



INSTITUTE OF  
**INDUSTRIAL  
& SYSTEMS**  
ENGINEERS



**IISE**  
Operational Excellence Division

## **Lean Manufacturing Laboratory for Hands On Learning in Industrial Engineering**

**August 27, 2 PM to 3 PM EST**



**Anuj Mittal**



**Dave Adolfson**

**Department of Industrial Engineering Technology  
at Dunwoody College of Technology**

## Mission

- To provide its membership with the operational excellence practices body of knowledge, networking opportunity, recognition, and educational programs to stay competitive in the global market.

## Vision

- To be the hub that facilitates knowledge development and sharing in the domain of operational excellence, lean six sigma, and all continuous improvement practices.

**Sponsor of the**  
Lean Six Sigma & Data Science Conference  
IISE Annual Conference LeanSixSigma Track

## Division Awards

*Best Student Paper Competition*

*Teaching Award*

*Best Practice Competition*

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- Support **Conference Tasks** (IISE Annual & ELSS Conf.)
- Serve on the **Division's Board** (Professional and Student Leadership)

# Lean Manufacturing Laboratory for Hands-on Learning in Industrial Engineering

Anuj Mittal

David Adolfson

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Dunwoody College of Technology



# Agenda

- Background and Objective
- Laboratory 1: Introduction to Standard Operating Procedures
- Laboratory 2: Standard Operating Procedures for Disassembling and Assembling Engines
- Laboratory 3: Continuous Improvement of an Engine Assembly Line
- Key Observations
- Challenges and Lesson Learnt
- Materials and Costing

# Dunwoody College of Technology

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- Private non-profit college located in Minneapolis, MN
- Dunwoody College of Technology offers two and four-year technical degrees in several disciplines
- School of Engineering offers BS degrees in various disciplines
- High focus on hands-on education





