

Understanding CNC Capacity Through Production Time Estimation

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Abstract

Recent disruptions in the labor and material markets have emphasized the importance of machine utilization. For high-mix, low volume manufacturers like Landscape Forms especially, accurate estimates for production times are necessary to decrease wasted resources and reduce product lead times. For this project, machine run-time, set-up time, and product characteristics were studied and incorporated into a mathematical capacity model. The capacity model was integrated into Excel to assist the manufacturer in scheduling operations potentially resulting in an increased equipment utilization, a reduction of costs, and shorter lead times.

Sponsor: Landscape Forms

- Founded in 1969
- Located in Kalamazoo, MI
- Industry leader in high-design furniture
- Customers: Harvard University, Linked In, Google, Nike, Adidas, Microsoft, and Uber

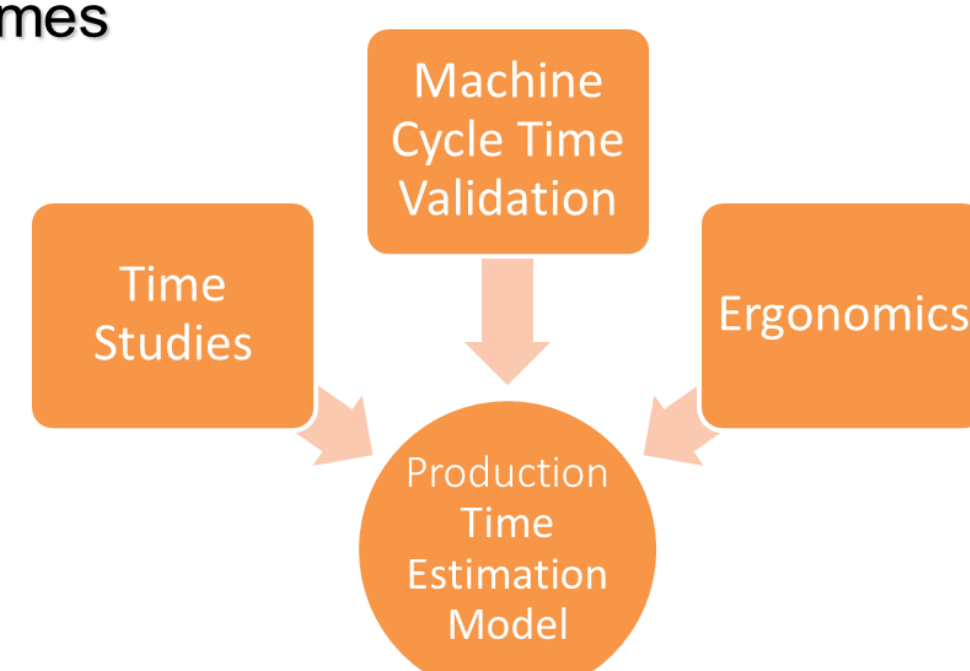


Problem

- CNC Machines are the bottleneck due to WIP waiting on CNC
- Previous Routing times were inaccurate and not user friendly
- Landscape Form's wanted a CNC Capacity Model

