College of Engineering
Department of Mechanical Engineering

DATE HARVESTING IMPLEMENT

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PROJECT ADVISOR:
DR. Emad Tanbour

Learning Outcome Assessment III:
Graduation Project

Abstract

- The Date Harvesting Implement provides a safe and convenient method of harvesting dates on the contrary to the traditional methods currently in use.
- truck-mounted type with:
  - Lifting Mechanism
  - Horizontal reach Mechanism
  - Landing gear
  - Rotary mechanisms
  - Platform
- Utilizes hydraulic actuators in the scissor
- OSHA's working at height safety standards, where the harvester will perform the task.

Acknowledgment

- The project team would like to thank Dr. Emad Tanbour, the project's advisor, for his continuous guidance and support throughout the life of the project.

- to Mr. Ahamd Al-Dawoud, the project's guest student, for his sincere dedication, ideas and efforts.

Outline

1. Introduction
   a. Dates in Saudi Arabia
   b. Design Process
   c. Problem Statement
2. Objective
3. Theory
4. Procedure
5. Stress Analysis
6. Conclusion
7. Recommendations

Introduction

a. Dates in Saudi Arabia:
   - Religious aspect: Ramadan
   - Second Largest Producer
   - National emblem

b. Design Process:
   - Define the Problem ☑
   - Do Background Research ☑
   - Specify Requirements ☑
   - Create Alternative Solutions ☑
   - Choose the Best Solution ☑
   - Do Development Work ☑
   - Build a Prototype ☒ ***CAD PROTOTYPE***
   - Test and Redesign ☒ ***CAD TESTING***

Introduction (Cont'd)

c. Problem Statement:

- Creating uncivilized scenes
- Ruining Crops
- Falling of Harvesters

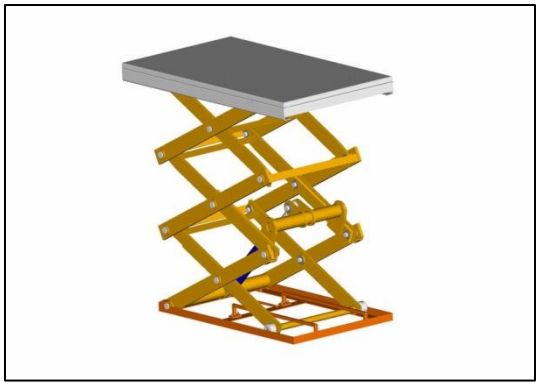
OSHA STANDARDS (48") HANDRAILS

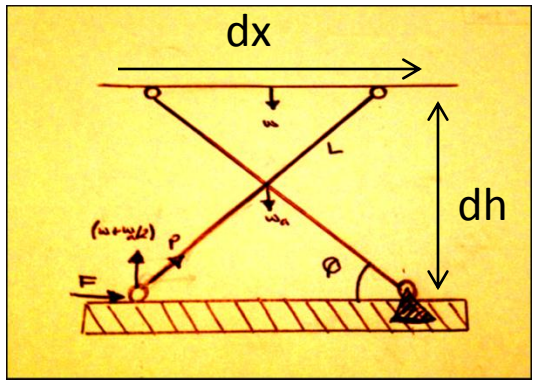
Objectives

- The project is intended to provide a safe and convenient method of harvesting dates.
- The stretched goal of such project is be familiar with the process to design and develop products that improve work safety and quality of harvested dates. The project is aimed at practicing mechanical engineering design, CAD and mechanism design techniques through a real-life solution. The students are expected to learn basic project management, time management, team work and brainstorming approaches among

Theory

- Scissor Mechanism:
  - Pivoted link + moving link
  - Works as a truss : One member under compression while the other is under tension.
  - Length depends on the geometry of the housing plate.





$$F = \frac{W}{\tan(\emptyset)}$$

$$F = \frac{(W + Wa/2)}{\tan(\emptyset)}$$

$$F = \left(\frac{W + Wa}{2}\right) \times \frac{dh}{dx}$$

Work Done

$$F = \frac{\left(\frac{W + Wa}{2}\right)}{\tan(\emptyset)};$$

Procedure

1. Project Schedule
2. Project Meetings
3. Conceptual Design
4. Sculpture
5. CAD *"SolidWorks"*
6. Design Obstacles
7. Remedies
8. Material
9. Final Design
10. Stress Analysis
11. Cost Estimation

Procedure
1. Project Schedule

- A Gantt chart, type of bar chart, was prepared to illustrate the project's steps by breaking it down into activities and sub-activities. The activities identified in the schedule were as follows:
  - Identifying the Problem
  - Brainstorming
  - Identifying Solution
  - Research
  - Conceptual Design
  - CAD – SolidWorks – Design
  - Final Design
  - Project's Final Package


Preliminary Schedule.pdf

Procedure
2. Meetings

- The project's meetings with the team members were set to be on weekly basis excluding all Skype conference calls, which were at least once every mid-week, and meetings with the project's Advisor. The meetings were primarily to gauge progress and for assigning tasks to team members. Meeting with the project's advisor were constant basis for guidance and assistance with the design obstacles.

Procedure
3. Conceptual Design

- Truck Selection & Dimensions:

Part	Dimension (m)
Ground To Bed	0.90
Bed's Width	1.51
Bed's Length	1.95
Bed's Depth	0.50

- Design Assumptions " Parameters":

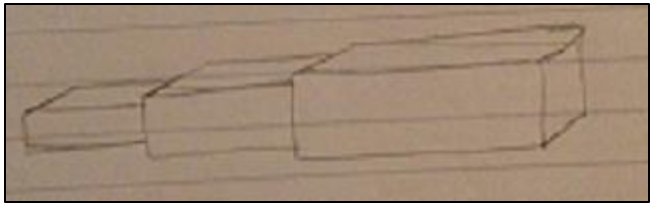
Targeted Vertical Distance	4.5m
Targeted horizontal Distance	5m
Harvester's Length	1.5m

Procedure
3. Conceptual Design (Cont'd)

- Parts:
  - Vertical Reach: thought of to be telescoping cylinders.

WHY ?

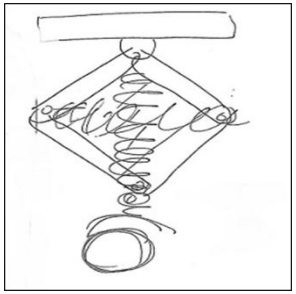
  - Horizontal Reach: Telescoping tubes



WHY ?

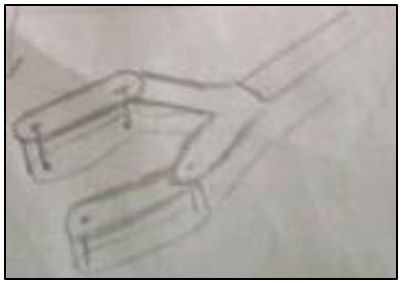
Procedure
3. Conceptual Design (Cont'd)

- Parts:
  - Joint Box: a box joining the horizontal reach with vertical reach mechanisms as well as accommodating the scissor links.
  - Rotary Mechanism: Crank shaft mechanism
  - Landing Gear:
    - Telescoping mechanism.
    - Leading screw mechanism.



