11/7/2018

Design of a Mechanical Tool

Module 01 Mechanical Engineering

Mechanical Engineering Group 7
UNIVERSITY OF TWENTE

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1. Overview of the Process

This is the project report for the manufacturing of a plate dispenser, which is a part of module 1 of the Mechanical Engineering programme at the University of Twente. This plate dispenser is designed for the 'European Food Technology BV' [1]. In this report, a reflection on the project as a whole and the process of making the plate dispenser is shown.

1.1 The Analysis Phase

The first phase of the project was the analysis phase, which began in the first week of the academic year. During this phase, the group contract was made (Appendix A.1) and the problem was analysed, which resulted in a total of ten questions (Appendix A.2) to be answered. Each member of the group answered two questions, incorporating it with market research, after which the answers for each question were combined. Unfortunately, Ash left the group in week 1 for another university, leaving eight group members.

1.2 Conceptual Design

The second phase of the project included making structural sketches, a morphological diagram and a design sketch. These are all included in Appendices B.1 through B.3. In this phase, two members made the morphological diagram. The other six members of the group split up in teams of two people, each making a structural sketch. This means that the result was three structural sketches in total. The design sketch was a group effort, but it was eventually sketched by two members of the group.

1.3 Detailed Design

The third phase included making all required parts for the dispenser in SolidWorks and creating the full assembly out of these parts. Also, drawings for all the parts and assemblies were made during this phase. Lastly, a measurement plan was made to make sure the prototype would fulfil the requirements

[1] 'Project description: Design of a Mechanical Tool', T.G.M. Krone, August 28th 2018.

1.4 Manufacturing a Prototype

In the fourth phase or also known as the manufacturing phase, a prototype for the plate dispenser was created in the workshop, a test program for this prototype was created. The tests are based on situations that could take place in a kitchen and on our requirements from the analysis phase. In the workshops, the measurements plan was conducted and lastly, the implementation of the motor in the dispenser was designed.

1.5 Evaluation and Redesign

In the last phase of the project, the evaluation phase, the plate dispenser was subjected to a couple of tests. From the results faults, hazards and overall problems with the design were highlighted. In this phase, the safety in design and the faults in the prototype will be discussed and after the evaluation of the test program, a few parts were chosen for redesigning including use in series production. These parts were redesigned to cut costs and labour involved in the production process.

2. The Analysis Phase

During the analysis phase, the group contract and the ‘Analysis Phase Questions’ were made.

2.1 The group contract

During the analysis phase, the group contract was made and signed. This group contract was made to prevent any problems within the group from a working standpoint, as everyone should do their part and be present in all meetings where he is to be expected. This is why the ‘Bad Points’ system was created. In summary, you can earn bad points for coming too late to meetings, not finishing work in time etc. With three points obtained, said person will have to bring an apple pie to the next meeting.

2.2 Analysis Phase Questions

The ten questions for the analysis phase were divided over all nine group members, including Ash. Every group member got two questions to answer, except for one member, who got three questions to answer. This way, every question would have at least two people answering it. This was in case a member of the group wouldn't finish his work on time, but also get multiple viewpoints. At the beginning of the second week, Ash left the group, having made none of the questions. After this, eight group members remained. Eventually, the questions were combined resulting in the following requirements for the plate dispenser:

- The dispenser must not be heavier than 15 kilograms
- The dispenser needs to be able to store at least 6 plates at a time
- The maximum dimensions for the dispenser are 600x600x750 mm
- The dispenser should have a minimum lifetime of five years
- The dispenser must dispense a plate every 7.62 seconds

The full list of questions, including answers, can be found in Appendix A.2.

3. Conceptual Design

During the conceptual design phase, the structural sketches, the morphological diagram and the design sketch were made.

3.1 The Morphological Diagram

To make the three structural sketches, a morphological diagram was created to display all the different functions the plate dispenser needed to fulfil, and how different designs could accomplish them. To recap, these solutions were made for the following problems:

- The storage of the plates, which includes the ability for one person to store the plates easily without getting hurt. It also includes storing six plates at a time.
- The spacing apart of the plates. This was the most difficult problem to solve, as plates fall slightly in each other, making the space between each plate very small. Due to this stacking, it is difficult to make one plate go through the dispenser at a time, without breaking.

- The movement of the plates, which includes moving the plates from the dispenser to the conveyor belt below it.
- Ejecting the plates onto the conveyor belt. This means that the plates should be ejected from the plate dispenser without breaking or tearing.

In summary, two or three solutions were made for each problem in the plate dispenser. These solutions were combined together in a morphological diagram, found in Appendix B.1.

A Google survey was set up to allow group members to vote on the best design for each aspect of the morphological design. These were correlated by one group member.

3.2 Structural Sketches

3.2.1 Choice of design

From the morphological design, a total of three structural sketches (Appendix B.2) were drawn, each combining different solutions of the morphological design. The structural sketches were made in such a way that all the functions would work as cohesive as possible with each other, optimizing the efficiency of the plate dispenser.

3.2.2 Weighing Table

To help make a decision on what structural sketch to carry forward into the design phase a weighing table was created. This rated each aspect according to how important the group thought it was and then rated each sketch out of 5 for each aspect. Multiplying these two values together creates a table as seen in Appendix B.6.

3.2.3 Selecting Structural Sketch

Initially, the third structural design was chosen for the design sketch and modified again to make the plate dispenser more efficient. This structural sketch was chosen because it scored the best on the rating system. The problem with the first structural sketch was that the gears would probably grab onto multiple plates at once, which definitely should be avoided. The second structural sketch included a too complex system, with too many flaps and unreliability. For example, the probability of all plates crashing down was rather high. These reasons were incorporated into the weighing table as seen before and allowed us to come to the final conclusion of using structural sketch 3.

3.3 First Design Sketch

From the third structural sketch to the final design sketch, a few modifications had to be made to optimize the efficiency and reliability of the plate dispenser. The modifications made are the following:

- The holding area for the plates was placed on an angle of 45 degrees, rather than completely vertical. This lowered the fall height of the plates, increasing the chance of keeping all the plates intact. But also reduced the force of gravity acting on the plates down the holding area. An initial option was to place the holding area horizontal but increasing this to 45 degrees removed the friction force between the plates and the holding area frame. This increased efficiency and reduced damage to the plates over time. By placing the holding area 45 degrees, there was no need for a lowering system with a belt, this makes the design simpler and more reliable, as there are fewer moving parts.
- The flaps for separating the plates were replaced by gears, as those would be more reliable and stronger. Also, the flaps would need a spring system to return itself to starting position and apply a force to the next plate to be released, controlling time of release. This is not a problem with gears, however, because they can continuously spin and separate each plate one by one.
- An insert had to be made at the top left to prevent the plates from tipping over after leaving the gears and going to the slide, which leads to the conveyor belt.
- The spring moving the plates forward was replaced by a turning gear moving a tube outward using screw thread in the inside of the tube and the outside of a piston.

After this, the dimensions for the full plate dispenser were added, making it fully defined.

3.4 Revised Sketches

3.4.1 Revised Structural Sketch

After a very thorough reflection on first the design sketch that was drawn, a lot of black boxes, correlating to the lack of manufacturing ability. The first of these problems were the two gears at the bottom right couldn't be manufactured due to the diagonal design. This is due to the available means in the workshop. The piston with the screw thread on it couldn't be manufactured either as for smooth operation a trapezium thread would be required, this was not available and difficult to create. These parts were critical for the design to work; therefore, the current design was too difficult to work with. Eventually, no plausible solutions could be found for these rather big black boxes, resulting in the group going a step backwards in the design process.

The big concern with the first structural sketch was that the gears lowering the plates would probably catch multiple plates at ones, this is not ideal for the designs and prevents the operation of the design according to its product function. After some reflection, an additional structural sketch was made. This structural sketch included more consideration towards manufacturing technique. This revised structural sketch is shown in Appendix B.4. This sketch consisted of a locking system above lowering gear. This which would slide

between the first and second plate and hold all but the bottom plate. This design allows only one plate to be lowered at a time.

This new structural sketch was added to the weighing table. This table keeps all the same values for previous sketches and new ratings for the new design. This addition allows a comparison of the new design to previous structural sketches. (Appendix B.7)

3.4.2 Revised Design Sketch

From this new structural sketch, a new design sketch was drawn (Appendix B.5).
The plate dispenser, according to this design sketch, is built up as follows:

- There are two gears present on the main rod, this is the rod connected to the motor. These gears are both connected to other gears, one for transmitting power to the other side of the dispenser, and the other one for powering the first side of the locking system (part no. #600). The two lockers are in a V-shape to bring more stability to the plates resting on them and to prevent the plates from tipping over. The flaps for lowering the plates onto the conveyor belt are in the shape of an X so that the plates will have more surface area to rest on.

The operation of the plate dispenser works as follows:

- The plates will be put in with a separate insert (part no. #001) onto the two lockers, which will be hung up to the side of the dispenser. After this, the motor, driving all gears and chain wheels, can be turned on. The locker system will go from an ‘in’ to ‘out’-position, dropping all six plates on the bottom gears. After this, the locker system will go back in, grabbing onto the second plate and above. Because of the partial gear in the locker system, the lockers will then stay in the ‘in’-position for the rest of the cycle, after which the plates will be lowered onto the conveyor belt through the flaps.

4. Detailed Design

During the detailed design phase, all parts were completely thought out and made in SolidWorks. Also, drawings for all these parts, subassemblies and finally, assembly were made.

4.1 Design Choices

The complete plate dispenser is built up according to the assembly tree in Appendix D. The full set of drawings for the plate dispenser is available in Appendix F.

4.1.1 The Frame

The frame, part no. 100, of the plate dispenser consists of 11 square tubes with several holes in them, connected to each other by welding. The welds will make sure that the frame is strong enough for a long-time usage. Different pieces of sheet metal were added all around the dispenser; the reason for this is explained below.

One of the requirements for the design of the plate dispenser was safety. To ensure that the dispenser was safe to use by a regular employee, metal sheets were added on each side of the plate. A few rods are sticking out of these sheets, but not as far as to hinder the user's experience. The outside of the plate dispenser would look like a box, shown on the right of this page. A full-sized technical drawing of the plate dispenser is also available in Appendix F (Drawing #000). The hole on the top is for putting in the plates, with the help of the separately manufactured insert. The sheets are tightened to the frame tubing with bolts.

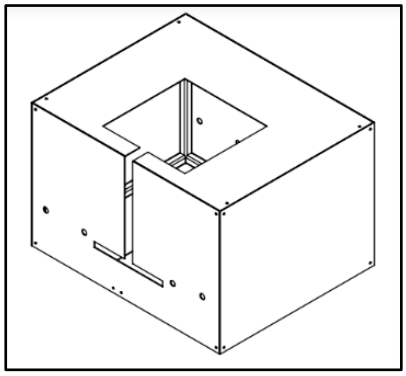


Figure 1: Box-shaped dispenser

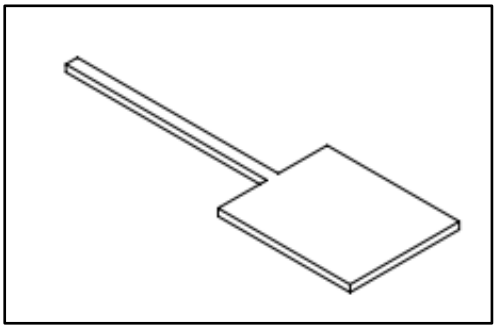


Figure 2: Separate insert for the plates

Another choice that was made to ensure the safety of the design, was the creation of a separate insert to lower the plates into the dispenser, instead of doing it by hand. This insert can be put in from the above, lowered to rest the plates on the lockers, and pulled out of the front. This insert is made out of plywood and is laser cut, making it light, but strong at the same time. The complete drawing of this insert can be found in Appendix F, Drawing #001.

The frame also contains a 'Puzzle Plate' insert (drawing #1201), which is there to support the rods that don't go all the way through in the assembly, and to the longer rods in the assembly.

4.1.2 The Rods

A complete drawing of the assembly is shown below:

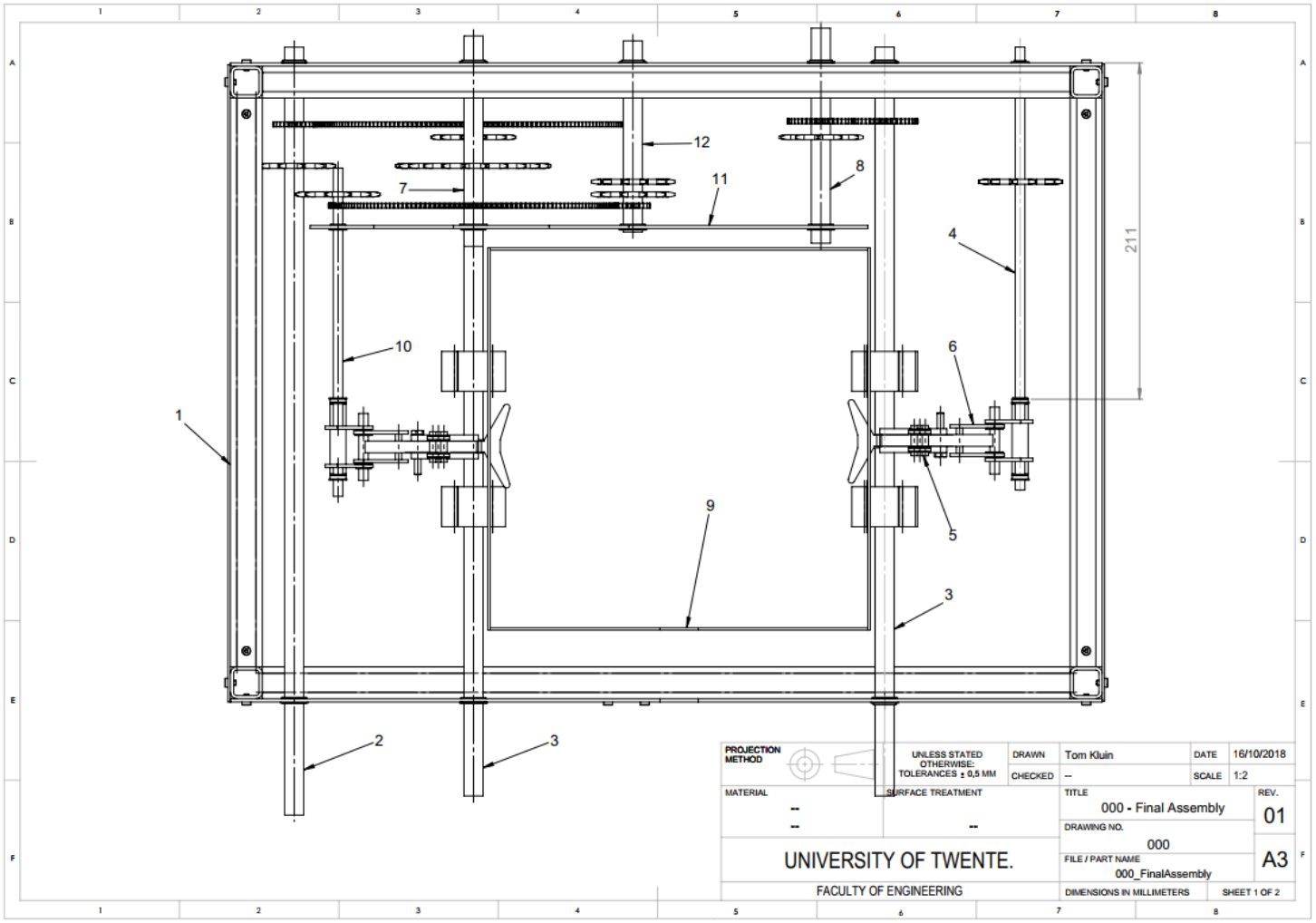


Figure 3: An inside drawing of the full assembly

The different rod assemblies include the following, where the numbers represent the same numbers as in the drawing above:

- The main rod, no. 2. This assembly consists of a rod through the whole length of the plate dispenser, a gear to drive the left flaps, and a chain wheel that drives the rod assembly with the partial gear on it (no. 7). The main rod is also connected to the motor, which drives the whole plate dispenser.
- The flap rods, no. 3. This assembly contains the two rods with the flaps on them. There is a large gear on the left rod, which is connected to a smaller gear on the main rod. These are on a scale of 1:8, to ensure that the speed of the motor matches a turning speed of the flaps which allows the release of plates with a 40cm gap between plates. A full calculation on this is shown in Paragraph 4.1.6. There's also a chain wheel on the left rod, which is connected with a chain to the 'Lonesome Set'

assembly (no. 8). This chain wheel is present to drive power to the right side of the plate dispenser. The right rod of the flap assembly contains a gear, which is again connected to the 'Lonesome set'. The reason for this lonesome set in the assembly is to reverse the direction of the right rod because the flaps have to turn in the opposite direction to each other.

- The partial gear rod, assembly no. 7. This is the rod which will indirectly drive power to both of the lockers in the locking mechanism. The main part of this assembly is the 180 mm gear with only 20 teeth on it. This gear is connected to a smaller 20 teeth gear in assembly no. 12. The partial gear was chosen to make sure that the flaps wouldn't go in and out all the time, but only when a new plate has to be dropped and the other plates have to be picked up again. After this, the lockers should remain in the 'in'-position for a set period of time, so that one plate can be lowered. After the lowering of this one plate, a new plate must be delivered. At that point, the teeth on the large and small gear will meet each other again, letting the lockers go out and then back in again. The assembly also has a chain wheel on it, which is connected to the main rod, in order to supply power to the assembly.
- The 'Lonesome Set' assembly, no. 8. This assembly has a gear and a chain wheel on it, and is used to drive power to the right flaps. The assembly itself is driven by the chain wheel on the left rod of the flap rod assembly (no. 3).
- The 'Small Gear Rod', no. 12. This is the rod that directly transmits power to both lockers. The rod itself is driven by the partial gear rod (no. 7) with the connection of a small gear. The rod contains two chain wheels, one for the power transmission to every locker.
- The locker rods, no. 10 and 4. These are the rods that contain the lockers. They are both connected to the 'Small Gear Rod' (no. 12) by chains.

4.1.3 The 'Puzzle Plate'

The 'Puzzle Plate', drawing no. 1201, is a separate plate in the middle of the dispenser. This plate has number 11 on the previously shown assembly drawing. This plate has various holes in it, in order to hold several rods in the right position. This 'Puzzle Plate' is put into the assembly in order to save material by making the rods shorter and to hold them in the correct place. The 'Puzzle Plate' has finger joint style edges which match holes in the outer sheet metal. This allows this plate to be supported without any permanent joining methods.

4.1.4 The Inner Shaft

The Inner shaft, drawing no. 900, is a rectangular box, made of sheet metal. The shaft has number 9 in the drawing on the previous page. This shaft is put into the assembly to make sure that the plates can't move or shift around, reducing damage to the plates but also to the dispenser. The two rails for the lockers are also welded to the shaft.

4.1.5 The Locking Mechanism

The locking mechanism (assembly no. 600) is the most complex sub-assembly of the plate dispenser. It consists of various tiny laser cut parts and rods, and is used to separate each plate from one another. It is held in place by rod 10 and 4 on the drawing, and can slide over a rail (no. 1000) connected to the inner shaft. This rail will make sure that the lockers will slide only in the horizontal direction, and can't bend up and down. The height difference between the lockers and the flaps is 1mm higher than the height of one plate (4mm), therefore it will separate each plate from each other and make sure that the plates leave the dispenser one by one.

4.1.6 Calculating the Gear Ratios

The original spin speed is 25 RPM, as this is the speed of the electric motor. So, the main crank, attached to the spinning handle, has a rotational speed of 25 RPM. The band speed of the conveyor belt is 5 meters per minute, which is 1/12 meter per second. A requirement of the design is to space the placement of the plates within 40 centimeters. This means that a plate must be placed every:

$$V = \frac{S}{t}\ t = \frac{0.40}{\frac{1}{12}} = 4.8\ s$$

Every 4.8 seconds, a plate is placed, so per minute 12.5 plates are placed on the belt. Combining this with the main rod of 25 RPM, a plate must be placed every 2 revolutions.

The flaps have to turn ¼ of a revolution to release one plate. So, with every 2 revolutions of the main rod, the rod for the flaps must turn ¼ revolution. From this, the perimeter of the gear on flaps rods must 8 larger than the gear on the main rod. The diameter of the main gear is 25 mm. Therefore, the diameter of the gear on flap rods must be 200 mm.

The locking mechanism has to retract and extend within the period of 4.8 s. The window where the plates will fall has to be in the range of 0.5 to 1 second. So, every 2 rotations the locking mechanism rod needs to make one revolution in 0.5 seconds: $\frac{0.5}{4.8} = 0.1042$
So the chain wheel size of the locking mechanism rod is twice as large as that on the main rod. The connection between partial gear and full gear connecting lockers must complete in 0.5 seconds. This means that the full gear must be 10.5% the size of the partial gear. The diameter for the gear on the main rod is chosen to be 180 mm, because of a limit of size for the smaller full gear. Then the number of teeth on the gear has to be $180 * 0.1042 \approx 19$. The teeth of each gear need to grab on to each other, so 1 extra tooth is added, which gives the gear a total of 20 teeth out of 180. The full gear also has 20 teeth.

5. Manufacturing a Prototype

During the manufacturing phase, a prototype for the plate dispenser was created in the workshop and all parts were measured, after which the complete assembly was tested on strength, durability and other factors. Pictures of the complete prototype can be found in Appendix E.

5.1 Measurement Report

For the measurement report, the most vital parts for the proper functioning of the plate dispenser were chosen. The first parts are all parts from the Locking Mechanism because these had to be made very precisely in order for the locking mechanism to work properly. Also, the rail (no. 1000) for the locking mechanism was chosen to be measured, because the alignment for the rails has to be correct as well for the locking mechanism to work. Lastly, a few parts of the frame were measured, in order to make sure that all rods, gears and chain wheels would be properly aligned. The full measurement report can be found in Appendix C.1

5.2 Work Preparation Sheets

In total, three work preparation sheets were needed to create the plate dispenser. These are all shown in Appendix C.2 through C.4.

The first preparation sheet (C.2) is for creating the tubes for the frame. First, the tubes are cut to the right size with a saw. After this, the tubes are drilled and tapped. These tubes are eventually welded together according to the Frame drawing (no. 100).

The second preparation sheet (C.3) is for creating all the rods which are needed in the assembly. The rods have to be cut to the right size first. After this, a center hole has to be drilled in the middle of the rod, parallel to length, in order to support the rod while turning. Then, the grooves in the rods are cut with a 1 mm slot cutter.

The third preparation sheet (C.4) is for creating the sheet metal plates on the sides of the plate dispenser. These plates are first cut to the right size, and then the holes are drilled in the plates.

5.3 Implementation of the motor

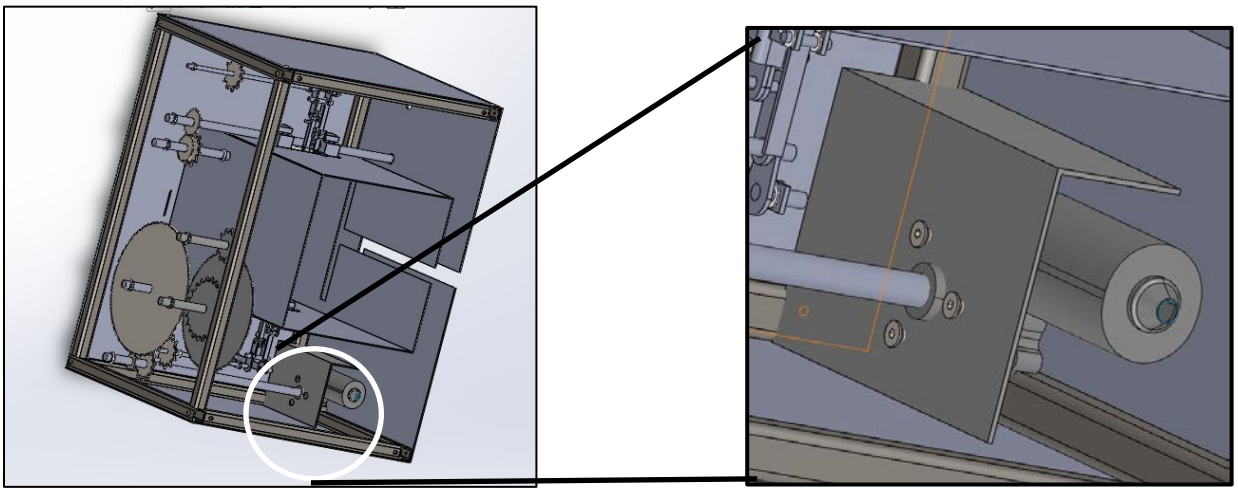


Figure 4: Implementation of the motor in the plate dispenser

It was briefly stated in the initial design that the product should be designed such that it could be driven by an electric motor. In accordance with this, a final assembly design was created. The electric motor was placed on the opposite side of the rod to the hand wheel. This is due to the location of gears in the assembly. This does require the rod to spin in the counter-clockwise direction. However, this is no issue for the electric motor. A right-angled plate with 3 holes is tag welded to two sides of the sheet metal frame. With three screws the electric motor can be attached to this, as shown in the figure above. The electric motor can then run at 25 RPM and place plates at the required distance specification.

6. Evaluation and Redesign

6.1 Test Program

In order to make sure that the plate dispenser fulfilled the requirements of the customer, a test plan was created and conducted.

6.1.1 Important Aspects

Important aspects in the design of the plate dispenser are:

- The lowering plate must consistently hold the weight of at least 6 plates
- The structure must be able to support sufficient daily load to prevent collapsing
- Total weight of the product
- Test ease to access the internals of the product and fix any issues
- Stand stable on the conveyor belt, doesn't move for minor impacts
- Tests involving running of plate dispenser possible with one person
- Must lay plates on conveyor belt 40cm apart

6.1.2 The Tests

1. Lay the weight of 6 plates on the lowering plate and measure the angle of deflection, this should be done three times and an average is taken. (Acceptable value <10°)
   A value of 10 degrees is chosen, because if the lowering plate bends more then 10 degrees the plates will slide and have unnecessary contact with the inner shaft, resulting in wear and eventually damage to the plates. On top of this, larger deflection than 10 degrees also increases the rate at which the lowering plate will break.
2. Load up the external structure with a maximum possible load it could have placed on the top (Weight of small child = 30kg). Do this at least three times with weight in different locations. Must consistently hold this weight.
   During the dispenser's life in a kitchen, the product will be subjected to the placement of other kitchen items. This results in a resultant load on top of the dispenser. A safe maximum of 30kg is chosen as probable chance that a load larger than this is placed on the dispenser is minimal.
3. One person in the group should be able to lift the dispenser and walk with it for 3 minutes.
   A required aspect of the design is the use, and transport of the dispenser should be done by one person. To quantitively measure this ability, a time of three minutes is selected as there is little chance of longer transportation times in the kitchen but more importantly indicates the ease of use for shorter durations of time.
4. Record the time taken to open the dispenser to have access to all internals (Under 120 seconds)

This test gives a quantitively measure the ability to easily access and repair the dispenser. Any time longer than 120 seconds would indicate that an untrained kitchen employee might have more trouble access for troubleshooting.

5. Place the dispenser on top of the conveyor belt, on the frame. This must stand stable, without rocking. This should stay true for minor forces applied to sides of the dispenser (A perpendicular force ≤ 10kg
   This test is to validate the safety of the product when in use on a conveyor belt. A force of 10kg is chosen to recreate the force applied if a kitchen employee were to lean against the dispenser.
6. The dispenser is consistently and easily able to be used by one person (One person use for 2 minutes)
   Although the electric motor will eventually replace this task, it is still useful to verify that one-person use is both plausible and easy to do. Two minutes is chosen as it gives an indication of the effort required to operate the dispenser for longer than a few cycles.
7. Test use of dispenser for all 6 plates. Measure the distance between every passing plate and take an average (must be 40 ± 5cm)
   This last test is to verify the ability of the dispenser to both run and comply with the required specification.

6.1.3 Results

Test 1

To measure the angle of deflection a protractor triangle has been used.
The results are as follows:

Measuring no.	Angle of deflection (°)
1	4
2	3
3	4
Average	3,67

Test 2

A light person of approximately sixty kilograms was used as the testing object. The person sat at two sides of the dispenser and stood on the dispenser. All three positions did not cause any problems.

Test 3

One person can hold the plate dispenser for one minute and walk around. It was however not comfortable and should only be carried if the dispenser really needs to be moved. Two persons handling it is preferable.

Test 4

The time to open the plate dispenser at a natural screwing speed, so without hurrying is 70 seconds.

Test 5

The conveyor belt was not available during the tests. Instead, the dispenser was placed on a small table. The dispenser was very stable and could withstand small forces applied from the side.

Test 6

One person can easily put the plates into the dispenser. The handwheel can easily be turned but due to the problematic connectivity between gears, this does not create fluid movement in the system.

Test 7

The accuracy of distance could not be measured; however, the plate dispenser was unable to run.

6.2 Faults in the prototype

During the workshop sessions and the testing phase, several problems occurred. The biggest issue is located in the gear system. When turning the wheel, the gears do not move smoothly. This is caused by the large number of gears which are placed in the prototype that needed to be perfectly aligned. This is necessary because the thickness of the gears is not very large, 3 mm. When more time is past the alignment of the gears starts to deviate, this is caused by a small amount of play in the rods. There are also small amounts of solder in the teeth of the smallest gear, controlling the action of the locking mechanism. This prevented a good connection between the two gears.

Furthermore, the locking mechanism causes problems in the prototype. The locking mechanism is too fragile and does not turn smoothly this is due to the rails as elaborated below but also to the design of the lockers, the locker structure included one more hinge than necessary. Due to the stiffness of the hinges, this design feature caused increased friction against the roller. Also, the suspension of the locking mechanism is not straight. This happened when the rails were welded to the inner shaft. During the welding process, it was not possible to keep the rails in place, because the part is too small to hold it in place with clamps and no additional team members could be used due to space in the workshop. These small amounts of movement in the process of welding lead to friction between the rail and the locking mechanism, this prohibits fluid motion.

Another problem that occurred is that some holes in the outer sheet metal, for the rods are too small. Because of this, the bearing clamps slightly onto the rod, this caused the rod to rotate roughly through the bearing. This problem negatively influences the turning mechanism.

Lastly a problem that was encountered was the slipping of the flaps. When the load was on the flaps they would turn without the axle. Retaining rings were clamped and tightened on either side of all four flaps but the friction force was not high enough to counteract the downwards force due to the weight of the plates. This fault meant some plates would fall through when not wanted but also then miss aligns all the flaps for the plates that follow.

6.3 Redesign for Series Production

For the redesign of our product, the group looked at the parts which took the most time and those that were the most unreliable due to the way they were manufactured.

6.3.1 The Frame

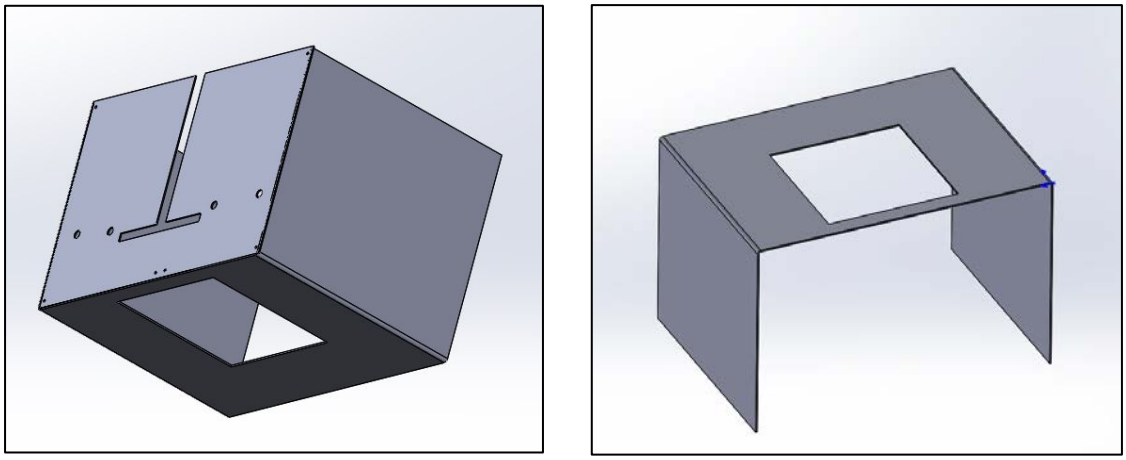


Figure 5: Redesign of the frame

One important part of the design, that also took a large time to manufacture was the frame and sheet metal exterior. To set this up for series production a design that was accurate, faster and more reliable. This is done by integrating the frame and sheet metal into one part, and then a primary structure with three of the 6 sections of sheet metal as one single part. This is formed by laser-cutting and then 2 bends. The two sides of the dispenser would be welded, in series production MIG welding could be done autonomously by robots.

The top plate would be fastened with a hinge. This hinge is screwed into the side of the bent sheet metal. This allows the external design to be mass produced but still easily accessible by employees or technicians.

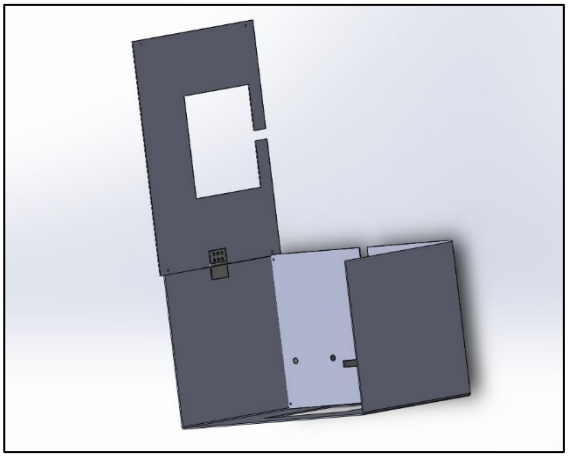


Figure 6: Hinge in frame redesign

6.3.2 The Gears with Retaining Rings

The second part of the design is the gears with retaining rings. The process of connecting the gear to the retaining ring was both difficult to do and time-consuming. First, an axle is made to a length of 15 mm, this allows the 2 parts to be spot welded together. The axle could only be used for 2 spot welds due to deformation of the axle during the welding process.

The process for the redesigning of the gears with retaining rings will be injection molding including a mandrel for the internal cavity and for the creation of the thread, for the tightening screw. This part is used a lot in our design, so there is a need for a process which can produce a high quantity and with a good precision. Injection moulding meets both requirements, it has good precious and it can make a screw thread in the process so the ring doesn't have to be drilled and tapped in a secondary operation. The downside is that the moulds for the process are expensive, but they can be re-used so it is a one-time investment to create the part.

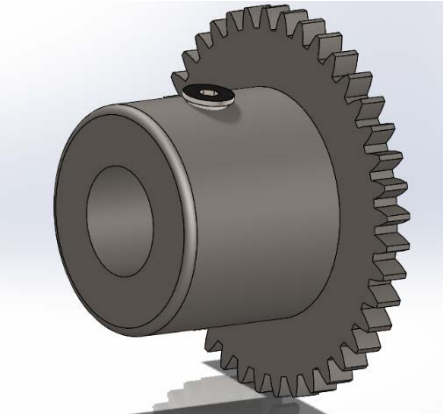


Figure 7: Redesign of the gears

6.3.3 The Locking Mechanism

The reason this assembly was redesigned is due to the many problems faced with the older design, most of these were misalignments because of a lack of skill with operating experience in the project group. The old design consisted of 23 separate parts, thus increasing the needed time to construct the assembly. In the previous design, the second hinge was supported by a rail sliding system to keep it straight and make the mechanism move forward. In practice, this rail would start bending instead of giving the needed reaction force. Due to the lack of the reaction force, the locking mechanism would push itself downward instead of forward, this led to too much friction and the entire plate dispenser would stop working. Hence the assembly had to be redesigned for easier production, less cost, better alignment and a better way to slide horizontally.

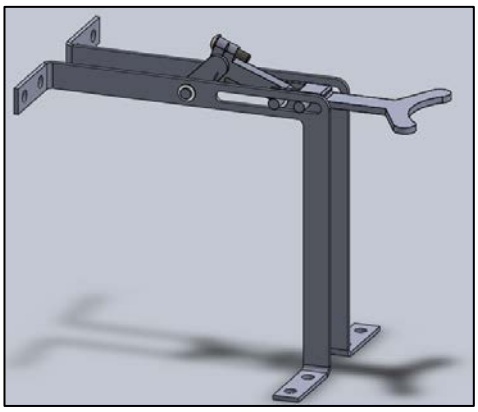


Figure 8: Redesign Locking Mechanism

Proposed solutions to the problems:

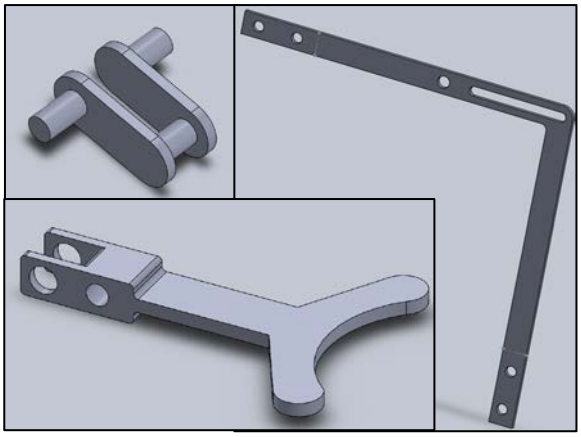


Figure 9: Redesigning combined parts

- *Easier production and lower costs:*

To reduce production time and cost, parts were combined and simplified, reducing the number of parts in the assembly to 14. To reduce time and cost even further several parts are to be made using forging, this will also increase strength, thanks to the work hardening effects of cold forging.

These parts consist of:

- The crankshaft (see: **Assembly 1300 Part 1303**, Appendix **F**)
- The plate holder (see: **Assembly 1300 Part 1301**, Appendix **F**)
- The connector part (see: **Assembly 1300 Parts 1304/1307**, Appendix **F**), between plate holder and crankshaft

The crankshaft and connector would need further machining to make the holes(drilling) and the thread in the connector(tapping).

- *Improving the ease to align parts*

To improve the ease of aligning all the different parts, the holding bracket was redesigned as two separate parts, this way the parts could be placed in an easier order, requiring less effort and better precision. Before the redesign, the crankshaft-like mechanism consisted of separate parts, when a large amount of stress was applied the rods would slip in their holes, breaking the straightness of the connection. If this part is forged in one go the alignment will always be straight and will be able to withstand higher levels of stress. The biggest change to ensure better alignment of the subassembly in the machine has been accomplished by redesigning the way the supporting bracket is attached to the frame. By switching to precisely placed holes, made by laser cutting. The same could be done for the outside frame. Then the bracket could be attached to the frame, by the use of nuts and bolts, resulting in better alignment. With these changes, the assembly becomes more stable (supported both horizontally and vertically) and better positioned than before.

- *A better way to slide horizontally*

For the final problem, the top rail system had to be removed and replaced by something more stable and something that would have a reaction force act on the second hinge. A solution to this problem was to have the second hinge inside a horizontal slot at the same height as the axle of the crankshaft. Using a slot this design could also support the Plate Holder (**Figure 9:** *Bottom left*) and make sure it's kept in a straight line.

6.4 Design Process and Safety of Design

The different hazards in the plate dispenser design are displayed in the following table:

Hazard	Protection measures
Fingers can get stuck between different gears or chains.	To protect people from sticking their hands in, the gears need to be covered. This has been done by the sheet metal plates mounted on the frame.
The user's hands can get stuck between the plates and the dispenser when filling the plate dispenser.	An inner shaft of sheet metal plates has been added to the dispenser. This also prevents the plates from dislocating. To put the plates in a lowering plate is being used. With this lowering plate, the user won't get close to sharp edges.
The plate dispenser can fall from the conveyor belt.	Small forces can be applied to the dispenser without it falling off. The user has to be informed by a label that you are not allowed to lean on the dispenser. In redesigning, the dispenser must be mountable by screws.
The user might cut him- or herself on sharp edges.	All the edges have been deburred with a deburring tool or by a grinding machine.
Due to its high weight, the user might hurt his/her back.	The user has to be informed by a label that you should handle the dispenser with two persons.

6.5 Conclusions and Recommendations

A plate dispenser has been designed and manufactured. Despite the fact that the design was based on an elaborate analysis phase, several issues were encountered in this process. Therefore, changes needed to be made to the design. In the future the redesigns will be used to solve the biggest issues in the design and these redesigns also allow the plate dispenser to be mass produced.

The biggest problem that occurred was the locking mechanism. The mechanism caused problems in the prototype, to solve these problems a new, more reliable mechanism has been designed. In a new prototype the use of this new locking mechanism is recommended. Several issues were encountered in the gear system. Joining the gear to the ring was time consuming and not a very accurate process. To save time, which is essential for mass production, the gears have been redesigned from 2 separate parts to just 1 part. Another manufacturing process has been chosen to produce the gears. If a new prototype is to be made the new gears with retaining rings incorporated into them should be used. Another problem that occurred is that some holes for the rods are too small, because of this, the bearings were too tight in the hole and the rods were turning roughly. In a future redesign the holes should be bored to a larger diameter and reamed to the perfect size. The last problem in the gear system was the bad alignment of the gears, this could be caused by 3

primary problems: the thickness of the gears, the play in the rods and the alignment of the gears in the workshop. In the future it's recommended to make the gears thicker to prevent misalignment of the gears, also make stricter tolerances for the grooves so the play in the gears will be minimized.

An important aspect of the prototype is the safety. This is controlled by covering the gear systems with sheet metal plates. The user also does not have to put his hands in the dispenser thanks to the lowering plate. The downside of the covering with sheet metal plates is the increase weight, so it is recommended to use a lighter material like plastics. For further improvement of the product's safety, an emergency stop could be designed, which would stop all gears form turning when used, thus avoiding a possibly dangerous situation in which the plates or user could have been damaged.

