



College of Engineering
Department of Mechanical Engineering

Design of Date Picking Elevator



Assessment III: Senior Project

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Statement of purpose



- To design a date picking elevator. Since the date picking process takes a long time and is dangerous sometimes, we have decided to design a date picking elevator that will help the farmers do the date picking process easily and fast.
- To practice the application of computer aided design “SolidWorks” in the design of mechanism.



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Problem Definition



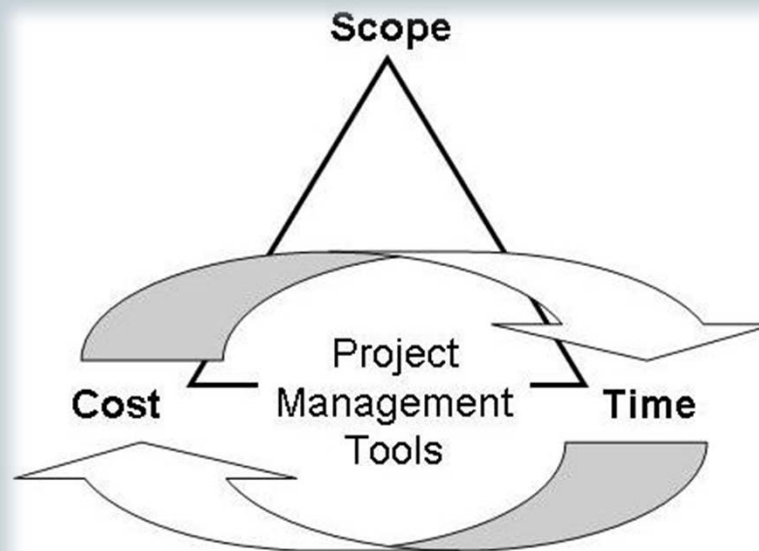
- Design a date picking elevator. This machine can perform all the required operations for date picking process. Factors considered are safety, stability, speed, cost, and efficiency.



Scope of the Project



- The scope of this project is to design a date picking elevator that can be built using locally available resources and manufacturing techniques.



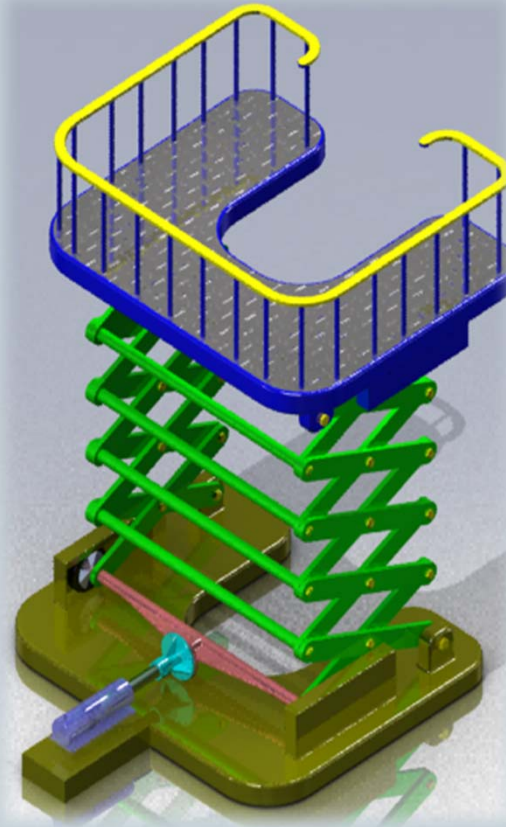


Abstract



- Saudi Arabia is considered one of the top ten countries around the world to export dates.
- Since the date picking process takes a long time and is dangerous sometimes, we have decided to design a date picking elevator that will help the farmers do the date picking process easily and fast.
- Normally, the farmers use a rope to climb the palm trees, but with our date picking elevator the farmers will reach the dates fast and safe.

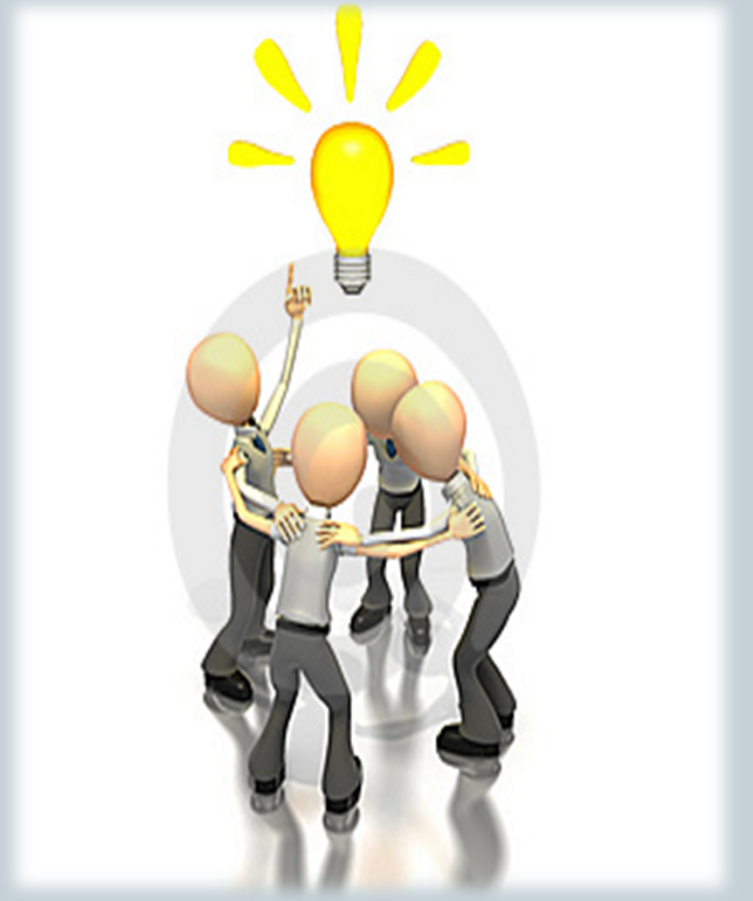
Process of Date Picking



Brainstorming



- List of input to design date picking elevator:
 1. The height of the palm tree.
 2. Average radius and tree trunk.
 3. Weight of the operator.
 4. Materials used to build the elevator.
 5. Target cost of elevator.
 6. Safety requirements.
 7. Target Weight of the elevator.
 8. Lifting machine.
 9. Speed.
 10. Power needed.
 11. Load time for operating.
 12. Manufacturability.
 13. Defined the problem statement.