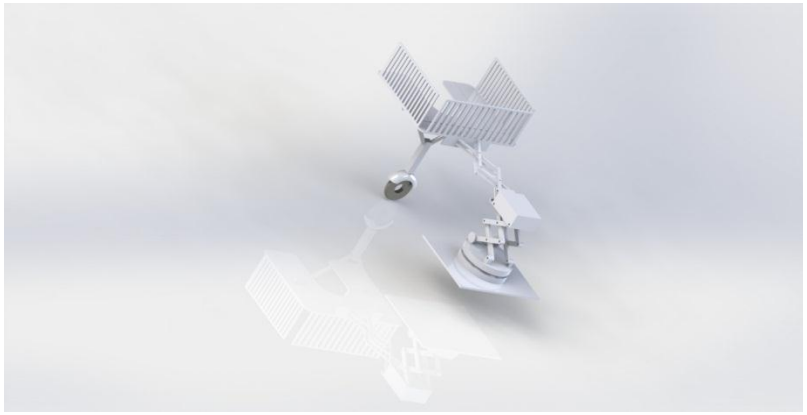
Procedure
3. Conceptual Design (Cont'd)

- Parts:
  - Platform: dynamic platform that closes to hug the palm tree creating a circular path for the harvester.



Procedure
4. Sculpture

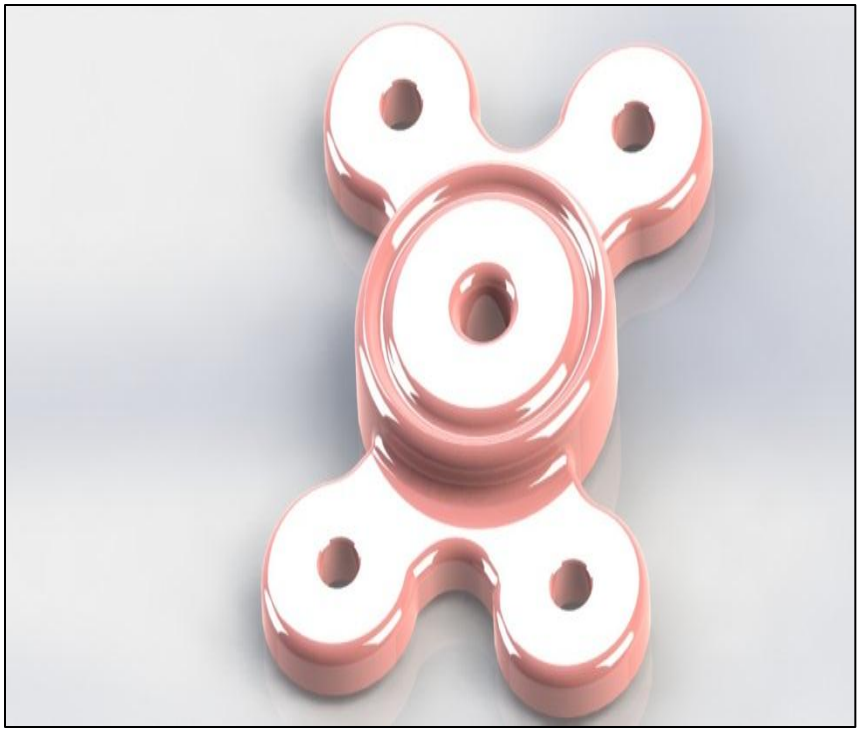
- When want to design your 1st car



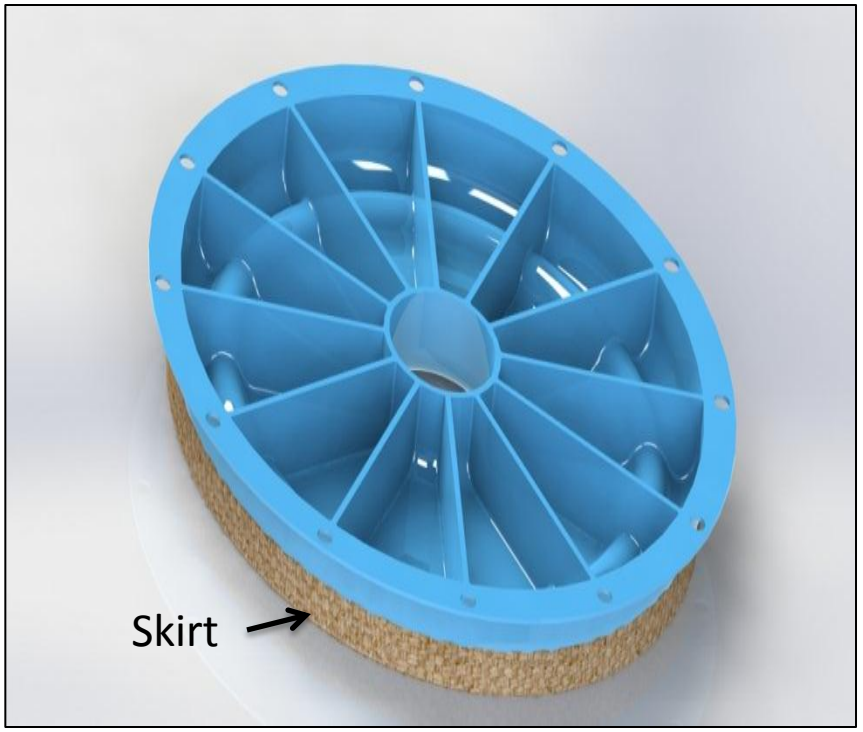
4. Sculpture

5. CAD *"SolidWorks"*

1. Bottom Mount

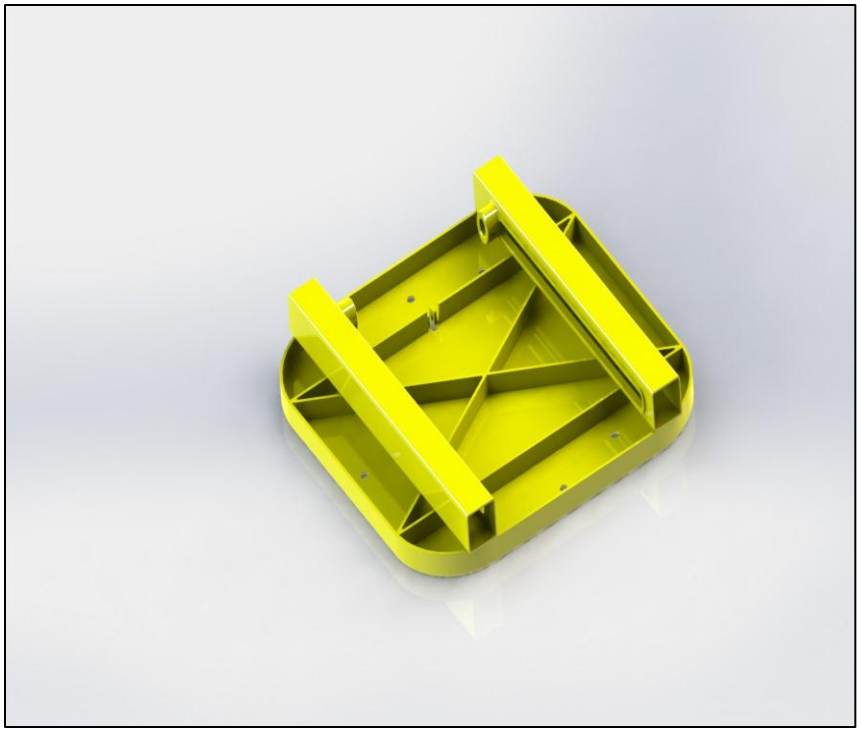


2. Cap

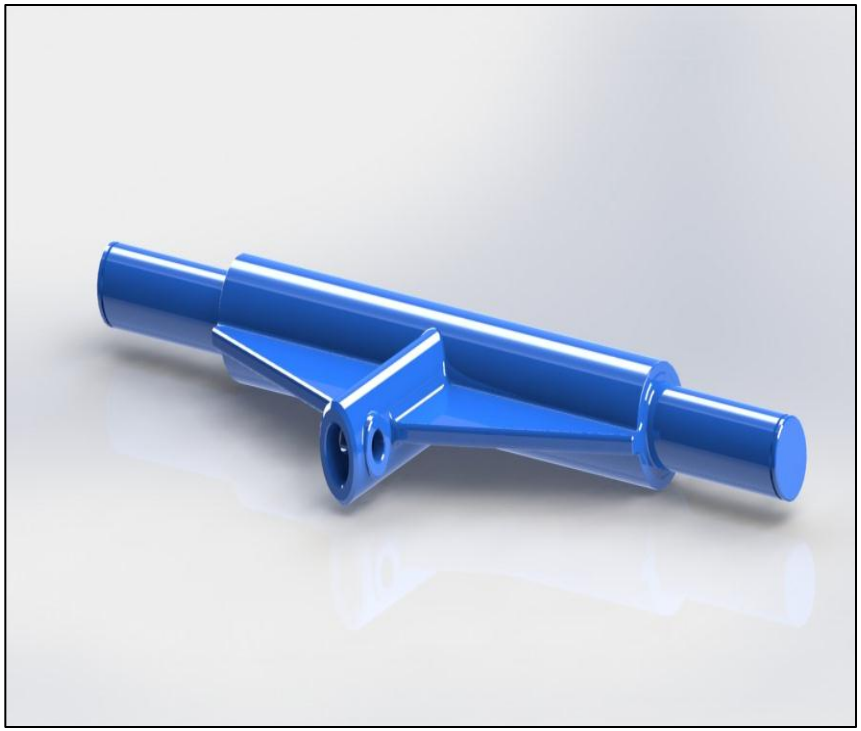


