
GRASS HOPER

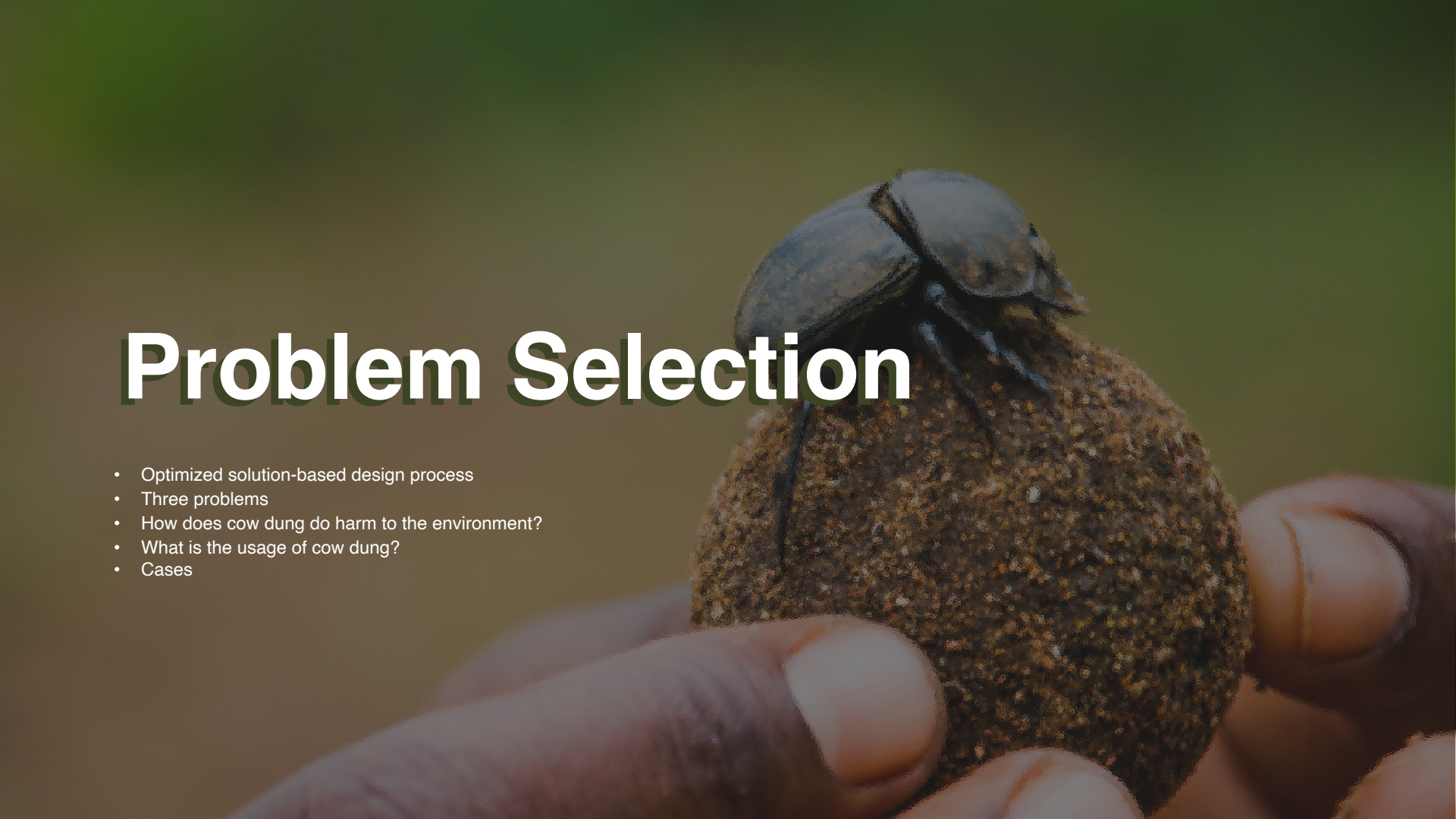

GRASS HOPER
TO CLEAN UP COW DUNG IN MEADOW EFFECTIVELY
GROUP 4
Xiao Yunzhong/Project Manager
Zhang Zhengxiang/ CFO/ Meeting Minutes
Wei Ziyu/Technical Project Manager/ Industrial Design
Yu Tongge/Industrial Design
Lai Jingyi/Mechanical Engineering
Ban Shu/Electronic Engineering

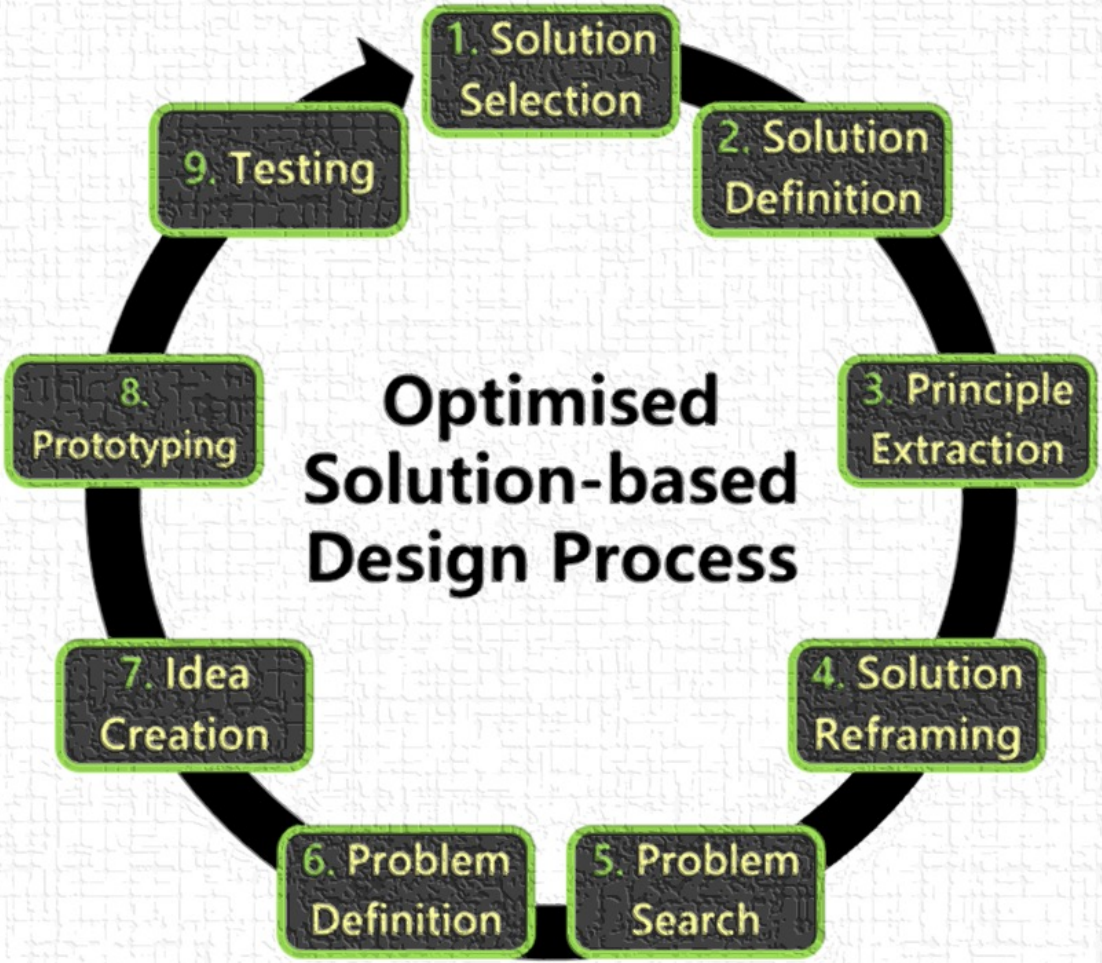
Grass Hoper

Yunzhong Xlao | Tonge Yu | Zhengxiang Zhang | Ziyu Wei | Jingyi Lai | Shu Ban

Problem Selection

- Optimized solution-based design process
- Three problems
- How does cow dung do harm to the environment?
- What is the usage of cow dung?
- Cases



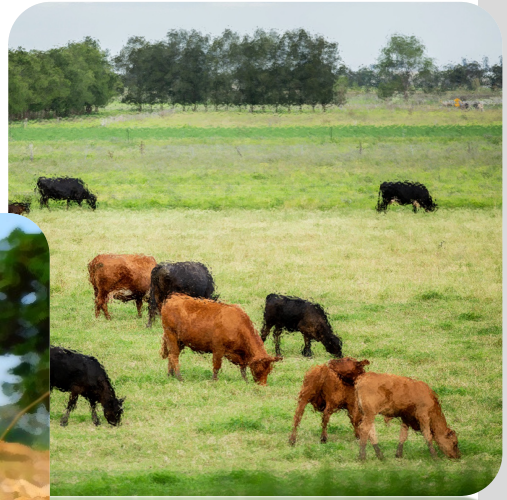

1. Solution Selection
2. Solution Definition
3. Principle Extraction
4. Solution Reframing
5. Problem Search
6. Problem Definition
7. Idea Creation
8. Prototyping
9. Testing
Optimised Solution-based Design Process

Three Problems

- Cow health monitoring

- Cow dung collection

- Grasslands health monitoring



How does cow dung do harm to the environment?

- Soil
- Atmosphere
- Water
- Human health

Cow Dung Composition	
C-Organic %	29,7
Nitrogen %	1,65
Phosphor %	0,5
Kalium %	2,3
pH	6,6-6,8
C/N ratio	18
Moisture %	11 - 25

What is the usage of cow dung?

- Produce fuel gas in methane tank.
- Great fertilizer with rich nutrient
- Environmental-friendly fuel.
- Economic values in breeding industry.

Cases

The cow dungs problem in Australia is so severe that they have to import Chinese dung beetles to decompose the dungs.

Concept design

- User research
- Function Features
- Work Flow
- Human Factor Design

User research

Concept design

Persona

Target user: Herdsmen, Hulunbeir Grassland, Inner Mongolia Province

User need: Herdsmen pick up cow dungs in spring and autumn, to keep the grass growing.

Pain point: 3 people spent 1 week to clean only 0.27km^2 of meadow.

Persona

Meadow size: About 0.27km^2

Number of cows: 50 – 70

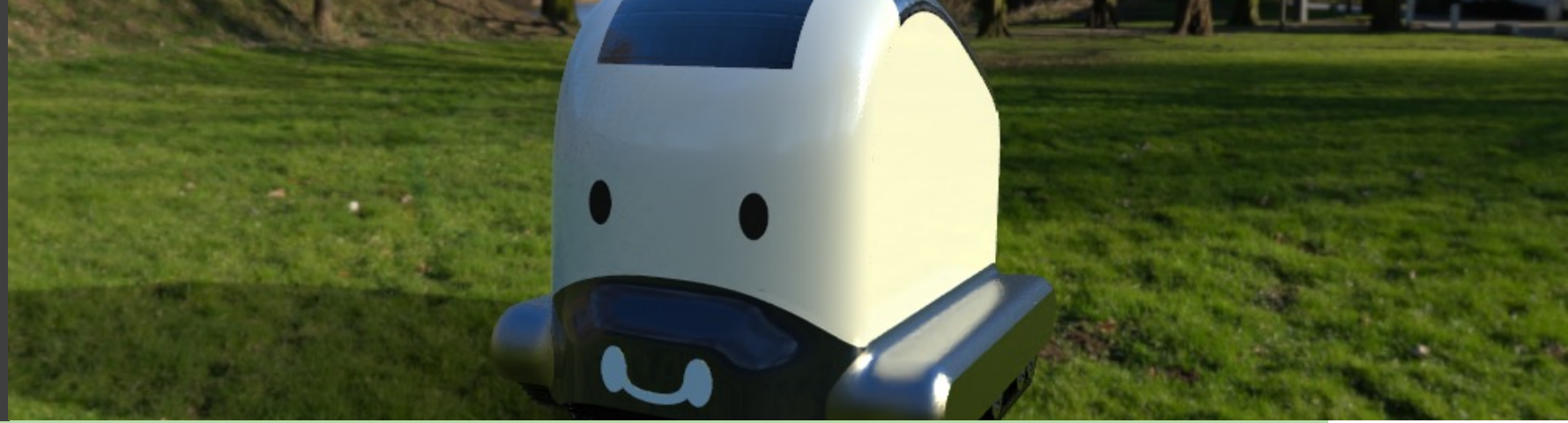
Amount of cow dungs: About 175t

Diameter of cow dungs: 15 – 20cm

Thickness: 0.8cm

Weight of a single cow dung: 1.2 – 1.7kg

Distribution density of cow dungs: 0.45kg/m^2



Features

Concept design

Features

Load capacity: 1.5t

Maximum speed: 30km/h

Performance: 1350kg/h (Half a football field)

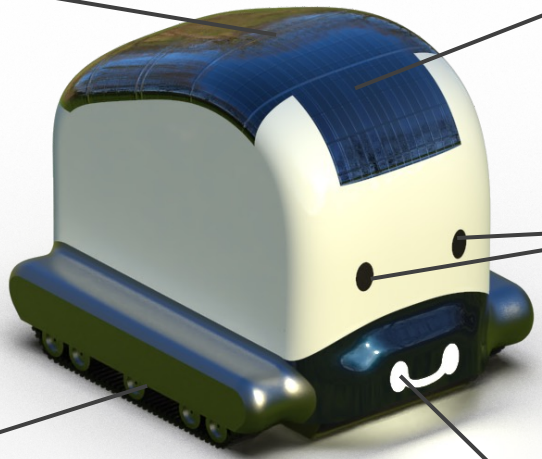
Appearance:

- Cute & Friendly look
- Prevent being blown over

Features

Drone: Identify the distribution of cow dungs

Solar panel: Complementary energy source

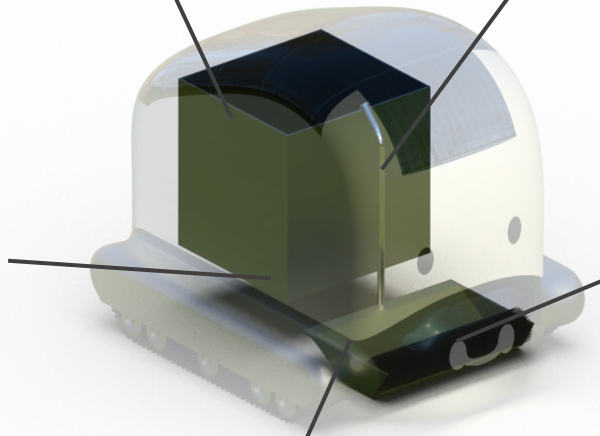


Binocular camera: Identify the precise location of cow dungs

Caterpillar band: Deal with all kinds of terrains

Front light: Allow Grass Hoper to work at night

Features



Storage tank: Store the cow dung

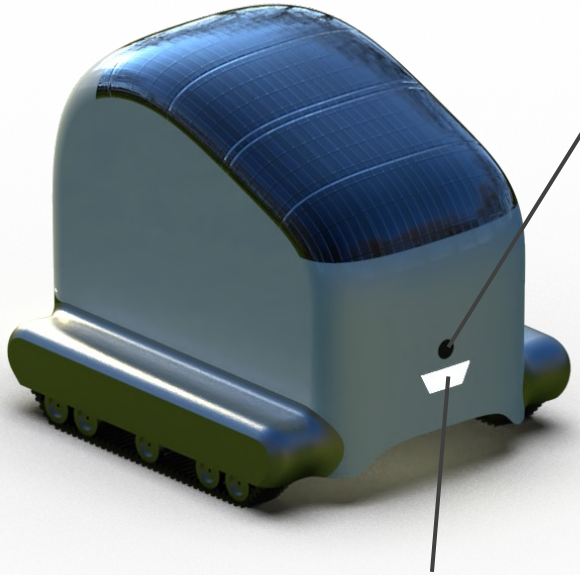
Leading pole: Guide the movement of the scoop