PARTITION (IN)		FEED RATE	FEED TO GO	TO GO
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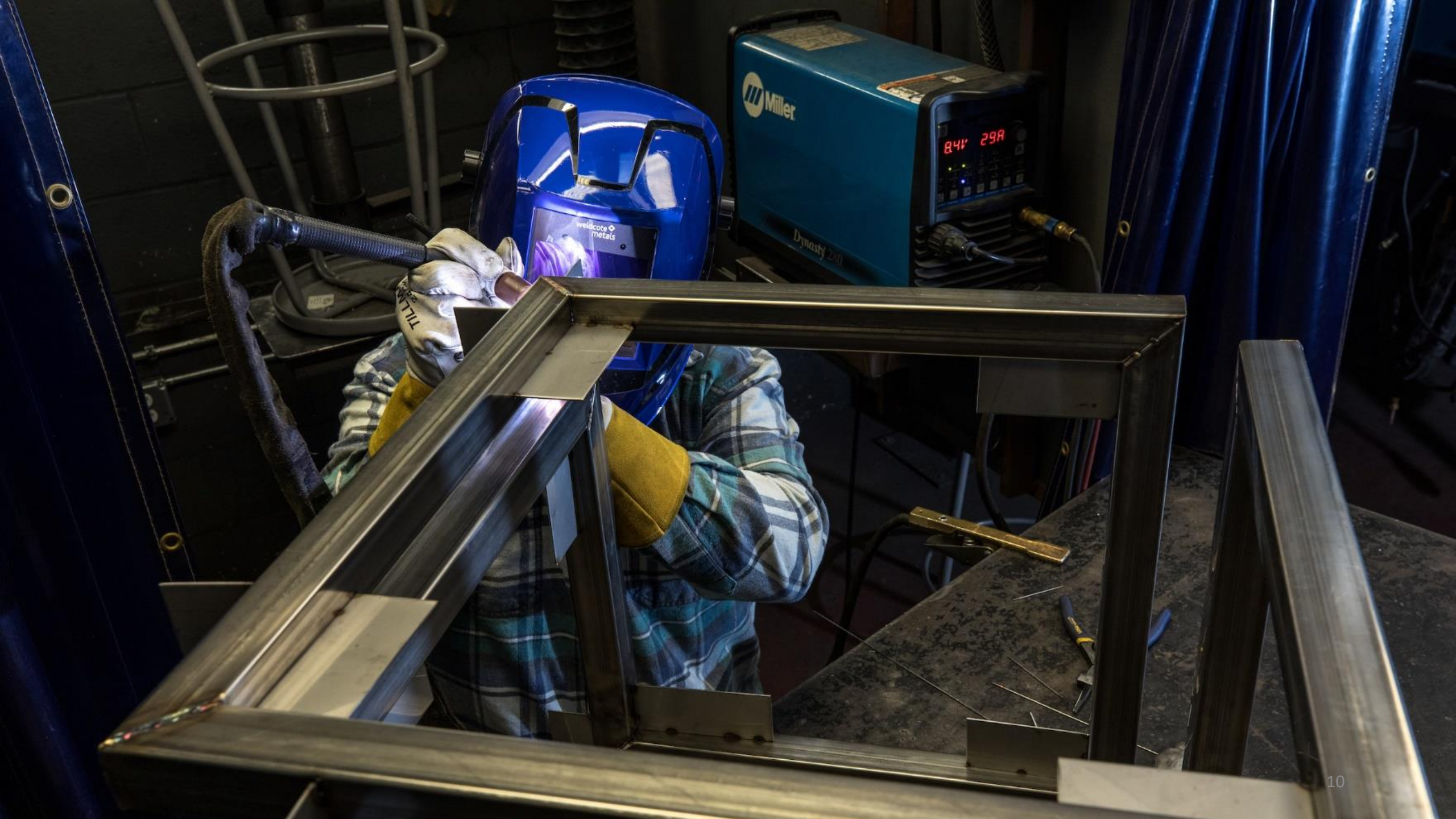
M CODE	FUNCTION
M00	Program Stop
M01	Optional Stop
M02	End of Program
M03	Spindle On (Machining)
M04	Spindle On (Clocked)
M05	Spindle Stop
M06	Tool Change
M07	coolant On
M08	coolant Off
M09	Mist Coolant On
M10	Mist Coolant Off
M11	Flood Coolant On
M12	Flood Coolant Off
M13	Tool Length Compensation On
M14	Tool Length Compensation Off
M15	Tool Wear Compensation On
M16	Tool Wear Compensation Off
M17	Tool Wear Compensation Zero
M18	Tool Wear Compensation Reset
M19	Tool Wear Compensation Stop
M20	Tool Wear Compensation Start
M21	Tool Wear Compensation End
M22	Tool Wear Compensation Cancel
M23	Tool Wear Compensation Hold
M24	Tool Wear Compensation Release
M25	Tool Wear Compensation Lock
M26	Tool Wear Compensation Unlock
M27	Tool Wear Compensation Alarm
M28	Tool Wear Compensation Clear
M29	Tool Wear Compensation Reset
M30	Program End
M31	Program Start
M32	Program Pause
M33	Program Resume
M34	Program Stop
M35	Program Restart
M36	Program End
M37	Program Start
M38	Program Pause
M39	Program Resume
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M88	Program Stop
M89	Program Restart
M90	Program End
M91	Program Start
M92	Program Pause
M93	Program Resume
M94	Program Stop
M95	Program Restart
M96	Program End
M97	Program Start
M98	Program Pause
M99	Program Resume











# School of Engineering @ Dunwoody College of Technology

- Industrial Engineering Technology program is a "2+2" program
- Mechanical, Electrical and Software Engineering programs are traditional 4-year programs
- Adding a traditional 4-year Industrial Engineering program is being investigated

# How People Often Learn Lean?

- On the job training programs
- Doing Gemba walks, Kaizen activities, etc. on the manufacturing floor

