=758 rpm | |
| Tap M6 hole | Tapping chuck with M6 tap and cutting fluid | N=... rpm | Ask for rpm in the workshop |

| Part name: Support rod for plates | | Date:................ | Sheet number:...... |
|---|---|---|---|
| Amount: 4 | Material:.............................. | | |
| Starting dimensions material: ⦰16 X 250 | | | |
| **Operation** | **Tool**<br>fixtures, tools and other aids | **Settings**<br>speed (V), number of revolutions (N), feed (f), depth of cut ($t_0$) etc. | **Remarks** |
| Smooth the edges of the rods | Sanding tool | Use the sanding machine | Do this by hand till there are no more sharp edges |

| Part name: Support rod | | Date:……………. | Sheet number:….. |
|---|---|---|---|
| Amount: 6 | Material:………………………………… | | |
| Starting dimensions material: ⌀15mm X 120mm | | | |
| **Operation** | **Tool**<br>fixtures, tools and other aids | **Settings**<br>speed (V), number of revolutions (N), feed (f), depth of cut ($t_0$) etc. | **Remarks** |
| Smoothen the edges | Chamfering tool | N = 768 rpm | Both sides of the rod |
| Make a center hole | Centre drill<br>and cutting fluid | N = 1488 rpm | 9mm from the edge |
| Drill hole Ø 4 mm | Drill Ø4 mm and cutting fluid | N = 768 rpm | Before drilling add oil to the contact surface of the drill |
| Tap hole M4 | cutting fluid | | Done manually by hand |