Project #9702
BiPV

[**Benjamin Tan** - Team Lead]

[**George Lastowka** - Design Lead]

[**Alexander Wurst** - Fabrication Lead]

[**Hector Espinal** - Analysis Lead]

[**Joseph Soucy** - Evaluation Lead]

Design Concept & Second Semester Plan

November 11th, 2020

Project Goal and Scope

Sponsor Scope:

- Establish a design for Building integrated photovoltaics that:
  - is cost effective in production and installation
  - has potential for Implementation of Roll to roll manufacturing

Glenn Weinreb
Chief Technology Officer
www.Manhattan2.org

Project Goal and Scope

Team scope:

The document detailing the project goes into far more detail than just the mechanics of the project. Electrical work and programming are involved as well. What our team is responsible for is the mechanical aspect of the project that will allow for the solar panels to be transported and deployed with ease and efficiency. We are just one of the many teams working on achieving the ambitious goals of our sponsor.

Project Goal and Scope

Justification:

- Global warming is a looming threat to society
- The market has had an increasing interest in solar energy over the years
- Flexible photovoltaics implemented into R2R manufacturing can significantly reduce the production cost and increase accessibility of Solar energy.
- This manufacturing process requires thinner materials which will lower the overall weight and be more cost effective
- Direct to plywood offers an easy way to cover lots of area in solar material

Project Goal and Scope

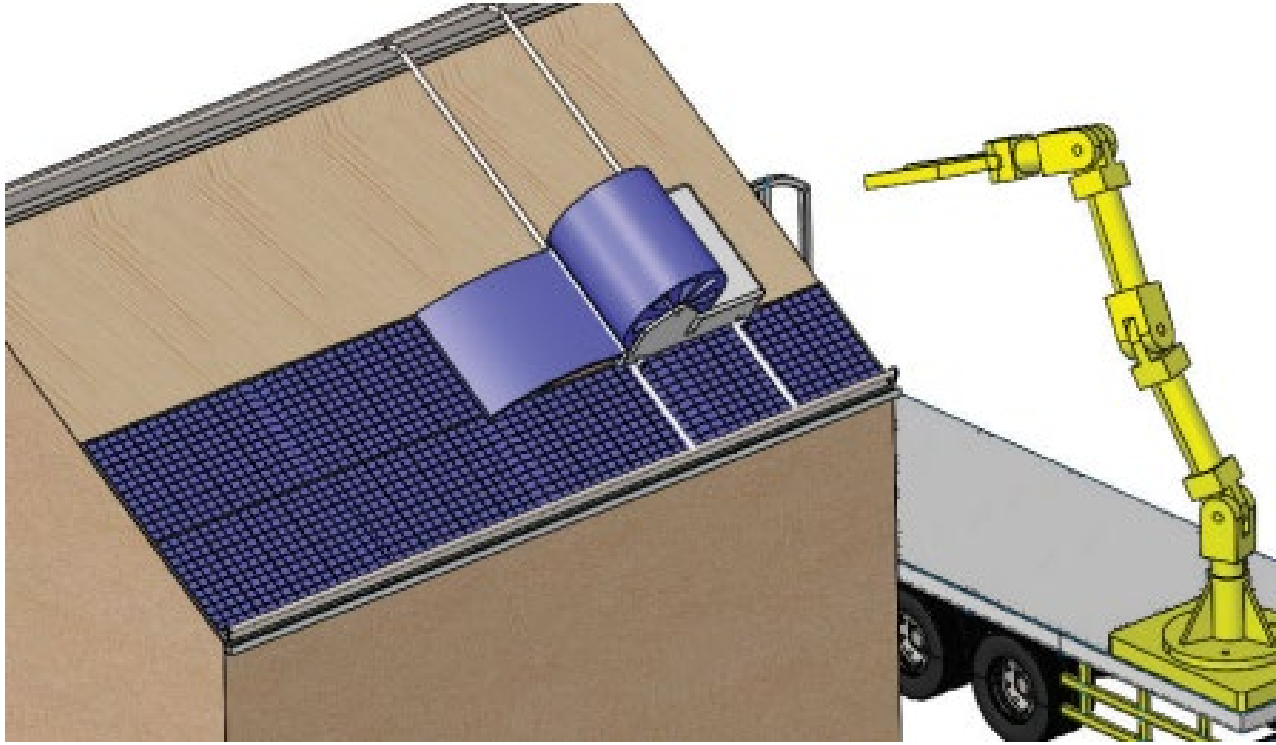
UMass BiPv Team Goals:

1. Material stack-up for rollable photovoltaics **must be capable of bending up to a one meter radius** to display roll to roll capability**.**
2. Design roof mounting system with photovoltaic material directly applied to plywood **acting as the water barrier.**
3. Design should be tailored to **maximize lifespan** while still being economic

The design requirements set by the sponsor will display the mechanical capabilities of the photovoltaic material. Additionally, the aluminum and glass used will not be susceptible to degradation from UV rays like other roofing material such as rubber and asphalt shingles.

Project Goal and Scope

Our project is a proof of concept for rollable photovoltaics and their potential to be implemented into roll-to-roll, (R2R), manufacturing and building integration as a lighter more cost effective alternative to rigid framed solar panels.



- **Prof. Cordula Schmid: Associate Professor at UMass Lowell**
  - Research in Photovoltaic (PV) Performance and Durability Analysis
  - PhD in Mechanical Engineering at Karlsruhe Institute of Technology

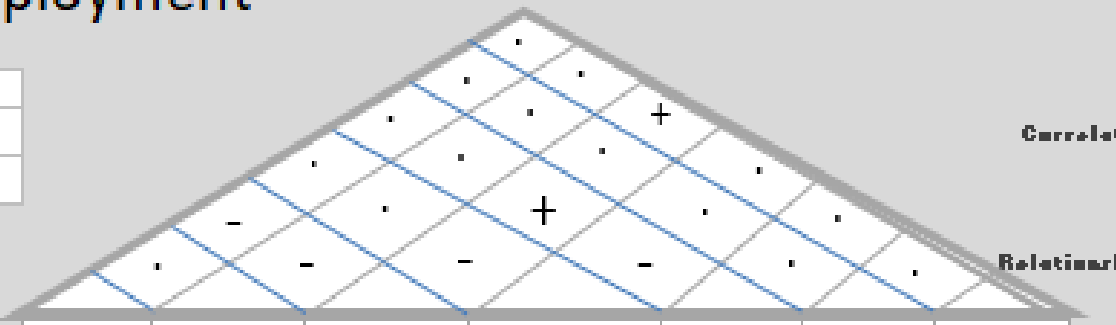
- **Glenn Weinreb:**
  - CTO of Manhattan 2 (manhattan2.org)
  - Founder/CEO of GW Instruments

- **Ashwin Ramasubramaniam**
  - Assisting in mechanical properties of materials
  - Advising on thin-film mechanics
  - Help with analysis to prevent delamination

- **Amir Arbabi**
  - Assisted in calculations for energy absorption through multiple layers