# Objective: Simulating the Way Lean is Taught in the Industry



# Laboratory 1: Introduction to Standard Operating Procedures (SOP)

- SOP defines process and:
  - Serve as a baseline for future improvement of processes, facilitates training, and reduces variability
  - Backbone to conduct kaizen activities
- Laboratory 1: assembling workbenches
  - DIY workbenches
  - Using manufacturer's SOP
  - Groups of 2-3 students

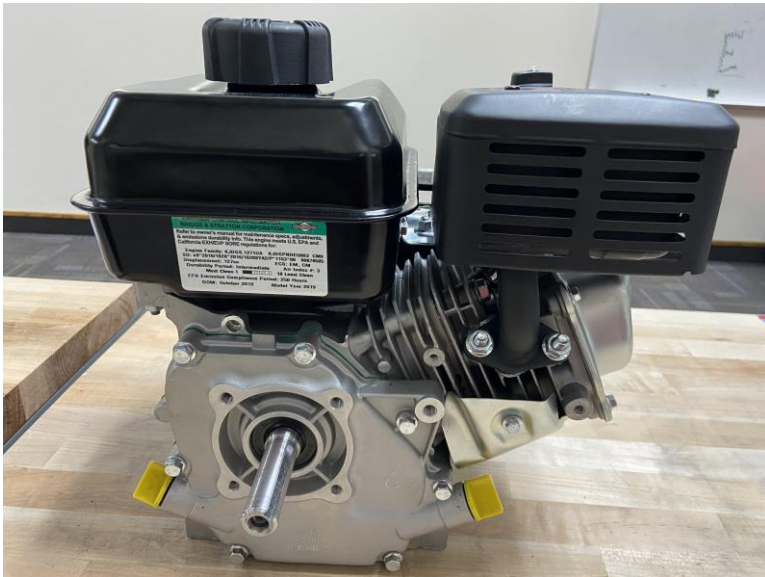


# Laboratory 1: Outcomes



# Laboratory 2: Standard Operating Procedures for Disassembling and Assembling Engines

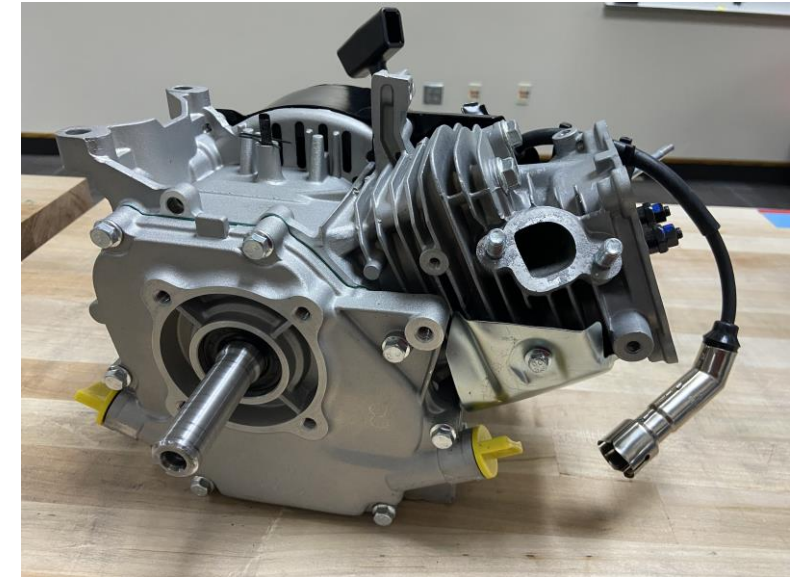
- Briggs & Stratton Engines were used
- Students were provided with pictures showing step-by-step approach to disassemble engines