Processor: GPS, path planning, control motors, avoid obstacles…

Brush: Sweep the cow dung

Scoop: Pick up the cow dung

Features



Rear camera: Confirm whether the cow dung has been picked up

Rear light: Allow rear camera to work at night

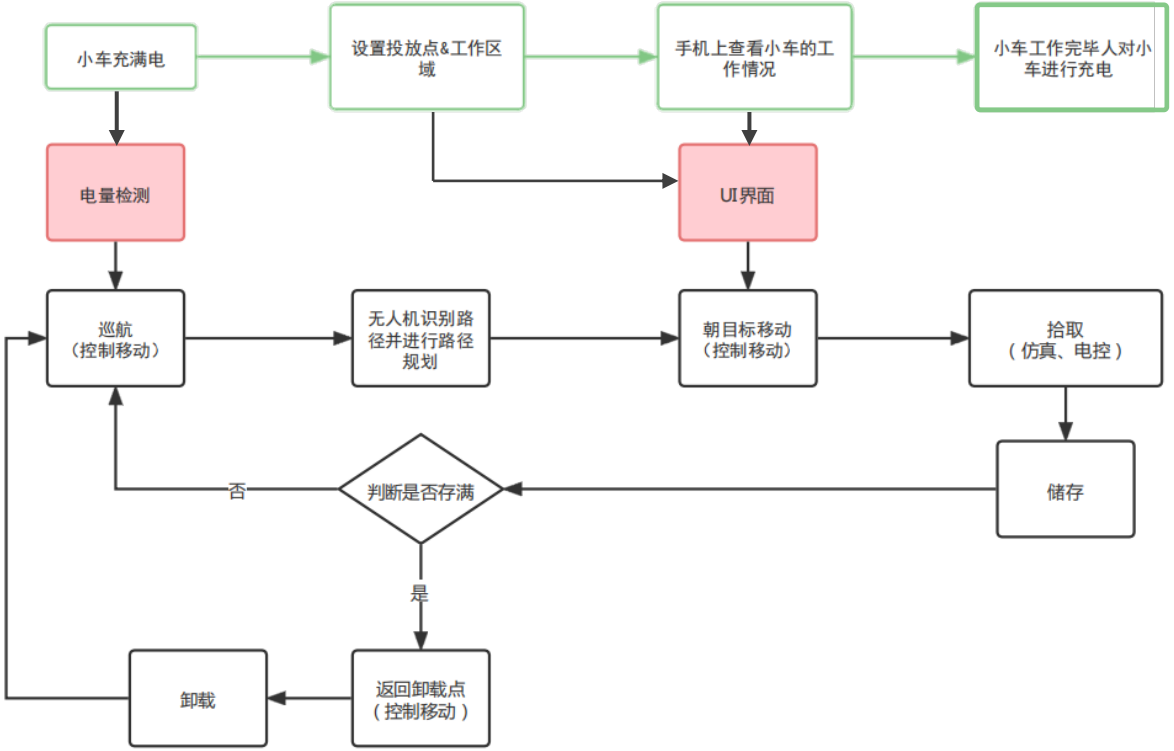
Workflow & Ergonomics

Concept design

Workflow

For Users：

For Grass Hoper：



Ergonomics

UI interface —— Human interact with Grass Hoper

1. Mongolian
2. Simplifying operational processes

Machine performance —— Environment interact with Grass Hoper

1. Sleek Profile: coping with gales on the grassland
2. Suitable for the terrain：Track with gear plate

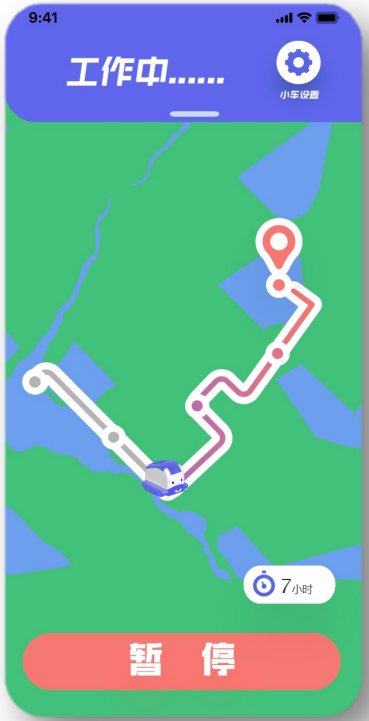
Ergonomics —— Mongolian

Illiteracy rate: 3.3%

Proportion of permanent residents with less than lower secondary education: 56%

1. Maximize graphic language
2. Two language models
3. Speech pattern

Ergonomics —— Simplifying operational processes



Ergonomics —— Simplifying operational processes

1. Reduce the number of setup options on the start screen

2. Use visual graphical representations as much as possible

Machine performance —— Sleek Profile

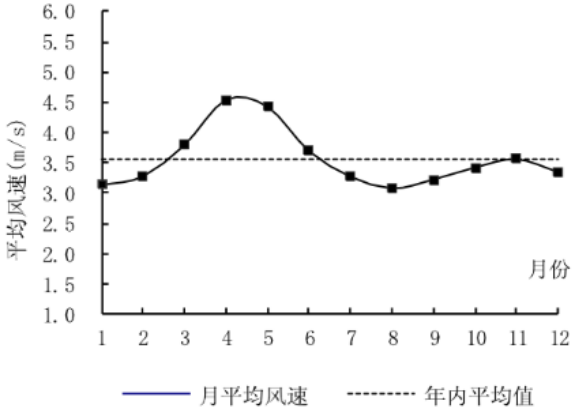
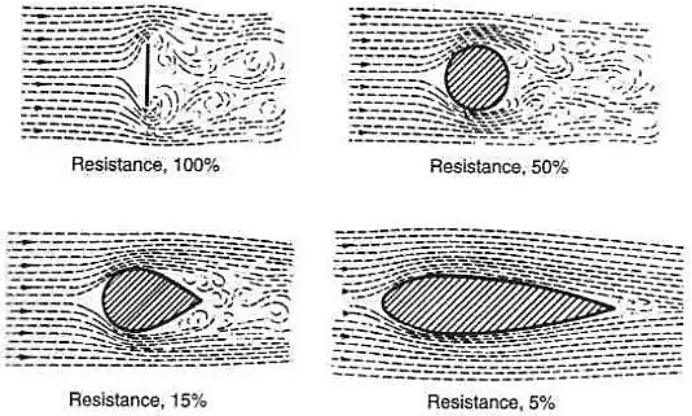
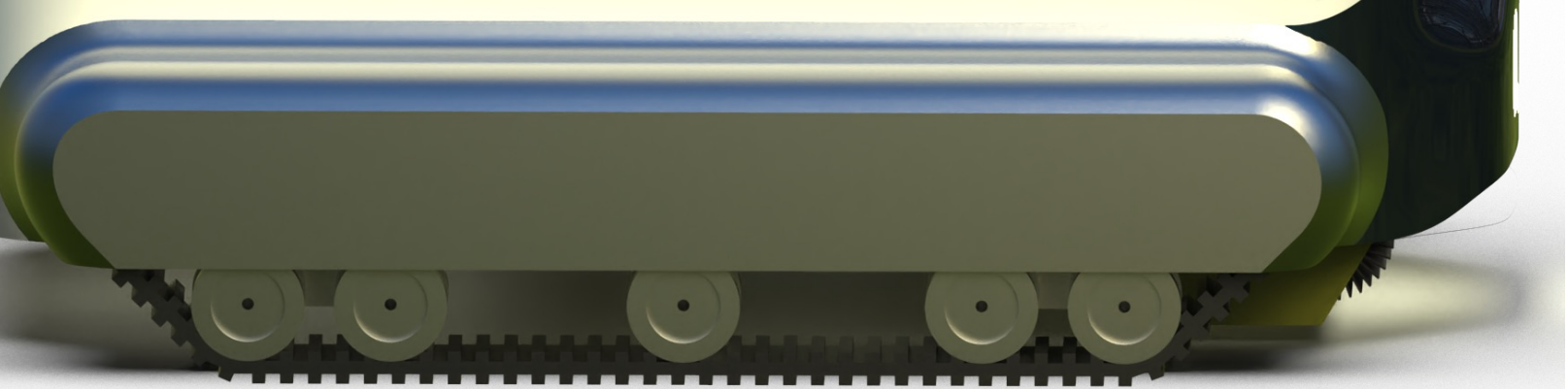


图1 内蒙古地区6个气象站平均风速的年内变化
Fig.1 The annual changes of average wind speed of 6 weather stations in Inner Mongolia



Machine performance —— Sleek Profile

- Filet
- streamline



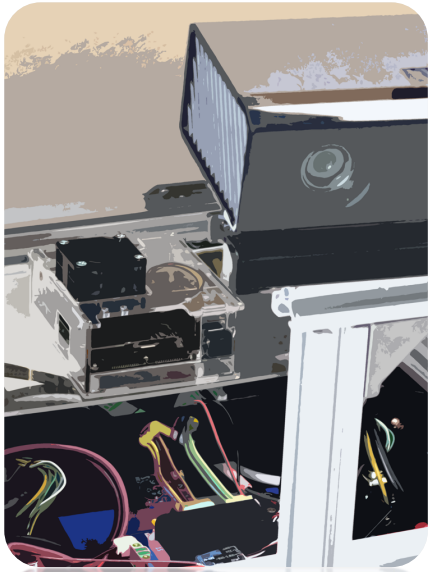
Low center of gravity

Off-road performance ：Track with gear plate

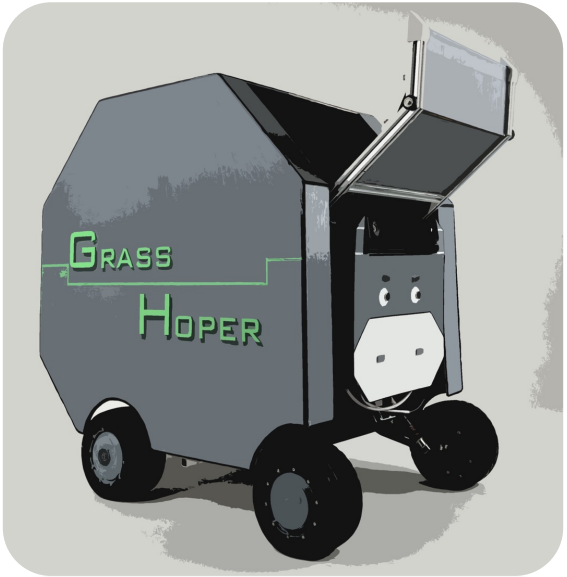
Joint vision system for obstacle avoidance

