Optimizing the Goodwill Production Facility

Jacob Chan, Michael Chiu, Lexine Kagiyama, Austin Regier, Zante Wesley
University of Washington Industrial & Systems Engineering

Introduction

Problem Statement	Make recommendations resulting in greater efficiencies and ease of operations in Goodwill's flow of production. Goodwill looks to add a new store's production into Seattle facility in the future.
Goal	↑ Throughput ↑ Utilization ↑ Capacity : **Of Production**
Scope	Textile department due to high volume and high production value
Deliverables	Updated Delivery System, Textile Area Future State Simulations, New Station and Production Layout

Textiles

Textile Production Process

Currently, there are three separate textile production systems: University District (UD), South Lake Union (SLU), and Seattle, all in the same facility.

Receive Cage of Clothes → Inspect Item from Cage → Hang on Clothes Rack or Deem Salvage → Audit Clothes Rack → Tag Clothes Rack → Size Clothes Rack → Move for Transport

Safety Test (Machine Learning Methods)

Purpose	Will altering the textile manufacturing process affect other product's manufacturing lines (books, wares, etc.)?
Method	Machine Learning Methods: Linear Regression & Random Forest Higher MSE values represents textile production independency
Variables	Y Variable - Textiles X Variable - Other Products
Result	The team can focus on the textile production process without affecting other production lines because of the large MSE values

MSE Values from Safety Tests

	Linear Regression	Random Forest
Seattle	7595880	2325194
SLU	11374	8007
UD	554992	204129

*MSE - Mean Squared Error, lower is more dependent on other productions

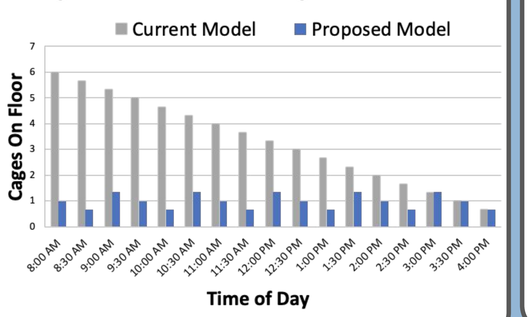
Manufacturing

Kanban, Buffer, and Delivery Schedule

Purpose	Improve cage flow to save space and ensure high production utilization
Method	Deliver a new cage 30 min before the Production Assistants(PA) finish sorting cages instead of storing cages on manufacturing floor all day
Result	Save 37 ft² per PA = $333* One cage = 7.42 ft² Current Model: holds 6 $\frac{cages}{sorter}$ Proposed Model: holds 1 $\frac{cages}{sorter}$ Smaller buffer results in: ↑ Visibility Quality Control

*Goodwill values space at $9 per sq. ft annually

Cages On Manufacturing Floor Per PA

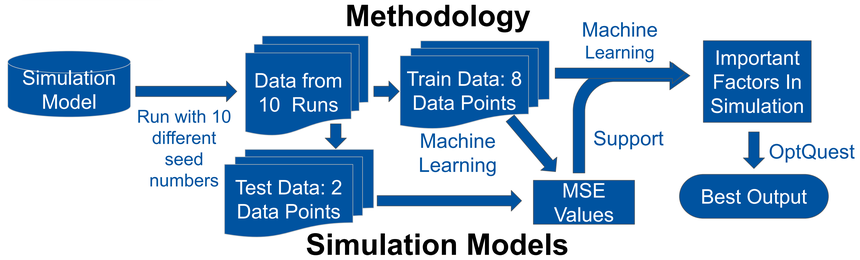


Operations Research and Statistics

Simulation Model, Machine Learning and OptQuest

Purpose	Determine the distribution of Production Assistants (PAs) and workstations which produces the highest textile production throughput

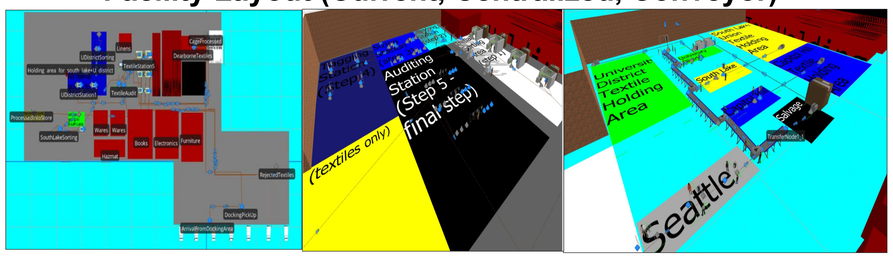
Methodology



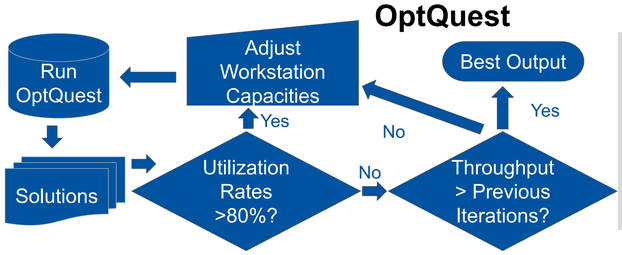
Simulation Models

The team created seven different simulation models to represent future states in the Goodwill facility. The following are most relevant.	Does Not Include New Store	Includes New Store
Centralize Stores Into One Production System - No Conveyor	Model 2	Model 3
Production System Separated by Store Production Areas of Stores Determined by Conveyor Belt	Model 4	Model 5