It is also recommended to place a keyhole in the flaps and rod to prevent any slipping of the flaps.

To ease the use in an industry environment, an electric motor can be implemented into the free space of the prototype. In this way, the dispenser actually replaces the labour of a kitchen employee.

7. Appendices

Appendix A.1 Group Contract

What do we want to achieve?

We'd like to get at least above a 7, but we don't want to aim too high as we also want to have time for the other parts of this module.

What tasks and roles are needed for this?

Designers, information gatherers, builders, secretary, chairman...

Who will take on what task/roles?

The task/roles will be appointed at least a week before the appointment of the task/role itself. Every meeting there will be a chairman and a minute taker who rotates with every meeting through alphabetic order. There will also be minor roles which are permanent, given below:

Name	**(Small) Task**
Auke Jaspars	Adjusts Agenda Weekly
Bram Vloedgraven	Last checkpoint
Jasper Wijnen	Informant/Collator of minutes
Miguel Cacarin Cumbal	
Shyngys Bayankul	
Tom Kluin	Manager over the workshop
Tom van Hensbergen	Facilitator
Jesper Kussendrager	Manager over the design phase

Agreements on the agenda

Everybody has to do their task in time or a punishment will follow except if a good excuse is mentioned 1 day before the deadline.

Agreements on the minutes

To make sure everybody gets on time, we have given bad points to the amount minutes you are late, shown in the table below;

How many minutes late	Earned bad points
0-5	1
6-10	2
11+	3

When a person has earned 3 points he/she has to buy the group an apple pie. When a person is not coming to the meeting without telling anyone, he or she has the buy the group a crate of beer. When a week has passed by for the person, who has 3 points or more, another point will be added. These added points will not be removed after the buying of the apple pie.

How do we check if everything is going well?

Everybody has to write down their work, date, and duration in a logbook.

What do we do if this is not the case?

First step, inform the other group members, if they don't know what to do, take up contacts with the tutor or a teacher.

Plan B

When someone doesn't show up for a meeting and he/she is the chairman or the minute taker. The person next in line for the job will do it.

When a person didn't do their work before the deadline it will be discussed in the next meeting.

Appendix A.2 Analysis Phase Questions

What is the design topic about?

- *Auke*

'European Food Technology BV' [1] is a company specialized in providing equipment for food processing. They invited our project group to develop a dinner plate dispenser for transporting dishes and serving food. The dispenser places plates on a conveyor belt which will then transport the plates to the kitchen employees. The employees will then serve the food onto the plates.

What are the important functions?

- *Bram*

The most important function the plate dispenser should fulfil is the ability to place plates onto an existing conveyor belt at a given speed. The dispenser also has to have space to store at least 6 plates. The user has to be able to put the plates easily into the dispenser. The dispenser also needs to be closed when it is operating, in that way the user can't get stuck between moving gears.

- *Jasper*

There are a few important functions that the plate dispenser has to fulfil. This is to smoothly release plates, from a holding compartment of many plates, onto a conveyor belt. It should do this in a way that leaves at least a 40 cm gap between the plates. The speed should be able to be adjusted so that different types of conveyor belts can utilise the dispenser. In addition to all this, an important function is the ability of the plate dispenser to be maintained and repaired quickly and easily.

As a function, the dispenser also needs to be safe. This means making it difficult or impossible to accidentally touch moving parts whilst the machine is operating.

This is an example of an existing plate dispenser. This has a simple design, allowing it to hold plates and move them upwards using a spring-loaded method. This makes it easy to maintain and repair. However due to the exposed design, it isn't as safe as it could be, but as there are very little moving parts it isn't much of an issue for the design. However, as only springs are used to control the lift of the next plate, it is very difficult to use this design method to

place plates at set distances and even more difficult to change how quickly the plates are dispensed based on the speed of the belt.

For this design, a similar method for creating movement is used but it's encased to increase the safety for users. If the casing can be removed then it still allows for easy access for maintenance. What can we use from this:

- Could use a spring-loaded system to create movement
- Could rise plates to the belt instead of lower plates onto the belt

Where is the design to be used?

- *Miguel*

The project mainly is focused for use in common-restaurant which determined space in the kitchen due to dispenser have to follow specific requirements, and it has to be able to use by one person. Dispenser generally will be used in off-peak periods to make easy and reduce the waiting time of consumer in restaurant moreover according to the needs of the restaurants the product could be adjusted.

- *Tom K*

The plate dispenser will mostly be used in average-sized kitchens, because it should be operable by one person, meaning that there's not a lot of staff available, but plate dispensers aren't very cheap either. This means that the average small restaurant probably can't afford one. Smaller restaurants probably don't have space either in the kitchen for a plate dispenser including a conveyor belt, and passing the plates along will be easier and quicker for them anyways. The larger restaurants will probably need a bigger plate dispenser, as ours will only carry around 8 plates at maximum. A larger plate dispenser than ours could also be an outcome for buffet style restaurants, as it would be easier for the customers to get a plate. In this case, it may be better to use a conveyor belt that goes around, as there won't be a continuous need for plates.

Why is there a need for this design?

- *Shyngys*

Probably, there will be demand from restaurant owners, who want to reduce their expenses in terms of salary for employees. Besides, this dispenser will correspond like a bridge between the kitchen and dining room. Certainly, the chief will just put food on the dispenser.

- *Tom H*

The plate dispenser will mostly be used by large or high-quality restaurants. When there is a constant flow of dishes being served it is handy to have machine placing and spacing the plates on a treadmill. This will take away the time for the cooks to manually place the plates. The placing of the plates by a machine is also better for the hygiene of the food.

When will the design be used?

- *Jesper*

The design will be used in medium-sized kitchens meaning the machine should be operable by one person since there won't be too many working forces in the kitchen. Also because of the tight space, any bits that might stick out should be avoided because of easily bumping into them and thereby destroying part of the plate dispenser.

Who will interact with the design?

- *Auke*

The catering industry will use the dinner plate dispenser in the kitchen of restaurants or other food serving companies, because of this a lot of employees will interact with the design like: kitchen employees, waiters and dishwashers. In the first phase of the dispensing circle the dishwashers will fill the dispenser with clean plates, then the clean plates will be transported to the kitchen employees. The kitchen employees will put food on the clean plates and then the food will go to the waiter using the conveyor belt. The waiter will pick up the dinner plates and he will serve the food.

- *Bram*

The dispenser will be used by restaurants or other food serving companies. Therefore the kitchen employees, the waiters and the dishwashers will interact with the design. First, the dishwasher will fill the dispenser with clean plates, then the kitchen employees will put food on the plates and when the meal is ready the waiter will take the plates of the conveyor belt.

How long will it be used?

- *Jasper*

The plate dispenser should be used for a long period of time to make it a worthy investment for a business. To accomplish this, it should be made of materials that are durable to constant use. This is seen in the use of other designs as shown before, the designs all use some form of sheet metal or metal casing to make it durable to the use inside of a kitchen and also easy to clean. It also means that the design should allow for maintenance as this will increase the longevity of the dispenser. It also means that the design should have a relatively simple method of creating movement as a simpler design will increase the longevity. The design should have a minimum lifetime of 5 years. If it is to be used for a long time it should also be able to adapt to changes to other technology such as different conveyor belts with different mounting methods.

Photos from before for reference:

What can we use:

The use of a durable and easy to clean exterior to the design, such as metal.

- *Miguel*

The plate dispenser should be able to support long periods of constant work without rest and also the structure. The life period of the project could oscillate according to use but with an regular service and some adjustments, the product could work for many years. however, the project has the characteristic of it could be repairable if some parts don't do the assigned function which adds the useful period of the project.

How heavy may the dispenser be?

- *Tom K*

The plate dispenser cannot be very heavy, because any person has to be able to carry and operate the dispenser easily by him/herself. The plate dispenser should not be too light either, as that would sacrifice a lot of quality and durability. This is mainly because we are only allowed to use metal as a material, which isn’t very light compared to other materials.

The ideal weight for the plate dispenser, including the plates is about 15 KG because anyone is able to carry that amount of weight and enough metal can be used to make the dispenser durable and of good quality. The place dispenser needs to be able to hold six plates at minimum, so we'll take eight plates into account, as different plates can have different weights. An average dinner plate weighs about 600 grams, so eight plates will weigh around 8*600 = 4800 grams. This is approximately 5 KG. This means that the plate dispenser by itself should weigh 10 KG at maximum. Of course, we'd like to make the dispenser lighter if possible, but because we can only use metal, this will be a difficult task without compromising on the quality of our dispenser. If we would be allowed to use other materials, we could make an even lighter plate dispenser, making it easier to carry around in a kitchen.

- *Shyngys*

Mainly, the plate dispenser will be used very often for feeding people quickly in crowdy buildings, then it means it also needs to be sustainable as much as possible. Firstly, if it is created with a big weight, it will be inconvenient to lift it up or to move from one place to another. In the same time, it also shouldn't be too light, because as it said before, in kitchen, there will be many people, who can have a contact with device or press on the dispenser with their hands. Shortly, it shouldn't be too heavy or too light and the structure of it has to be invented from solid and strong metal. The group can try to use practical material to construct a dispenser with a weigh around 15-17 kg.

How fast must the design perform?

- *Tom H*

The design is required to run at a certain speed which is noted in the requirements of the machine. The spacing between must be 40 centimeters and the speed of the belt is 5 meters per minute. After the requirements, it's also handy to have these settings in the machine adjustable because not every belt is the same. Also, the spacing is different for each person/restaurant and, if possible, also be adjustable.

- *Jesper*

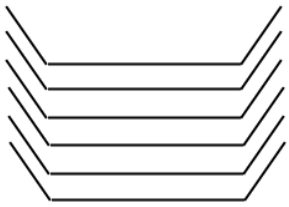
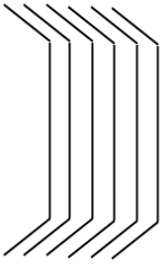
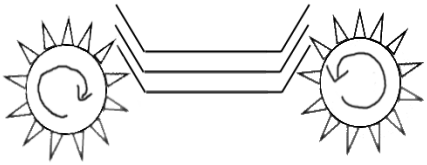
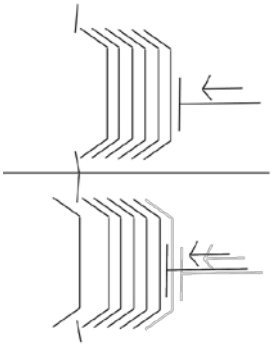
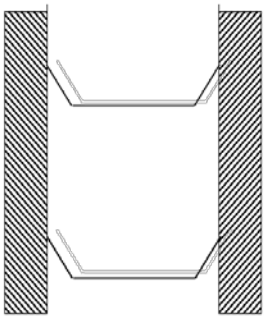
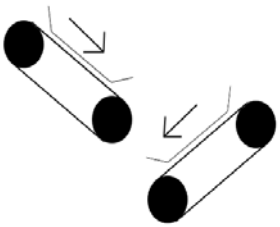
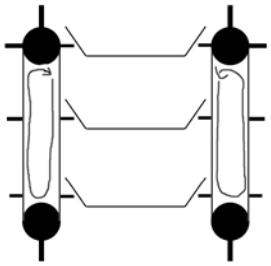
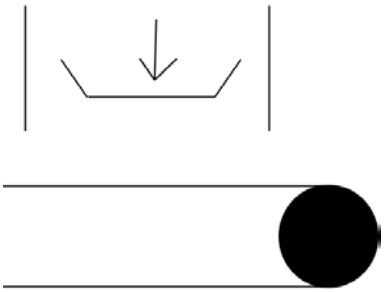
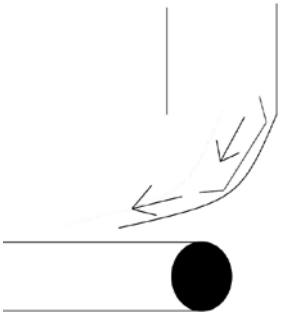
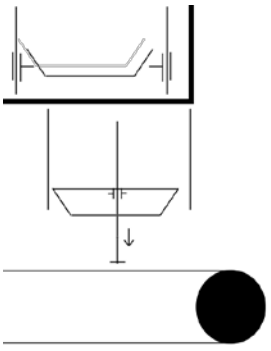
The design has to perform at a constant speed and should be able to run on an electrical motor that has a speed of 25 revolutions per minute. At this constant speed, the plates need to be dispensed onto the conveyor belt 40 centimeters apart. The conveyor belt used has a speed of 5 meters per minute, so 1 plate (approx. 235mm, further measurements needed) per $\frac{40+23,5}{500} \times 60 = 7.62$ seconds. At this speed the people behind the conveyor belt will be able to do their job well, at higher speeds they can start to struggle getting the food ready before the plate passes, there will be too many plates on the belt.

How big may the design be at a maximum and/or at a minimum?

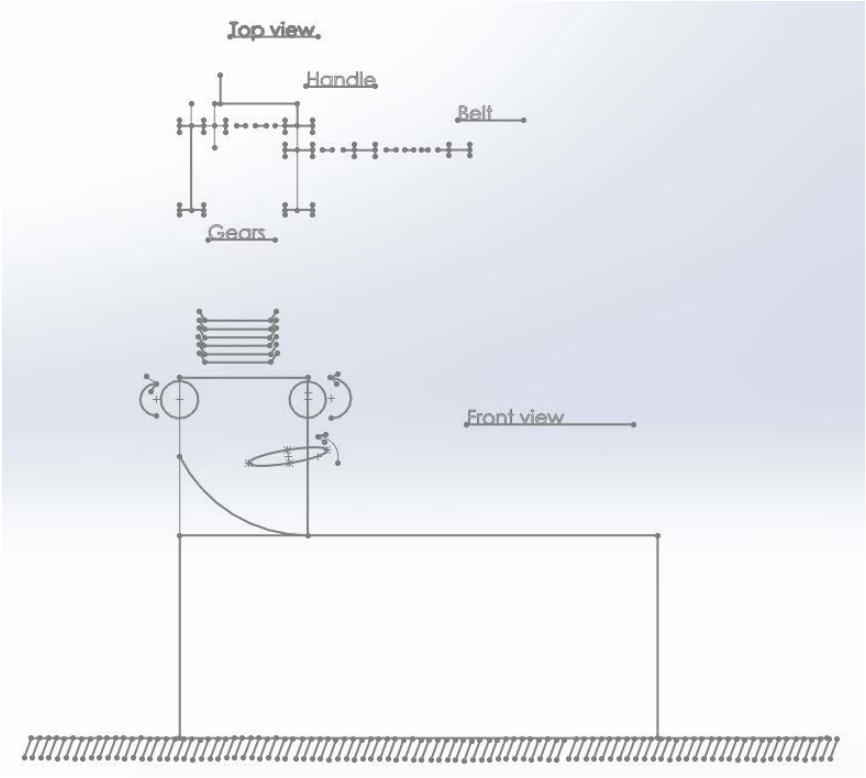
- *Jesper*

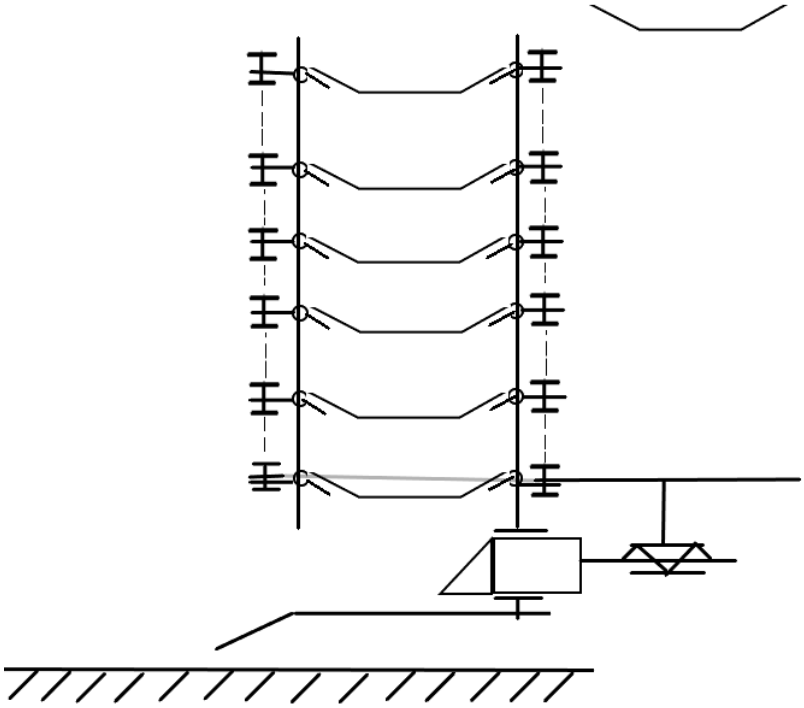
Dimensions are at maximum (l x w x h) 600 x 600 x 750 mm, but this wouldn't be practical since such a design would weigh too much for one person to install and also would stick out quite a bit from the dispenser interface on the conveyor belt (410x400mm). Minimum dimensions should be at least 410x400mm (l x w), measurements of the dispenser interface for the most stability. When building too high stability becomes an issue, so a wish should be to keep the height smaller than the length and the width.

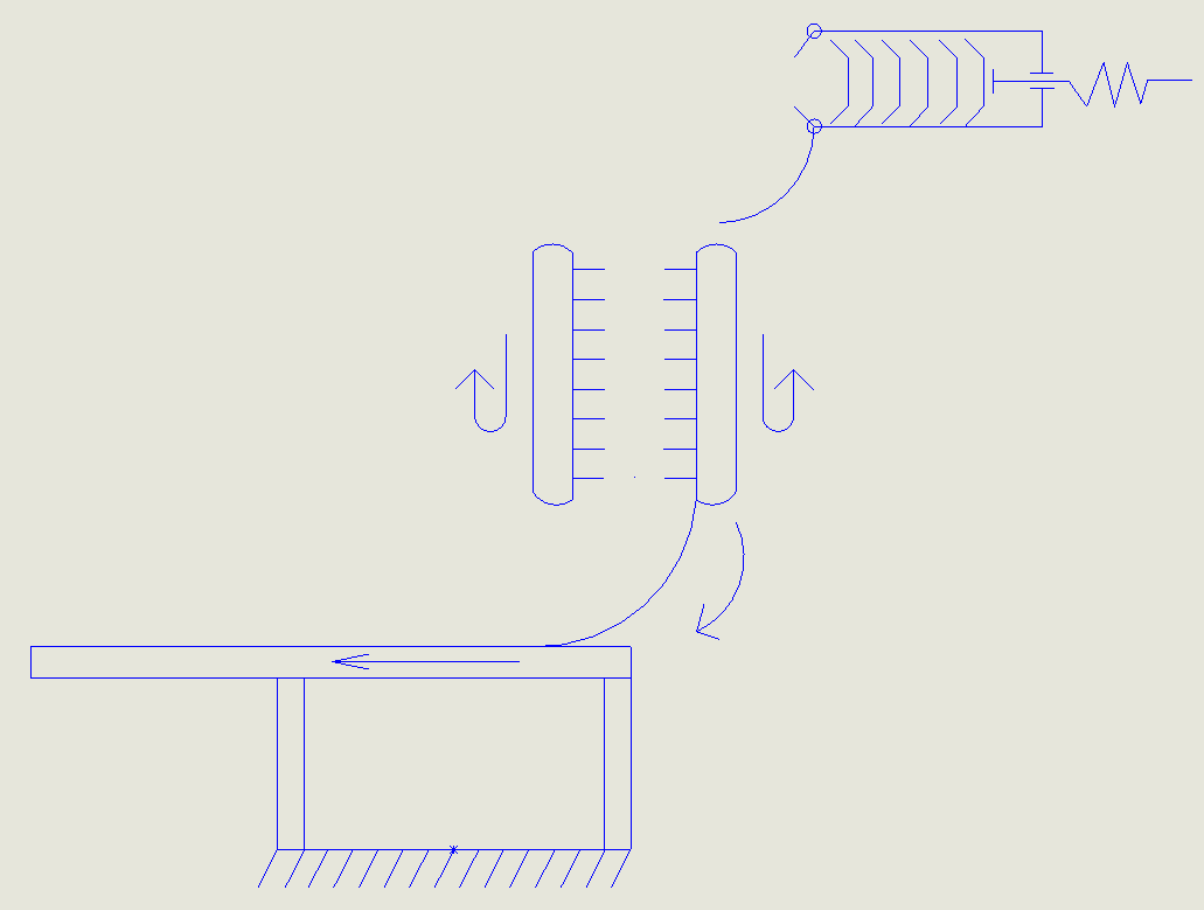
Appendix B.1 Morphological Diagram

Function:	Sketch 1	Sketch 2	Sketch 3
Storage of the plates			
Spacing apart of the plates			
Moving the plates downward			
Ejecting the plates onto the conveyor belt			

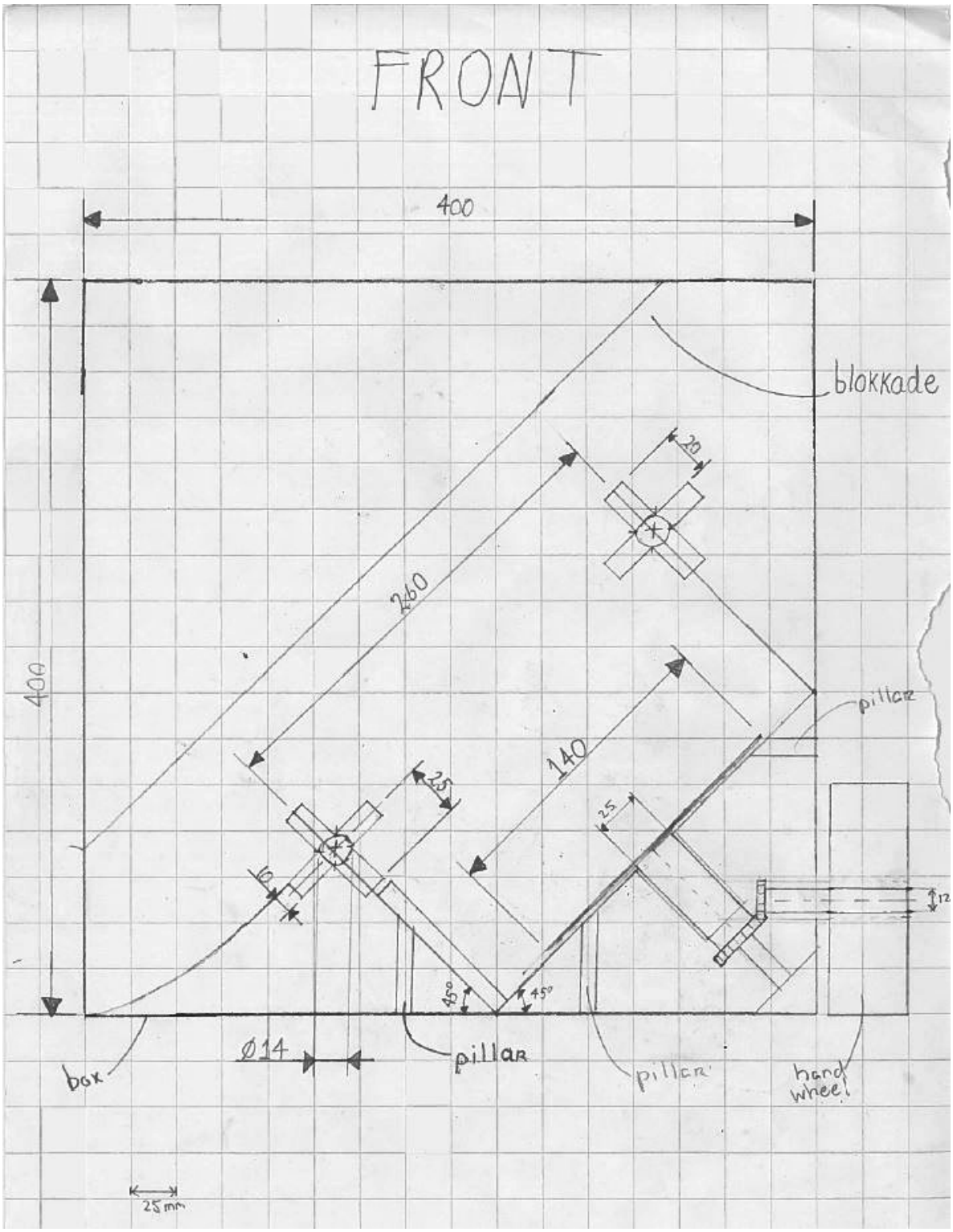
Appendix B.2 Structural Sketches

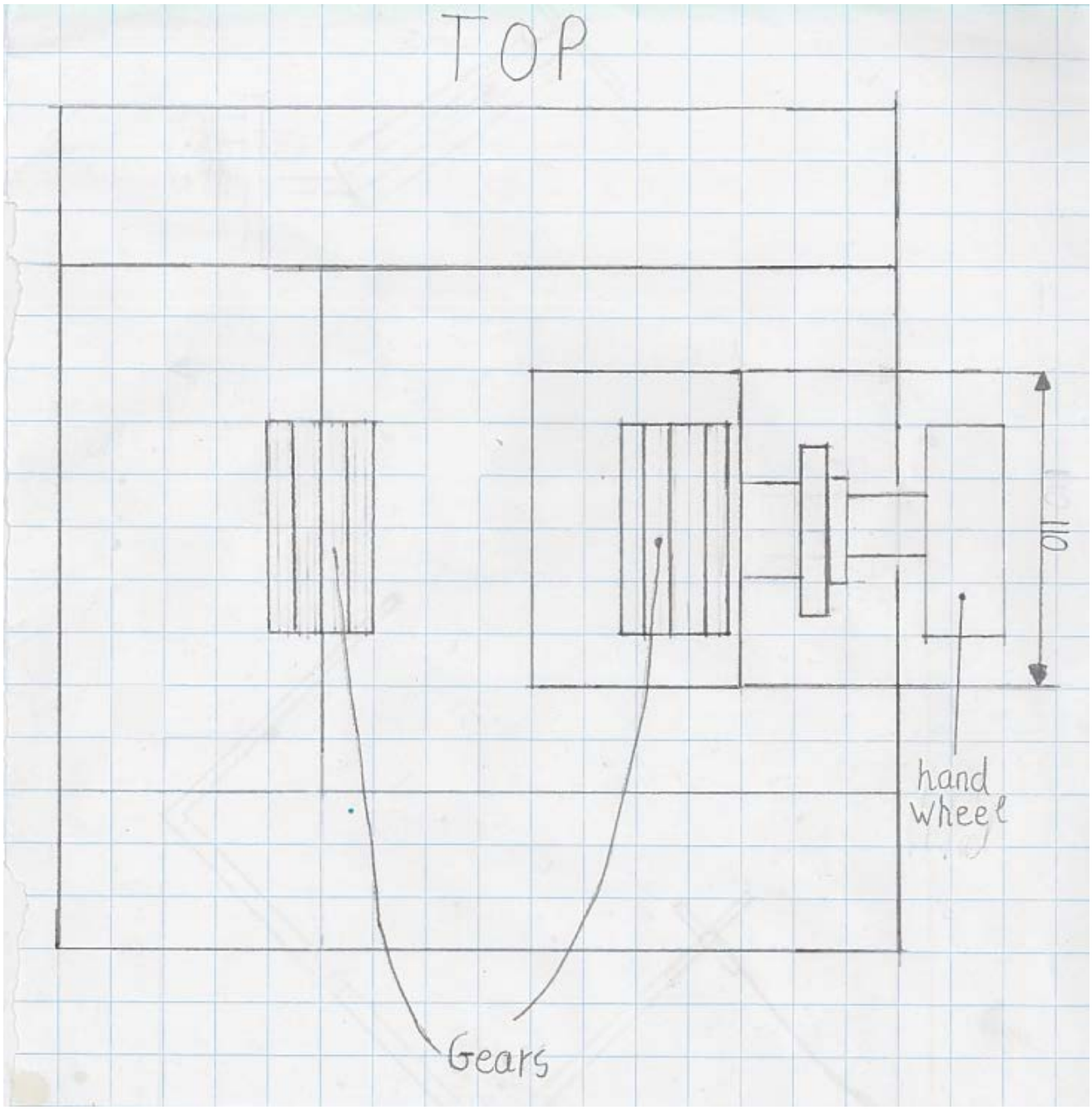




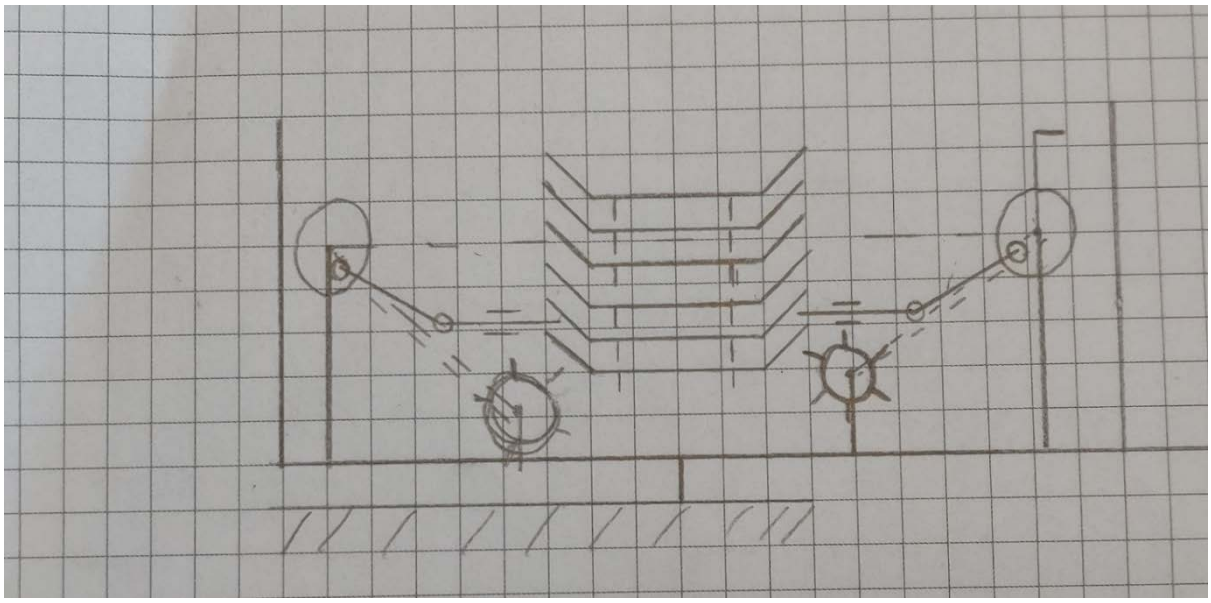


Appendix B.3 First Design Sketch

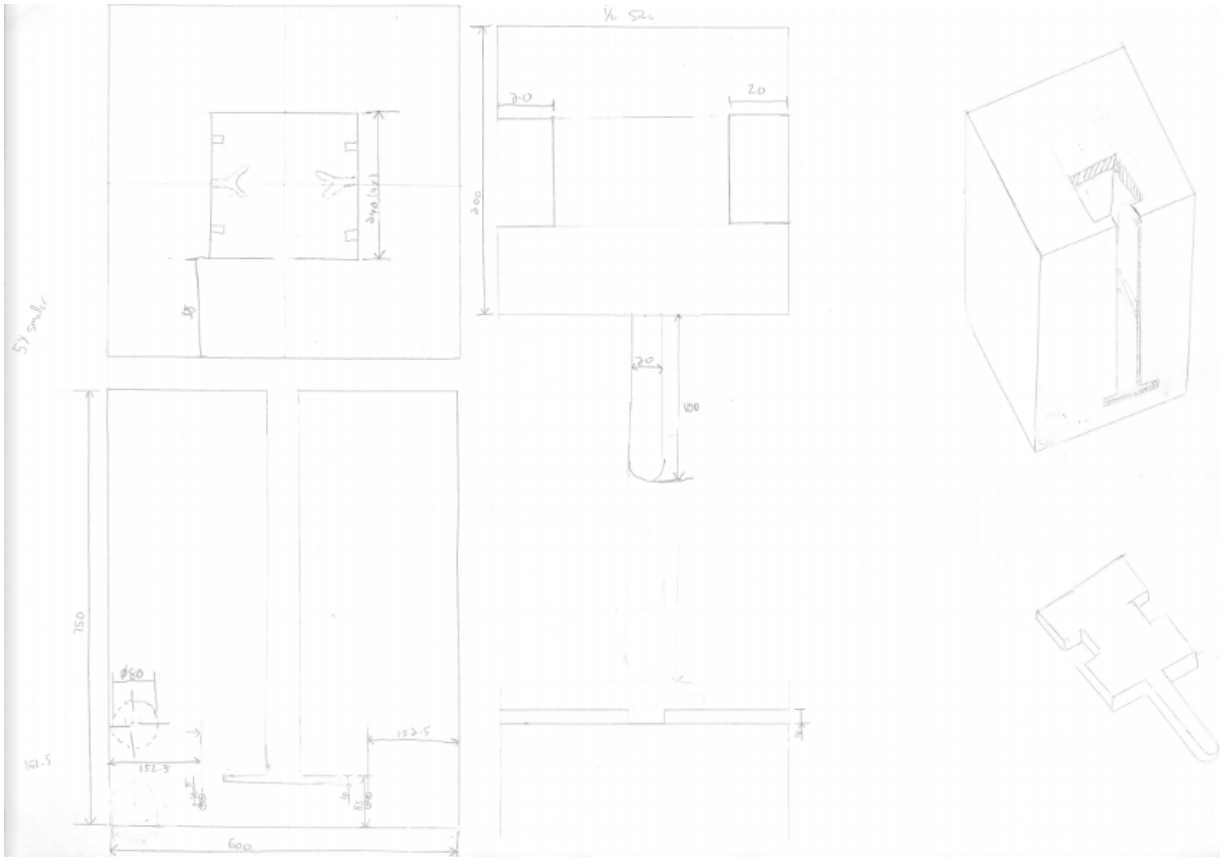


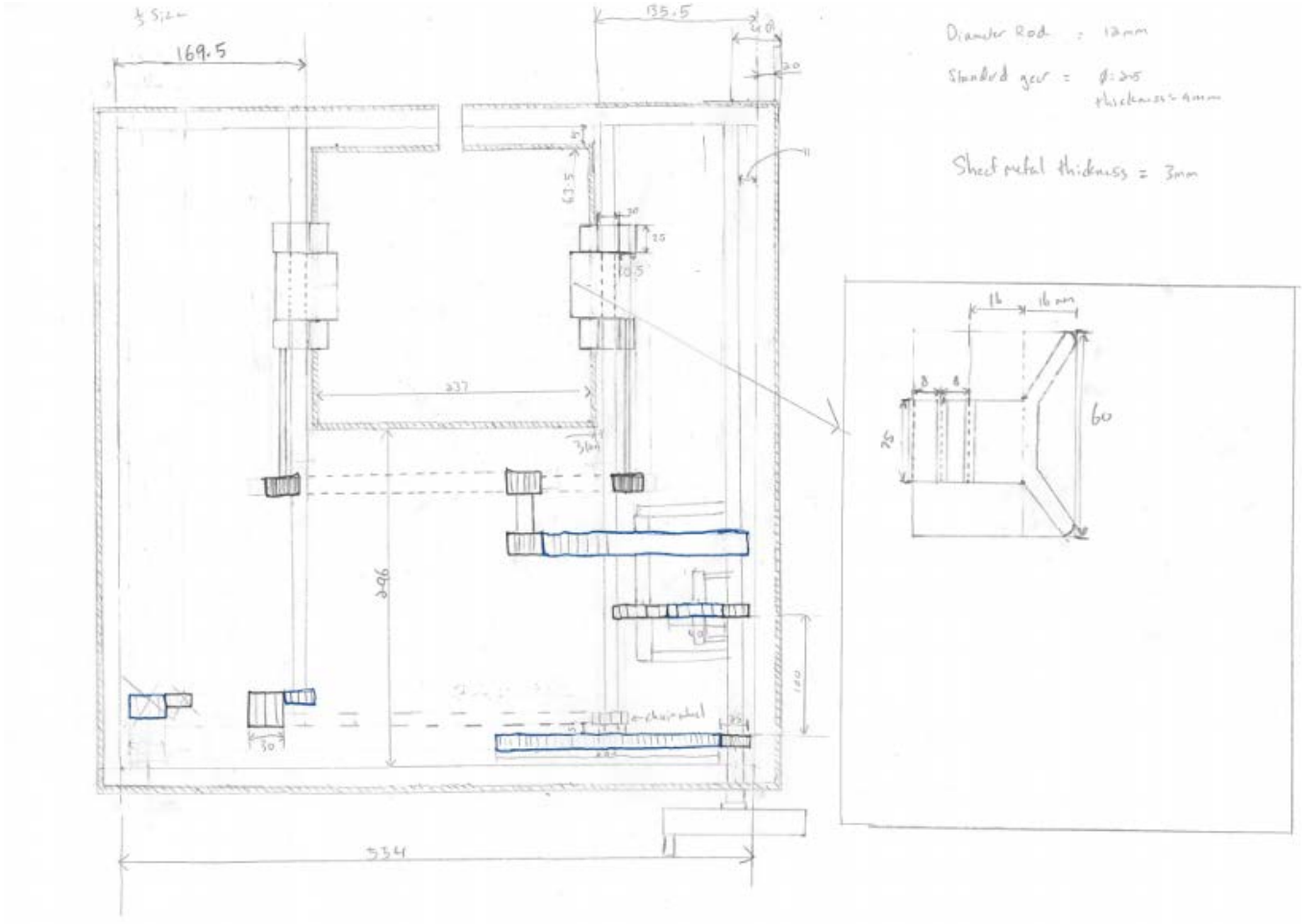

TOP
110
hand wheel
Gears

Appendix B.4 Revised Structural Sketch



Appendix B.5 Revised Design Sketch





Appendix B.6 Weighing Table 3 Sketches

Weighing Table							
Functions	Weight	Sketch 1		Sketch 2		Sketch 3	
Easy to repair	2	2	4	3	6	3	6
Safe to use	2	3	6	3	6	3	6
Storage	2	4	8	2	2	1	2
Damaging plates	2	2	4	2	4	2	4
Convert motion	3	2	6	2	3	1	3
Ability to separate	3	4	12	2	6	2	6
Weight	1	1	1	4	3	3	3
Ability to manufacture	3	2	6	4	12	4	12
		47		42		42	

Appendix B.7 Weighing Table 4 Sketches

Weighing Table									
Functions	Weight	Sketch 1		Sketch 2		Sketch 3		Sketch 4	
Easy to repair	2	2	4	3	6	3	6	3	6
Safe to use	2	3	6	3	6	3	6	3	6
Storage	2	4	8	2	2	1	2	3	6
Damaging plates	2	2	4	2	4	2	4	3	6
Convert motion	3	2	6	2	3	1	3	4	12
Ability to separate	3	4	12	2	6	2	6	4	12
Weight	1	1	1	4	3	3	3	2	2
Ability to manufacture	3	2	6	4	12	4	12	3	9
		47		42		42		59	

Appendix C.1 Measurement Report

Drawing No.	Serial No.	Dim ID.	According to Drawing	Measured	Measuring tool used	Conclusion
606	1	A	133.00	133.0	Ruler	OK
606	1	B	50.0	52.0	Ruler	Small deviation, proves to be acceptable in the prototype.
604	1	A	Cylindrical 6.0	6.1	Triple roundness measurement	OK
604	1	B	Cylindrical 5.0	4.9	Triple roundness measurement	OK
604	1	C	4.0	4.3	Caliper	OK
604	1	D	17.0	17.5	Caliper	OK
1002	1	A	13.0	14.8	Caliper	Small deviation, causes troubles for the locking mechanism to slide over the rails.
1002	1	B	20.0	20.7	Caliper	Small deviation, causes troubles for the locking mechanism to slide over the rails.
101	1	A	10.0	10.8	Caliper	Small deviation, no consequences for the assembling of the side plates.
101	1	Total Length	357	355	Ruler	Small deviation, no consequences for the assembling.
102	1	A	10.0	10.4	Caliper	Small deviation, no consequences for the assembling of the side plates.
102	1	Total Length	357	355	Ruler	Small deviation, no consequences for the assembling.
103	1	A	242.0	239.0	Ruler	Small deviation, no consequences for the assembling of the side plates.