Machine performance —— Suitable for the terrain

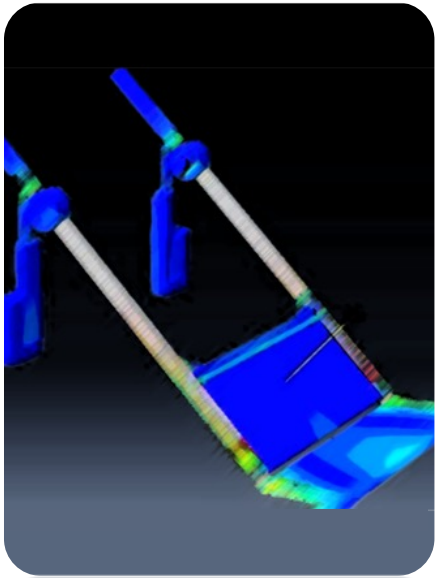
Electronic Control

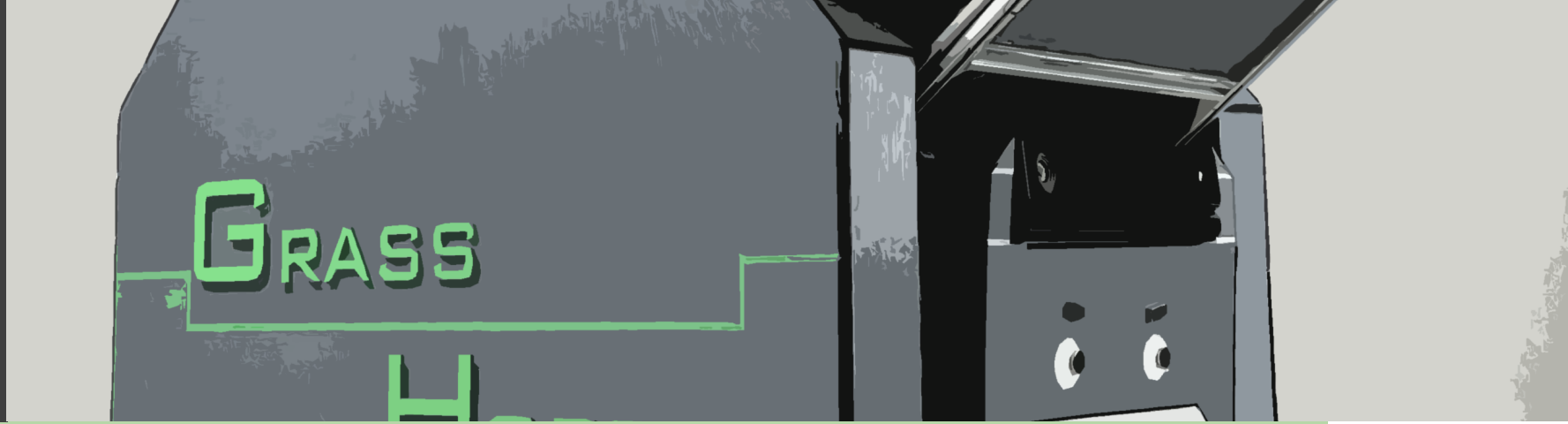


Function Feature



Abaqus Simulation





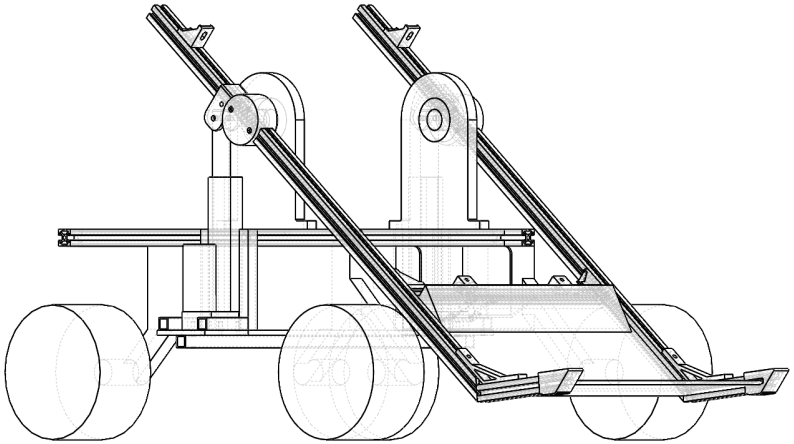
Function Feature

Scoop
Storage Tank
Offloading Plate
Protective Shell

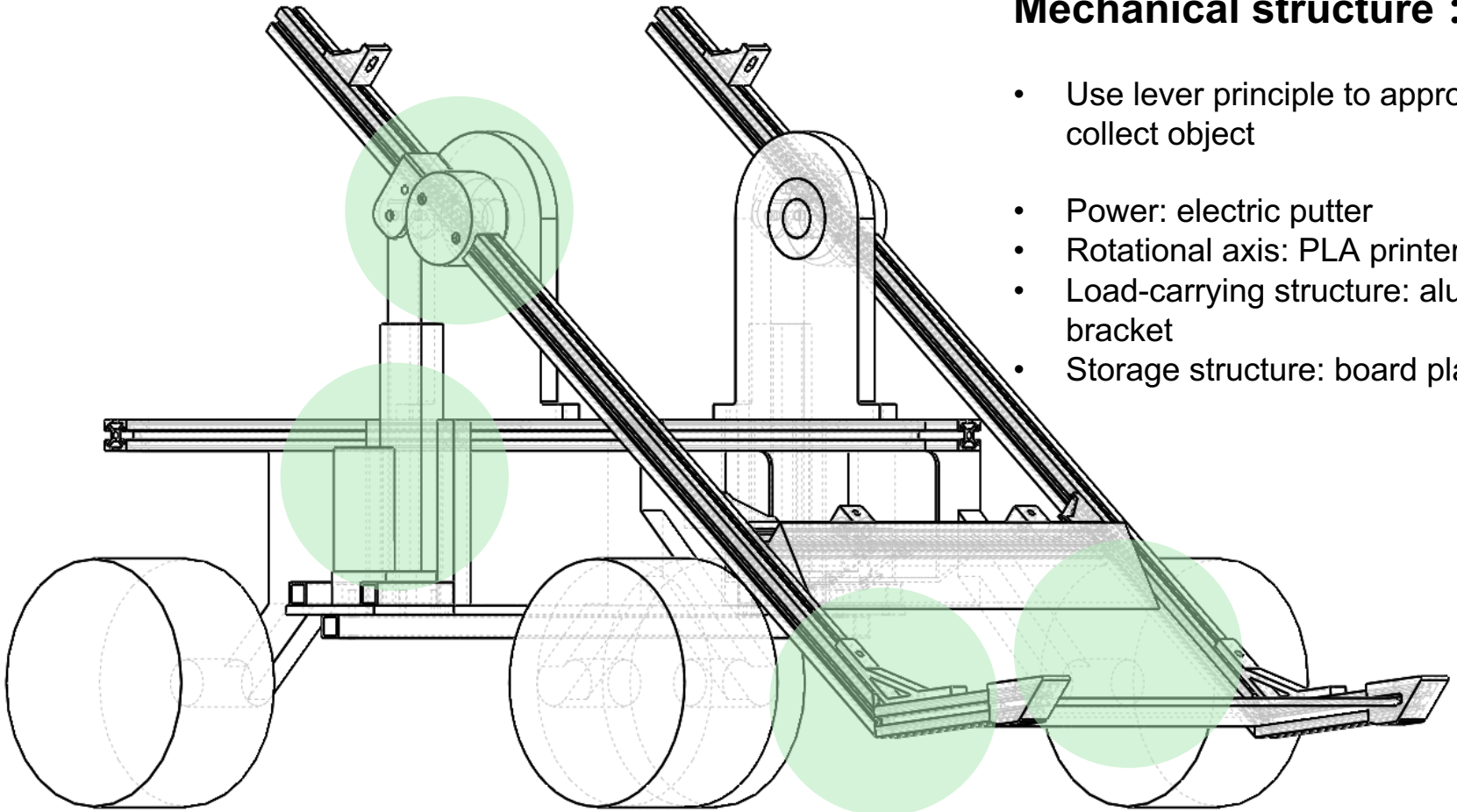
Mechanical structure： Scoop

- Use lever principle to approach and collect object

- Power: electric putter
- Rotational axis: PLA printer
- Load-carrying structure: aluminum bracket
- Storage structure: board plane

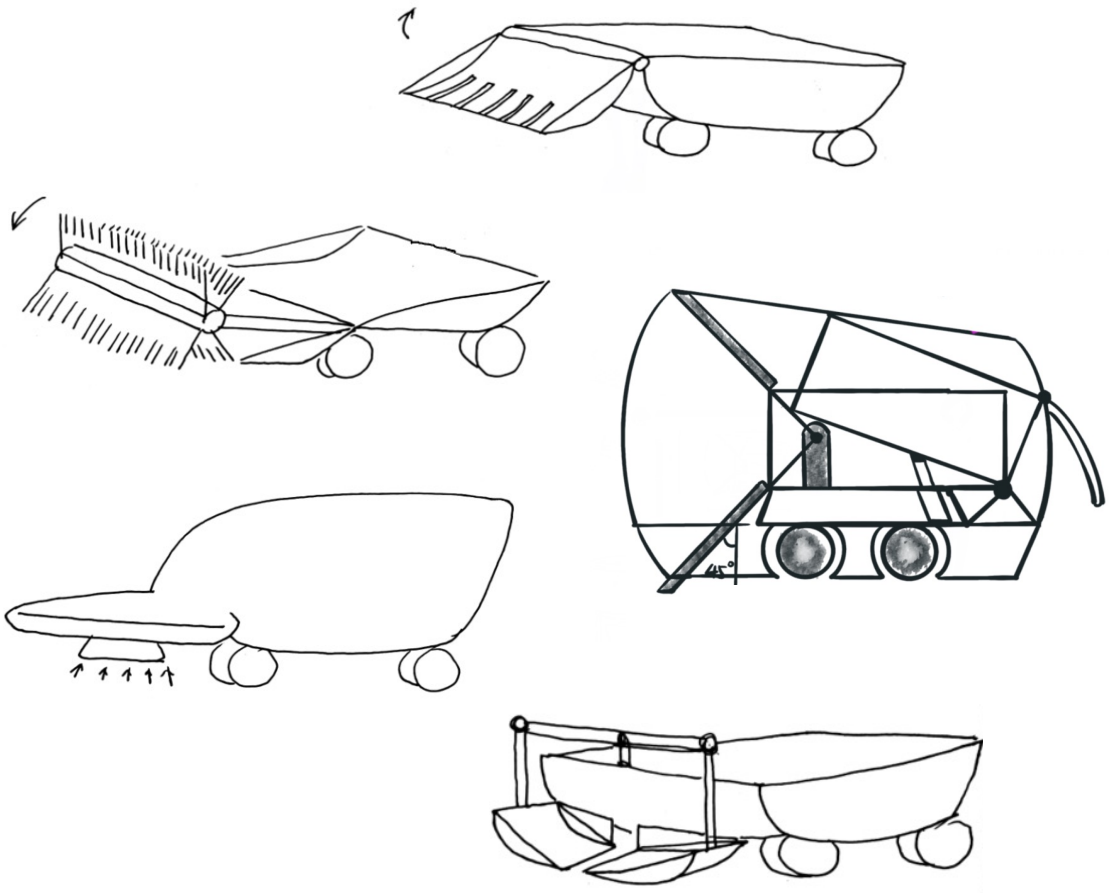


Mechanical structure： Scoop



- Use lever principle to approach and collect object

- Power: electric putter
- Rotational axis: PLA printer
- Load-carrying structure: aluminum bracket
- Storage structure: board plane



Mechanical structure : Scoop

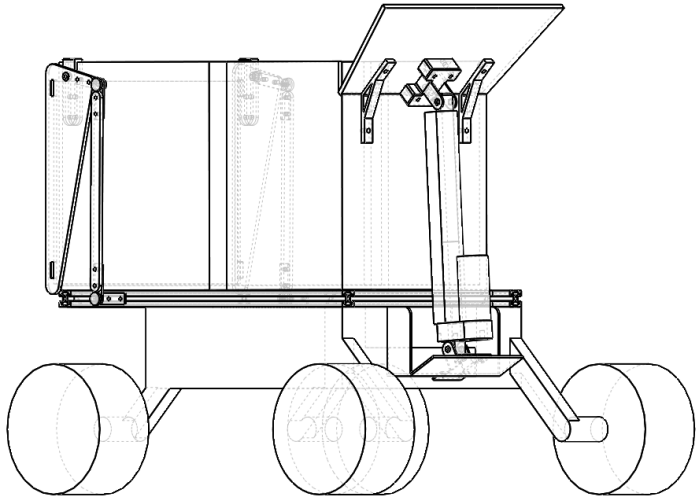
- Brain storming!!
- Refinement: bamboo-PLA printer; Add load at rear end
- Improvement: increase DOF + Brush

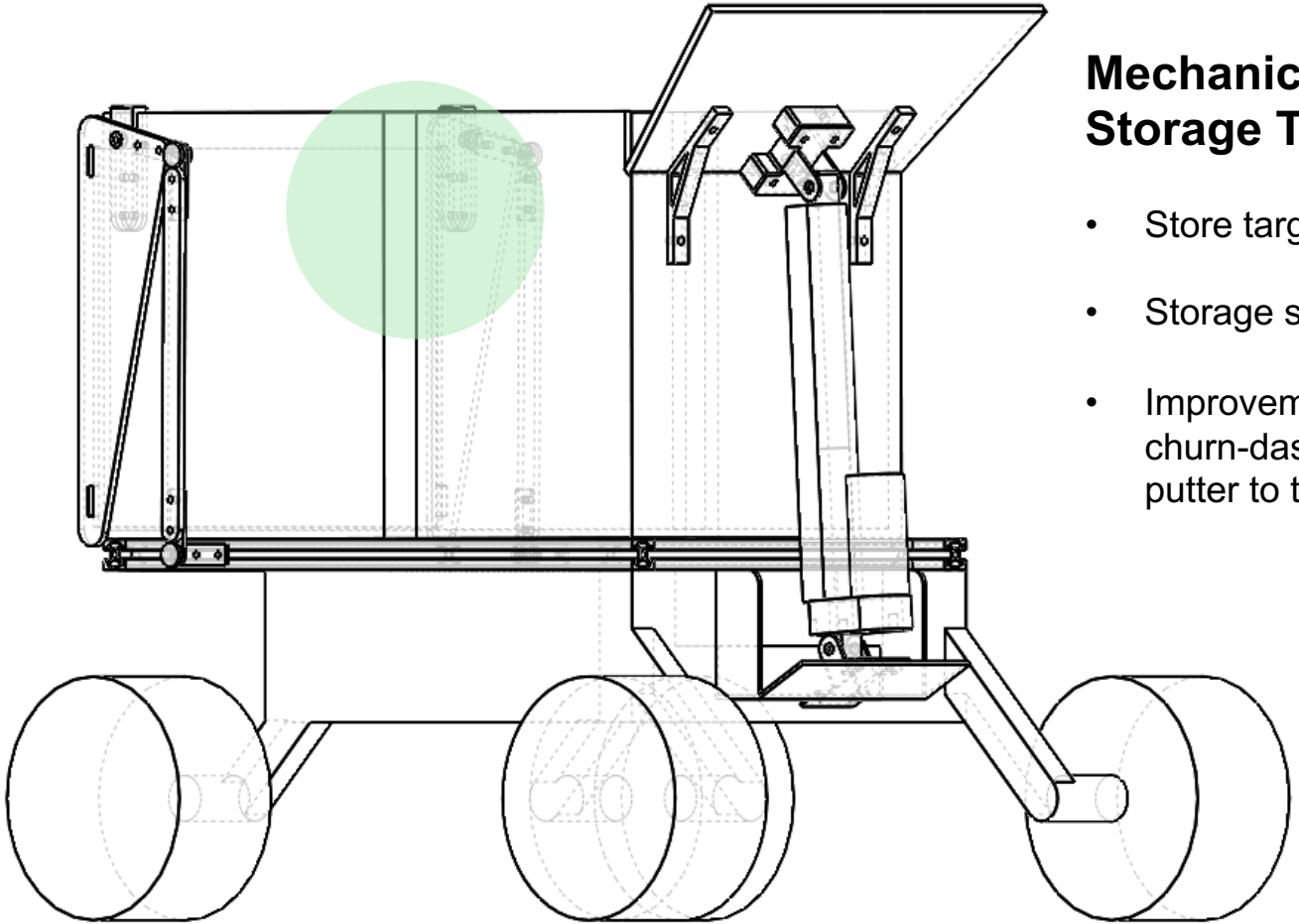
Mechanical structure: Storage Tank

- Store target cow dung
- Storage structure: board plane

Mechanical structure: Storage Tank

- Store target cow dung
- Storage structure: board plane





Mechanical structure: Storage Tank

- Store target cow dung
- Storage structure: board plane
- Improvement: increase volume, add churn-dasher, move the electric putter to the bottom

Mechanical structure : Offloading Plate

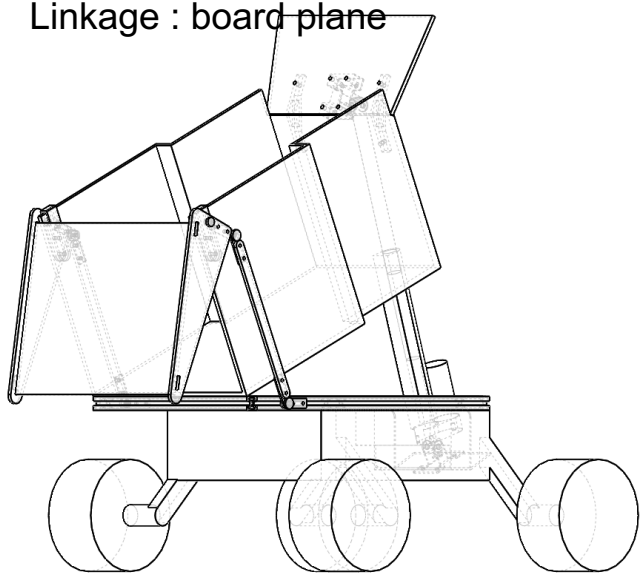
- Use linkage system to transfer the target dung from storage tank to the ground