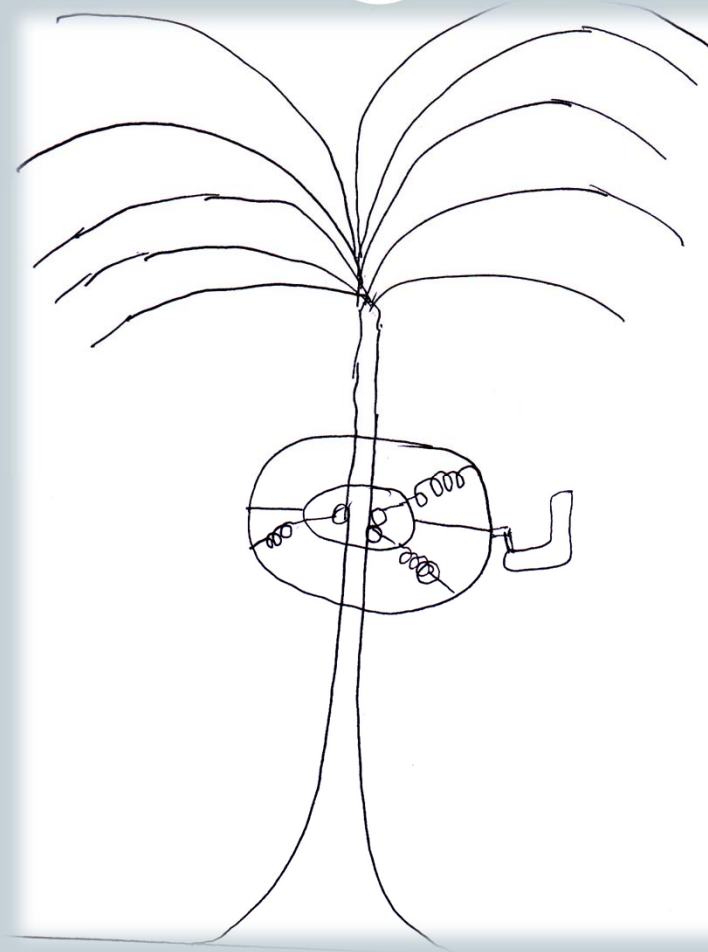


Initial Ideas

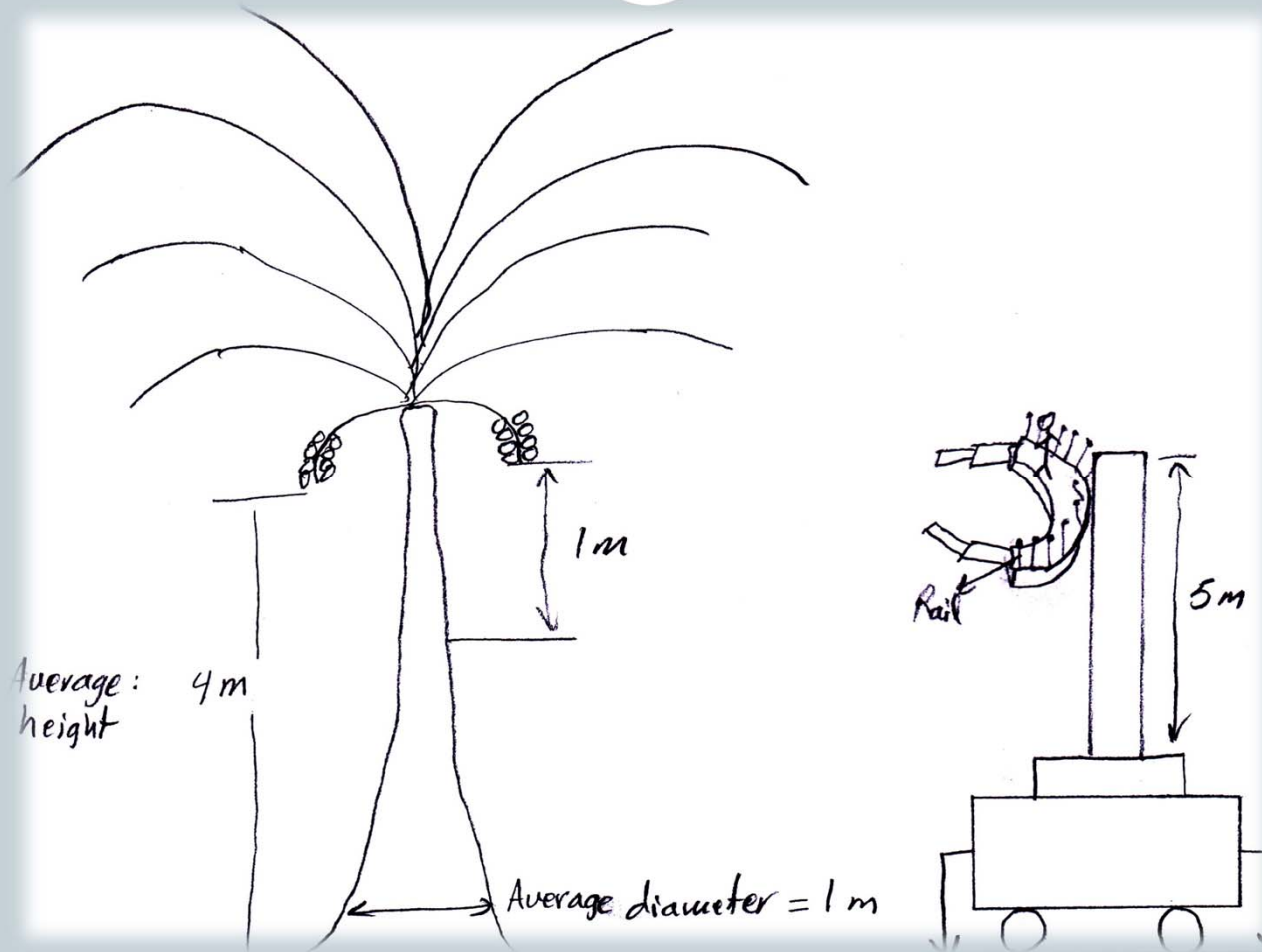


1. The first idea was to design the machine in a donut shape.
2. The donut shape will hug the palm tree.
3. The donut shape will be lifted by two hydraulic beams.
4. The donut shape can be compressed or extended depending on the palm diameter.

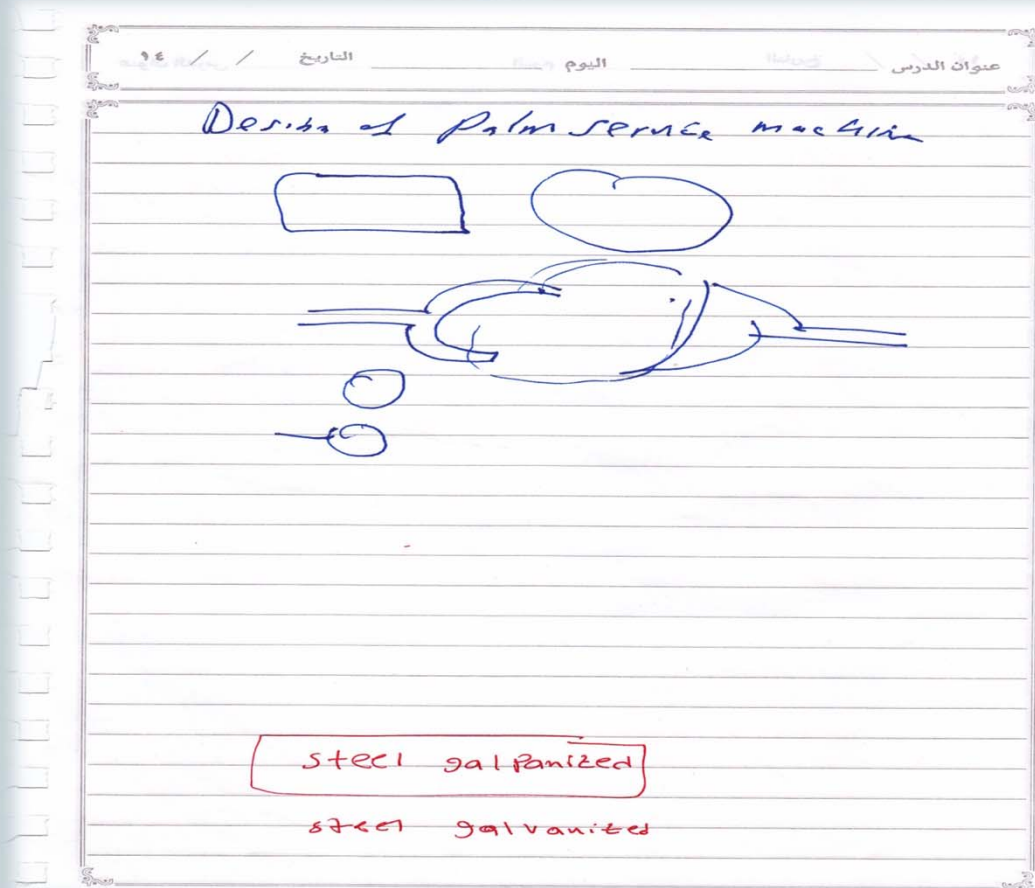
Initial Sketch



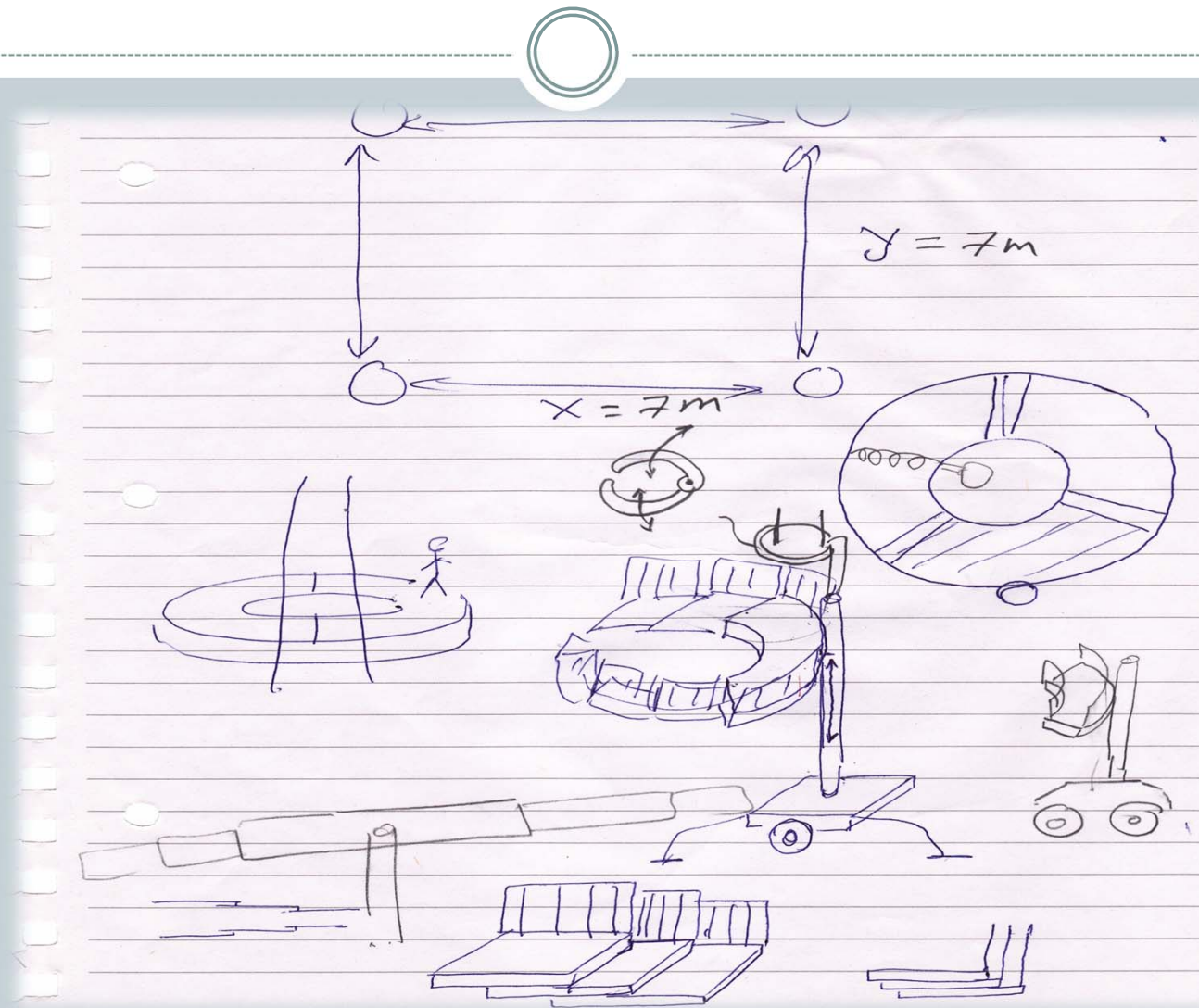
Initial Sketch



Initial Sketch



Initial Sketch



Initial Ideas Discussion



- **Problems:**

1. Some palm trees are not straight; with the machine that we designed we will have problems with such trees.
2. In some farms, palm trees are so closed to each other. Our machine needs space available between palm trees.
3. The extend parts of the donut will not be supported enough to handle weights.
4. Our initial design will be very difficult to move for the farmer due to the donut radius.
5. Palm trees have different heights, so for example in the palm tree is 11 m height this will cause some bending and curve in the hydraulic beam due to the height of this palm tree.
6. Hydraulic beam is costly.
7. Hydraulic beam is not stable.