Quality Function Deployment

Project Title: Li Bi photovoltaics
Project Leader: Ben Tan
Date: 11/11/2020



Correlation:	+	.	-
	Positive	No correlation	Negative

Relationships:	9	3	1	0
	Strong	Moderate	Weak	None

		Desired direction of improvement (↑,0,↓)	↑	↑	↓	↑	↓	↑	↑					
	1: low, 5: high	**Functional Requirements (How) →**								Competitive evaluation (1: low, 5: high)				
	Customer importance rating	**Customer Requirements - (What) ↓**	Strain	Binding Agent Shear Strength	Thickness of Stack up	Transmittance	Refractive index	Sealant Life span	Max Bearing Load	Weighted Score	Satisfaction rating	Renogy	SunPower	TP-Solar
1	4	Weight	1	1	9	0	0	0	3	56	5	5	5	5
2	3	cost	0	1	1	0	0	3	0	15	5	4	4	5
3	5	flexibility	9	9	3	0	0	0	3	120	3	5	3	3
4	5	durability / life span	9	9	3	0	0	9	9	195	1	2	1	1
5	4	efficiency	0	0	0	9	9	0	0	72	4	4	4	4
6	4	Water Barrier	0	0	0	0	0	9	0	36	0	0	0	0
7										0				
8										0				
9										0				
		Technical importance score	94	97	69	36	36	90	72	494				
		Importance %	19%	20%	14%	7%	7%	18%	15%	67%				
		Priorities rank	**2**	**1**	**5**	**6**	**6**	**3**	**4**					
		Current performance												
		Target or limit	**>10^-5**	**<3.6 Mpa**	**2" +/- 0.25"**	**91.25%**	**~1.5**	20yrs +/- 5	~5400 psi					
		Benchmark												
		Difficulty	2	4	4	1	1	1	1	1: very easy, 5: very difficult				
		Cost and time	2	3	5	1	1	1	1	1: low, 5: high				
		Priority to improve	**1**	**3**	**2**	**5**	**5**	**5**	**5**					

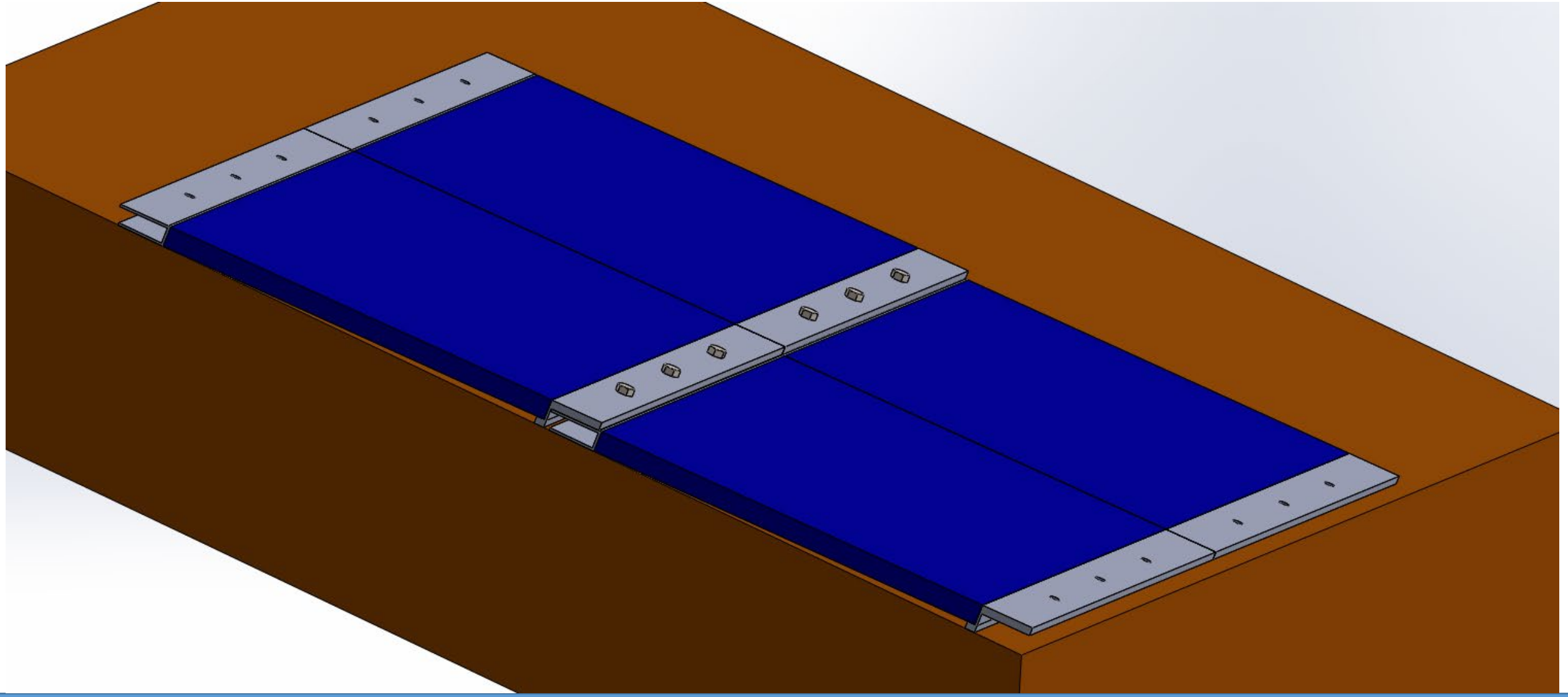
Preliminary Design Concepts

Results of the chosen design paths meeting or exceeding project specifications will be determined by the prototypes ability to meet the following criteria:

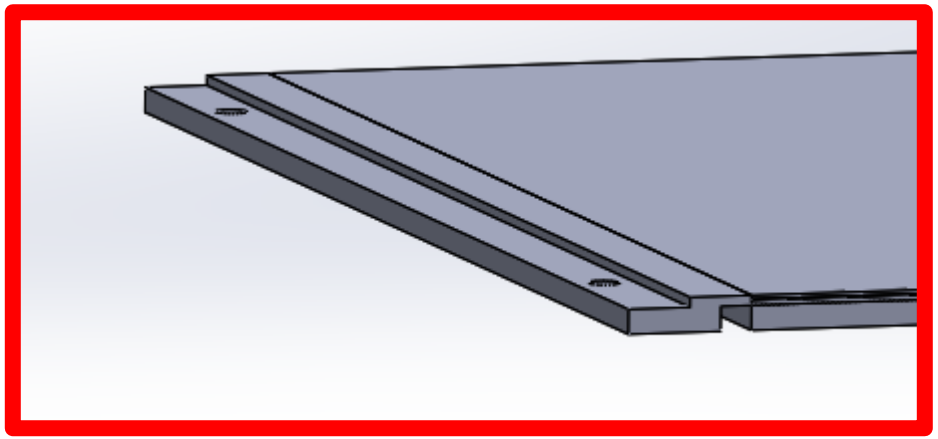
- 1 meter rolling radius
- Approximate efficiency of 20%
- Long lasting sealant providing strong water barrier
- Mounting system that properly secured PVs to plywood

