2023 Summer Internship
Jefferson City, TN

Christian Pack

PRESENTATION OUTLINE

- ORGANIZATION OVERVIEW
- INTERNSHIP GOALS
- PROJECTS
    1. STANDARD WORK INSTRUCTIONS
    2. ASSEMBLY LINE TIME STUDIES
    3. COUPLER MANUFACTURING PROCESS
    4. CAB SUB ASSY. OPTIMIZATION
    5. INVENTORY TOOLING & HAND TOOLS
    6. UTILITY DROPS & LAYOUT PLANNING
    7. ASSY. LINE UTILITY BOARDS
    8. BOOM TOOLING FIXTURE
- ACCOMPLISHMENTS
- LESSONS LEARNED
- CONCLUSION

ORGANIZATION OVERVIEW

- **JLG INDUSTRIES, INC.**
  - JLG Industries is the world's leading designer, manufacturer, and marketer of access equipment. JLG delivers powerful and versatile machinery that can be used for reaching difficult areas safely; some of these machines include:
    - Telehandlers
    - Scissor lifts
    - Boom lifts
  - As an Oshkosh Corporation Company, JLG Industries values Honesty, Integrity, Accountability, Respect, and Citizenship in their day-to-day operations. JLG strives to uphold these values through their manufacturing and engineering practices.

INTERNSHIP GOALS

- **COMING INTO THIS INTERNSHIP, I WANTED TO:**
  - Improve my understanding of the manufacturing processes and how it works.
  - Build my professional network by meeting and connecting with employees through different departments.
  - Learn a new software program that is applicable to my future career.
  - Obtain on-hands experience solving real-life issues and the thought process behind solutions.
  - Gain experience working on a team and collaborating towards a desired goal.
  - Improve technical skills relating to machinery usage such as operating a lathe, a mill, and a welder.

PROJECT OVERVIEW

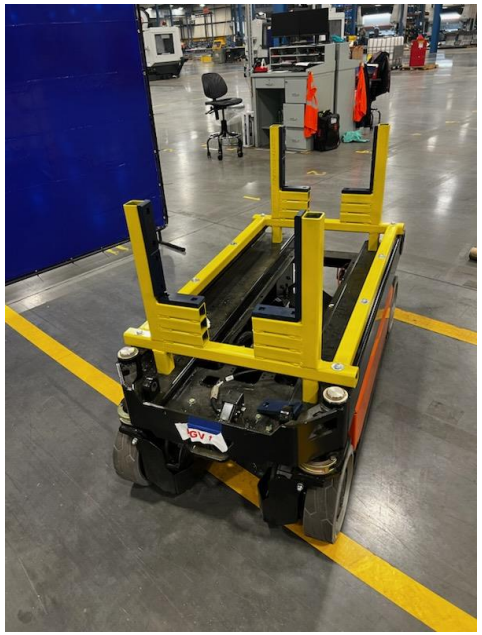
G5-18A SUPER COMPACT PROJECTS:

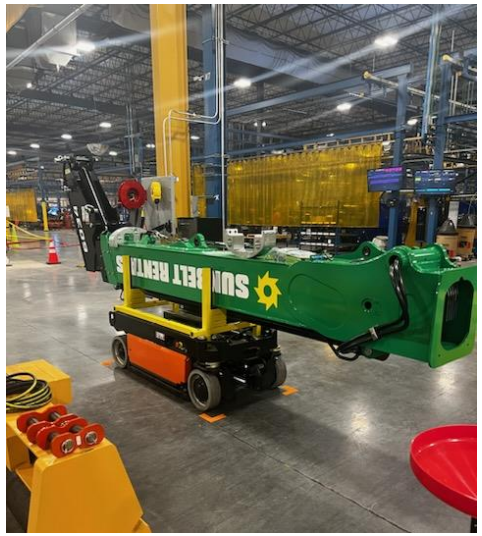
1. STANDARD WORK INSTRUCTIONS
2. ASSEMBLY LINE TIME STUDIES
3. COUPLER MANUFACTURING PROCESS
4. CAB SUB ASSY. OPTIMIZATION

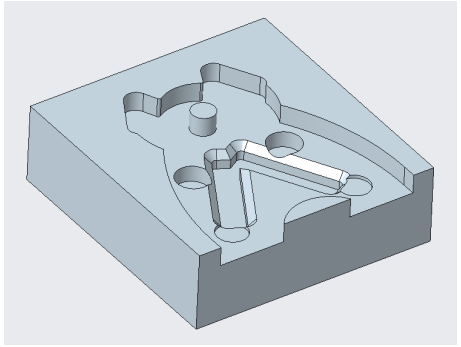
6034/6042 SKYTRAK PROJECTS:

5. INVENTORY TOOLING & HAND TOOLS
6. UTILITY DROPS & LAYOUT PLANNING
7. ASSY. LINE UTILITY BOARDS
8. BOOM TOOLING FIXTURE

PROJECT OVERVIEW







Components

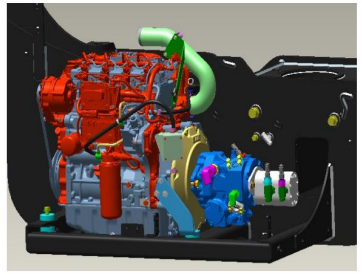
(4) Bolts ( )

(4) Nuts ( )

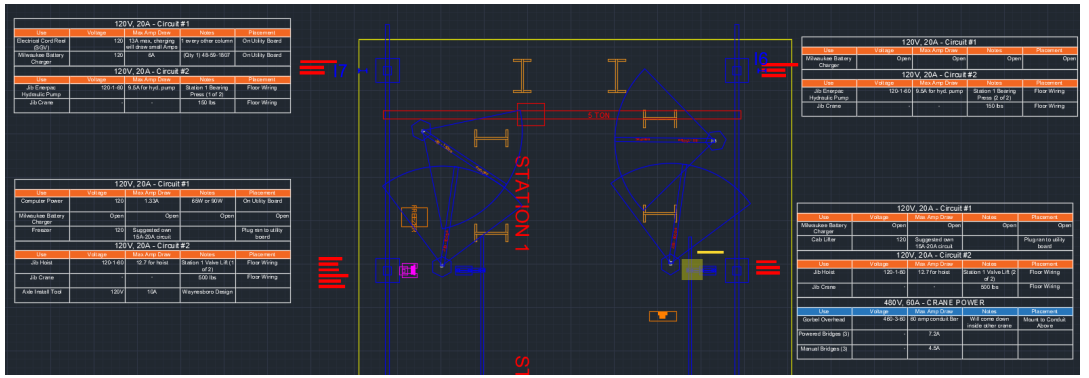
(8) Small Washers ( )

(4) Big Washers ( )

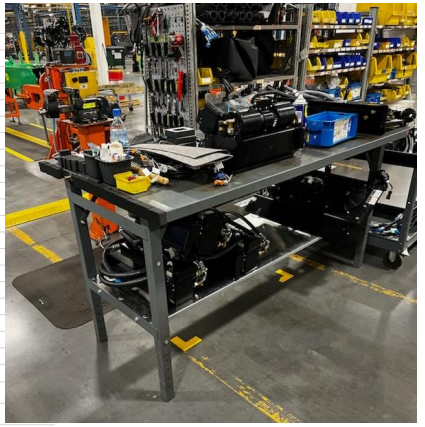
(4) Isolators ( )



• Install the (JLG) or (CAT) Engine Assembly to pod frame using (4) of the bolts, (8) of the washers, (4) of the washers, (4) of the Isolators, and (4) of the nuts.
•**Torque nuts to 185 Ft. Lbs.**