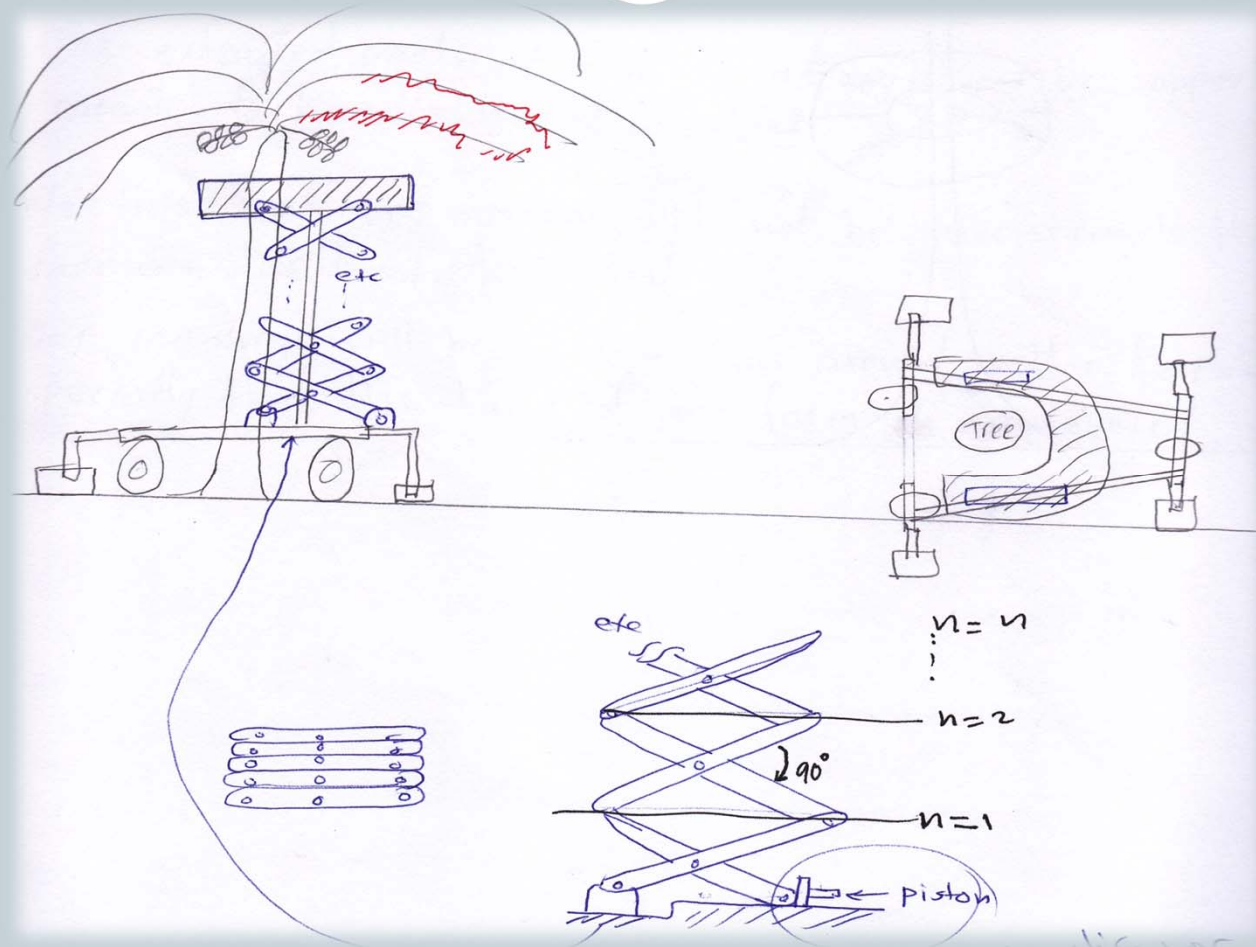
Initial Ideas Discussion



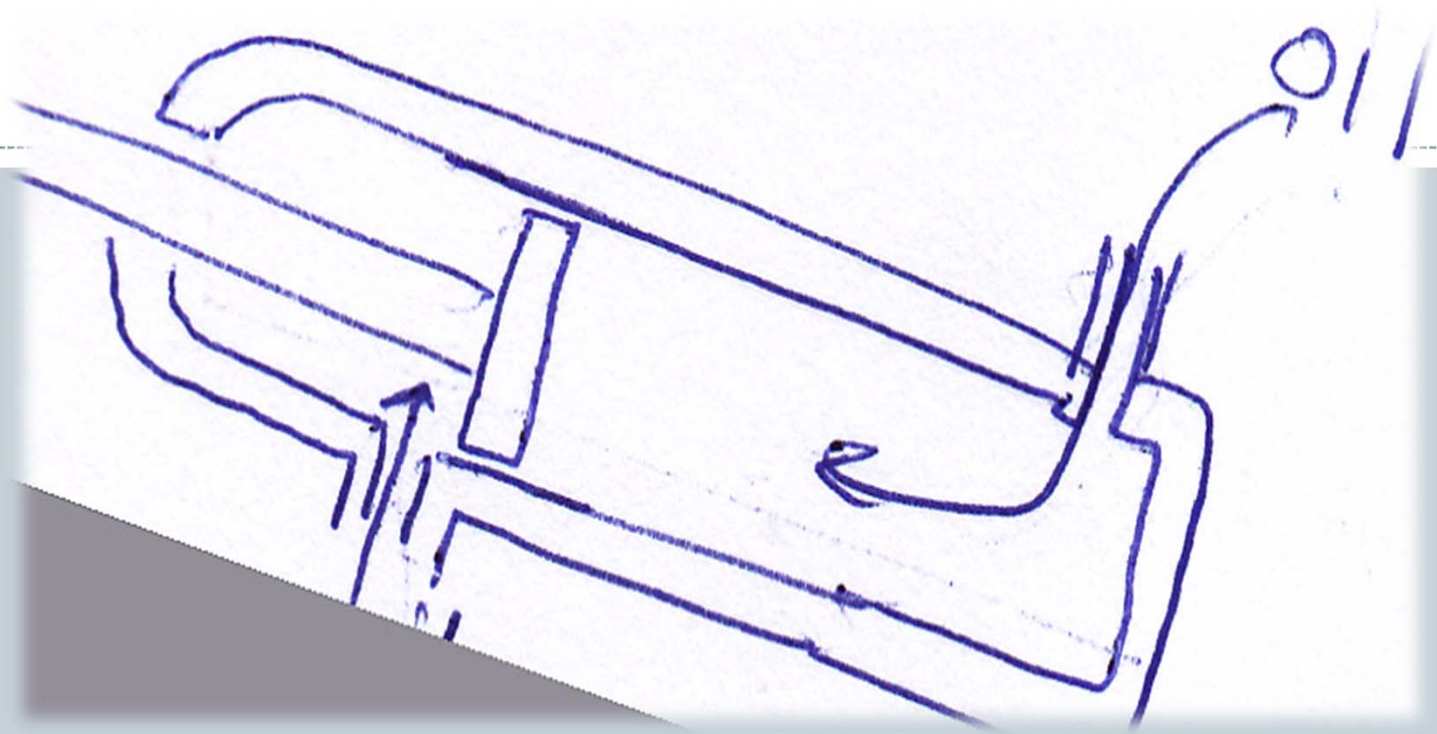
- **Solutions:**

1. We decided to design a U letter shape rather than the donut shape.
2. The U letter shape, will hug the palm tree easily even if there were differences in the diameter of the trunk of the palm tree.
3. Design a scissor mechanism rather than hydraulic beam.
4. Scissor mechanism guarantees good stability.
5. The U shape will be easier to move in the farm than the donut shape.
6. By using the U shape, we can benefit from more than one side of the mechanism when we do the date picking process.

Final Design Sketch



Final design sketch



HYDRAULIC CYLINDER

Gantt Chart



1. Gantt chart is a graphical representation of the duration of tasks against the progression of time.
2. It is a useful tool for planning and scheduling projects.
3. It is helpful when monitoring a project's progress.
4. It is a type of bar chart that illustrates a project schedule.
5. It illustrates the start and finish dates of the terminal elements and summary elements of a project.

Design Specifications



- **A. Palm Tree Dimensions.**

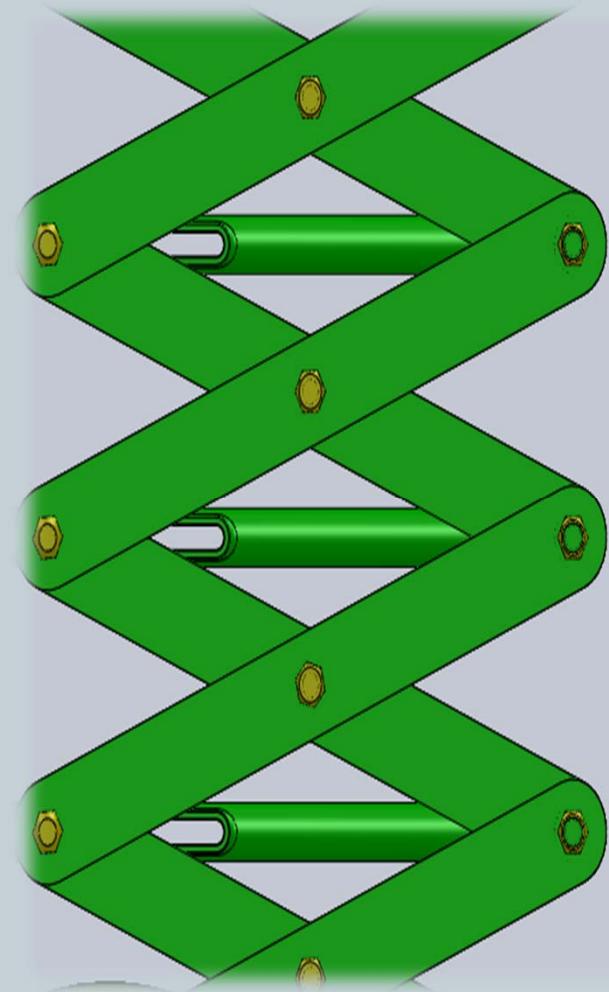
We went to a farm in Al-Hassa and took some measurements. These measurements are:

1. Average height of the palm tree is 7 m.
2. The distance between the palm trees in the X and Y axes is 5 m.
1. Average diameter of the palm tree is 1 m.
2. The average diameter of middle palm trunk is 0.5 m.
3. The average distance between the date and the ground is 5 m.