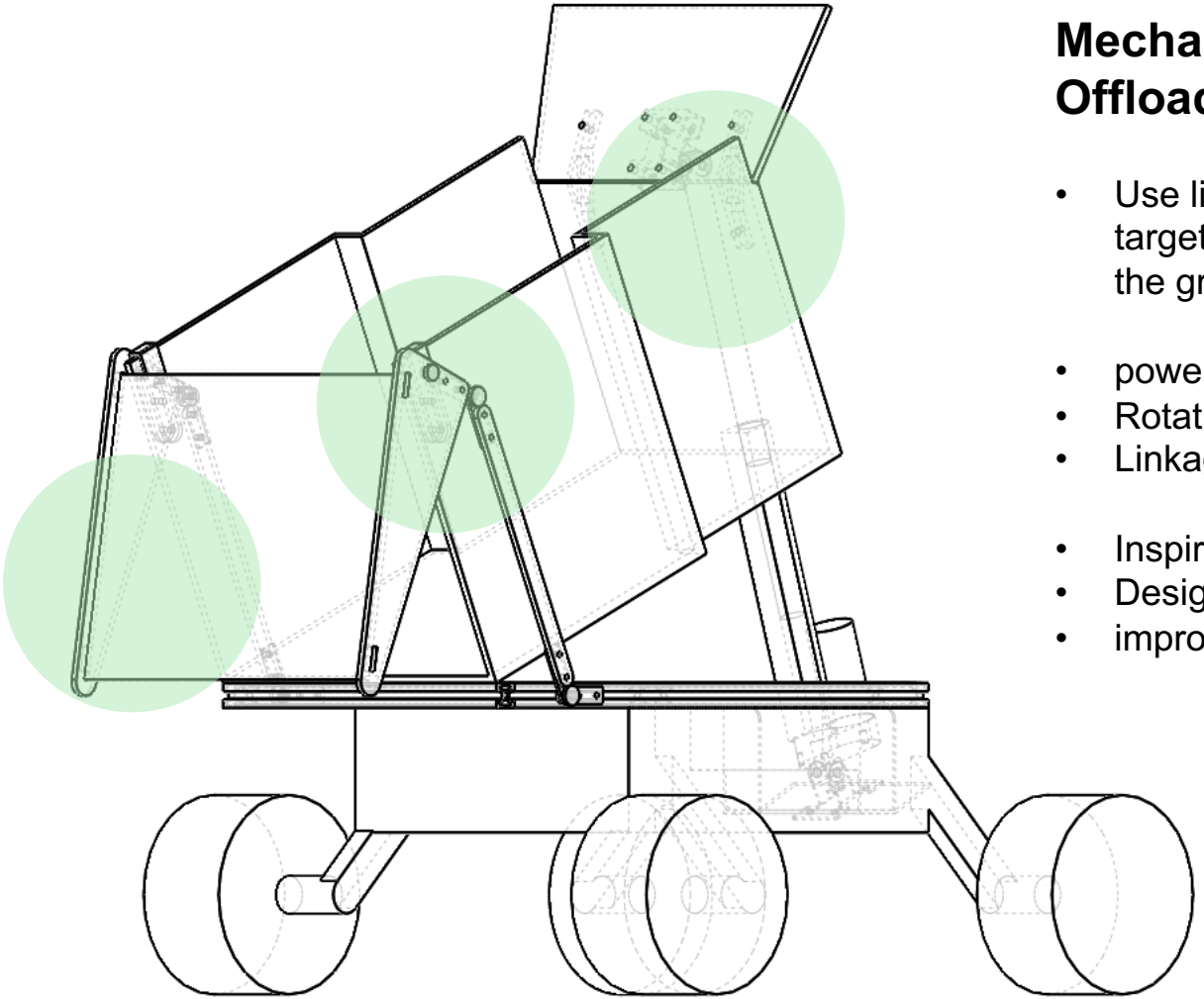
- power : electric putter
- Rotational Axis: hinge
- Linkage : board plane

Mechanical structure : Offloading Plate

- Use linkage system to transfer the target dung from storage tank to the ground

- power : electric putter
- Rotational Axis: hinge
- Linkage : board plane



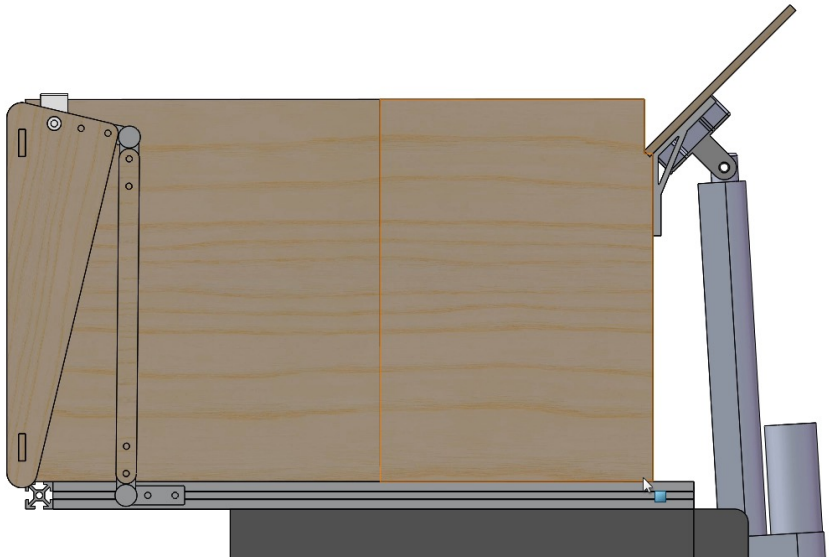


Mechanical structure : Offloading Plate

- Use linkage system to transfer the target dung from storage tank to the ground

- power : electric putter
- Rotational Axis: hinge
- Linkage : board plane

- Inspiration : Dump Truck
- Design process : Geogebra
- improvement : Adjust the angle



Mechanical structure：Offloading Plate

- Use linkage system to transfer the target dung from storage tank to the ground

- power：electric putter
- Rotational Axis: hinge
- Linkage : board plane

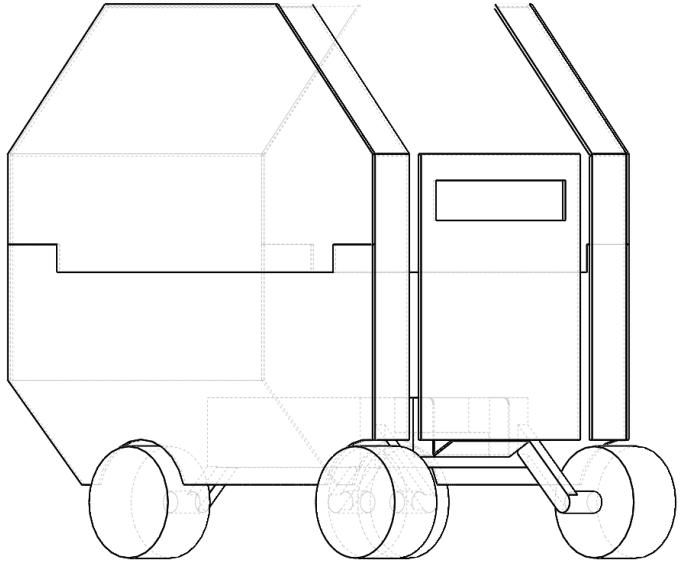
- Inspiration：Dump Truck
- Design process：Geogebra
- improvement：Adjust the angle

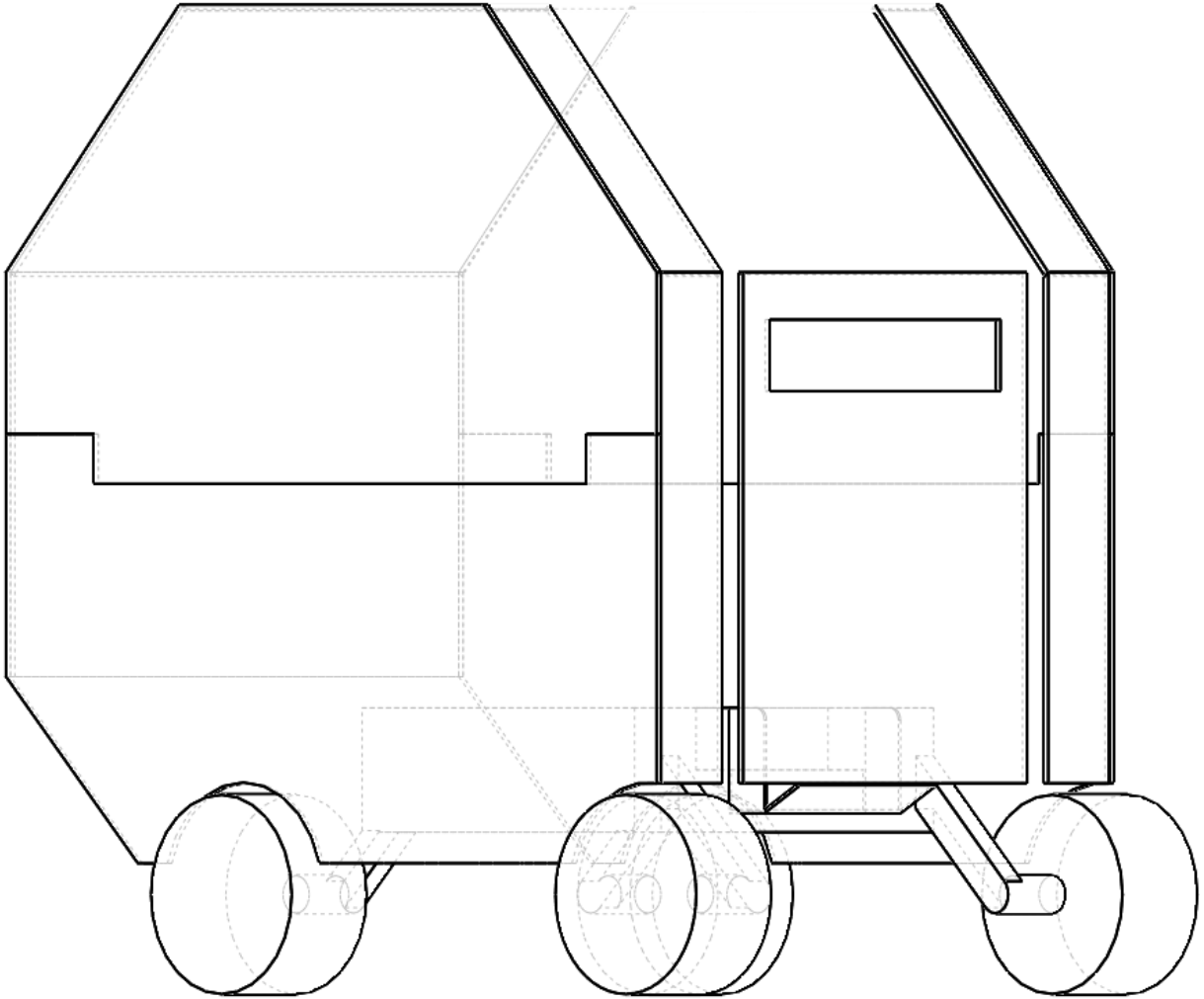
Mechanical structure: Protective Shell

- Protect the inner structure
- Grasslands-friendly
- Stylish and recognizable

Mechanical structure: Protective Shell

- Protect the inner structure
- Grasslands-friendly
- Stylish and recognizable

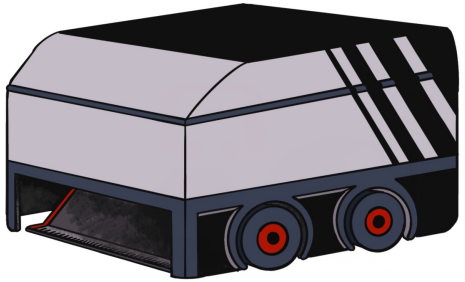


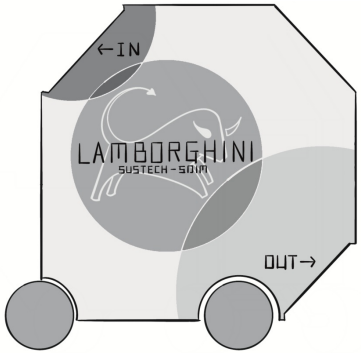


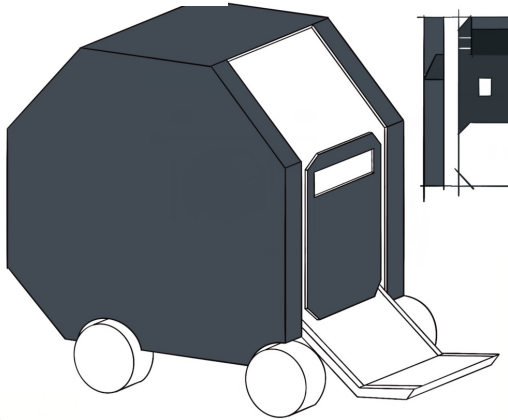
Mechanical structure: Protective Shell

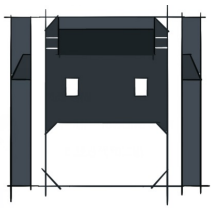
- Protect the inner structure
- Grasslands-friendly
- Stylish and recognizable

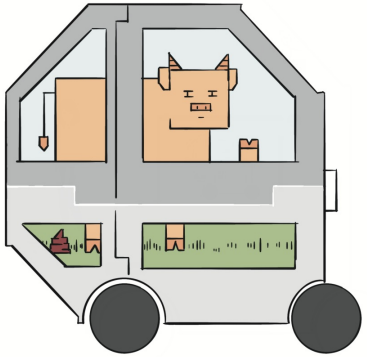
- KT board+propylene
- Green + gray : gransslands + technology
- LOGO

