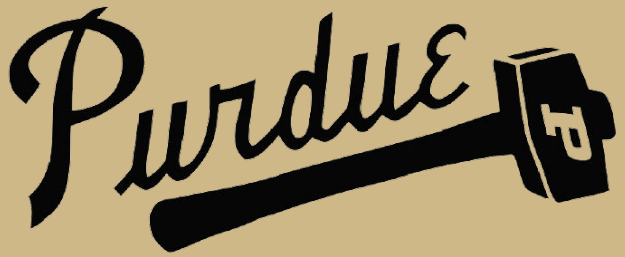
PURDUE PETE'S HAMMER FACTORY



IE 484 - Team 6

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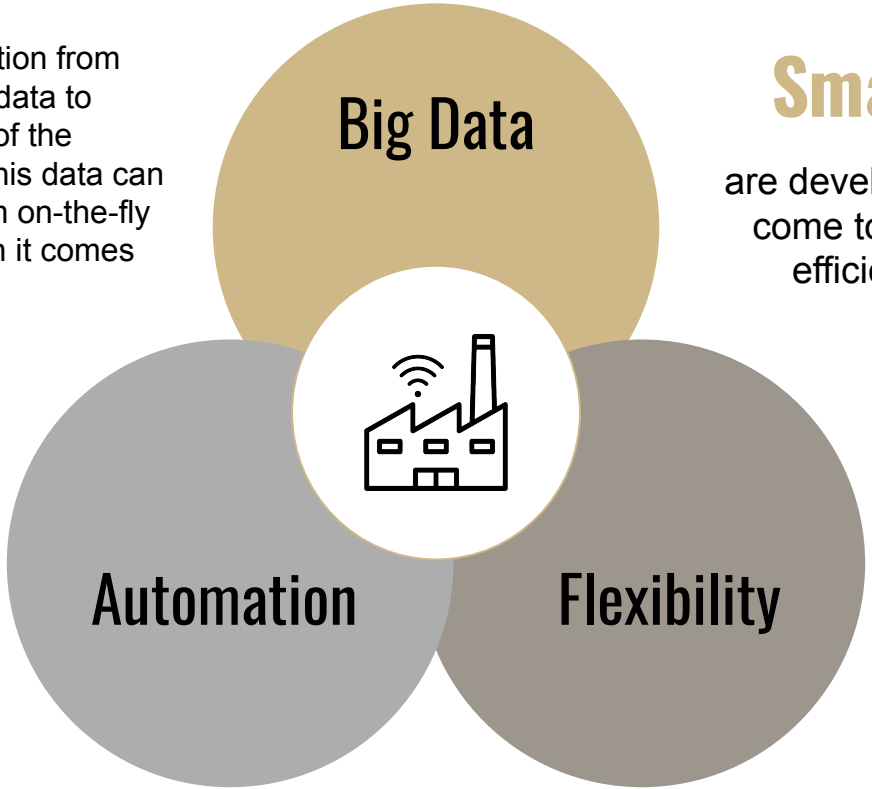
Introduction

What is a Smart Factory?

Big Data uses information from sensors and location data to understand the state of the system at all times. This data can be used to help inform on-the-fly decision making when it comes to product flow.



