Increase productivity in the molding process through a blade tracking tool and identification of main causes for rework

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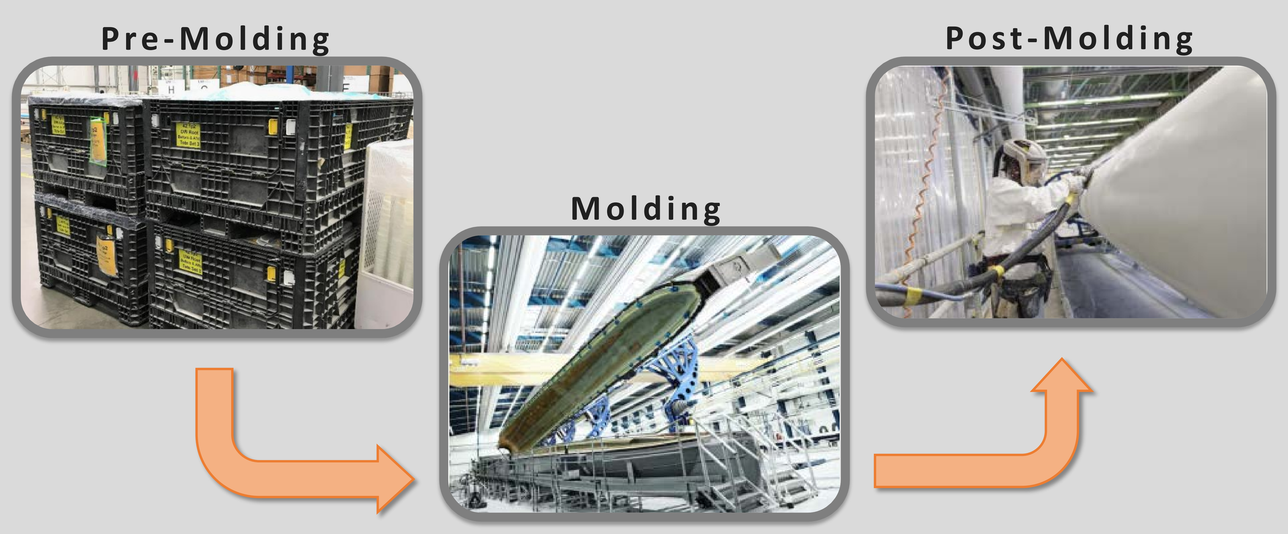
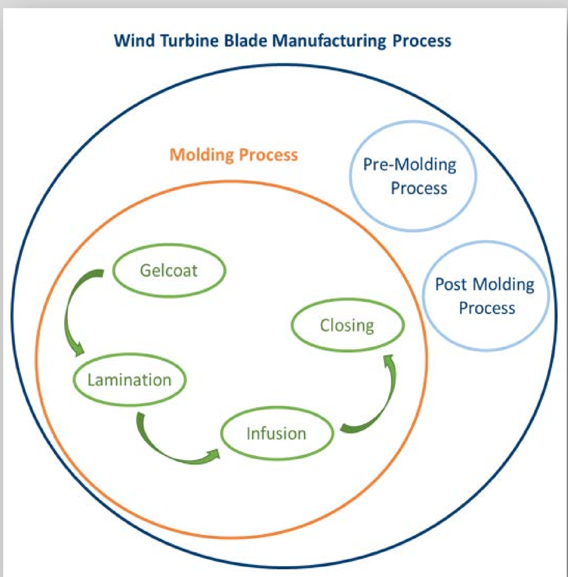
LM WIND POWER a GE Renewable Energy business

UNIVERSITY OF ARKANSAS

Blade Manufacturing Process Overview:

The **blade manufacturing process** in LM consists of three major steps: Pre-Molding, Molding and Post molding.