5. CAD *"SolidWorks"*

3. Main Tower Plate

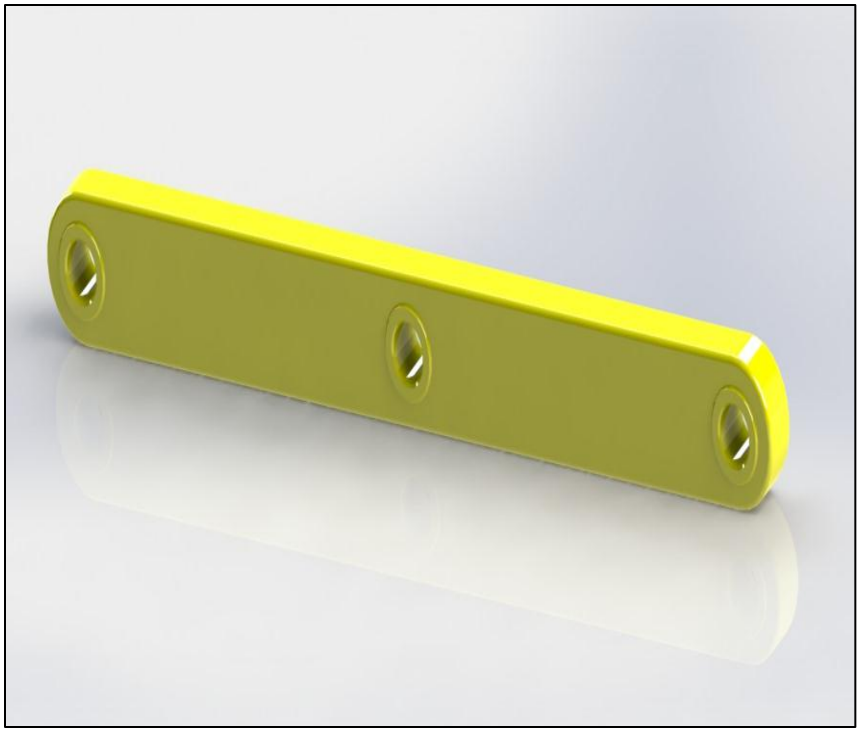


4. Main Ax

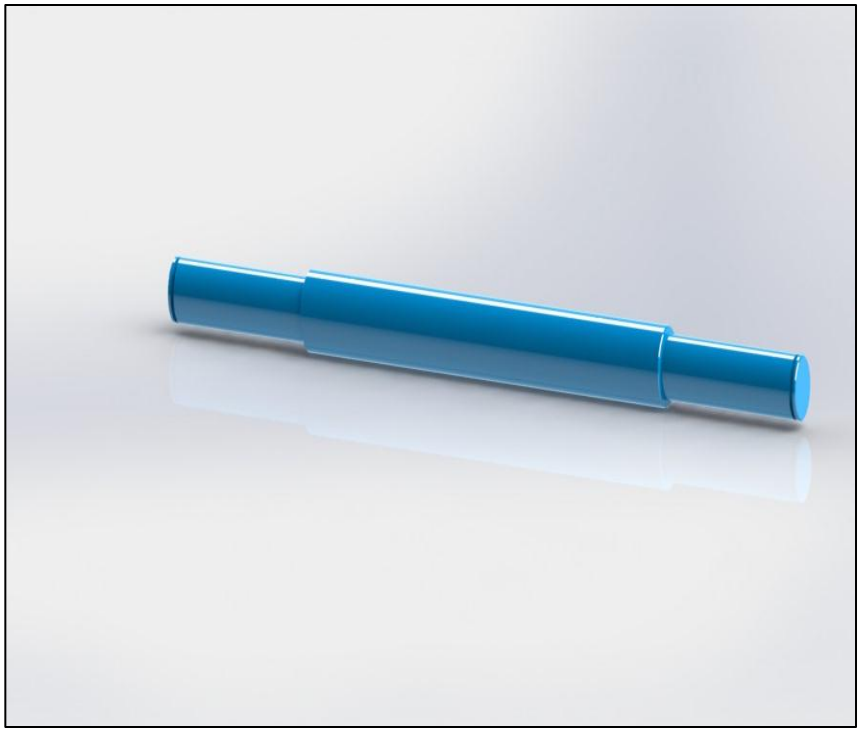


5. CAD *"SolidWorks"*

5. Scissor Link

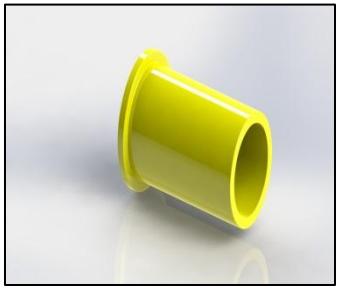


6. Main Box Rod



5. CAD *"SolidWorks"*

7. One Lipped Bushing



7. Retainer Ring

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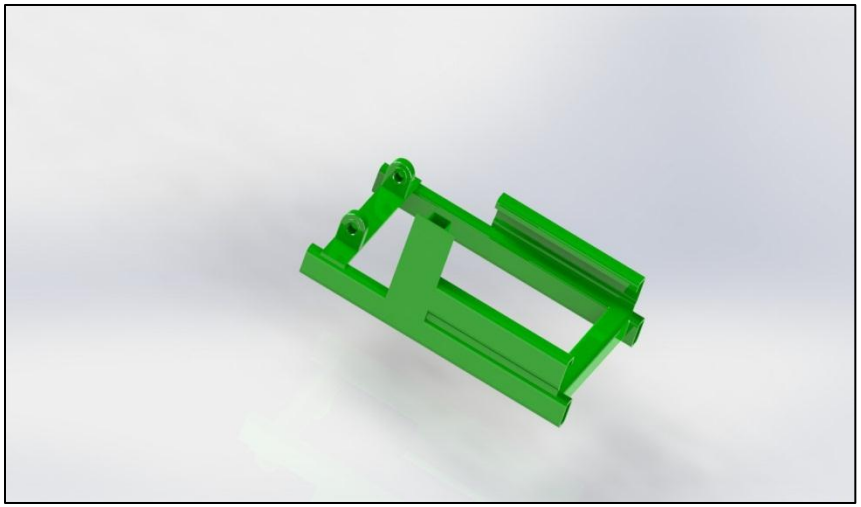
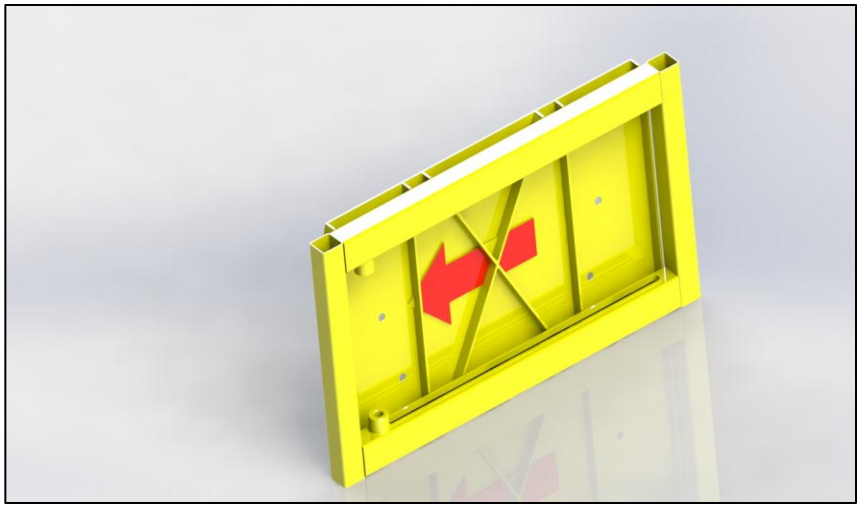
5. CAD *"SolidWorks"*