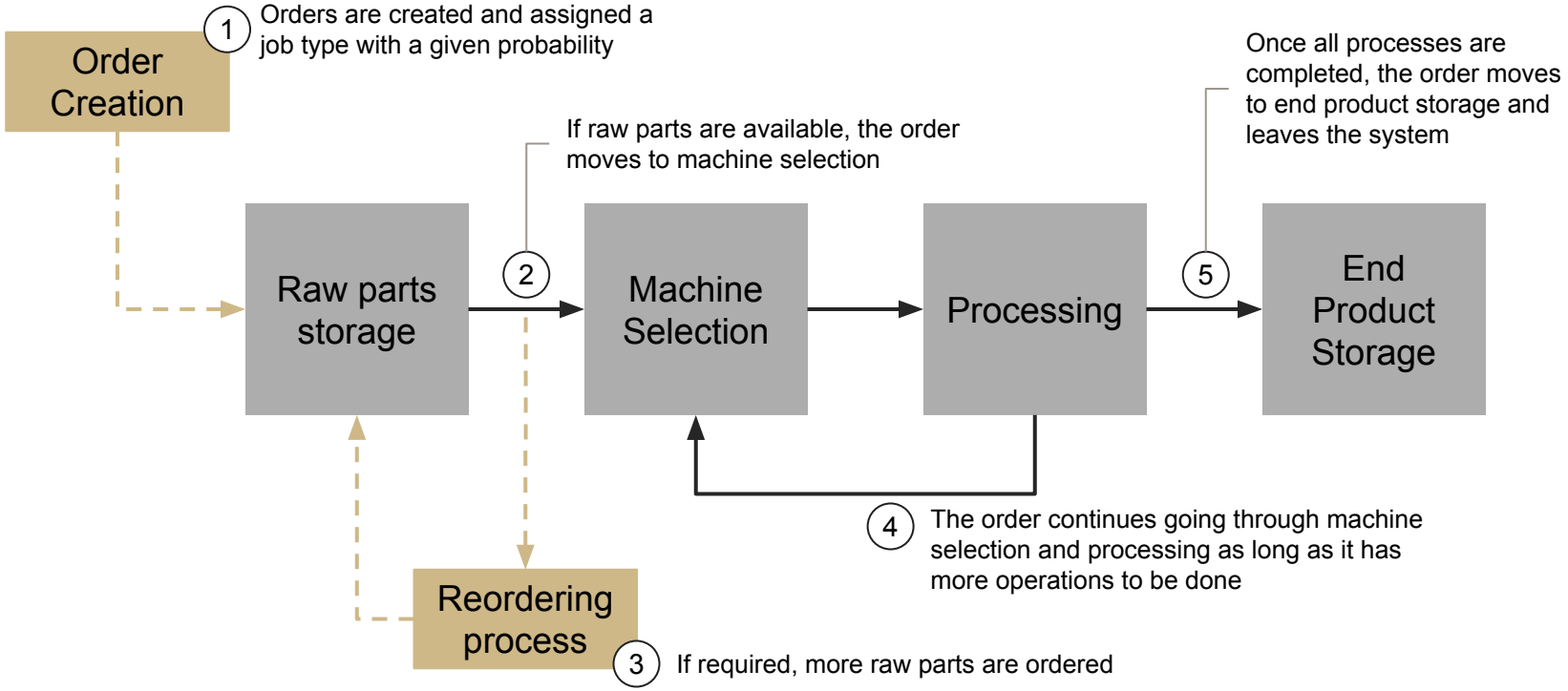
Smart Factories

are developed when these aspects come together to create a more efficient production system

Automation allows the system to make decisions about product flow on its own, thus taking out the human-based "guesswork." Automated systems utilize big data to determine optimal paths.

Flexibility means the system can easily adapt to changes and will therefore be more easily able to process orders efficiently

Factory model overview

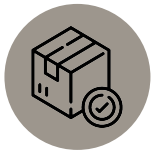


Objective function

minimize total cost represented by:

(2 * avg customer waiting time) + avg parts in system

by modifying



Inventory Control

Machine Layout

Job Selection

Machine Selection

Baseline Performance

Understanding the model - job types

The probability of each job's occurrence combined with the its operation sequence is used to determine average flow between departments

Job type	Probability of occurrence	Operation sequence
1	10%	1-2-3-0-0
2	20%	3-1-4-2-5
3	5%	2-5-4-1-0
4	10%	4-3-1-2-5
5	20%	1-3-5-0-0

Job type	Probability of occurrence	Operation sequence
6	5%	3-2-1-5-0
7	10%	5-1-2-4-3
8	15%	4-2-1-0-0
9	5%	1-3-5-0-0
10	0%	3-1-5-2-4