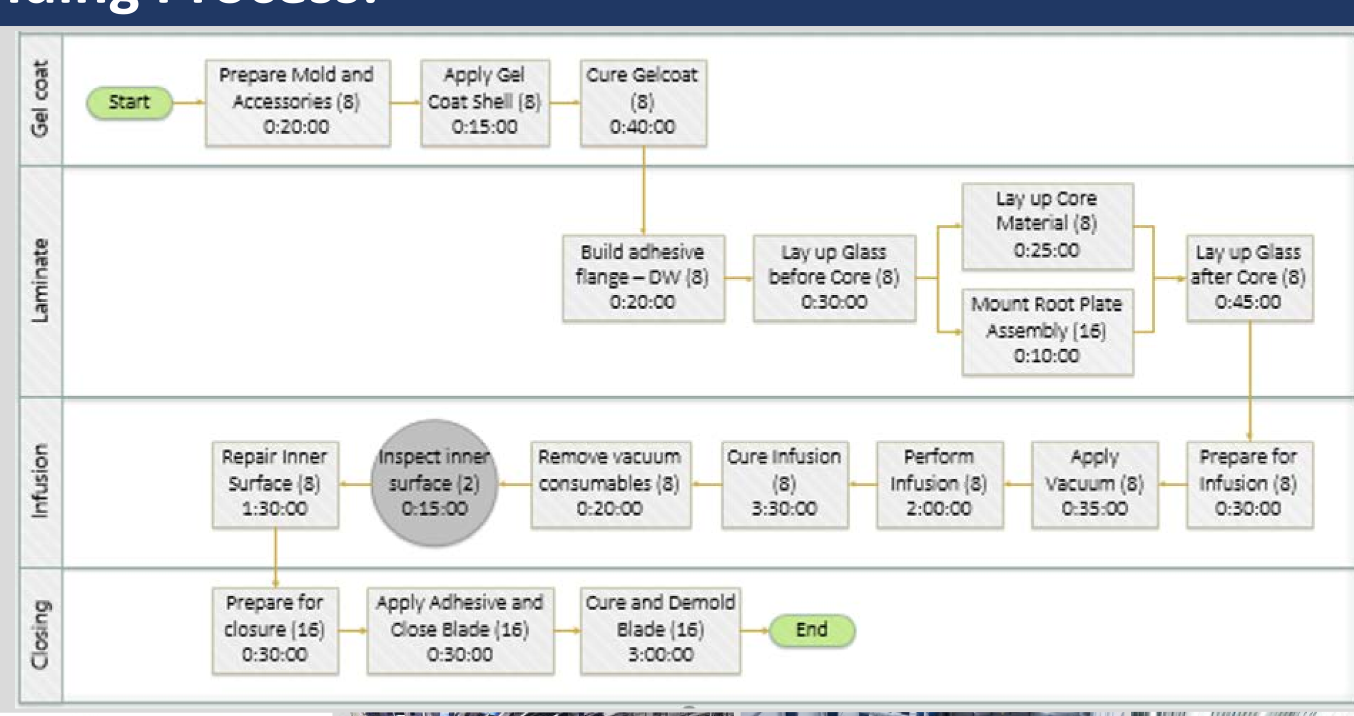


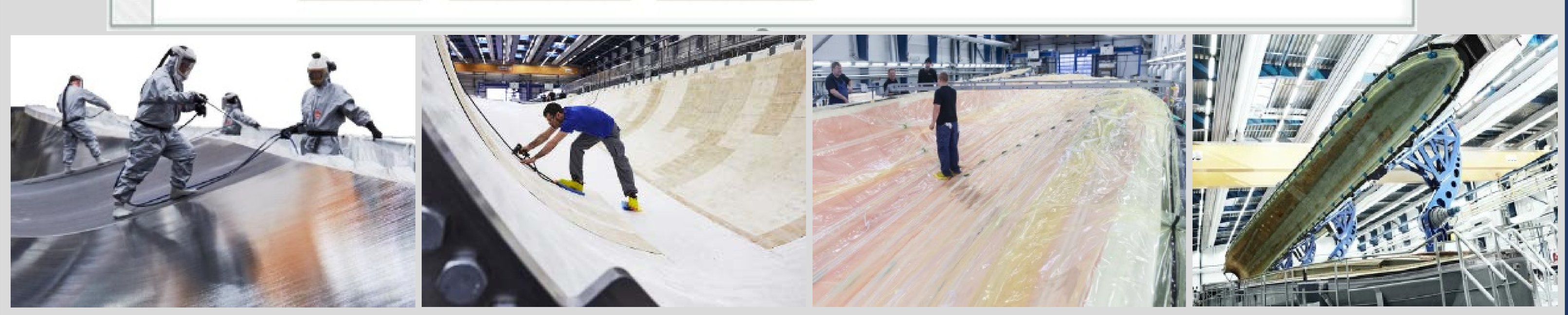


The **meta system** is the wind turbine blade manufacturing process and the lateral systems are the pre and post molding processes.

