

Assembly Cart Automation Project

Kubota



PROBLEM STATEMENT

- Operator in the current assembly line of Kubota plant has to unhitch a heavy cart from the AGV and manually wheel it to the conveyor chain and drop the pin for the dog lever to engage
- This operation becomes strenuous and is cause of fatigue when it has to be performed repeatedly for several times in a typical work day
- Above said manual process is causing a significant production loss and huge time lapse in the assembly line

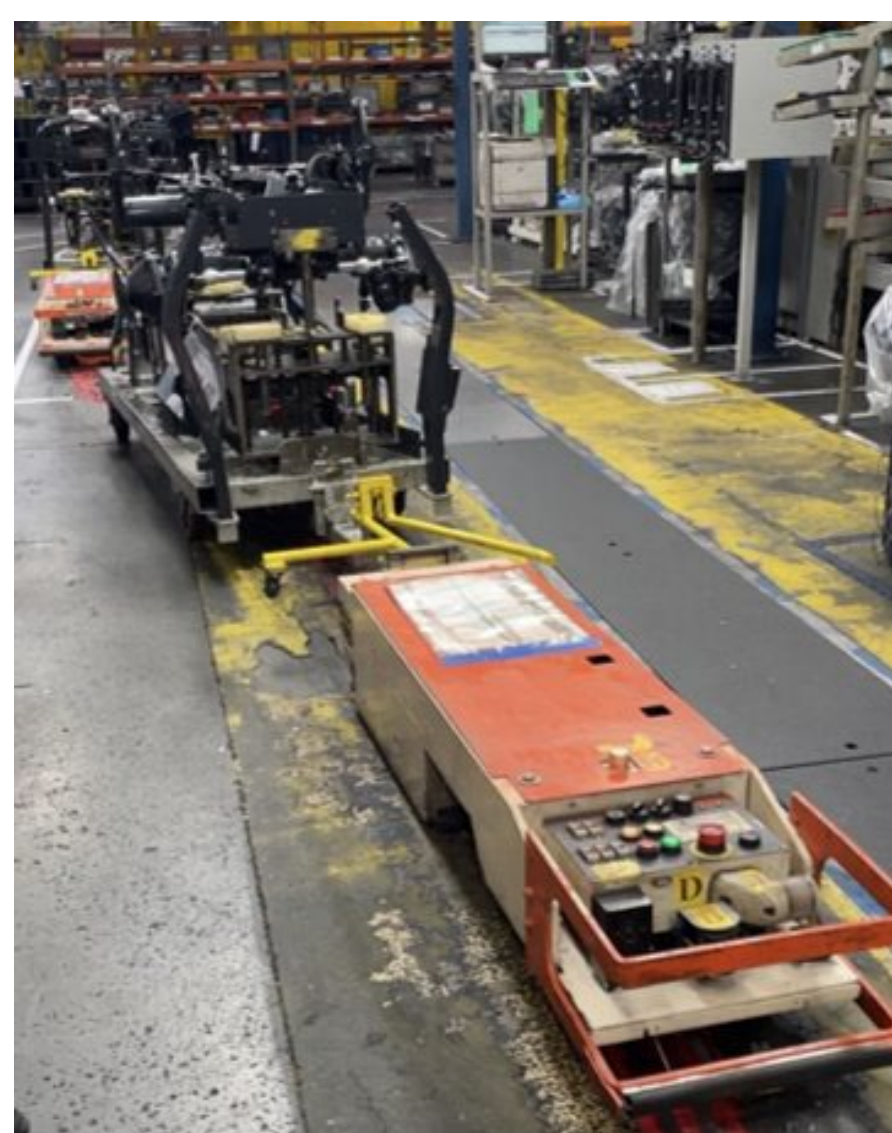


Figure Caption: Multiple carts waiting to be unhitched. They are backed up due to the operators having too much workload



Figure Caption: An operator having to manually pull the cart and drop the pin to the conveyor chain