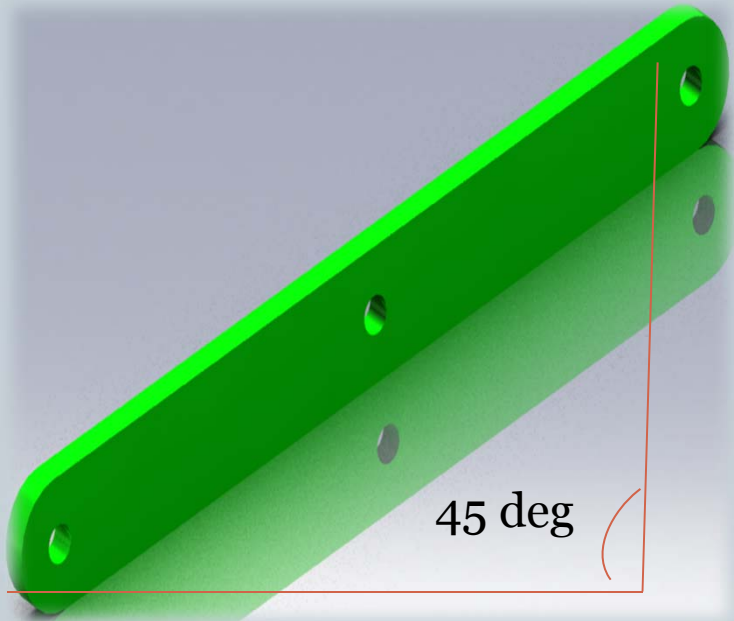


Concept Design

- **B. Scissor Mechanism**
- The scissor mechanism contains more than one arm that are connected together forming a scissor shape.
- It is used in many applications that require handling heavy loads.
- The most common example of the scissor mechanism is the car jack.



Arm Calculations



$$n = 5 / h$$

$$n = 5 / \sqrt{2}$$

$$n = 5\sqrt{2} / L = 7 / L$$

$$2h^2 = L^2$$

$$L = h\sqrt{2}$$

$$h = L / \sqrt{2}$$

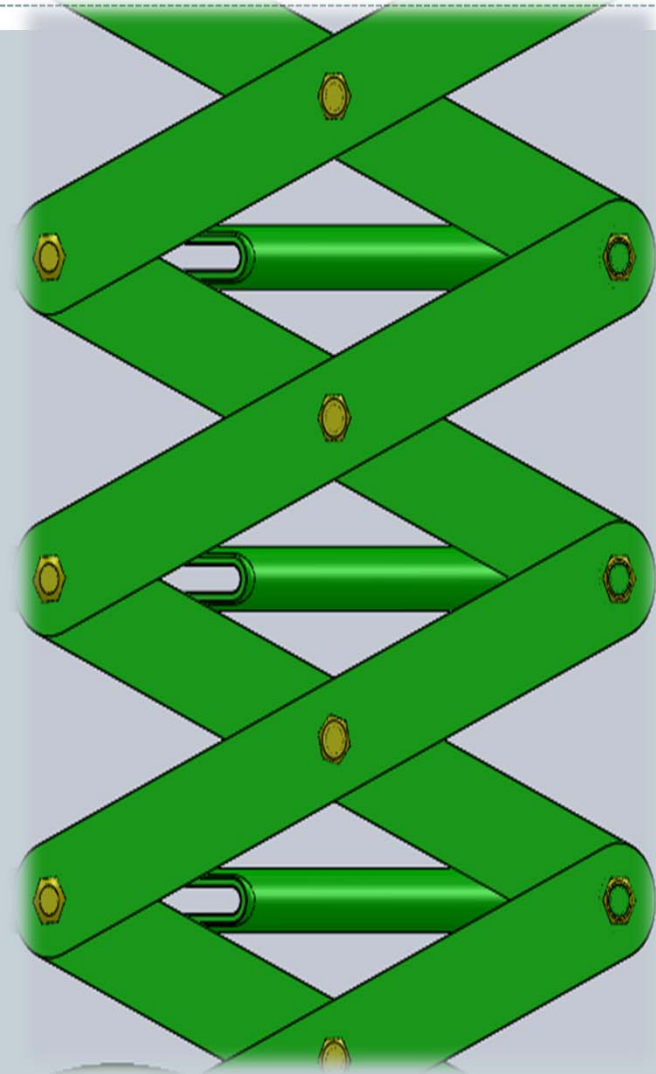
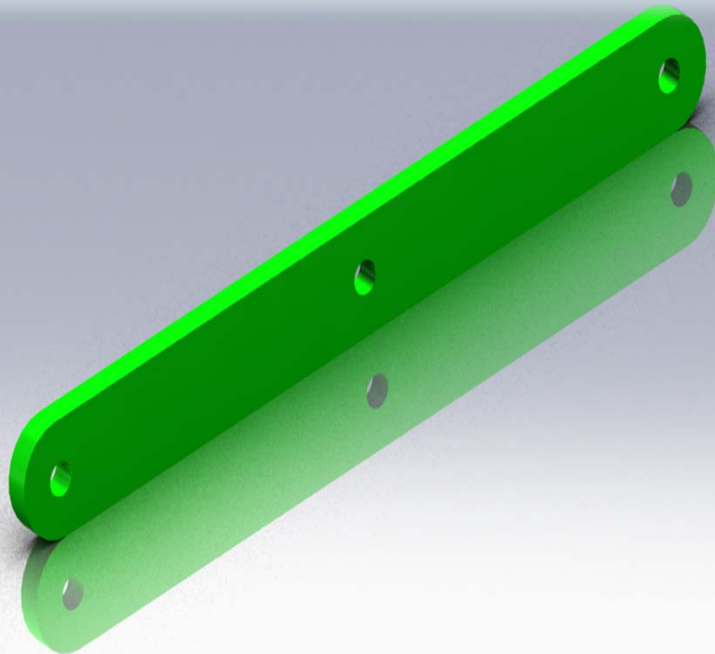
- If $L = 1 \text{ m}$ $n = 7$
If $L = 1.5 \text{ m}$ $n = 7/1.5$
- $n = 5$, which is number of two combined arms (scissor)

Arm Dimensions

Φ (Diameter) = 5.2 cm

$L_{Arm} = 150$ cm

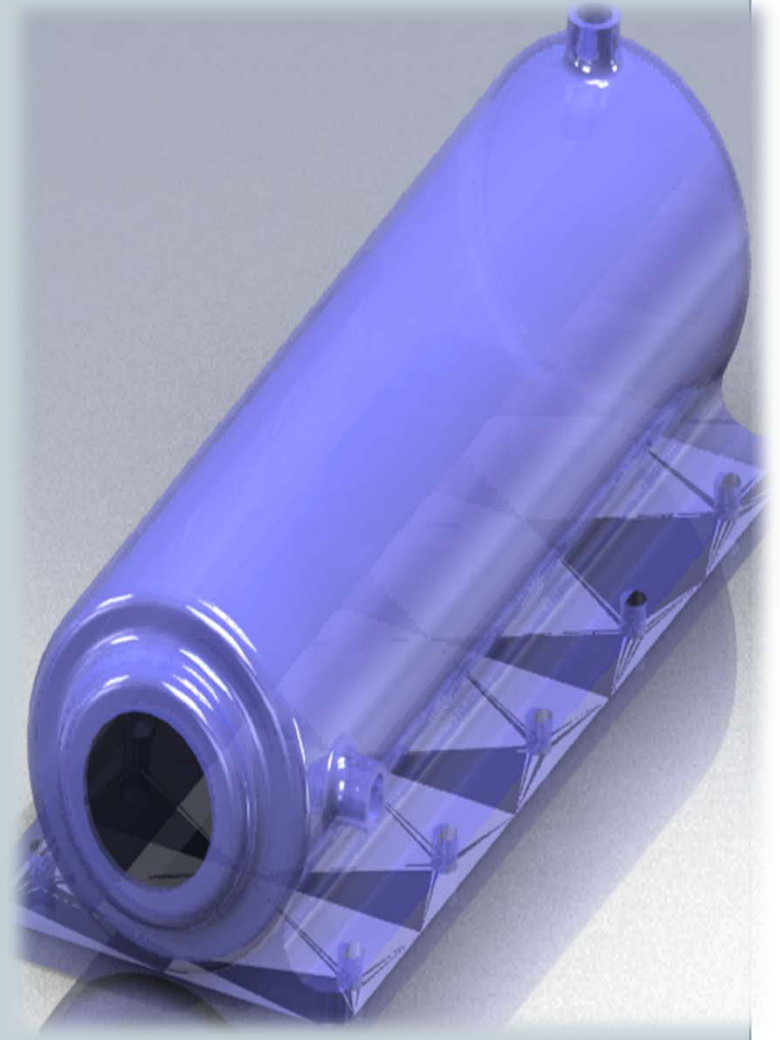
$T_{Arm} = 5$ cm



The Hydraulic Cylinder



- The purpose of the hydraulic cylinder is to move the whole mechanism.
- Pressurized fluid will be used inside the cylinder to help move the mechanism using a piston.