Assembled engine



Hand tools



Disassembled engine



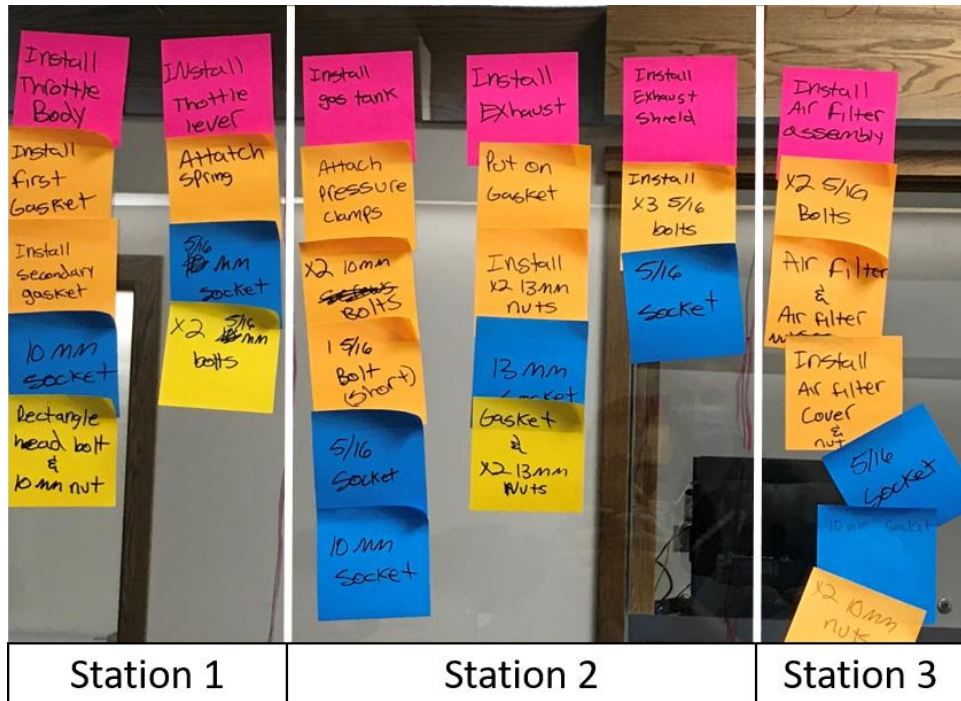
# Laboratory 2: Outcomes

- Students developed SOP to disassemble engines
- SOP were swapped between groups to assemble engines for peer feedback



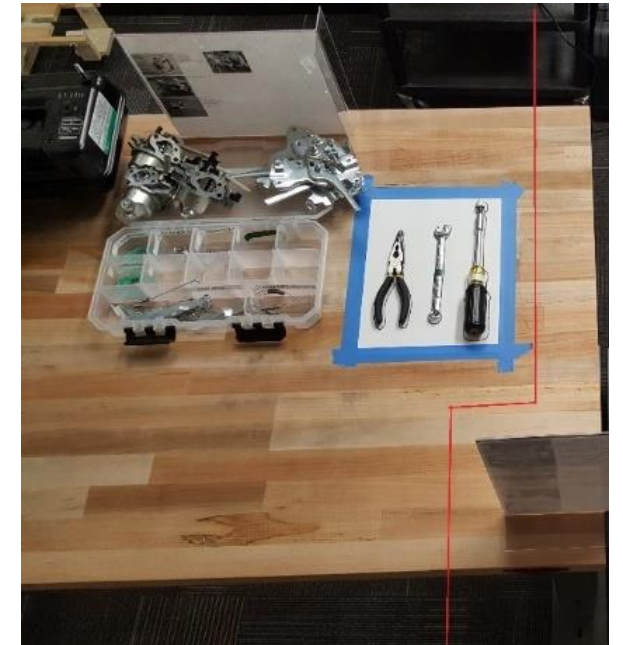
# Laboratory 3: Continuous Improvement of an Engine Assembly Line

