Implementation of Lean Manufacturing
in a
Coating and Laminating Operation

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What is Lean Manufacturing ?

Lean Manufacturing is an operational approach focused on eliminating waste and reducing production cycle times.

What is Waste ?

Overproduction
Waiting
Transportation / Motion
Inventory
Excess Processing
Defects

Overproduction

"Production ahead of demand"

Caused by:

Poor forecasting
Production processing and scheduling limitations
Push vs. Pull Production
Unknown process yields

Overproduction

Examples from a C & L Operation:

Unknown Process yields lead to making more material “Just in Case”

WIP rolls create losses that drive overproduction

Waiting

“Waiting for the next production step”

Caused by:

Production processing and scheduling limitations
Manufacturing change-overs
Poor manufacturing flow / lay-out
Multiple Pass Processes

Waiting

Examples from a C & L Operation:

Line speed mismatches when cascading material through different production lines.

Machine change-over delays

WIP roll storage time

Transportation

“Moving products when not adding value”

Caused by:

Poor manufacturing flow / lay-out
Multiple processes at different sites/locations & buildings

Transportation

Examples from a C & L Operation:

Moving WIP rolls in and out of storage racks in between processes

Moving material to different buildings or machines for additional processing.

Inventory

All components, WIP and FG

Caused by:

Multiple step manufacturing processes
Multiple processes at different sites/locations

* WIP – Work in Process
  FG – Finished Goods

Inventory

Examples from a C & L Operation:

WIP rolls in storage

Finished Goods rolls in storage, that need further processing

Excess inventory “Just in Case” yields are low

Excess Processing

“Poor equipment design – creating excess activity”

Caused by:

Poor machine layout
Multiple step manufacturing processes
Not taking advantage of combining processes

Excess Processing

Examples from a C & L Operation:

Winding and unwinding the same material as process steps are completed

Running the same material through different machines in order to complete the product.

Defects

"The time, material losses, and effort spent inspecting for and fixing defects"

Caused by:

Multiple inspections for each process step
Not mistake proofing
Not taking ownership of their process, self inspection

Current State

Window Film Manufacturing Process

Process Pass No. 1 – Laminate two films together and wind-up 8000 – 20,000 lft of film.
WIP roll goes to storage
Process Pass No. 2 – Apply scratch resistant layer and wind-up 8000 – 20,000 lft of film
WIP roll goes to storage
Process Pass No. 3 – Apply PSA and silicone liner
Finished Goods roll goes to storage
Finished Goods roll is scheduled for slitting, Process **Process Pass No. 4** - inspection, roll is converted to 100 ft rolls for sale

Current State

Yield Losses

Process Pass No. 1 – Laminate two films 95%- 97%

Process Pass No. 2 – Apply Hard coat 95-98%

Process Pass No. 3 – Apply PSA 95%- 97%

Finished Goods roll to slitting 85% - 92%

Final Yield ~ .95 X .95 X .95 X .85 = 73% (Low)
~ .97 X .98 X .97 X .92 = 85% (High)

Current State

Average Throughput

Process Pass No. 1 – Laminate two films 80 fpm

Process Pass No. 2 – Apply Hard coat 100 fpm

Process Pass No. 3 – Apply PSA 100 fpm

Finished Goods roll to slitting 50 fpm

Final Throughput/ finished roll: ~19 fpm
Combining two Pass No. 2 & 3 : ~23.5 fpm

How do you apply Lean to a mature converting process ?

You completely redesign the manufacturing process
Start with a new approach, “clean sheet of paper”

Lay-out the facility with U-shaped product flow
Minimize wasted transportation/motion
Minimize yield losses
Minimize overproduction/excess processing
Minimize inventory
Eliminate waiting between process steps.

Future State

Window Film Manufacturing Process

Process Pass No. 1 – Apply three coatings, laminate twice, digitally inspect the product, edge trim and wind into 100 ft rolls for sale in 60 seconds or less.

Future State

Yield Losses

One Process Pass – 95% - 98%

Raw material in --- Roll for sale out

You only handle the material once.

Future State

Average Throughput

Average Throughput 100 fpm – 150 fpm

One machine, produces more than three converting lines, a number of slitters and many more operators can produce.

Dramatically reduces waiting time, wasted product, overproduction, excess transportation and motion.

Lead times are slashed to < 1 day.

Future State

Defect Reduction

Winding large rolls of window film induces several defects: Corrugation, and core impressions, (i.e. EOR losses)

Running several process passes on different converting lines causes problems with film flatness or curl.

Winding large rolls of window film into finished goods rolls then inspecting during slitting yields unknown problems, and missed deliveries due to higher than expected losses.

Future State

Inventory Reduction

Work-In-Process (WIP) rolls are eliminated from inventory.

Finished Goods rolls are eliminated from inventory

Only raw film, and rolls ready for sale are left in inventory.

Short rolls due to roll mismatches during lamination are eliminated.

Future State

Overproduction Reduction

Roll quality is determined in real time via digital inspection systems.

Machine adjustments made in real time to eliminate defects.

Rolls are produced to order - Pull

No surprises at slitting/ final inspection. Excess material is not produced.

Deliveries are not missed due to low yields.

Future State

Cost Savings

Yield increase

Inventory reduction

Reduced cycle time/ increased inventory turns

Higher factory throughputs/ Lower Overhead

Current State– Yield Loss

Per 10,000 foot roll

4 Pass Process

	Pass No. 1	Pass No. 2	Pass No. 3	Pass No. 4	Total yield Or Loss
Average Process Yields / Pass	0.95	0.95	0.95	0.85	0.73
Material Value	0.20 / sq ft	0.25 / sq ft	0.30 / sq ft	0.32 / sq ft	
$ loss per 10,000 ft Roll	$500	$594	$ 677	$ 2,058	$ 3.828

Current State– Yield Loss

Per 10,000 foot roll

3 Pass Process

	Pass No. 1	Pass No. 2	Pass No. 3	Total yield Or Loss
Average Process Yields / Pass	0.95	0.95	0.85	0.78
Material Value	0.20 / sq ft	0.30 / sq ft	0.32 / sq ft	
$ loss per 10,000 ft Roll	$500	$ 713	$ 2,166	$ 3.379

“Tandem Coater”

Future State – Yield Loss

Per 10,000 foot roll

1 Pass Process

	Pass No. 1	Total yield Or Loss
Average Process Yields / Pass	0.95	0.95
Material Value	0.32 / sq ft	
$ loss per 10,000 ft Roll	$800	$ 800

Future State – Increased Revenue

Per 10,000 foot roll

Manufacturing Approach	Scrap Reduction per 10,000 ft roll	Extra Sales Revenue per 10,000 ft roll	Total Benefit
Current State 4 Pass	$ 0	$ 0	$ 0
Tandem Coater 3 Pass	~ $ 400- $ 500	~ $ 600 - $1,000	$ 1,000 - $ 1,500
Lean Manufacturing 1 Pass	~$ 2,000 - $ 3,000	~ 4,500 - $ 7,500	~ $ 6,500 - $ 10,000

Conclusion

What was done in this example of employing lean manufacturing was not a huge jump technically.

It was a risk, some said, “it can't be done that way”

If we continue to operate the same way we operated in the 80's and 90's, the rest of the world (Asia) will pass us by.

Take a risk & Think outside of the box.