The **molding process**, our system, is subdivided into 4 phases which are Gelcoat, Lamination, Infusion and Closing which were identified as the **subsystems**.

Molding Process:





Stakeholders:

An **affinity diagram** helped identify our stakeholders and prioritize their interest. A **survey** revealed the issues they are facing and their needs.

- Supervisors
- Team Leaders
- Area Managers
- Global Production Engineering

PRIORITY

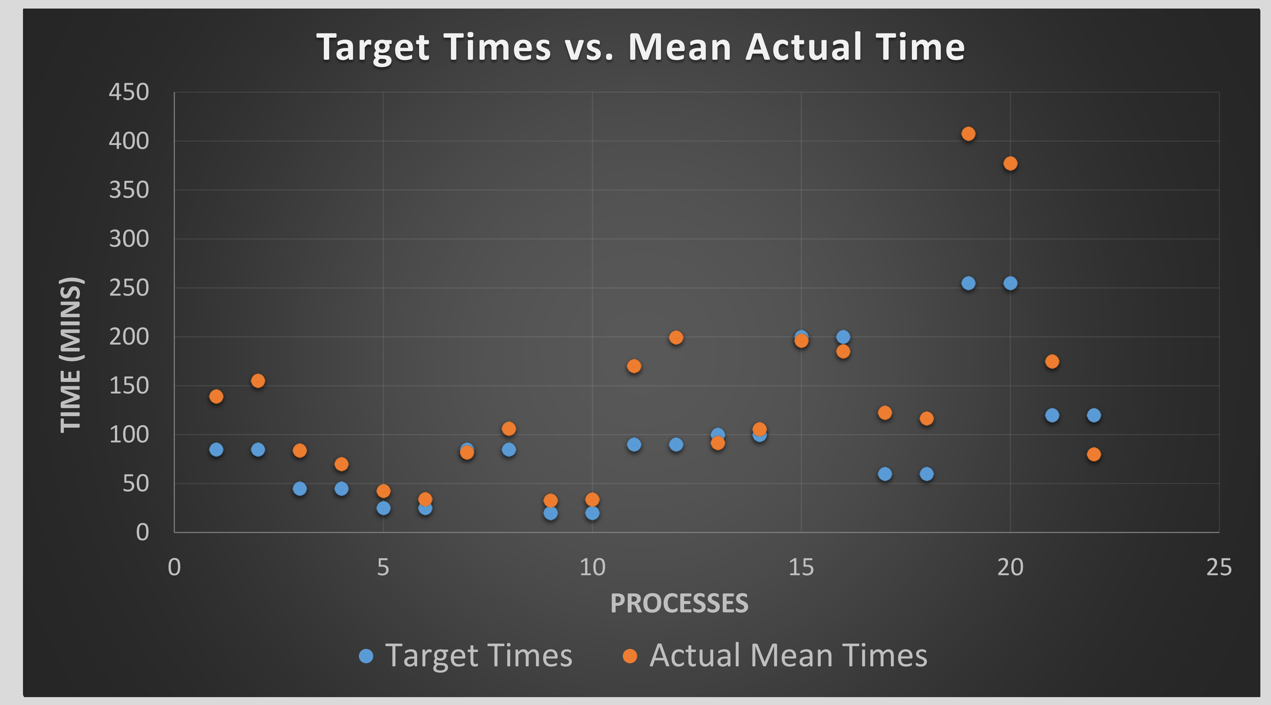
- Rework/Additional Inspection
- Unplanned crane movements
- Missed milestones
- Easier tracking system

Current Process:

The current performance of the molding process was analyzed by performing a **t-test** on the cycle times for each of the 23 sub-process, using an alpha of 0.05.

