

# Ideation Derby

Team Seven Subteam:  
Kismet Crossdale, Hayden Fuller,  
Jameson Giannattasio

# Problem Statement + Design Criteria



## Problem Statement

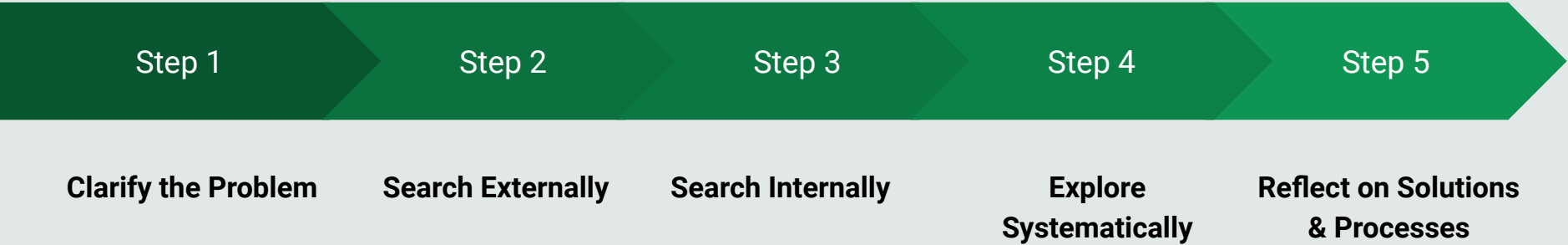
Goal: To design a device that reduces time and labor of cleaning solar panel in the absence of rain; through cleaning, will increase the solar panel efficiency



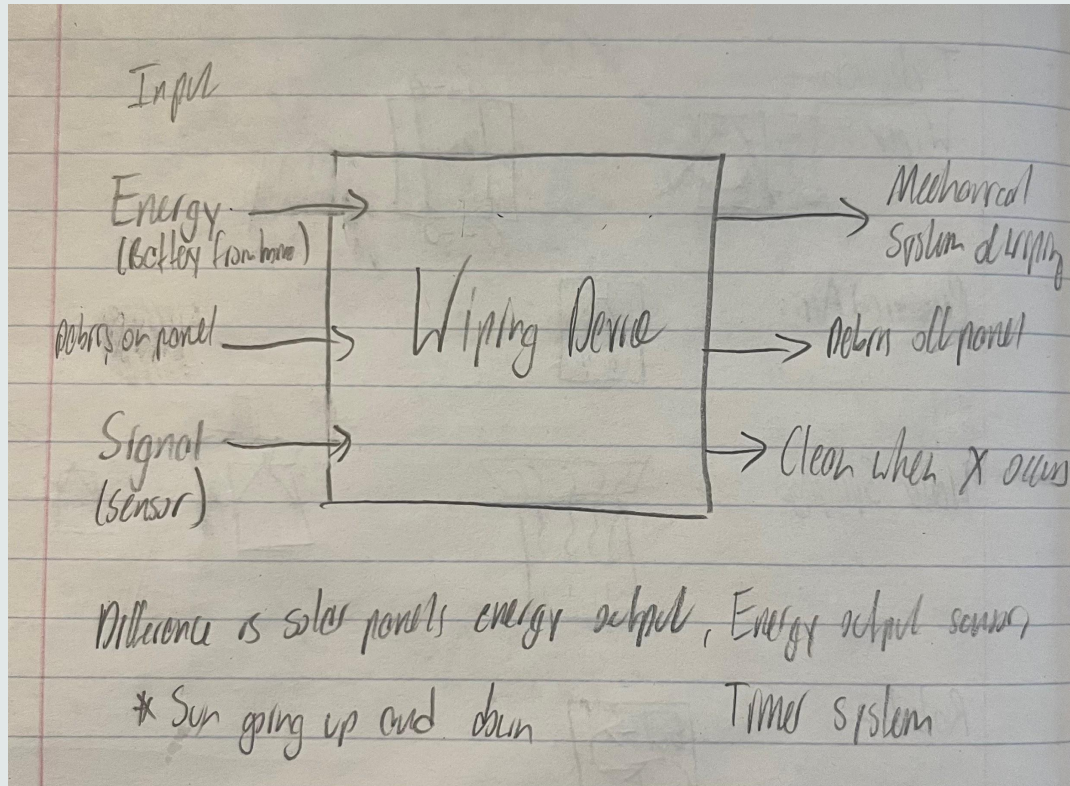
## Design Criteria

- Affordability - less than \$100 USD
- Easy to Install - can install within 30 minutes
- Energy Output - consistent source of energy
- Longevity - lifetime of solar panel increases by 10 years