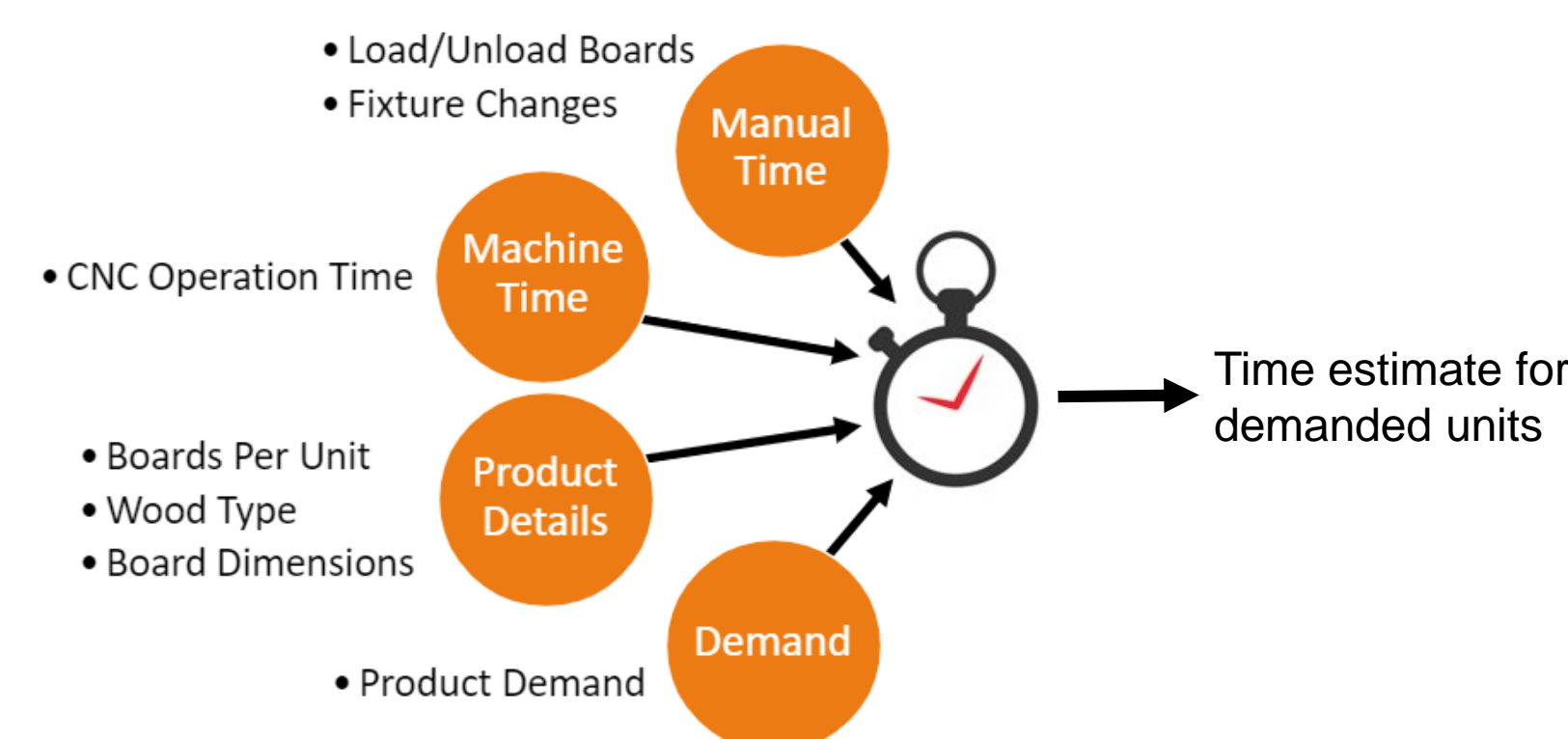
Methods

- Time studies generated and validated the production time estimation model
- Machine cycle times were collected, and validation was used to determine best method to collect machine cycle times
- Ergonomics to determine the number of trips to load the equipment based on a safe recommended weight limit
- Analysis of the product information such as board weight, wood type, number of boards and the product demand was performed.



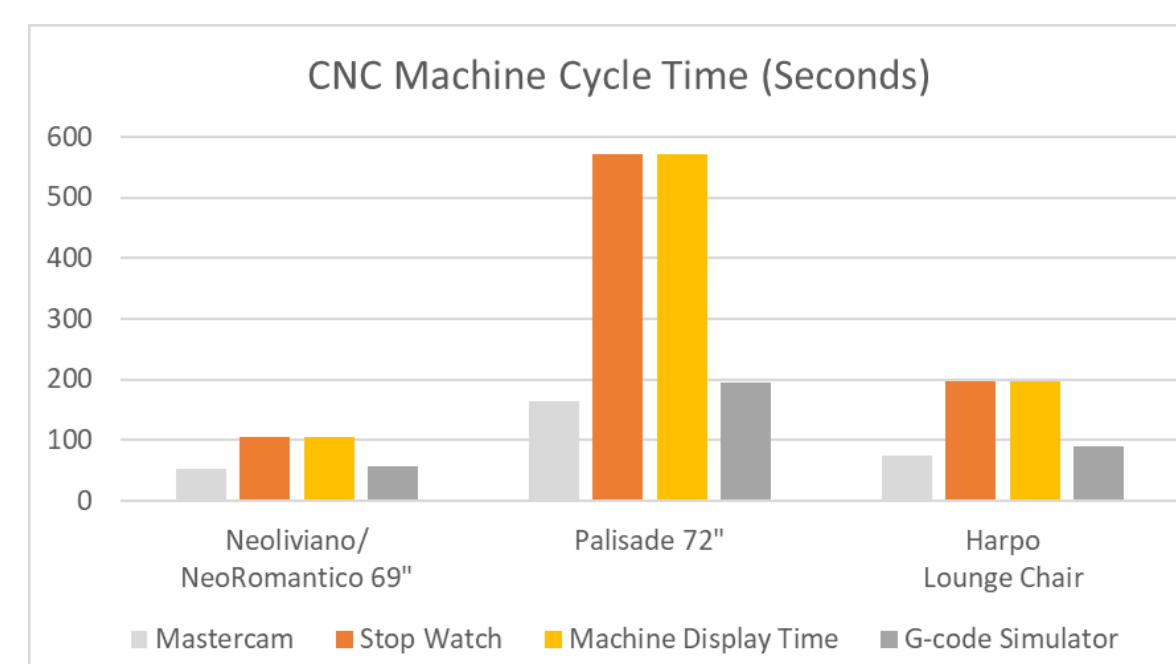
Production Time Estimation Model

Based off the data collected, a production time estimation model was created in Excel. The model is based off inputs from the company that will allow the model to generate the overall production time for the demand.