8. Box Joint

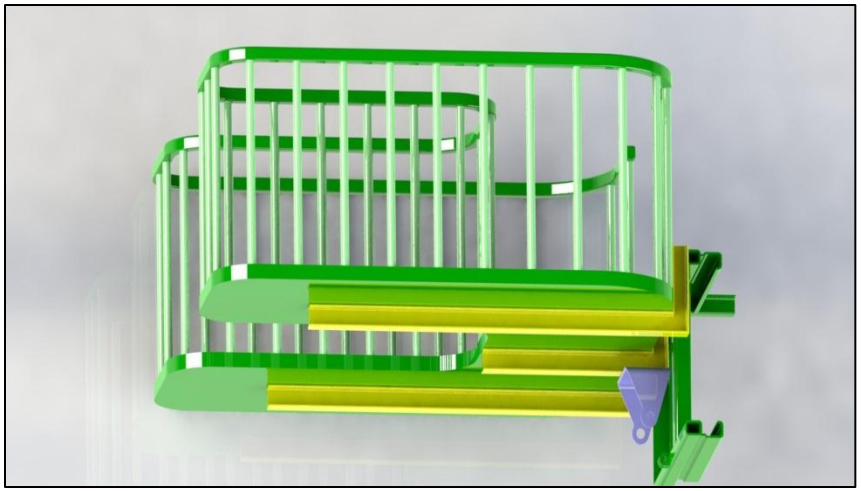


8. Horizontal Tower Plate

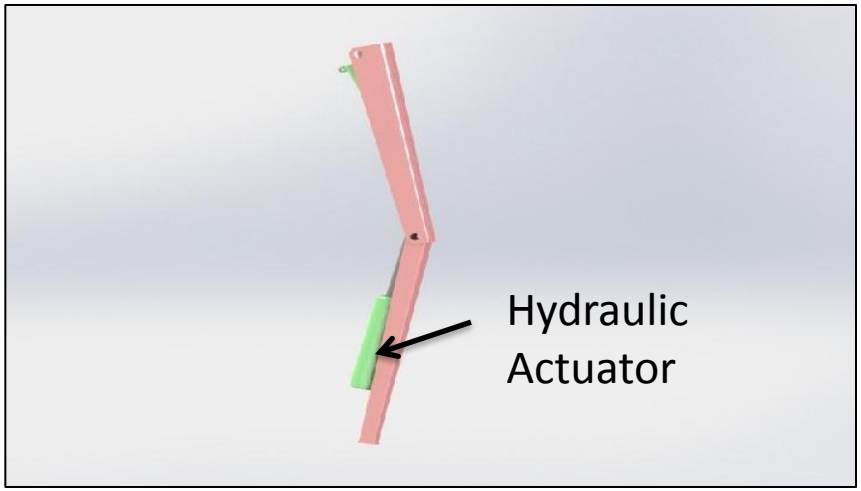


5. CAD *"SolidWorks"*

9. Platform

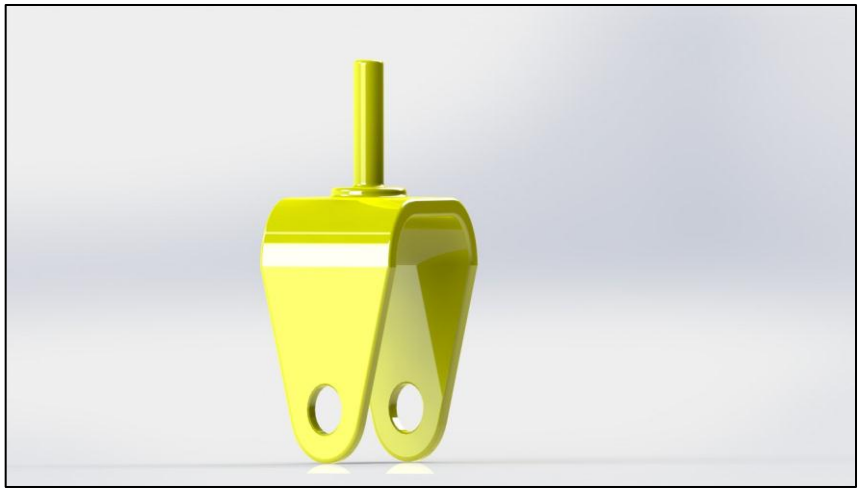


10. Landing Gear

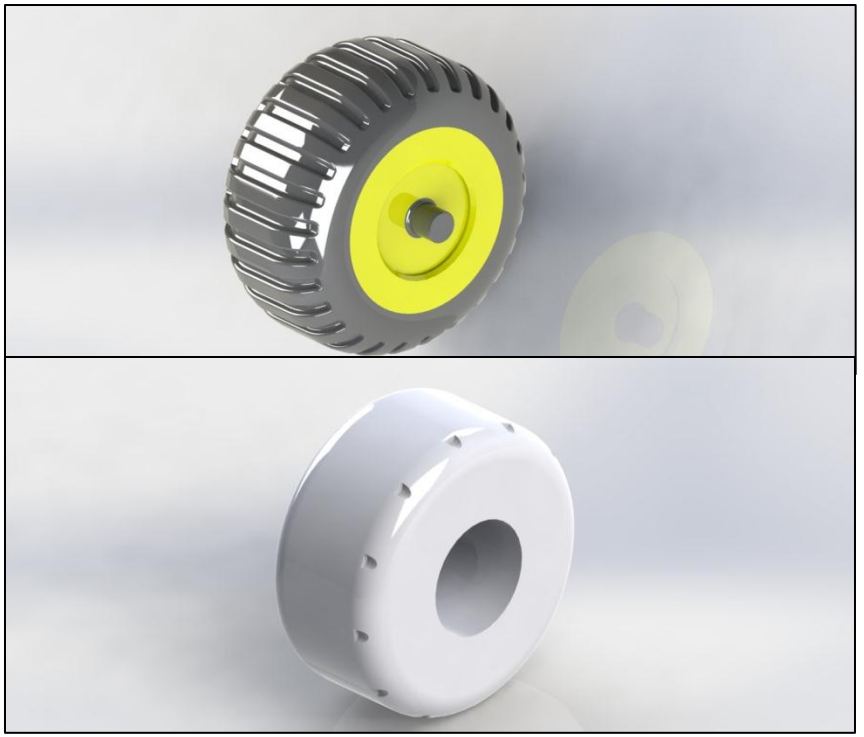


5. CAD *"SolidWorks"*

11. Swivel Fork



11. Rollers & Wheels



6. Design Obstacles

1. Finding a Solid-work-dummy-car of Chevrolet Sierra for the implement to be mounted to.
2. For the vertical reach, it was previously selected to be telescoping cylinders.
3. The shape of the joint box connecting the vertical scissor mechanism to the horizontal one.
4. Telescoping landing to the platform.
5. One size of hydraulic piston cylinders was used in the scissor mechanism and the landing gear.

7. Remedies

1. To overcome the Chevrolet Sierra cad model obstacle, a ready CAD model international-truck Car is chosen.

2. Due to dusty environment surrounding the implement, scissor mechanism is the best choice. In addition, telescoping cylinders is difficult to manufacture and heavy in weight.