- Students were reorganized in a group of three
- Each group set up the initial assembly layout by themselves
  - Drew the process map for assembling engines using sticky notes



# Laboratory 3: Kaizen Events on the Assembly Line

- Students used different lean methods (e.g., 5S, visual management, poka-yoke, SOP) to improve the assembly line throughput
- Student video taped their activities to conduct time studies and balance the assembly line

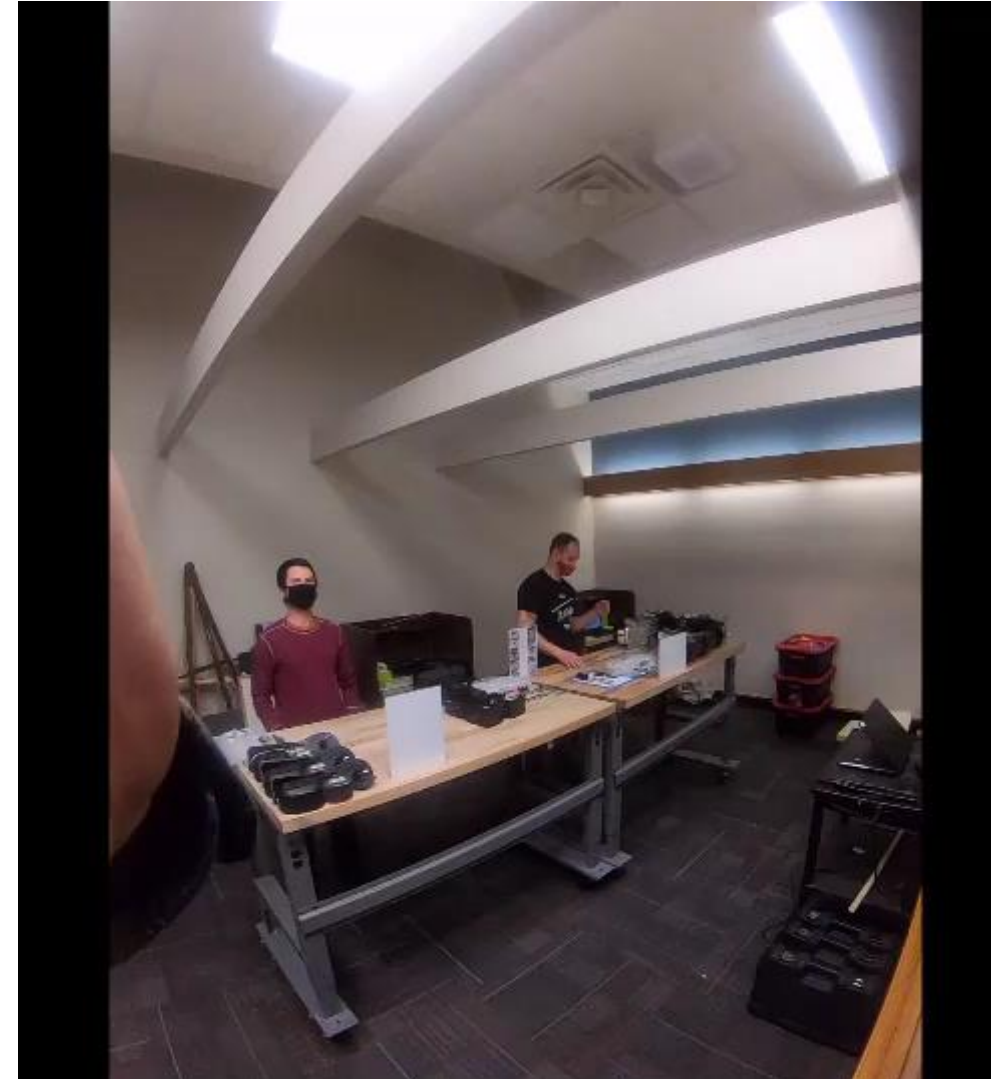


# Laboratory 3: Before and After

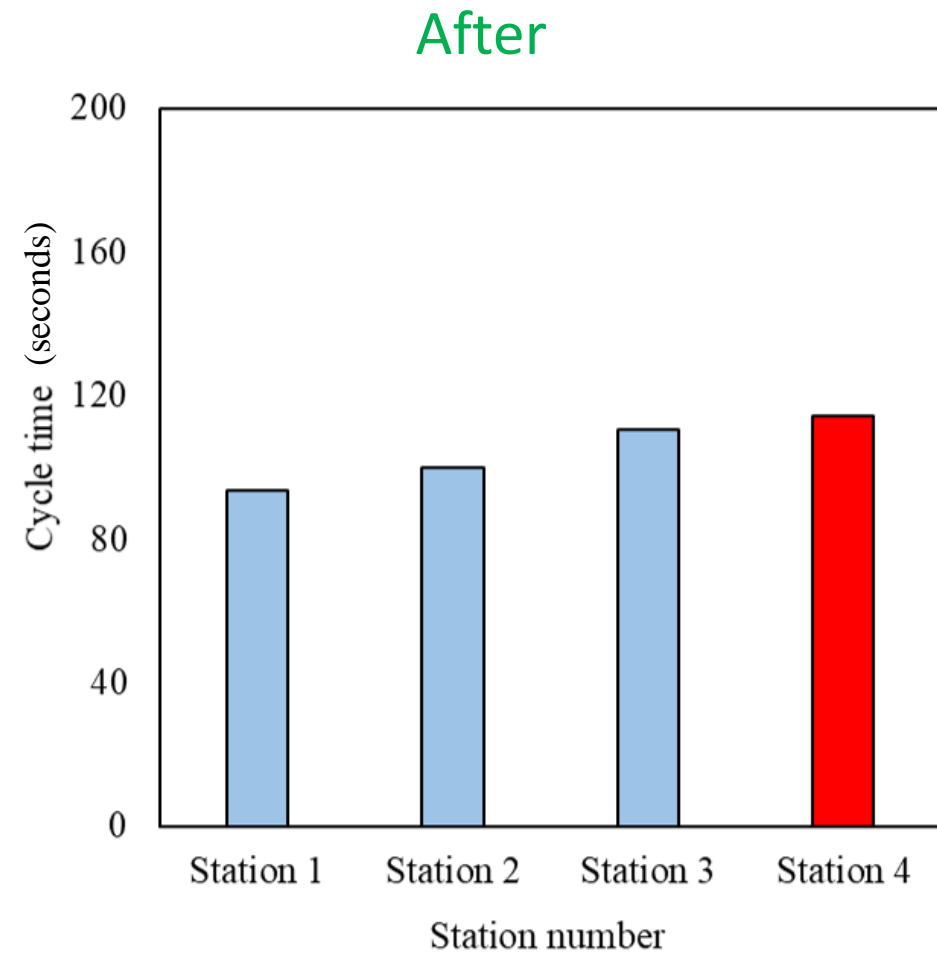
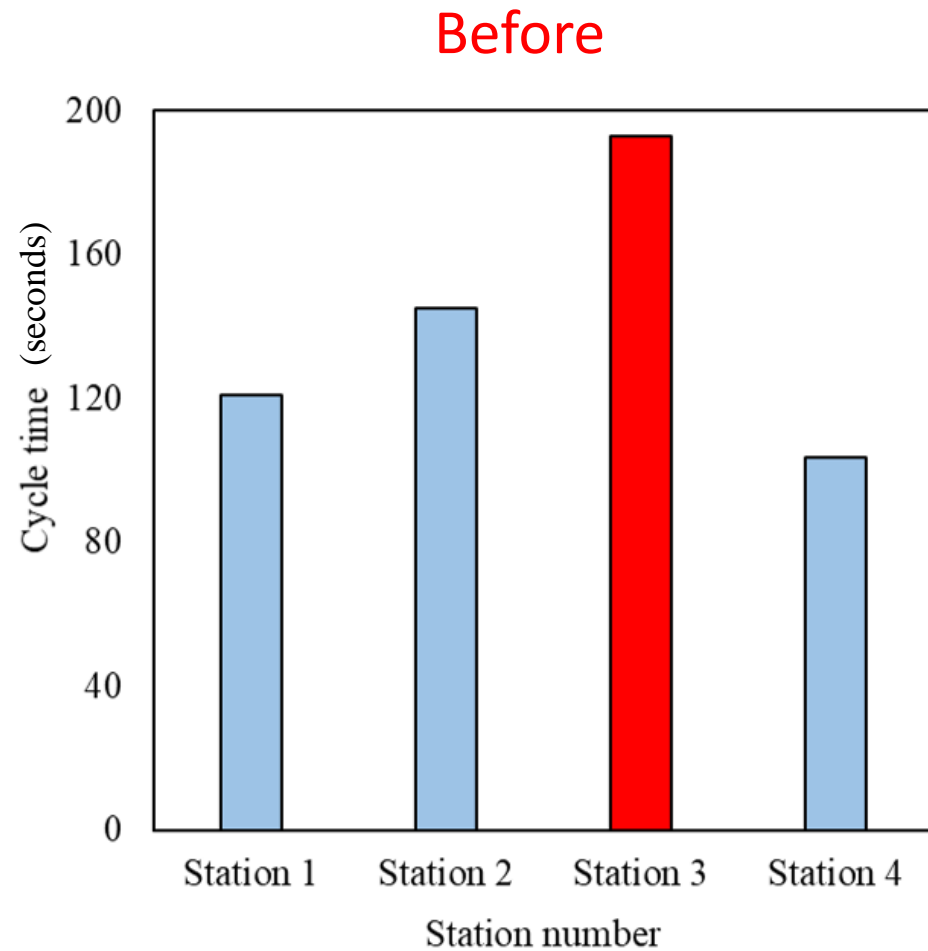
Before