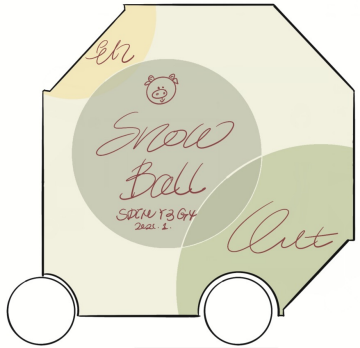


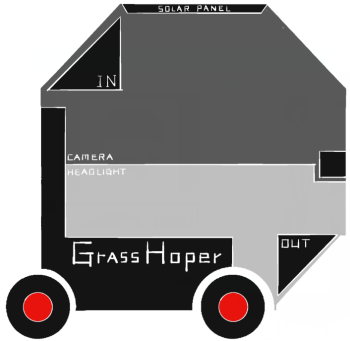










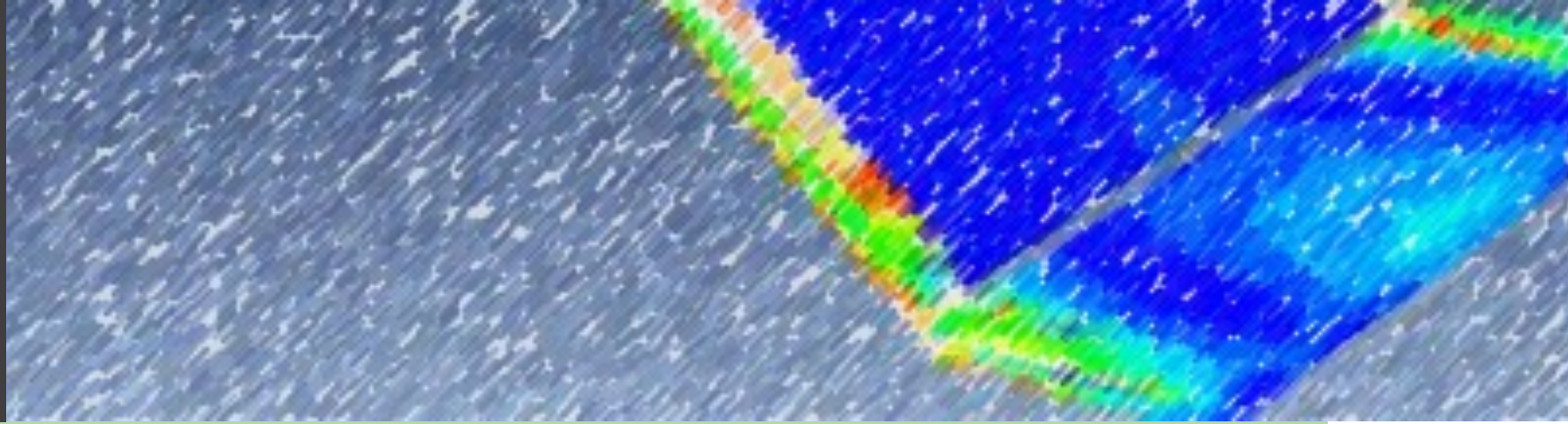


Mechanical structure: Protective Shell

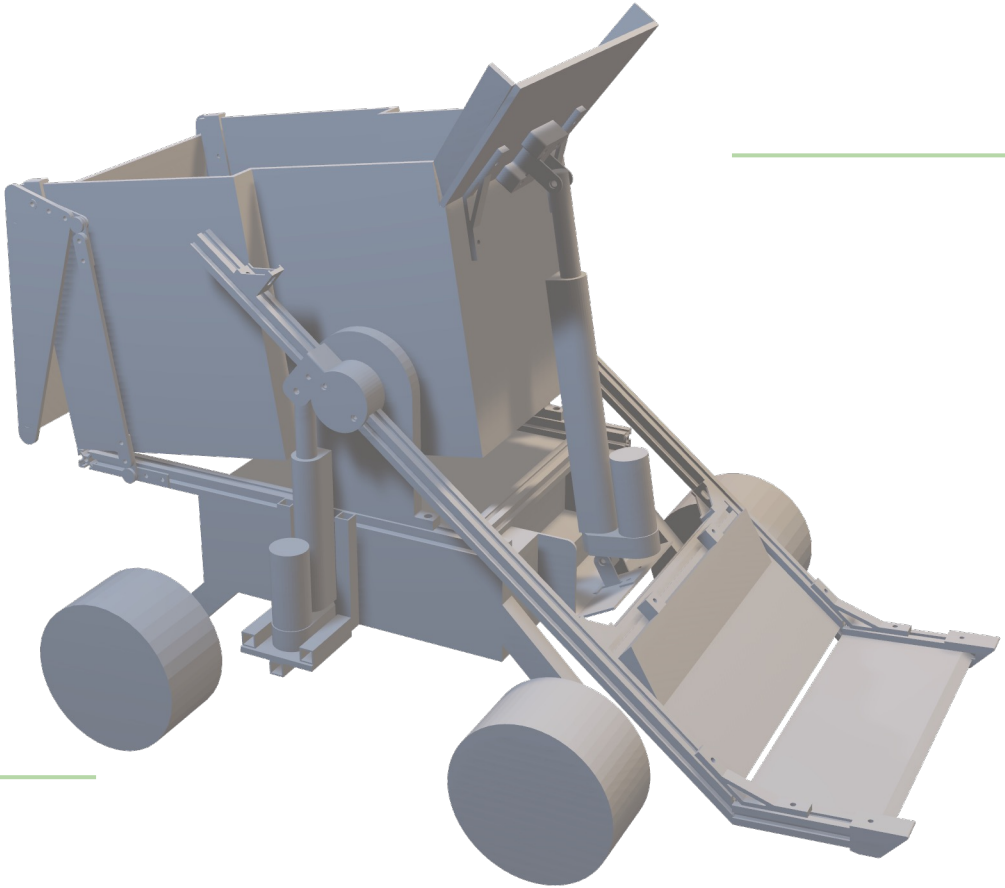
- Protect the inner structure
- Grasslands-friendly
- Stylish and recognizable

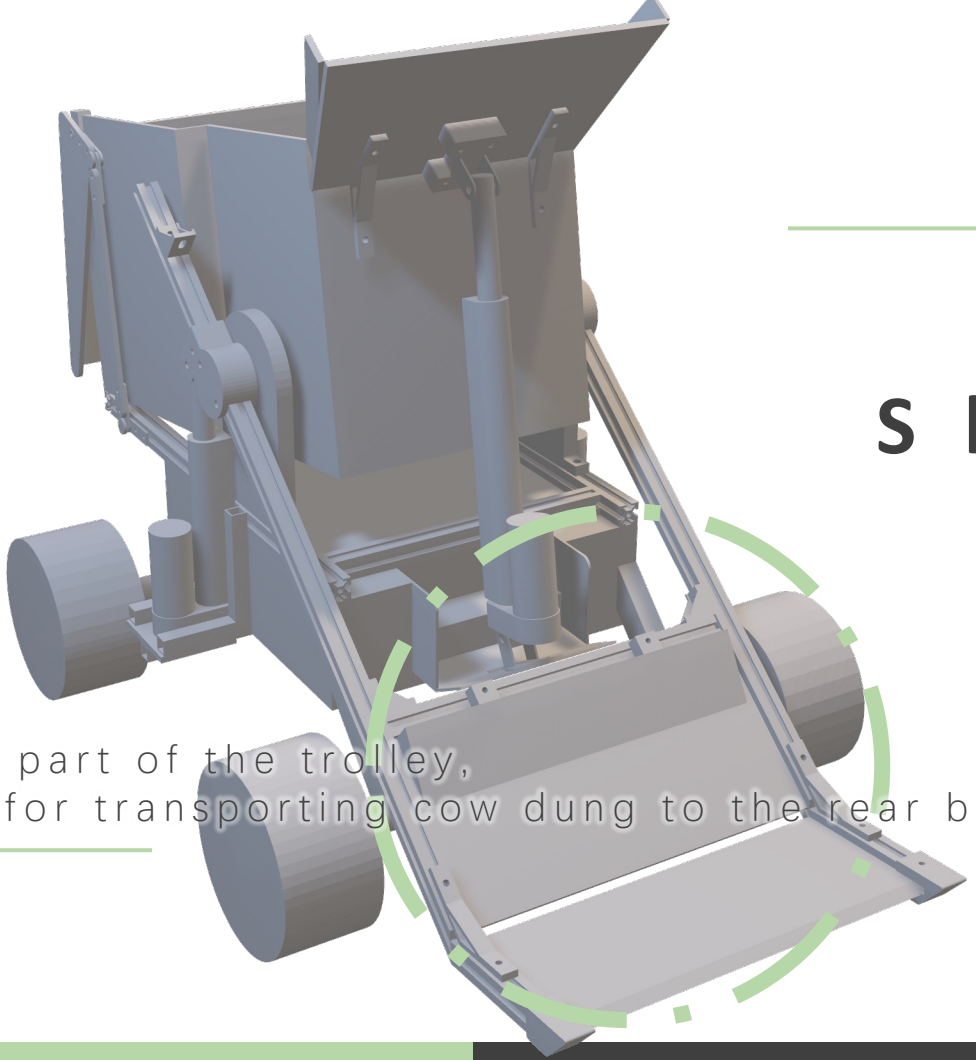
- KT board+propylene
- Green + gray：gransslands + technology
- LOGO

- Iteration!!!



Abaqus Simulation



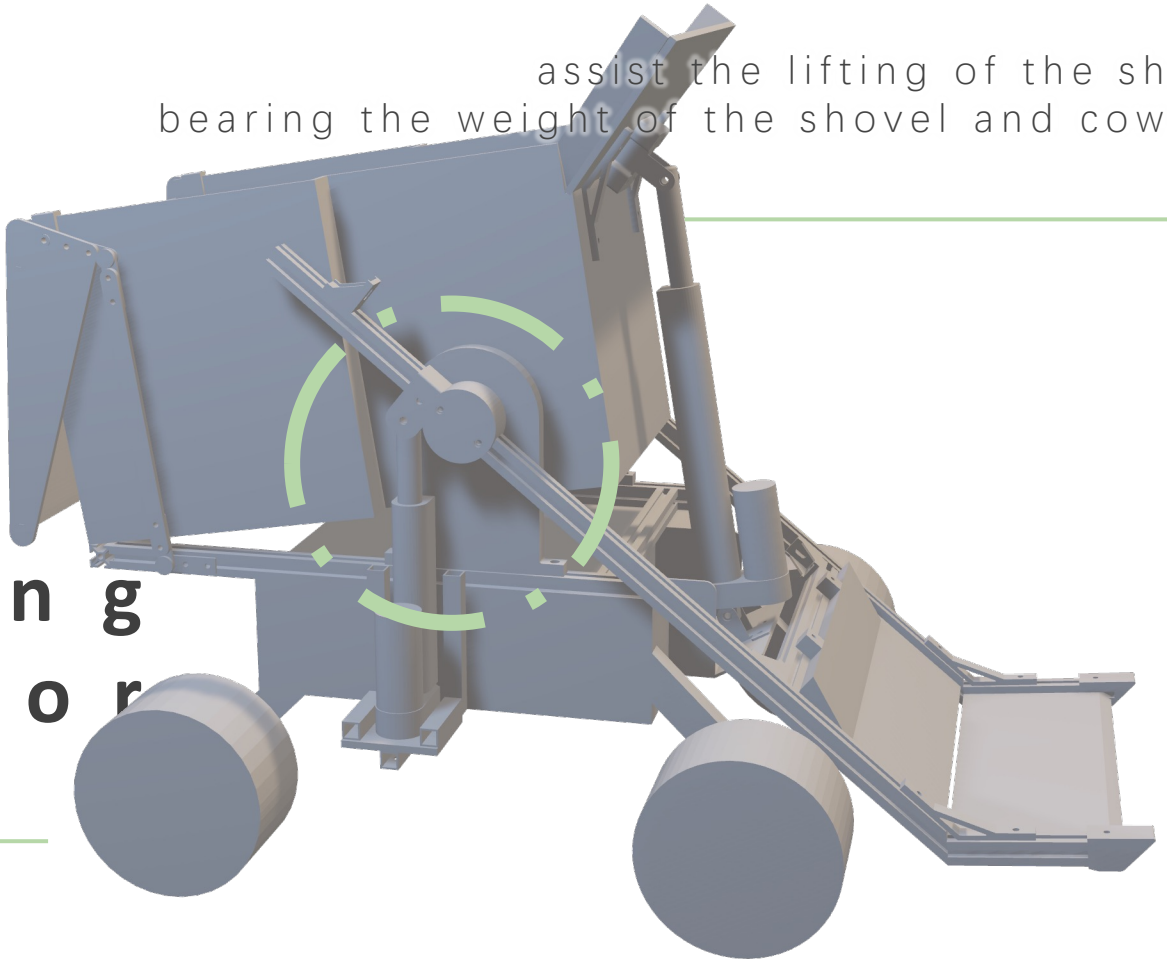


Shovel

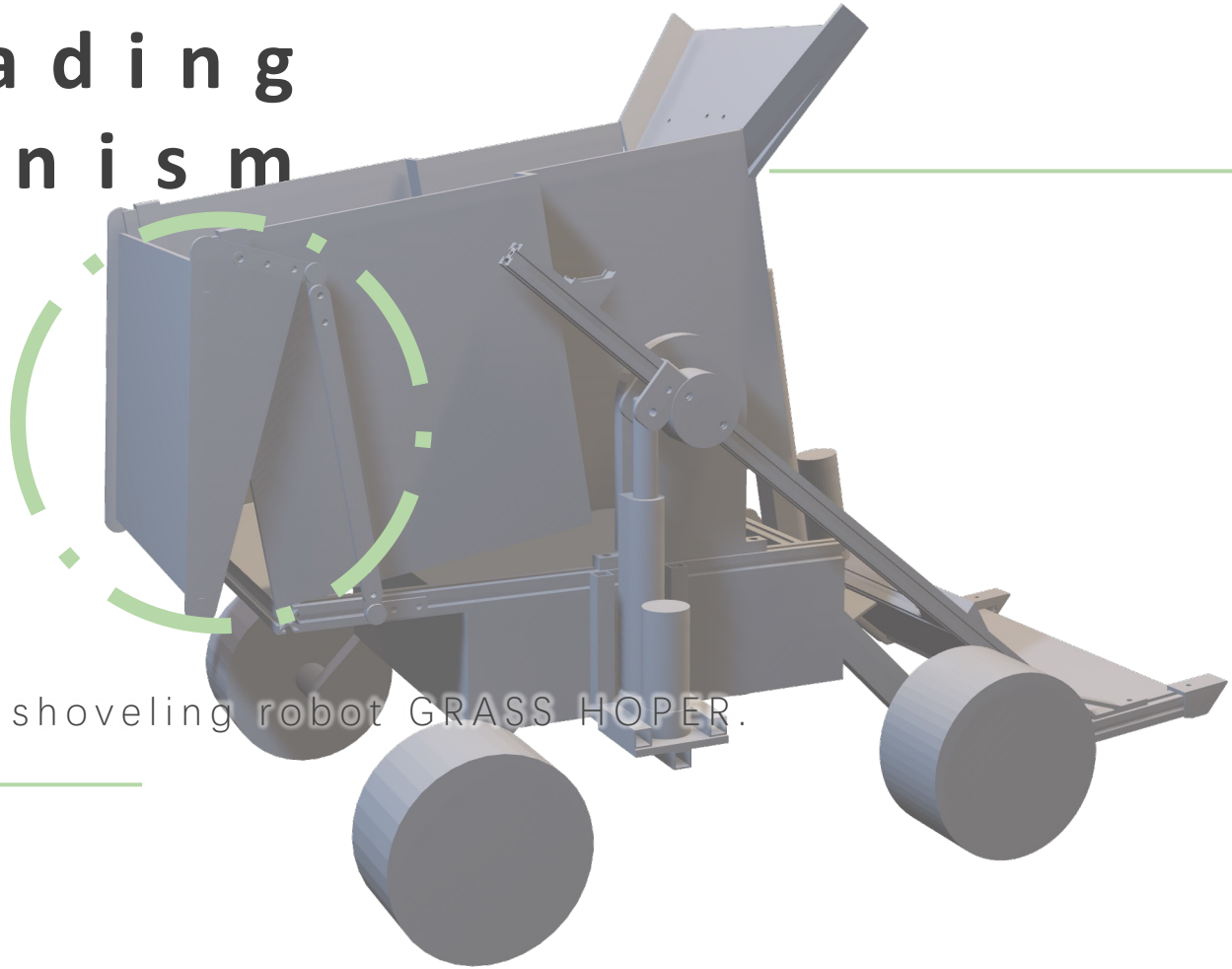
the most important part of the trolley,
mainly responsible for transporting cow dung to the rear box

assist the lifting of the shovel,
bearing the weight of the shovel and cow dung

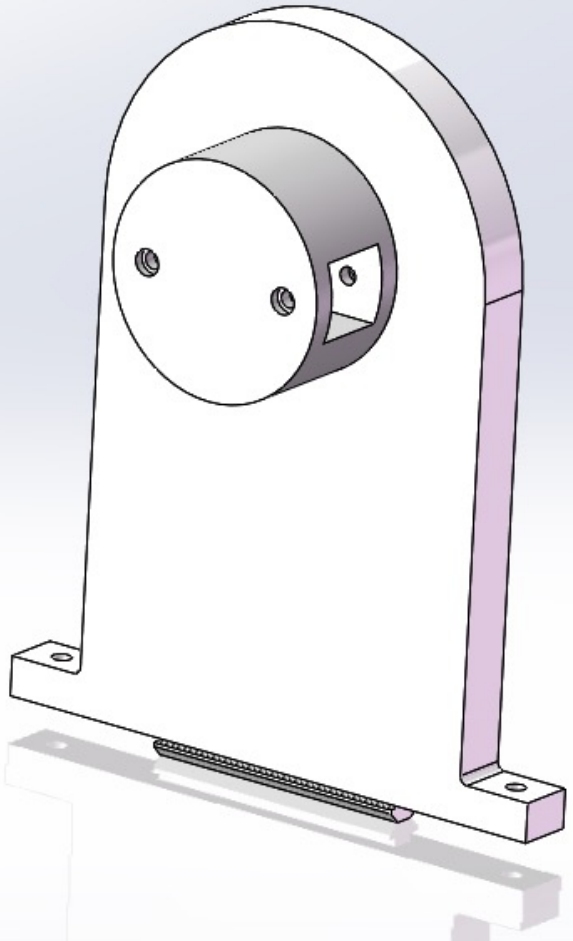
Bearing Connector



Offloading Mechanism



the last link in the shoveling robot GRASS HOPER.