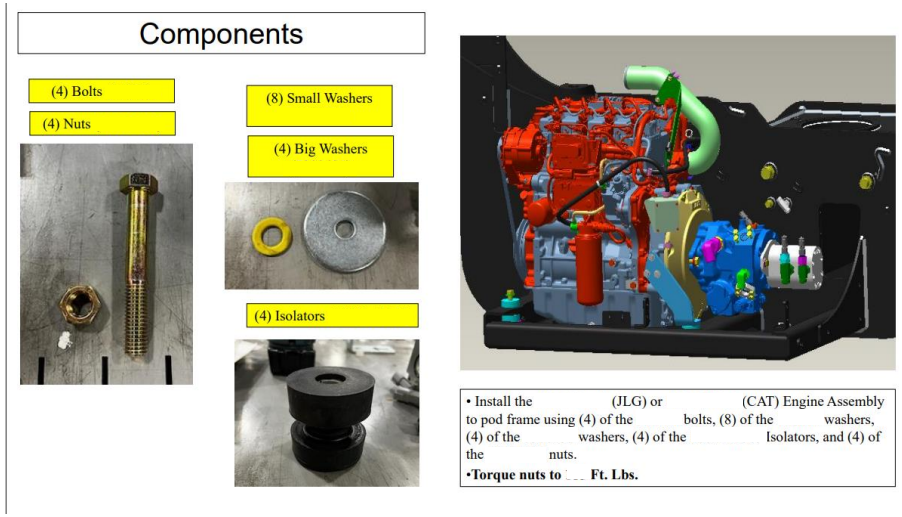


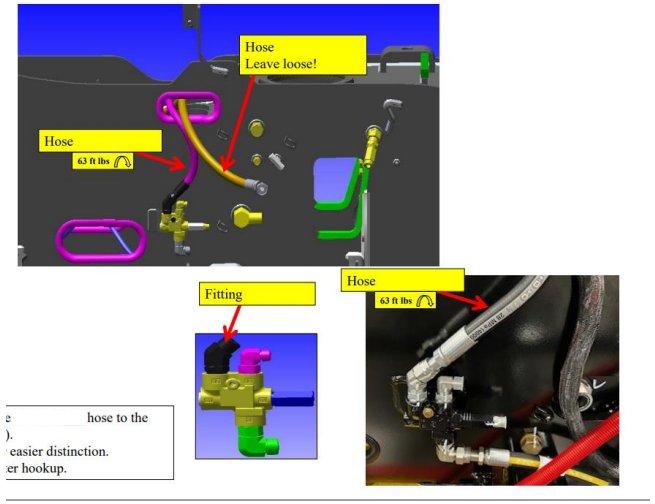
3. Cab Install	Step #	Action	Time	Seconds	Task Time	Recorded Station Time	Notes
-	1	Prep Cab Frame and electrical					Battery and fuses are typically already prepped by the time it gets to cab. Depends on how backed up, parts, etc. 4 Operators working around each other. • Prep Work/Battery/Under Cab Routing • Engine/Radiator Routing • Installing Cab, Rear Fender, Air Filter • Sometimes under frame cab routing, accessory work mostly. 3 of the operators on 3 different sections of the cab use the same torque wrench; sometimes waiting on the other.
-	2	Prep hose placement and hook Cab to move					
6,7,8	4	Hoist cab and align in Holes					
7	5	Impact Top Bolts					
Move to Radiator Install 21	6*	Install Hyd. Hose T Port of Pump (from Cab)					
9,10,11,12,13,14	6*	Connect hoses underneath Frame (Steering Valve)					
16-21	6*	Connect hoses at PCV and MCV					
22,23	7	Install Hyd. Tank Breather Line (Cab)					
Move to Radiator Install 7	9	Install Rear Fender Plate					
Move to Radiator Install 26		Install Glow Plug Relay					
Move to Radiator Install 8	10	Install Air Filter and Clamp Hose					
Move to Radiator Install 7	11	Foam Padding on Rear Fender Plate					
?	13*	Install hose to second T-fitting on Pump					
24	13*	Install Ground Wires and Ready Fuses					
24	13*	Install Relays, Harness, Fuse Panel					
26	14*	Install Horn					
Move to Radiator Install 28	14*	Connect Compressor/Heat Hoses to Cab					
-	14*	Mark Paint Torque					
7	15	Impact Bottom Bolts					
25	16	Install Battery					
Specify 35	17	Fill up Diesel Fuel (@CABS)					
	Total	3 Operators					



PROJECT #1: STANDARD WORK INSTRUCTIONS

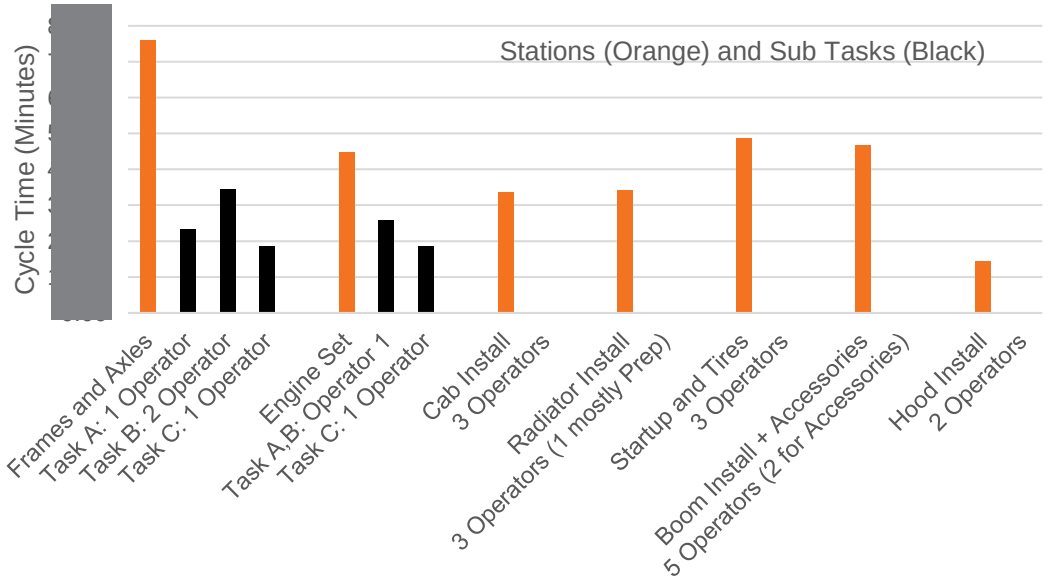
- **OPTIMIZED STANDARD WORK INSTRUCTIONS**
  - Spent the first few weeks understanding JLG machinery with experienced advice from technicians.
  - Cross-checked / updated torque requirements, part numbers, and processes called for in the SWI.
    - Included 3D Models and Updated Pictures for the new SWI's.
  - Re-ordered tasks according to current methods and optimized locations.
    - Noted extra steps and tooling required that was not previously listed.





