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A Lean Analysis Methodology Using Simulation

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abstract

This paper presents a case study where simulation was used to convert from a manufacturing resource planning (MRP) based push process to a demand-driven pull process in a single plant operation factory floor. Simulation is a software program that allows one to visually see and measure how processes perform over time, including materials, information and financial flows, and how probabilistic variables impact them.

terms

Lean
Simulation
Process
Methodology
Six Sigma
Manufacturing

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A Lean Analysis Methodology Using Simulation

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Introduction

This paper presents a case study where simulation was used to convert from an MRP based push process to a demand driven pull process in a single plant operation, factory floor.

Simulation is a software program that allows one to visually see and measure how processes perform over time, including materials, information and financial flows, and how probabilistic variables impact them.

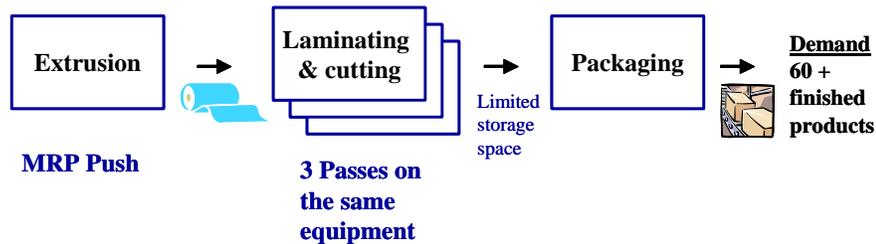
It is particularly valuable in where a mix of products share resources, and it is difficult to “get your head around” all the things that are happening asynchronously. The devil is in the details when it comes to designing a workable new process

Two important takeaways from this case study:

1. Valuable for evaluating things other tools cannot – product mix, setups, variability, ...
2. Internal people can be trained to use and develop these models, particularly people that have been trained in six sigma already. It becomes another key part of their toolbox.

Case study

Set Up Pull Process in a Flow Shop for Laminated Plastic Manufacturing



Each work center operates on a different work schedule.

←--5 days/week--→ ←--7 days/week--→ ←--7 days/week--→

Units = lots/rolls of extruded plastic in this example

Unique things – cure time, several passes on same equipment, analogous to a job shop embedded in the middle

Make to Stock process - MRP driven

Methodology

- Value stream map was first developed
- Issues in the before process: service levels, labor cost over budget
- Describe data missing

- Start with demand & work back through the process to meet pull objective
- People & organization & how they worked together: Master black belts (MBBs) worked with supervisor of operation, planner/scheduler to develop ideas they had for improvement
- Train MBBs on the model
- Provide template to start with – configure for unique aspects of operation
- Run & review results with supervisor & planner/scheduler

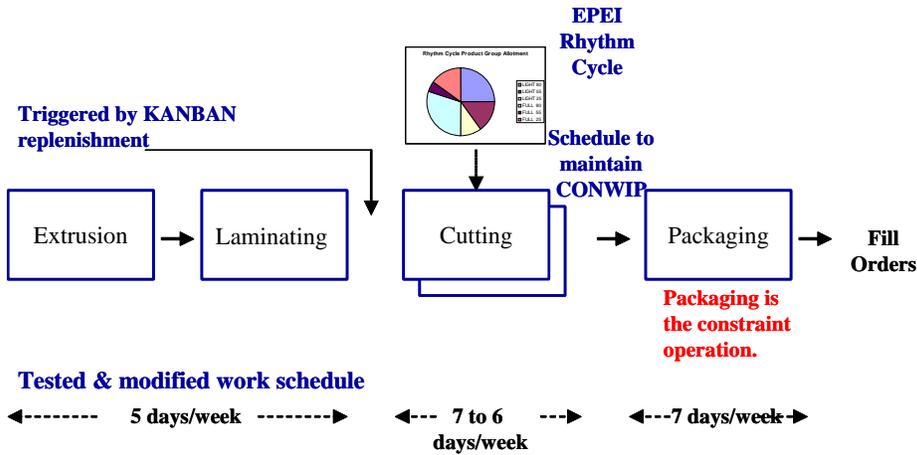
Analysis steps with model:

1. Replicate current process
2. Analyze work shifts & responsibilities
3. Try Make to Order – for finished goods
4. Try kanban for extrusion instead of MRP trigger
5. Try CONWIP to keep packagers busy with EPEI cycle to deal with the variety of products and setups between
6. Quality testing after the packaging was initially not included in the process. However, as the throughput was improved, quality testing became the bottleneck

Model Capabilities used in the analysis

CAPABILITY	USED
Kanbans	√
Schedules	√
EPE (every-part-every ...) interval	√
Campaign lengths vs. one lot flow	√
Setup reduction	
Routing changes	√
Shared resources	√
Postponement	
Variability impacts	√
Downtime impacts	√
Yield & scrap	√
Material lead time	