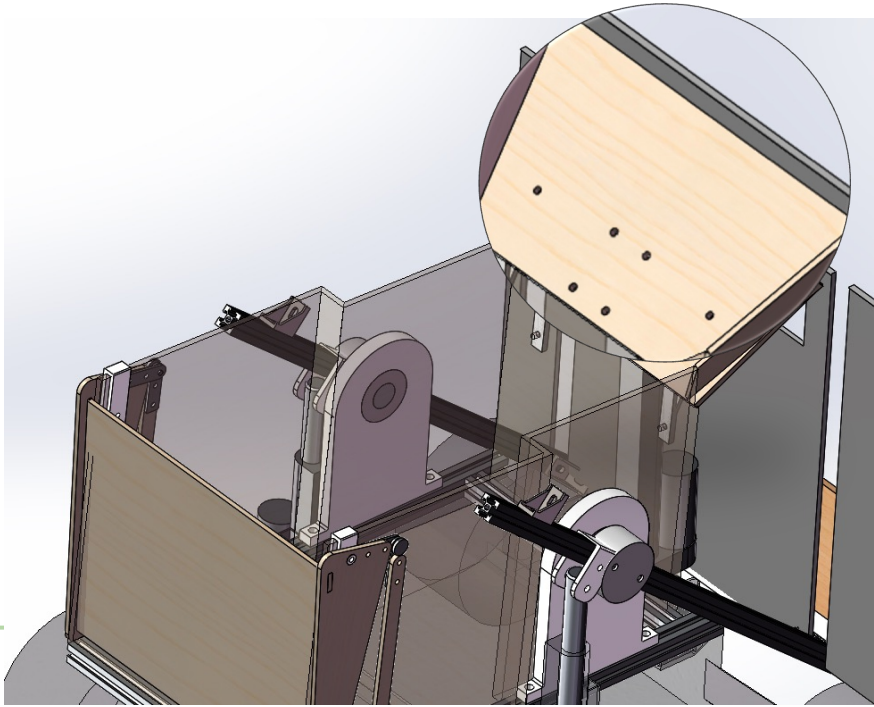


Bearing Connector

Modeling

仅考虑力矩最大时；

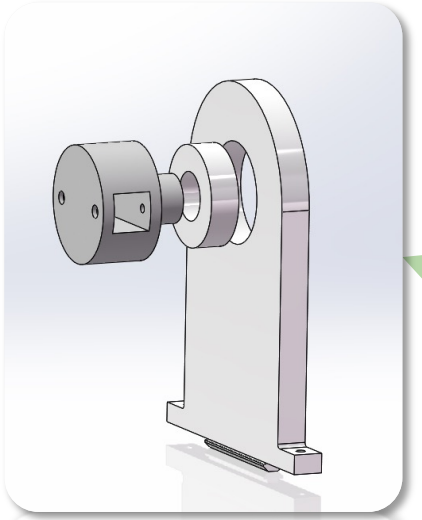
静态学问题

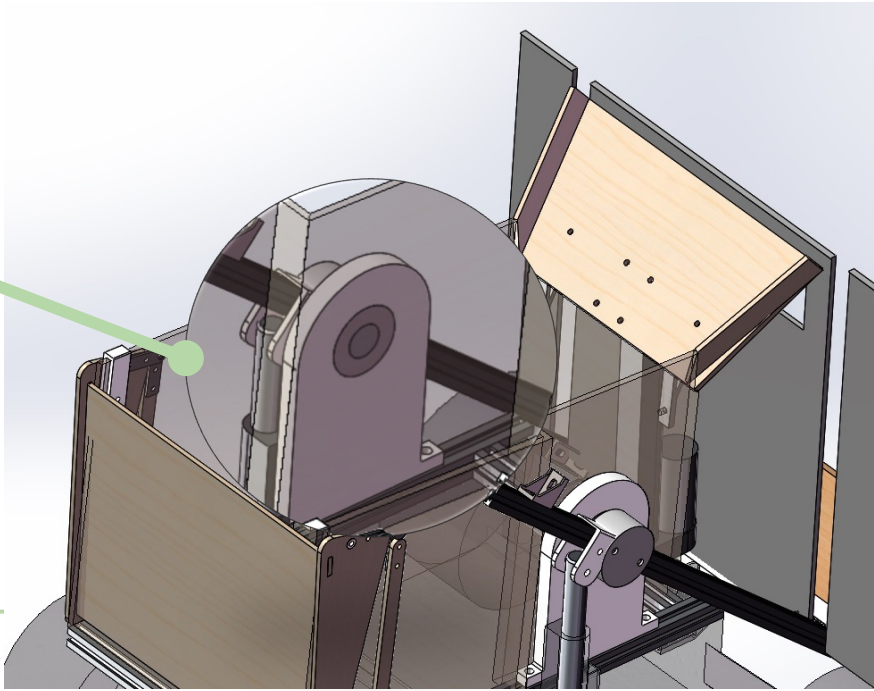


Modeling

仅考虑力矩最大时；

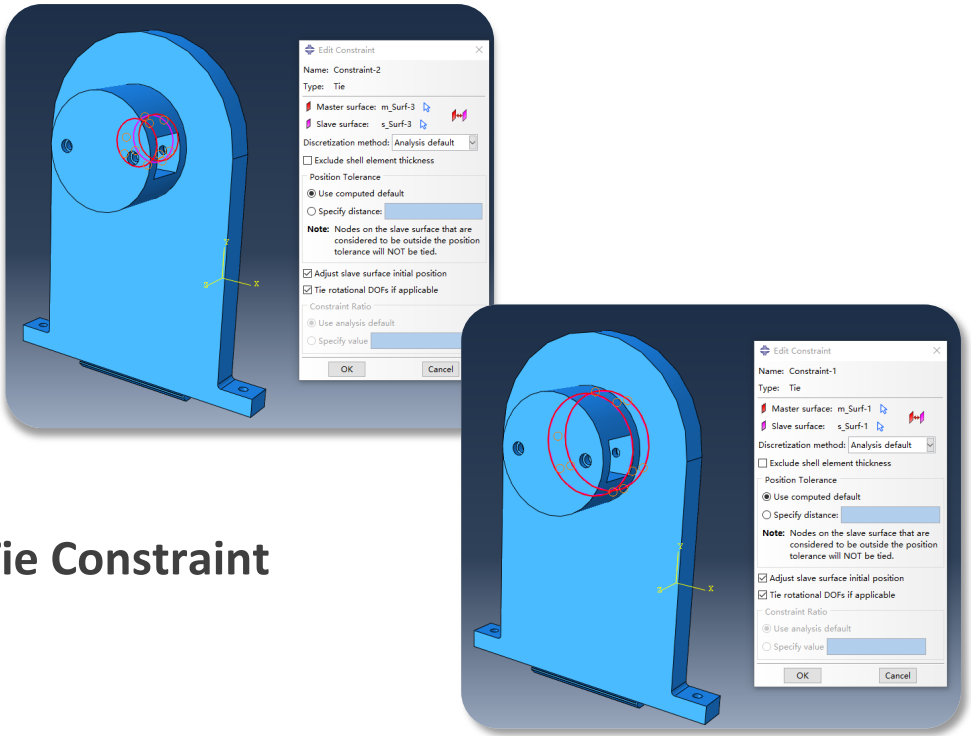
静态学问题





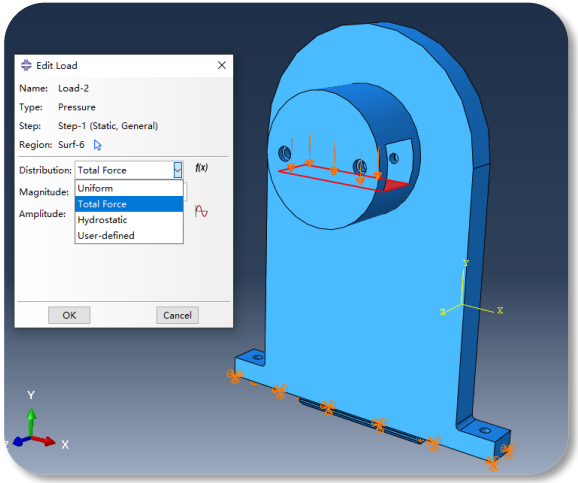
Interaction Setting

- Interference fit
- Tie constraint remains unchanged during the analysis
- Tie contact is defined in a particular step and before the analysis step begins, the two surfaces are not connected.



