

# Banana Leaf Pad Assembly Process

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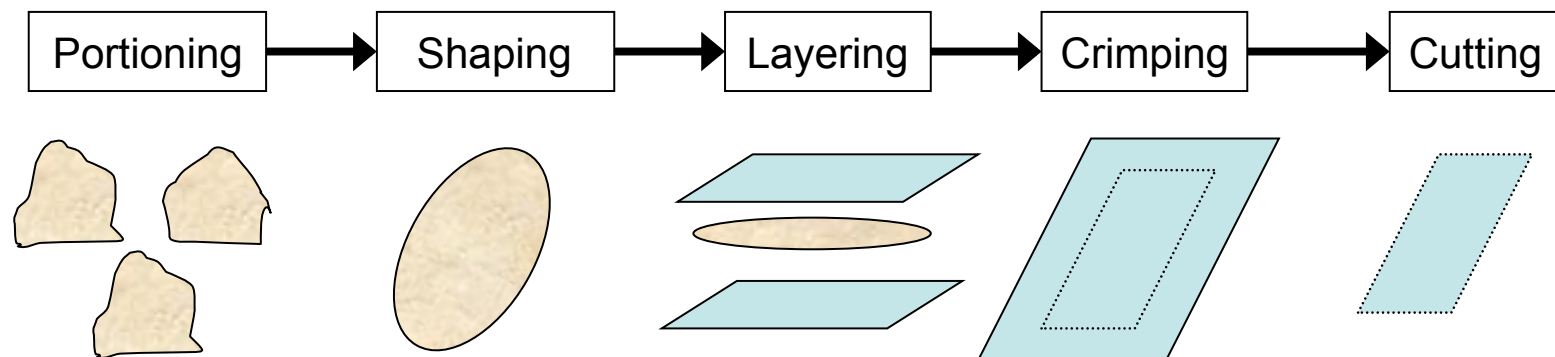


# Concept

- Women in Rwanda lack affordable feminine pads
- Low volume, low cost, low tech



- Designing production sub-processes:

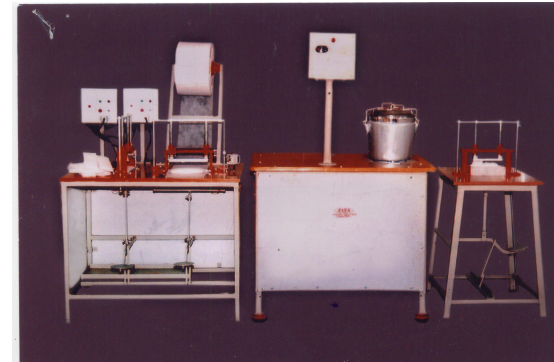


# Contract

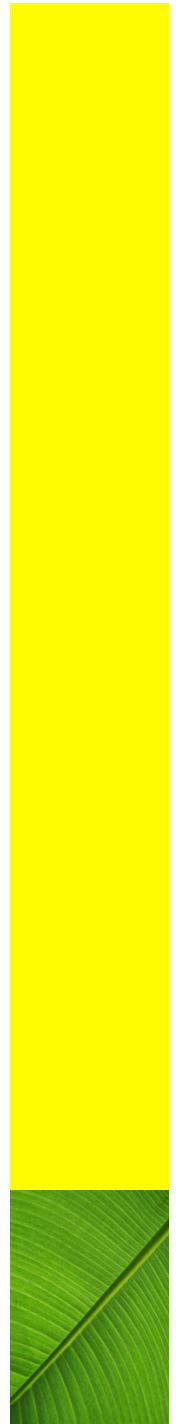
**Product Description:** Assembly machine for making banana leaf pads