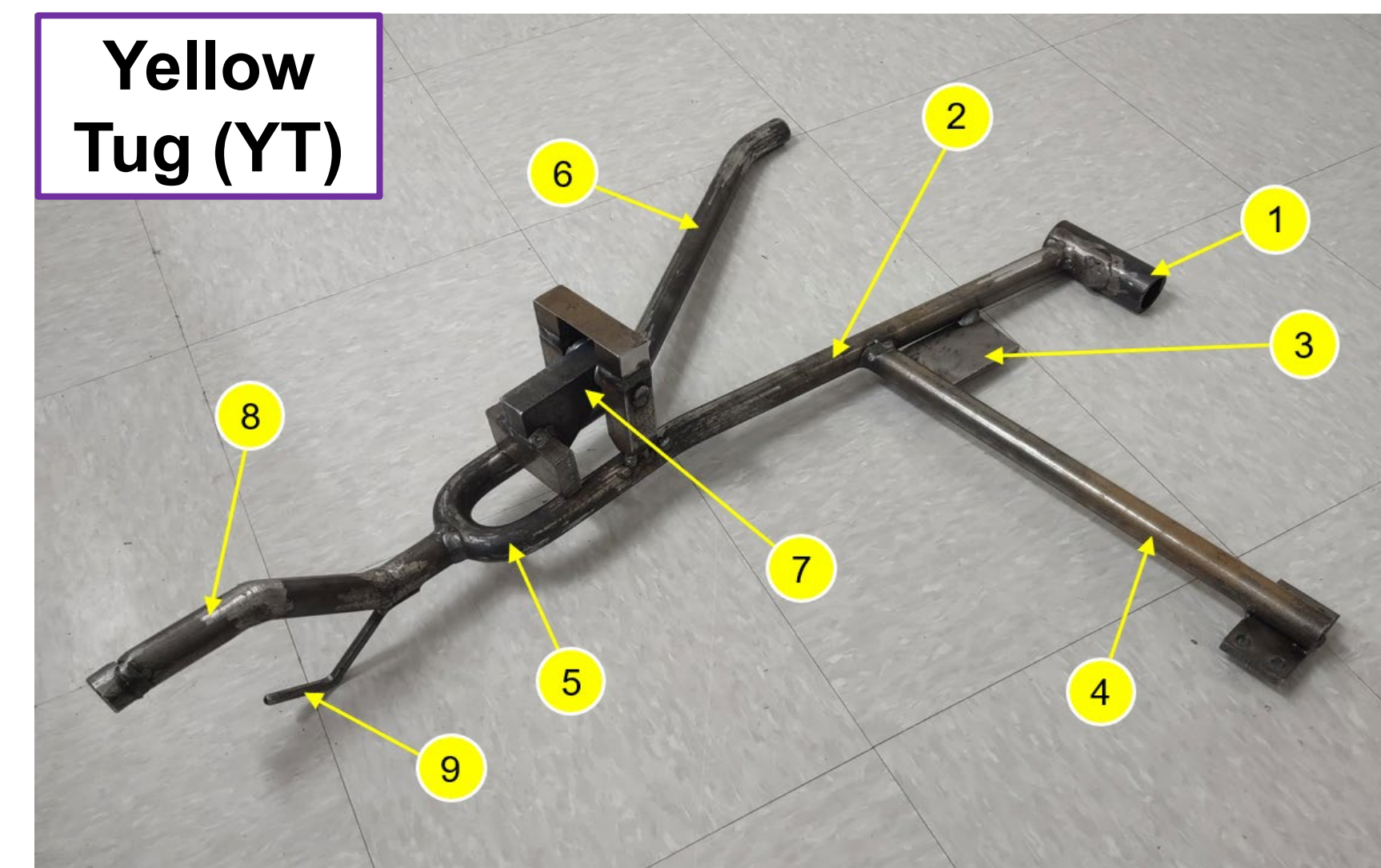
REQUIREMENTS

- Transfer of cart from the AGV and its engagement with the dog chain needs to be automated with manual override
- The Design needs to meet Kubota Safety standards and manufacturable by inhouse Welding shop.