Means
μ_1: Actual Time
μ_2: Target Time

Hypotheses
H_0: $\mu_1 = \mu_2$
H_1: $\mu_1 > \mu_2$



16 out of 23
processes were significantly higher than the standard time

Problem Statement:

Issue: 70% of processes are significantly larger than their target times

Causes: Un-informed decision that lead to lost productive time | Defects in manufacture that cause rework

Solutions: Build blade tracking tool | Identify main defects that cause the most time in rework

Value Measure: Cycle Time

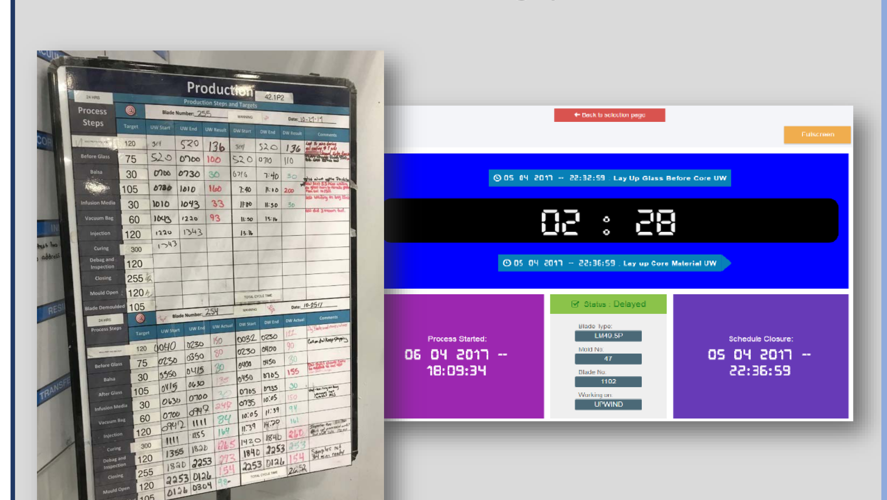
Project Objective:

Affect **scheduling of activities** and **allocation of resources** by creating a blade tracking tool that will aid in planning and by identifying the main defects that cause rework so that they can be reduced.

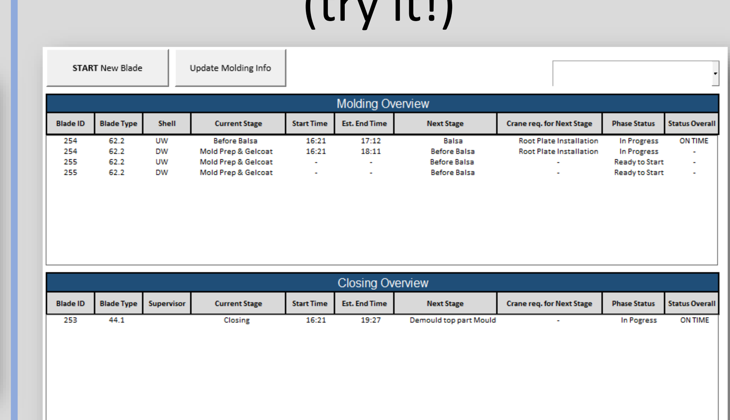
Blade Tracking Tool:

LM is requiring a tool that provides an **overview** of the molding process, that is **customizable**, and that will aid supervisors making well-informed and fast **decisions**.

