CNC Pancake Printer

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Sponsor: UVU Smith College of Engineering

UVU MECHANICAL AND CIVIL ENGINEERING

Introduction & Objectives

- Scope: To create a functional pancake printing machine capable of printing custom shapes
- Project Vision: Design and build an automated system capable of creating pancakes in customizable shapes using a CNC-inspired motion platform
- Market Gap: Eliminate post-extrusion dripping, enable automated double sided cooking workflow

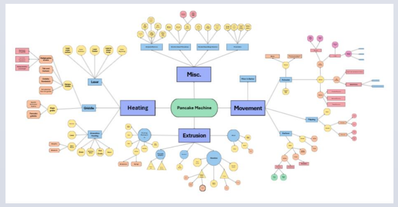
Design Requirements & Stakeholder Metrics

- Primary Stakeholders: CNC/3D Printing Enthusiasts, UVU Marketing, Northrop Manufacturing, Restaurant Chefs.
- Gather Customer needs
- Assign metrics to each need
- Assign an importance rating to each listed need
- Top Customer Needs: Reliability (4/5), Fun/Entertaining (5/5), Precision (4/5), Food Safety (5/5).

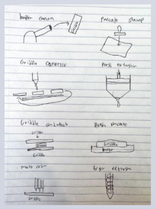
Metric #	Need #s	Metric	Imp. (1-5)	Units	Marginal Value	Ideal Value
1	3,4,5,7,18,	Time for one operator to setup machine	3	Minutes	<20	10
2	5	Displays error messsage if something goes wrong	4	Binary	TRUE	TRUE
3	5	Time to fix troubleshooting errors	3	Minutes	<10	2
4	6,9	Time to clean the components	2	Minutes	<15	10
5	8, 52	Steps to follow for the user interface	4	Steps	1 to 5	3
6	10	How much batter does our container hold	4	Ounces	10 to 30	20
7	12,13, 25	Time from when extrusion starts to when its on the plate	5	Minutes	3 to 8	5
8	17	Overall weight to the machine	1	Pounds	10 to 30	10
9	19	Power needed to operate device	5	Volts	120	120
10	24	Does it comply with FDA standards	5	Binary	TRUE	TRUE
11	26	Have a hot label on or near hot surfaces	5	Label/Hot surface	1 to 3	1
12	27	Satisfaction survery while in testing phase	4	Subj	1 to 5	5
13	31, 36	Clear SOP	4	Binary	TRUE	TRUE
14	35	How many pancakes it can print without print failure	3	Subj	40 to 60	60
15	39	Time to replace components	1	Minutes	30 to 60	30
16	40	Cost of overall project	2	Dollars	500 to 1500	1000
17	44	Accuracy of prints	3	Percent	50 to 100	70
18	45	How accurate is the heat of the griddle	2	Percent Error	1 to 5	1
19	49	How many templates are used	4	Subj	5 to 15	10
20	50,51	Process can be easily viewed	5	Subj	TRUE	TRUE
21	12	Maximum size for a pancake	2	cm	20 X 30 - 31 X 61	25 X 40

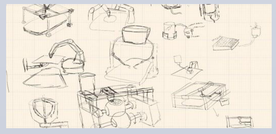
Concept Generation Methods 1&2

- Method: Individual subsystem brainstorming
- Team mind map categorization



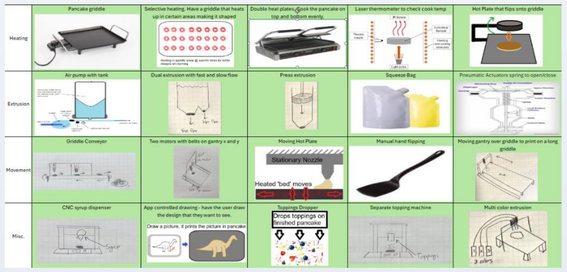
- Method: Sketch all thoughts and ideas to consider all possible configurations
- Individual idea sketches were presented to every member of the group and recorded in one file





Concept Generation Method 3

- Method: Create a morph chart to visualize ideas and combinations
- Categorize all ideas by subsystem

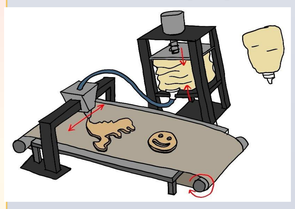
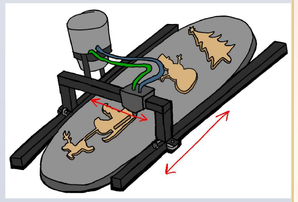


Concept Selection

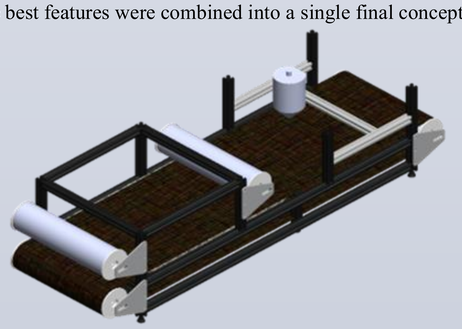
- Selected Configuration:
  - Heating: Traditional Pancake Griddle (Score: 4.04 / 5) - Best balance of food safety and ease of cleaning
  - Extrusion: Peristaltic Pump (Score: 3.83 / 5) - Superior flow consistency over squeeze bag methods
  - Motion: Griddle Conveyor System (Score: 3.92 / 5) - Enables continuous workflow and automation