After Model



<p>EPEI Cycle Product Group Allotment</p>	<p>~60 total products; in 6 product groups</p> <p>As demand arrives for each product, the production order is assigned to the next available cycle spot</p> <p>Fairly complex setup rules between product groups</p>
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Data required

- Rules
- History
- Root cause analysis
- Service levels
- Facts

Metrics important in a lean design to compare alternatives

Service levels

END TO END PROCESSING OF LOTS

MEAN CYCLE TIME (days): MTL AVAILABLE TO FULFILLMENT: 4.19

STND DEV OF CYCLE TIME (days): 1.79

MAX CYCLE TIME (days): 14

MIN CYCLE TIME (days): 1

THROUGHPUT

LOTS PRODUCED: 298

LOTS RELEASED: 298

DEMAND & FULFILLMENT

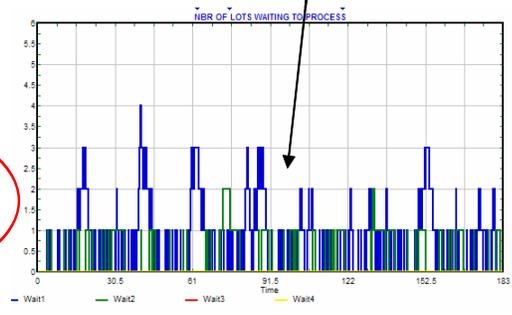
TOTAL LOTS ORDERED: 338

FULFILLED: 256

BACKORDERED: 82

Not meeting demand

Packaging operation is sometimes starved



END TO END PROCESSING OF LOTS

MEAN CYCLE TIME (days): MTL AVAILABLE TO FULFILLMENT: 3.8

STND DEV OF CYCLE TIME (days): 2.14

MAX CYCLE TIME (days): 18

MIN CYCLE TIME (days): 1

THROUGHPUT

LOTS PRODUCED: 339

LOTS RELEASED: 339

DEMAND & FULFILLMENT

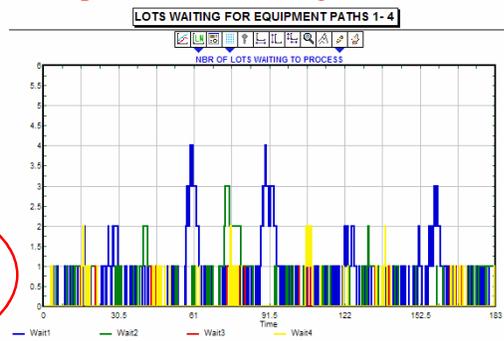
TOTAL LOTS ORDERED: 338

FULFILLED: 338

BACKORDERED: 22

Better Demand fulfillment

Improvement in Packager utilization



End to end cycle times – example from model below

EXAMPLE OUTPUT METRICS

JOB TIMES (days)

Mean Process Time: 3.7774

Lower Confidence Limit: 2.736

Upper Confidence Limit: 4.8188

EACH JOB COMPLETED

Arrival(days)	Priority	Job ID	Test Type	Nbr of Tests
0	0.8225	1	1	3
1	1.88256048141	1	2	3
2	3.12489703482	1	3	2
3	4.8125	1	6	3
4	5.08802910815	1	5	2
5	7.50537137167	1	7	2

Confidence intervals for results, e.g., end-to-end time & utilization

[37] Resource Stats

Statistics | Export | Comments

Records statistics on all resource-type blocks in the model. Update Now

Block	Block Name	Available	Utilization
0	E1 DRILL	Resource Pool	± 0.6573±0.1001
1	E2 MACHINING	Resource Pool	± 0.8288±0.08749
2	E3 LATHE	Resource Pool	± 0.5637±0.1542
3	E4 JIG PRESS	Resource Pool	± 0.4156±0.2081
4	SKILL1	Resource Pool	± 0.09041±0.08971
5	SKILL2	Resource Pool	± 0.3062±0.1186
6	SKILL3	Resource Pool	± 0.2214±0.03744
7	SKILL4	Resource Pool	± 0.002095±0.0008

Note – this example needs to be one from the same model in the case

Takt times/rates for each work center – add example from model

Overall Equipment Effectiveness for each piece of equipment
Define & show example outputs

Next steps – related activities in a methodology such as is proposed

Summary – potential other uses of a model developed in a project such as this:

- Continuous improvement
- Decisions about how to schedule vs doing it ad hoc on the floor
- Compare to MES & ERP systems
- Capacity planning

The examples in this case study are from models developed in Extend™, a discrete simulation program from Imagine That Inc. Following is one of many example models that come with Extend, for people to use in learning to model with it.