3. Redesigning the joint box connecting the vertical scissor mechanism to the horizontal one in way that reduces the box weight and keep the scissor roller parallel paths.

7. Remedies (Cont'd)

4. Due to sandy atmosphere, heavy weight, and aerodynamic issues landing gear is redesigned with two hydraulic piston cylinders.

5. Landing gear is supporting the platform. In order to withstand the weight on the platform (man, dates weights), we decided to enlarge the piston cylinders of the landing gear.

7. Remedies (Cont'd)

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5. Landing gear is supporting the platform. In order to withstand the weight on the platform (man, dates weights), we decided to enlarge the piston cylinders of the landing gear.

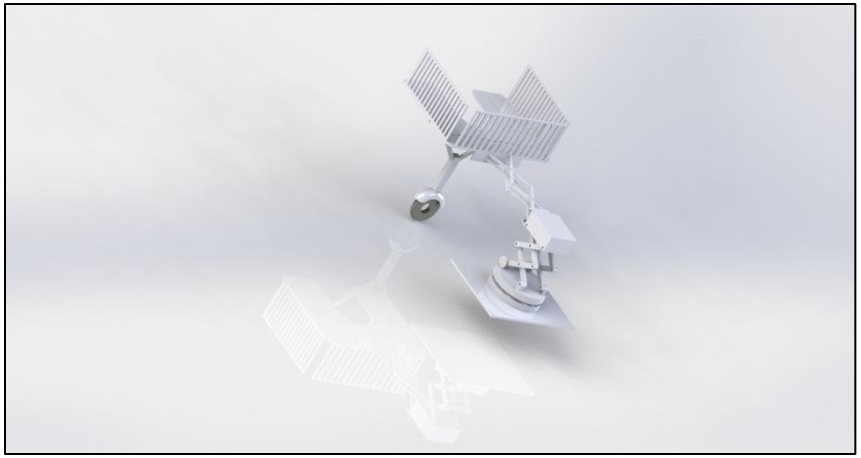
8. Materials

- Scissor Links, Tower Plates, Landing Gear & Mounts:
  - SABIC Commercial Steel
- Platform:
  - Aluminum Alloys

9. Final Design

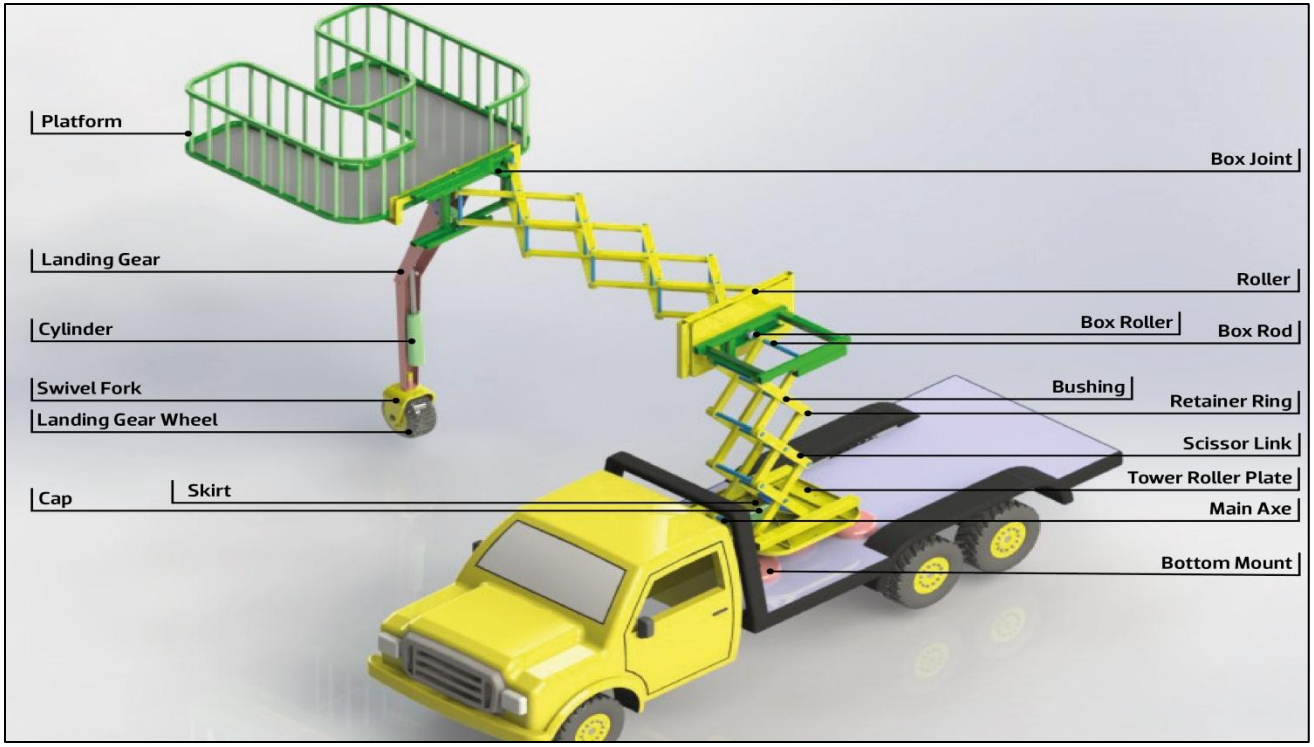
DESIGN REFINEMENT PRODUCT:

Before



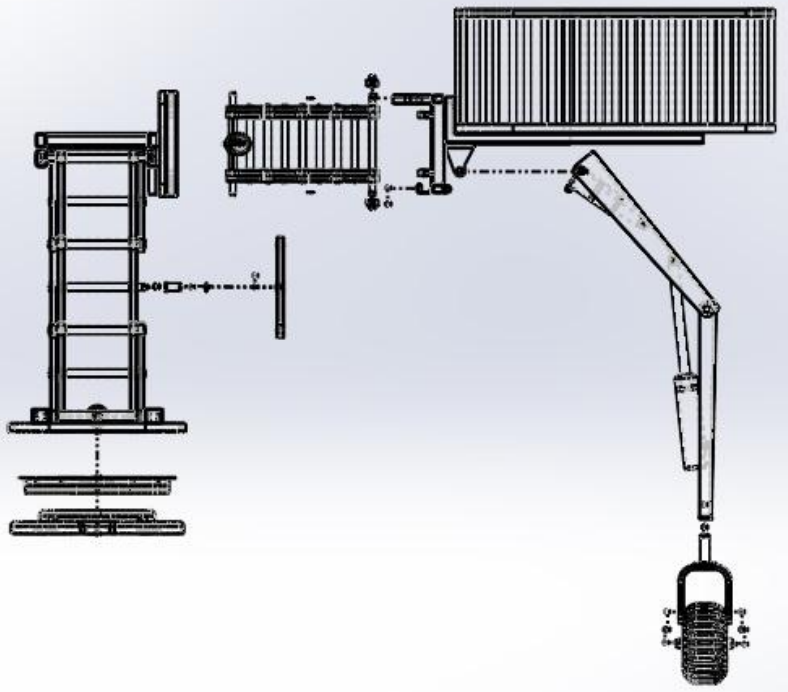
After

9. Final Design

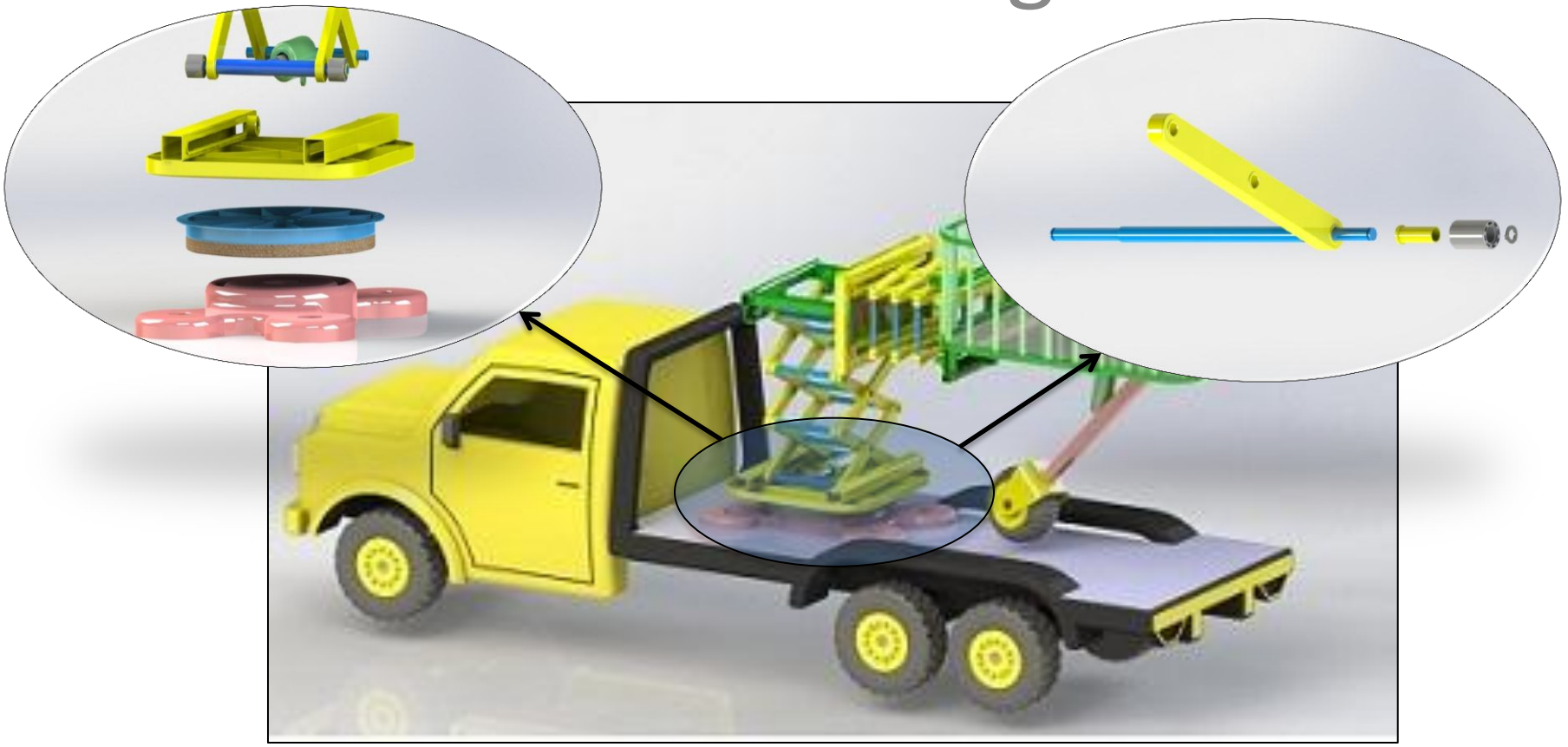


9. Final Design

ITEM NO.	PART NUMBER	QTY.
1	bottom mount	1
2	cap	1
3	tower-roller-plate	1
4	main ax	1
5	mail roller	2
6	main ax bushing	32
7	main tower link dec 7	12
8	retainer ring	32
9	main horizantal rod	9
10	box-joint	1
11	box rod	1
12	box roller	2
13	tower-roller-plate$C to 80 pecent	1
14	main horizantal rod$C to 80 pecent	12
15	main tower link dec 7$C to 80 pecent	16
16	mail roller$C to 80 pecent	2
17	main ax$C to 80 pecent	1
18	box rod$C to 80 pecent	1
19	box roller$C to 80 pecent	2
20	retainer ring$C to 80 pecent	2
21	box-joint$C to 80 pecent	1
22	truck with wheels	1
23	landing gear upper	1
24	landing gear lower NEW	1
25	swevil fork	1
26	tru swivel wheel	1
27	hyd-cylinder	3
28	hyd-piston	2
29	Lower LG Cylinder	1
30	hyd-piston - landing gear 2	1
31	hyd-piston - new	1