Appendix C.2 Work Preparation Tubes

Work preparation form			
Part name: Frame tubes		Date:	Sheet number:1
Belonging to drawing: 100 series		Made by: Jesper	
Part no: 101, 102 103	Amount: 4x 101 4x 102 1x 103 2x 104	Material: steel	
Starting dimensions material: 3000mmx20mmx20mm			
Machining sequence: Sawing, drilling, tapping			
Operation	**Tool** fixtures, tools and other aids	**Settings** speed (V), number of revolutions (N), feed (f), depth of cut (t_0) etc.	**Remarks**
Sawing tubes	Saw	N=1000rpm F= manual T0=20mm	Follow the drawings to do it.
Drilling holes	Drilling Ø3mm	N=1000rpm F= manual T0=2mm	Drill the holes in the positions according to the drawings.
Tapping M3 holes	Manual M3 tap	manual	

Appendix C.3 Work Preparation Rods

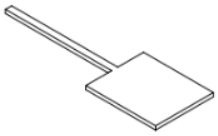
Work preparation form			
Part name: Rods		Date:	Sheet number:2
Belonging to drawing: 202, 304, 401, 505, 603, 608, 610, 703, 704, 1001, 1102		Made by: KM and Shyngys	
Part no: 202, 304, 401, 505, 603, 608, 610, 703, 704, 1001, 1102	Amount: Can be found in the bill of materials of the assembly drawings.	Material: Steel	
Starting dimensions material: 3000mmxØ12mm, 3000mmxØ6mm, 3000mmxØ4mm,			
Machining sequence: Cutting-Turning			
Operation	**Tool** fixtures, tools and other aids	**Settings** speed (V), number of revolutions (N), feed (f), depth of cut (t_0) etc.	**Remarks**
Cut the rods according to the different drawings.	Cutter	F= manual	Manual machine cut rods by applying pressure to the rod. Pay attention to the diameter of the rod.
Make a center hole in the middle	Center drill ¾ of the rod diameter. (8mm center drill for Ø12mm, 4.5mm center drill for Ø6mm, 4mm center drill for Ø6mm)	N=500rpm F= Manual T0=10mm	A hole needs to be drilled on one side for stabilizing the rod before turning.
Cutting the grooves on the lathe.	Slot cutter 1 mm	N=800rpm F= Manual T0=1mm	

Appendix C.4 Work Preparation Side Plates

Work preparation form			
Part name: Side plates		Date:	Sheet number:3
Belonging to drawing: 108		Made by: Jesper	
Part no: 108	Amount: 2	Material: steel metal	
Starting dimensions material:			
Machining sequence: Drilling			
Operation	**Tool** fixtures, tools and other aids	**Settings** speed (V), number of revolutions (N), feed (f), depth of cut (t_0) etc.	**Remarks**
Cutting the sheet metal.	Cutting machine	d = 400 mm l = 360 mm	
Drilling holes	3.4mm drill	N=1000rpm F= manual T0=2mm	Drill holes in each corner, follow the drawings

Appendix D Assembly Tree

Plate dispenser

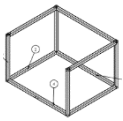


001-Pizza plate

100.Frames

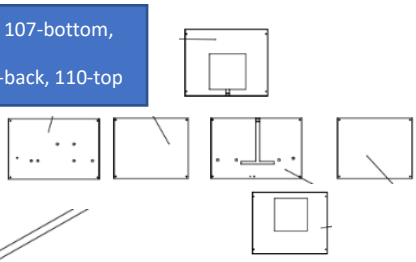
Frames:

101(4x),102(4x), 103,104(2x)

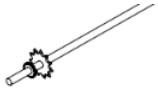


Sheets:106-front, 107-bottom,

108-side(2x), 109-back, 110-top

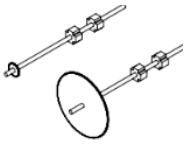


200.Main rod

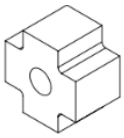


202-Main rod
203-Gear,d=25mm
501-Chain wheel

300.Flap rod

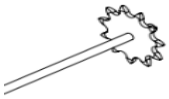


303-Flap(4x)



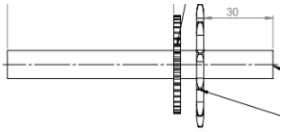
301-Chain Wheel
302- Gear, d=40mm
304-Rod(2x)
305-Gear,d=200mm

400.Right rod



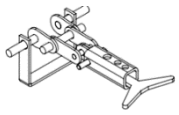
401-Rigth rod
1101- Chain wheel

500.Lonesome set



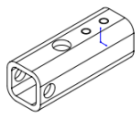
501-Chain Wheel
504-Gear,d=40mmm
505-Shaft

- Plate dispenser
  - 600. Locking mech. (2x)



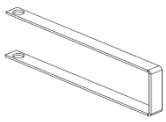
    - 601-Connection 1 (2x)
      602-Connetion 2 (2x)
      607-First Connection (2x)

    - 604-Tube ISO M4

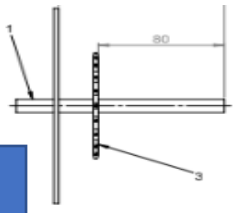


    - 605-Plate Holder

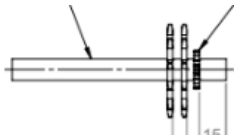
    - 606-Holder



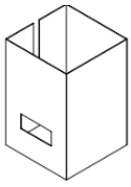
    - 603-Pipe one
      608-Rod 30mm (2x)
      610-Rod 42mm
  - 700.Partial Gear Rod



    - 701-Chain Wheel
      702-Gear, 180mm
      704-Rod, 132mm
  - 800.Small Gear Rod



    - 501-Chain Wheel(2x)
      702-Spur gear, 20mm
      703-Rod, 127mm
  - 900.Shaft



    - 901-PlateBack
      902-InnerPlate(2x)
      903-FrontPlate

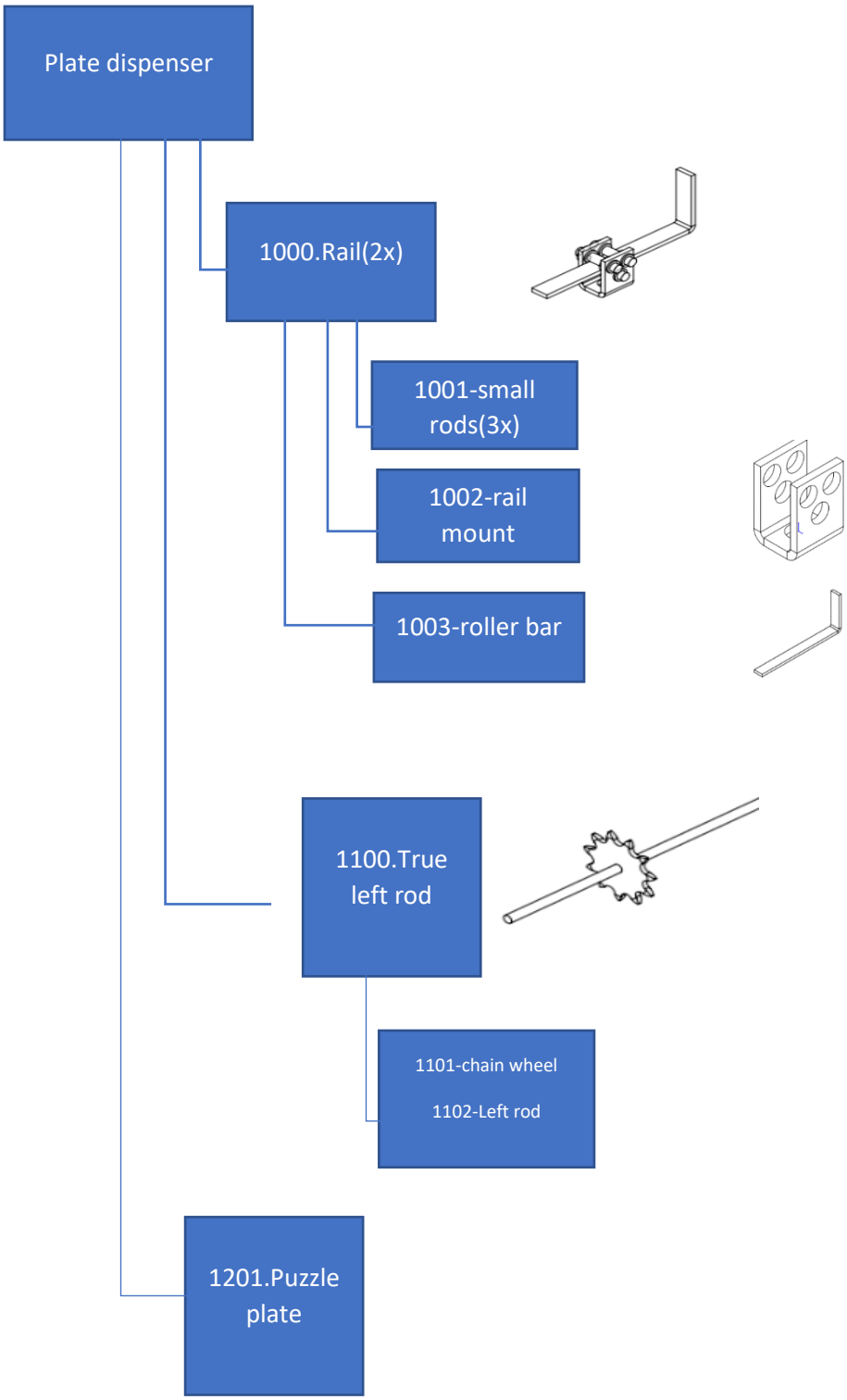
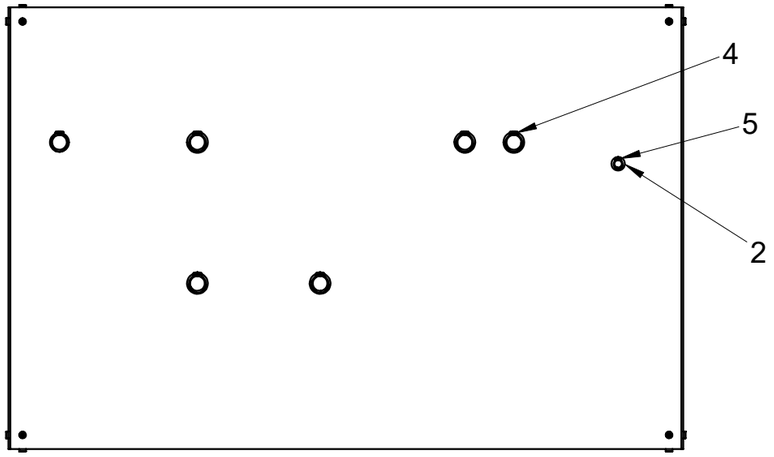
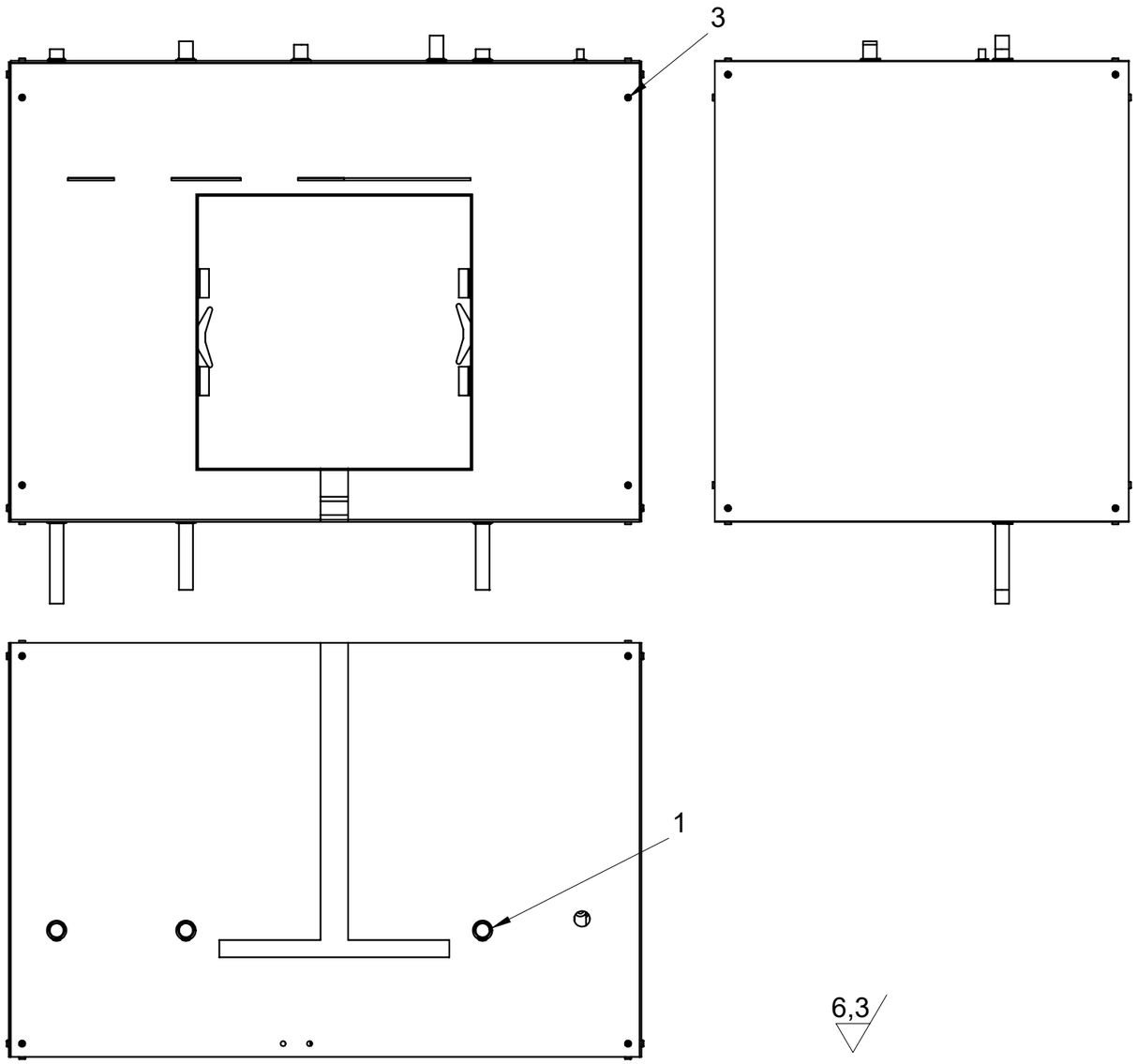


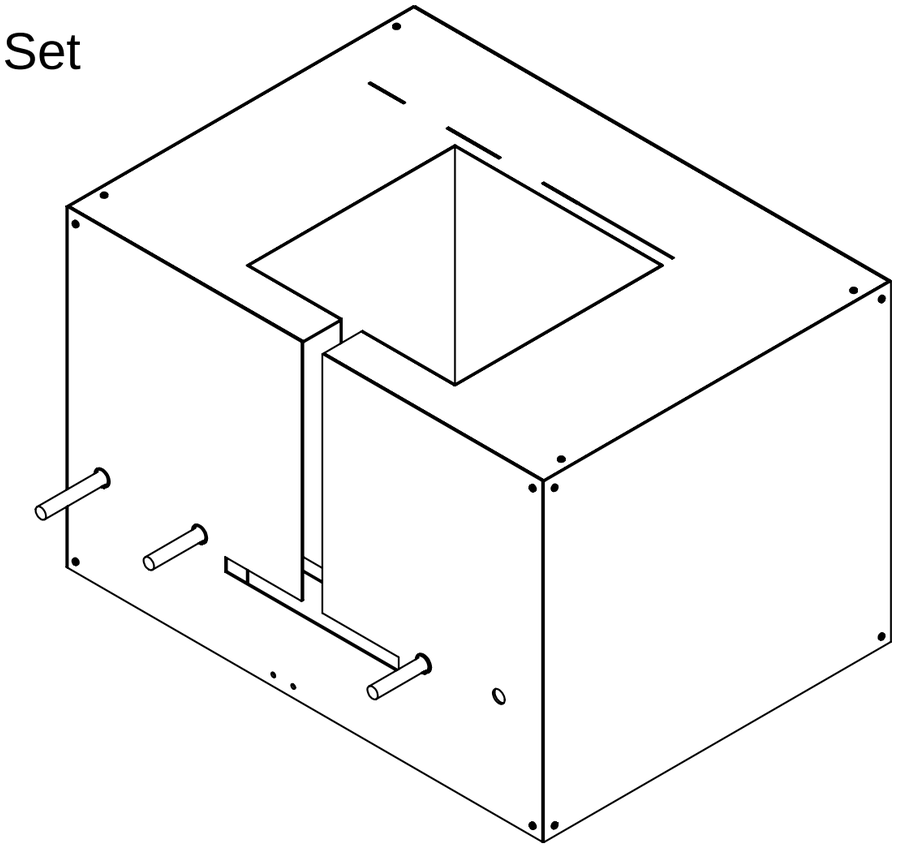
Plate dispenser
1000.Rail(2x)
1001-small rods(3x)
1002-rail mount
1003-roller bar
1100.True left rod
1101-chain wheel
1102-Left rod
1201.Puzzle plate

Appendix E Prototype

Appendix F Full Drawing Set



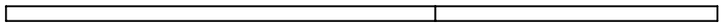


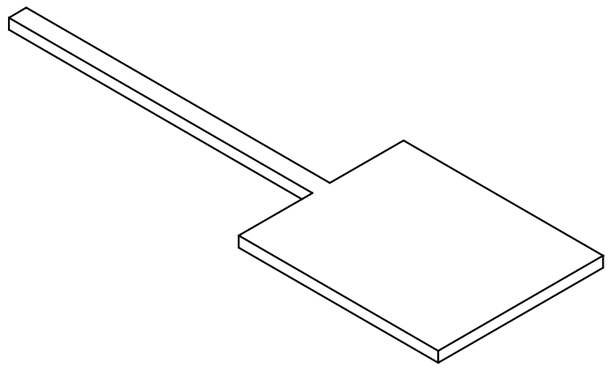


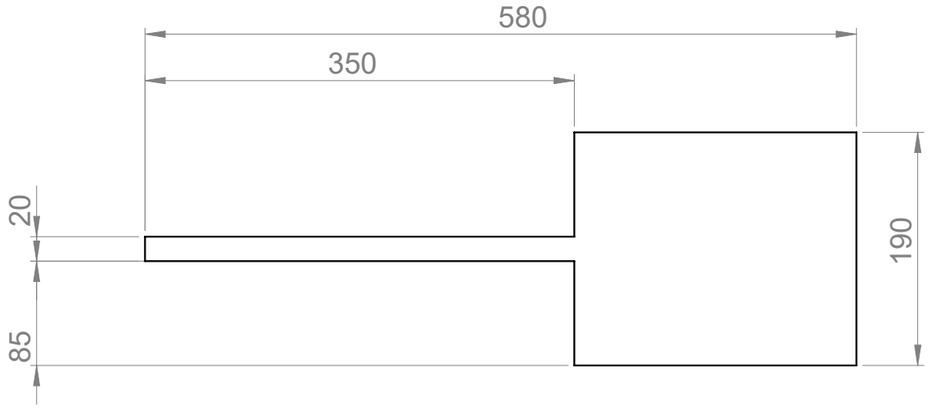
6,3

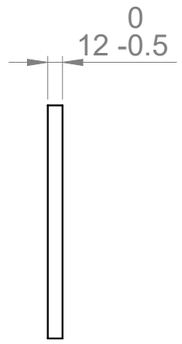
POS.	QTY.	NAME	MATERIAL	NORM / DIMENSION	REMARK
5	1	Circlip DIN 471 - 6 x 0.7			
4	9	Circlip DIN 471 - 12 x 1			
3	24	DIN 7984 - M3 x 5 --- 3.5N			
2	10	800 - Shaft			
1	13	Plate bearing 12 mm			

PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom Kluin	DATE	01/11/2018
		CHECKED	--	SCALE	1:10
MATERIAL: -- / --	SURFACE TREATMENT: --	TITLE: 000 - Closed Box Assembly		REV.	01
UNIVERSITY OF TWENTE.		DRAWING NO.: 000		A3	
FACULTY OF ENGINEERING		FILE / PART NAME: 000 - Closed		DIMENSIONS IN MILLIMETERS	SHEET 1 OF 1

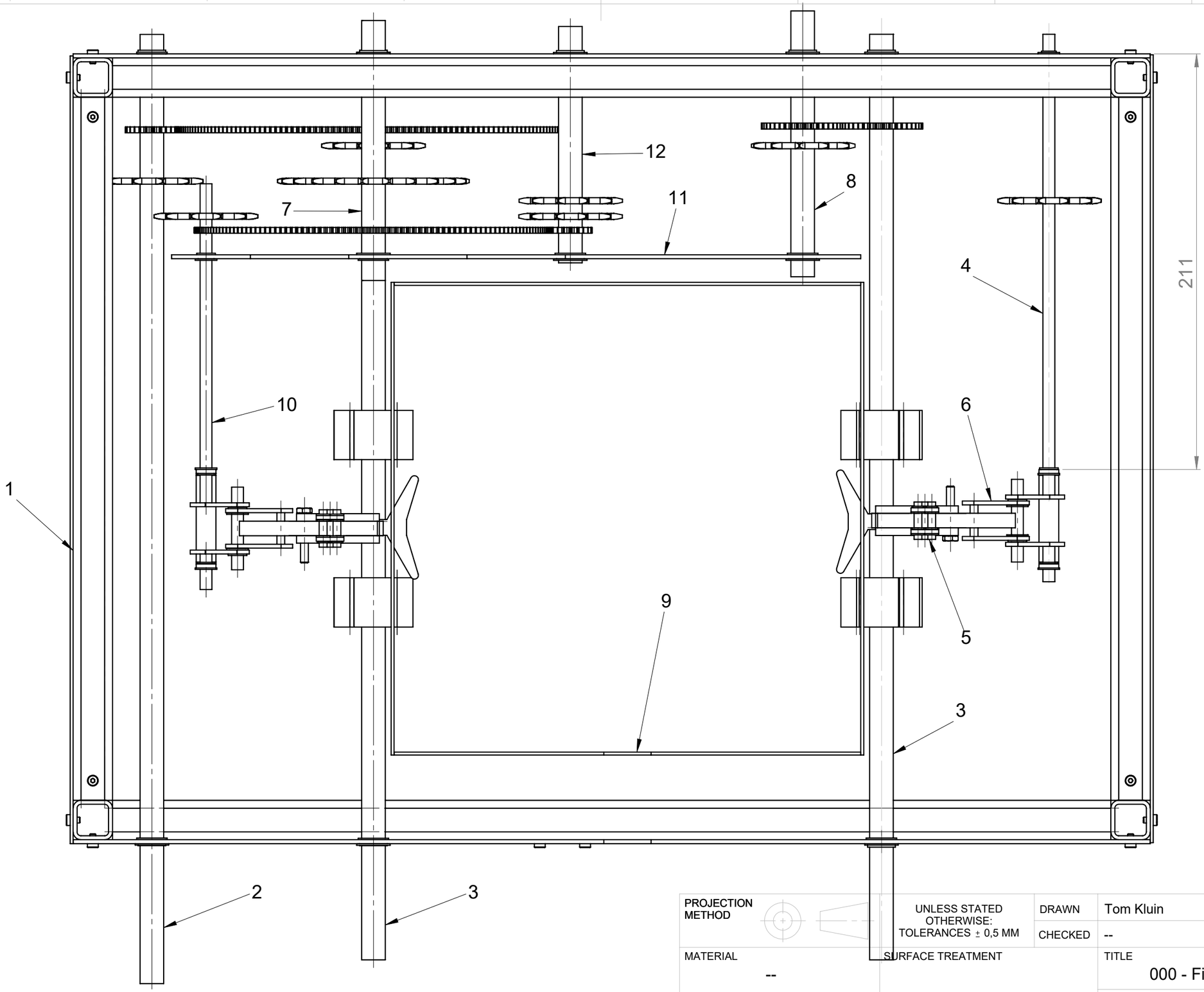






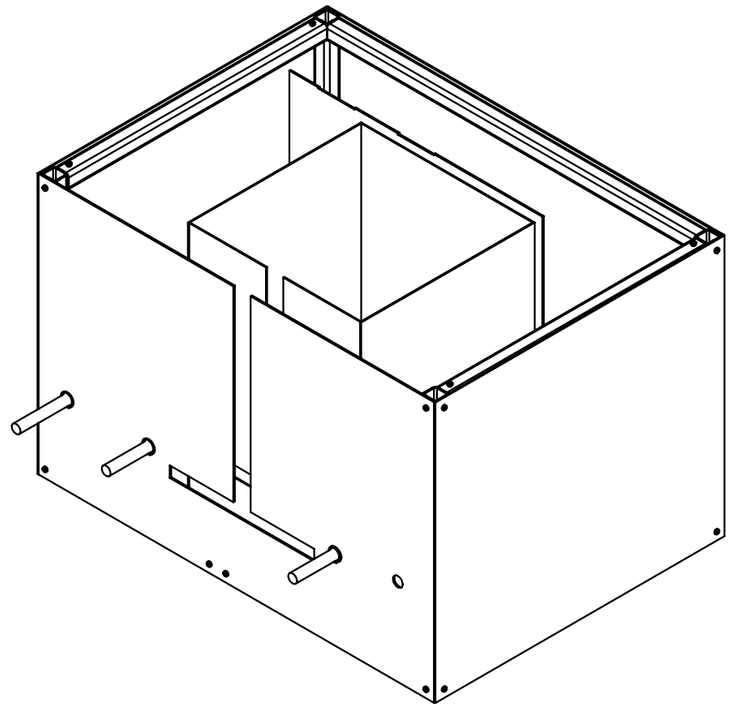


PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 2 MM	DRAWN	Auke Jaspars	DATE	11/10/2018
		CHECKED	--	SCALE	1:5
MATERIAL: Plywood --	SURFACE TREATMENT: --	TITLE: Pizza plate			REV.: 01
		DRAWING NO.: 001			
UNIVERSITY OF TWENTE.		FILE / PART NAME: 001 - Pizza plate			A3
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	



PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom Kluin	DATE	16/10/2018
		CHECKED	--	SCALE	1:2
MATERIAL: -- / --	SURFACE TREATMENT: --	TITLE: 000 - Final Assembly		REV.: 01	
UNIVERSITY OF TWENTE.		DRAWING NO.: 000		A3	
		FILE / PART NAME: 000_FinalAssembly			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 2	

POS.	QTY.	NAME	MATERIAL	NORM / DIMENSION	REMARK
12	1	800 - Small Gear Rod			
11	1	1201 - Puzzle Plate			
10	1	400 - Right Rod			
9	1	900 - Shaft			
8	1	500 - Lonesome Set			
7	1	700 - Partial Gear Rod			
6	2	600 - Locking Mechanism			
5	1	1000 - Rail			
4	1	1100 - True Left Rod			
3	1	300 - Flap Rod			
2	1	200 - Main Rod			
1	1	100 - Frame	Sheet Metal		



PROJECTION METHOD

UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM

DRAWN: Tom Kluin | DATE: 16/10/2018

CHECKED: -- | SCALE: 1:2

MATERIAL: -- / --

SURFACE TREATMENT: --

TITLE: 000 - Final Assembly

REV.: 01

DRAWING NO.: 000

FILE / PART NAME: 000_FinalAssembly

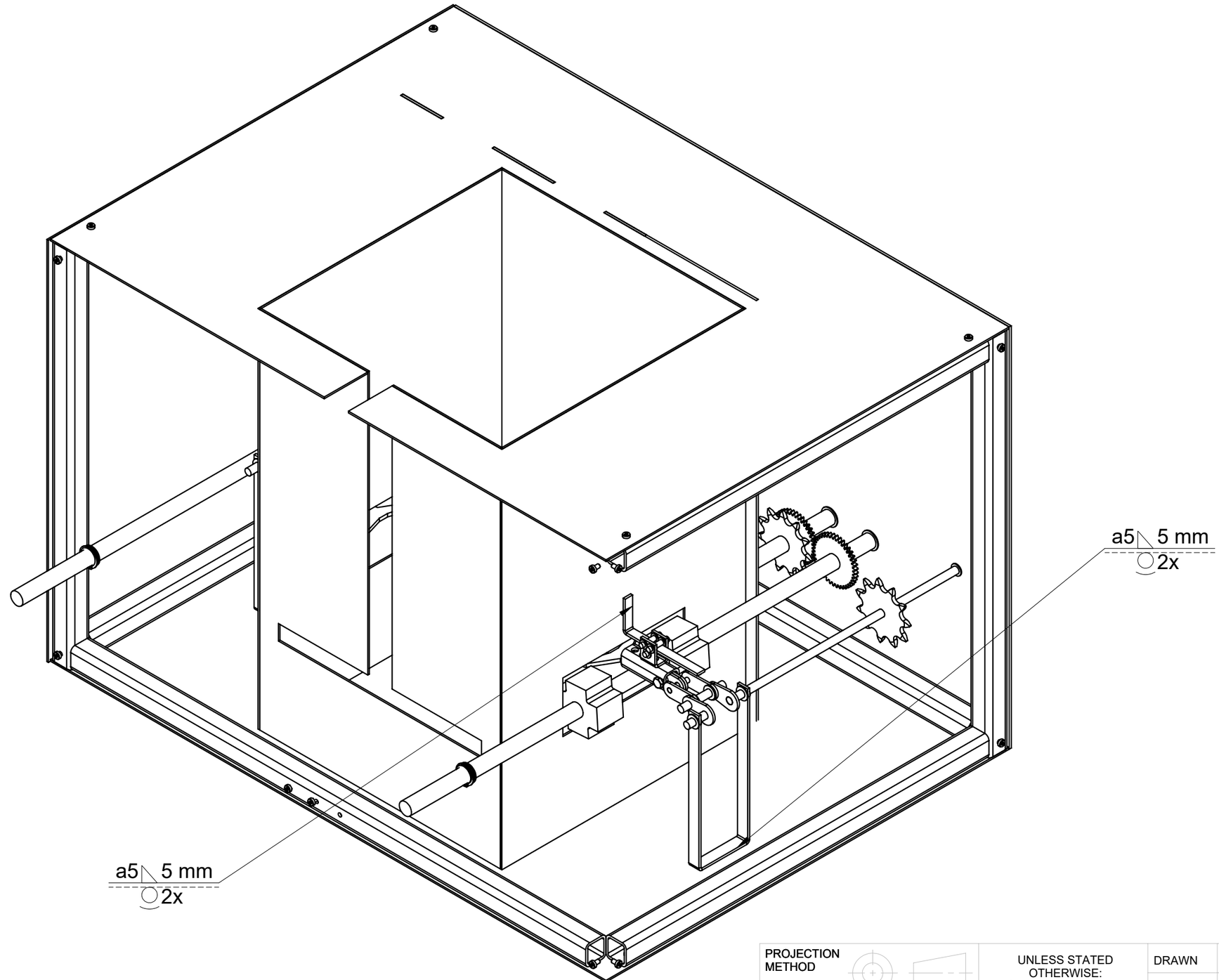
A3

UNIVERSITY OF TWENTE.

FACULTY OF ENGINEERING

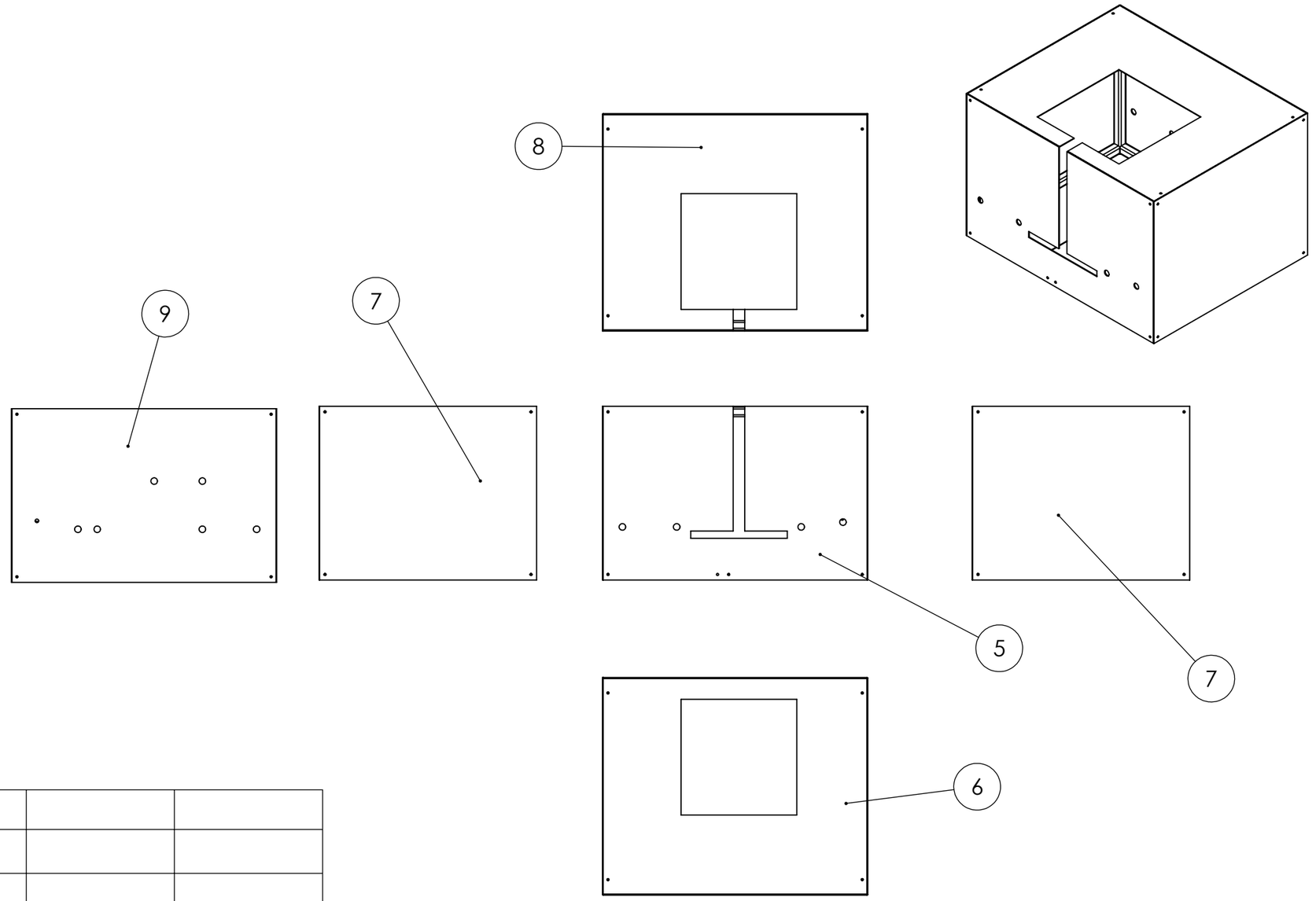
DIMENSIONS IN MILLIMETERS

SHEET 2 OF 2



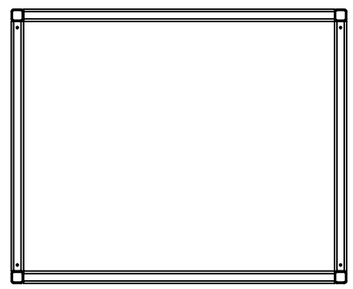
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom Kluin	DATE	07/11/2018
		CHECKED	--	SCALE	1:3

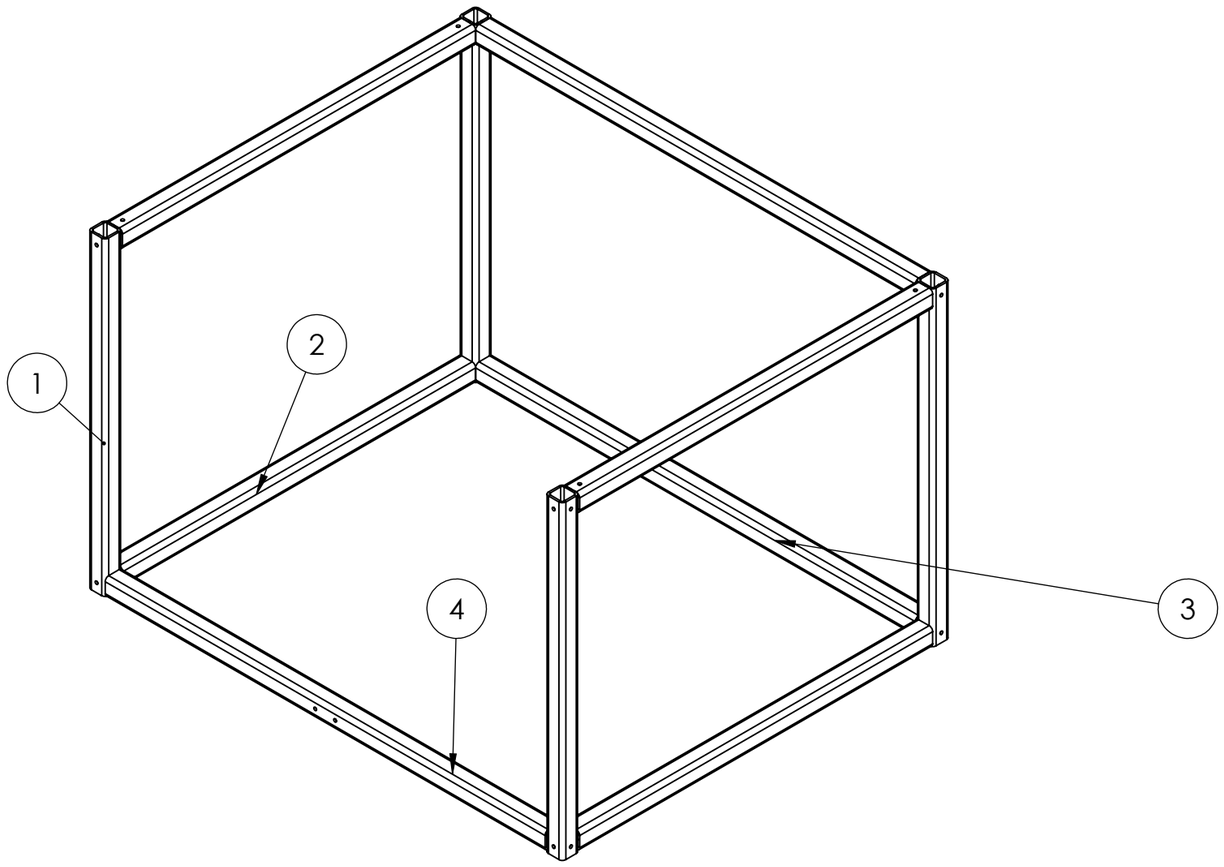
MATERIAL -- --	SURFACE TREATMENT --	TITLE 000 - Final Assembly Welds	REV. 01
		DRAWING NO. 000	
UNIVERSITY OF TWENTE.		FILE / PART NAME 000 - Final Assembly Welds	A3
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS	SHEET 1 OF 1

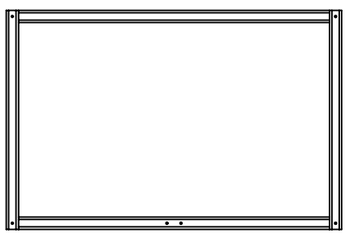


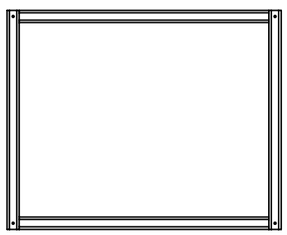
POS.	QTY.	NAME	MATERIAL	NORM / DIMENSION	REMARK
9	1	109_sheet500mm 360mmback			
8	1	110_sheet500mm 450mmTop			
7	2	108_sheet360mm 450mmSide			
6	1	107_sheet500mm 450mmBottom			
5	1	106_sheet500mm 360mmFront			
4	1	103_tube457mm2 0mmFront			See 100.1
3	2	104_tube457mm2 0mm			See 100.1
2	4	102_tube407mm2 0mm			See 100.1
1	4	101_tube357mm2 0mm			See 100.1

PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Jesper Kussendrager	DATE	12-10-2018
		CHECKED	--	SCALE	1:5
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: Assembly Frame Complete		REV.	01
UNIVERSITY OF TWENTE.		DRAWING NO.: 100			A3
FACULTY OF ENGINEERING		FILE / PART NAME: 100_AssemblyFrame		DIMENSIONS IN MILLIMETERS	SHEET 1 OF 1





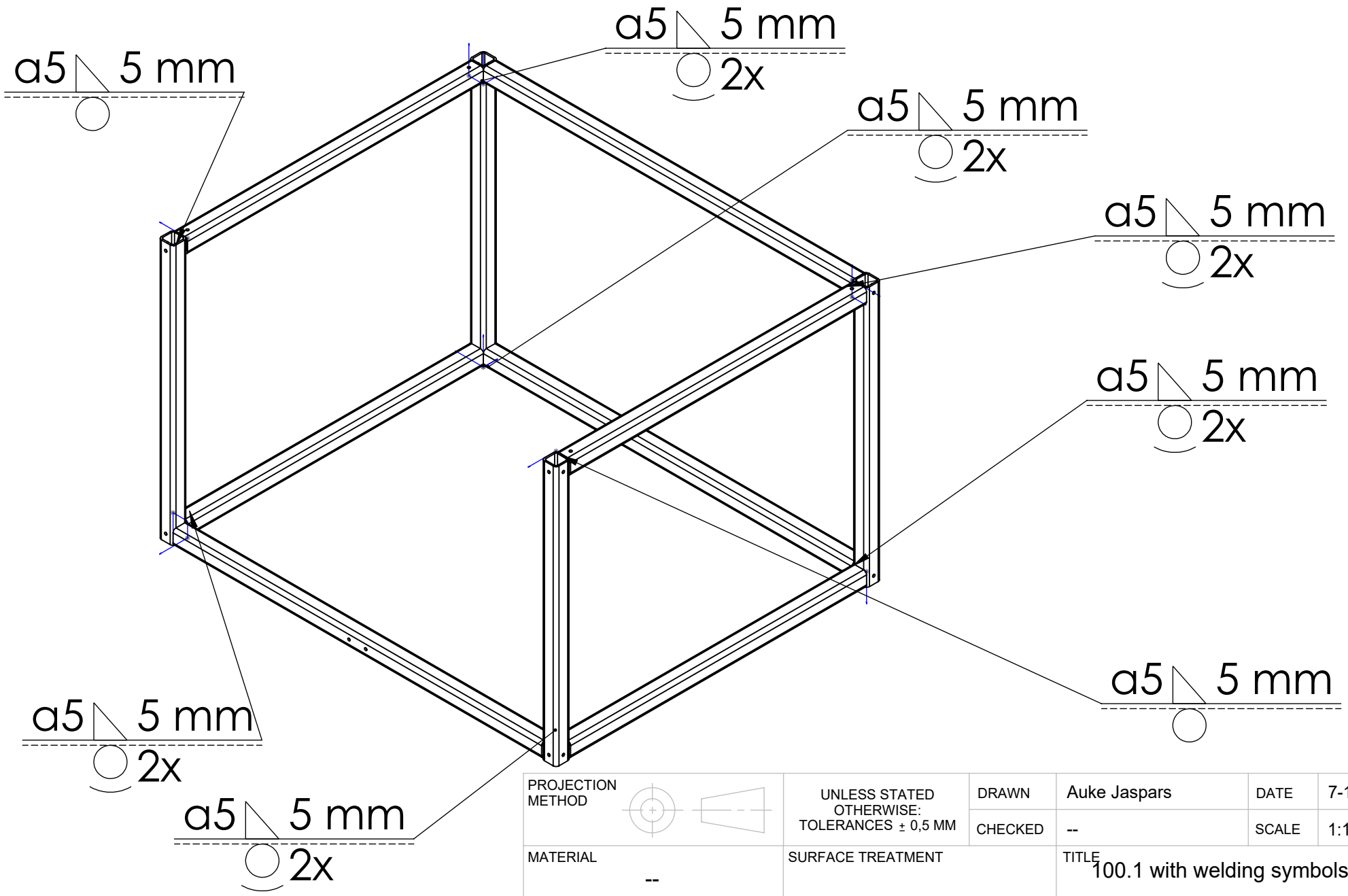




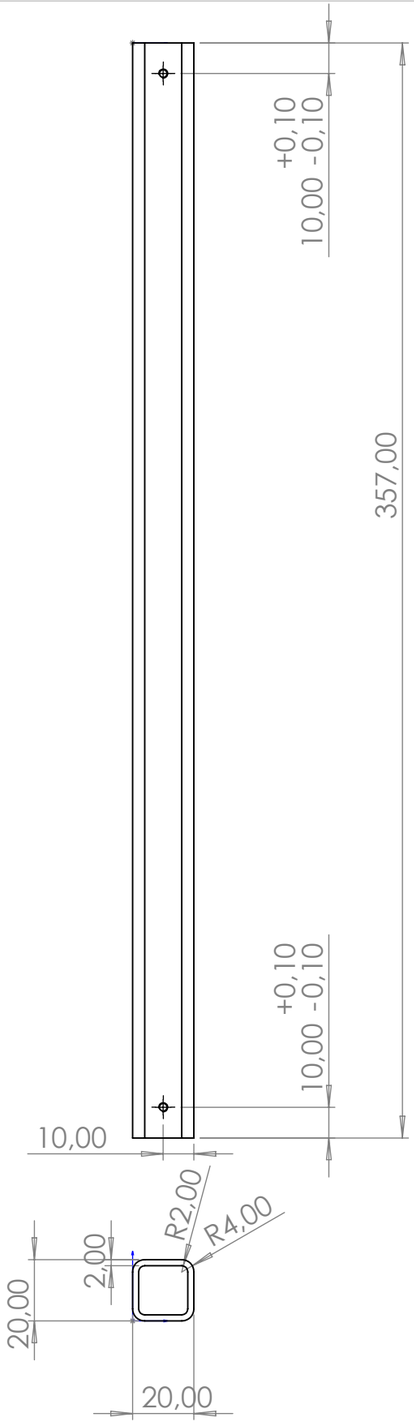
POS.	QTY.	NAME	MATERIAL	NORM / DIMENSION	REMARK
4	1	103_tube457mm20mmFront			
3	2	104_tube457mm20mm			
2	4	102_tube407mm20mm			
1	4	101_tube357mm20mm			