PROJECT #2: ASSEMBLY LINE TIME STUDIES

- **PERFORMED TIME STUDIES**
  - After understanding the assembly process, definitive tasks were established for timing purposes.
  - Evaluated the main assembly line and determined tasks to be moved or carried out by other technicians or stations for a more efficient process.
    - Ex: Moving hood latch panel sub assembly from Boom Install to Hood Install (~5 min)



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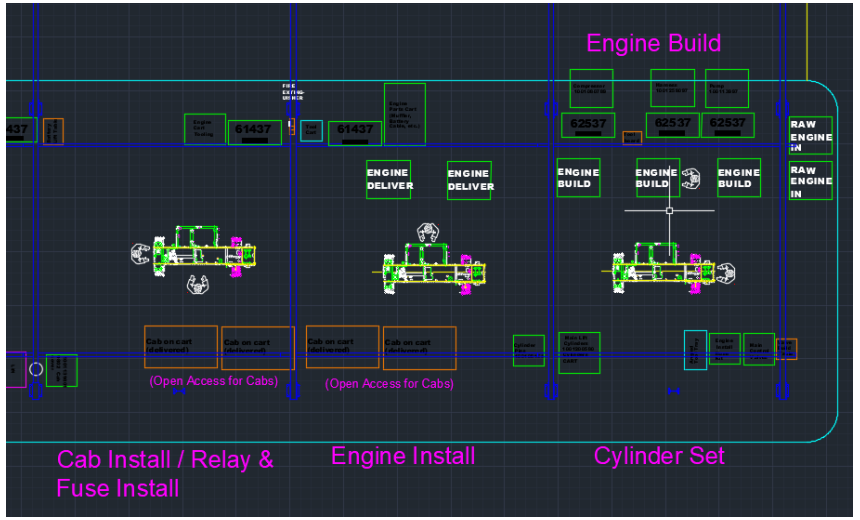
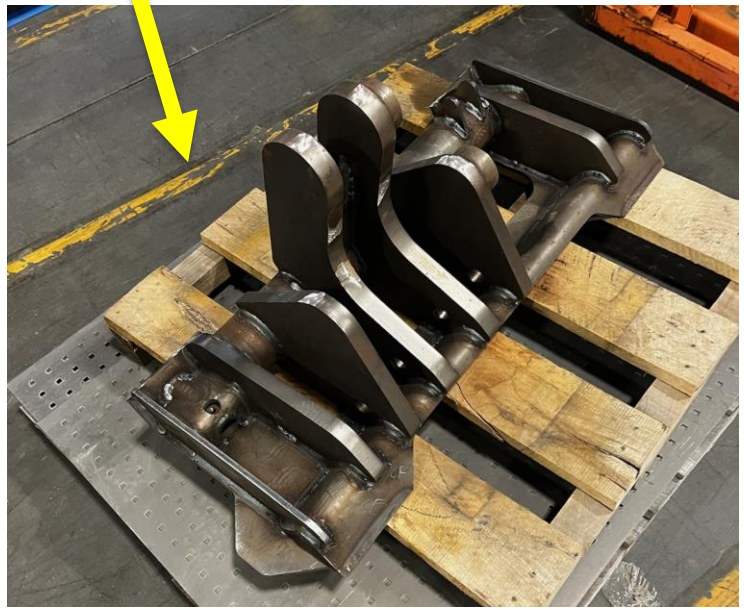
PROJECT #2: ASSEMBLY LINE TIME STUDIES

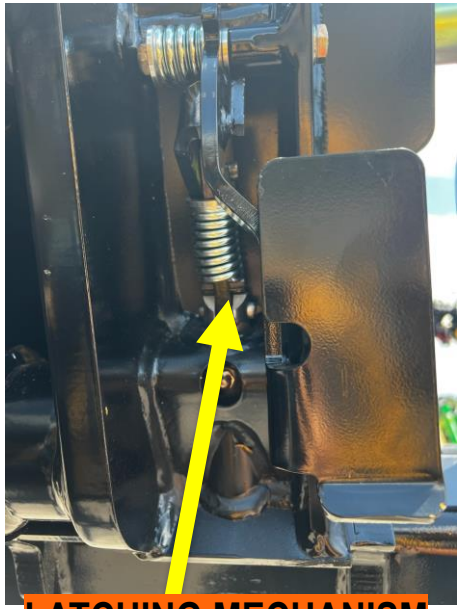
- **DEVELOPED SOLUTIONS**
  - Created general improvements for time-loss situations.
    - Ensuring Cylinder Install has their own tool cart + torque wrenches to prevent foot traffic (~4 to 5 minutes).
    - Storage Bin for Radiator Sub Assy to prevent coolant tanks from falling at workstation (~15 min a day balancing tanks for storage or picking them from the floor).
  - Re-arranged layout with guidance from experienced technicians and engineering employees.
    - New Car Lifting Device required re-arrangement of layout.

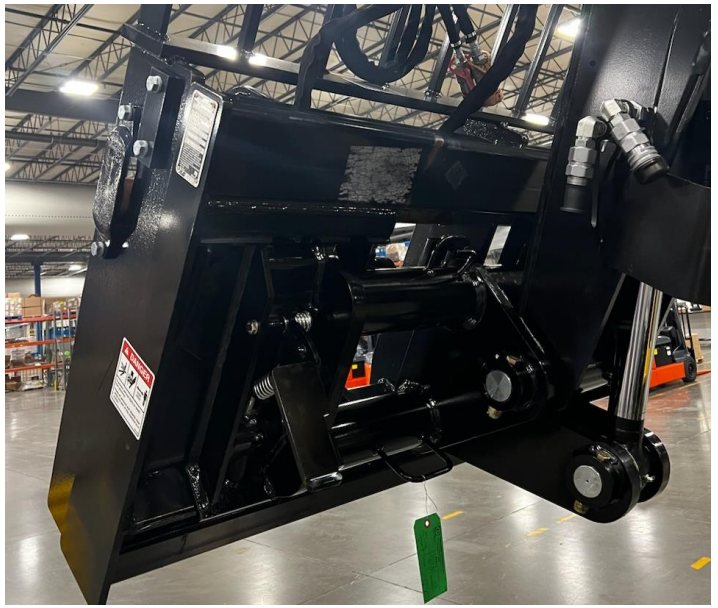


PROJECT #3: COUPLER MANUFACTURING PROCESS

- **COUPLER LATCHING MECHANISM**
  - This model coupler requires two latching mechanisms that allow for a quick removal or install of a telehandler carriage attachment.
  - Previously, we were receiving couplers pre-assembled into our facility, but as a push towards cost reduction Jefferson City opted for a welding initiative to produce in-house couplers.
    - Reducing costs from ~$4000 to ~$1600 per coupler.

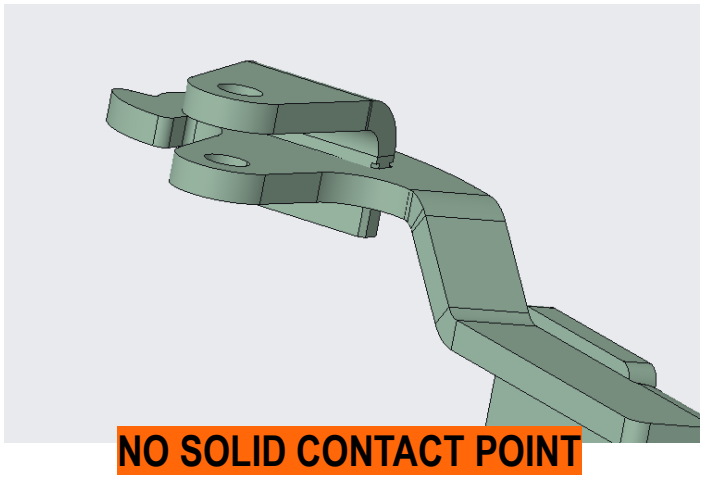






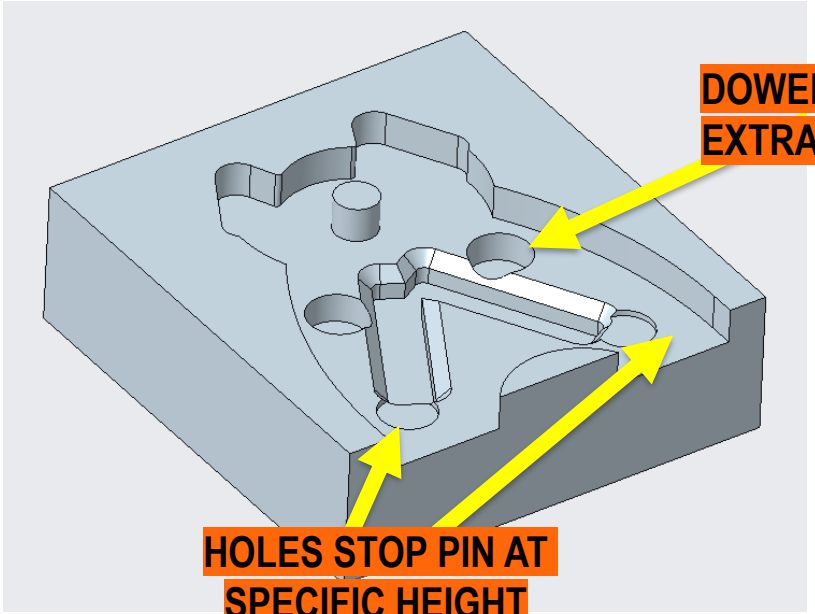
PROJECT #3: COUPLER MANUFACTURING PROCESS