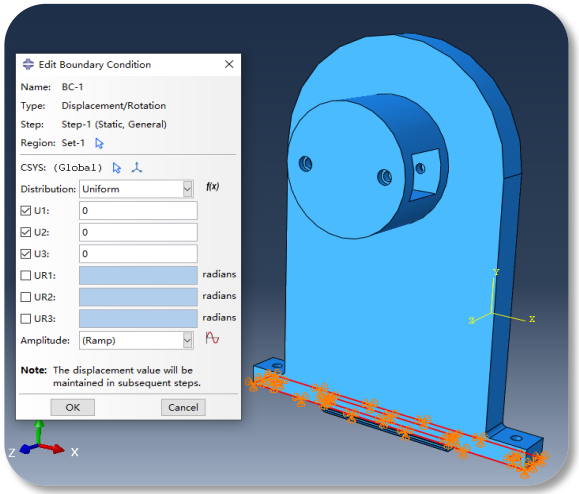
Tie Constraint

Load and Boundary Condition Setting



Total Force

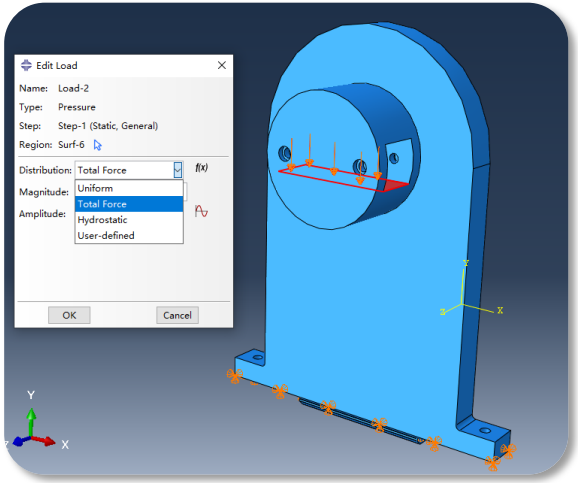
Avoid superfluous operation



Displacement

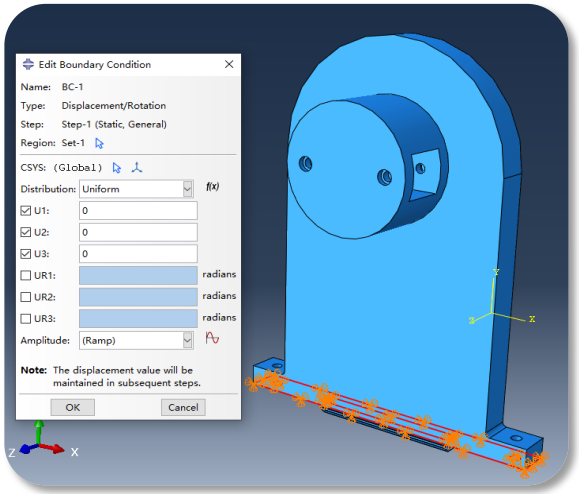
Set as zero

Load and Boundary Condition Setting



Total Force

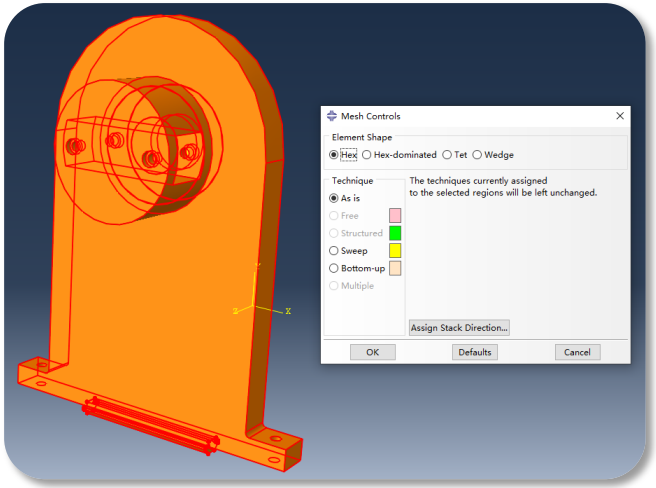
Avoid superfluous operation



Displacement

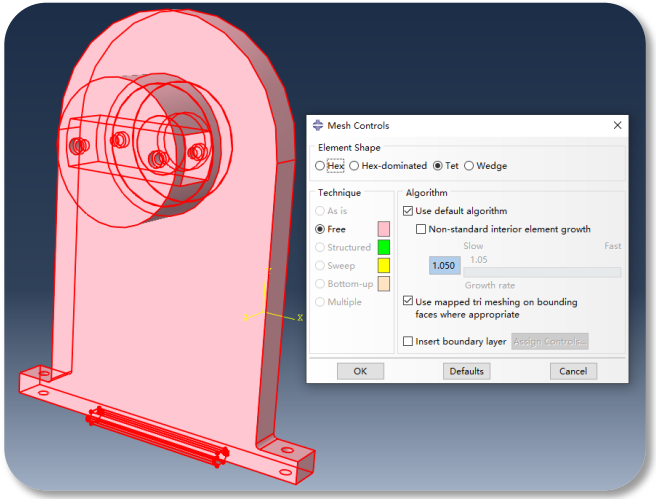
Set as zero

Mesh Generation



Hex mesh

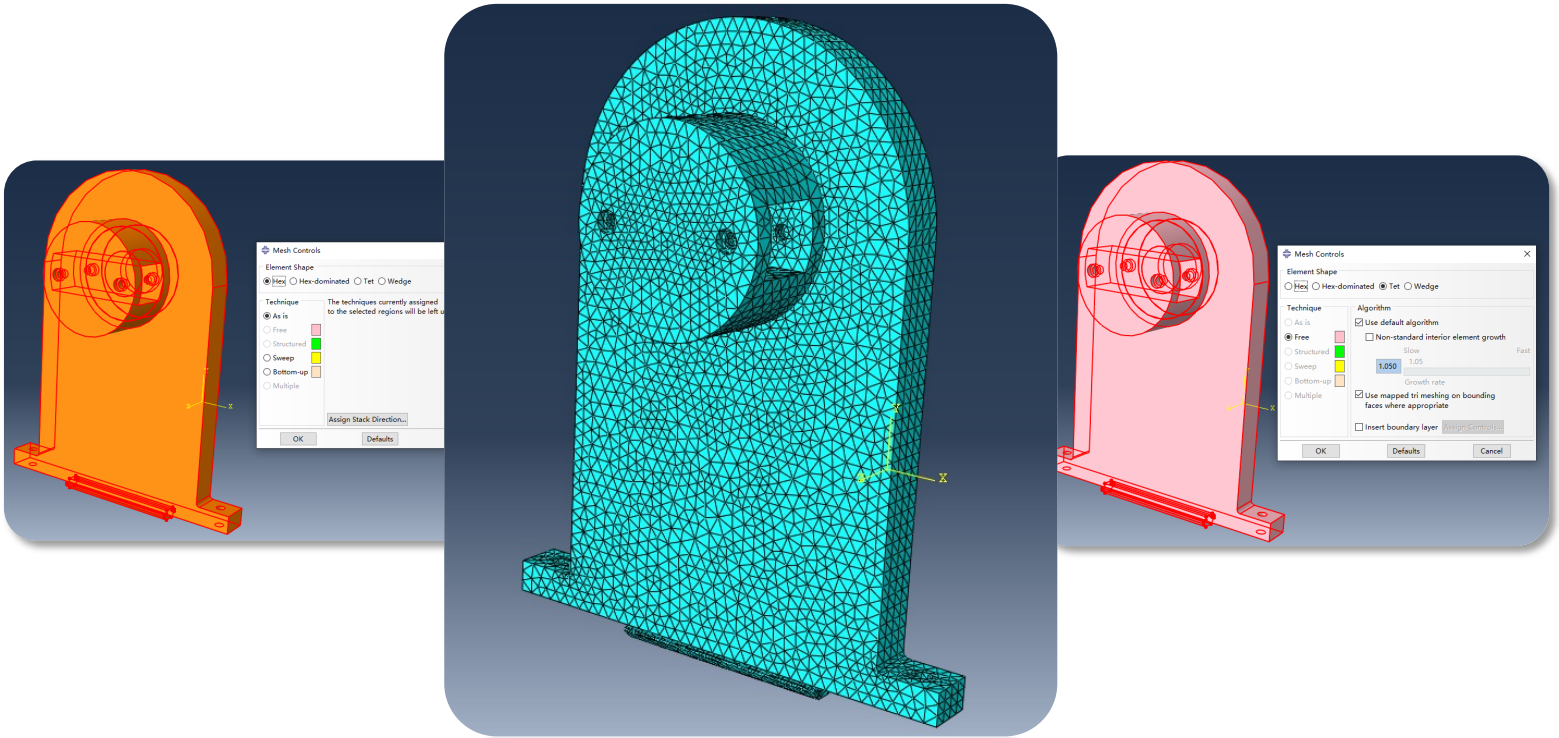
Report an error



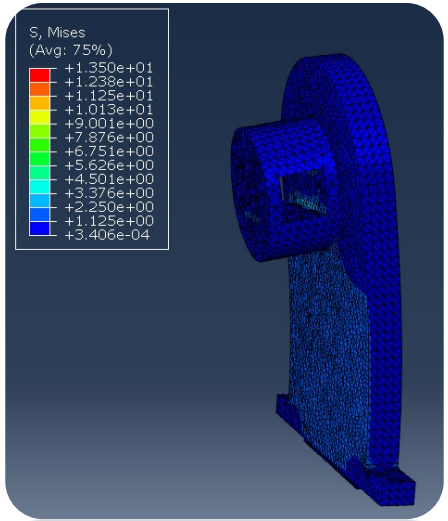
Tet mesh

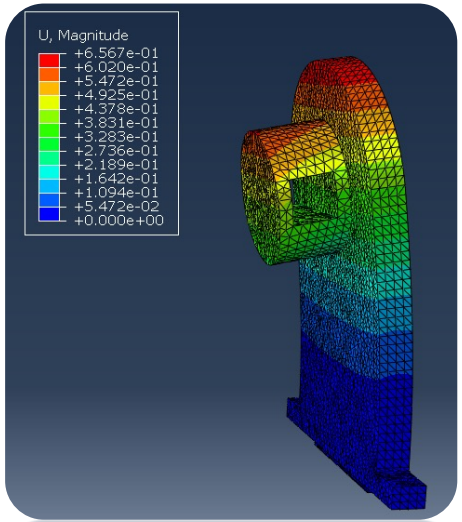
The accuracy is not high
but it is simple to mesh

Mesh Generation



Result Analysis

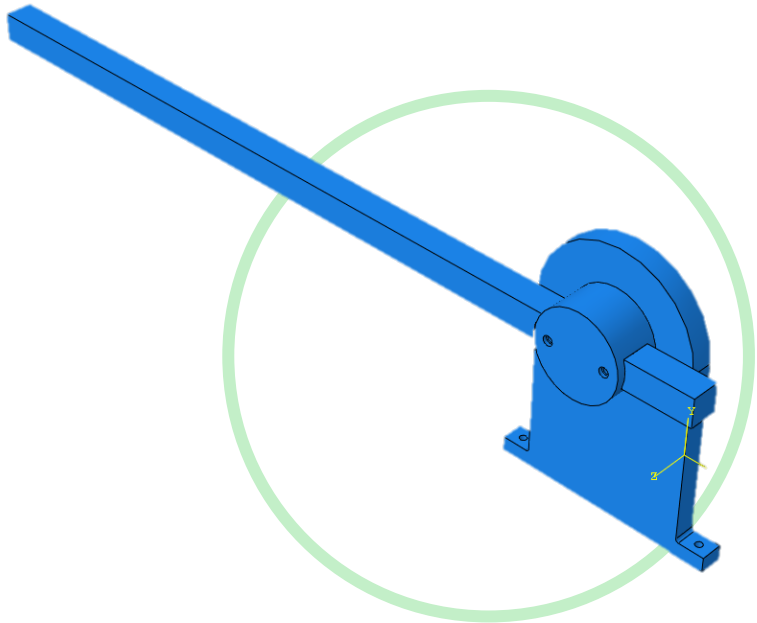




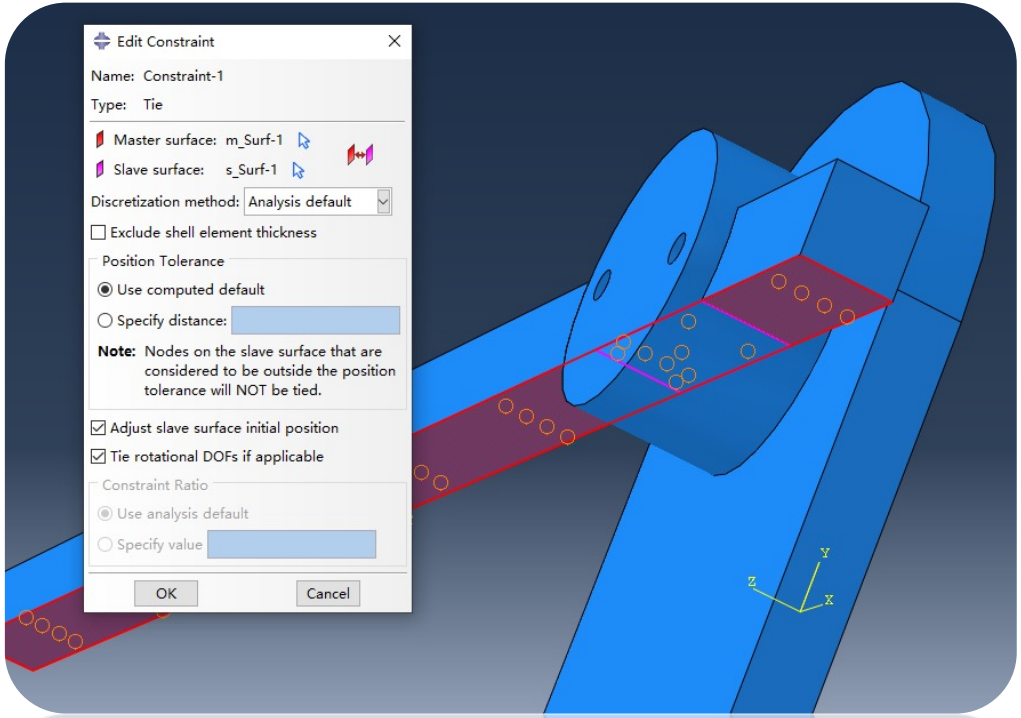
- Deformation: 0.6567mm
- Within acceptable range

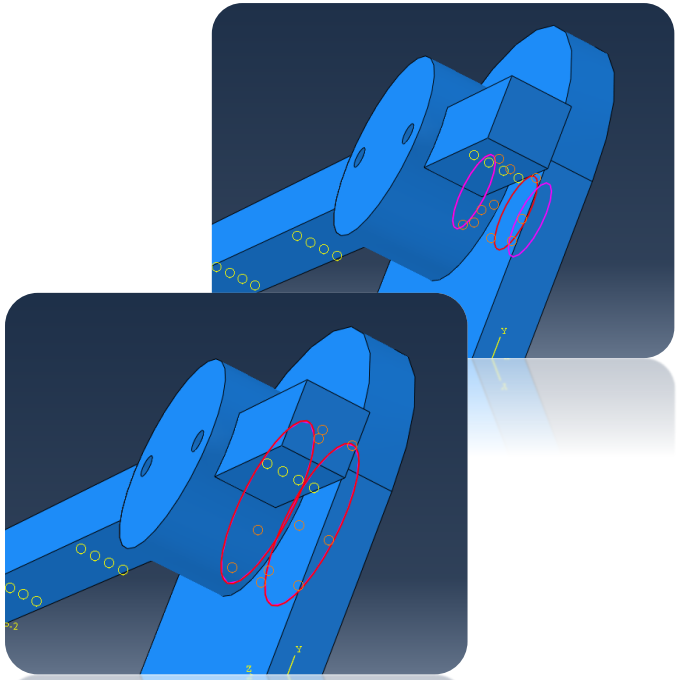
Validation

- Regardless of force arm
- Validate the correctness and reliability of 1st version



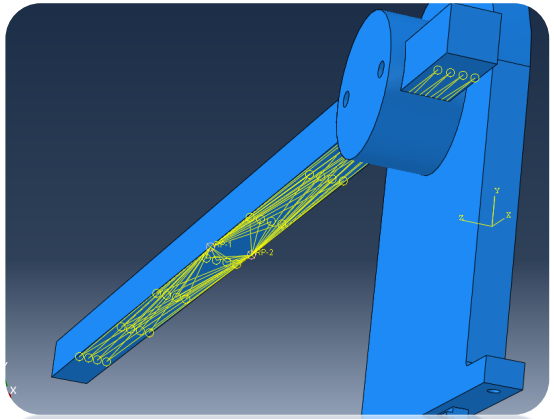
Interaction





Load

- Reference Point
- Coupling

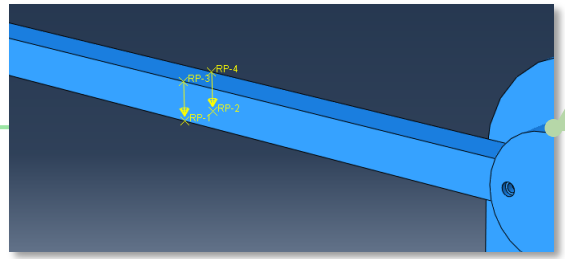


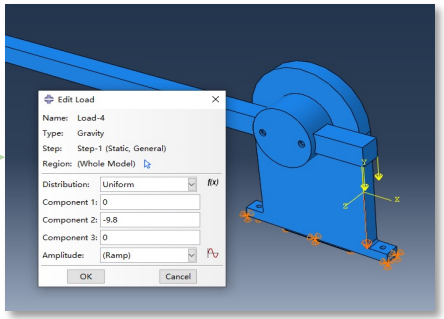
Aborted

```
Error in job Job-2: OVERCONSTRAINT CHECKS: NODE 220 INSTANCE shovel_connector - copy-4-1 IS USED MORE THAN ONCE AS A COUPLING NODE IN THE *KINEMATIC COUPLING KEYWORD. REMOVE MULTIPLE USAGE OF THIS NODE AS A COUPLING NODE.
Error in job Job-2: OVERCONSTRAINT CHECKS: NODE 225 INSTANCE shovel_connector - copy-4-1 IS USED MORE THAN ONCE AS A COUPLING NODE IN THE *KINEMATIC COUPLING KEYWORD. REMOVE MULTIPLE USAGE OF THIS NODE AS A COUPLING NODE.
Error in job Job-2: OVERCONSTRAINT CHECKS: NODE 230 INSTANCE shovel_connector - copy-4-1 IS USED MORE THAN ONCE AS A COUPLING NODE IN THE *KINEMATIC COUPLING KEYWORD. REMOVE MULTIPLE USAGE OF THIS NODE AS A COUPLING NODE.
Error in job Job-2: OVERCONSTRAINT CHECKS: NODE 235 INSTANCE shovel_connector - copy-4-1 IS USED MORE THAN ONCE AS A COUPLING NODE IN THE *KINEMATIC COUPLING KEYWORD. REMOVE MULTIPLE USAGE OF THIS NODE AS A COUPLING NODE.
Error in job Job-2: OVERCONSTRAINT CHECKS: NODE 240 INSTANCE shovel_connector - copy-4-1 IS USED MORE THAN ONCE AS A COUPLING NODE IN THE *KINEMATIC COUPLING KEYWORD. REMOVE MULTIPLE USAGE OF THIS NODE AS A COUPLING NODE.
Error in job Job-2: OVERCONSTRAINT CHECKS: NODE 245 INSTANCE shovel_connector - copy-4-1 IS USED MORE THAN ONCE AS A COUPLING NODE IN THE *KINEMATIC COUPLING KEYWORD. REMOVE MULTIPLE USAGE OF THIS NODE AS A COUPLING NODE.
Error in job Job-2: OVERCONSTRAINT CHECKS: NODE 250 INSTANCE shovel_connector - copy-4-1 IS USED MORE THAN ONCE AS A COUPLING NODE IN THE *KINEMATIC COUPLING KEYWORD. REMOVE MULTIPLE USAGE OF THIS NODE AS A COUPLING NODE.
Error in job Job-2: Error message limit reached. No further error messages will be reported.
Please see the dat file for more errors.
Job Job-2: Analysis Input File Processor aborted due to errors.
Error in job Job-2: Analysis Input File Processor exited with an error
Job Job-2 aborted due to errors.
```

Check dat file

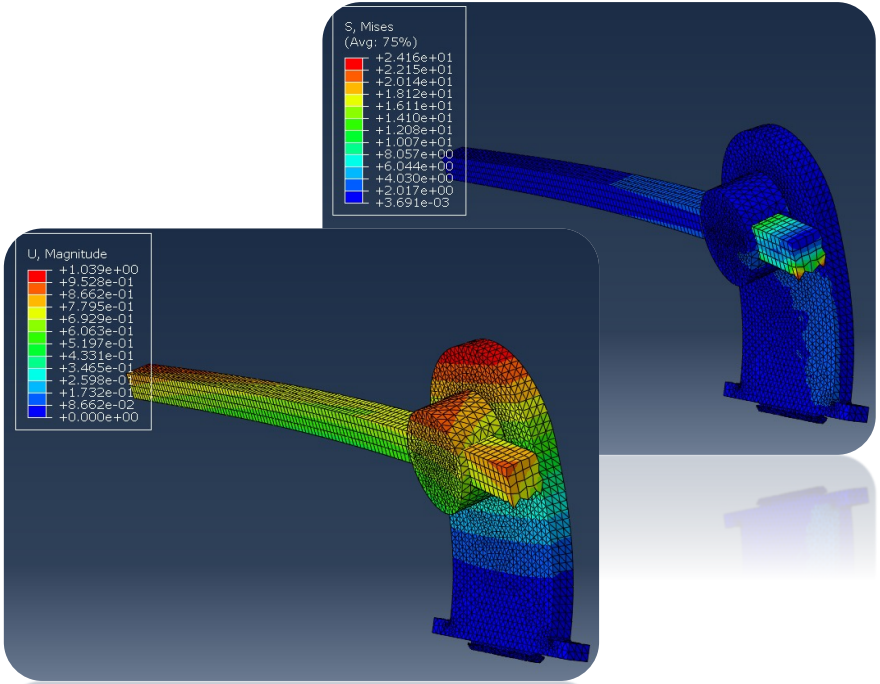
```
***ERROR: OVERCONSTRAINT CHECKS: NODE 5 INSTANCE shovel_connector - copy-4-1
          IS USED MORE THAN ONCE AS A COUPLING NODE IN THE *KINEMATIC COUPLING
          KEYWORD. REMOVE MULTIPLE USAGE OF THIS NODE AS A COUPLING NODE.
***NOTE: DUE TO AN INPUT ERROR THE ANALYSIS PRE-PROCESSOR HAS BEEN UNABLE TO
          INTERPRET SOME DATA.  SUBSEQUENT ERRORS MAY BE CAUSED BY THIS OMISSION
```