Machine Cycle Time Validation

The best method for recording CNC machine cycle times was collecting them off the machine screens. These matched closely to the time studies that were conducted.



Ergonomics

- NIOSH lifting equation to determine recommended weight limits (RWL)
- RWL's determine the number of trips needed to load and unload boards
- Origin is the cart the boards are unloaded from and the destination is the CNC table they are loaded onto

	Origin	Destination
Recommended Weight Limit (RWL)	28.72	22.45
Lifting Index (LI)	0.35	0.45

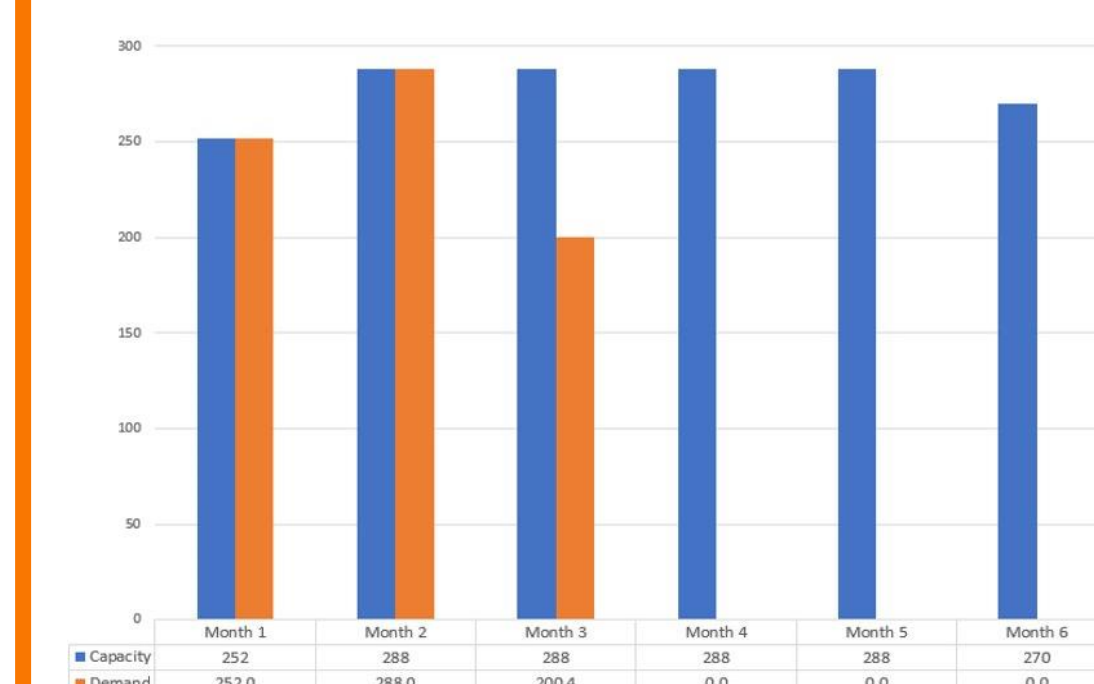
Production Time Model Validation

- The model was validated by comparing the model estimated production times to time study data that was collected
- The Harpo Lounge chair was used to validate the model because of its simple process and the Morisson table for its more complex process
- The goal is to have a percent error less than or equal to 10%

Product	Time Study (Minutes)	Model Estimation (Minutes)	%Error
Harpo Lounge Chair	5.83	5.88	0.89%
Morrison 40x80	10.28	11.28	9.73%

CNC Capacity Model

- The green cells are user inputs which are used to determine the capacity for each month.
- Demand time is pulled from the production time estimation model into the CNC capacity model
- The model will show the varying capacity per month as defined by the user and how long it should take to complete the demand.



Monthly CNC Machine Capacity		
Month	1	2
Shift Hours	10	10
Shift Minutes	600	600
Days / Week	4	4
# of Shifts	1	1
Breaks/Start-Up/Clean up	60	60
# of Machines	2	2
Unplanned Downtime	0	0
Time Denomination	Hours	Hours
Planned Downtime	4	0
Daily Capacity	18	18
Demand Time =	740.44 Hours	

Summary

- Landscape Forms Inc. requested a CNC capacity model
- The team provided a user-friendly production estimation model and a CNC availability model
- Implementing this model could potentially result in increased equipment utilization, reduction in costs, and more accurate lead times