- **3-D PRINTED AID FOR HYDRAULIC PRESS**
  - To sustain our in-house coupler welding initiative, we also required in-house production of these latching mechanisms.
  - Created a 3-D printed piece to hold coupler handle steady as hydraulic press presses roller pins into assembly.
    - Originally, there was no continuous surface solid enough to press a pin into without deformation.
    - Odd curvature of handle made roller pins tricky to press consistently and efficiently.



PROJECT #3: COUPLER MANUFACTURING PROCESS

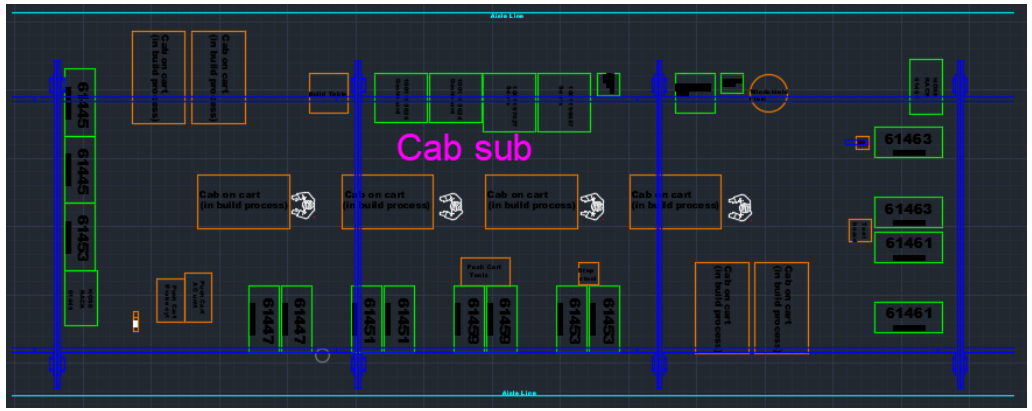
- **3-D PRINTED AID FOR HYDRAULIC PRESS**
  - Printed aid to a certain height that allowed handle to sit flush giving two solid points of contact.
    - Can work on both left and rights handles for convenience.
  - Designed with future CNC milling in mind for a stronger alternative to PLA.



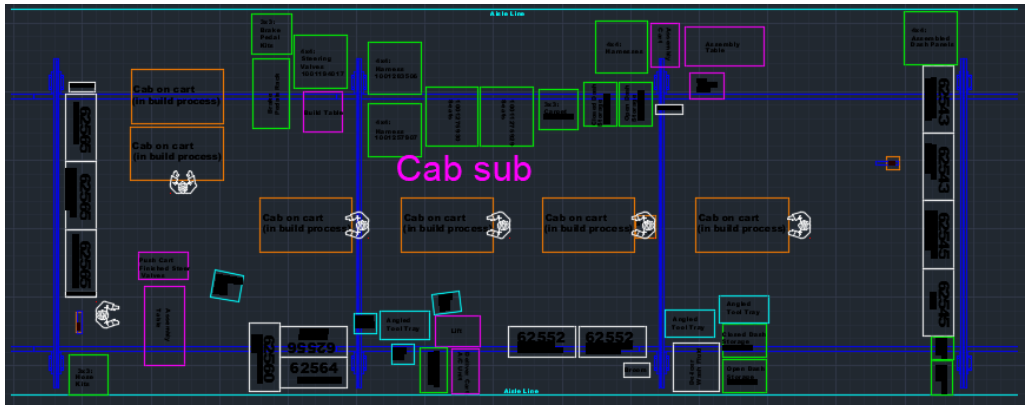
PROJECT #4: CAB SUB ASSY. OPTIMIZATION

- **FLOOR LAYOUT AND WORK PROCESS IMPROVEMENTS**
  - Studied SWI and evaluated logical order and grouping for certain tasks. Then proceeded to rearrange the required parts/hardware for each task closest to a technician's area in station.
  - Previously, cabs could only get an average of 6 to 7 cabs in one workday (10 hours), now cabs can easily produce 6 to 7 cabs within 6 hours at normal staffing occupancy.
    - 0.7 cab/hr v.s. 1.16 cab/hr. Thus, increasing production to an average of 10 cabs completed per quota requirements.
    - Overall, with a more organized and established floor layout / task order, cabs have increased production by roughly 65%.

OLD LAYOUT



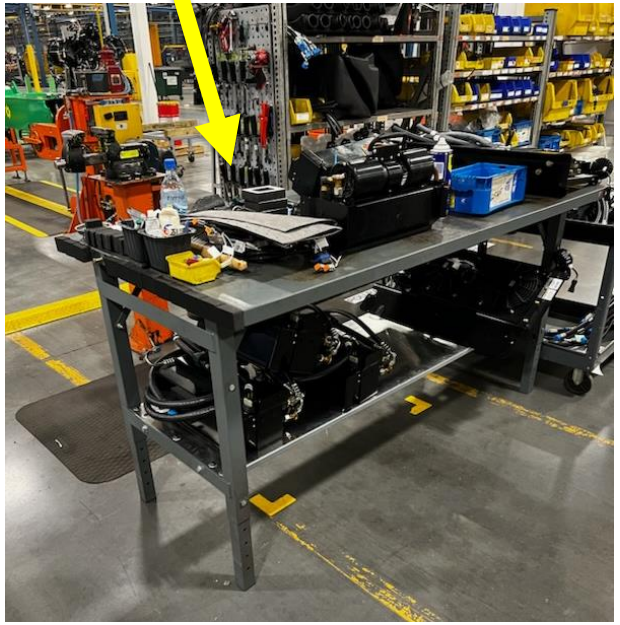
NEW LAYOUT



PROJECT #4: CAB SUB ASSY. OPTIMIZATION

- **NEW STATION COMPONENTS**
  - Cut and assembled custom assembly tables and racking to store parts and hardware benefiting both technicians and materials handlers.
    - Originally would be storing SAME part in two different places due to constraints.
  - Measured required dimensions, laser cut aluminum sheeting, and cut Unistrut framing for an additional storage shelf.
    - Technicians expressed appreciation for solution, saves struggle with walking/organization.