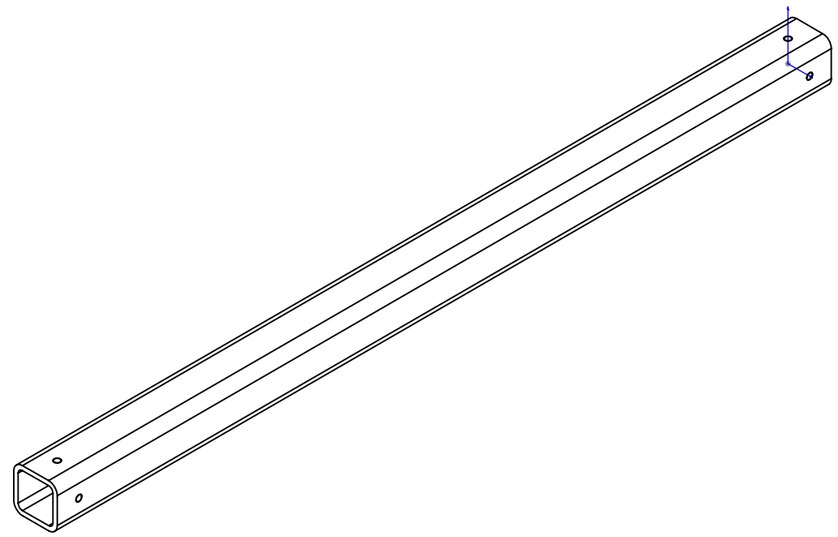
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Jesper Kussendrager	DATE	12-10-2018
		CHECKED	--	SCALE	1:5

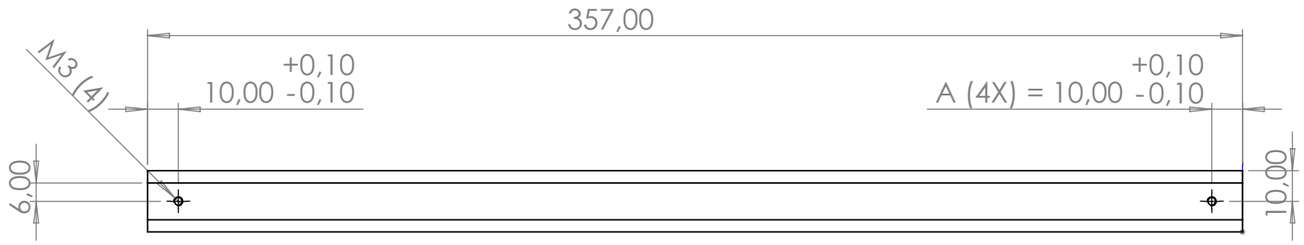
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: Assembly Tubes for Frame	REV.: 01
		DRAWING NO.: 100.1	A3
UNIVERSITY OF TWENTE.		FILE / PART NAME: 100.1_AssemblyFrameTubesOnly	
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS	SHEET 1 OF 1



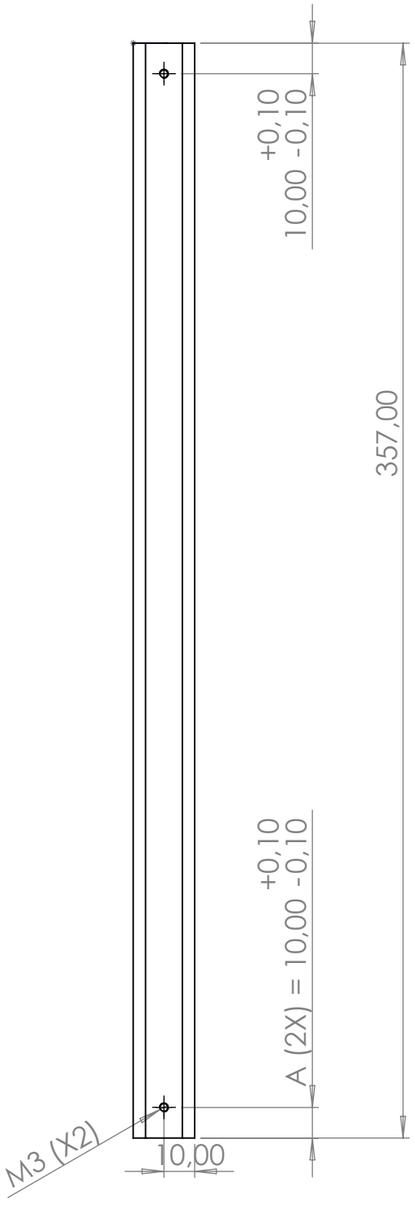
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Auke Jaspars	DATE	7-11-2018
		CHECKED	--	SCALE	1:10
MATERIAL: -- / --	SURFACE TREATMENT: --	TITLE: 100.1 with welding symbols			REV.: 01
		DRAWING NO.: 100.1			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 1MainFrame1_withouth_drawing			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	

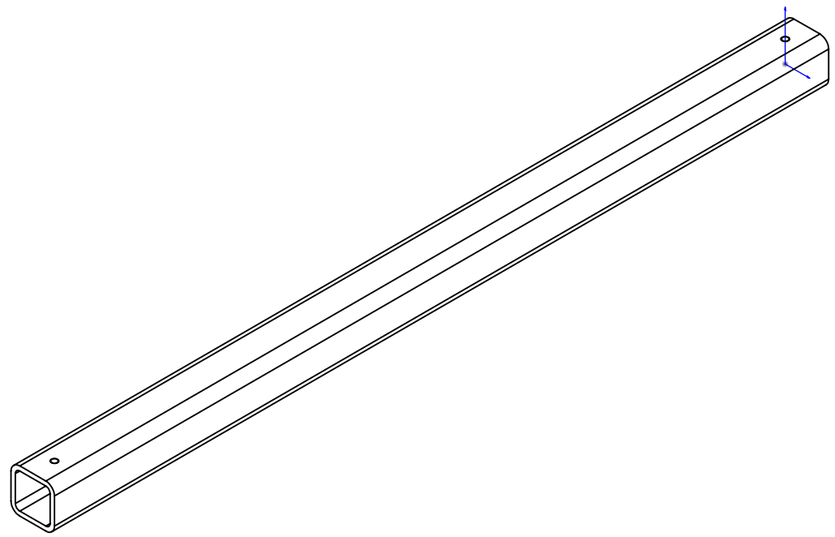


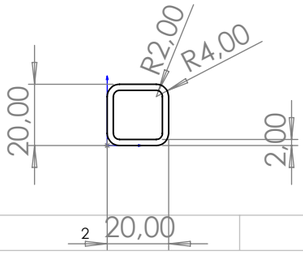




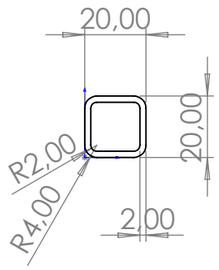
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom van Hensbergen	DATE	1-11-2018
		CHECKED	--	SCALE	1:2
MATERIAL: -- / --	SURFACE TREATMENT: --	TITLE: 101 Tube 357x20x20mm			REV. 01
UNIVERSITY OF TWENTE.		DRAWING NO.: 101			A3
FACULTY OF ENGINEERING		FILE / PART NAME: 101_tube357mm20mm_drawing			
		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	

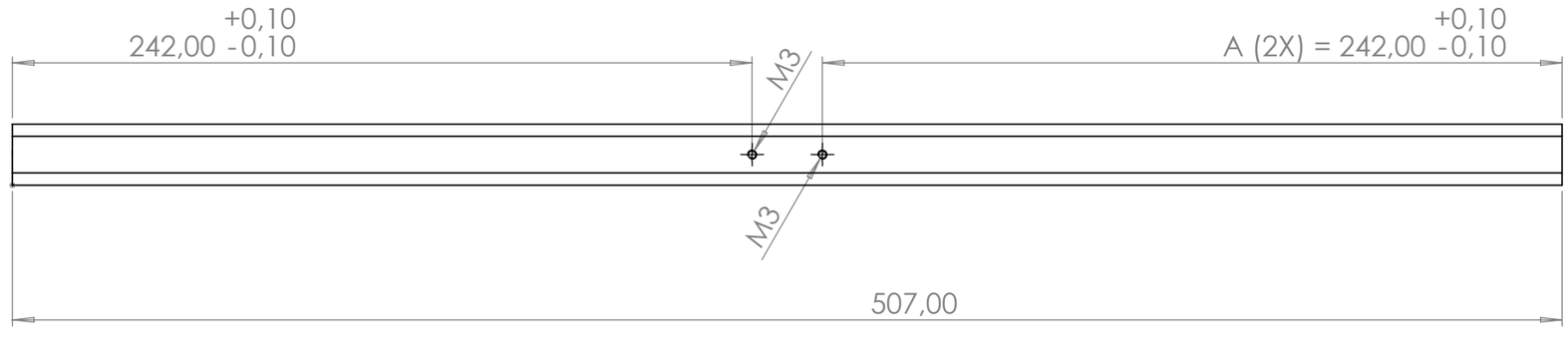




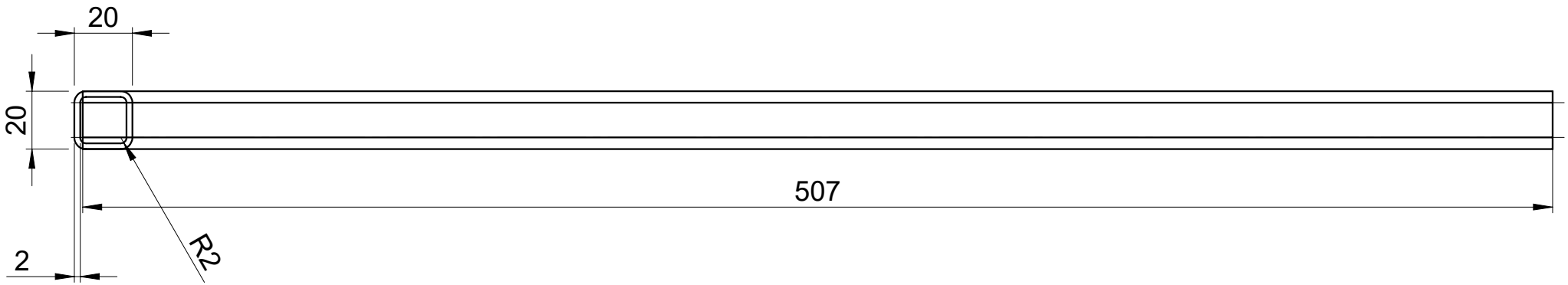


PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom van Hensbergen	DATE	1-11-2018
		CHECKED	--	SCALE	1:2
MATERIAL: -- / --	SURFACE TREATMENT: --	TITLE: 102: Tube 407x20x20mm			REV.: 01
UNIVERSITY OF TWENTE.		DRAWING NO.: 102			A3
FACULTY OF ENGINEERING		FILE / PART NAME: 102_tube407mm20mm_drawing			
		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	

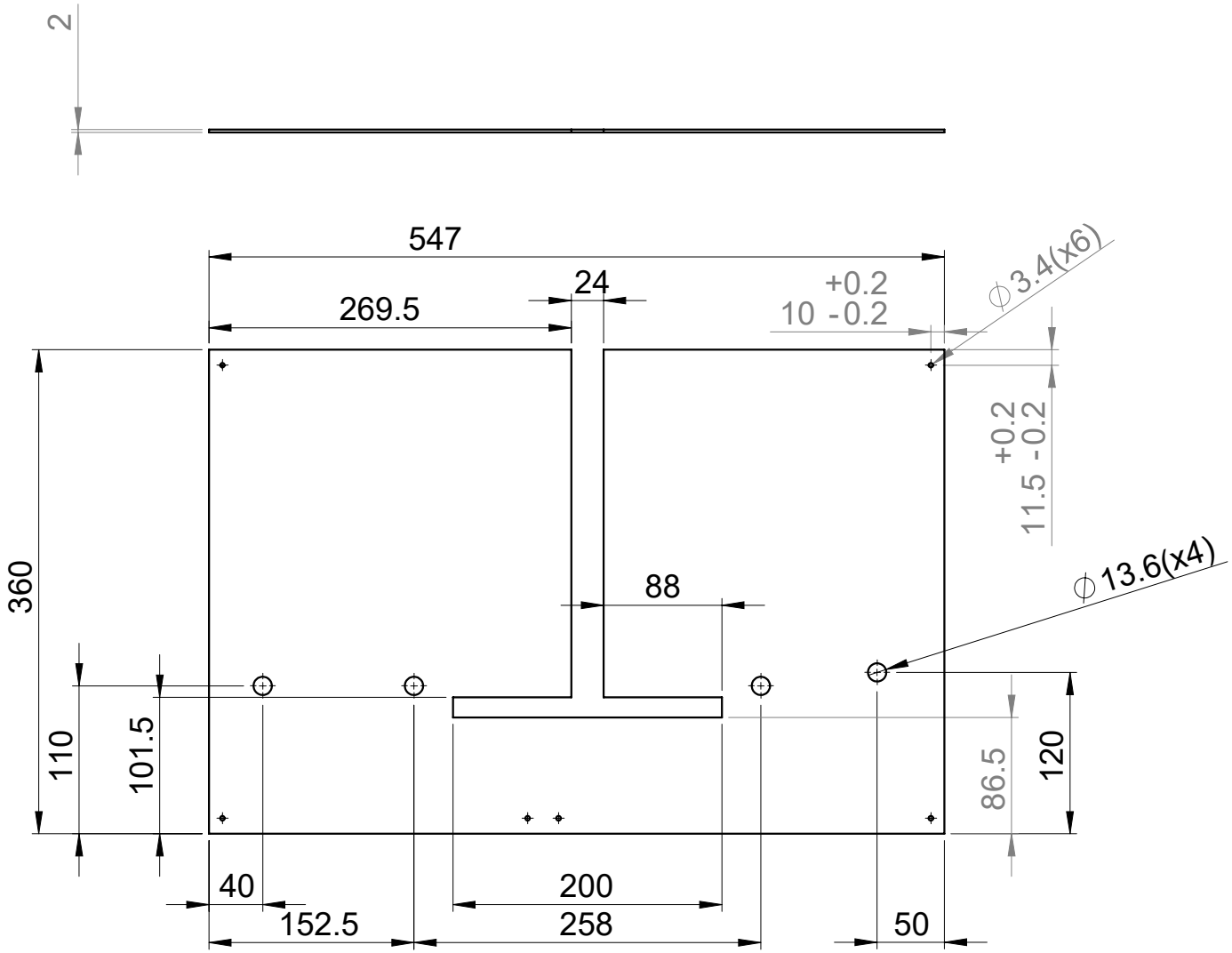




PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom van Hensbergen	DATE	2-11-2018
		CHECKED	--	SCALE	1:2
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: 103: Tube 457x20x20mm		REV.	01
		DRAWING NO.: 103			
UNIVERSITY OF TWENTE.		FILE / PART NAME: 103_tube457mm20mmFront_drawing			A3
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	

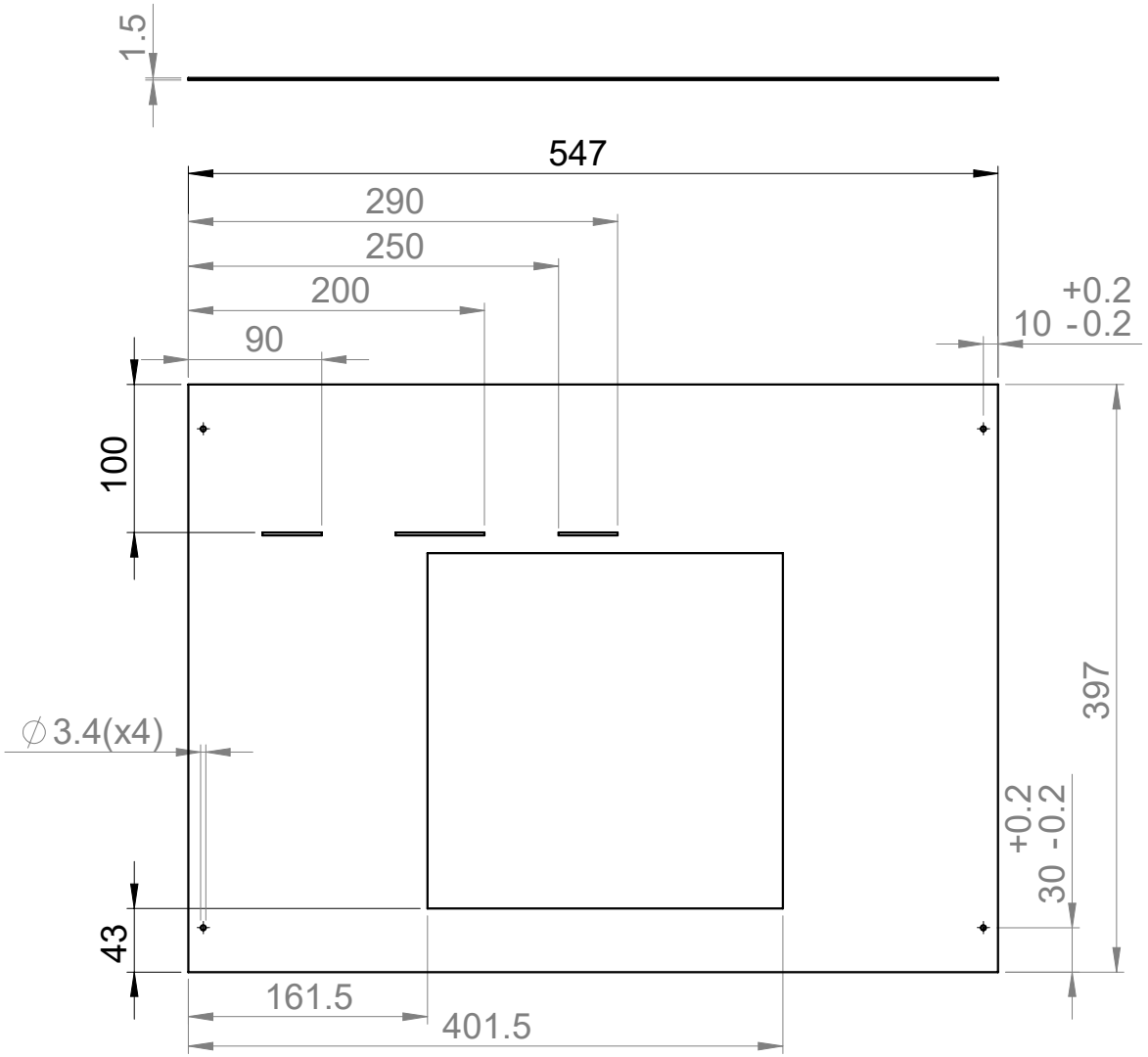


PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Bram Vloedgraven	DATE	11/10/2018
		CHECKED	--	SCALE	1:2
MATERIAL: Sheet metal --	SURFACE TREATMENT: --	TITLE: 104: Tube 457x20x20mm			REV.: 01
		DRAWING NO.: --			
UNIVERSITY OF TWENTE.		FILE / PART NAME: 104_tube457mm20mm			A4
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	



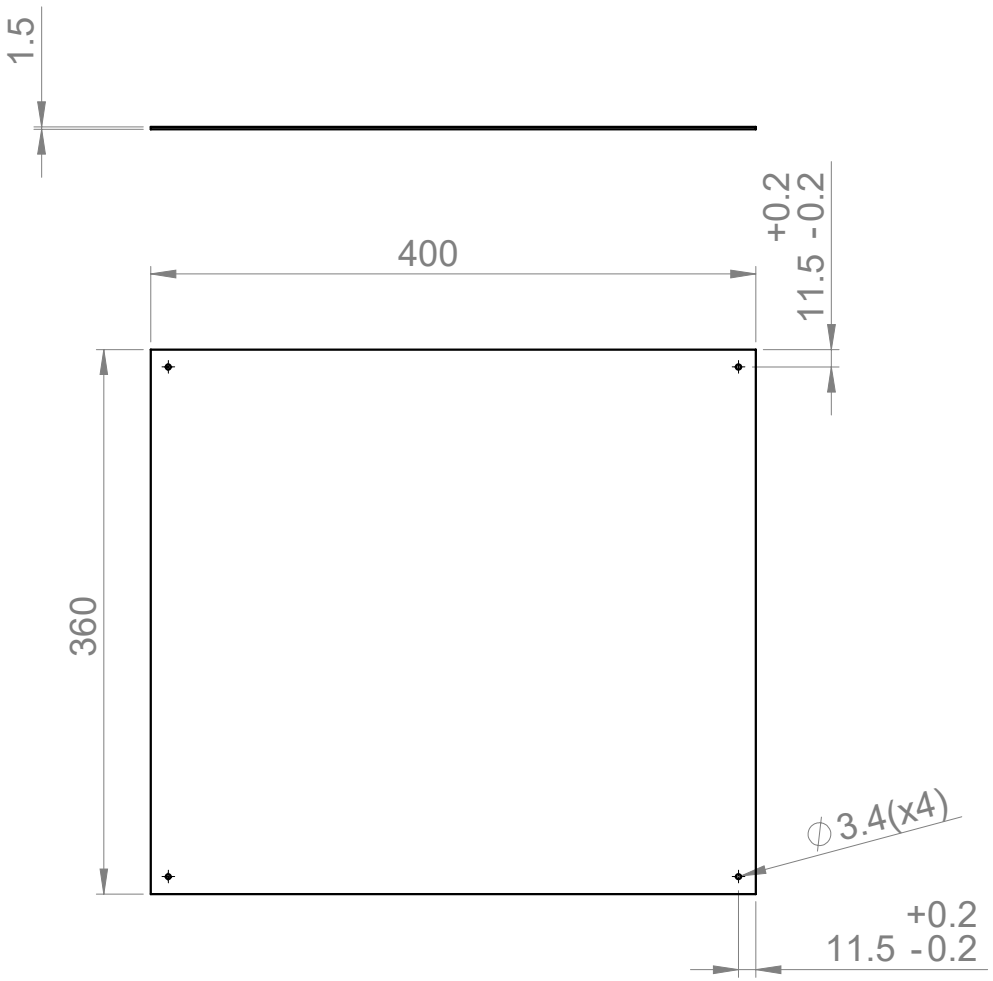
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom Kluin	DATE	01/11/2018
		CHECKED	--	SCALE	1:5
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: 106 - Front Sheet			REV.: 01
		DRAWING NO.: 106			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 106 - Front Sheet			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	

6.3



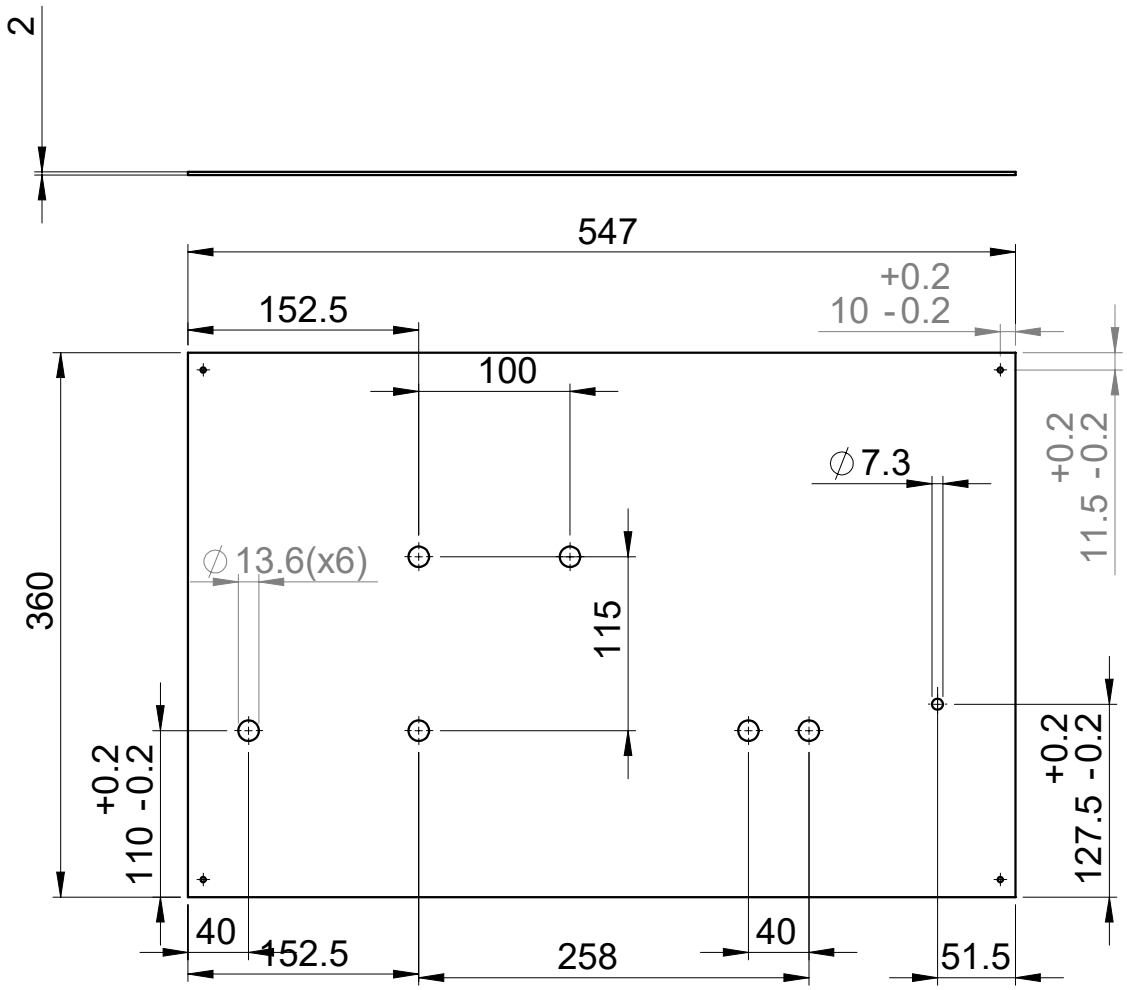
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom Kluin	DATE	01/11/2018
		CHECKED	--	SCALE	1:5
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: 107 - Bottom Sheet			REV.: 01
		DRAWING NO.: 107			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 107 - Bottom Sheet			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS			SHEET 1 OF 1

6.3



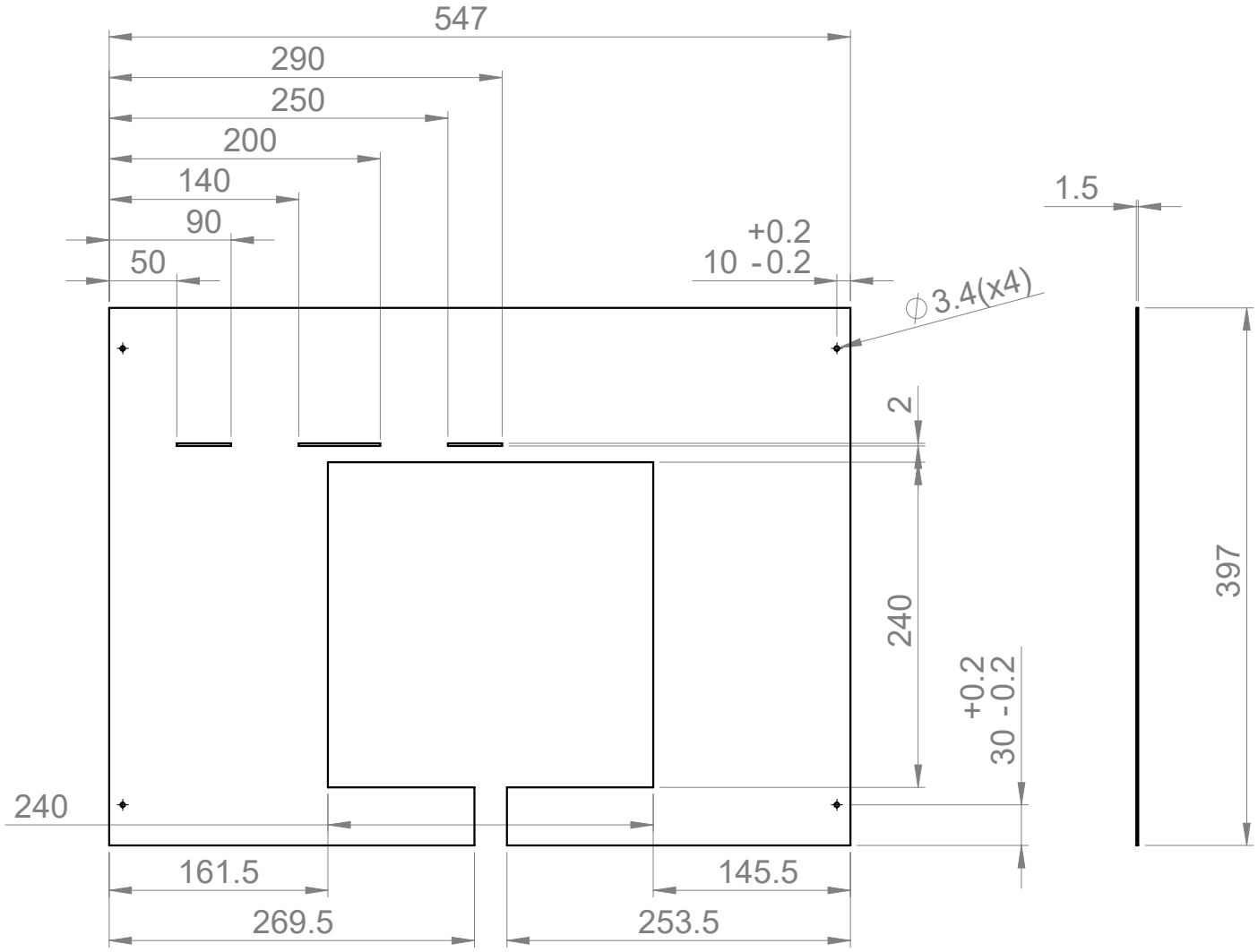
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom Kluin	DATE	01/11/2018
		CHECKED	--	SCALE	1:5
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: 108 - Side Sheet			REV. 01
		DRAWING NO.: 108			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 108 - Side Sheet			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	

6.3



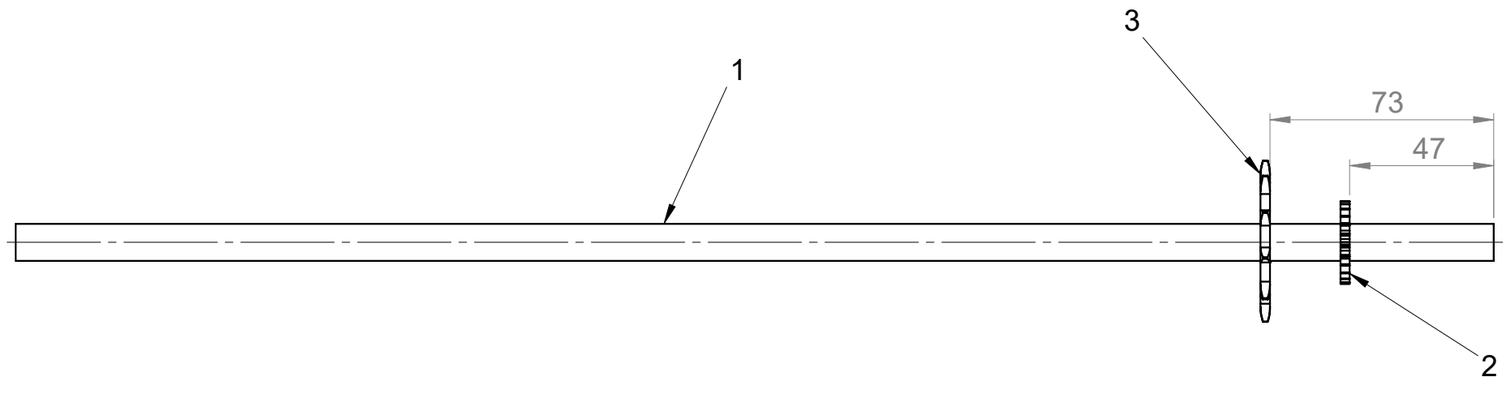
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom Kluin	DATE	01/11/2018
		CHECKED	--	SCALE	1:5
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: 109 - Back Sheet			REV.: 01
		DRAWING NO.: 109			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 109 - Back Sheet			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS			SHEET 1 OF 1

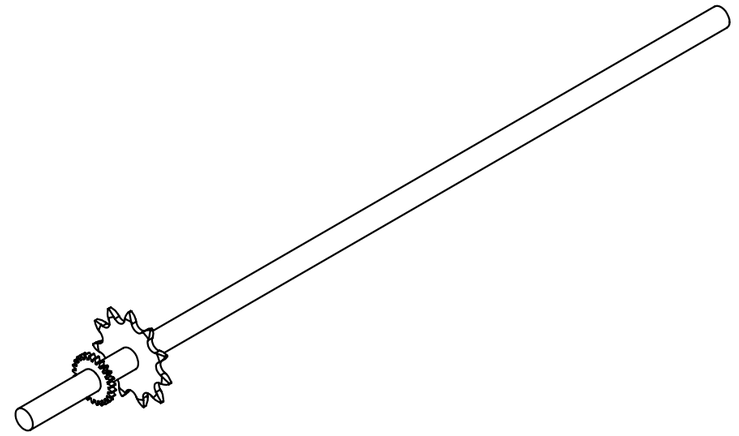
6.3

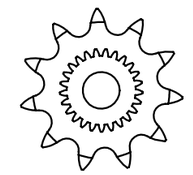


PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom Kluin	DATE	01/11/2018
		CHECKED	--	SCALE	1:5
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: 110 - Top Sheet			REV.: 01
		DRAWING NO.: 110			
UNIVERSITY OF TWENTE.		FILE / PART NAME: 110 - Top Sheet			A4
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	

6.3





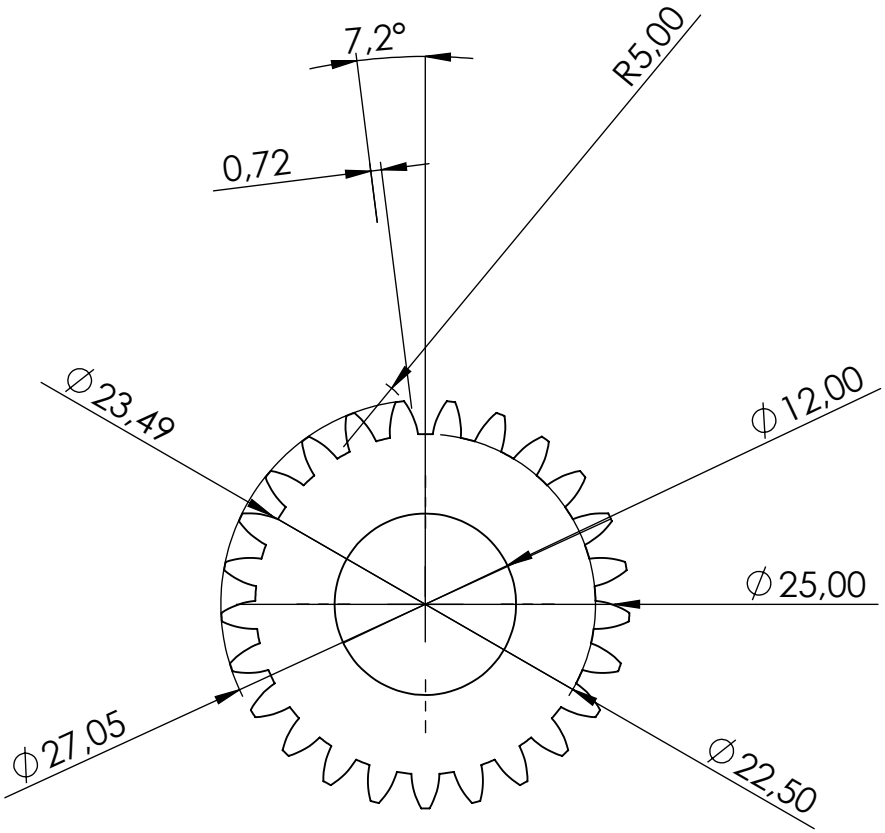


POS.	QTY.	NAME	MATERIAL	NORM / DIMENSION	REMARK
3	1	501 - Chain wheel ISO - 11Z 081 -- 11SA12.0N			
2	1	203 - ISO - Spur gear 1M 25T 20PA 3FW --- S25A75H50L12.0 N			
1	1	202 - Main rod			

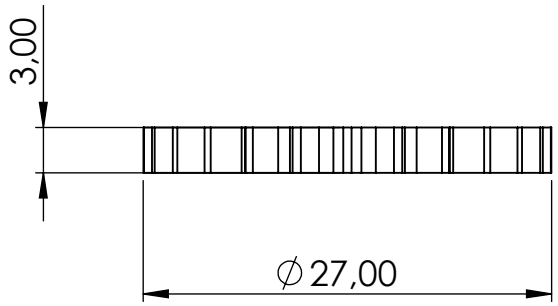
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom Kluin	DATE	01/11/2018
		CHECKED	--	SCALE	1:2
MATERIAL: -- / --	SURFACE TREATMENT: --	TITLE: 200 - Main Rod			REV.: 01
		DRAWING NO.: 200			
UNIVERSITY OF TWENTE.		FILE / PART NAME: 200 - Main Rod Assembly			A3
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	