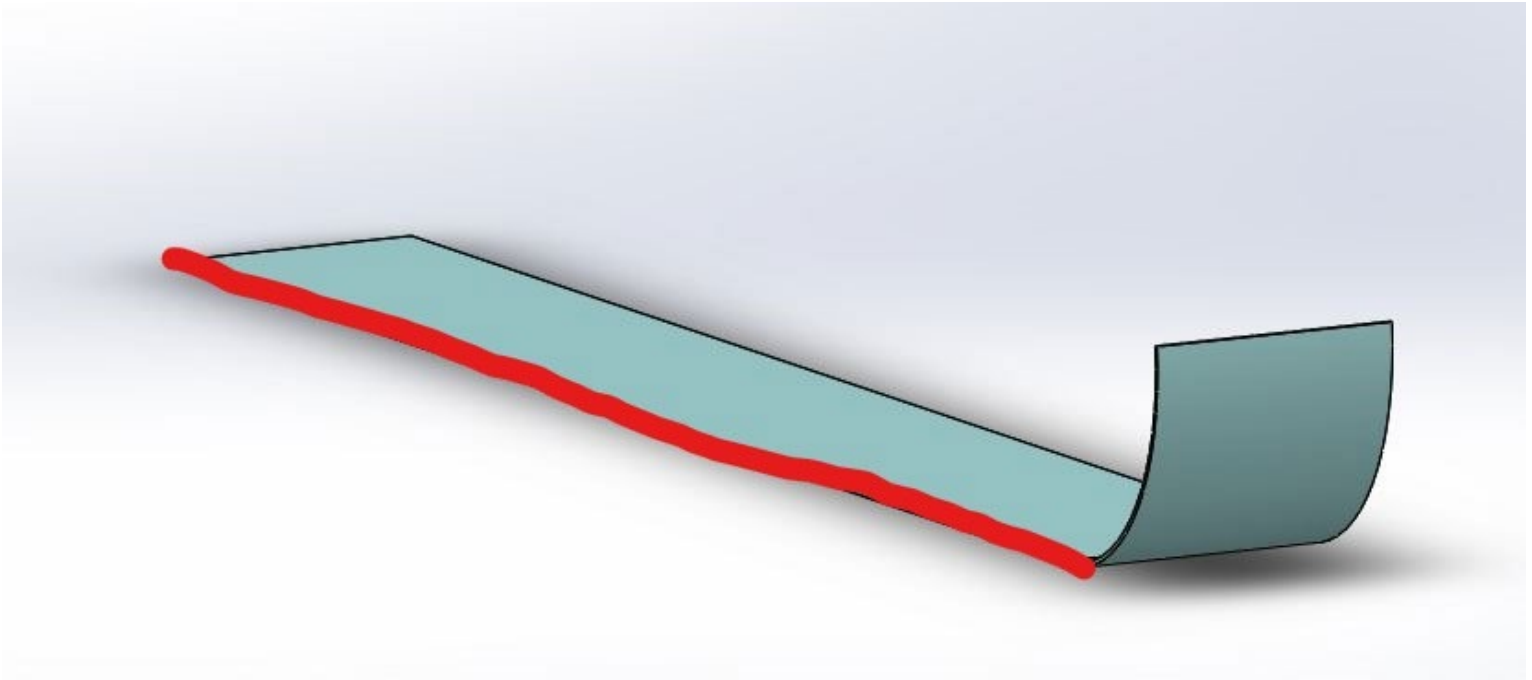

Key:
Yellow - ETFE
Green - EVA
Purple - Silicon
Red - Aluminum
Blue - Honeycomb

Preliminary Design Concepts



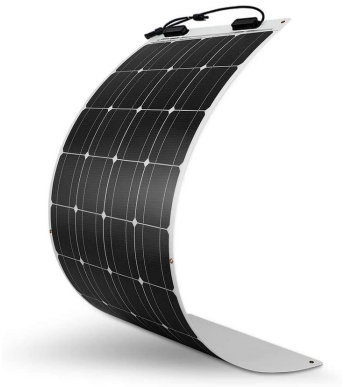
Preliminary Design Concepts

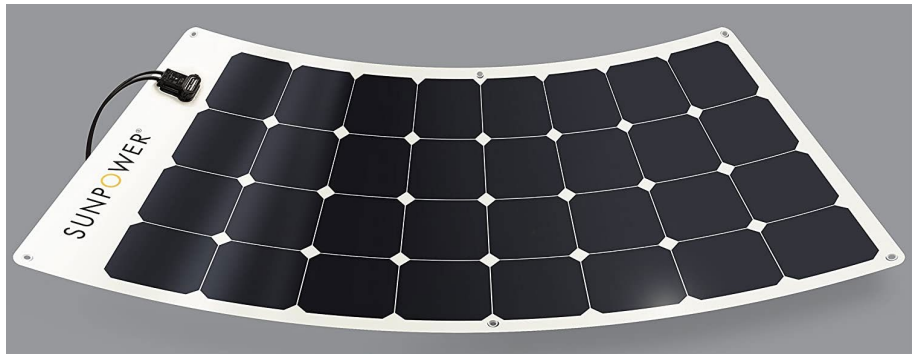




Competitors

- Existing flexible solar panels from companies such as Renogy and SunPower have consumer grade solar panels that are made for application to things such as boats or RVs.





- Our product will be a more permanent option that will compete with solar panels that are currently used on commercial and residential buildings for long periods of time.

Engineering Standards

The specific Engineering standards we are using:

- IEC standard 60529
  - IP code-degree of protection against intrusion from particles and water
- IEC 61215-1-1:2016
  - Testing for prolonged exposure of crystalline silicon PV modules
- Many standards are related to the electrical aspects of the PV material, which will not be applicable for our group

Second Semester Plan

- Iterate and finalize mounting designs
- Manufacture a physical prototype
- Test the effectiveness of the solar panel acting as water barrier for the plywood
- Analyze efficiency of prototype
- Analysis of resistance to impact force
- Analysis of effect on prototype due to radius of curvature
- Analyze the effect of thermal cycling on our design

End