NEW ASSY. TABLES

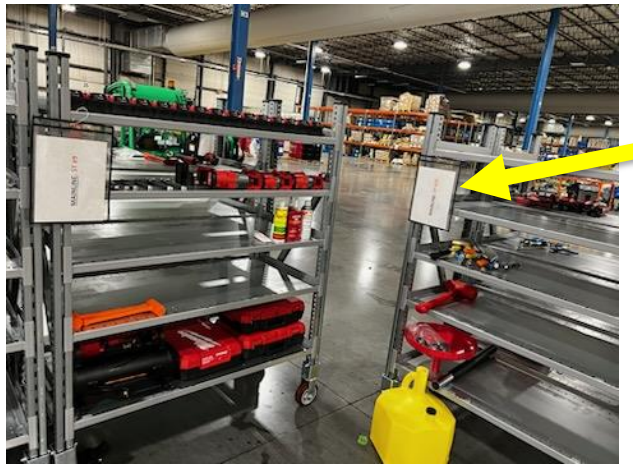


NEW STORAGE SPACE

PROJECT #5: INVENTORY TOOLING & HAND TOOLS

- **HAND TOOLS LIST**
  - Utilized tools list from Chambersburg, PA Facility and verified our received in hand tools for each station for the new Skytrak Telehandler Line.
  - Organized each station onto shelf and ordered missing tools (sockets, hand tools, impacts) if needed prior and during Skytrak Launch.
  - After line set up, additional or missing tools were ordered and distributed to station.
    - All additional purchases were tracked and recorded for a finalized tools list of assembly line.
    - Started a hand tools list for the G5-18A Super Compact line as well for reference.

	On Shelf?	Description	Drive	size	well
Station #4A	y	Breaker bar	1/2"	18"	N/A
	y	extension	1/2"	4"	N/A
	y	Milwaukee	1/2"	2862-22R	case
	y	Milwaukee	3/8"	2668-20	wrench
	y	side cutter			
	y	Socket	1/2"	15/16"	Deep
	y	Socket	3/8"	1/2"	Deep
	y	Socket	1/2"	15/16"	deep 12pt
	-	Torque Wrench (Quality)	N/A	N/A	17 ft. lbs.
	-	Torque Wrench (Quality)	N/A	N/A	23 ft. lbs.
	y	Wrench	N/A	15/16"	N/A
	n	Wrench rachet	N/A	1/2"	N/A



ORGANIZED BY STATION

PROJECT #5: INVENTORY TOOLING & HAND TOOLS

- **LARGE TOOLING LIST**
  - Coordinated with project manager to arrange placement and storage of received in tooling for the weeks leading up to launch.
  - Labeled received in tooling and followed up with outside distributors on missing components that were critical to line set up.
    - Ex: Notified project manager we were awaiting cab lifting device for Station #2, critical for first week of launch.
  - Ensured all tooling was here for smooth transition for initial machine production.
    - 1st Week of Production (7/31-8/4) had initial machines through each of their targeted stations.
    - Program Manager and others stated no other line setup has been on track, much less ahead of the goals.

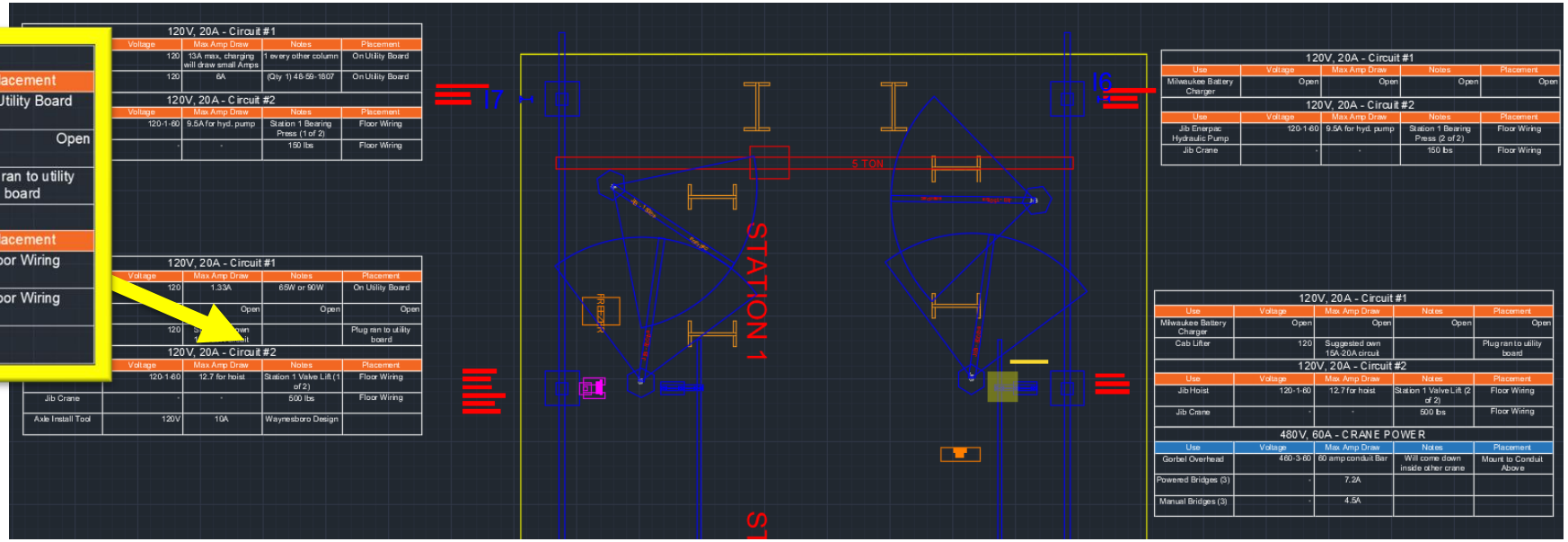
LINE	Crucial	Verified	COMPONENT
		y	OH (5T)
		n	Base Lift Table
		y	Small Lift Table
		n	Tele Cylinder lift table topper
		y	Rollers SM
		y	Rollers LG
		n	Roller Frame Short (???)
		n	Roller Frame (18x32x96)
		n	Winch Stand
		n	Winch
		y	HYDRO PUMP FOR WINCH
Boom Sub BASE/MID/FLY		y	Jib - 150lb Bearing Press
		-	Need tooling for bushing press.
	Only 3	y	Grease Pump

VERIFIED RECEIVED TOOLING

PROJECT #6: UTILITY DROPS & LAYOUT PLANNING

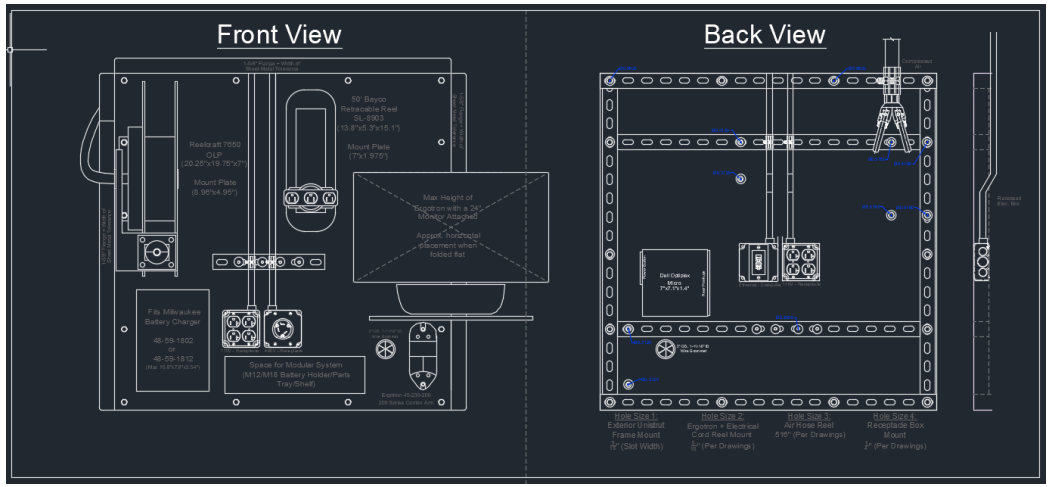
- **MAPPED ELECTRICAL REQUIREMENTS**
  - Each station required specific utilities such as compressed air, 120V, or 480V hookups.
  - Knowing that, I mapped out what utilities would be at each station and researched the requirements for each device.
    - Presented our electrical contractors a large plot of pre-determined electrical circuits detailing their desired location, used devices, and amperage and voltage requirements.
    - Contacted exterior distributors for unclarified electrical ratings necessary for our contractors.