**Intended Customers:** Women in Rwanda

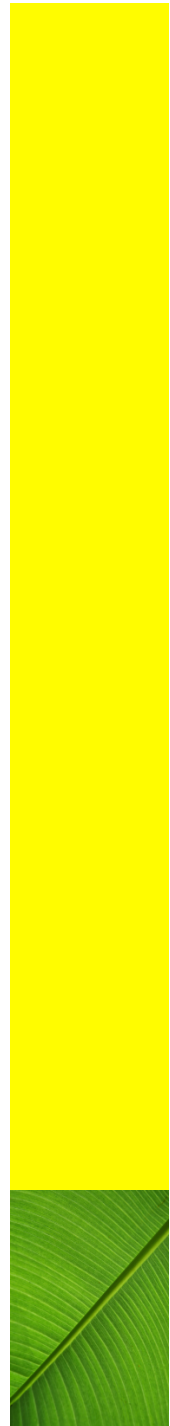
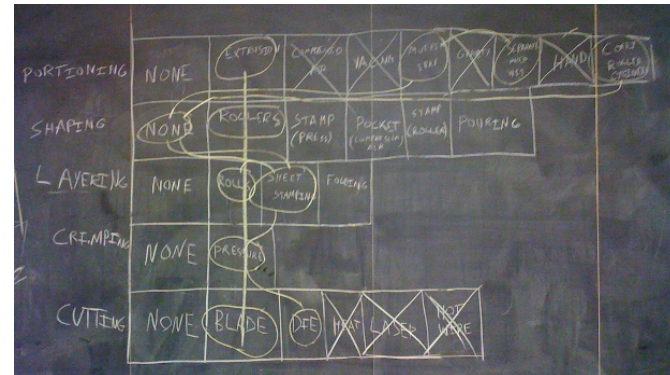
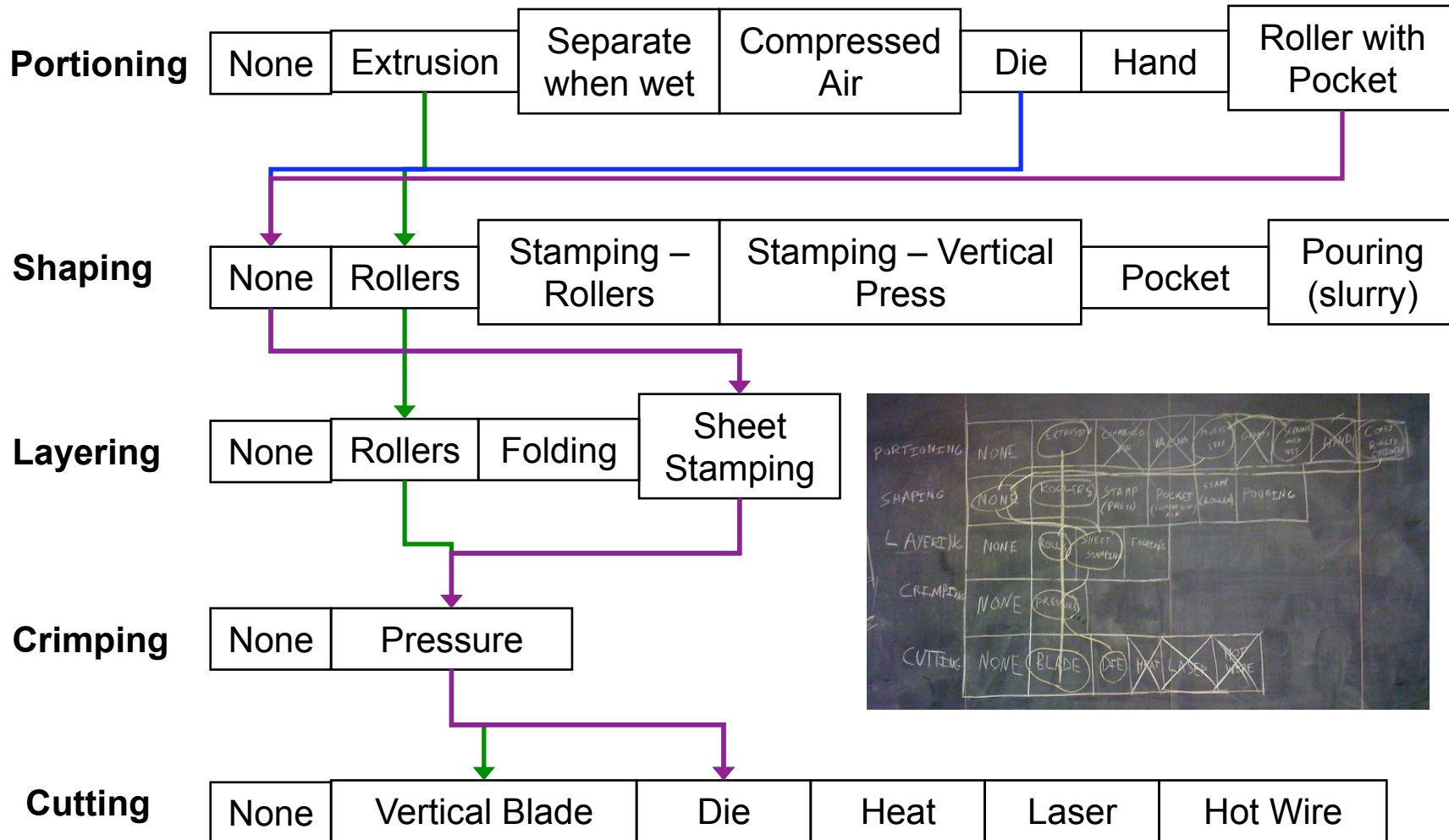
**Market:** Developing World