# Concept Generation Process



# Step 1: Clarify the Problem



Pictured to the left: Black box diagram

# Step 2: Search Externally

## 3 Related Patents:

- ❖ Pleco Solar
  - Robot w/ rotating brush
  - Doesn't utilize water
  - Too expensive
  
- ❖ Straight Sweep Windshield Wiper
  - Efficient motor arm
  
- ❖ iRobot Roomba
  - Excellent debris detection

Competitive Product	Patent Number	Title/Description	Relation to the Project
Pleco Solar	Based on Bar-Ilan University Patents  Patent Pending?	Robot Solar Panel Cleaner	Concept for brushing debris off  Rotating brush (robot does not use water)
Straight Sweep Windshield Wiper	US4245369A	Wiper arms	Concept for the movement of the wiper
iRobot Roomba	US9883783B2	Debris detection	Concept for detection of when to clean the panel.

## Pleco Solar (Brushing)

### Pros:

- Little to no water use
- Ease of application
- Cleaning efficiency

### Cons:

- Expensive (>\$100 USD)
- Not simplistic in design

### How it influenced the concept selection and generation process:

- Realized importance of device not using any water/cleaning solution to bring down cost

Metric	Importance	Score
No Water Use	4	5
One-Time-Purchase	5	4
Cost	4	1
Easy-to-Use	4	5
Brushing Debris	5	5
Simplicity	5	2
Compatibility with panels	4	4

# Straight Sweep Windshield Wiper

## Pros:

- Efficient in motion ability
- Length
- Simplicity in design

## Cons:

- Blades are not the entire length of wiper arm

## How it influenced the concept selection and generation process:

- Length of blade & wiper arm
- Rotational motion

Metric	Importance	Score
Motion efficiency	4	4
Long length	4	3
Blades are whole of wiper arm length	4	1
Motor driven arm	5	4
Simple design	5	4
Low cost	5	3
Durability	5	4

## Roomba Dirt Detect

### Pros:

- Inability to be impeded by debris
- Durability

### Cons:

- Not low cost ( $> \$100$  USD)

### How it influenced the concept selection and generation process:

- Realized importance of specificity of sensor
- Detection style of sensor

Metric	Importance	Score
Doesn't clog up	5	4
Low cost component	4	3
Piezoelectric sensor	3	5
Durable	5	4
Detects instantaneously rather than build up	3	5

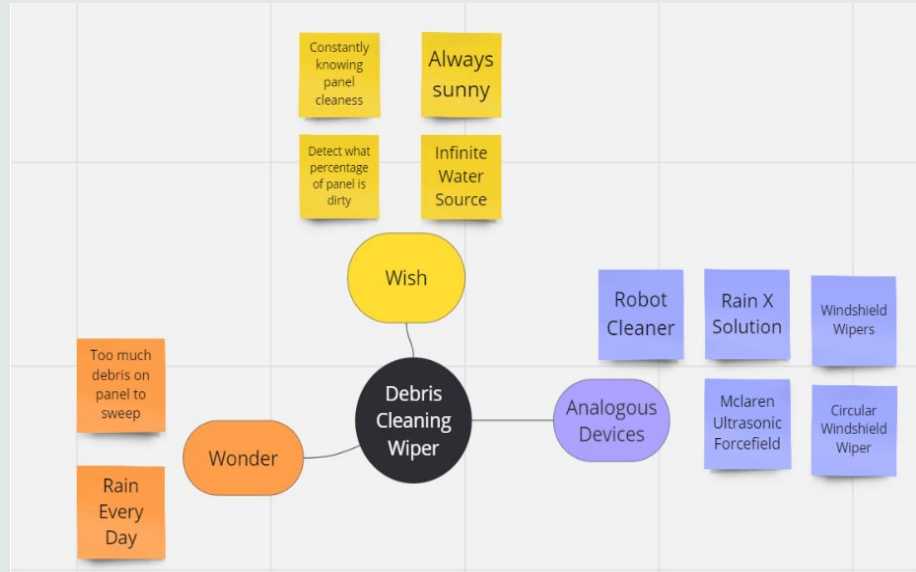


# Step 3: Search Internally

- Utilized ideation templates such as Miro
- Generated concepts using personal knowledge/creativity