Current tracking process

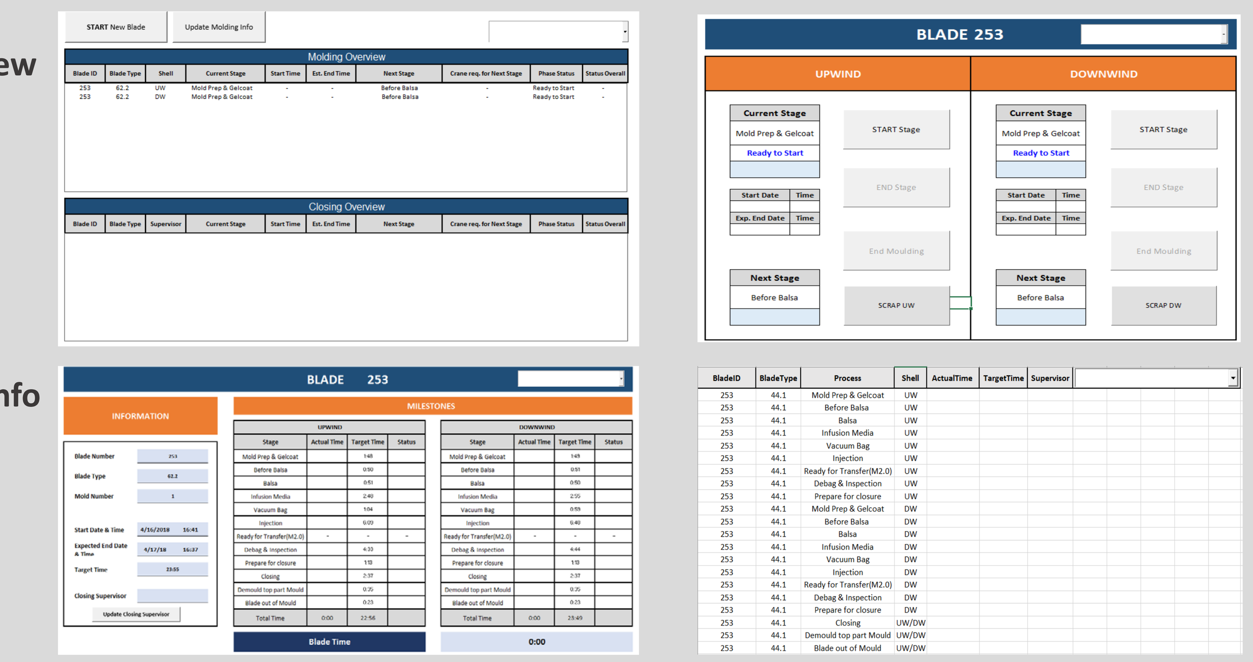


Our recommended tool (try it!)



Blade Tracking Tool:

The **overview tab** designed for the supervisors to see the whole process. The **input tab** is for team leaders to update the information. The **blade info tab** gives information about a blade and the **history tab** is where the information is stored.

