Purdue Smart Manufacturing Team – Extrusion Machine

Team 15

Extrusion Team

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Purdue Mentors / Customers: Ralph Munguia, Professor McPherson, Professor Athinarayanan
Purdue Professors: Dr. Fred Berry & Dr. James Condron

PURDUE POLYTECHNIC

Customer Background

Since the Purdue Polytechnic Institute was founded in 1964, the professors have dedicated their lives to help students become a driving force in a rapidly transforming digital age. Dr. Grant Richards & Dr. Ragu Athinarayanan have developed a plan to help students dive into Industry 4.0 practices while developing a SMART manufacturing process to help with future education. By providing access to industry leading software and hardware, Purdue has developed a bridge between education and implementation.

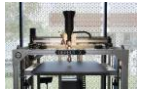
Problem Statement / Scope of Work

The Capstone Team 15 has been tasked with finding and purchasing a plastic extrusion machine that will take recycled plastic and melt it into a new skateboard deck. By developing this extrusion machine and mold, it will allow for skateboard decks to be made repeatedly while continuously removing plastic waste from the earth. Not only will this skateboard satisfy the client, but it will also provide a way for Purdue students to make their own skateboards.

Requirements Matrix

Rep. #	Requirement	Description	Test to Verify
1	Cost	The overall design and production of the extruder, mold, and material must be within the specified budget of $8000.	Tracking Budget and budget planning.
2	Structural Integrity of Part	Need to ensure that the board can hold a max load of 250 lbs. and last for 10 years.	FMEA analysis, Load analysis, impact testing, drop testing.
3	Automation- Extruder	The extrusion process ideally is to be fully automated.	Design and prototyping.
4	Automation- Mold	The ejection of the part from the mold is to be fully automated.	Design and prototyping.
5	Shredded Recycled Material Strength	The material used will be recycled material that has been shredded in the plastic shredder.	Conduct physical tests to confirm strength properties.
6	Shredded Recycled Material Size	The recycled material that has been shredded in the plastic shredder must be small enough to fit in the hopper and barrel of the extruder.	Conduct system tests to confirm functionality of specified size.
7	Documentation	Design files for the mold clamping, release, and ejection of the deck must have proper documentation which follows the GD&T standards.	Follow GD&T requirements and standards.
8	Extrusion and Mold Assembly	As a group it needs to be ensured that all of the CAD drawings and parts fit for assembly.	Analysis of CAD files for both the Mold and Extrusion Machine
9	Durability of Machine	The machine should be fit to run for several years without excessive replacement of parts.	Analysis of prototype test and machine parts.
10	Quality	This machine and mold should be designed to produce a high quality for a skateboard deck.	Visual analysis of the final product done by clients.
11	Replaceability	Machine should come with a user manual on how to replace parts as well as where to obtain them if need be.	Take apart aspects of the machine that are expected to be replaced in the future and try replacing them.

Experimentation / Concepts Exploration



Gigabot X

Strengths:
- Produce many skateboards per day.
- 3 Hours to produce.

Weaknesses:
- Cost / Availability

Extrusion Machine

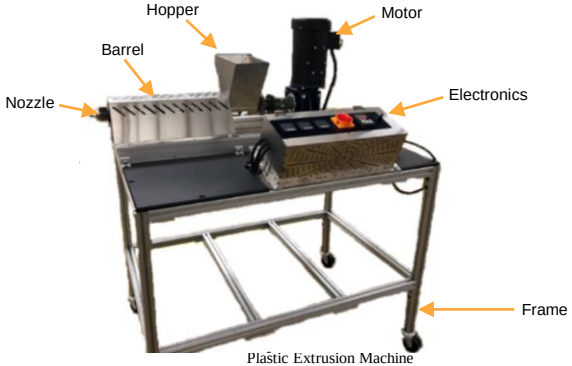
Strengths:
- Cost Efficient
- Can produce multiple skateboards/day.
- Uses recycled plastic.
- Reduces waste.

Plastic Casting

Strengths:
- Cheaper
- Easiest to replace parts.

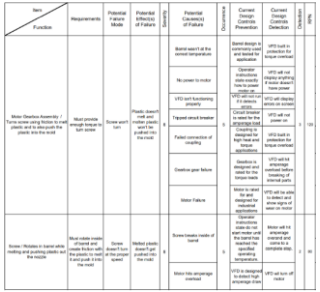
Weaknesses:
- Unsafe handling.
- Requires more manual labor.

Final Design



Plastic Extrusion Machine

Failure Mode and Effect Analysis



Testing

Extrusion Testing

Step	Test	Details	Outcome
1	Heat up Extrusion Machine	Plug it in, choose desired temp.	Machine heats up in about 15-20 mins.
2	Pour in plastic	Pour in desired amount of recycled plastic in the hopper.	Plastic sits in hopper.
3	Increase rpm of screw.	Increase rpm of screw to desired speed.	Screw starts turning, pushing plastic down the barrel.
4	Watch Feed Rates	Watch for abnormal conditions.	If abnormal conditions are present, stop machine.
5	Place bucket under nozzle	Hold bucket under nozzle until plastic starts to come out.	Plastic will come out of nozzle into bucket.

Mold Testing

Step	Test	Details	Outcome
1	Insert Model into Fusion 360.	Find desired model file.	Model is in fusion for testing.
2	Set desired parameters.	Temp, injection time, mold temp, injection location, etc.	Model is ready for study.
3	Review Results.	Review where warpage is, heat sinks, hard to fill areas.	Edit parameters.