9. Final Design



9. Final Design

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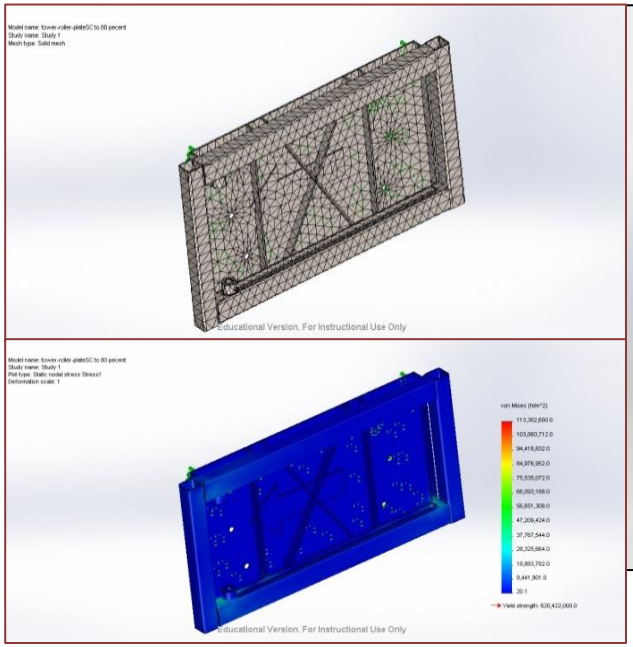
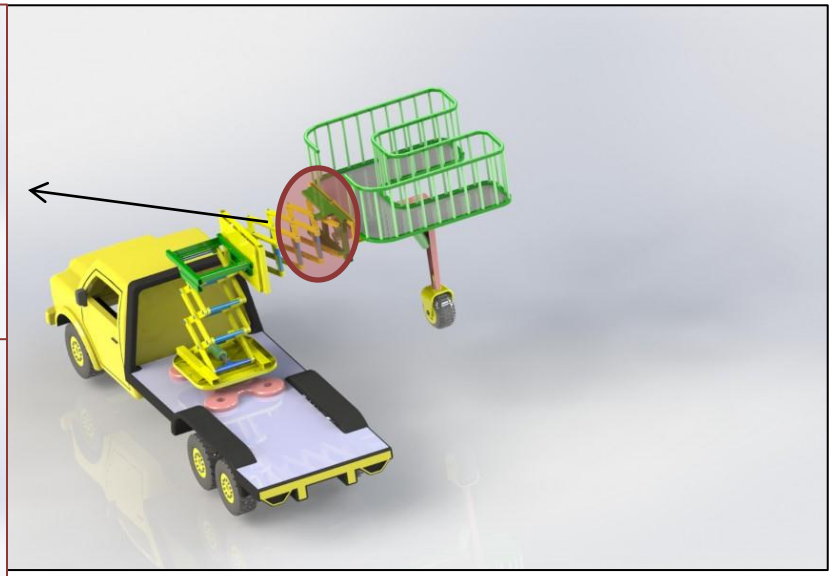
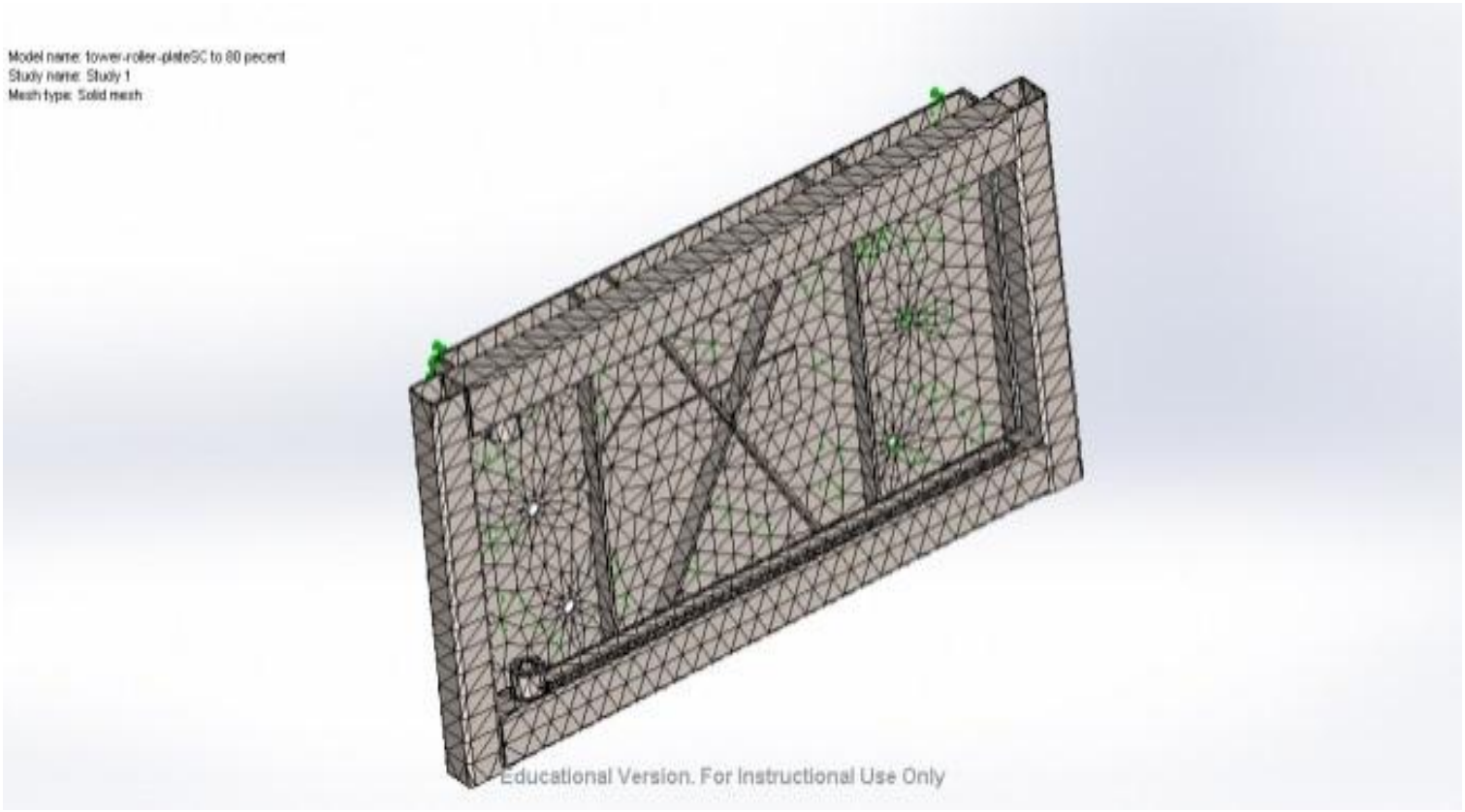
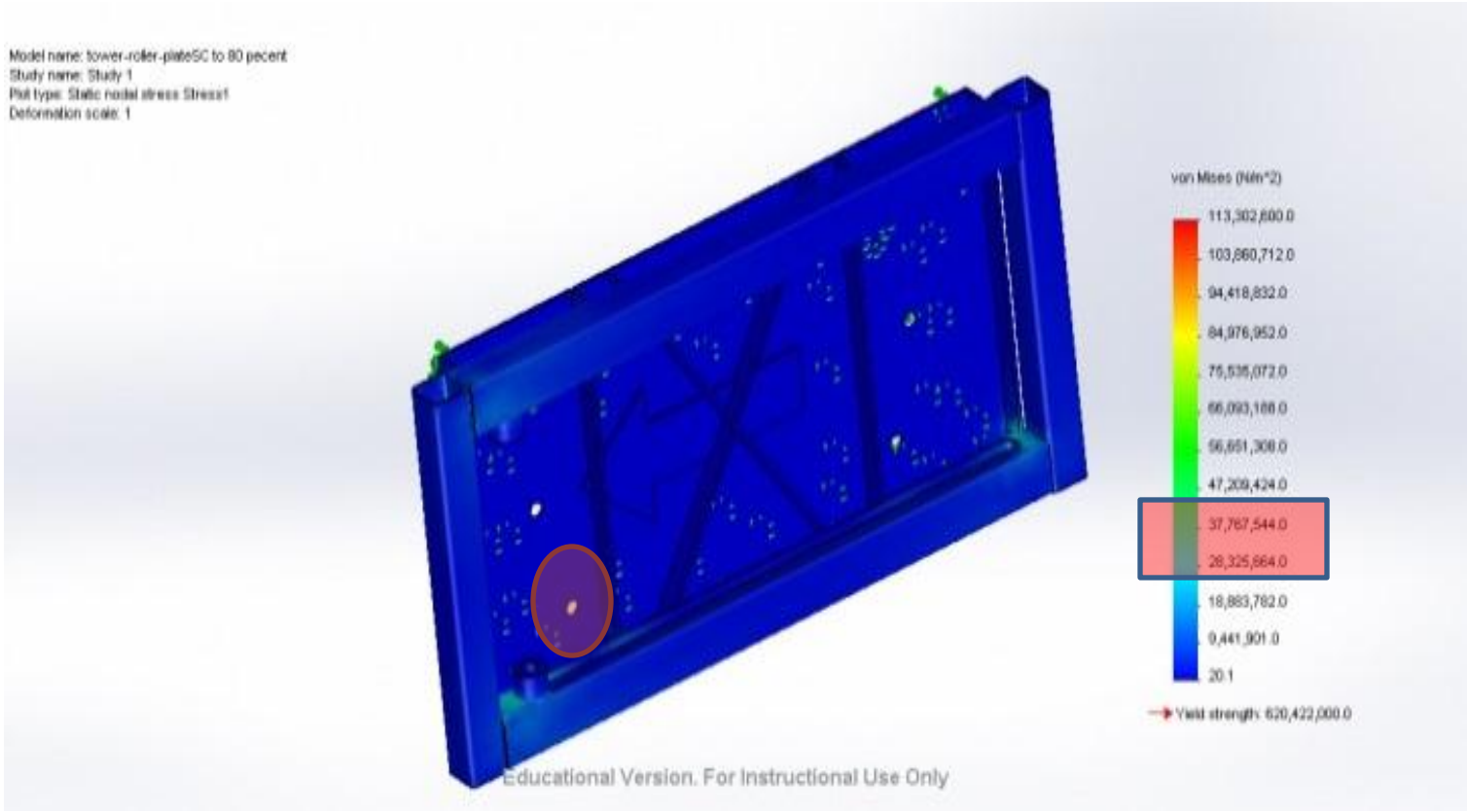