Customer Need	Product Attribute(s)	Engineering Specification(s)
Improve production rate	Rate	Minimum: > 5 pads per minute
Machinery can work within African infrastructure	Power	Less than 40W
Easy to repair/troubleshoot	Number of parts, robustness	Less than 50 parts, simple
Reduced labor cost	Automatic, ease	Less than 4 operators, steps must easy to do
Pads cost too much	Cost	Produce 10 pads for less than \$1.10

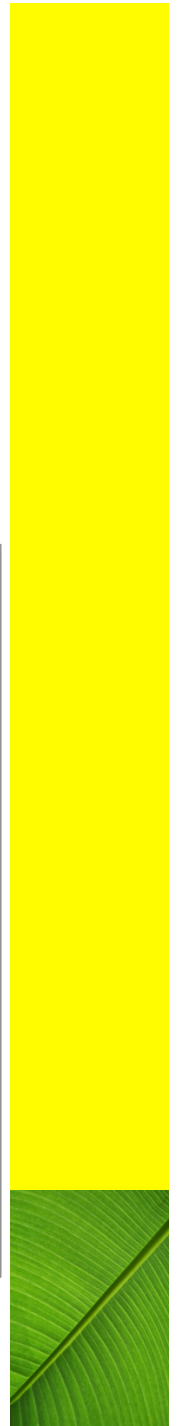
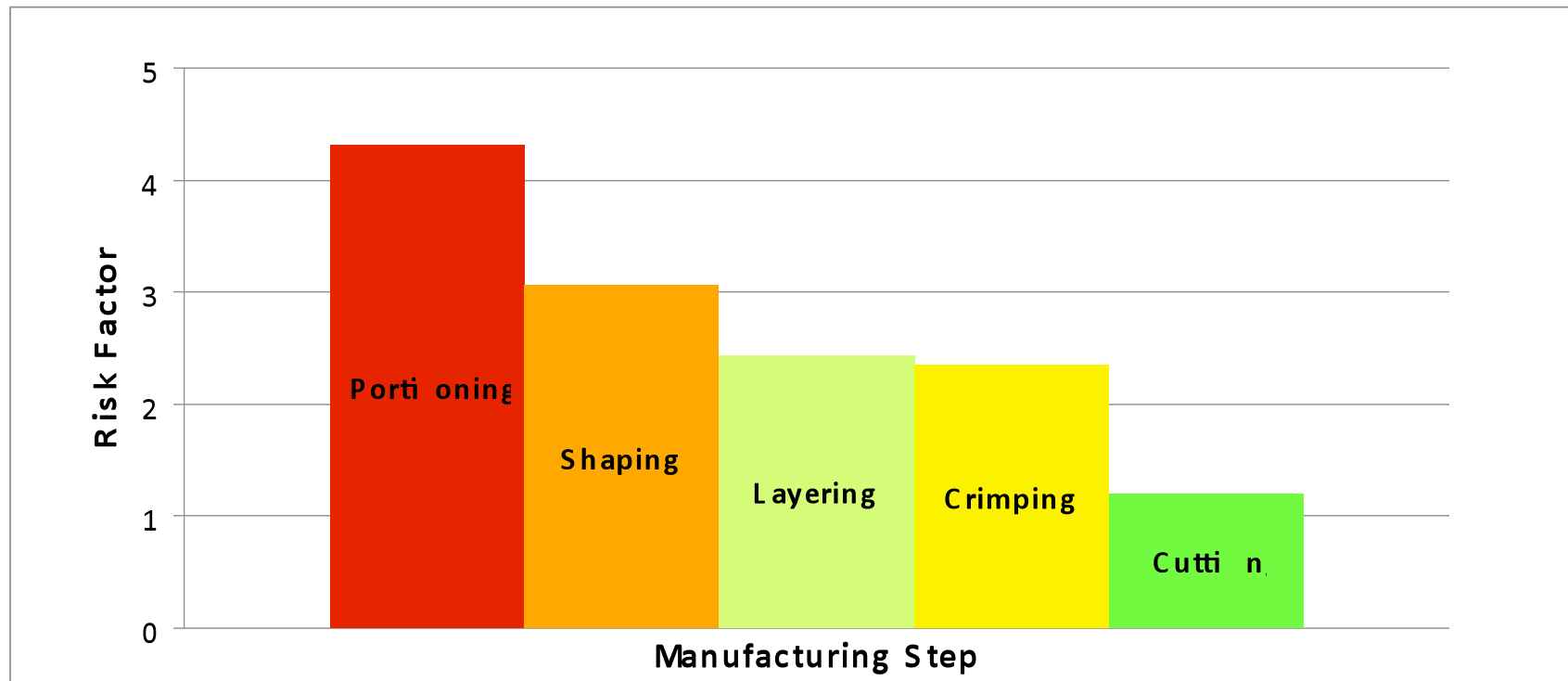