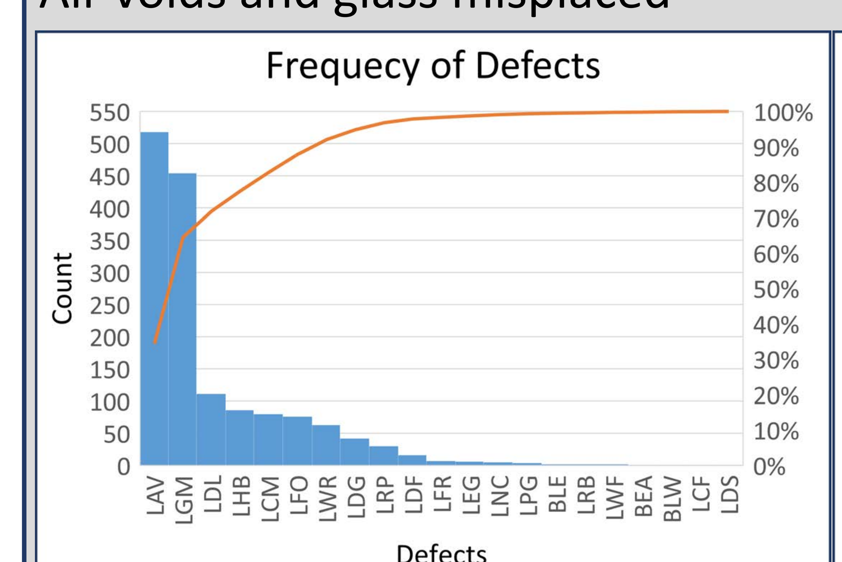


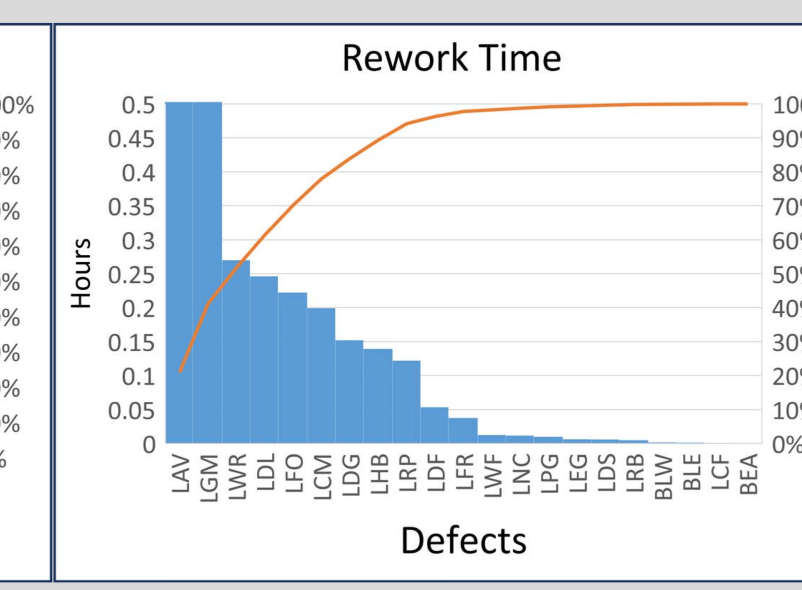
Benefits of our tool:

- Simple
- Highly customizable
- Includes key future activities
- Data storing process simplified
- Remote access from computers/tablets
- Decrease travel time for supervisors and TL

Main Defects that Cause Rework:

Pareto charts were used to identify the main defects to reduce: Air voids and glass misplaced





Results of Multiple Regression Analysis show defects directly related to closing times

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	23	256.155	11.1372	5.08	0.000
LAV	1	2.709	2.7090	1.24	0.270
LCM	1	5.454	5.4536	2.49	0.119
LDF	1	6.712	6.7115	3.06	0.084
LDG	1	0.001	0.0011	0.00	0.982
LEG	1	6.992	6.9916	3.19	0.078
LFO	1	0.005	0.0050	0.00	0.962
LFR	1	8.256	8.2561	3.77	0.056
LGM	1	0.133	0.1333	0.06	0.806
LHB	1	0.091	0.0914	0.04	0.839
LRB	1	14.202	14.2018	6.48	0.013
LRP	1	3.253	3.2530	1.48	0.227
LWR	1	65.324	65.3239	29.80	0.000
LAV*LAV	1	4.372	4.3721	1.99	0.162
LDG*LDG	1	1.520	1.5203	0.69	0.408
LFR*LFR	1	12.077	12.0769	5.51	0.022
LAV*LGM	1	5.373	5.3727	2.45	0.122
LCM*LGM	1	0.237	0.2373	0.11	0.743
LCM*LWR	1	6.340	6.3405	2.89	0.093
LDF*LEG	1	28.279	28.2787	12.90	0.001
LDF*LFR	1	20.794	20.7937	9.49	0.003
LDF*LRP	1	4.240	4.2397	1.93	0.169
LFO*LHB	1	13.817	13.8166	6.30	0.014
LGM*LRP	1	8.692	8.6922	3.97	0.050
Error	71	155.617	2.1918		
Total	94	411.772			

Regression Equation

Closing Time = 3.67 + 0.298 LAV + 0.401 LCM - 0.839 LDF - 0.012 LDG - 3.00 LEG - 0.008 LFO - 4.17 LFR + 0.034 LGM + 0.028 LHB + 3.37 LRB + 0.538 LRP + 0.926 LWR - 0.0264 LAV*LAV + 0.143 LDG*LDG + 3.09 LFR*LFR + 0.0377 LAV*LGM + 0.0159 LCM*LGM - 0.203 LCM*LWR + 8.62 LDF*LEG + 5.80 LDF*LFR + 2.42 LDF*LRP - 0.265 LFO*LHB - 0.220 LGM*LRP

Reducing LAV and LGM defects by One

Blade	Time Savings (hr)	Time Savings %
431	0.46	**4.07%**
390	0.06	**0.88%**
430	0.26	**4.10%**
376	0.31	**5.52%**
456	0.33	**6.13%**
478	0.07	**1.33%**
410	0.46	**10.65%**

Savings in a Year

Average of **99 hours**

Reduce Closing Time by **4.36%**

Assumptions:
1 blade is closed daily
355 days in a year