Understanding the model - product flow

To department

From department

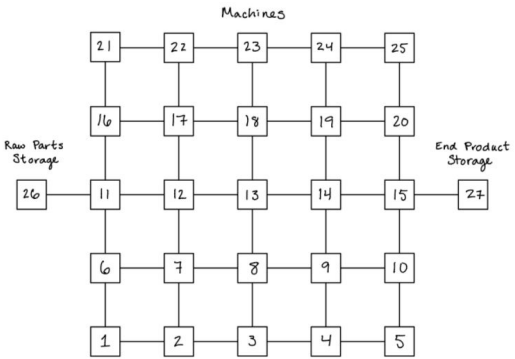
From-to chart	1	2	3	4	5	Total to	End product
1		0.3	**0.35**	0.2	0.05	**0.9**	0.2
2	0.2		0.1	0.1	**0.35**	0.75	0
3	0.3	0.05		0	0.25	0.6	0.2
4	0.05	**0.35**	0.2		0	0.6	0
5	0.1	0	0	0.05		0.15	**0.6**
Total from	0.65	**0.7**	0.65	0.35	0.65		
Raw parts	**0.35**	0.05	0.25	0.25	0.1		

Bolded values indicate critical flows

Total flow between departments

Flow	f_ij
f_12	**0.50**
f_13	**0.65**
f_14	0.25
f_15	0.15
f_23	0.15
f_24	0.45
f_25	0.35
f_34	0.20
f_35	0.25
f_45	0.05

Initial Factory Settings

Inventory Control	Machine Layout	Job Selection	Machine Selection
Reorder pt: 100 Reorder qty: 200		First-in-First-out (FIFO)	Shortest queue (NINQ)

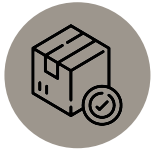
Baseline Performance

Model	Avg time in system*	Avg parts in system	Total cost
Baseline	**259.8**	**143.0**	**662.6**

* measured in minutes

Model Improvement

Improvement overview



Inventory Control

Change ***reorder_point*** and ***reorder_qty*** variables to identify the optimal value for each

Machine Layout

Rearrange machines, (usually with the operation as the department) by modifying the ***map*** variable

Job Selection

Select the order in which machines process jobs by modifying the queuing rules in the ***Rankings*** element

Machine Selection

Determine which machine will process a job by modifying the ***FindJ*** block formula