# Decision-Making Process

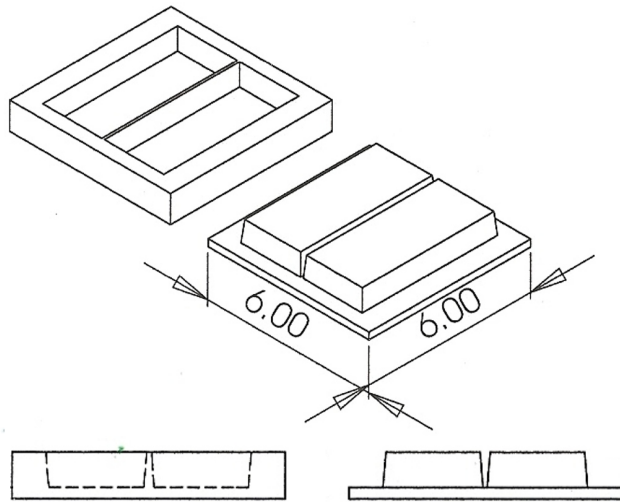


# Significant Risks: Portioning and Shaping

- Identified major risks through discussion and group vote



# Batch Solution: Pad Die

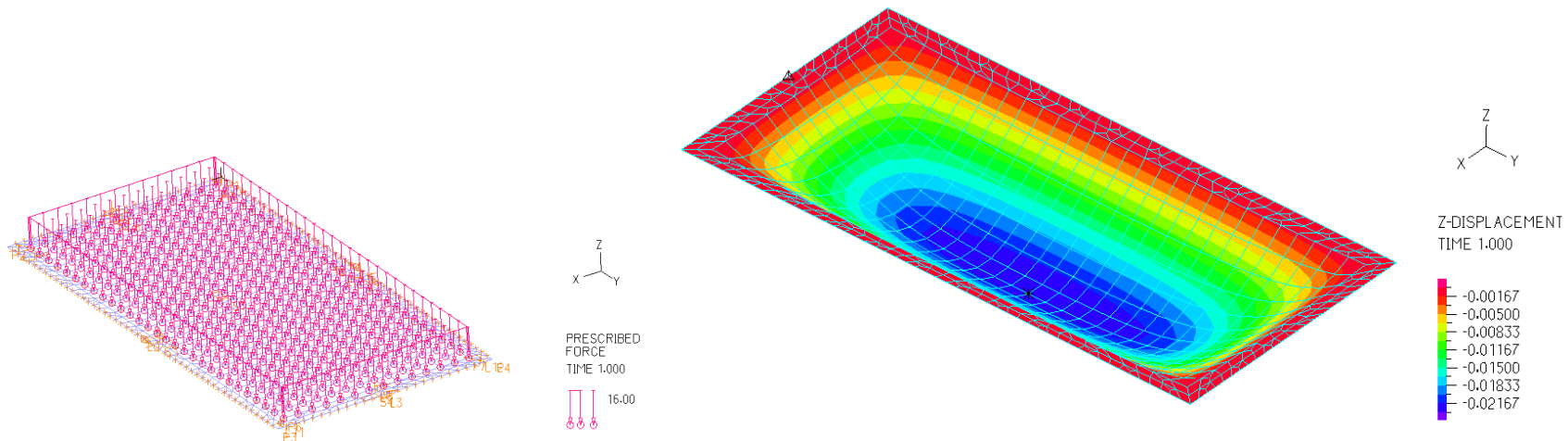


- Polyethylene and banana fiber layered on cavity
- Die core pushes and separates pads into pockets
- Polyethylene stretching approximation:

$$\frac{\sigma_y}{E} = \frac{\Delta L}{L_0}$$

yields inaccurate results