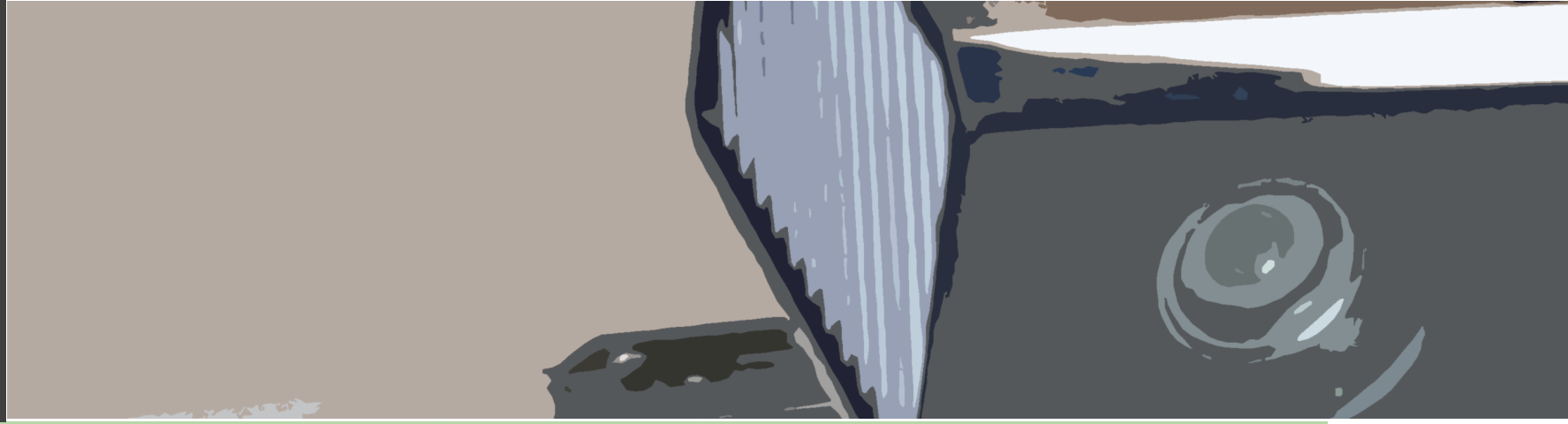


Gravity

Result and Introspection

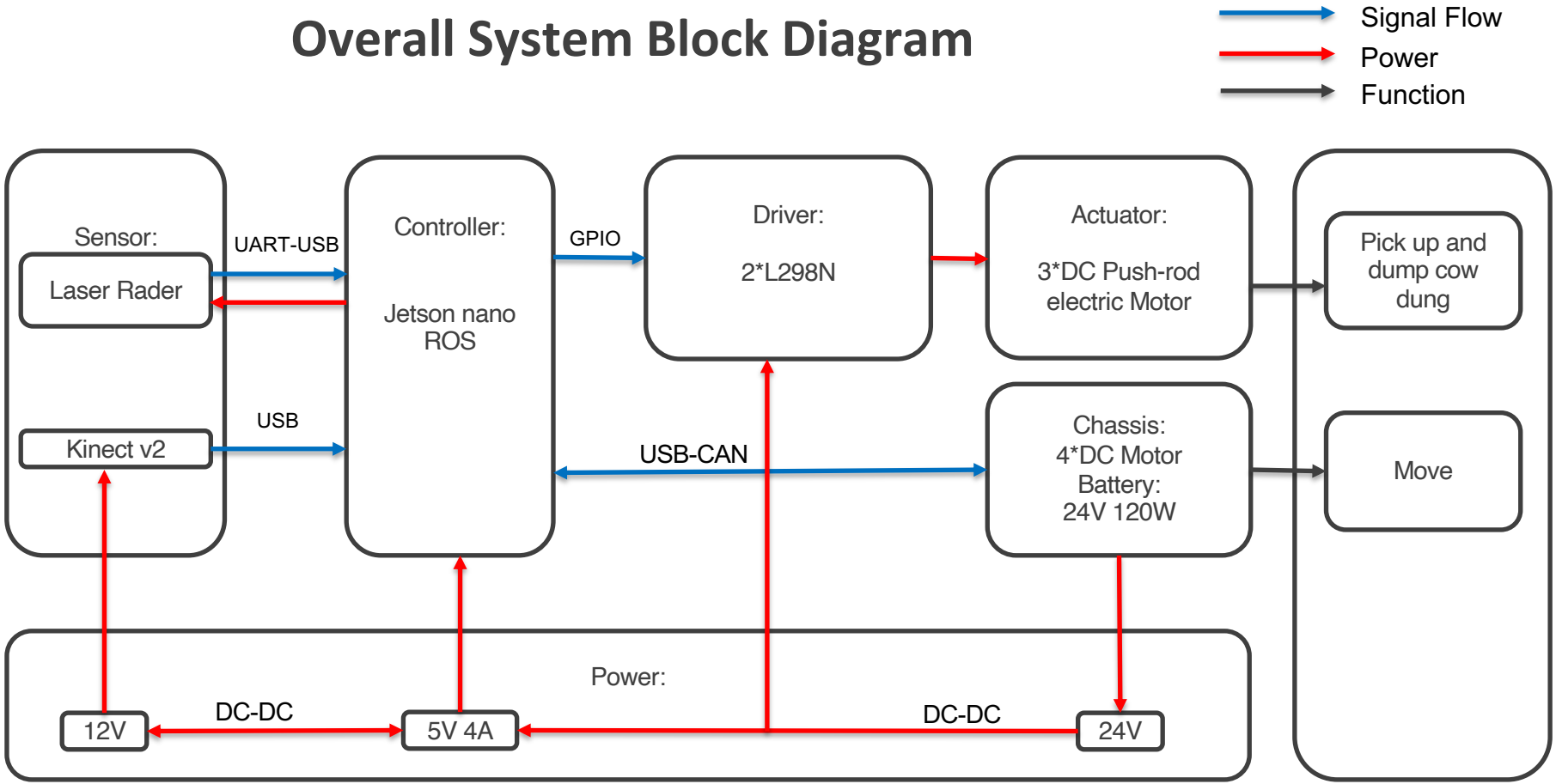


- Unit
- The first method does not add gravity and is not rigorous enough



Electronic Control

Overall System Block Diagram



Controller (Brain)

NVIDA Jetson Nano

VS

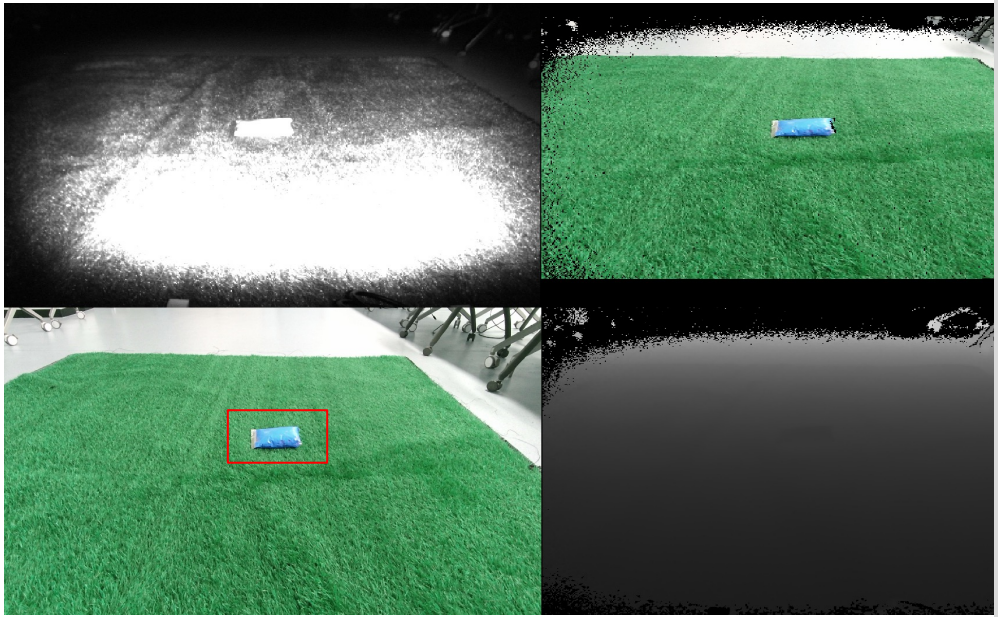
Raspberry Pi

	NVIDA Jetson Nano	Raspberry Pi 4
Price	$99	$55
Compatibility for ROS	√	
GPU	√	

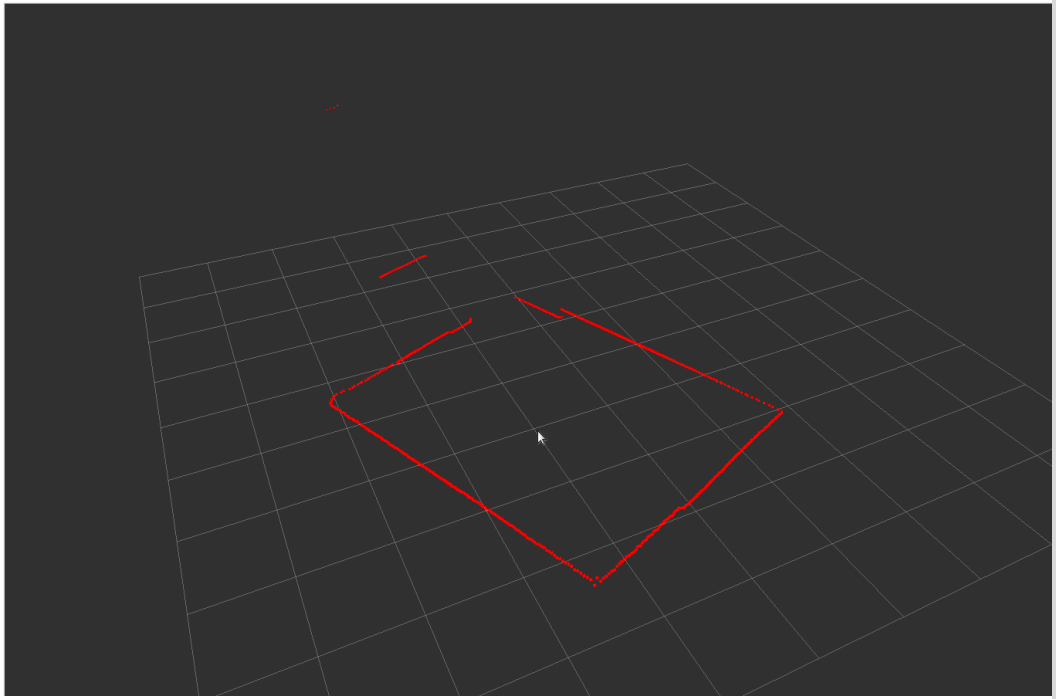
Sensor: (Eye)

Kinect v2 ---- RGB-D camera

Identity Cow Dung (Depth)

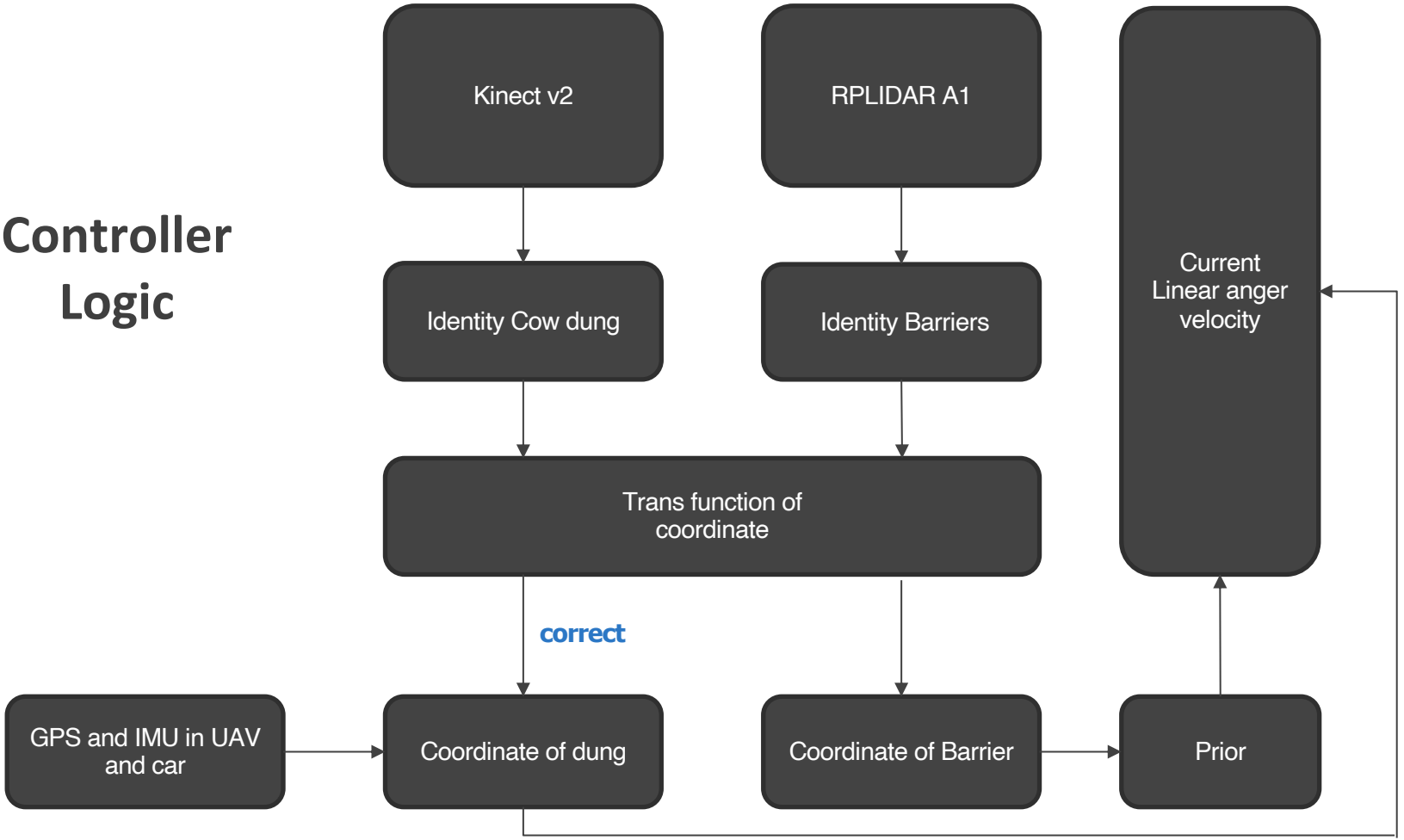


RPLIDAR A1----Laser Radar



Avoid Barriers (Surround)

Controller Logic




THANKS
TO CLEAN UP COW DUNG IN MEADOW EFFECTIVELY
GROUP 4
Xiao Yunzhong/Project Manager
Zhang Zhengxiang/ CFO/ Meeting Minutes
Wei Ziyu/Technical Project Manager/ Industrial Design
Yu Tongge/Industrial Design
Lai Jingyi/Mechanical Engineering
Ban Shu/Electronic Engineering

GRASS HOPER

GROUP 4