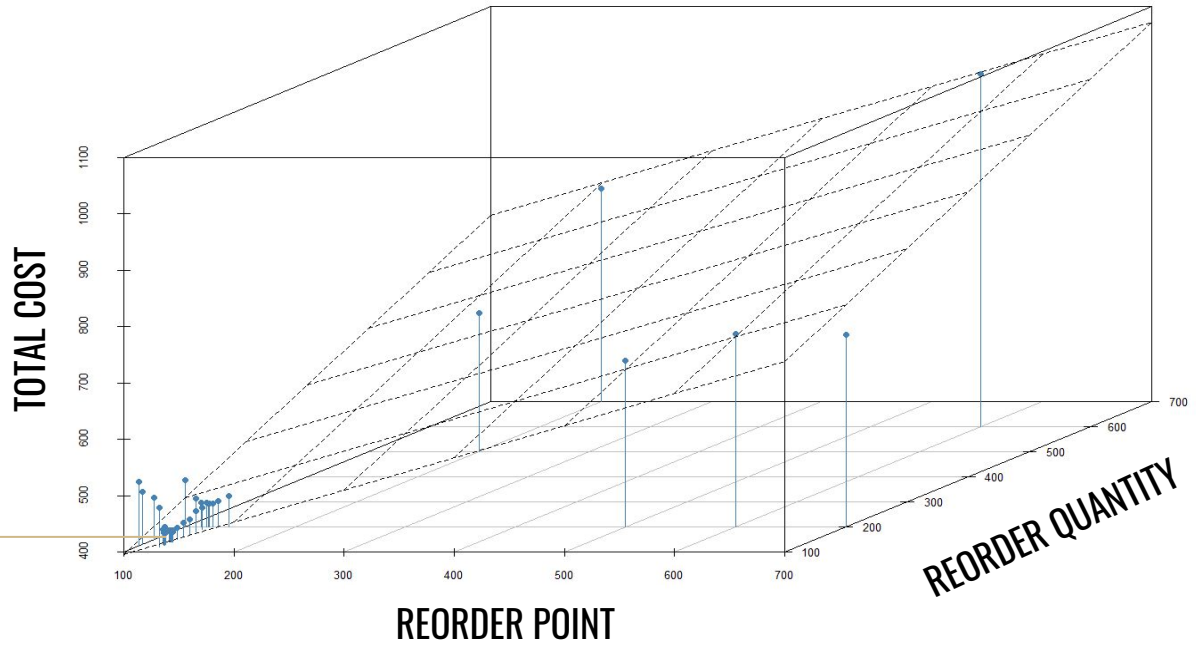
Inventory Control

The process analyzer was used to vary the reorder point and reorder quantity to find the optimal value for each

FINAL OPTIMAL VALUES

Reorder point
121

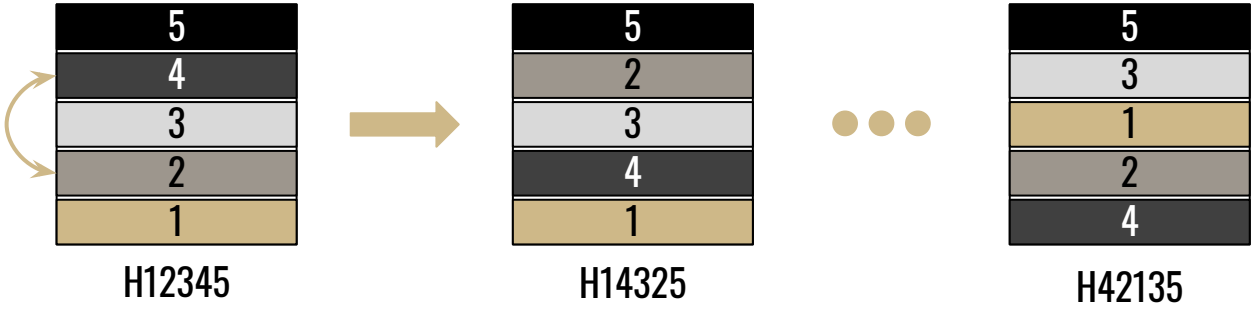
Reorder quantity
141



Machine Layout - PEM

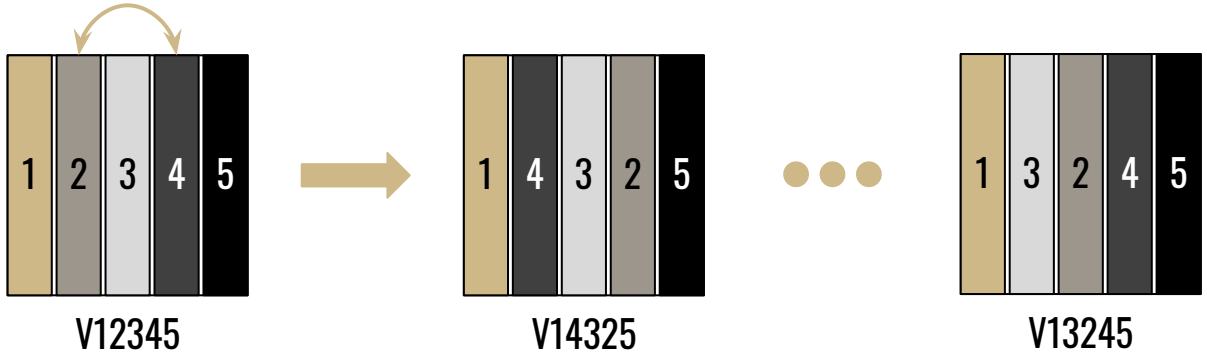
Horizontal PEM

Starting with layout H12345 exchange rows until a local minimum total cost is reached



Vertical PEM

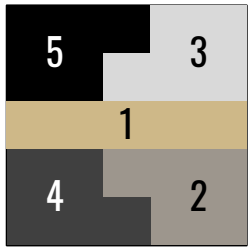
Starting with layout V12345 exchange columns until a local minimum total cost is reached