## Finite Element Approximation: Polyethylene Sheet



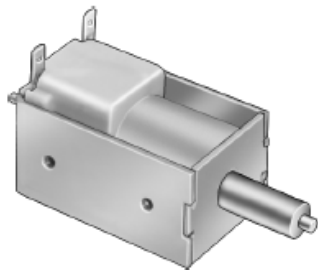
- Displacements similar to pocket depth
- Stress does not exceed material yield

# Continuous Solution: Extruder

## Portioning

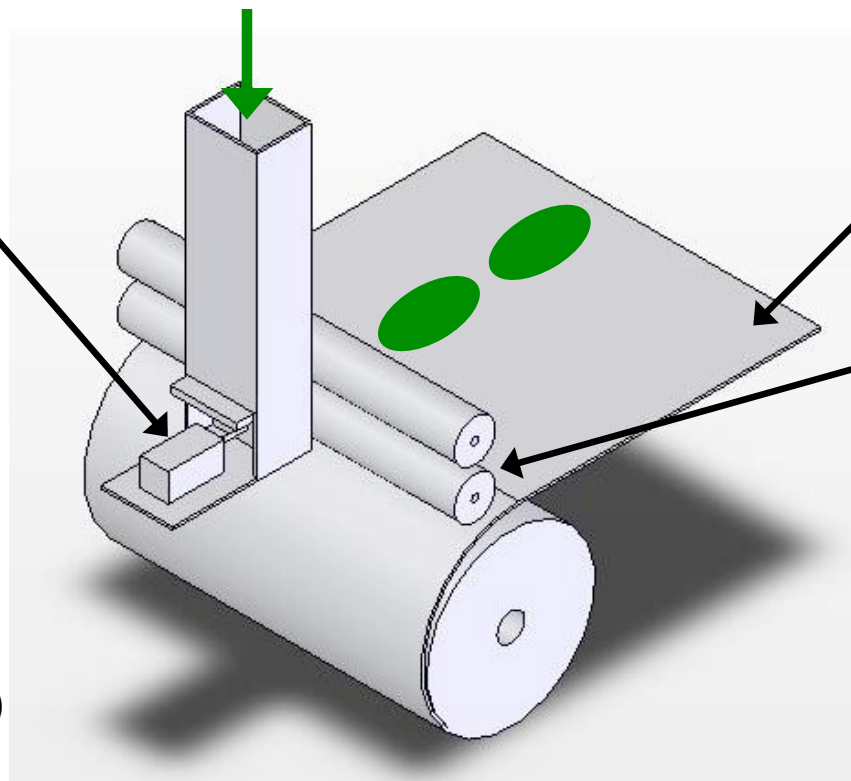
- Processed banana fiber inserted into chute
- Timing of linear actuator portions out pads onto polyethylene sheet

*Electric Solenoid  
Linear Actuator*



*Push Style*

- Limitation – short stroke length (~1")