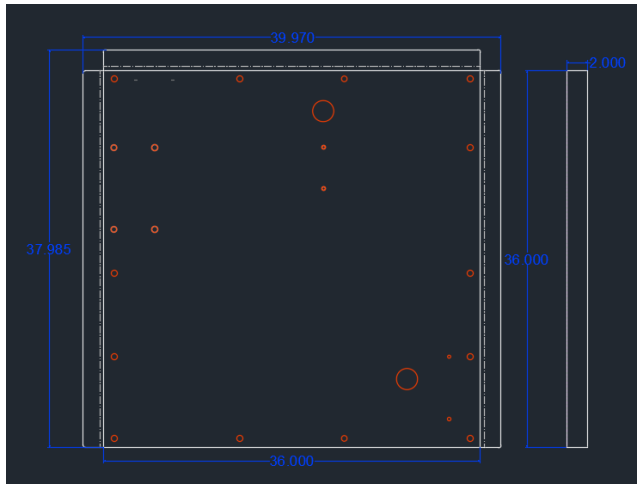
120V, 20A - Circuit #1				
Use	Voltage	Max Amp Draw	Notes	Placement
Computer Power	120	1.33A	65W or 90W	On Utility Board
Milwaukee Battery Charger	Open	Open	Open	Open
Freezer	120	Suggested own 15A-20A circuit		Plug ran to utility board
120V, 20A - Circuit #2				
Use	Voltage	Max Amp Draw	Notes	Placement
Jib Hoist	120-1-60	12.7 for hoist	Station 1 Valve Lift (1 of 2)	Floor Wiring
Jib Crane	-	-	500 lbs	Floor Wiring
Axle Install Tool	120V	10A	Waynesboro Design	

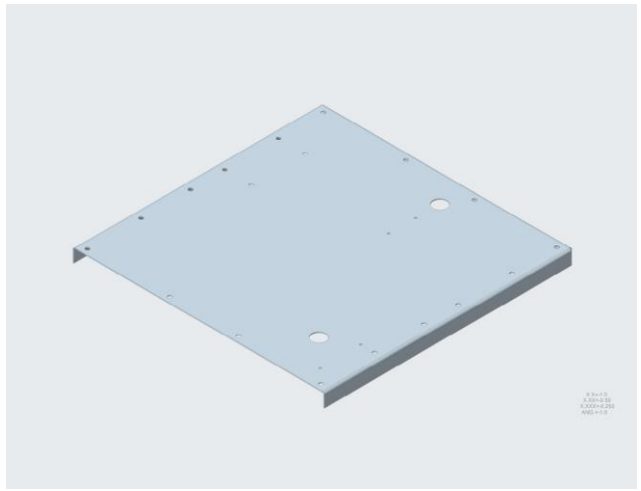


PROJECT #7: ASSY. LINE UTILITY BOARDS

- **CREATED A JLG STANDARD UTILITY BOARD**
  - Designed and fabricated a universal utility board with predetermined holes ready for mounting air hose reels, electrical cord reels, computer arms and more.
    - Researched and drafted needed dimensions for chosen tooling and hole spacing.
  - Featured a Unistrut frame backing for structural support.
  - Established throughout the 6034/6042 model assembly line at every column post.
    - A total of 60 boards were fabricated in-house and sent out for paint, 25 remain for future use.

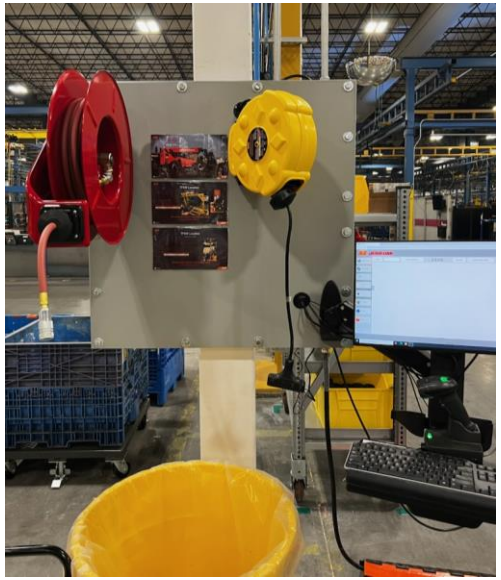






PROJECT #7: ASSY. LINE UTILITY BOARDS

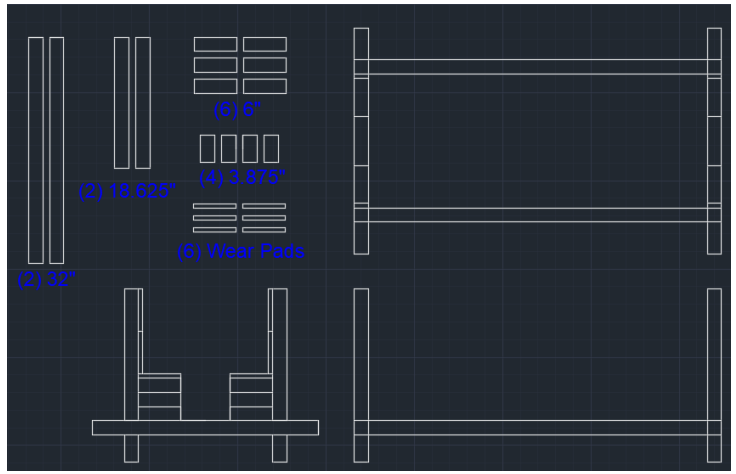
- **FUTURE EXPANSION**
  - Project Orchard is the first initiative towards developing Jefferson City'"Factory of the Future."
  - With these utility boards, every column post can be fully customizable and adapted to fit the current or future needs within that space.
  - The utility boards are pending official approval to add to the JLG standards' database.
    - Jeff. City Program Manager advocated for it, and Senior Directors expressed interest in it.