10. Stress Analysis



10. Stress Analysis (Cont'd)



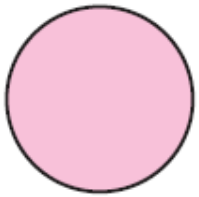
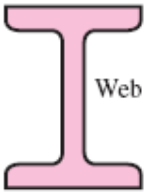
10. Stress Analysis (Cont'd)

- ***Safety design factor(n)***

$$= \frac{\boldsymbol{Shear\ Yeild\ Strenght}}{\boldsymbol{Von\ mises}} = \frac{\boldsymbol{620\times10^6}}{\boldsymbol{113\times10^6(\frac{N}{m^2})}} = \boldsymbol{5.4}$$

- Due to the fact that the implement is used to be a working platform for a harvester and its failure will affect human life, a 5 rated safety factor is acceptable even though it's a high safety factor

10. Stress Analysis (Cont'd)

Beam Shape	Formula	Beam Shape	Formula
 Rectangular	$\tau_{max} = \frac{3V}{2A}$	 Hollow, thin-walled round	$\tau_{max} = \frac{2V}{A}$
 Circular	$\tau_{max} = \frac{4V}{3A}$	 Structural I beam (thin-walled)	$\tau_{max} = \frac{V}{A_{web}}$

10. Stress Analysis (Cont'd)

$$\tau = \frac{4V}{3A}$$

$$\tau = \frac{4\ X\ 5\ kN}{3\ X\ (1.18\ X\ 10^{-3})} = 5.64\ MN$$

$\tau = 6$ Thread Openings X $5.64\ MN = 33.98\ MN$

11. Cost Estimation

Platform – Aluminum Alloy 6061

Main Scissor Link

AISI 4340 Steel - Annealed

Main Rod

AISI 4340 Steel - Annealed

Main Rod

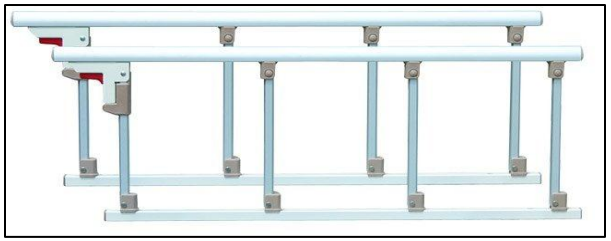
AISI 4340 Steel - Annealed

Conclusion

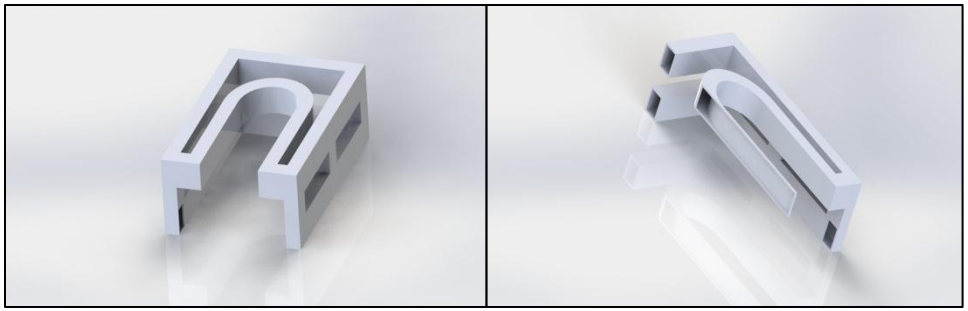
- The designed implement, with fourteen (14) designed main parts, meets the objectives of the project and provides better solutions to harvesting dates than the solutions currently in use.

Recommendations

1. Collapsing handrail:



2. Folding Platform:



3. Unifying & Standardizing of Rollers and other parts in size.