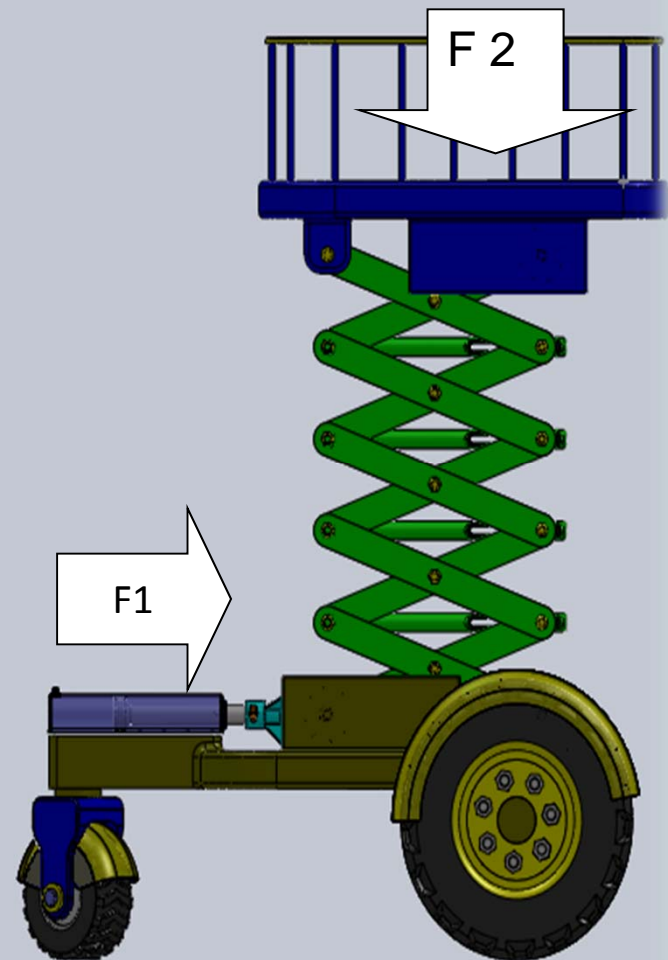


FBD of the Piston

- FBD is important to calculate the forces acting the mechanism.

F_2 = the weight of the farmer and dates.

F_1 = The force exerted on the piston.



Piston Force Calculations



- Assuming exerted force F is 100 N on the piston shaft. The diameter of piston is 19.1 cm and the diameter of scissor arm is 18 cm. The distance between the inlet of hydraulic cylinder and the piston coupling is 214.2 m. The length of the piston shaft is 26 cm. Neglect the mechanism and top weight.
- The force exerted on the piston is obtained by taking moments
 $(2.142\text{m}) \times (100\text{N}) - (0.26\text{m}) F_1 = 0$

$$F_1 = \frac{(2.142\text{m}) \times (100\text{N})}{(0.26\text{m})} = 823\text{N}$$

Piston Force Calculations



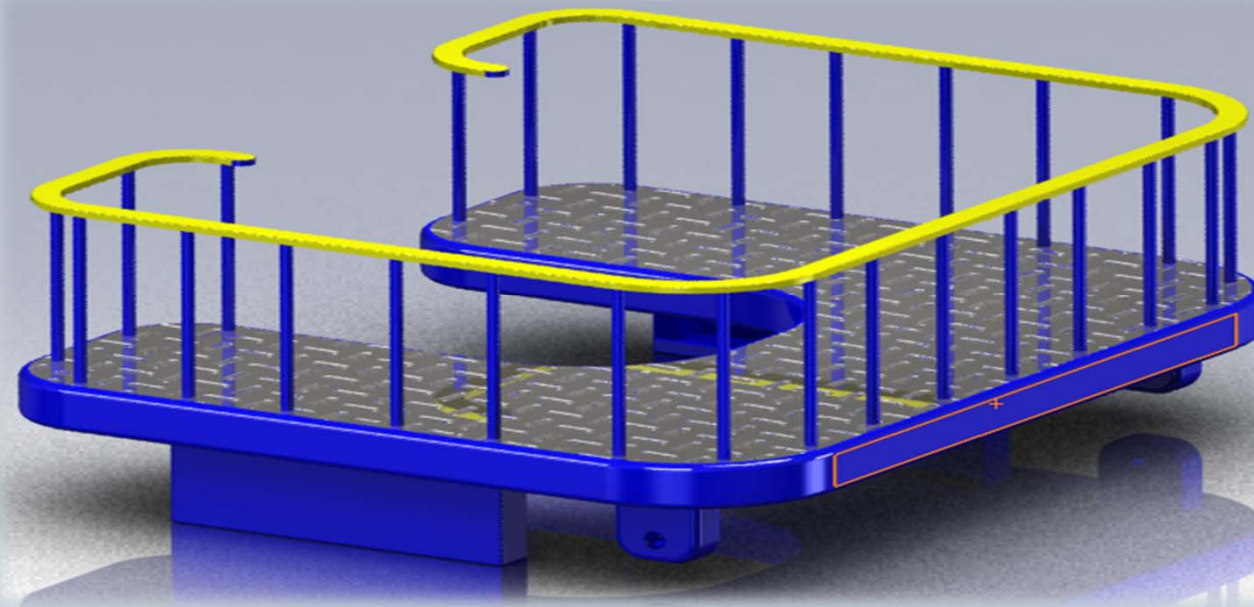
- Because the piston is in equilibrium, this force is equal to the pressure force on the piston:

$$P_1 A_1 = 823N \quad A_1 = \frac{\pi d^2}{4} = \frac{\pi(0.191)^2}{4} = 0.0286m^2 \quad P_1 = \frac{823}{0.0286} = 2.87 \times 10^4 N/m^2$$

- Now we know the pressure in the liquid. Therefore, we can solve for the force on the mechanism and the top platform. Since surfaces 1 and 2 are at the same elevation.
- Thus,

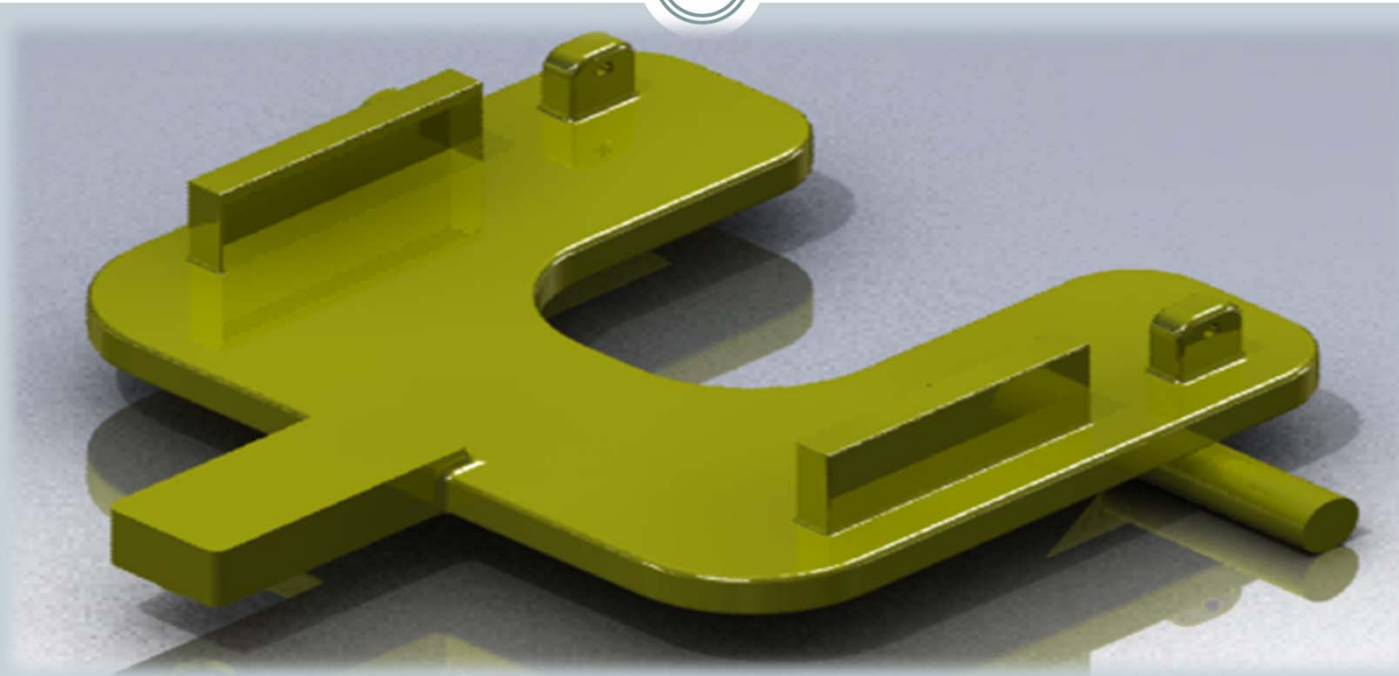
$$F_2 = P_1 A_2 \quad F_2 = 2.87 \times 10^4 N/m^2 \times \frac{\pi}{4} (1.8)^2 = 72.99KN$$

Top Platform



- The material used to manufacture the top platform is galvanized steel.
- The rail is put there to prevent the farmers from falling.

Bottom Platform



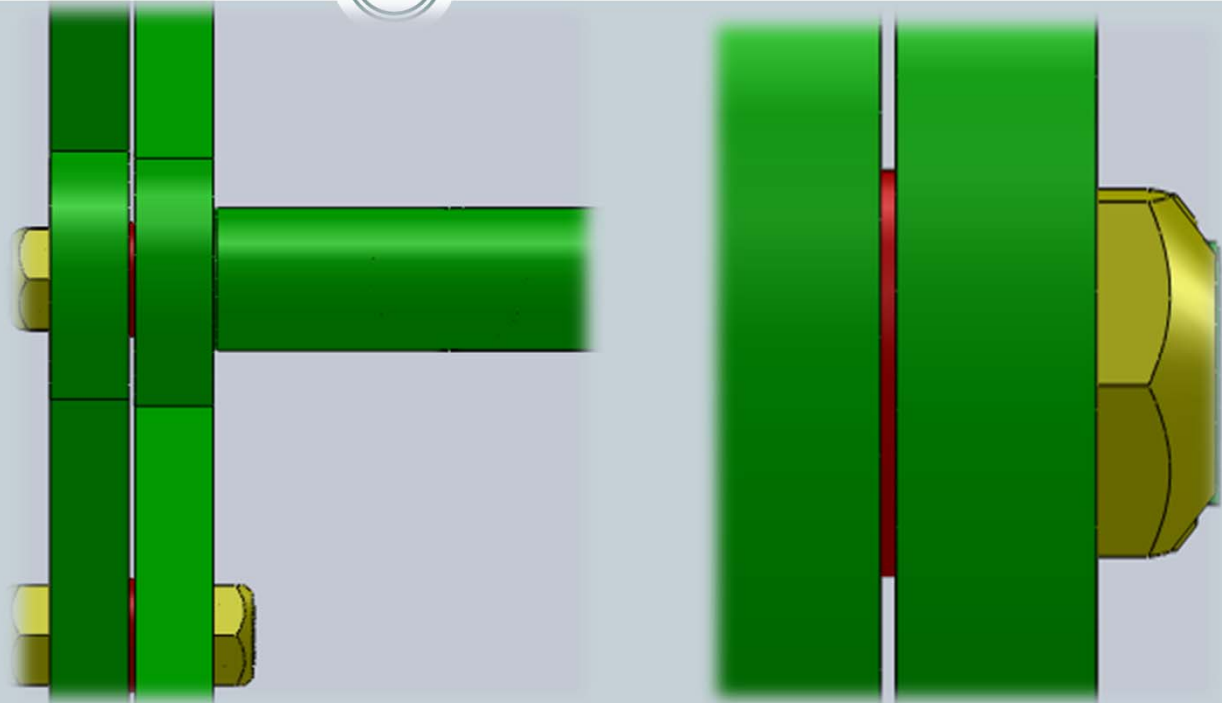
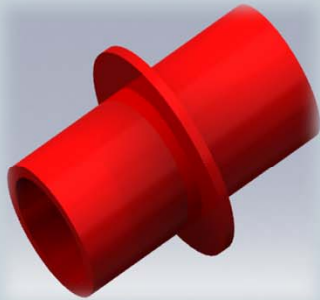
- The bottom platform consists of a plate the carries the hydraulic cylinder.
- It also has the wheels that will allow the mechanism to move freely.