6.3

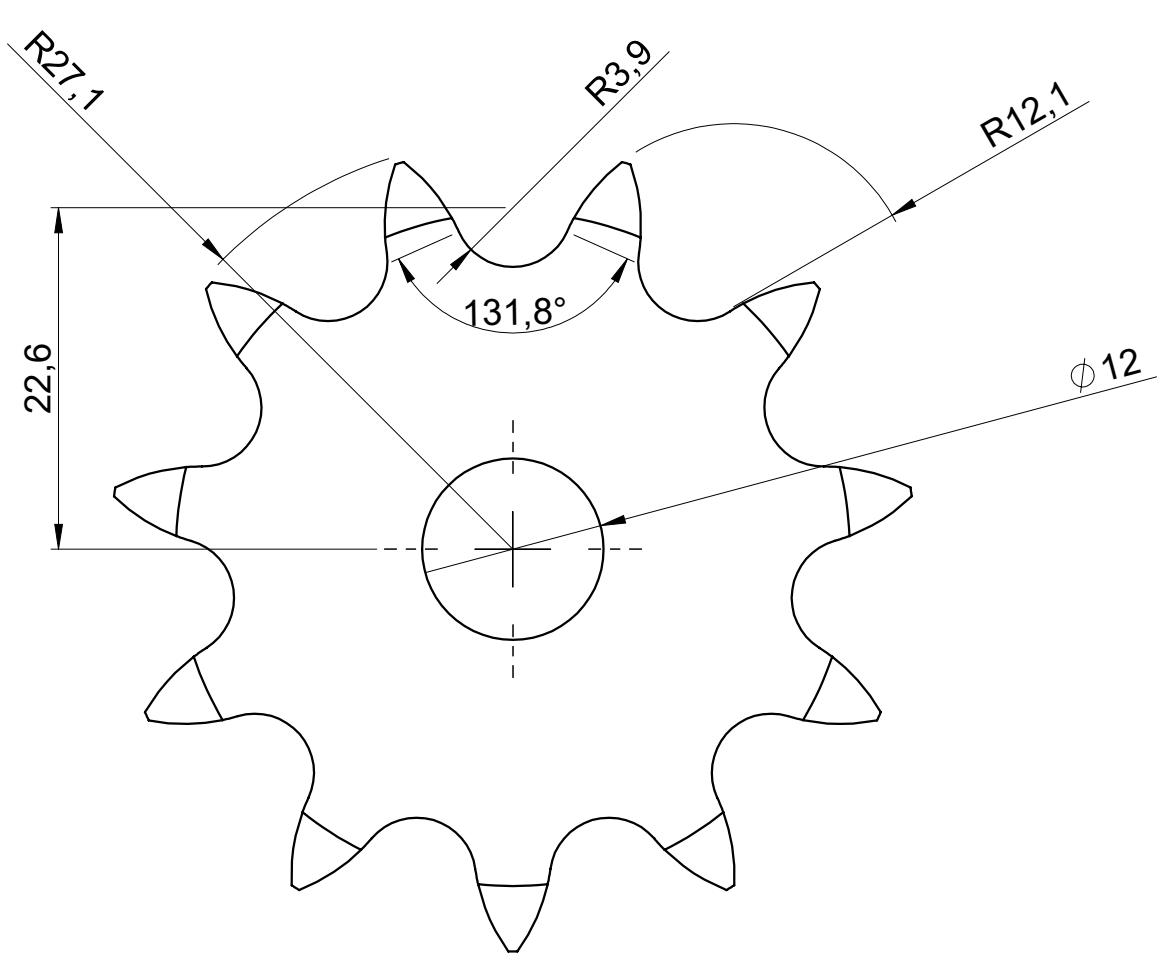
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Bram Vloedgraven	DATE	1-11-2018
		CHECKED	--	SCALE	1:2
MATERIAL: Solid steel rod / --	SURFACE TREATMENT: --	TITLE: 202 - Main rod			REV.: 01
		DRAWING NO.: 202			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 202 - Main rod			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS			SHEET 1 OF 1

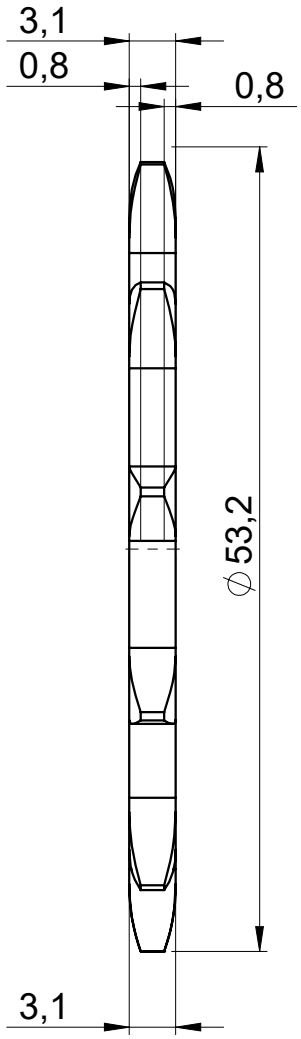


Number of teeth	25
Module	1
Pressure angle	20

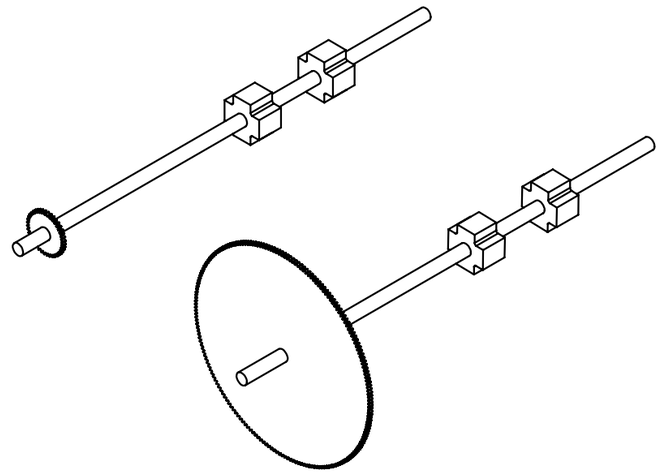


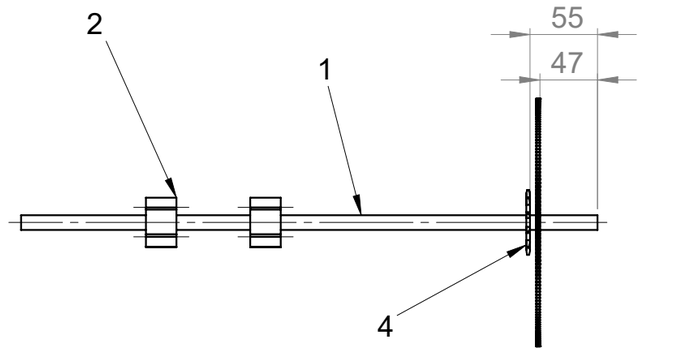
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Auke Jaspars	DATE	11-10-2018
		CHECKED	--	SCALE	2:1
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: 25 mm Gear			REV.: 01
		DRAWING NO.: 203			
UNIVERSITY OF TWENTE.		FILE / PART NAME: 25 mm gear drawing 203			A4
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	

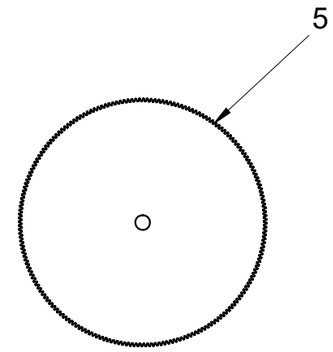


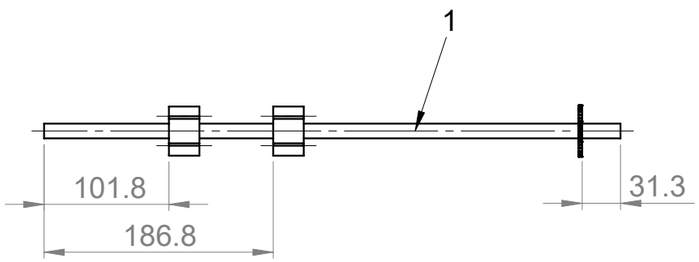


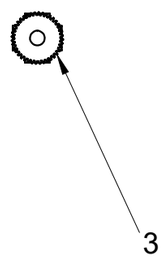
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Bram Vloedgraven	DATE	11-10-2018
		CHECKED	--	SCALE	2:1
MATERIAL: Sheet metal --	SURFACE TREATMENT: --	TITLE: 501 - Chain wheel ISO - 11Z 081 --11SA12.0N			REV. 01
		DRAWING NO.: --			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 501 - Chain wheel ISO - 11Z 081 --11SA12.0N			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	











6.3

POS.	QTY.	NAME	MATERIAL	NORM / DIMENSION	REMARK
5	1	305 - ISO - Spur gear 1M 200T 20PA 3FW --- S200A75H50L12.0N			
4	1	301 - Chain wheel ISO - 11Z 081 -- 11SA12.0N			
3	1	302 - ISO - Spur gear 1M 40T 20PA 3FW --- S40A75H50L12.0N			
2	4	303 - Flap			
1	2	304 - Rod			

PROJECTION METHOD

UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM

DRAWN: Tom Kluin | DATE: 01/11/2018

CHECKED: -- | SCALE: 1:5

MATERIAL: -- / --

SURFACE TREATMENT: --

TITLE: 300 - Flap Assembly

REV.: 01

DRAWING NO.: 300

FILE / PART NAME: 300 - Flap Assembly

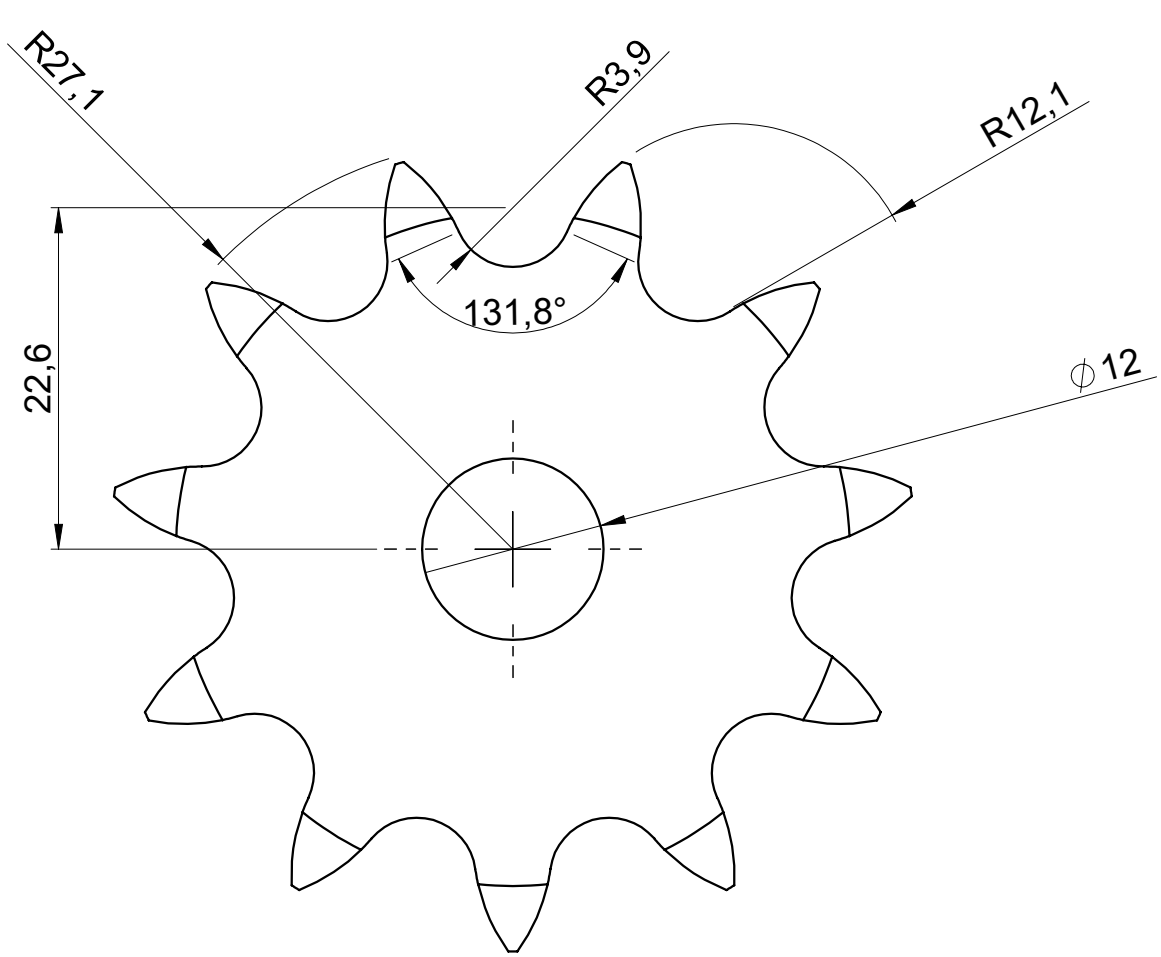
UNIVERSITY OF TWENTE.

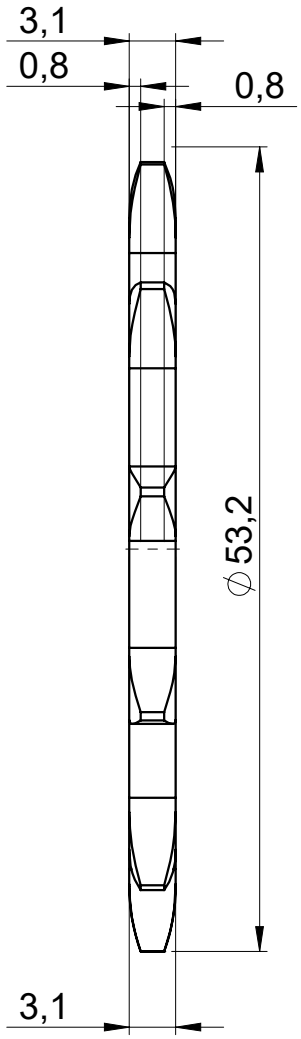
FACULTY OF ENGINEERING

A3

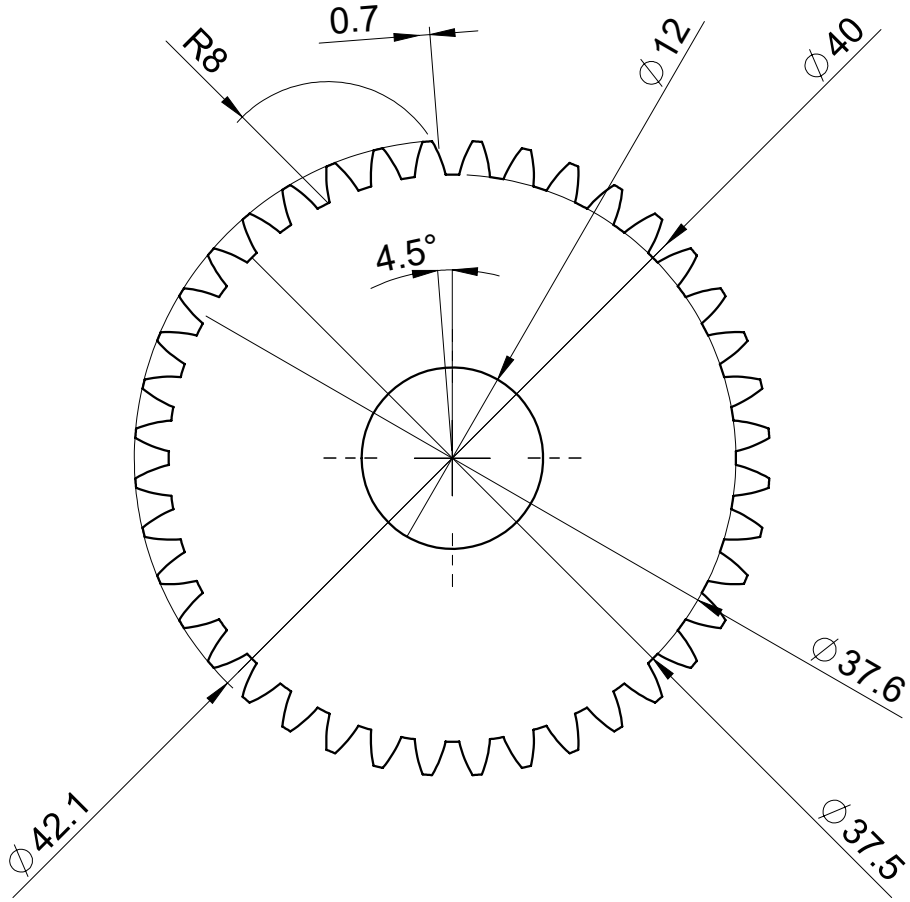
DIMENSIONS IN MILLIMETERS

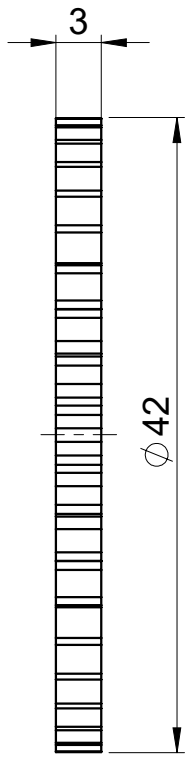
SHEET 1 OF 1



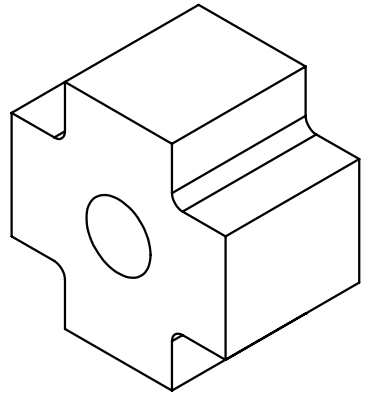


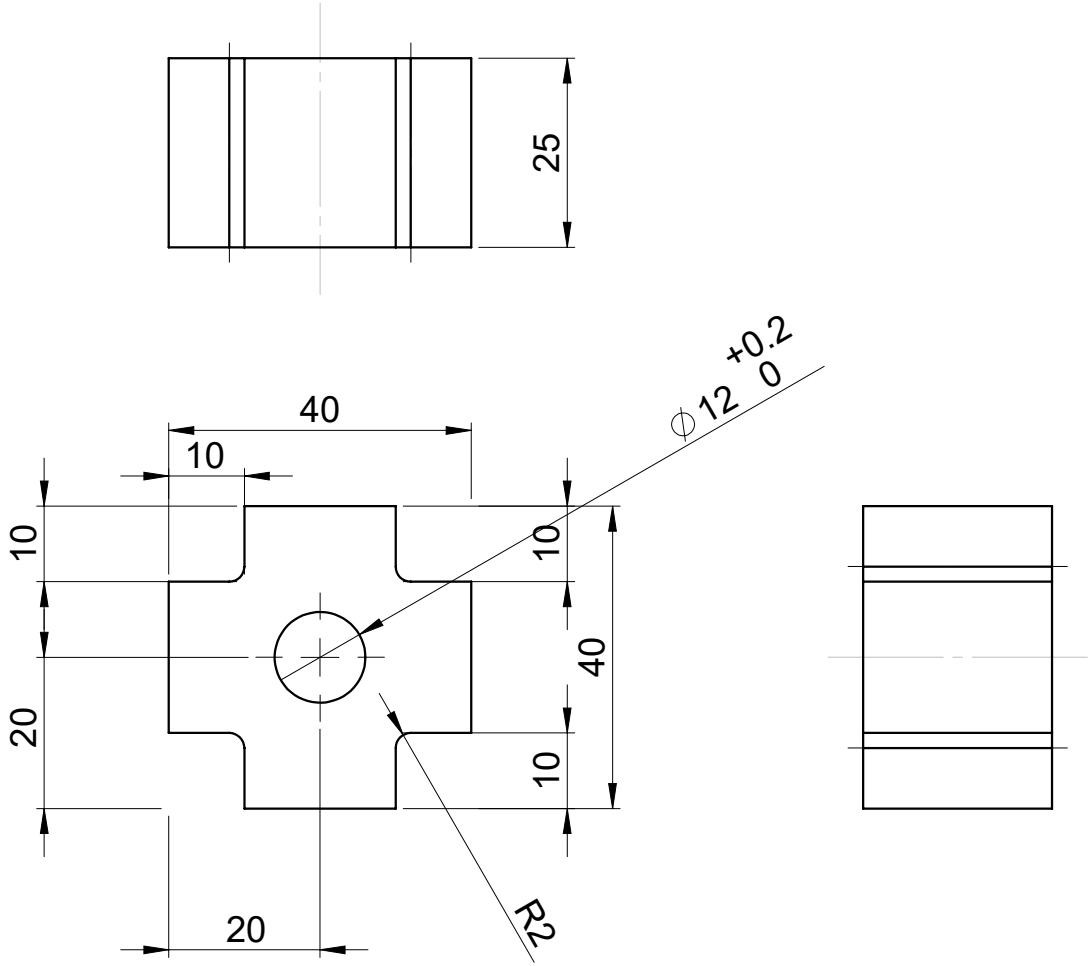
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Bram Vloedgraven	DATE	11-10-2018
		CHECKED	--	SCALE	2:1
MATERIAL: Sheet metal --	SURFACE TREATMENT: --	TITLE: 501 - Chain wheel ISO - 11Z 081 --11SA12.0N			REV. 01
		DRAWING NO.: --			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 501 - Chain wheel ISO - 11Z 081 --11SA12.0N			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	



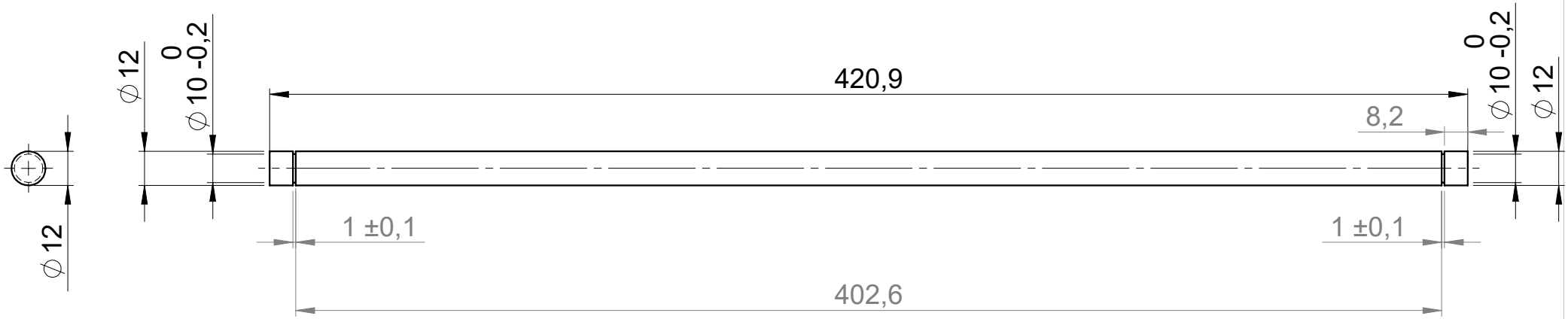


PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom Kluin	DATE	11/10/2018
		CHECKED	--	SCALE	2:1
MATERIAL: Sheet metal --	SURFACE TREATMENT: --	TITLE: 302 - Spur Gear 40 Teeth			REV. 01
		DRAWING NO. 302			
UNIVERSITY OF TWENTE.		FILE / PART NAME: 302 - ISO - Spur gear 1M 40T 20PA 3FW --- S40A75H50L12.0 N			A4
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	

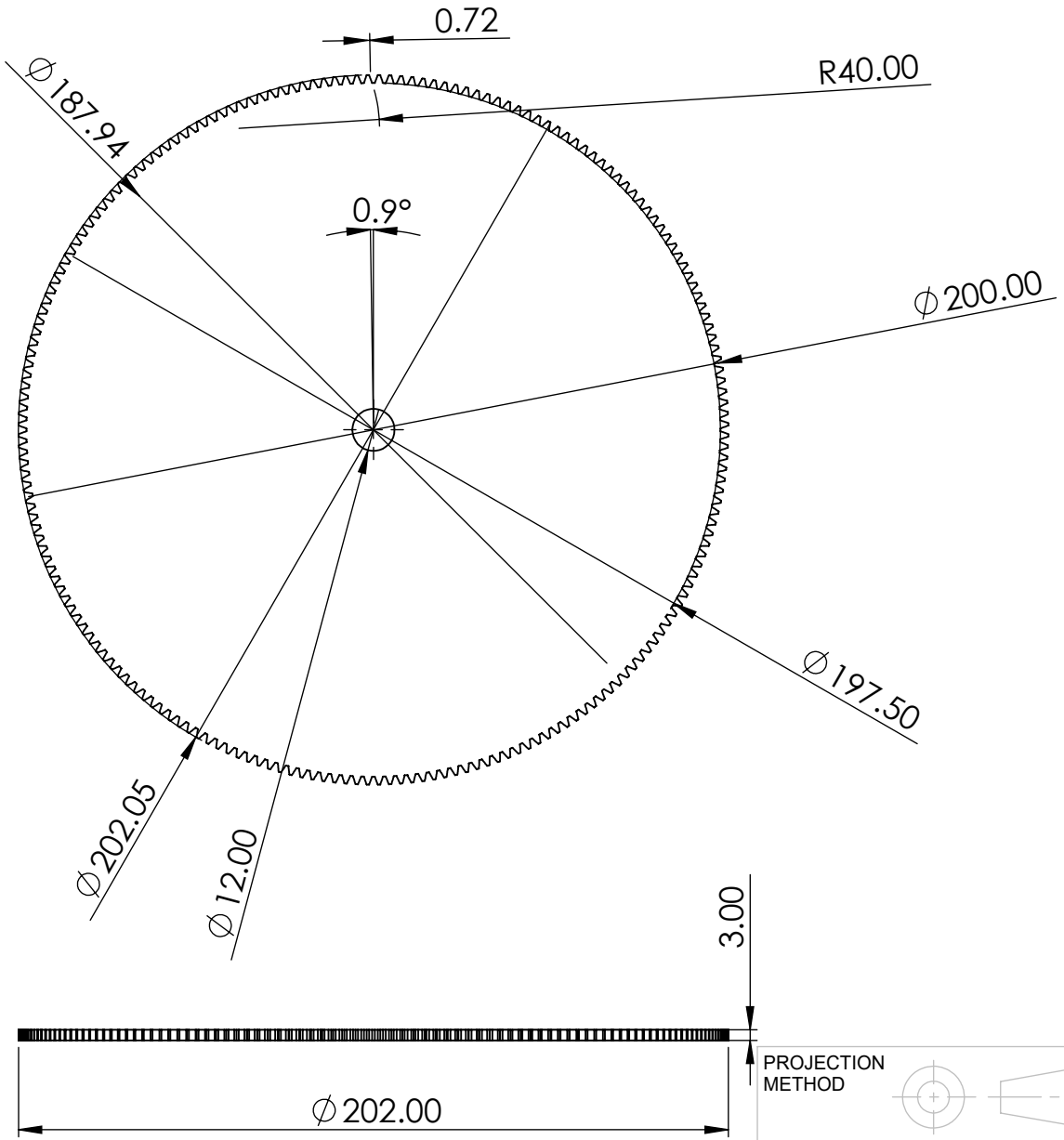




PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom Kluin	DATE	15/10/2018
		CHECKED	--	SCALE	1:1
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: 303 - Flap			REV.: 01
		DRAWING NO.: 303			
UNIVERSITY OF TWENTE.		FILE / PART NAME: 303 - Flaps			A4
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS			SHEET 1 OF 1



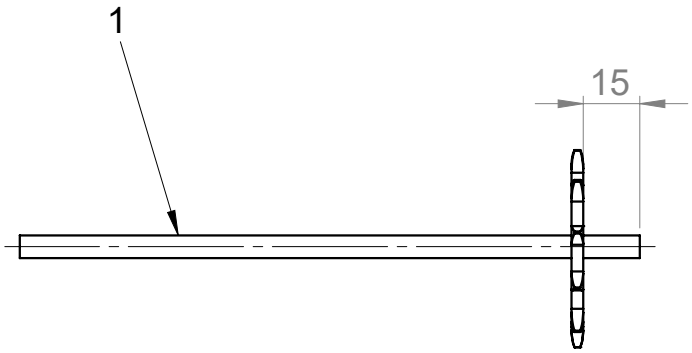
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Bram Vloedgraven	DATE	1-11-2018
		CHECKED	--	SCALE	1:2
MATERIAL: Solid steel rod --	SURFACE TREATMENT: --	TITLE: 304 Rod			REV.: 01
		DRAWING NO.: 304			
UNIVERSITY OF TWENTE.		FILE / PART NAME: 304 - rod			A4
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS			SHEET 1 OF 1

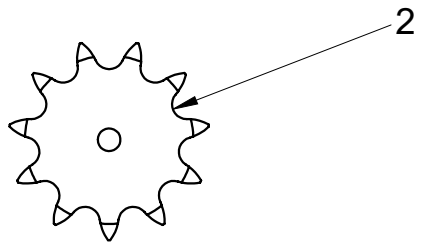


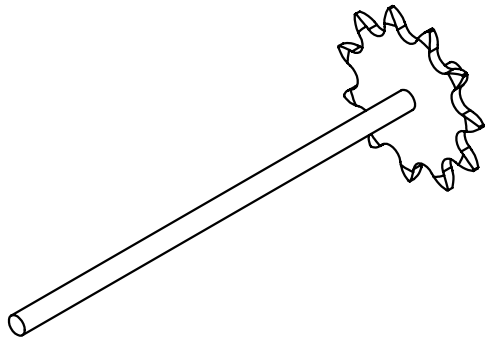
Number of teeth	200
Module	1
Pressure angle	20

PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Auke Jaspars	DATE	11/10/2018
		CHECKED	--	SCALE	1:2

MATERIAL	SURFACE TREATMENT	TITLE	REV.
--	--	305 - Spur Gear 200 mm	01
--	--	DRAWING NO. 305	A4
UNIVERSITY OF TWENTE.		FILE / PART NAME 305 - ISO - Spur gear 1M 200T 20PA 3FW --- S200A75H50L12. 0N	
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS	SHEET 1 OF 1







POS.	QTY.	NAME	MATERIAL	NORM / DIMENSION	REMARK
2	1	1101 - Chain wheel ISO - 11Z 081 --11SA6.0N			
1	1	401 - Right Rod			

PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom Kluin	DATE	01/11/2018
		CHECKED	--	SCALE	1:2

MATERIAL -- --	SURFACE TREATMENT --	TITLE 400 - Right Rod	REV. 01
		DRAWING NO. 400	A4
		FILE / PART NAME 400 - Right Rod	

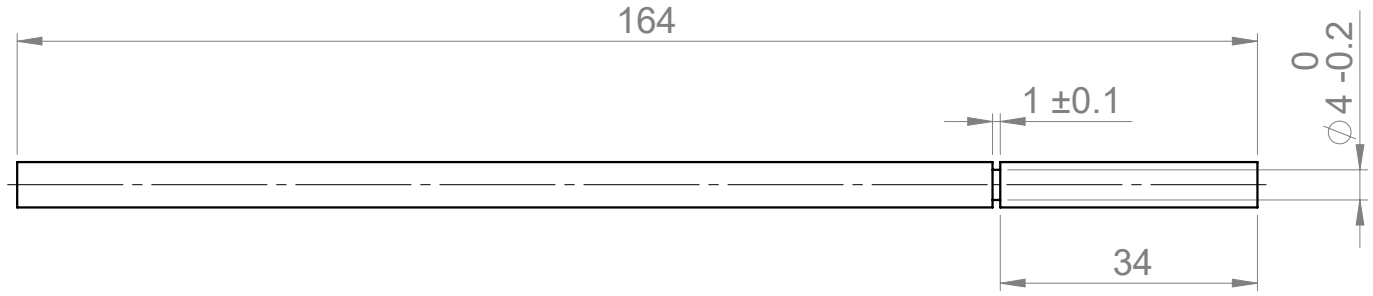
UNIVERSITY OF TWENTE.

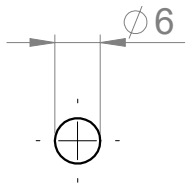
FACULTY OF ENGINEERING

DIMENSIONS IN MILLIMETERS

SHEET 1 OF 1

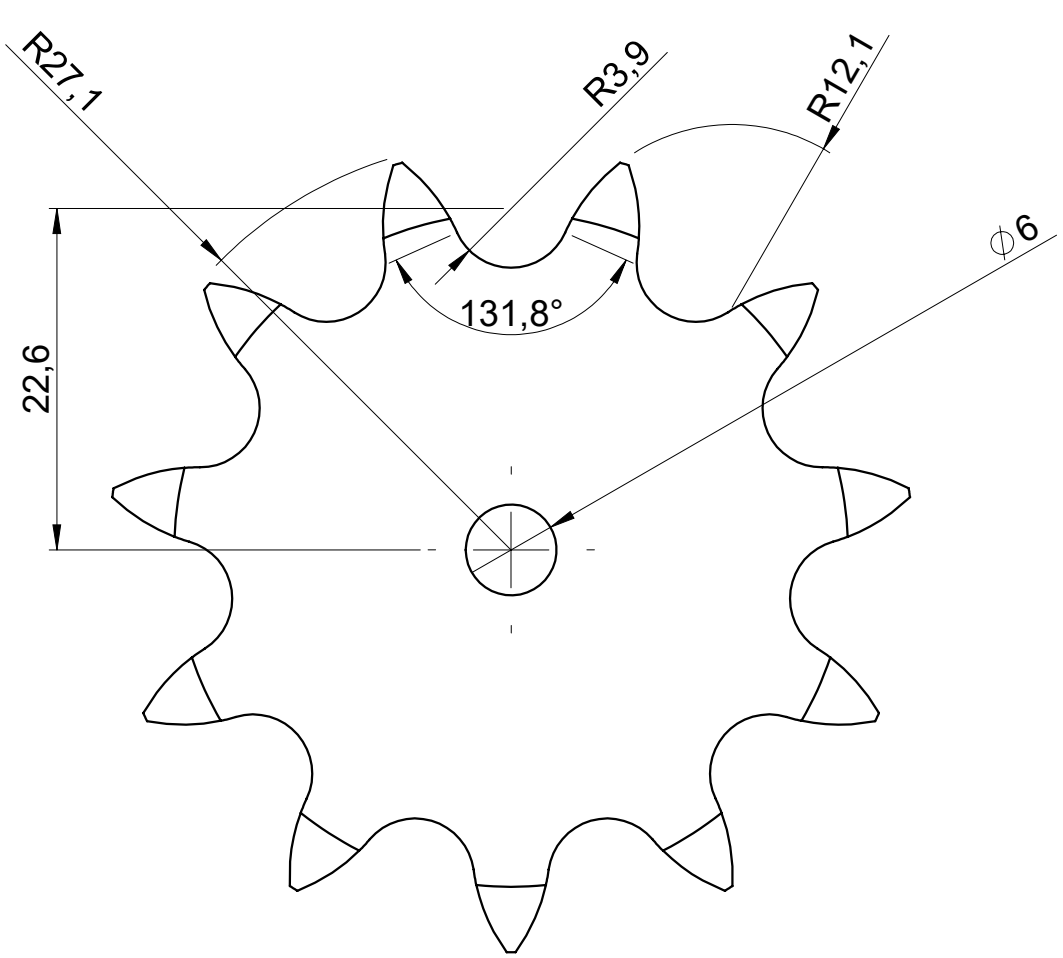
6.3

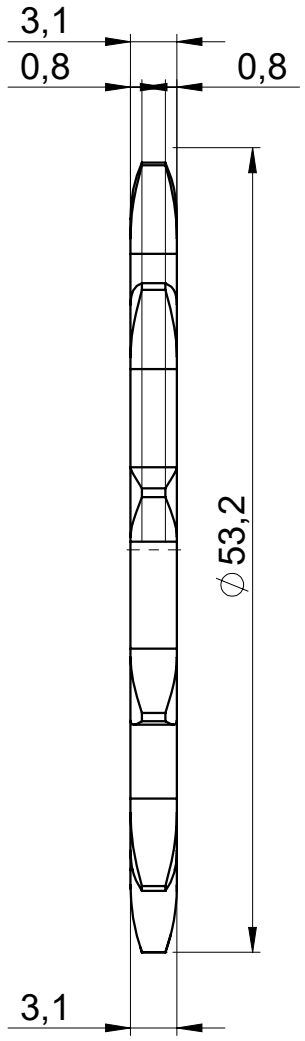




6.3

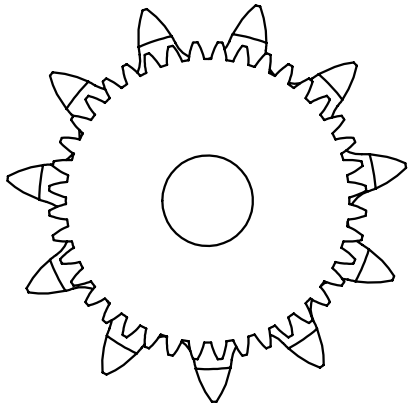
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom Kluin	DATE	01/11/2018
		CHECKED	--	SCALE	1:1
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: 401 - Right Rod			REV.: 01
		DRAWING NO.: 401			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 401 - Right Rod			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS			SHEET 1 OF 1

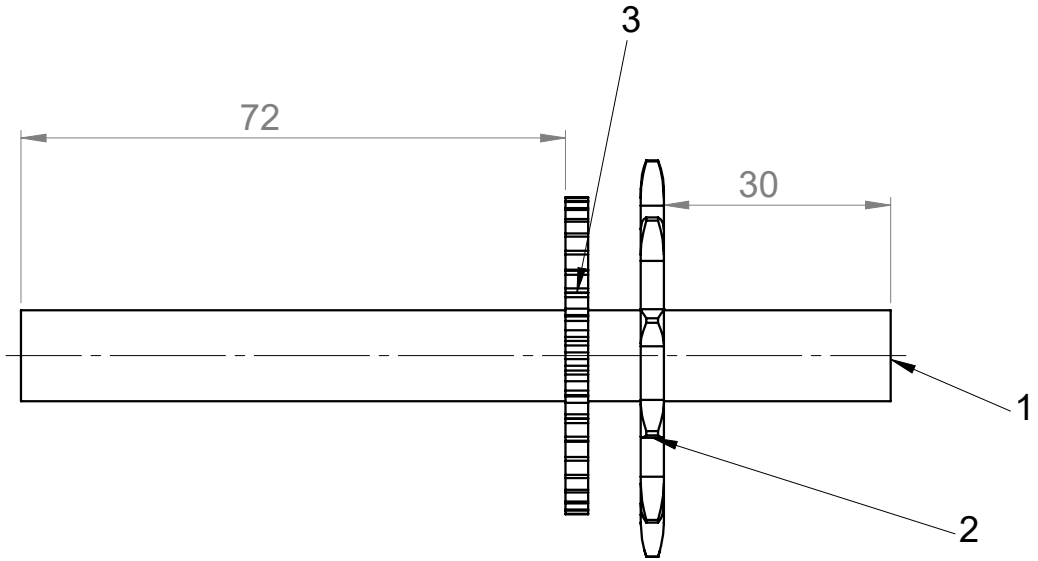




PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Bram Vloedgraven	DATE	12-10-2018
		CHECKED	--	SCALE	2:1

MATERIAL: Sheet metal --	SURFACE TREATMENT: --	TITLE: 1101 - Chain wheel ISO - 11Z 081 --11SA6.0N	REV. 01
		DRAWING NO. --	A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 1101 - Chain wheel ISO - 11Z 081 --11SA6.0N	
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS	SHEET 1 OF 1

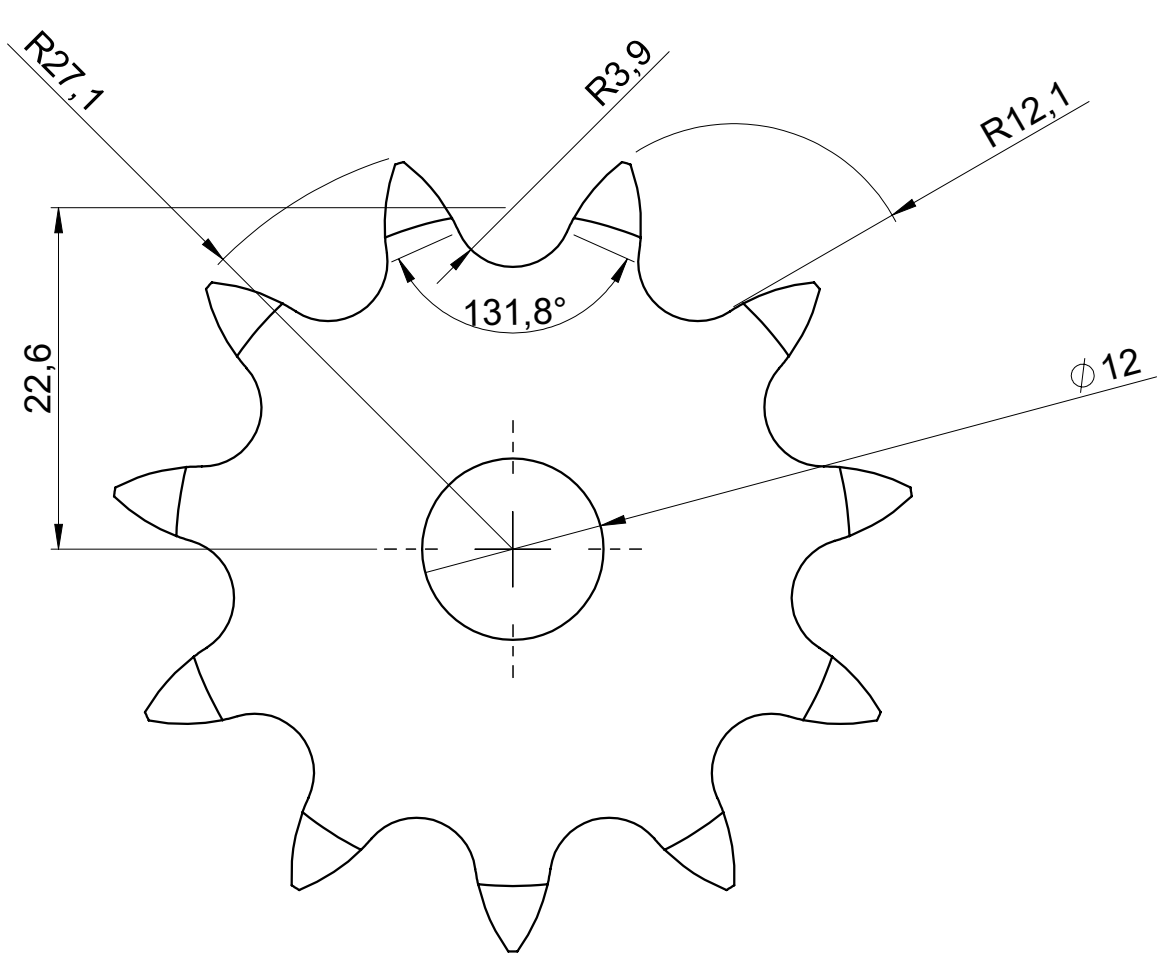


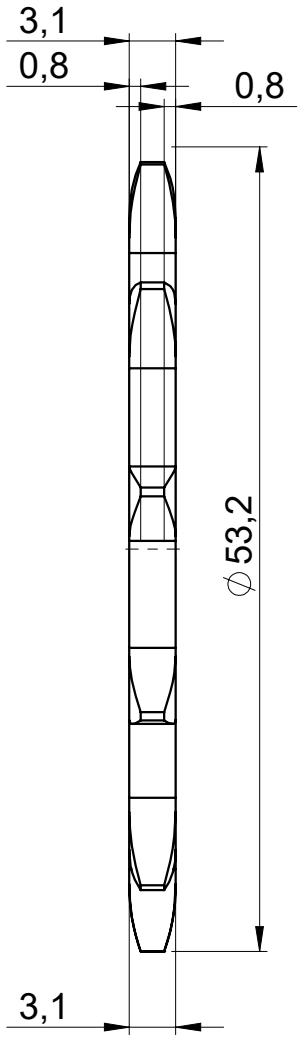


POS.	QTY.	NAME	MATERIAL	NORM / DIMENSION	REMARK
3	1	504 - ISO - Spur gear 1M 40T 20PA 3FW --- S40A75H50L12.0 N			
2	1	501 - Chain wheel ISO - 11Z 081 -- 11SA12.0N			
1	1	505 - Shaft			