Facility Layout (Current, Centralized, Conveyor)



OptQuest



OptQuest:
Simulation Add-In
- Allows multiple simulations to run at once
- Alters distribution of Production Assistants at workstations
- 12,000+ runs conducted

Analysis For Machine Learning

Purpose	Determine high impact variables for the results

Linear Regression
- Eliminates low-impact factors and analyzes the % change
- High % change confirms high-impact factors

Random Forest
- Non-linear model analyzes important factor patterns
- Small MSE values confirm high-impact patterns affecting output

Model #	Linear Regression (% Change)	Random Forest (MSE Values)
2	-28%	305
3	-41%	2444
4	-99%	1048
5	-81%	1396

Cost Analysis for OptQuest Outputs

- Average Retail Price changes depending on product and store combination
- Profit assumes all textiles are sold

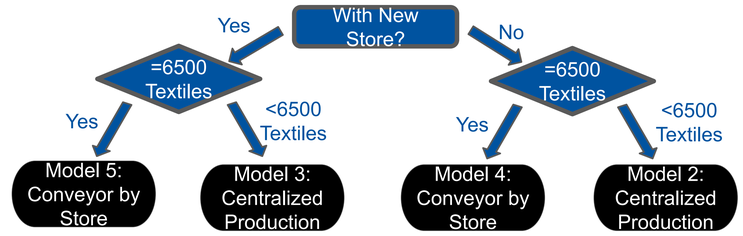
Model #	Throughput	Avg Retail Price	Avg PA Comp/Day	#PAs/Day	Gross Profit
2	6337	$6.84	$163	24	$39,433
3	6337	$8.71	$163	24	$41,714
4	6539	$6.84	$163	19	$41,630
5	6501	$8.71	$163	20	$43,547

Operations Research and Statistics

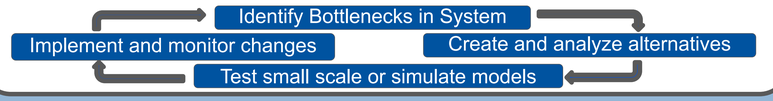
Results

	Important Factors from Machine Learning	Models with Greatest Throughput	% Increase in Throughput per Worker
Non-Conveyor Models	Cage Flow Time, Cage Waiting Time and Cage Number in System	Model 2 Model 3	1.14% 5.91%
Conveyor Models	Waiting Time & Textile Number on conveyor before first workstation	Model 4 Model 5	32.61% 30.37%

The best model depends on desired results. Optimal Production Assistant utilization is dependent on number of produced textiles. The following decision tree helps Goodwill decide which option to pursue when there are less than 24 Production Assistants.



Continuous Improvement

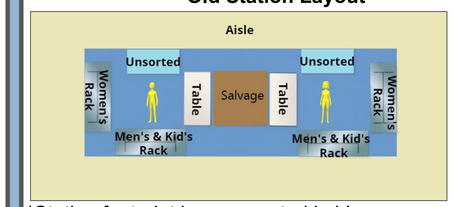


Human Factors

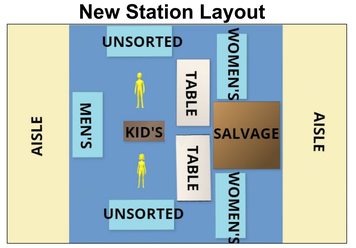
Station Layout

Purpose	Improve space utilization while creating an ergonomic station
Method	The most utilized containers are placed in front of the Production Assistants with the less utilized containers placed on their sides

Old Station Layout



New Station Layout



*Station footprint is represented in blue
Aisles are colored in yellow

Results

Old Station Layout		New Station Layout	
Footprint + Aisles	Footprint	Footprint + Aisles	Footprint
435 ft²	185 ft²	262 ft²	162 ft²
Estimated Annual Cost Savings:		$1557	$207

*Goodwill values space at $9 per sq. ft

Acknowledgements

The team would like to thank our Capstone mentor, Dr. Patty Buchanan as she guided us through this project. The team is thankful for the project sponsor, Brent Frerichs, for his guidance, support, and welcoming persona. The team would also like to thank Goodwill and all of its employees who interacted with the team and welcomed us to their facilities.