Score 1-5 1 - Lowest | 5 - Highest		Whole Machine with X Y Gantry							
		Griddle / Air Pump / Conveyor		Griddle / Squeeze Bag / Conveyor		Griddle / Air Pump / Long Griddle		Griddle / Squeeze Bag / Long Griddle	
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Pancake Production Speed	20%	4	0.8	4	0.8	4	0.8	4	0.8
Entertaining	15%	5	0.75	5	0.75	4	0.6	4	0.6
Pancake Detail	13%	3	0.39	3	0.39	5	0.65	5	0.65
Ease of Manufacture	12%	3	0.36	3	0.36	5	0.6	4	0.48
Reliable	11%	2	0.22	2	0.22	4	0.44	4	0.44
To make Food Safe	9%	5	0.45	5	0.45	5	0.45	5	0.45
Ease of Use	8%	5	0.4	4	0.32	5	0.4	4	0.32
Easy to clean	5%	3	0.15	4	0.2	4	0.2	5	0.25
Budget	5%	2	0.1	3	0.15	4	0.2	4	0.2
Portability	2%	5	0.1	5	0.1	5	0.1	5	0.1
Total Score		3.72		3.74		4.44		4.29	
Rank		1		2		4		3	
Continue?		No		Yes		Yes		No	

- Two concepts selected based on score:
  - Concept 1: X gantry, Y conveyor belt, compressed batter container pumped to the extruder nozzle
  - Concept 2: X-Y gantry, long griddle, batter from the container pumped directly to the nozzle

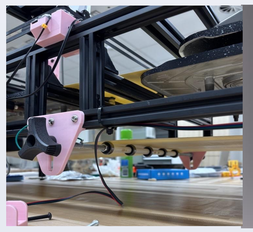
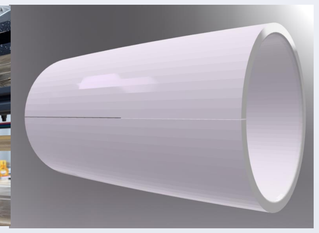



- Both concepts were explored and researched throroughly
- The best features were combined into a single final concept

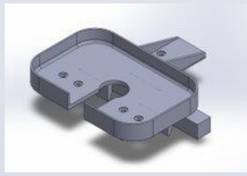


Prototyping & Testing

- Conveyor System:
  - Tracking Issue: Initial silicone belt tracking was unstable.
  - Solution: Implemented crowned rollers and slotted tensioning brackets with wingnuts for real-time belt alignment adjustment.
  - Fabrication: Custom-sewn silicone belt loop using high-temp nylon thread.

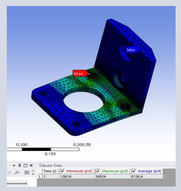
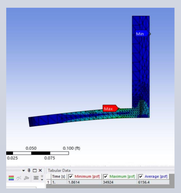
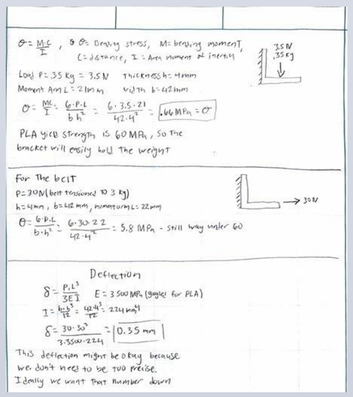



- Extrusion System:
  - Method Comparison: Air pump pressure caused post-extrusion dripping; Squeeze bag would cause inconsistent flow rates.
  - Optimization: Direct-drive peristaltic pump mounted on the gantry to eliminate air sealing requirements and improve start/stop precision.
  - Viscosity Control: Conducted flow cup testing to standardize batter mix for optimal print layer adhesion..



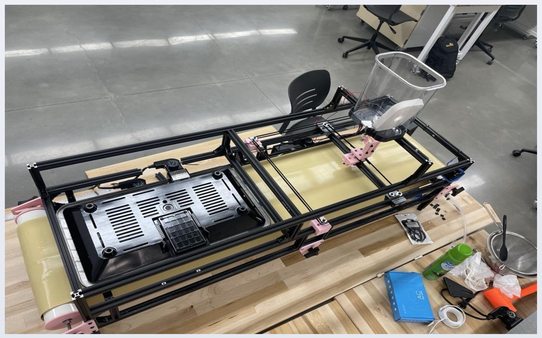


- Gantry & Structure:
  - Analysis: Hand calculations verified PLA 3D-printed motor brackets withstand operational loads
  - Refinement: Reinforced motor mounts to reduce vibration and improve long-term durability

Assembly

- System Architecture:
  - Motion: X-Y Gantry (Extrusion Head) + Y-Axis Silicone Conveyor Belt
  - Thermal: Dual-zone (Primary griddle plate + Overhead finishing element
  - Extrusion: Direct-drive peristaltic pump (gantry mounted)



Challenges & Lessons Learned

- Conveyor:
  - Belt tracking drift
  - Crowned rollers & slotted tensioning brackets (wingnut adjust)
- Fluid Dynamics:
  - Non-Newtonian clogging:
  - Flow cup viscometer standardization and batter ratio iteration
- Extrusion:
  - Post-extrusion dripping:
  - Direct drive pump (minimizing tube length/backpressure)
- Thermal:
  - Motor heat soak
  - Passive heat sinks on exposed stepper mounts
- Electrostatic:
  - Silicone belt static
  - Grounding rod contact below belt surface

Conclusion

- Results:
  - Fully automated CNC Pancake printing machine
  - Minimal extrusion dripping between prints
  - Increased batch size
  - Successful shape printing
- Future work:
  - Mobile UI for wireless operation
  - Increased shape complexity
  - Refine heating and temperature control
  - Optimize print speed

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