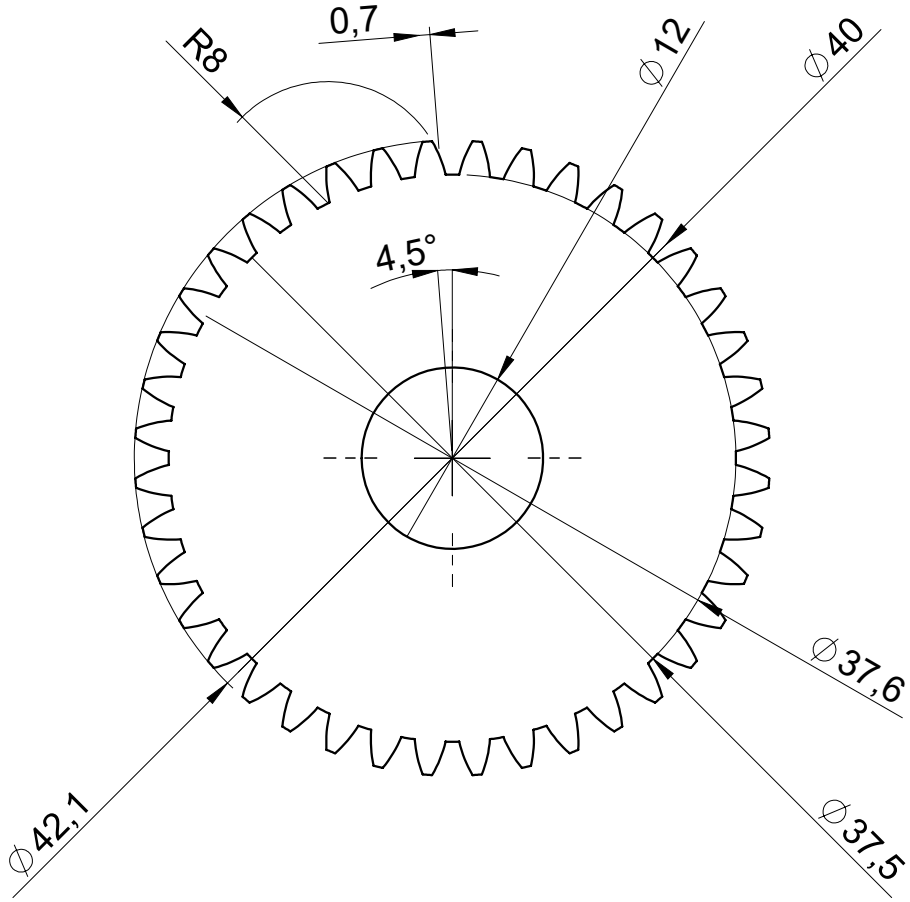
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Bram Vloedgraven	DATE	12-10-2018
		CHECKED	--	SCALE	1:1

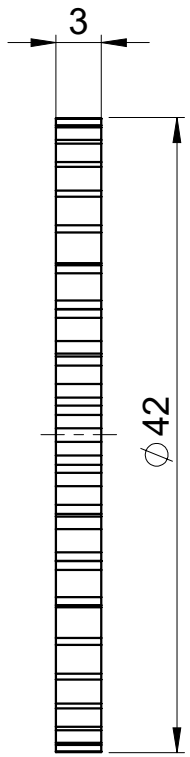
MATERIAL: Sheet metal, Steel	SURFACE TREATMENT: --	TITLE: 500 - Lonesome set	REV.: 01
		DRAWING NO.: --	
UNIVERSITY OF TWENTE.		FILE / PART NAME: 500 - lonesome set	A4
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS	SHEET 1 OF 1



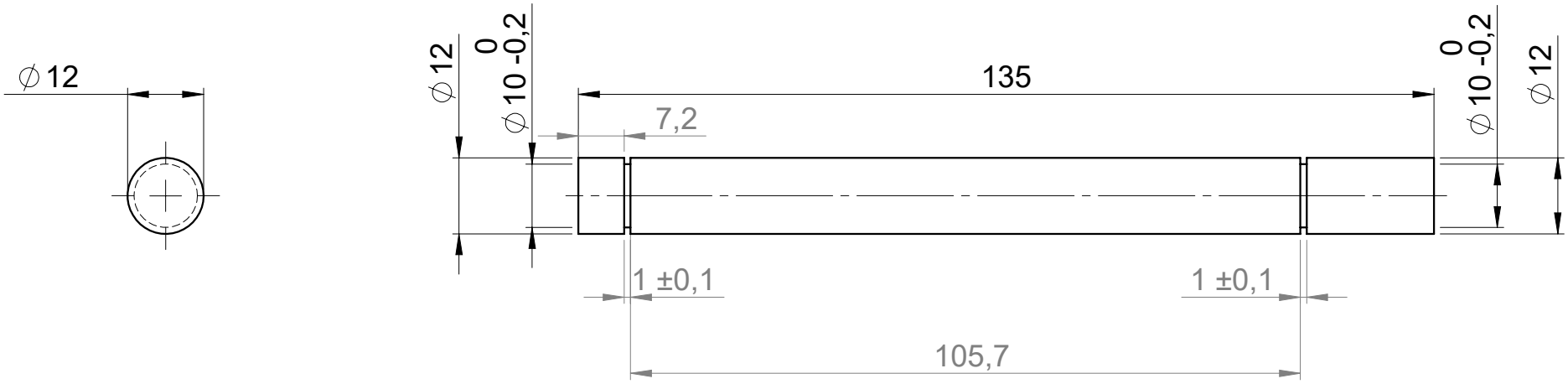


PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Bram Vloedgraven	DATE	11-10-2018
		CHECKED	--	SCALE	2:1
MATERIAL: Sheet metal --	SURFACE TREATMENT: --	TITLE: 501 - Chain wheel ISO - 11Z 081 --11SA12.0N			REV. 01
		DRAWING NO.: --			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 501 - Chain wheel ISO - 11Z 081 --11SA12.0N			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	

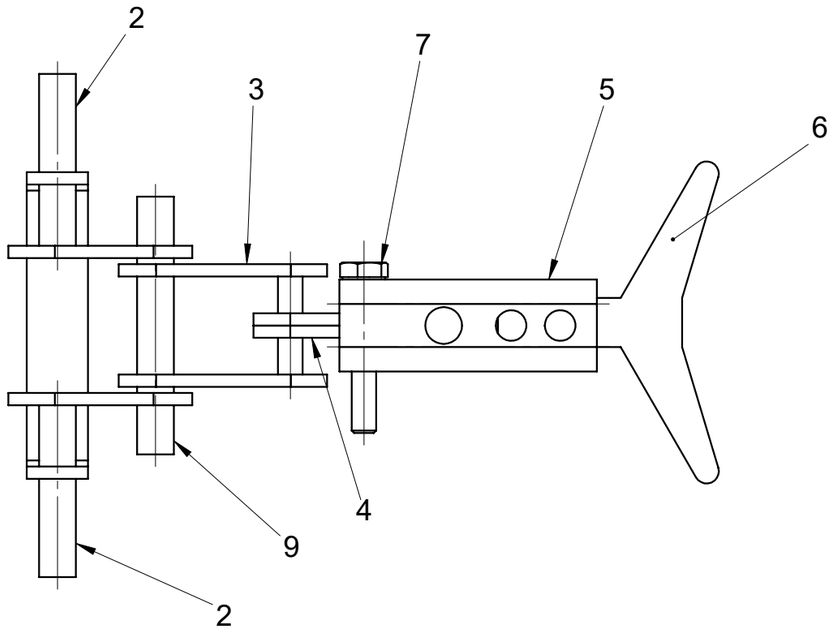


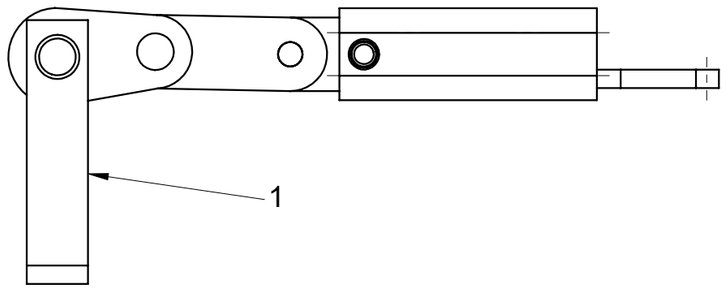


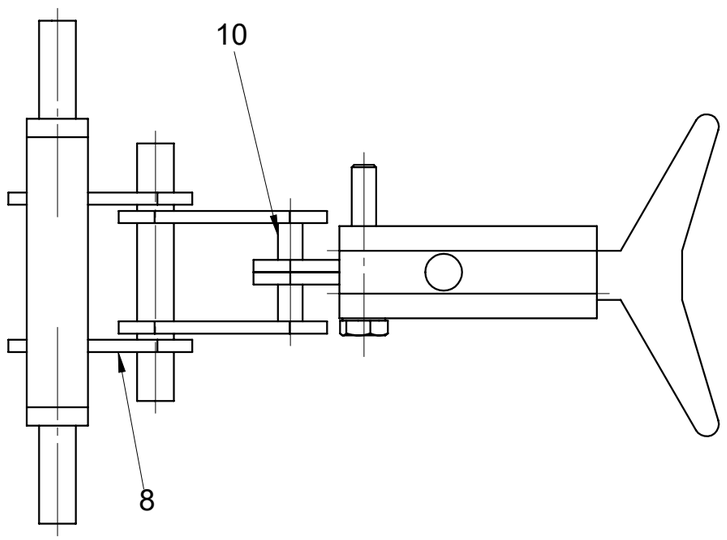
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Bram Vloedgraven	DATE	11-10-2018
		CHECKED	--	SCALE	2:1
MATERIAL: Sheet metal --	SURFACE TREATMENT: --	TITLE: 504 - ISO - Spur gear 1M 40T 20PA 3FW ---S40A75H50L12.0N			REV. 01
		DRAWING NO.: --			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 504 - ISO - Spur gear 1M 40T 20PA 3FW ---S40A75H50L12.0N			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	

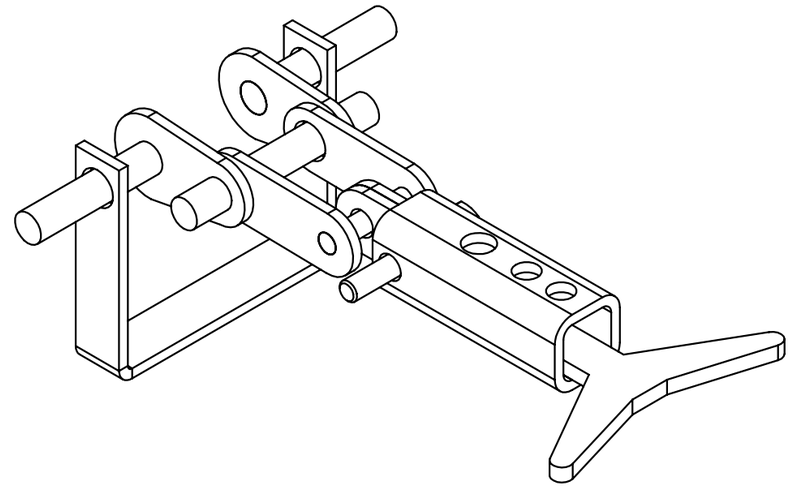


PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Bram Vloedgraven	DATE	1-11-2018
		CHECKED	--	SCALE	1:1
MATERIAL: Solid steel rod --	SURFACE TREATMENT: --	TITLE: 505 - Shaft			REV.: 01
		DRAWING NO.: 505			
UNIVERSITY OF TWENTE.		FILE / PART NAME: 505 - shaft			A4
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS			SHEET 1 OF 1









POS.	QTY.	NAME	MATERIAL	NORM / DIMENSION	REMARK
10	1	603 - Pipe One			
9	1	610 - Rod 42 mm			
8	2	607 - First Connection			
7	1	ISO 4014 - M4 x 25 x 25-C			
6	1	605 - Plate Holder			
5	1	604 - Tube 42 mm			
4	2	602 - Connection 2			
3	2	601 - Connection 1			
2	2	608 - Rod 30 mm			
1	1	606 - Holder			

6.3

PROJECTION METHOD

UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM

DRAWN: Tom Kluin | DATE: 02/11/2018

CHECKED: -- | SCALE: 1:1

MATERIAL: -- / --

SURFACE TREATMENT: --

TITLE: 600 - Locker Assembly

REV.: 01

DRAWING NO.: 600

FILE / PART NAME: 600 - Locker Assembly

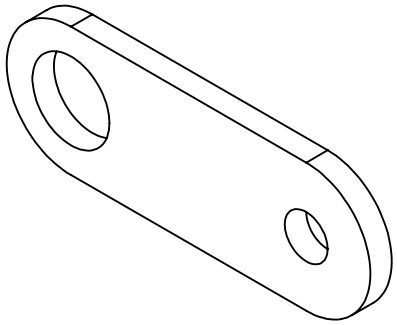
A3

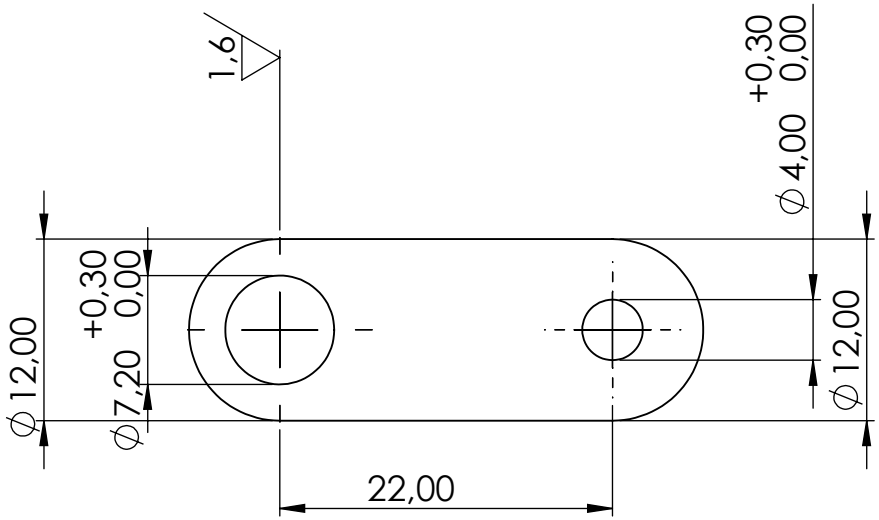
UNIVERSITY OF TWENTE.

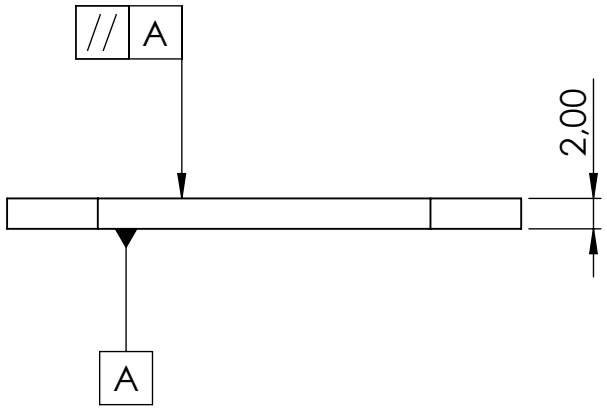
FACULTY OF ENGINEERING

DIMENSIONS IN MILLIMETERS

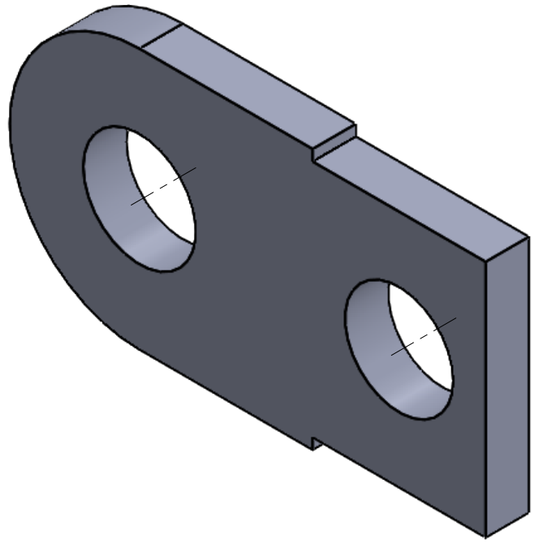
SHEET 1 OF 1

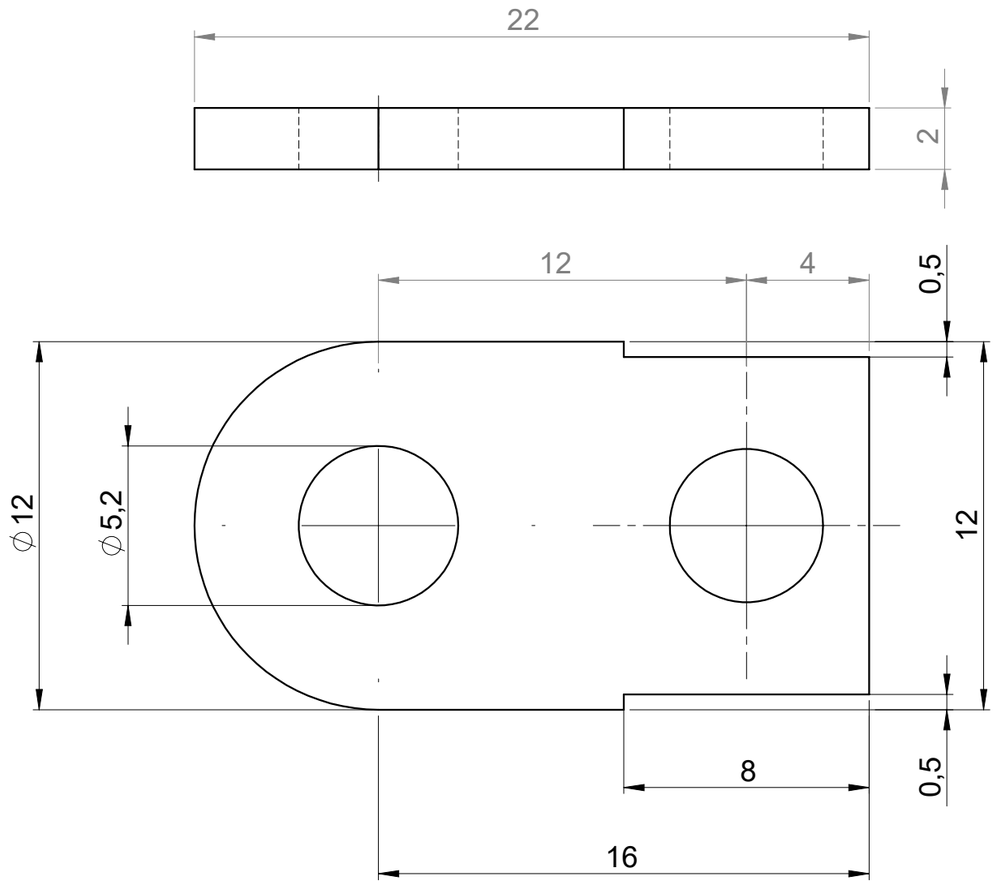




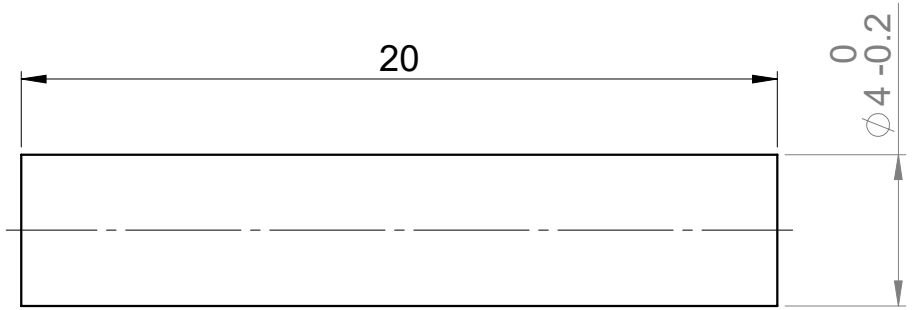


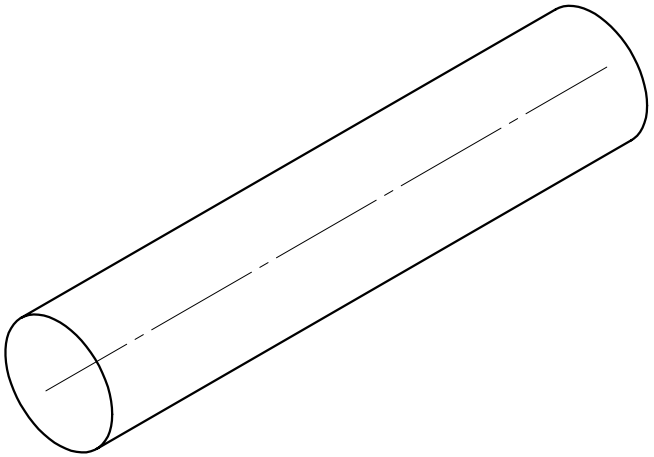
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Auke Jaspars	DATE	11-10-2018
		CHECKED	--	SCALE	2:1
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: Connection 1			REV.: 01
		DRAWING NO.: 601			
UNIVERSITY OF TWENTE.		FILE / PART NAME: 601_connection1			A4
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	

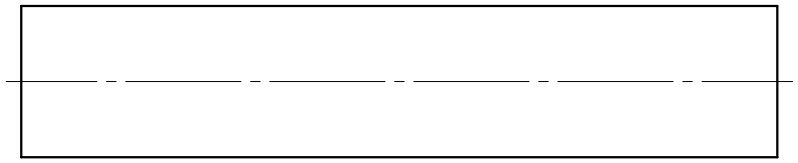


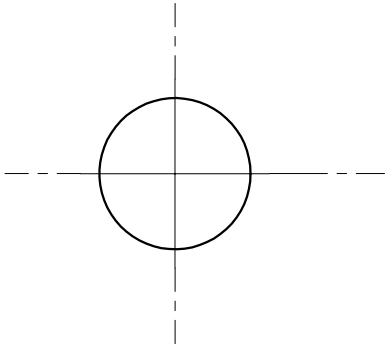


PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom van Hensbergen	DATE	11/10/2018
		CHECKED	--	SCALE	5:1
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: 602_connection2			REV.: 01
UNIVERSITY OF TWENTE.		DRAWING NO.: 602			A3
		FILE / PART NAME: 602_connection2			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	

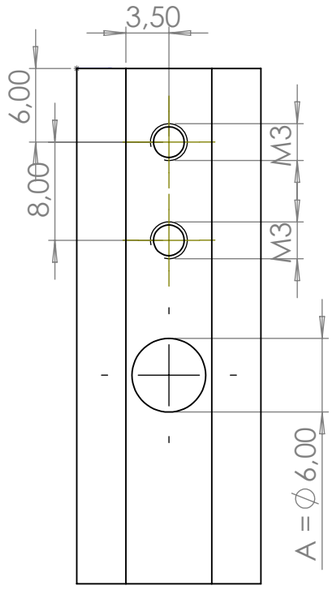


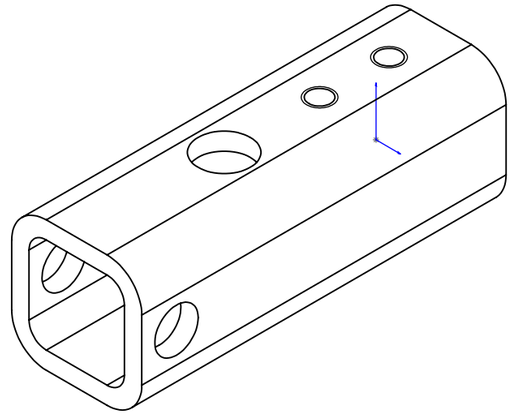


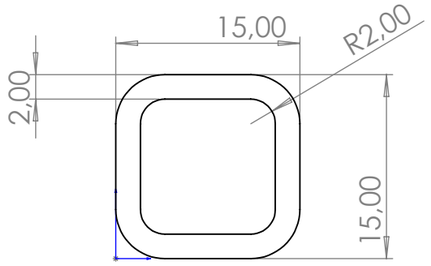


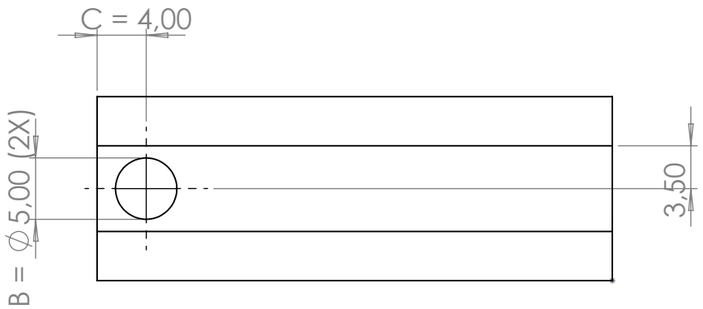


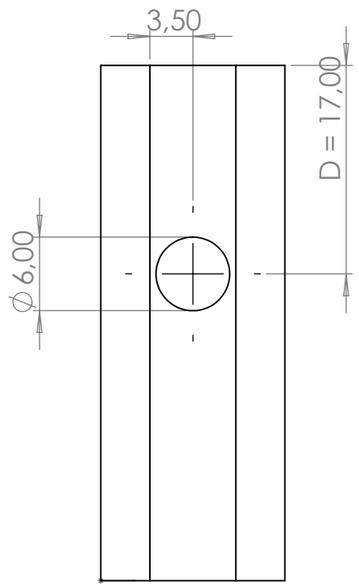
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom Kluin	DATE	11/10/2018
		CHECKED	--	SCALE	5:1
MATERIAL: Steel --	SURFACE TREATMENT: --	TITLE: 603 - Pipe One			REV. 01
		DRAWING NO.: 603			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 603 - Pipe One			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	



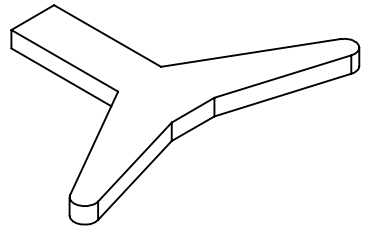


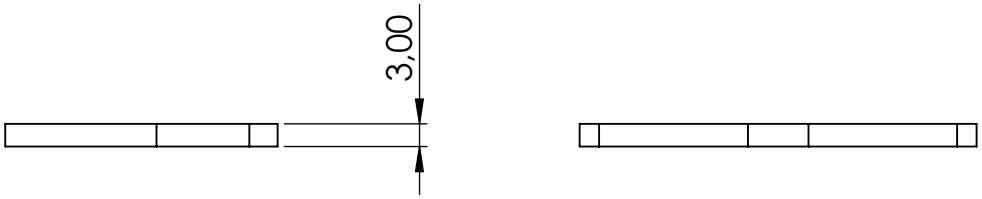


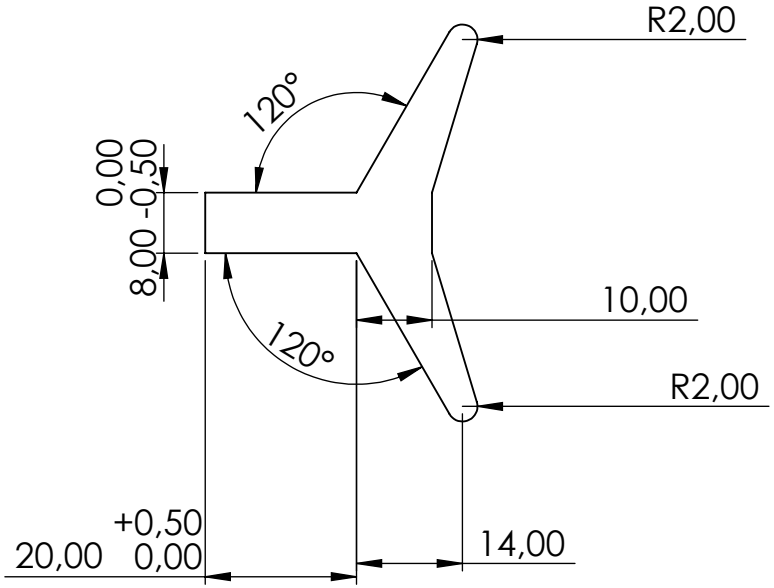




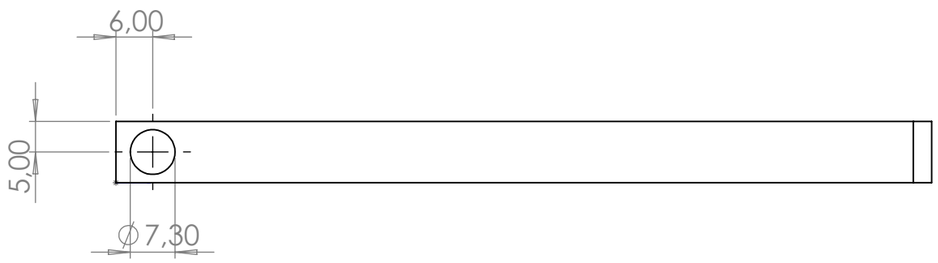
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom van Hensbergen	DATE	1-11-2018
		CHECKED	--	SCALE	2:1
MATERIAL: -- / --	SURFACE TREATMENT: --	TITLE: 604 - Tube 42 mm		REV.	01
UNIVERSITY OF TWENTE.		DRAWING NO.: 604			A3
FACULTY OF ENGINEERING		FILE / PART NAME: 604_tube42mm15mm_drawing			
		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	

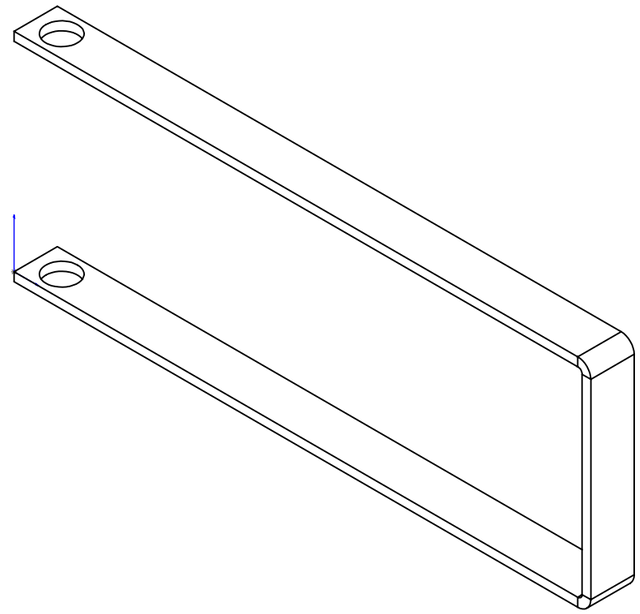


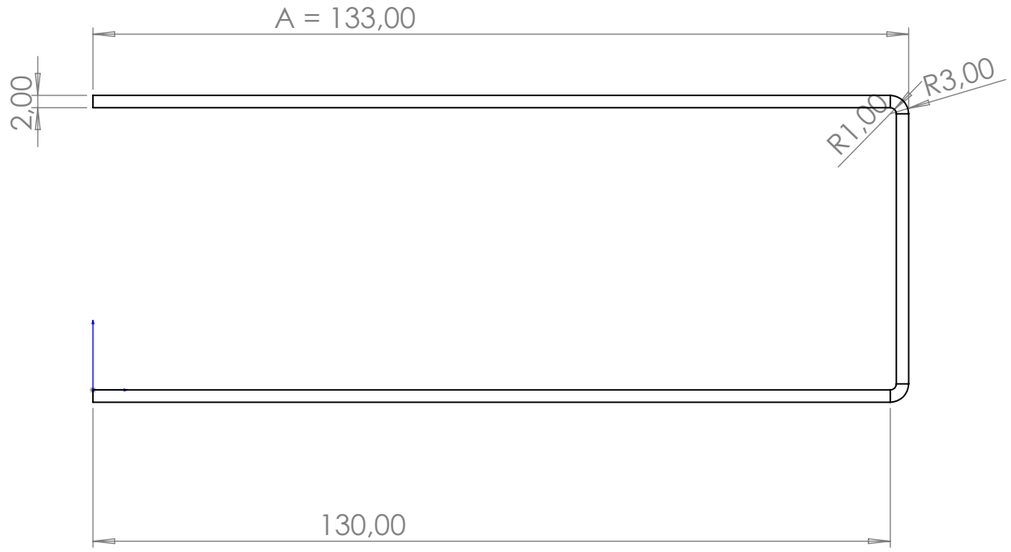




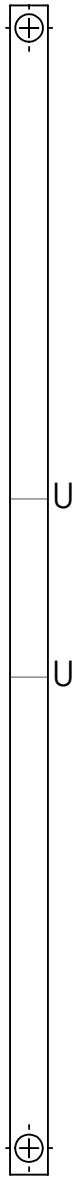
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Auke Jaspars	DATE	11-10-2018
		CHECKED	--	SCALE	1:1
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: Plateholder			REV.: 01
		DRAWING NO.: 605			
UNIVERSITY OF TWENTE.		FILE / PART NAME: 605_plateholder			A4
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS			SHEET 1 OF 1

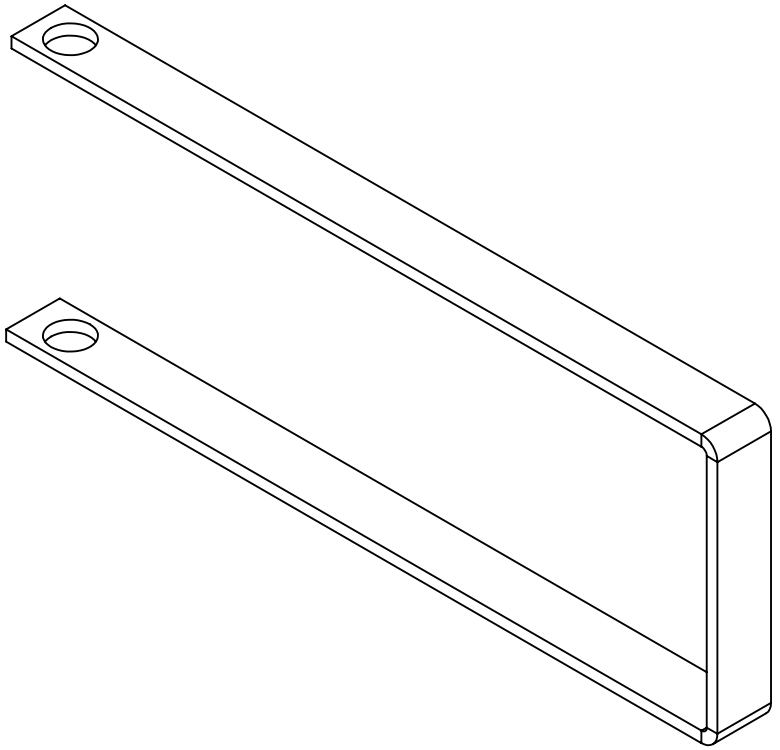




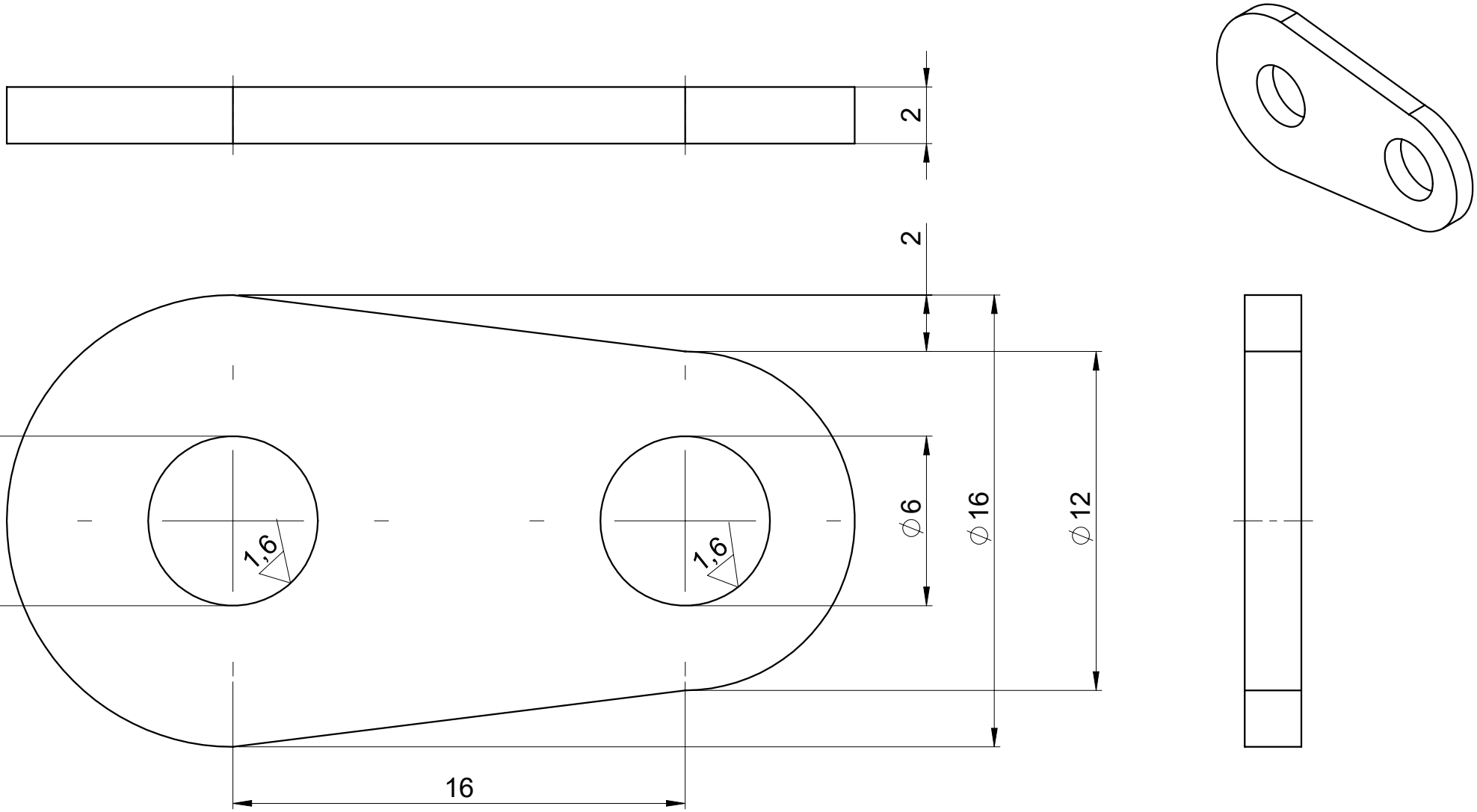


PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom van Hensbergen	DATE	1-11-2018
		CHECKED	--	SCALE	1:1
MATERIAL: -- / --	SURFACE TREATMENT: --	TITLE: Locker Holder			REV.: 01
UNIVERSITY OF TWENTE.		DRAWING NO.: 606			A3
FACULTY OF ENGINEERING		FILE / PART NAME: 606_holder_drawing			
		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 2	



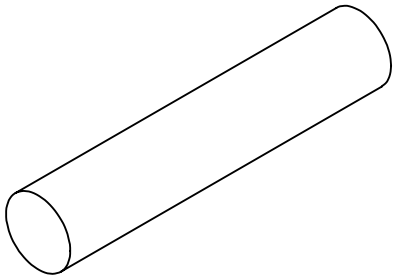


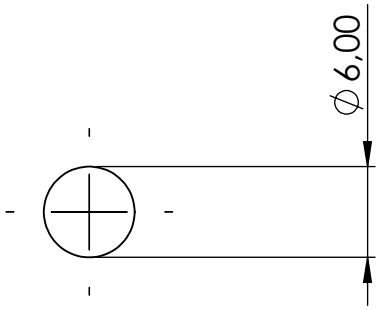
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Auke Jaspars	DATE	12-10-2018
		CHECKED	--	SCALE	1:1
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: locker holder			REV.: 01
		DRAWING NO.: 606			
UNIVERSITY OF TWENTE.		FILE / PART NAME: 606_holder			A4
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 2 OF 2	

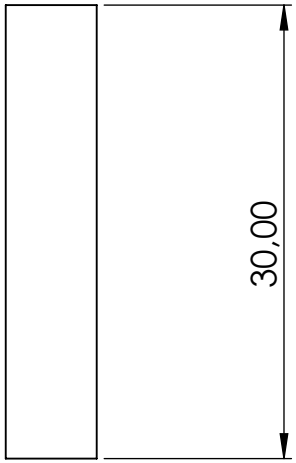


PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom Kluin	DATE	11/10/2018
		CHECKED	--	SCALE	5:1

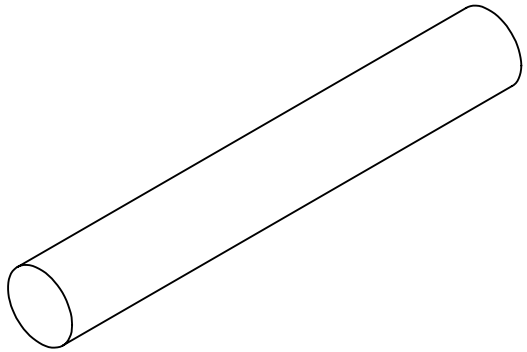
MATERIAL: Sheet metal / --	SURFACE TREATMENT: --	TITLE: 607 - First Connection	REV.: 01
		DRAWING NO.: 607	
UNIVERSITY OF TWENTE.		FILE / PART NAME: 607 - First Connection	A4
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS	SHEET 1 OF 1