*Polyethylene  
Sheet*

*Friction Rollers*

- sand paper provides friction

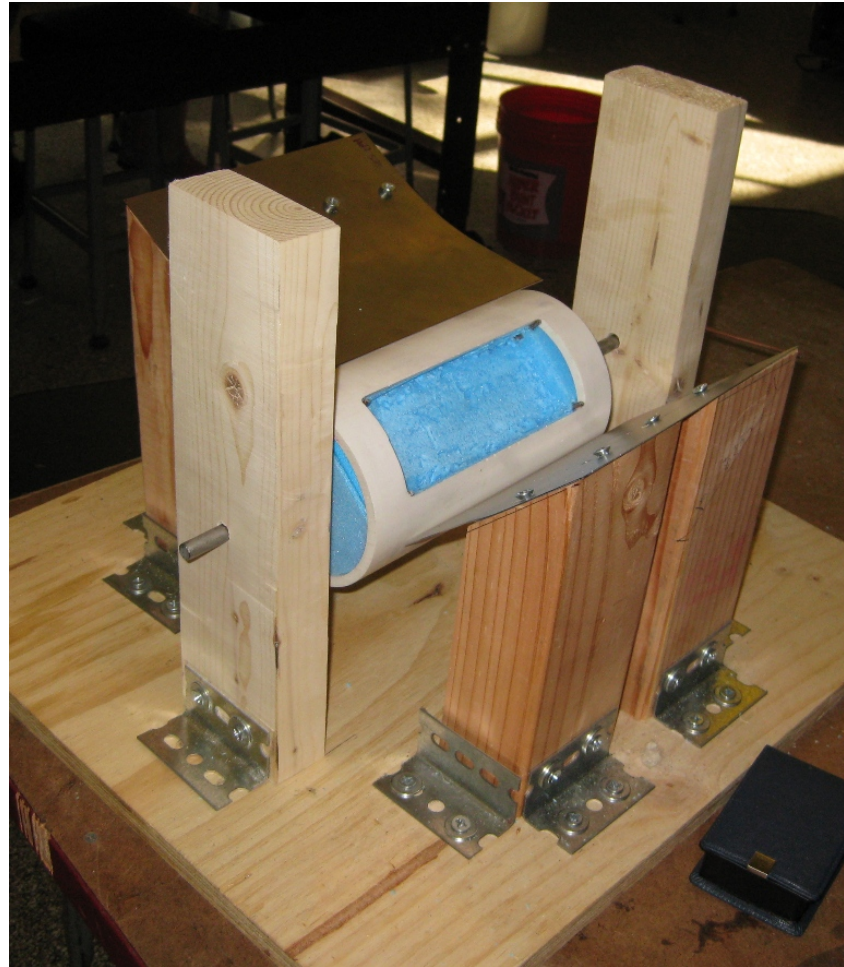
- total applied force:

$$F = 2m \cdot (\omega^2 R + \mu g)$$



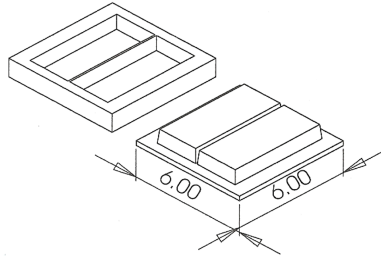
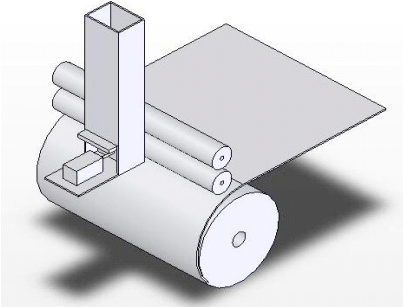
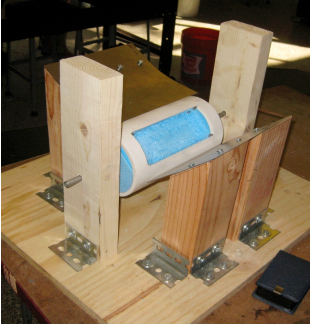
# Continuous Solution: Cylinder

- Roller cylinder with cavity that is filled with fiber
- Metal “scraper” to brush off excess
- Continuous process, hand crank operated
- Can be used as initial step





# Findings

	Die	Extrusion	Cylinder
			
Portion	0	0	+
Shaping	0	-	-
Estimated Rate	0	+	+

- **Conclusions:** individually each machine does not address portioning and shaping adequately
  - Best to combine concepts based on strengths

Questions?