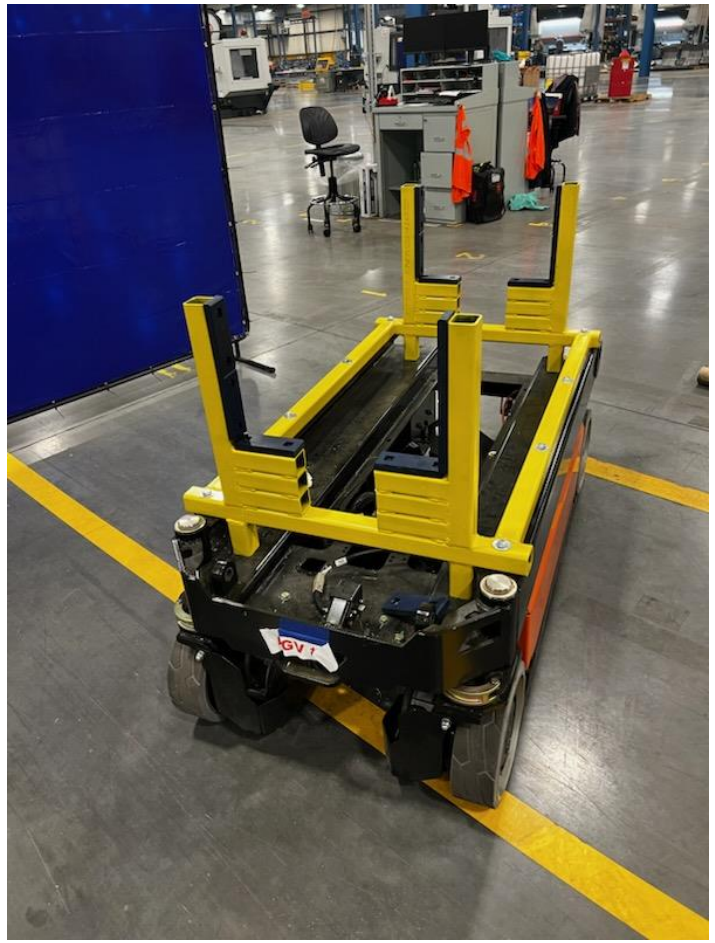
PROJECT #7: ASSY. LINE UTILITY BOARDS

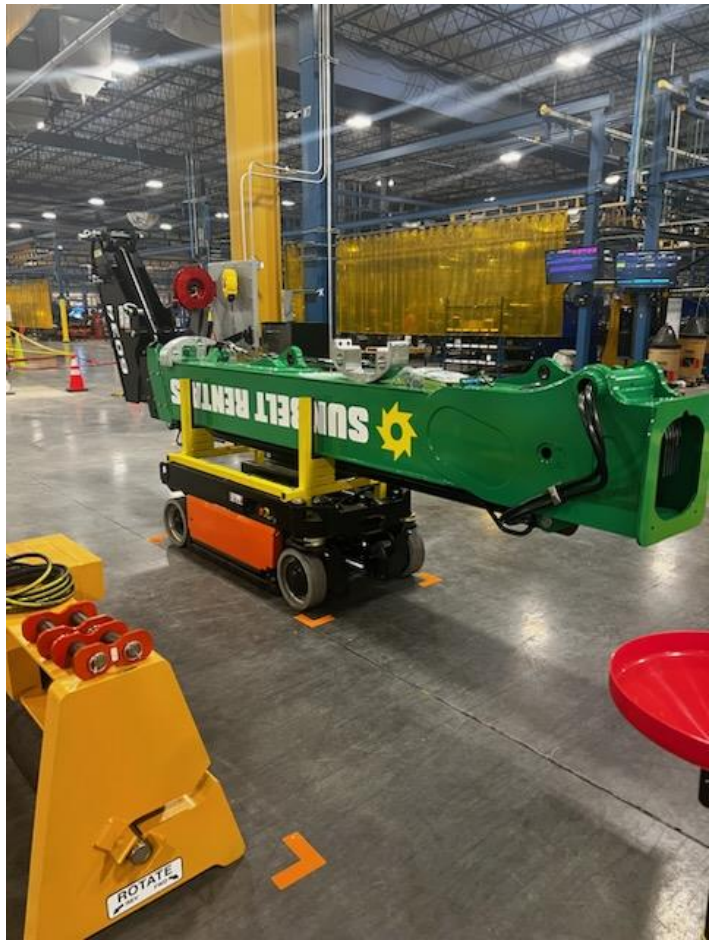
PROJECT #8: BOOM TOOLING FIXTURE

- **FABRICATED BOOM ARM TOOLING**
  - Took dimensions from Creo PTC and drafted a suitable tooling fixture with the materials we had on hand.
    - Used 2x2 steel tubing and boom wear pads to design a framed support that would be retrofit onto a scissor lift base.
  - Cut the steel tubing, welded the frame, and painted it OSHA safety yellow.
    - Drilled and tapped holes to mount wearing pads for boom paint protection.



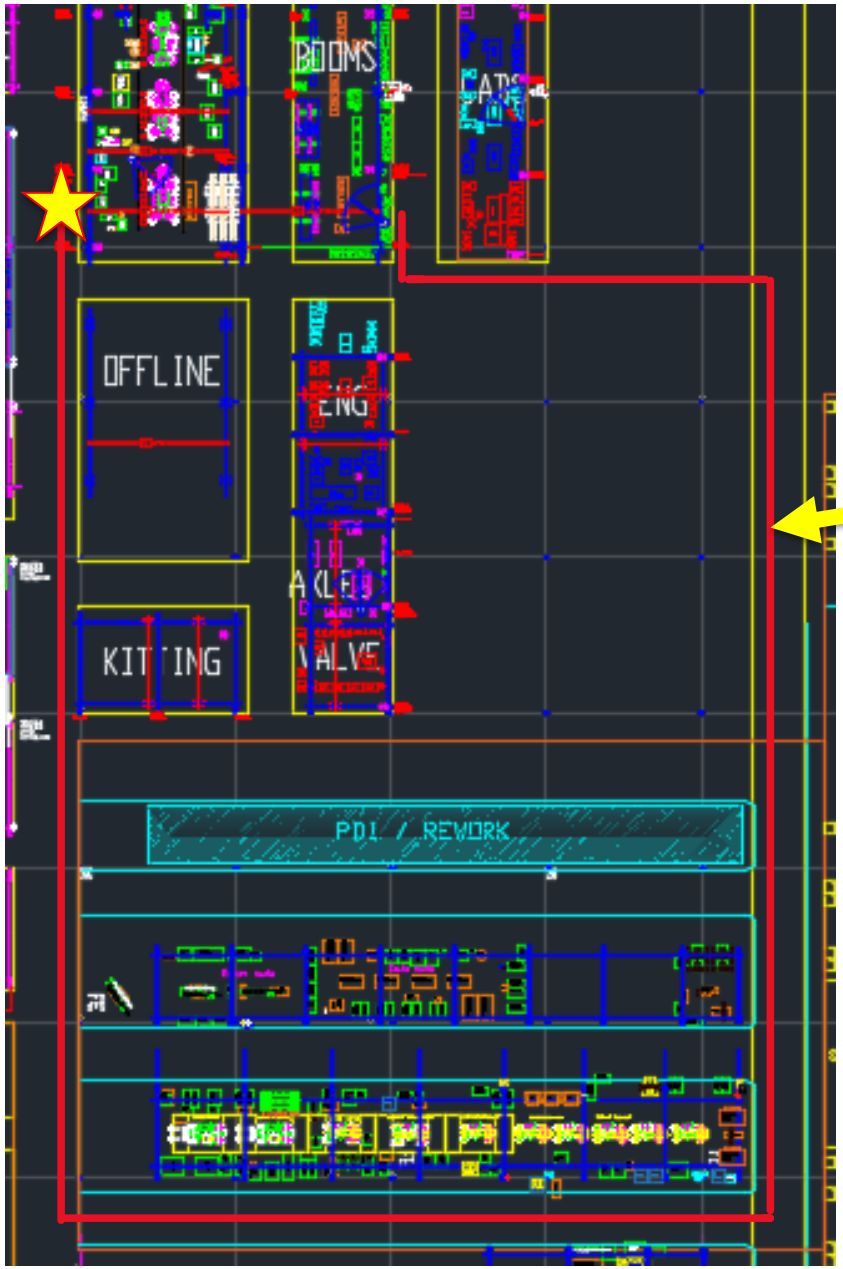
PROJECT #8: BOOM TOOLING FIXTURE





OLD BOOM DELIVERY SYSTEM:

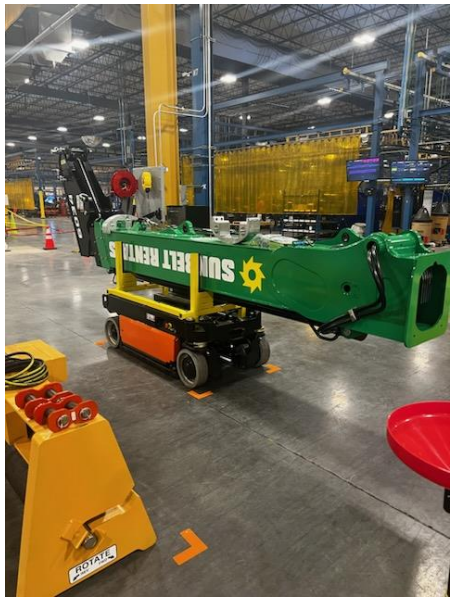
- PURCHASE COMBILIFT
- DRIVE ~700 FT TO DELIVER

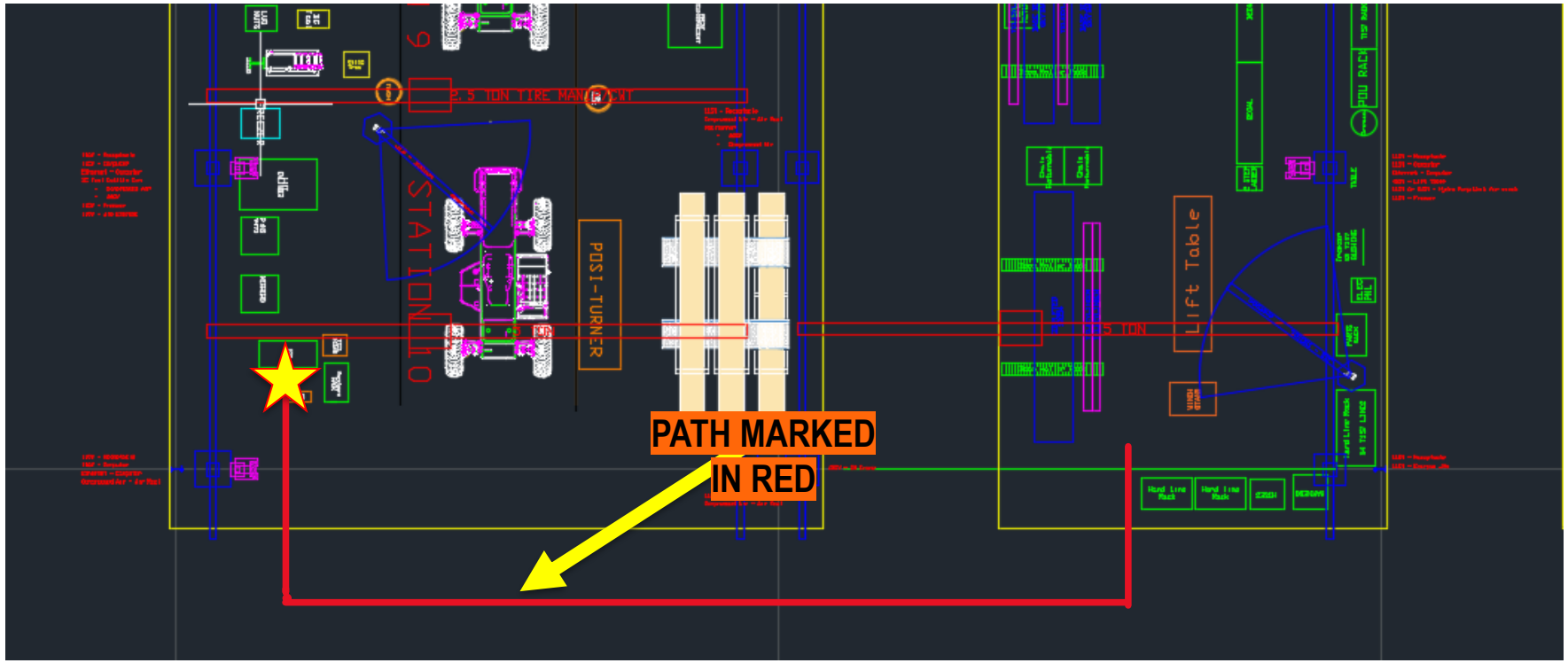


PATH MARKED IN RED

NEW BOOM DELIVERY SYSTEM:

- UTILIZE SCISSORLIFT BASE
- DRIVE ~60 FT TO DELIVER





Delivery placement is wrongly depicted, drawing was updated 7/19 with Positurner and Booms on marked side.

PROJECT #8: BOOM TOOLING FIXTURE

- **MORE COST EFFECTIVE AND LESS TIME CONSUMING**
  - Proposed Method: Purchase Combilift ($80,000), drive ~700 ft around warehouse, and deliver on exterior of aisleway.
    - Time: 59.65s @ 8mph (One Way)
    - Cost: $40,000 yearly maintenance + salary of Forklift Operator (~$40,000) + initial purchase.
    - Would have to wait on available Operator to drive over and hoist onto machine.
  - Tooling Fixture Method: Hoist boom into tooling, drive ~60 ft to main line, and deliver directly to Positurner machine.
    - Time: 13.63s @ 3mph (One Way)
    - Cost: $200-500 yearly maintenance + utilize pre-existing Technician
    - Can be sent over to Main Line by only one person hoisting into tooling + delivering.

	OLD METHOD	NEW METHOD
COST	$40,000 Yearly Maintenance + $40,000 New Salary	$200-500 Yearly Maintenance + Pre-Existing Salary
TIME	59.65s @ MAX 8mph + Wait for Forklift	13.63s @ 3mph + No Wait for Technician

ACCOMPLISHMENTS

- **SUPER COMPACT PROCESS IMPROVEMENTS**
  - Improved assembly line processes to deliver Super Compact Telehandlers down to a 45-minute cycle time.
    - Originally produced 7-8 Telehandlers a day, now 10 consistently due to organizational improvements.
  - Created custom components for line use that increased efficiency and productivity; ensured tasks were systematic and trouble-free.
    - Ensured that our technician's tasks were adequately systematic and trouble-free.
- **SKYTRAK LAUNCH**
  - Provided contractors with required utility drops (air and electrical) and designated tooling to each column location.
    - Worked with electricians to understand electrical schematics and amperage requirements for circuits.
  - Created universal utility board with adaptable use for current and future needs of assembly line.
    - Learned Creo Parametric to design the cuts and bends for aluminum sheet panels.
  - Fabricated tooling for boom arm transportation that cuts thousands on yearly overhead costs.
    - Underwent the engineering design process for a real issue and learned how to weld.

LESSONS LEARNED

- **THROUGH THIS INTERNSHIP I WAS ABLE TO:**
  - Learn how a large-scale manufacturing company operates on a day-to-day basis.
    - Understood delivery requirements, distributor concerns, mechanical designs, assembly line processes, and the overall structure of a manufacturing company.
    - Customers around the world depend on JLG for our notable quality when reaching new heights and areas; lives are at risk and our meticulous work is necessary for the safety of our customers.
  - Build technical skills that are applicable to my future career.
    - Learned new program suites such as Creo Parametric and Windchill while mastering previous skills in AutoCAD.
    - Underwent the engineering design process through creating utility boards and the boom fixture.
    - Learned and improved on valuable skills with a manual lathe, mill, and arc welder.
  - Enhance team communication and collaboration skills.
    - Worked with a group of 4 JLG employees to ensure smooth daily operations and improvements were made.
    - Communicated with Program Manager to warrant a smooth Skytrak launch, and all loose ends were tied.
    - Tasks were often delegated to respective employees and effective communication was required to ensure efficiency and correctness.

CONCLUSION

- **OVERALL, A VERY VALUABLE OPPORTUNITY**
  - Developed myself with practical technical skills while building confidence in team working abilities.
  - Very grateful for the opportunity and the mentors that guided me through the internship.