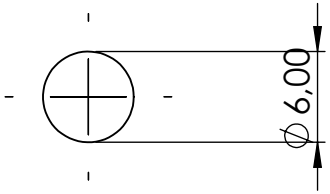


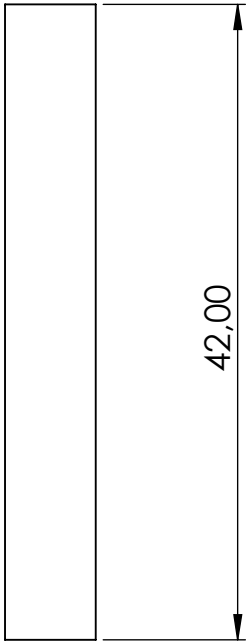




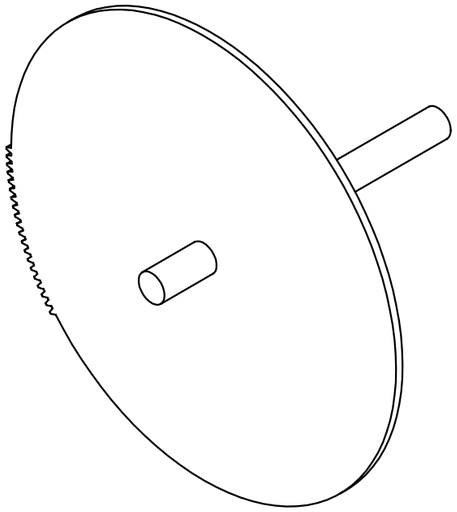
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Auke Jaspars	DATE	11-10-2018
		CHECKED	--	SCALE	2:1
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: Rod 608			REV.: 01
		DRAWING NO.: 608			
UNIVERSITY OF TWENTE.		FILE / PART NAME: 608_rod30mm (1)			A4
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS			SHEET 1 OF 1

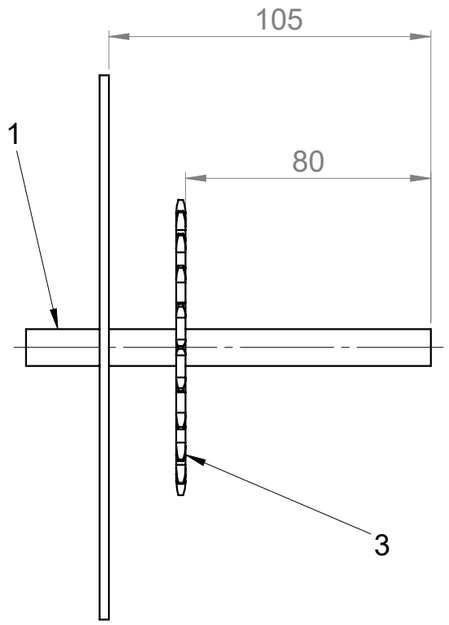


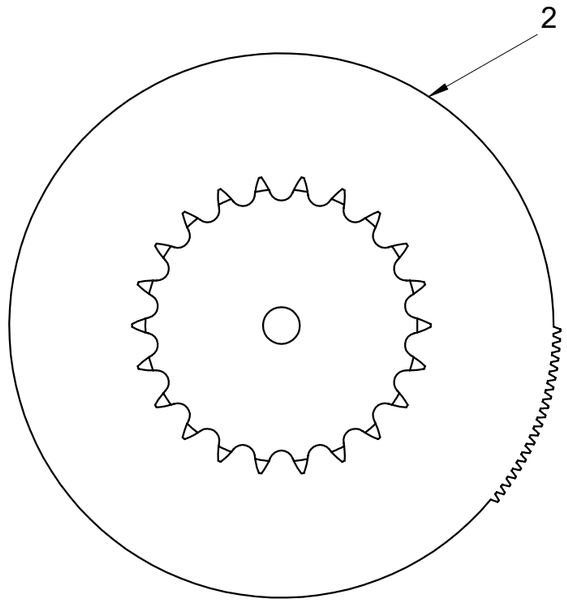




PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Auke Jaspars	DATE	11-10-2018
		CHECKED	--	SCALE	2:1
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: Rod 610			REV.: 01
		DRAWING NO.: 610			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 610 v2			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS			SHEET 1 OF 1





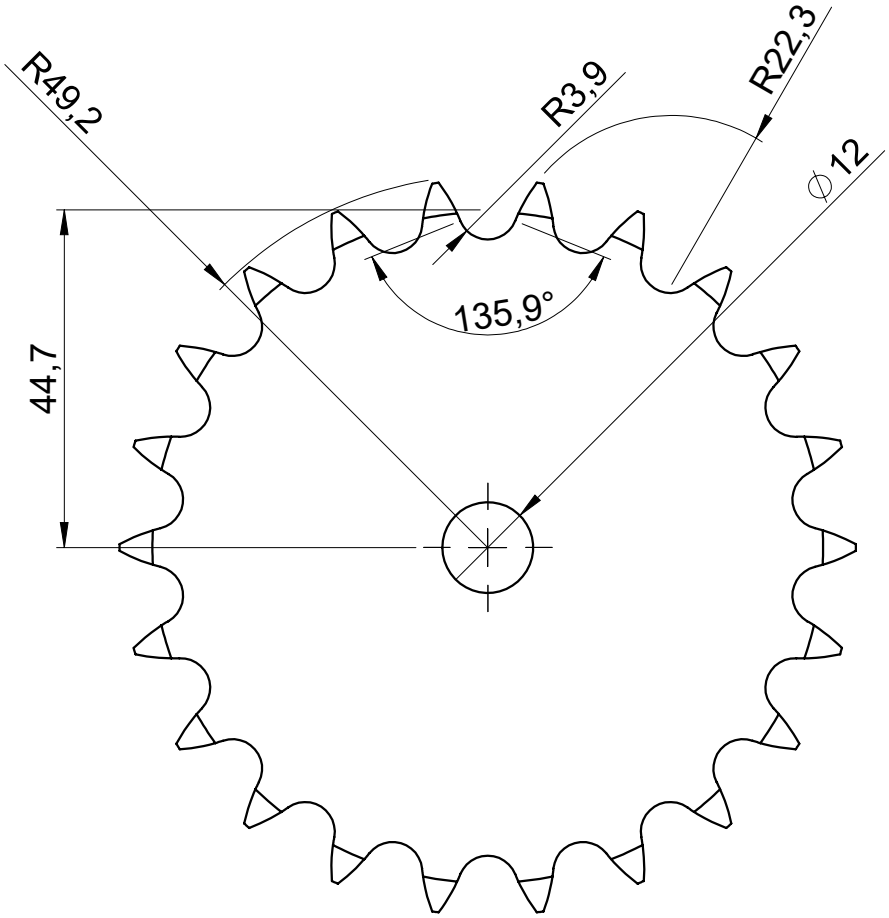


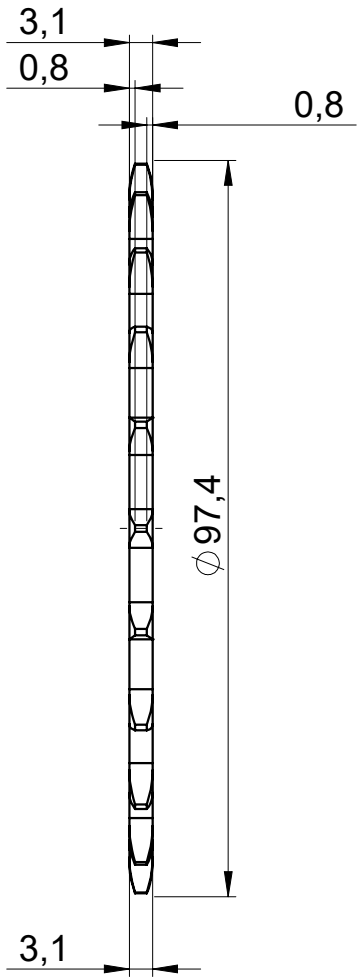
6.3

POS.	QTY.	NAME	MATERIAL	NORM / DIMENSION	REMARK
3	1	701 - Chain wheel ISO - 22Z 081 -- 22SA12.0N			
2	1	702 - ISO - Spur gear 1M 180T 20PA 3FW --- S180A75H50L12.0N			
1	1	704 - Rod Large Gear 132 mm			

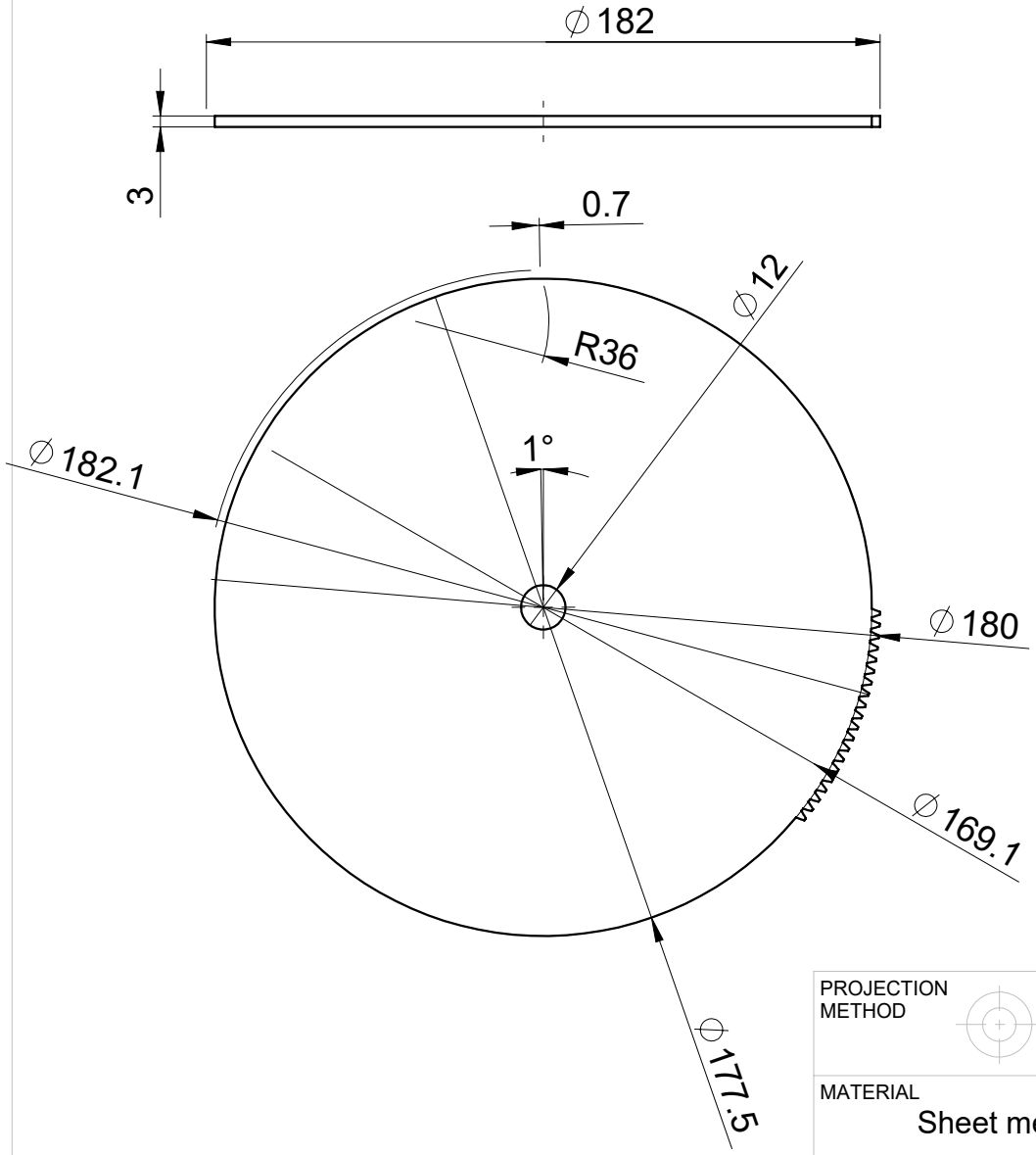
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom Kluin	DATE	02/11/2018
		CHECKED	--	SCALE	1:2

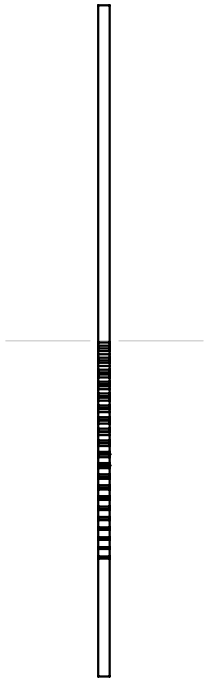
MATERIAL	SURFACE TREATMENT	TITLE	REV.
--	--	700 - Large Gear Rod	01
--		DRAWING NO. 700	
UNIVERSITY OF TWENTE.		FILE / PART NAME 700 - Large Gear Rod	A3
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS	SHEET 1 OF 1

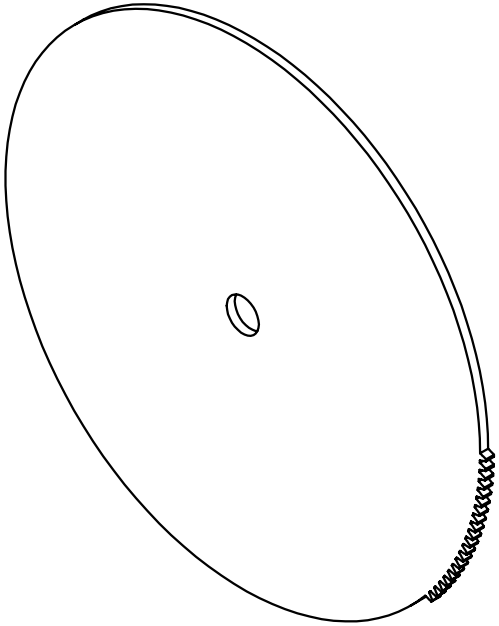




PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Bram Vloedgraven	DATE	11-10-2018
		CHECKED	--	SCALE	1:1
MATERIAL: Sheet metal --	SURFACE TREATMENT: --	TITLE: 701 - Chain wheel ISO - 22Z 081 --22SA12.0N			REV. 01
		DRAWING NO.: --			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 701 - Chain wheel ISO - 22Z 081 --22SA12.0N			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	



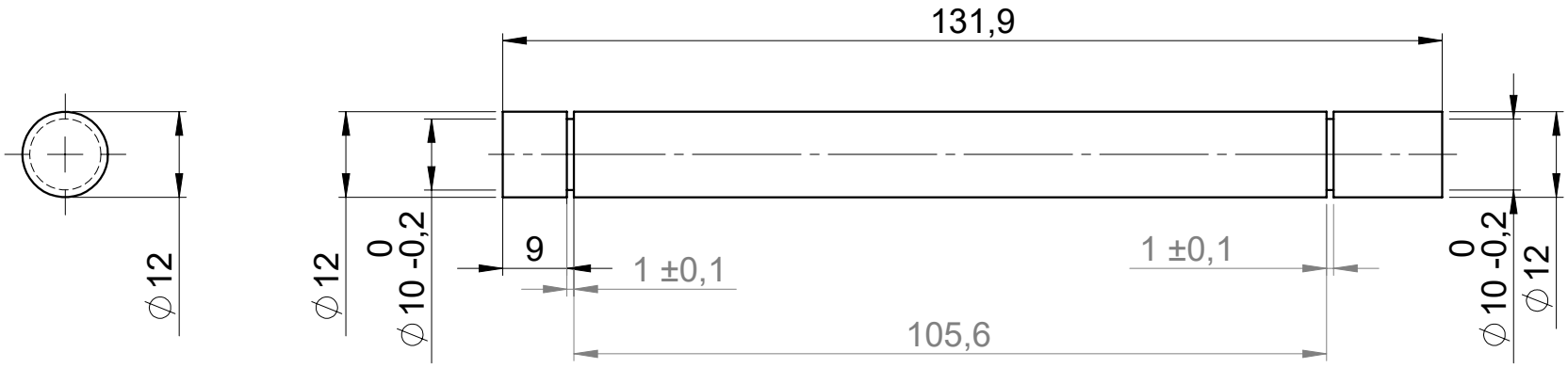




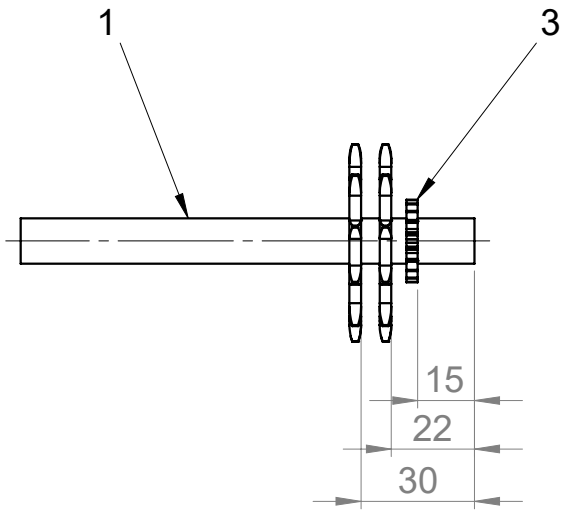
Number of teeth	20
Module	1
Pressure angle	20

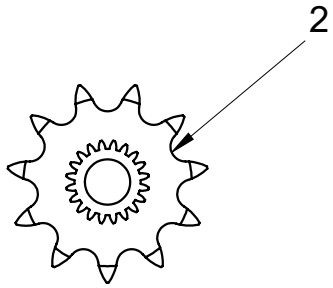
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom Kluin	DATE	02/11/2018
		CHECKED	--	SCALE	1:2

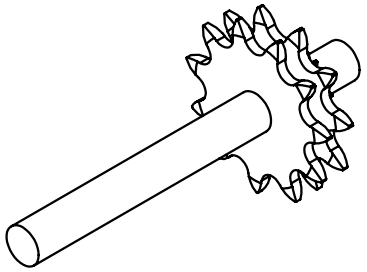
MATERIAL: Sheet metal / --	SURFACE TREATMENT: --	TITLE: 702 - Part Gear	REV.: 01
		DRAWING NO.: 702	
UNIVERSITY OF TWENTE.		FILE / PART NAME: 702 - ISO - Spur gear 1M 180T 20PA 3FW --- S180A75H50L12. 0N	A4
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS	SHEET 1 OF 1



PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Bram Vloedgraven	DATE	1-11-2018
		CHECKED	--	SCALE	1:1
MATERIAL: Solid steel rod --	SURFACE TREATMENT: --	TITLE: 704:Rod Extrude large gear			REV. 01
		DRAWING NO.: 704			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 704 - Rod Extrude large gear			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	





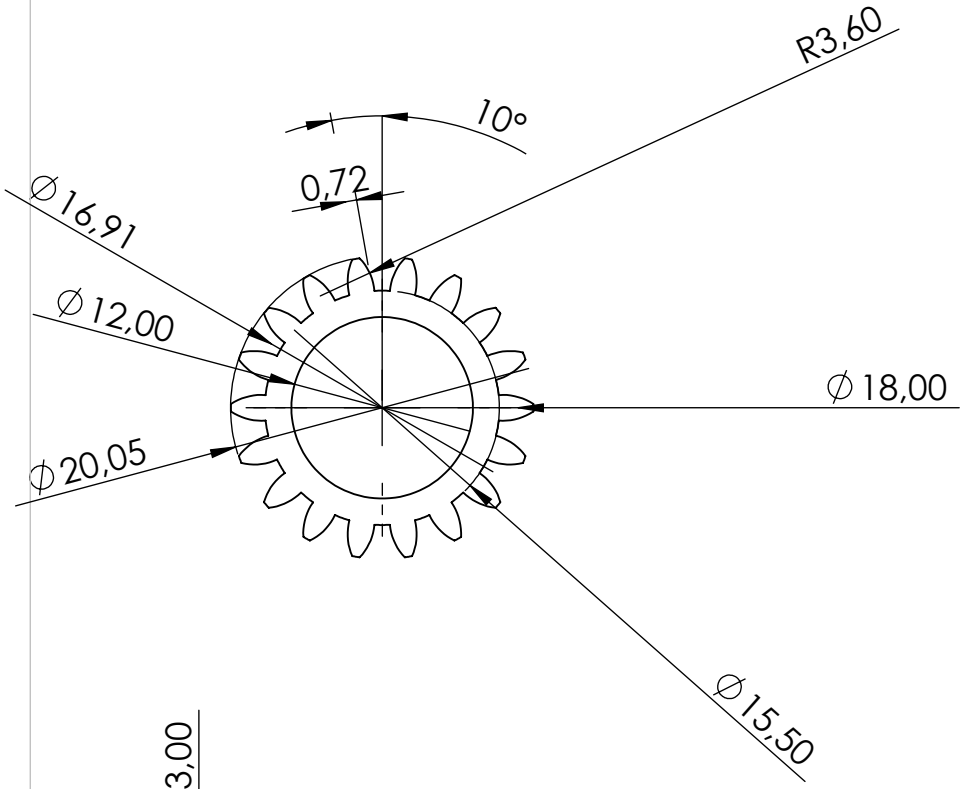


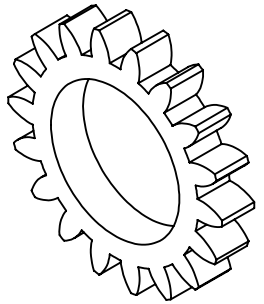
POS.	QTY.	NAME	MATERIAL	NORM / DIMENSION	REMARK
3	1	702 - ISO - Spur gear 1M 20T 20PA 3FW --- S20A75H50L12.0N			
2	2	501 - Chain wheel ISO - 11Z 081 -- 11SA12.0N			
1	1	703 - Rod 127 mm			

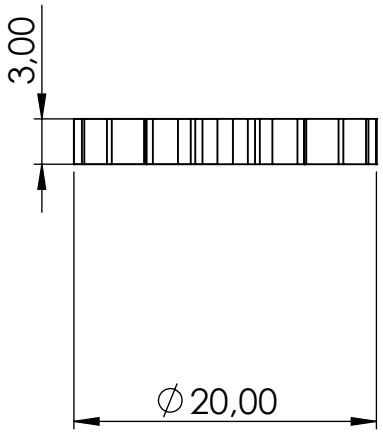
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom Kluin	DATE	02/11/2018
		CHECKED	--	SCALE	1:2

MATERIAL	SURFACE TREATMENT	TITLE	REV.
--		800 - Small Gear Assembly	01
--	--	DRAWING NO. 800	
UNIVERSITY OF TWENTE.		FILE / PART NAME 800 - Small Gear Assembly	A4
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS	SHEET 1 OF 1

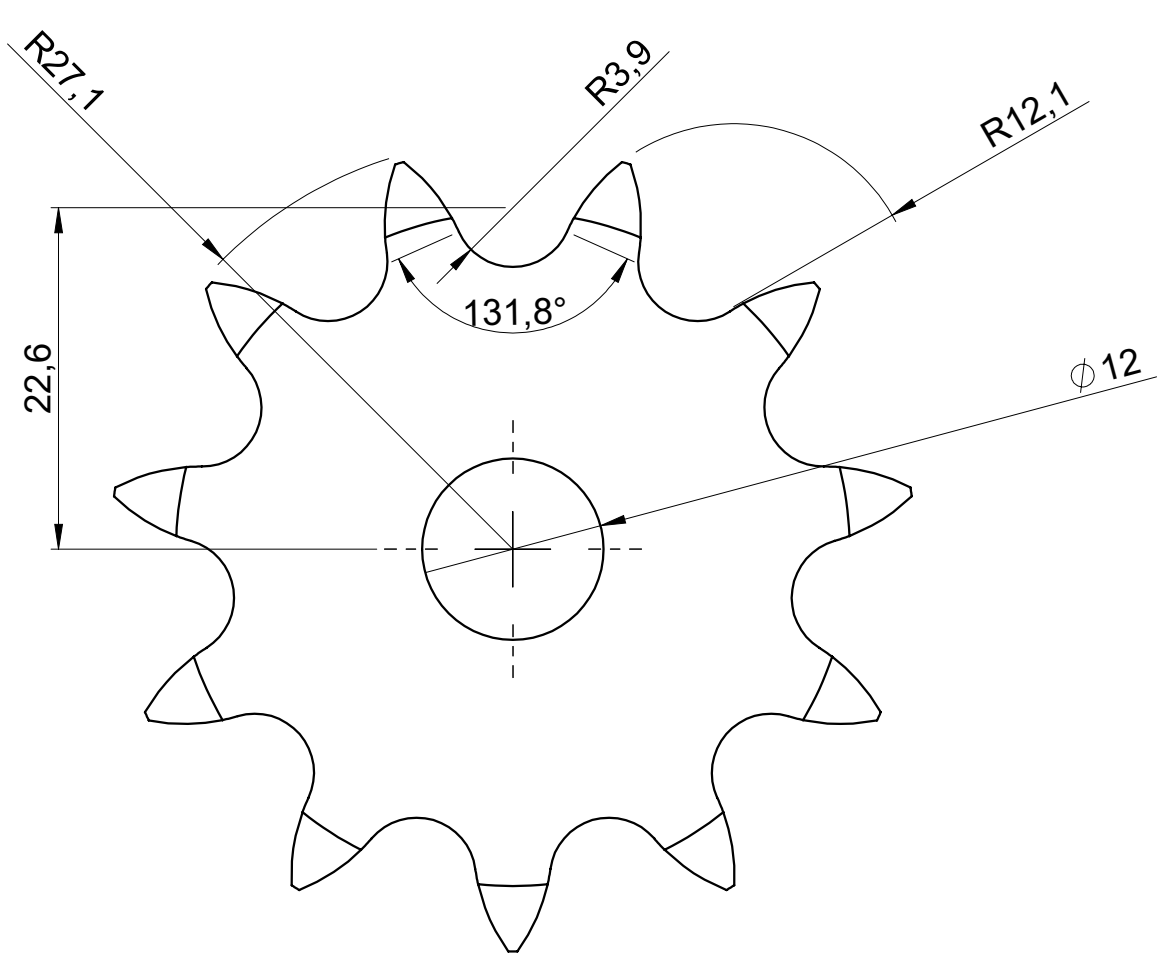
6.3

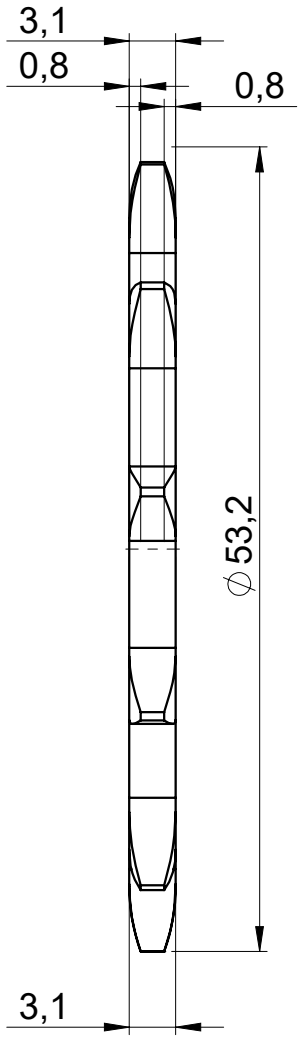




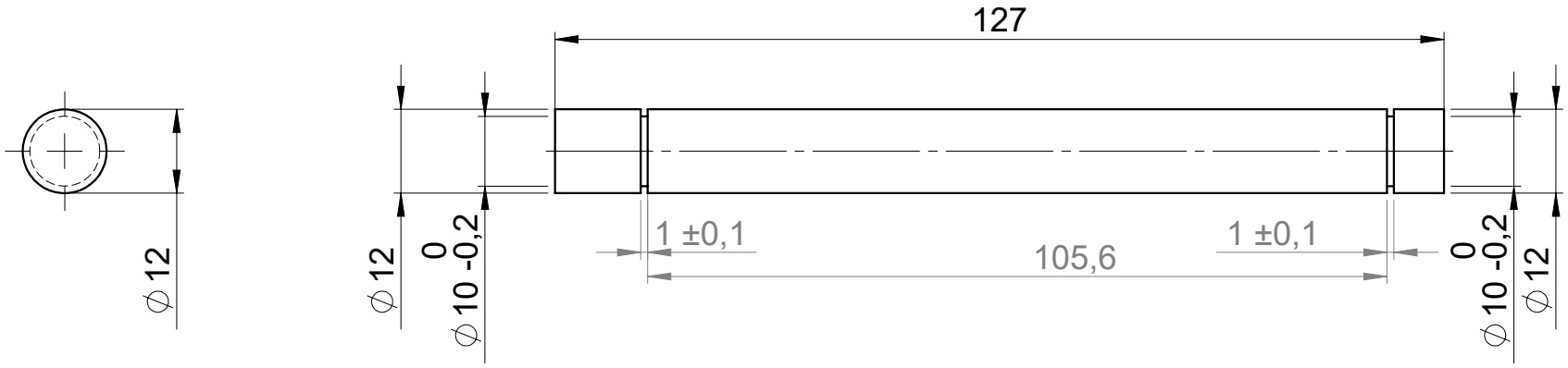


PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Auke Jaspars	DATE	12-10-2018
		CHECKED	--	SCALE	5:1
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: 20 teeth gear			REV.: 01
		DRAWING NO.: 702			
UNIVERSITY OF TWENTE.		FILE / PART NAME: 702-20teethgear			A4
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	

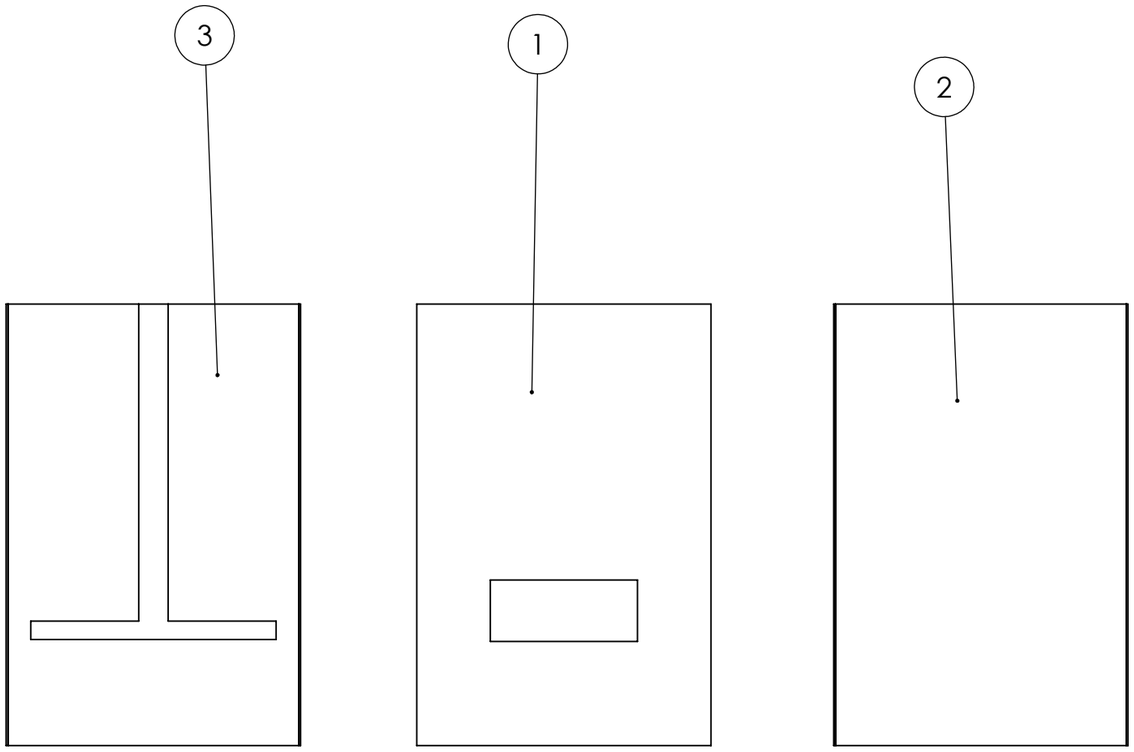


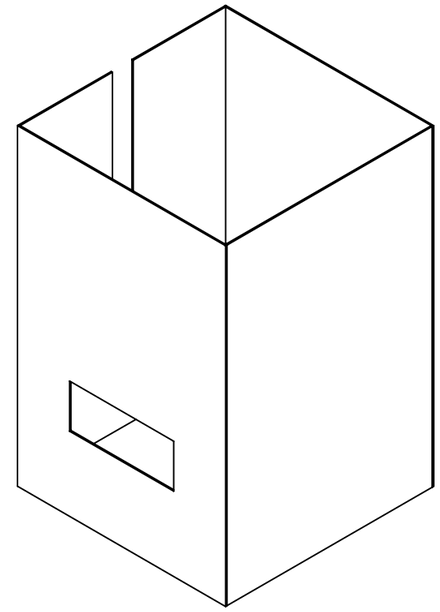


PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Bram Vloedgraven	DATE	11-10-2018
		CHECKED	--	SCALE	2:1
MATERIAL: Sheet metal --	SURFACE TREATMENT: --	TITLE: 501 - Chain wheel ISO - 11Z 081 --11SA12.0N			REV. 01
		DRAWING NO.: --			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 501 - Chain wheel ISO - 11Z 081 --11SA12.0N			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	



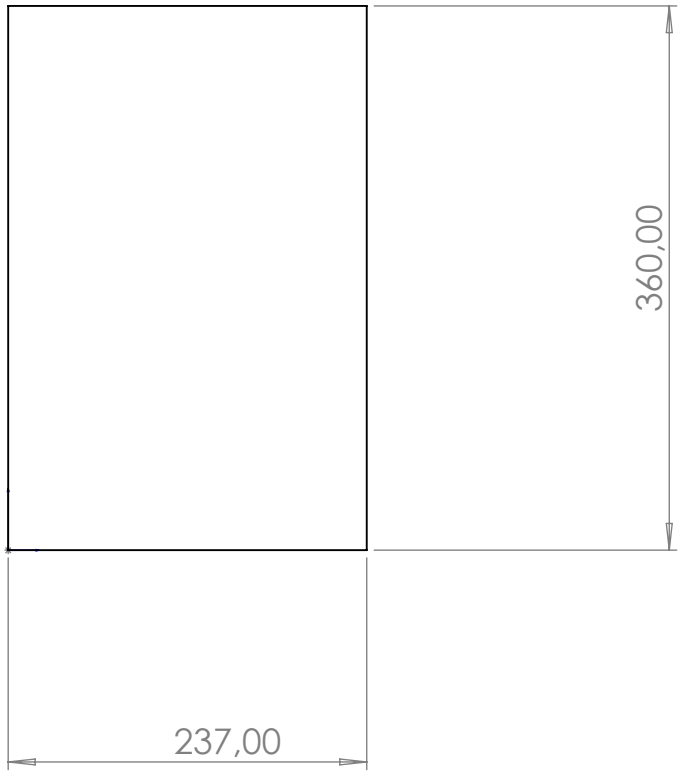
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Bram Vloedgraven	DATE	1-11-2018
		CHECKED	--	SCALE	1:1
MATERIAL: Solid steel rod --	SURFACE TREATMENT: --	TITLE: 703 - Rod extrude			REV.: 01
		DRAWING NO.: 703			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 703 - Rod Extrude			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS			SHEET 1 OF 1

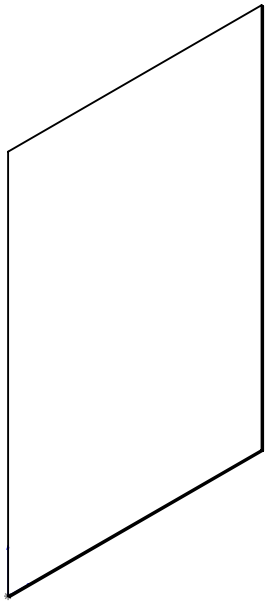




POS.	QTY.	NAME	MATERIAL	NORM / DIMENSION	REMARK
3	1	903_FrontPlate			
2	1	901_PlateBack			
1	2	902_InnerPlate			

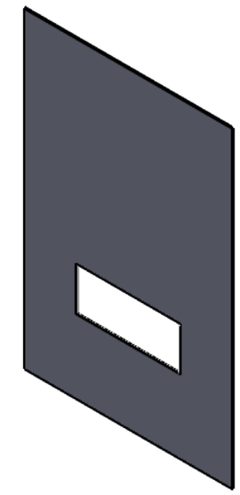
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Auke Jaspars	DATE	11-10-2018
		CHECKED	--	SCALE	1:5
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: assembly shaft			REV. 01
UNIVERSITY OF TWENTE.		DRAWING NO.: 900			A3
FACULTY OF ENGINEERING		FILE / PART NAME: 900_AssemblyShaft240mm		DIMENSIONS IN MILLIMETERS	SHEET 1 OF 1

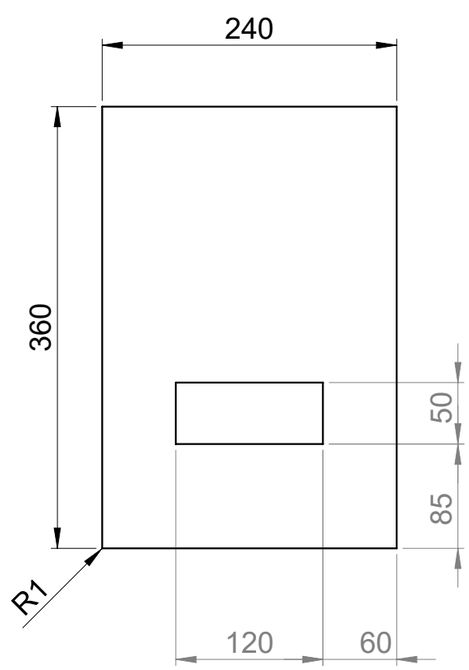




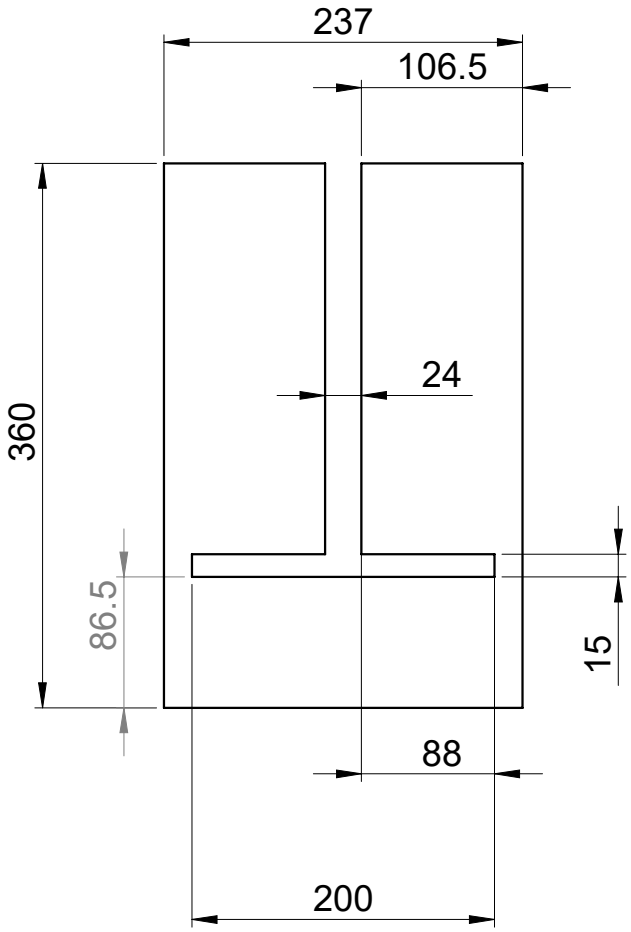
2

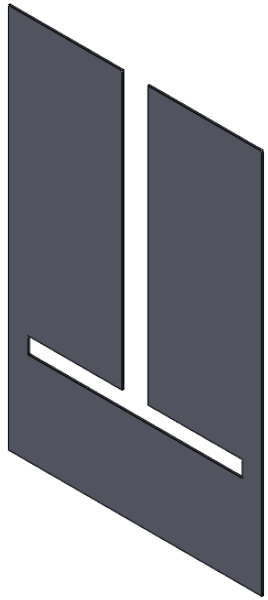
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom van Hensbergen	DATE	11-10-2018
		CHECKED	--	SCALE	1:5
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: Back Plate 360 x 237 x 1.5			REV. 01
		DRAWING NO.: 901			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 901_PlateBack			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	



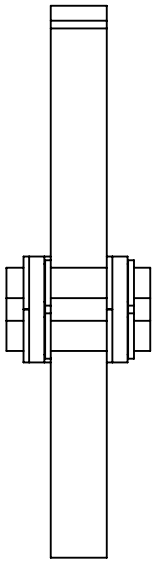


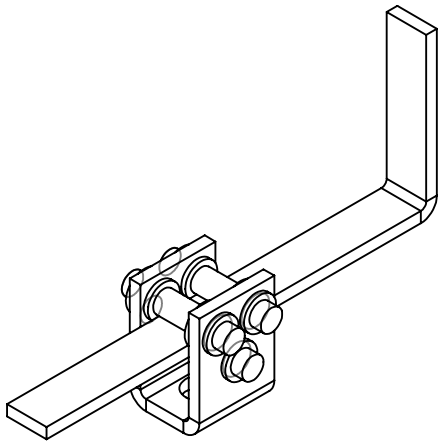
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Shyngys	DATE	11/10/2018
		CHECKED	--	SCALE	1:5
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: 902_InnerPlate			REV.: 01
		DRAWING NO.: 902			A3
UNIVERSITY OF TWENTE.		FILE / PART NAME: 902_InnerPlate			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	