## Brainstorming:

- Wish and Wonder
  - Identify boundaries of problem
- Analogous Devices
  - Recognize similar solutions



# Step 4: Explore Systematically

## Store/Accept External Energy:

- Battery
- Directly from solar panel
- AC power

## Triggering/Sensing Debris:

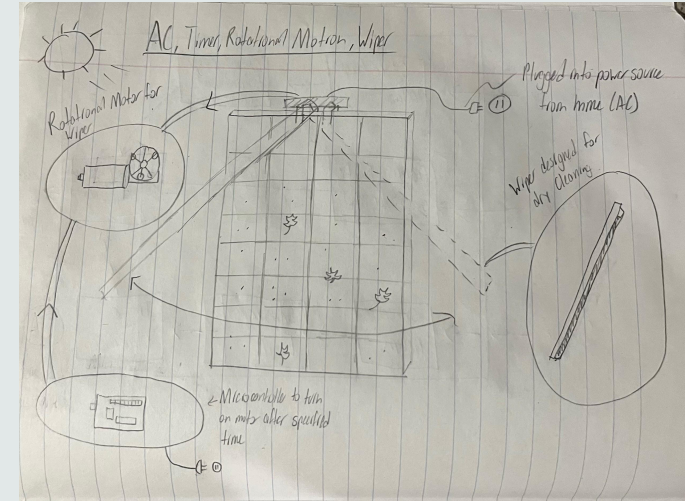
- Light detector
- Solar Efficiency
- Timer
- Manually triggered

## Energy to Debris:

- Rotational motor connected directly to blade (Windshield)
- Belt driven pulley system (Horizontal)
- Air/Water/Other liquids

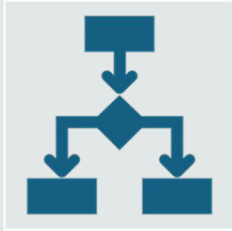
## Most Promising Methods:

Store/Accept External Energy	Triggering/sensing debris	Energy to Debris
AC power	Timer	Rotational motion
Battery	Efficiency calculation	Linear motion



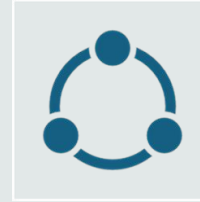
Sketch of 1st promising method

## Step 5: Reflections on Solution & Process



### Fully Explored Solution Space

- Sub functions & systems were entirely fleshed out
  - Black box diagram
  - Energy, Materials, & Signals framework



### Alternative function diagrams & problem decomposition

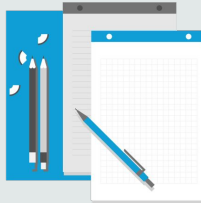
- Ex: functional block diagram, circle diagram
- We believe that the diagrams & frameworks we used (named above) were most efficient in decomposing the problem

## Step 5 (Cont.)



### External sources

- Chose patents most relevant to device due to similarities in subsystems & functions



### Collective brainstorm & integrated ideas

- Each member picked a different patent to explore
  - Kismet: **Straight Sweep Windshield Wiper - blade design and motion**
  - Hayden: **iRobot Roomba - sensor and detection abilities**
  - Jameson: **Pleco Solar - waterless solution & solar panel compatibility**
- Aspects welcomed & blended into final design
  - **AC power + Efficiency sensor + Wiper with Rotational Motion**

# Concept Screening

## Selection Criteria:

- Cleaning Effectiveness
- Detection Efficiency
- Durability
- Low Cost
- Motion Efficiency
- Simplicity

Ranked with +,-,o system

- C had best Detection
  - Combine with highest overall rank (B)

	Concepts				
	A Straight Sweep Windshield Wiper + manual (Reference)	B AC Power + Timer Sensor + Rotational Motion	C Battery + Efficiency Calculation Sensor + Linear Motion	D Ultrasonic Vibration Force Field	E Circular Windshield Wipers
Net Score	0	3	-1	-1	2
Rank	3	1	4	4	2
Continue?	Revise	Yes, Combine	Yes, Combine	No	Yes