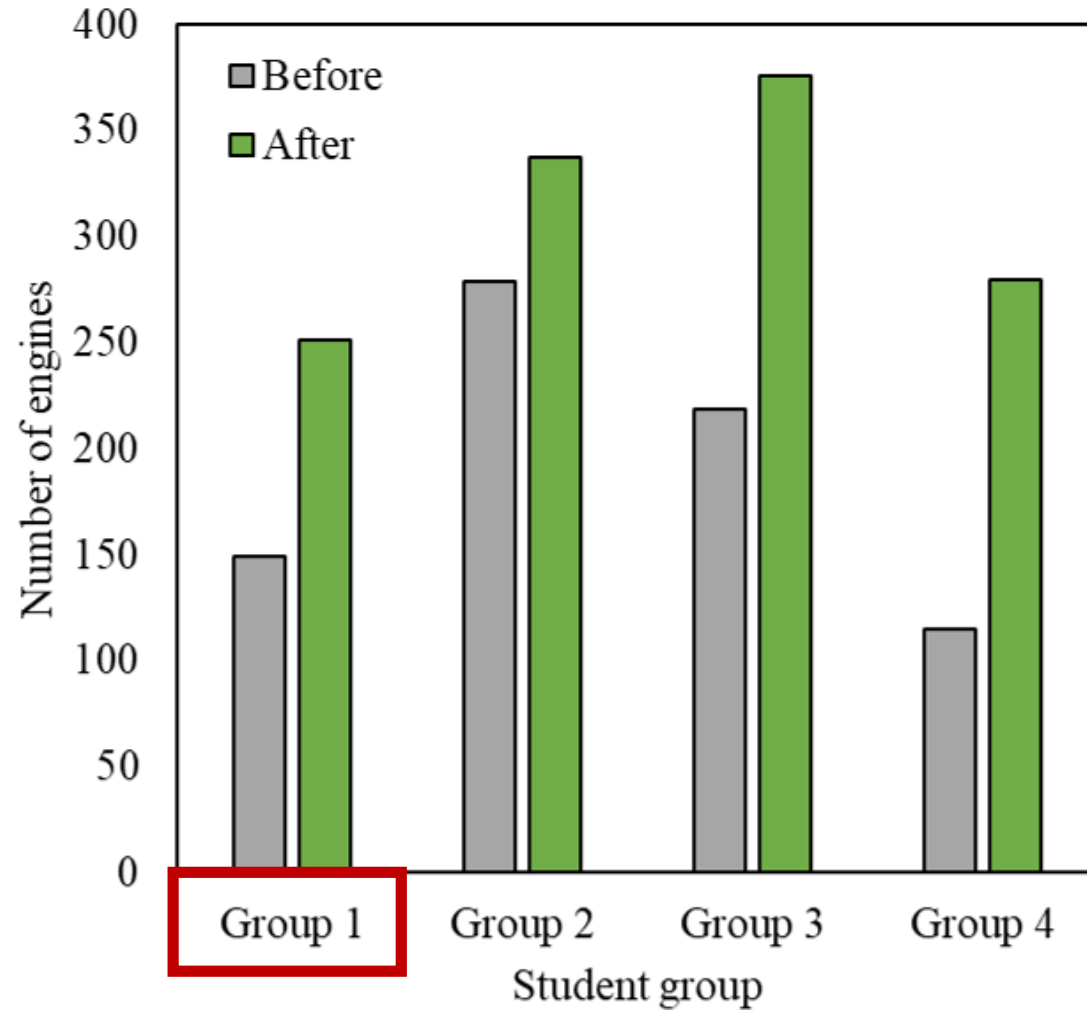
After



# Laboratory 3: Before and After Results (Group 1)



# Laboratory 3: Outcomes



# Overall Observations

- Benefits of using real engines and tools as compared to simpler products like Lego
- Built-in a level of complexity makes the application of lean tools realistic and is representative of what students experience in the industry
- A good way to learn is by struggling through more complex tasks



# Challenges and Lesson Learned

- In the initial weeks of Laboratory 3, assembly line activity turned into “**how fast the engines can be assembled as a group**”
- Using mobile phones/stop watch to conduct time studies is cumbersome
- Laboratory 1 cannot be repeated each semester: alternate product need to be identified for Laboratory 1 on SOP
- Important to have uniformly skilled groups if comparing results: student background differs



# Materials and Costing

- Briggs & Stratton Engines: ~\$300 each
- DeWalt hand tool sets: ~\$90 each
- Workbenches: ~\$450 each
- GoPro cameras: ~\$300 each
- Miscellaneous material (~\$25 each week for each student group)
- Total expenditure for a class size of 12: ~\$10,280

# Acknowledgements

- **William B. Hudson**, Dean for School of Engineering, Computer Technology, Math and Science, Dunwoody College of Technology
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- **Matthew Matson**, Assistant Professor, Department of Industrial Engineering Technology, Dunwoody College of Technology
- **Benjamin Dudley**, Junior, Department of Mechanical Engineering, Dunwoody College of Technology
- **Janet Nurnberg**, Former Faculty, Department of Industrial Engineering Technology, Dunwoody College of Technology

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The banner features a dark blue background with various icons representing data science (gears, lightbulb, DNA, airplane, globe) and lean manufacturing (factory floor, conveyor belt, gears). The text is prominently displayed in white and red.

## GREAT KEYNOTES!



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SEPT. 20  
**TOYOTA KATA: PEOPLE  
AND PROCESSES**  
**LEIGH ANN SCHILDMEIER**  
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The card features a dark blue background with a white border. It includes a small portrait of Leigh Ann Schildmeier and text describing the workshop.



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