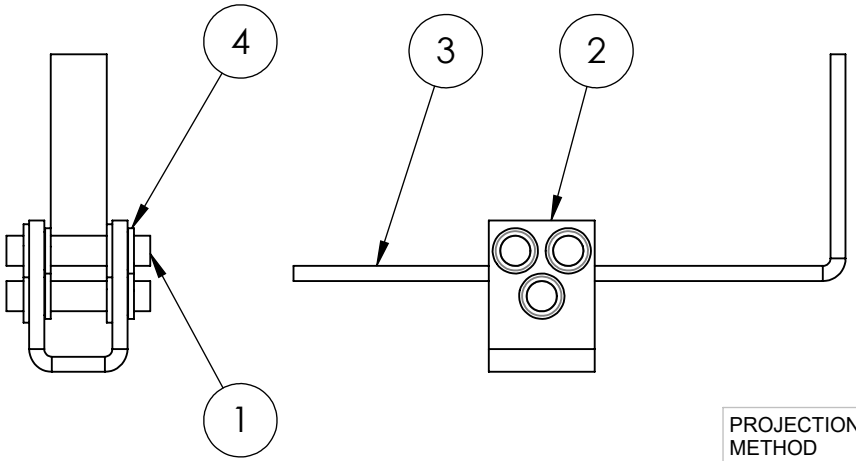




PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Miguel Cacarin	DATE	11/10/2018
		CHECKED	--	SCALE	1:5
MATERIAL: Sheet Metal --	SURFACE TREATMENT: --	TITLE: 903			REV.: 01
		DRAWING NO.: 903			
UNIVERSITY OF TWENTE.		FILE / PART NAME: 903_FrontPlate			A4
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	



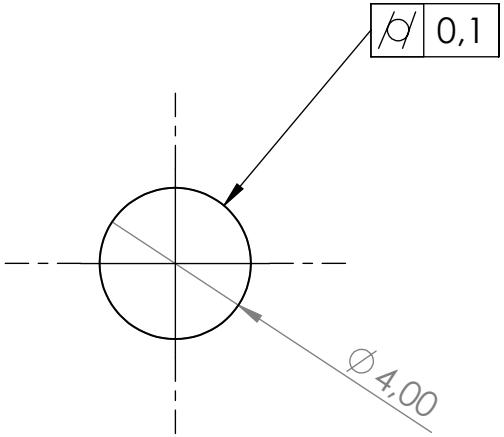


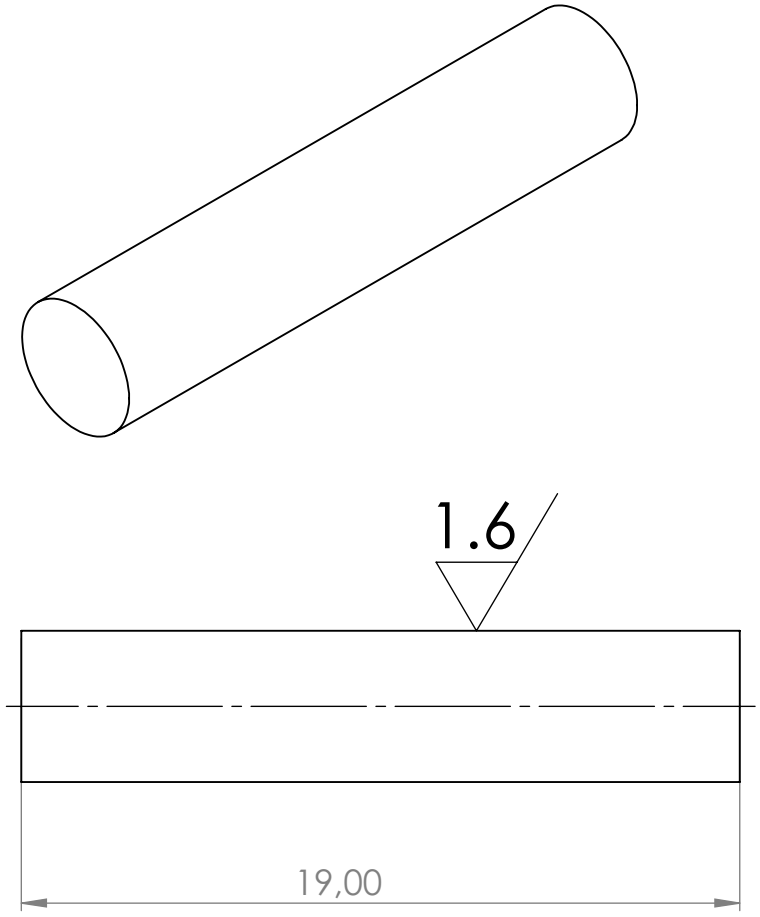


POS.	QTY.	NAME	MATERIAL	NORM / DIMENSION	REMARK
4	6	Plate bearing 4 mm			
3	1	1003			
2	1	1002			
1	3	1001			

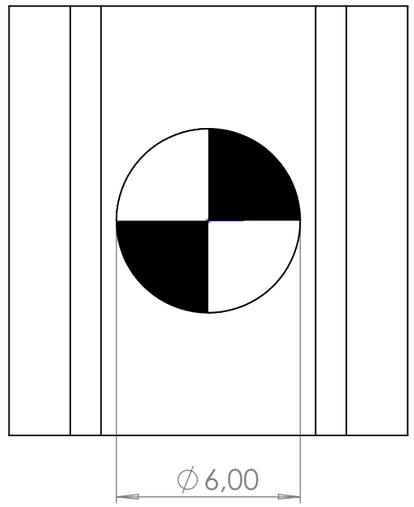
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Jesper Kussendrager	DATE	12/10/2018
		CHECKED	--	SCALE	1:1

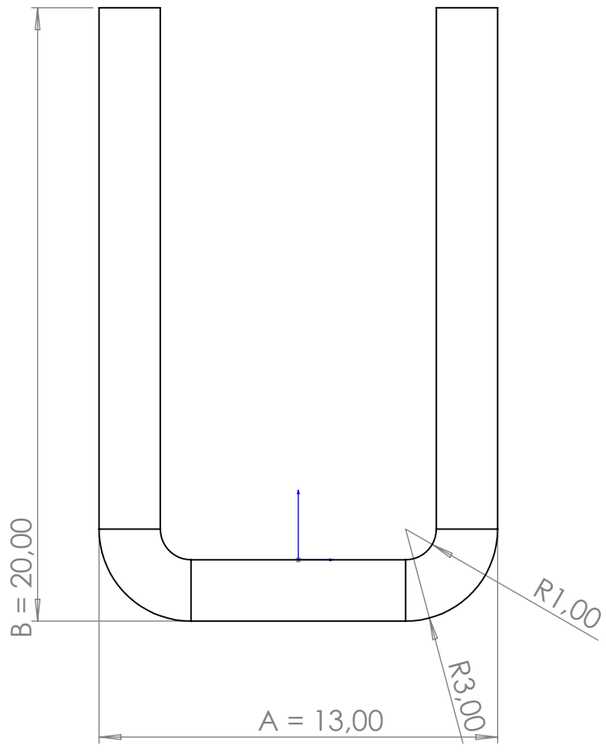
MATERIAL	SURFACE TREATMENT	TITLE	REV.
--	--	Assembly Railsystem	01
		DRAWING NO. 1000	A4
UNIVERSITY OF TWENTE.		FILE / PART NAME 1000_RailAssembly	
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS	SHEET 1 OF 1

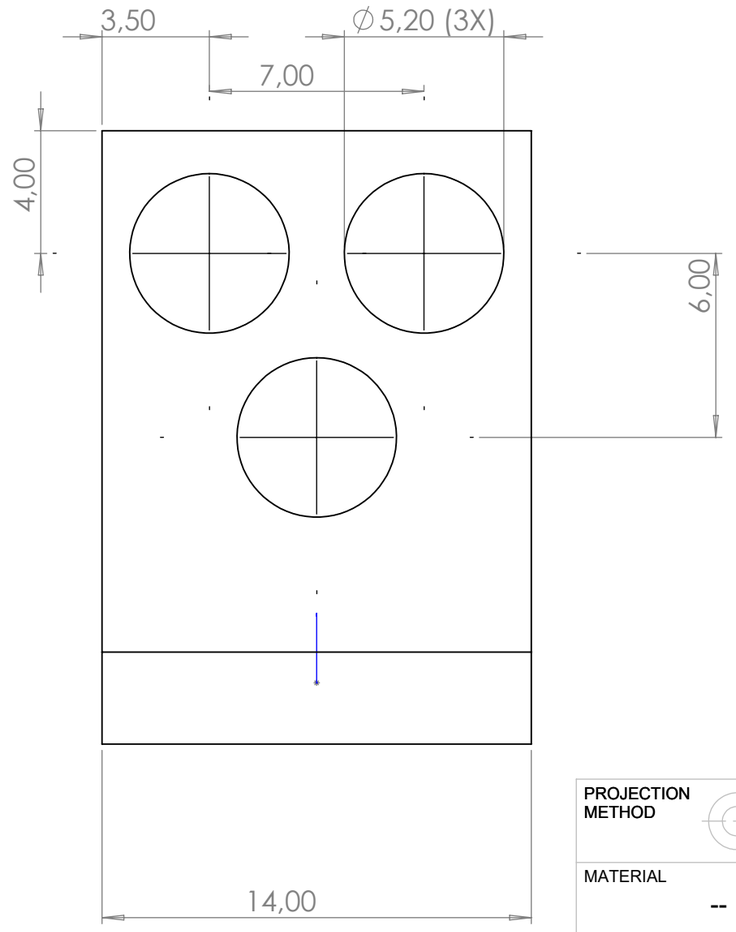


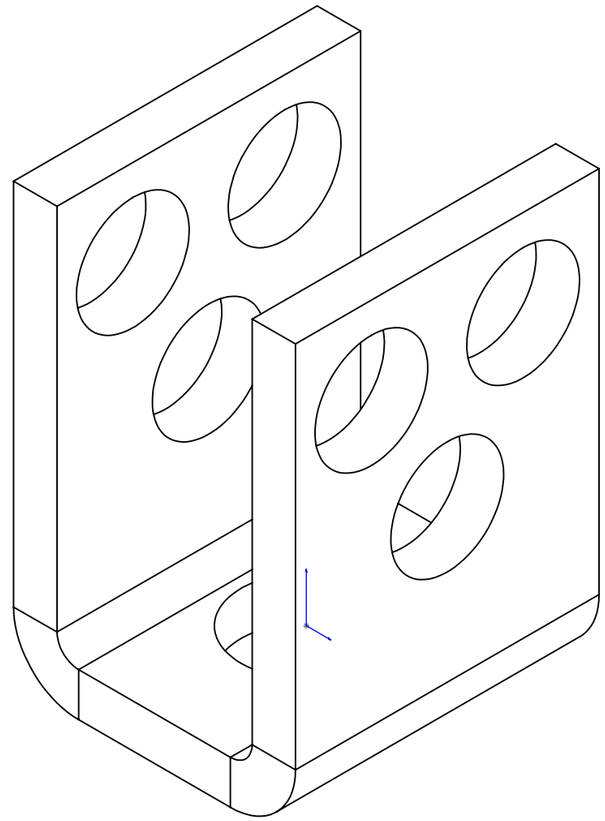


PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	--	DATE	12/10/2018
		CHECKED	--	SCALE	5:1
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: NO NAME			REV.: 01
		DRAWING NO.: --			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 1001			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS			SHEET 1 OF 1

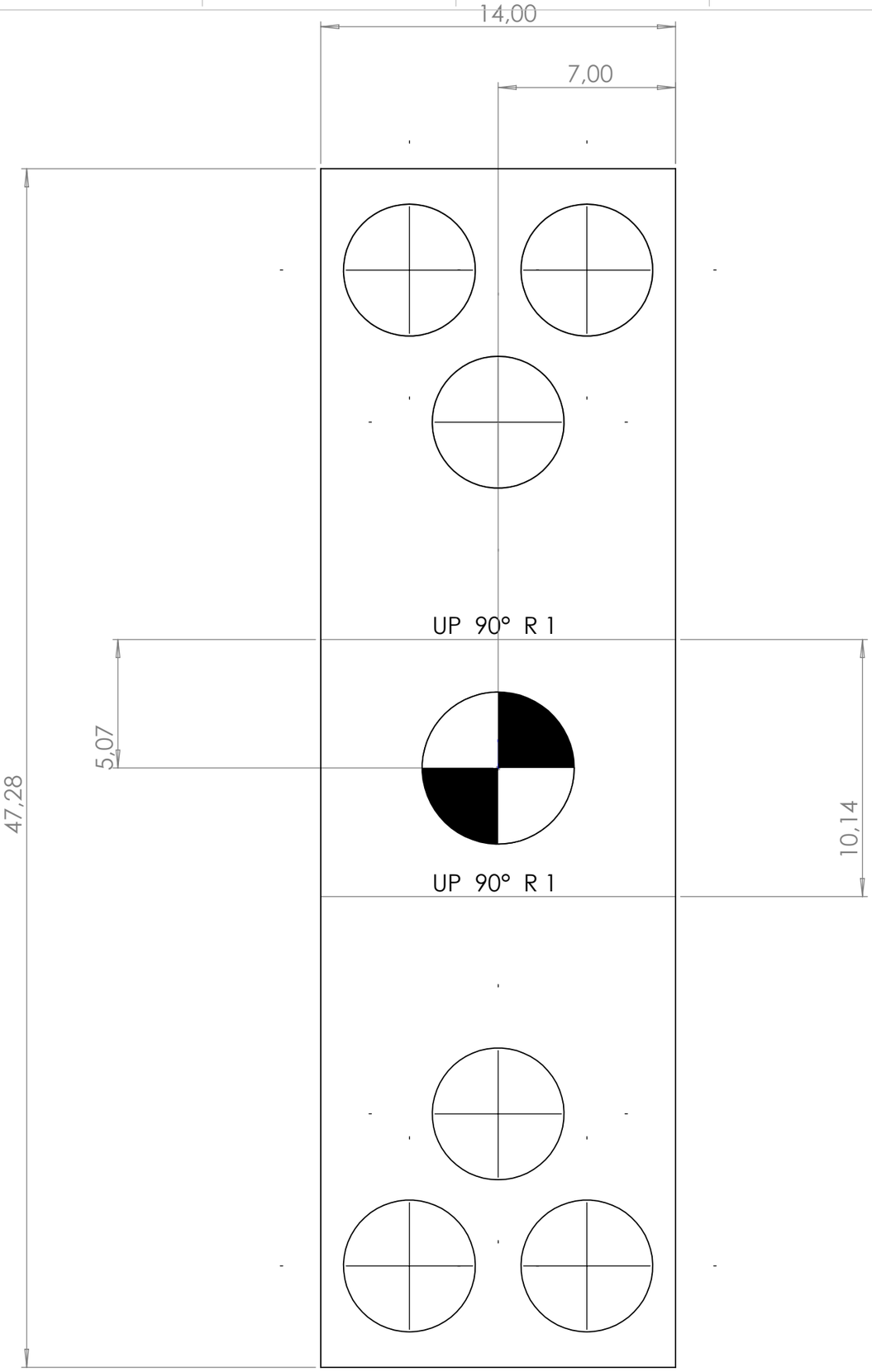


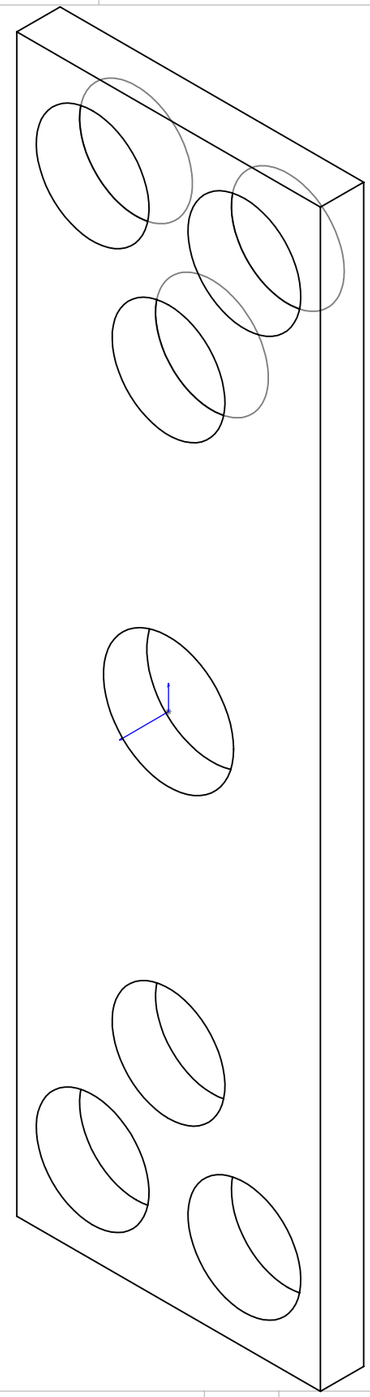




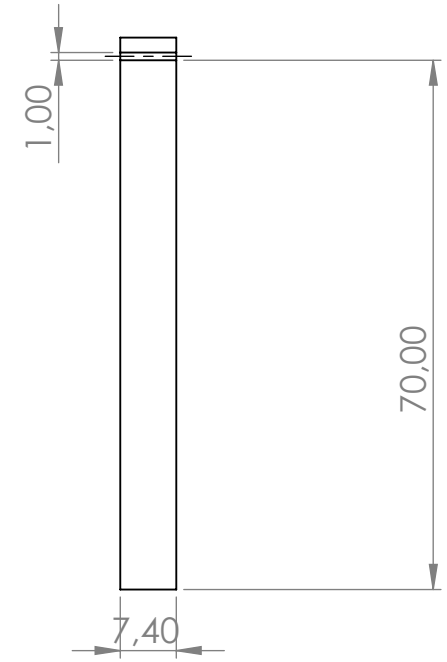


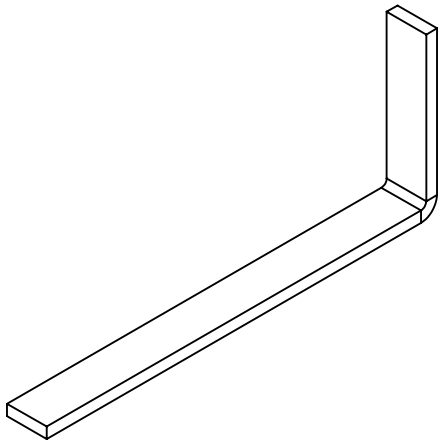
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom van Hensbergen	DATE	1-11-2018
		CHECKED	--	SCALE	5:1
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: U-shape Connector			REV.: 01
UNIVERSITY OF TWENTE.		DRAWING NO.: 1002			A3
FACULTY OF ENGINEERING		FILE / PART NAME: 1002_drawing			
		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 2	

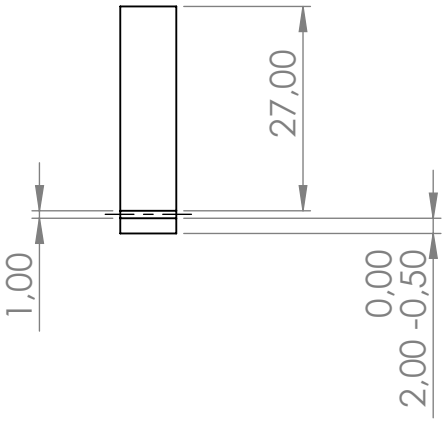


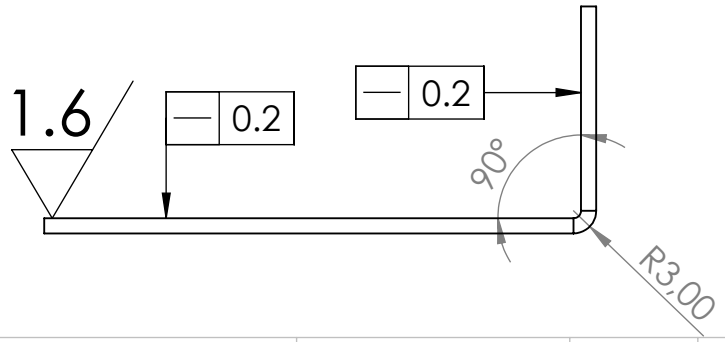


PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom van Hensbergen	DATE	1-11-2018
		CHECKED	--	SCALE	5:1
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: U-shape Connector			REV. 01
UNIVERSITY OF TWENTE.		DRAWING NO. 1002			A3
FACULTY OF ENGINEERING		FILE / PART NAME: 1002_drawing			
		DIMENSIONS IN MILLIMETERS		SHEET 2 OF 2	



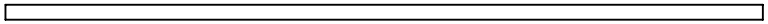


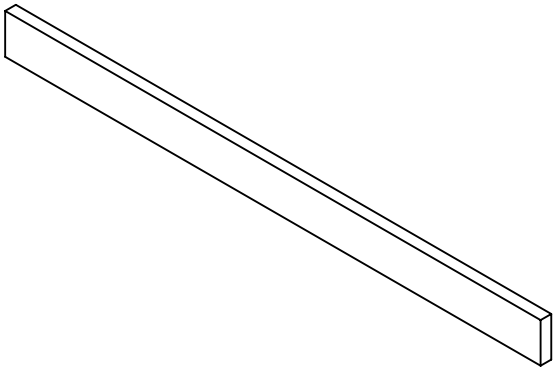


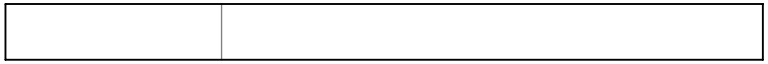


PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Jesper Kussendrager	DATE	12/10/2018
		CHECKED	--	SCALE	1:2

MATERIAL	SURFACE TREATMENT	TITLE	REV.
--	--	Rail	01
--	--	DRAWING NO. 1003	A4
UNIVERSITY OF TWENTE.		FILE / PART NAME 1003	
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS	SHEET 1 OF 2

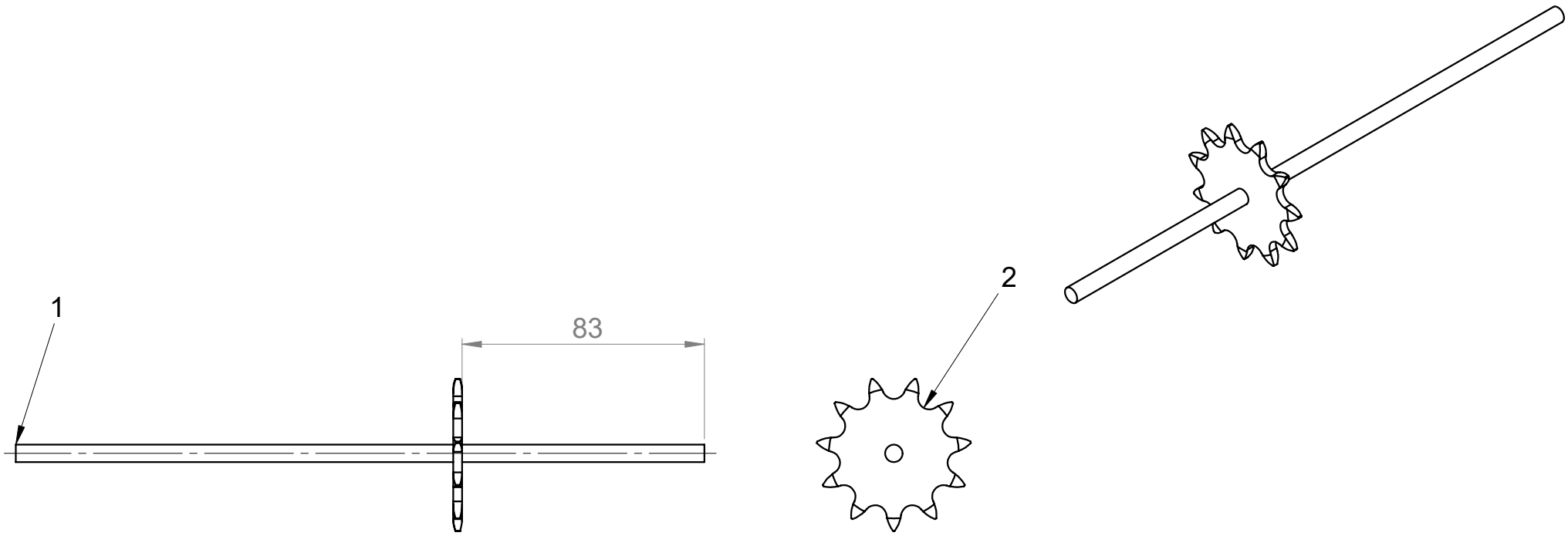






UP 90° R 1

PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Jesper Kussendrager	DATE	12/10/2018
		CHECKED	--	SCALE	1:1
MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: Flat Pattern of Rail			REV.: 01
		DRAWING NO.: 1003			
UNIVERSITY OF TWENTE.		FILE / PART NAME: 1003			A4
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS			SHEET 2 OF 2

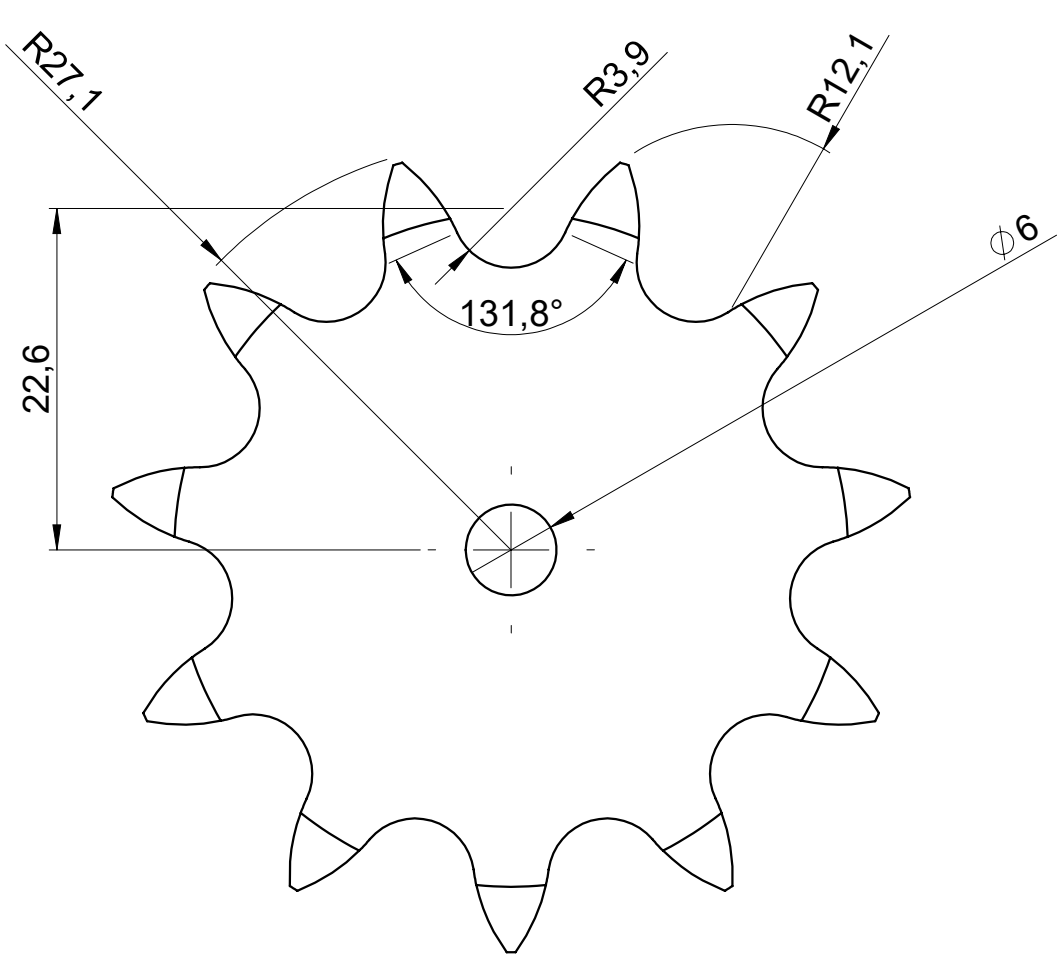


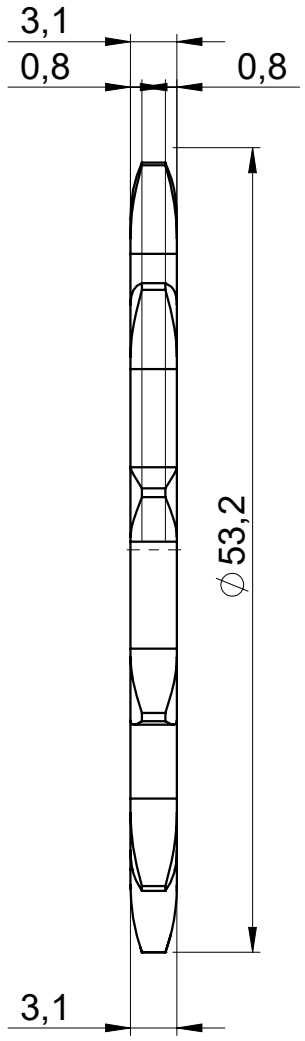
POS.	QTY.	NAME	MATERIAL	NORM / DIMENSION	REMARK
2	1	1101 - Chain wheel ISO - 11Z 081 --11SA6.0N			
1	1	1102 - Left Rod			

PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Tom Kluin	DATE	01/11/2018
		CHECKED	--	SCALE	1:2

MATERIAL	SURFACE TREATMENT	TITLE	REV.
--	--	1100 - True Left Rod	01
--		DRAWING NO. 1100	A4
UNIVERSITY OF TWENTE.		FILE / PART NAME 1100 - True Left Rod	
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS	SHEET 1 OF 1

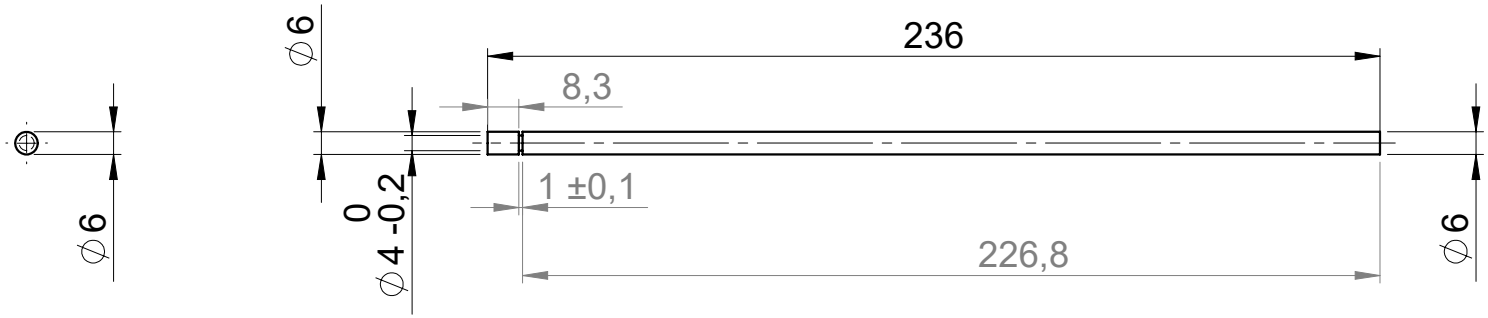
6.3



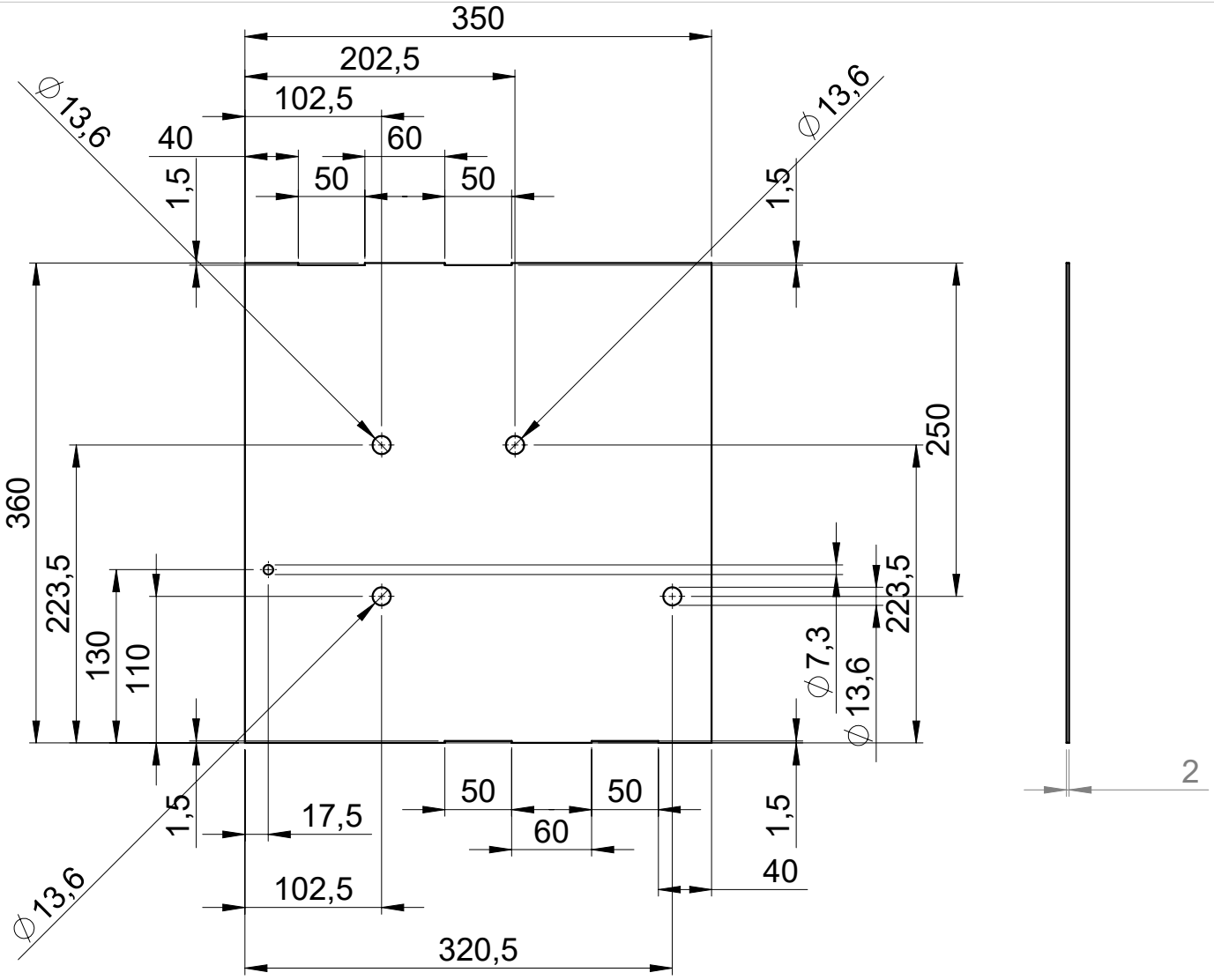


PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Bram Vloedgraven	DATE	12-10-2018
		CHECKED	--	SCALE	2:1

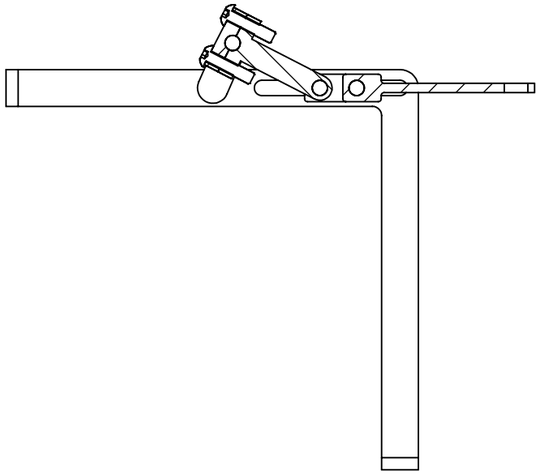
MATERIAL: Sheet metal --	SURFACE TREATMENT: --	TITLE: 1101 - Chain wheel ISO - 11Z 081 --11SA6.0N	REV. 01
		DRAWING NO. --	A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 1101 - Chain wheel ISO - 11Z 081 --11SA6.0N	
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS	SHEET 1 OF 1



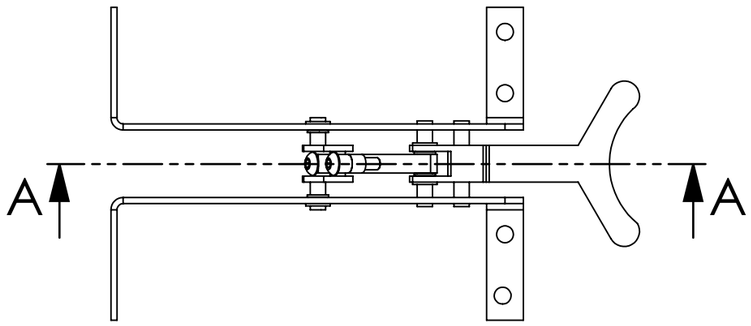
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Bram Vloedgraven	DATE	1-11-2018
		CHECKED	--	SCALE	1:2
MATERIAL -- --	SURFACE TREATMENT --	TITLE 1102 - New left gear for locker			REV. 01
		DRAWING NO. 1102			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME 1102 - New left gear for locker			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	

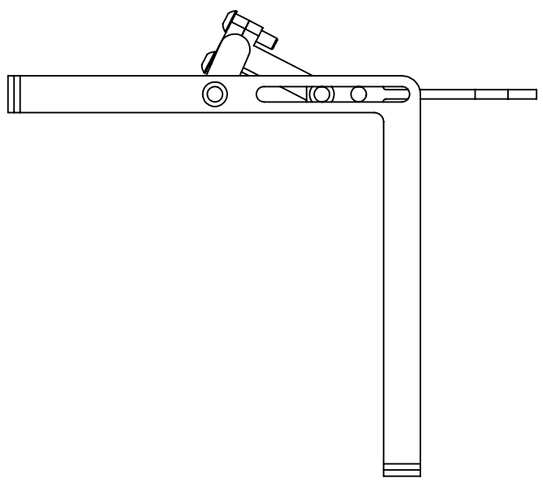


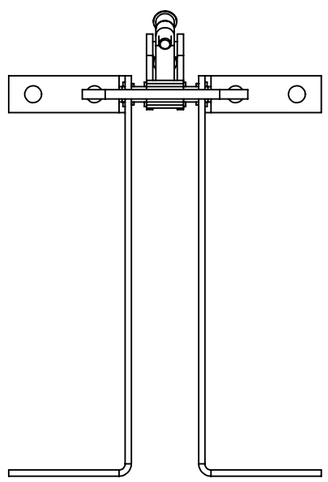
PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Bram Vloedgraven	DATE	12-10-2018
		CHECKED	--	SCALE	1:5
MATERIAL: Sheet metal, --	SURFACE TREATMENT: --	TITLE: 1201: PuzzlePlate			REV.: 01
		DRAWING NO.: --			A4
UNIVERSITY OF TWENTE.		FILE / PART NAME: 1201_PuzzlePlateLeft			
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS		SHEET 1 OF 1	

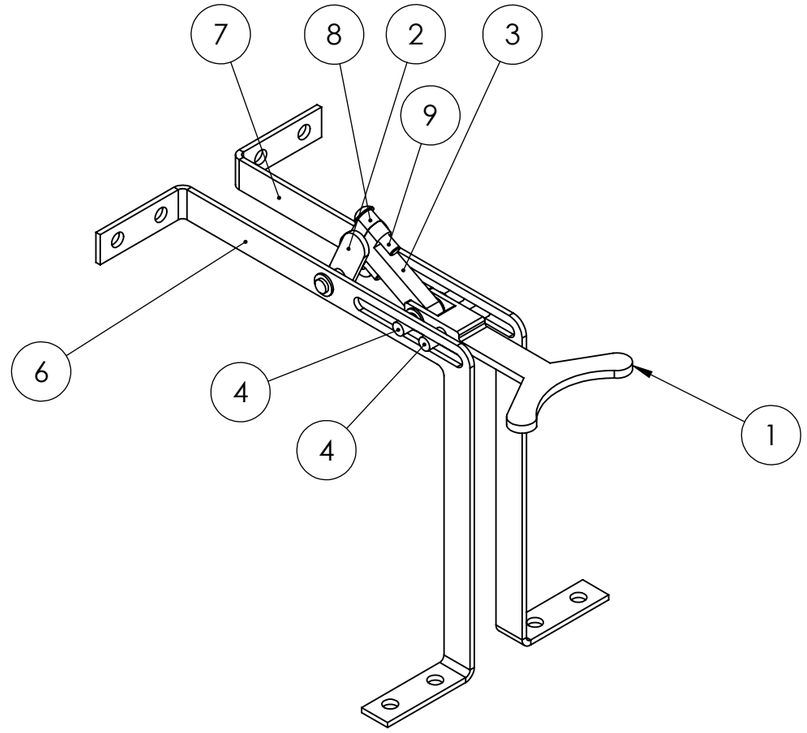


SECTION A-A









POS.	QTY.	NAME	MATERIAL	NORM / DIMENSION	REMARK
9	2	ISO 7380 - M4 x 16 - 16C			
8	1	Part1307			
7	1	Part1302.2			
6	1	Part1302.1			
5	4	Part1306			
4	2	Part1305			
3	1	Part1304			
2	1	Part1303			
1	1	Part1301			

PROJECTION METHOD	UNLESS STATED OTHERWISE: TOLERANCES ± 0,5 MM	DRAWN	Jesper Kussendrager	DATE	07/11/2018
		CHECKED	--	SCALE	1:2

MATERIAL: -- --	SURFACE TREATMENT: --	TITLE: Redesign Locking Mechanism	REV. 01
		DRAWING NO. 1300	A3
UNIVERSITY OF TWENTE.		FILE / PART NAME: Assembly1300_NewLocker	
FACULTY OF ENGINEERING		DIMENSIONS IN MILLIMETERS	SHEET 1 OF 1