Why We Chose Galvanized Steel

1. Low cost.
2. Less maintenance.
3. Long life.
4. Resistance of corrosion.



The Arm Bushing



- The arm bushing is used to reduce the friction between the arms of the scissor mechanism.
- It is located between each two arms.

Nylon locknut



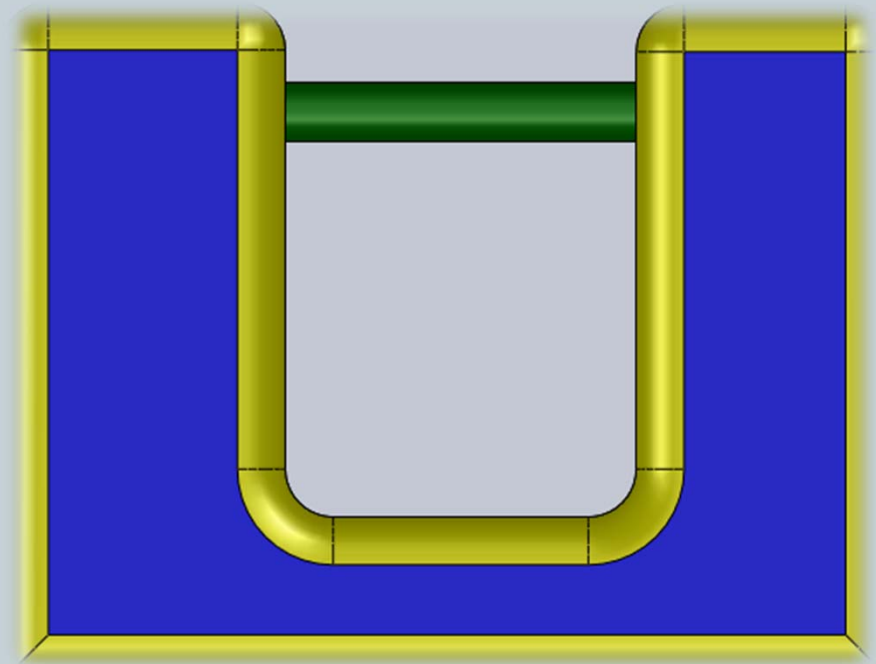
- Locknut is a nut that resists loosening under vibrations and torque. Nylon lock nuts differ from a standard hex nut in that they have nylon insert secured within the nut. The nylon insert is located in a tapered section located at the back of the nut.
- When you install the nylon lock nut onto a bolt or threaded stud, the nylon insert wraps around the threads and locks the nut in place. This gives a nylon lock nut a distinct advantage over a lock washer when the bolt or threaded stud is subject to vibration, as the nylon lock nut is unaffected by vibration.



Arm shaft



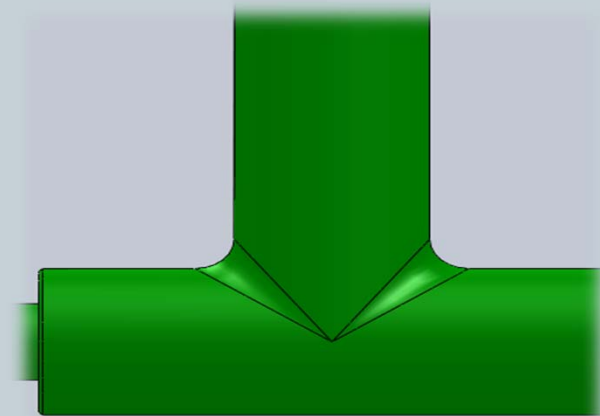
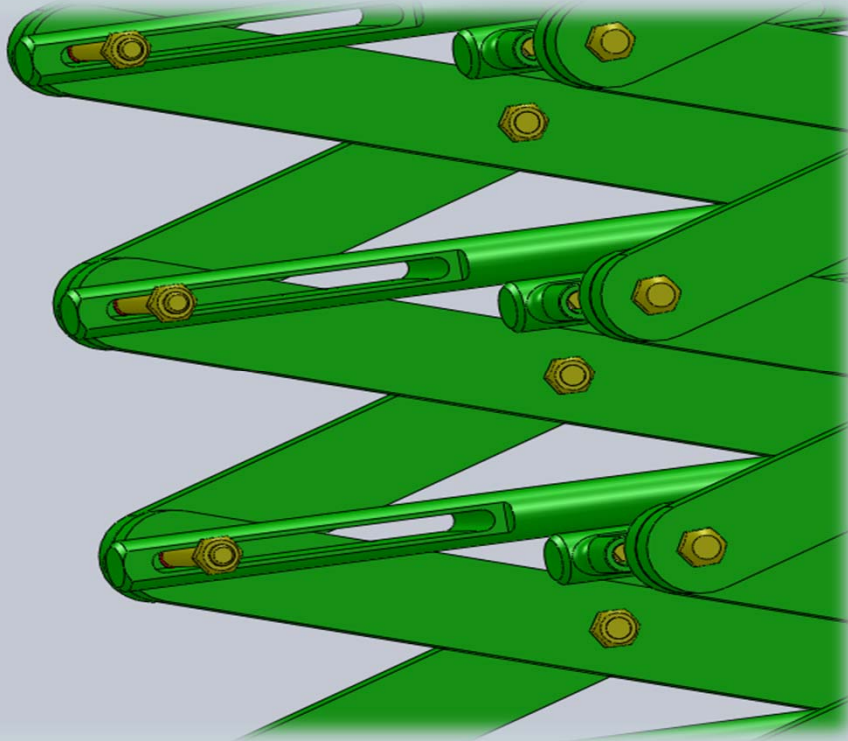
- We designed the arm shafts to make the mechanism more stable when rising and falling. We did more than one design. In the first design, we faced some problems as shown in the figure.
- The problem is that the front shaft will not allow the U shape to hug the palm tree while there was no problem with the addition of the rear shaft.



Final Design of the Arm Shaft



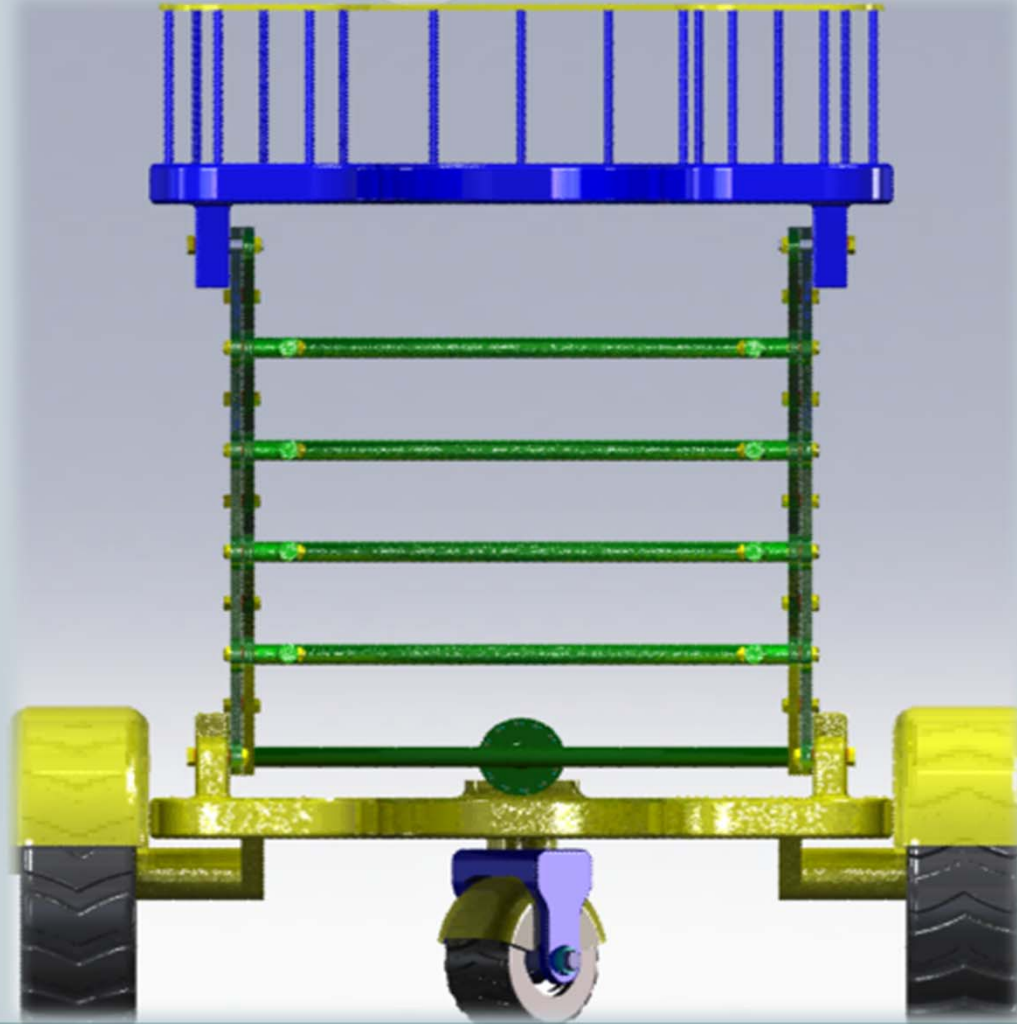
- By designing the new shape, there will be no problem. We can hug the palm tree easily.