# Decision Matrix

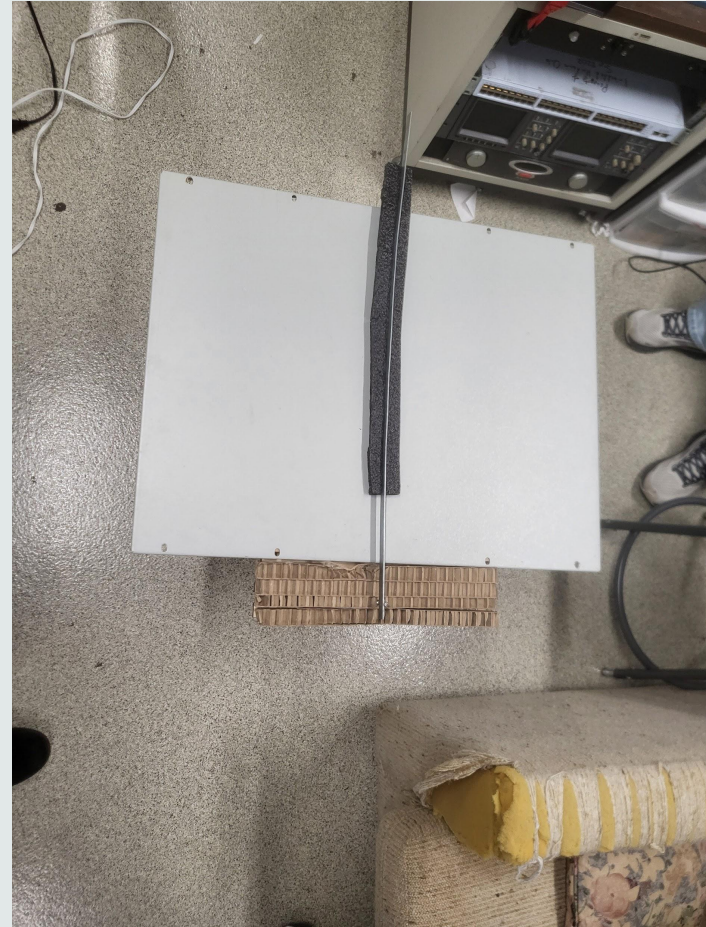
- Combined B and C
  - AC Power, Efficiency Sensor, Rotational Motion
- Weight of selection criteria determined by importance to users and product
- BC had highest score

		Concepts					
		A Straight Sweep Windshield Wiper		BC AC Power, Sensor, Rotational Motion		E Circular Windshield Wiper	
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Durability	15%	3	.45	4	.6	4	.6
Motion Efficiency	15%	3	.45	4	.6	4	.6
Low cost	20%	3	.6	3	.6	4	.8
Simplicity	15%	3	.45	3	.45	4	.6
Cleaning Effectiveness	20%	3	.6	3	.6	2	.4
Detection Efficiency	15%	3	.45	5	.75	2	.3
Total Score Rank		3 3		3.6 1		3.3 2	
Continue?		No		Develop		No	

# Low-Fidelity Prototype

## Functions and Materials:

- Solar Panel
  - Metal Sheet
- Wiper
  - Metal Blade
  - Foam
  - Bolt
- Mounting Apparatus
  - Wood
  - Cardboard



# Conclusion

Through the ideation process, a solution was collectively devised by our subteam that meets the design criteria:

- Proposed solution concept
  - Rotational wiper powered by AC source with an efficiency sensor
- Benefits of concept
  - Detects debris effectively
  - Efficiently removes all debris to increase energy output
  - Minimal parts to keep simplistic, affordable, and easily installable



Questions?

# Citations (IEEE)

- [1] “Product Pleco Solar” Blade Ranger. Accessed February 12, 2024. [Online]. Available: <https://bladeranger.com/pleco/>
- [2] “Straight Sweep Windshield Wiper” Google Patents. Accessed February 12, 2024. [Online]. Available: <https://patents.google.com/patent/US4245369A/>
- [3] “Debris Sensor for Cleaning Apparatus” Google Patents. Accessed February 12, 2024. [Online]. Available: <https://patents.google.com/patent/US20170202419A1/>
- [4] All Images courtesy of Kismet Crossdale, Hayden Fuller, and Jameson Giannattasio or Microsoft Powerpoint Stock Image, Icon, and Illustration Library.