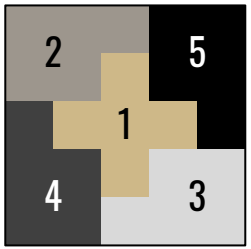
Machine Layout - Creative Layouts

Layouts A, B, C, D, J, and T all utilize the operation as the department

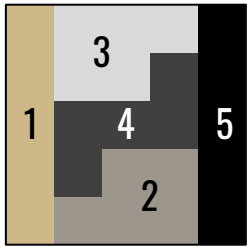
A



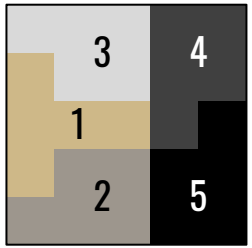
B



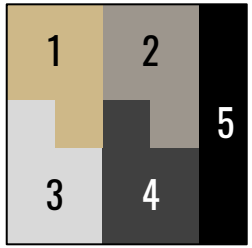
C



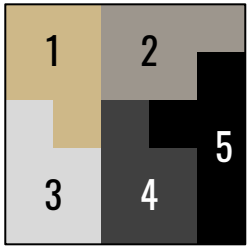
D



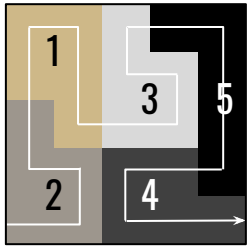
J



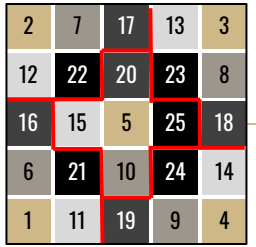
T



H



I



Layout I uses the machine as the department and places one in each section (divided by red borders)

Layout T produced the lowest total cost of the creative layout

Layout H is modeled using a space-filling curve

Machine Layout - Overall comparison

Model	Avg time in system	Avg parts in system	Total cost
Baseline	259.8	143.0	662.6
H42135	252.9	141.4	647.3
V13245	253.9	141.6	649.5
Creative - T	251.4	140.9	643.7

Machine Selection

Model	Avg time in system	Avg parts in system	Total cost
NINQ	259.8	143	662.6
LINQ	244.1	139.1	627.3
LINQ + STT	221.1	133.5	575.7
PTIME + STT + MST	213.4	136.5	563.3

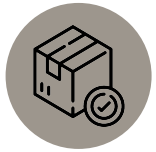
Job Selection

Model	Avg time in system	Avg parts in system	Total cost
Baseline (FIFO, LIFO, AT)	259.8	143	662.6
SPT	247.6	140	635.1
MSetT	243.2	138.8	625.2
SPT + MSetT	233.7	136.4	603.9
MRO	261.6	143.2	666.4
LRO	262.4	144.5	669.2
LRPT	257.5	141.8	656.9
SRPT	248.7	140.9	638.3

Developing the final model

STEP 1 Set map variable to layout with lowest total cost

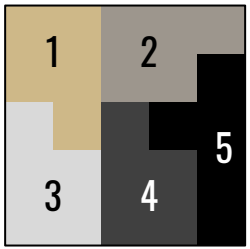
STEP 2 Find best combination of job selection and machine selection rules since they are dependent on each other



STEP 3 Run trials in the process analyzer to optimize reorder point and reorder quantity

Final Model

Final Model Settings

Inventory Control	Machine Layout	Job Selection	Machine Selection
Reorder pt: 121 Reorder qty: 141	T  	First-in-First-out (FIFO)	min(PTIME + STT + MST)

Final Model Performance

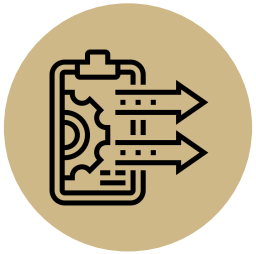
Model	Avg time in system*	Avg parts in system	Total cost
Baseline	**259.8**	**143.0**	**662.6**
Final Model	**153.8**	**110.8**	**418.5**
	-41%	-23%	-37%

Limitations & Discussion

Limitations

Changes were linked

- Some machine selection rules were based on the queuing model used



No demand in model

- Could not use inventory control equations
- Job selection based on due date was irrelevant

Time constraints

- Unable to test all possible layouts
- Limited testing of change combinations