Final Assembly

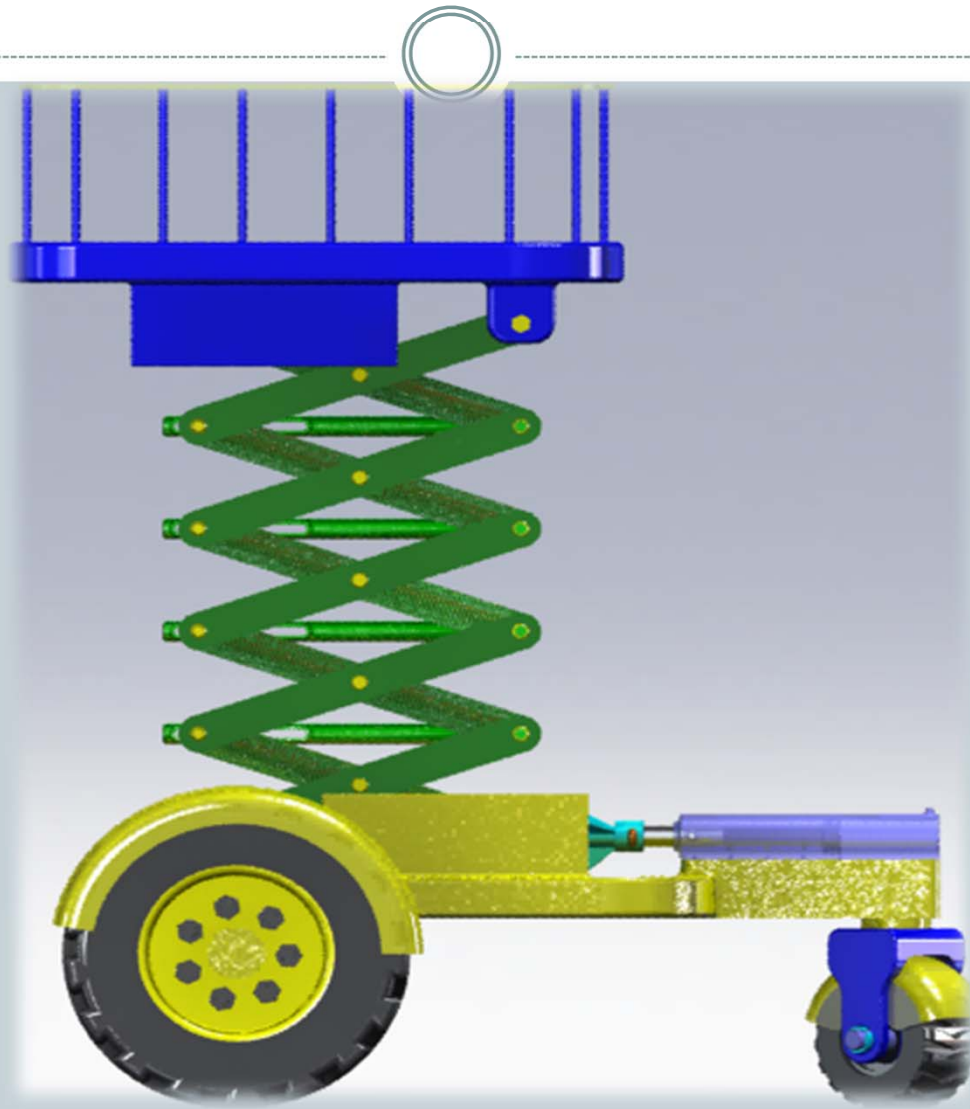


- Front View



Final Assembly

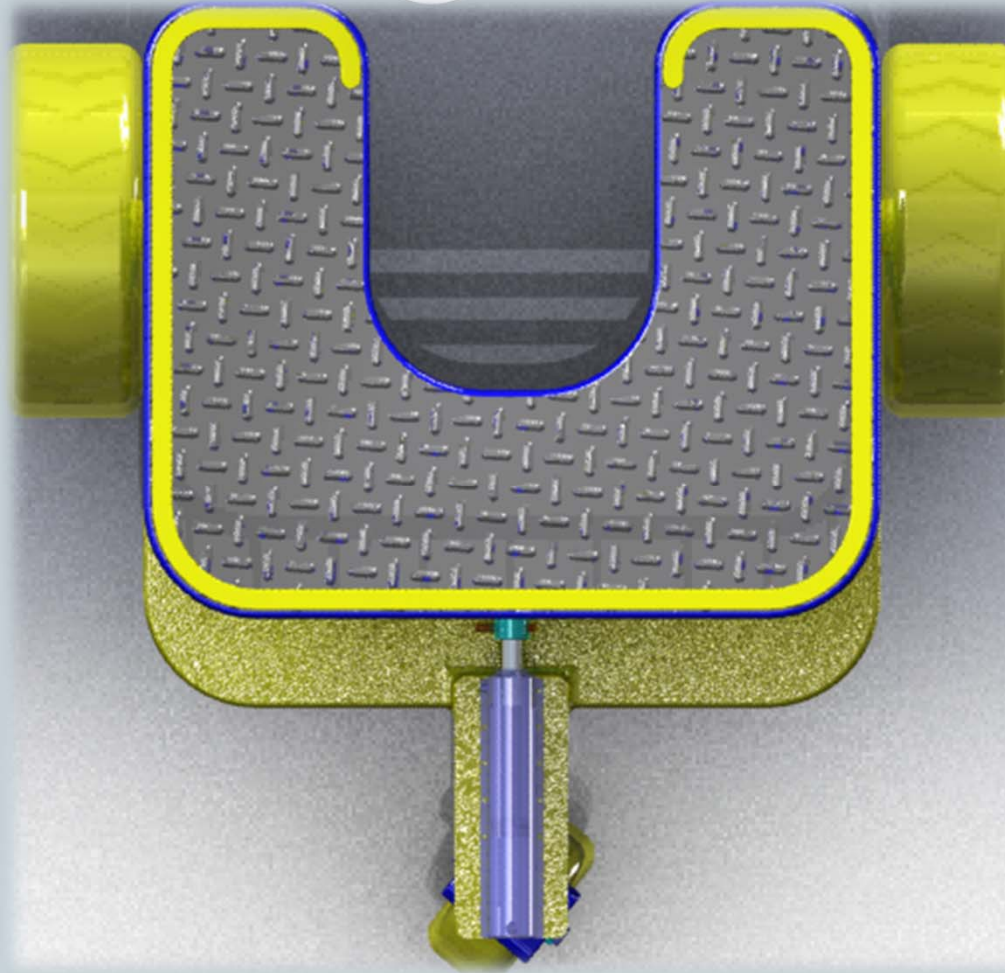
- Side View



Final Assembly



- Top View



Final Assembly



- Isometric View



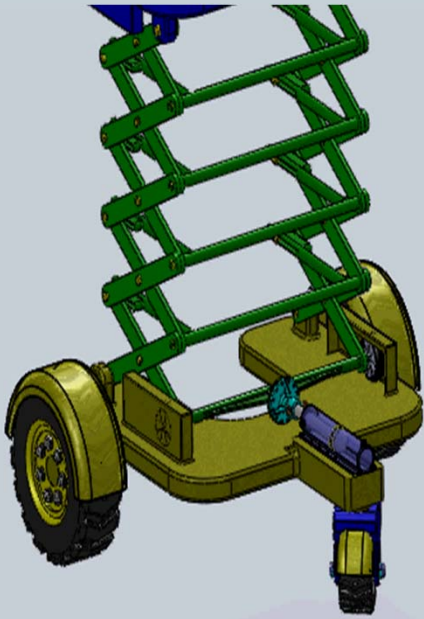
Final Assembly



- Another Isometric View



Animations

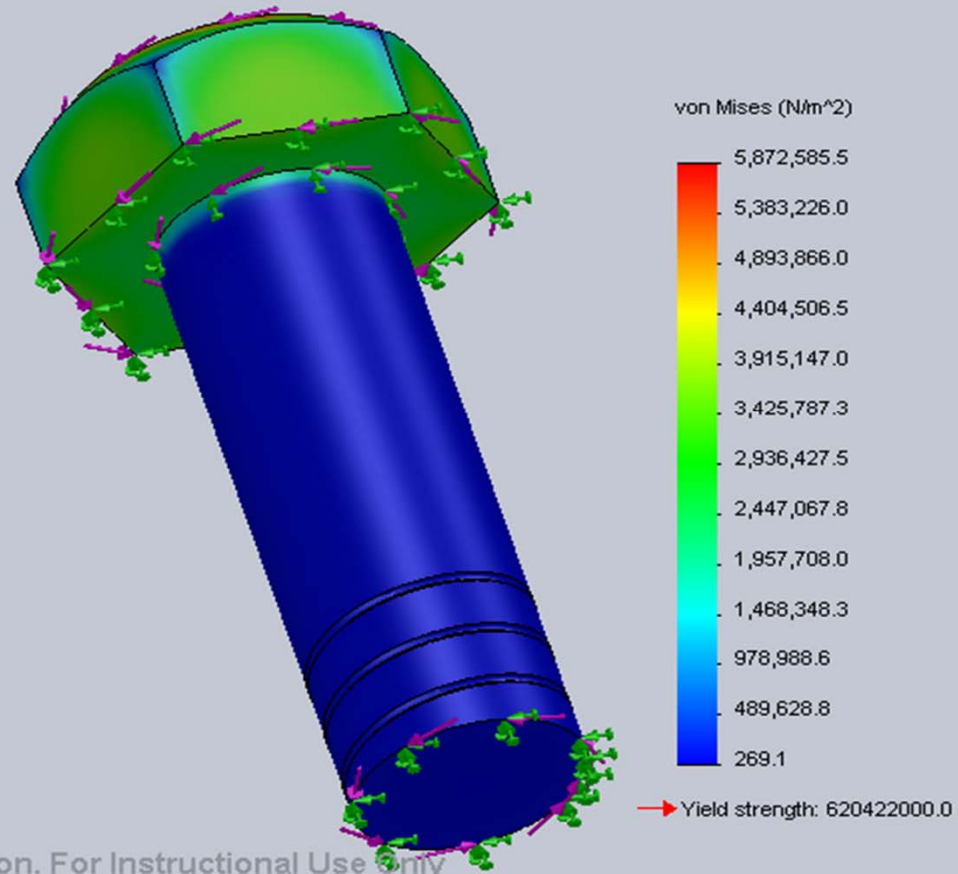


Play



Play

Stress Analysis

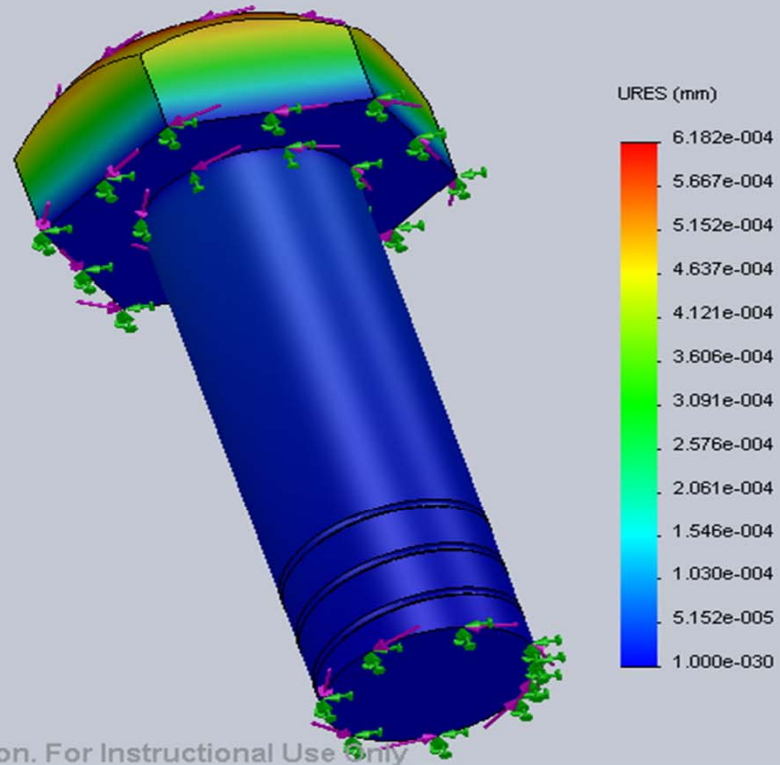


Strain-Strain

Stress Analysis



Model name: arm pin 2
Study name: Study 1
Plot type: Static displacement Displacement1
Deformation scale: 1

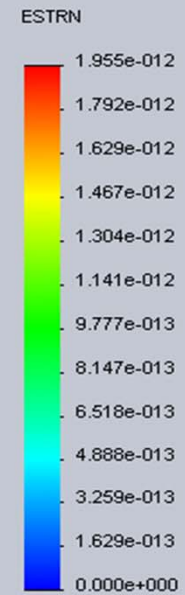
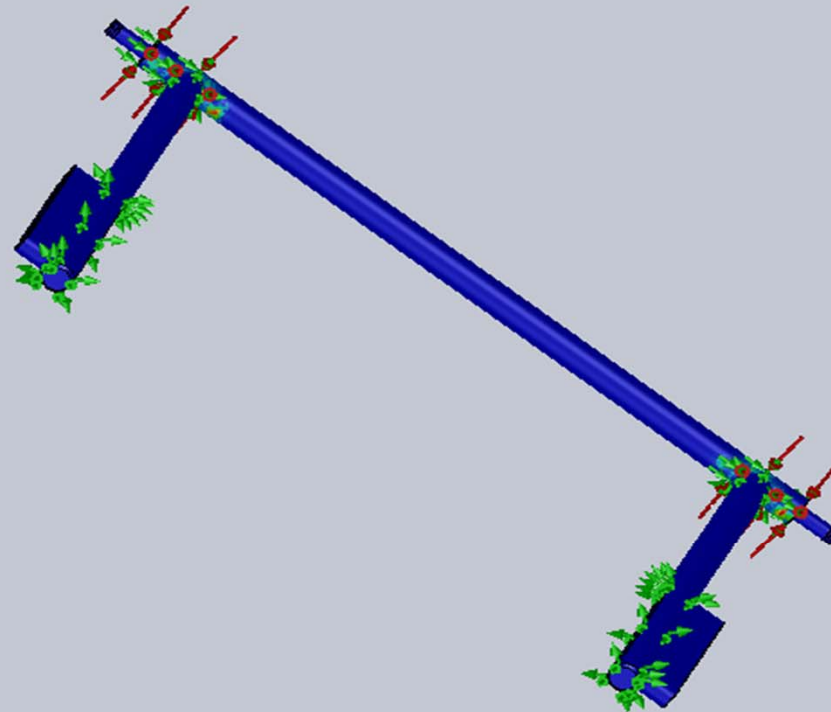


Displacement

Stress Analysis



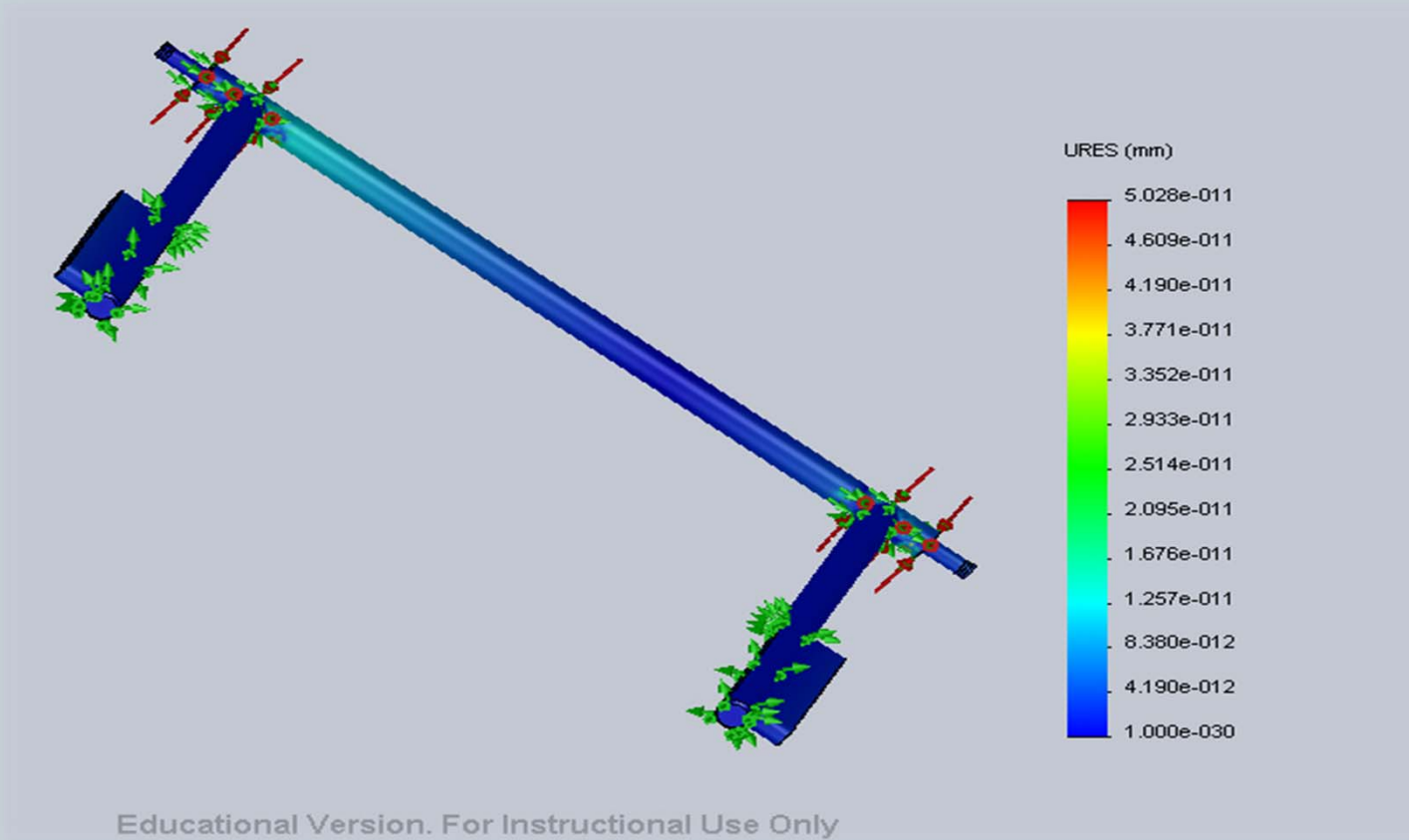
Model name: Shaft
Study name: Study 1
Plot type: Static strain Strain1
Deformation scale: 1



Educational Version. For Instructional Use Only

Strain-Strain

Stress Analysis



Displacement

Conclusion



- Designing a new product is not an easy job. It requires a lot of research and calculations.
- Senior Project has given us more experience and knowledge about designing since we are students.
- Gantt chart is very important for organizing and management projects.
- Brain Storming of the project is the first step to stand up that has to be done carefully.

Conclusion



- Sketches are very important to make the concept of the design clear.
- SolidWorks is one of the best designing softwares.
- Improved our CAD skills.
- In this project, we have covered the content of most of the mechanical engineering courses we have taken throughout our studying period.



Thank you for your
kind attention...

Feel free to ask
questions!