Anti-Theft Security Sticker Production Line Test Stand

Capstone Senior Design Project • Fall 2018

PURDUE UNIVERSITY Mechanical Engineering

The Pod Police

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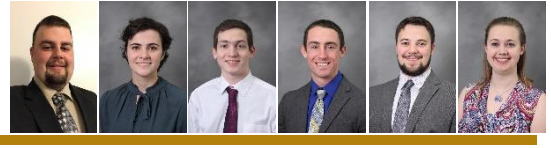


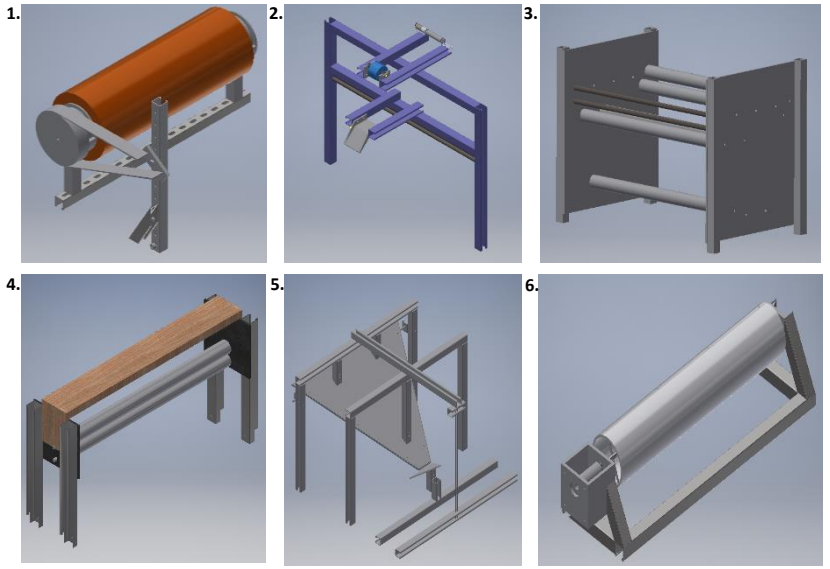
Problem Statement

- Theft of laundry pacs is a prevalent issue. Procter and Gamble plans to implement security stickers along its production lines.
- Successful implementation will provide an anticipated additional $18-$20 million in to the company annually.
- P&G's top priority is that the production line will not cause damage to security sticker tags, or to identify any areas that do.

Engineering Design

The most concerning areas of the production line were replicated using six independent modules mounted on a common 10' X 3' frame.

1. Supply Roller
   A horizontally mounted conveyor roller carries a roll of unformed film, controlled with a brake to provide tension.
2. Sticker Application
   Small motor and peel plate allows for uniform application of security stickers.
3. Idle Rollers
   Grid layout allows for repositioning of conveyor rollers to replicate geometries of line.
4. Crush Rollers
   Pliable rollers with contact pressure test stickers' resilience to crushing.
5. Forming Triangle
   Folds film into bag shape. Aluminum edges replicate surface geometry of production line.
6. Gather Roller
   Works in tandem with Supply Roller to draw film through modules at specified line speed and tension, in both vertical and horizontal configurations.

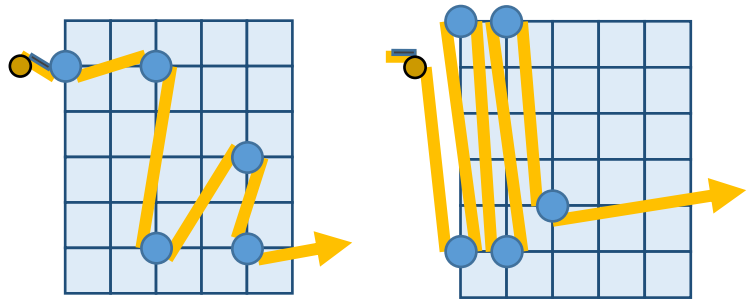


Validation and Results

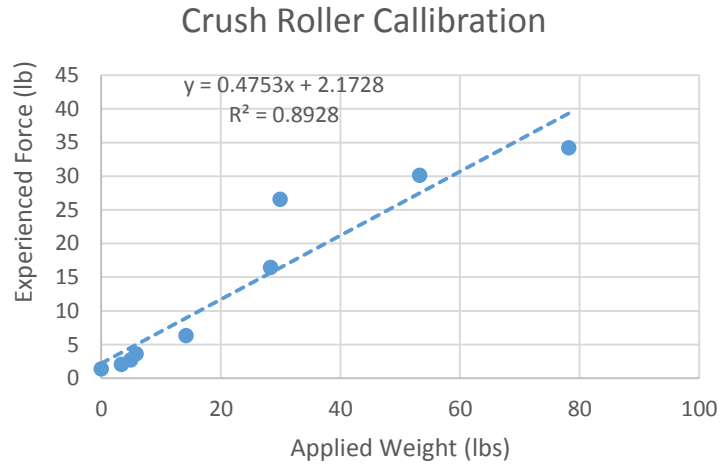
In order to accurately replicate the production line, key characteristics were identified:

Line Component	Value
Idle rollers	Roller diameter
	Contact angles
Pull rollers	Crush pressure
	Roller pliability
Forming triangle	Edge geometry
	Gusset triangle placement
Film dynamics	Tension
	Draw rate

Idle Roller Layouts to Replicate Line:



Calibration of Crush Force:



Fundamentals of Torque and Tension for Film Gathering

$$\sum \tau\Big|_{center} = I\dot{\omega}_r \qquad T = \frac{iV}{u}$$

i = current (A)
u = film speed (m/s)

$$\tau_r - TR = I\dot{\omega}_r$$
$$\tau_r = T(R_0 + R_f) + I\dot{\omega}_r$$
$$\tau_m = \frac{1}{N}T(R_0 + R_f) + I\dot{\omega}_r$$

$$V = DutyCycle * 12\ V$$
$$u = 2\pi r\omega$$