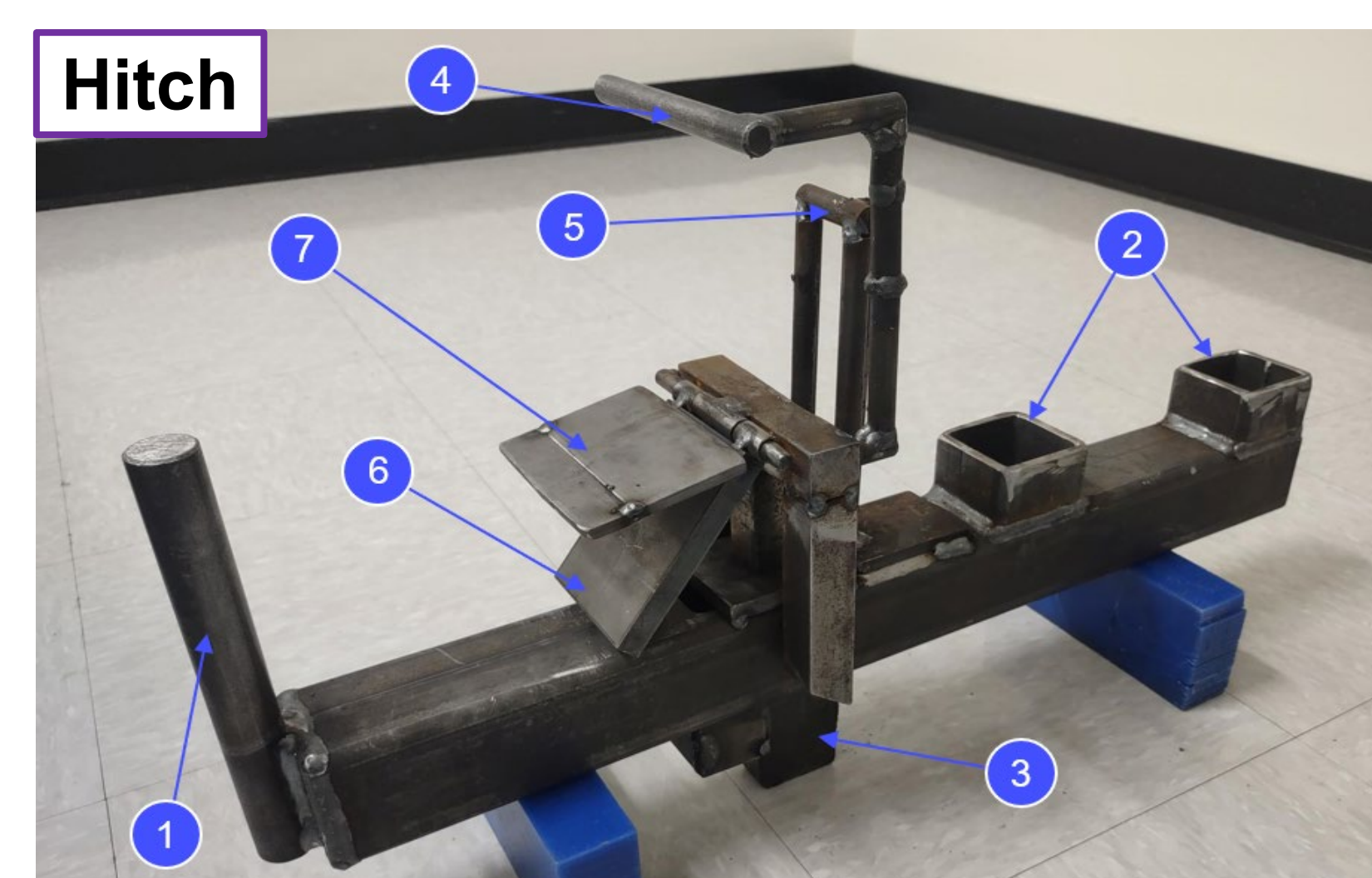
CONCEPTS

- Fixed Concept
- Four Bar Concept
- Pivot Link and Joint Concept
- Telescoping Cylinder Concept
- Up and Down Concept
- Wedge Concept

FINAL DESIGN, APPROACH, PLAN



Part Bubble	Part Name	Function
1	AGV Attachment	A pin joint where the AGV connects to the YT
2	Offset Arm	Aligns the AGV to the side of the dog chain while the cart is inline with it
3	Support Plate	Helps the YT rest on the AGV's support stop correctly
4	Caster Arm	Causes the YT to lift when its caster goes over a ramp
5	Hitch Pole Pocket	Is where the hitch pole sits and is pulled from
6	Funnel Arm	Funnels the hitch pole into the pocket when the AGV is picking up the cart
7	Gate	Allows the hitch pole to slip into the pocket but prevents it from sliding out
8	Pin Release Arm	Lifts and drops the pin
9	Gravity Latch Hook	Pulls the gravity latch out of the way when the pin drops



Part Bubble	Part Name	Function
1	Hitch Pole	Is pulled by the YT
2	Cart Attachments	Where the hitch attaches to the cart
3	Pin	What drops into the dog chain
4	Pin Handle	What is lifted by the YT
5	Pin Guides and Stop	Keeps the pin aligned and stops it from coming out
6	Gravity Latch	Keeps the pin in the up position after it is pulled up
7	Gravity Latch Lever	What the YT hooks on to pull the gravity latch out of the way

RESULTS

FEA Stress Results of the Yellow Tug

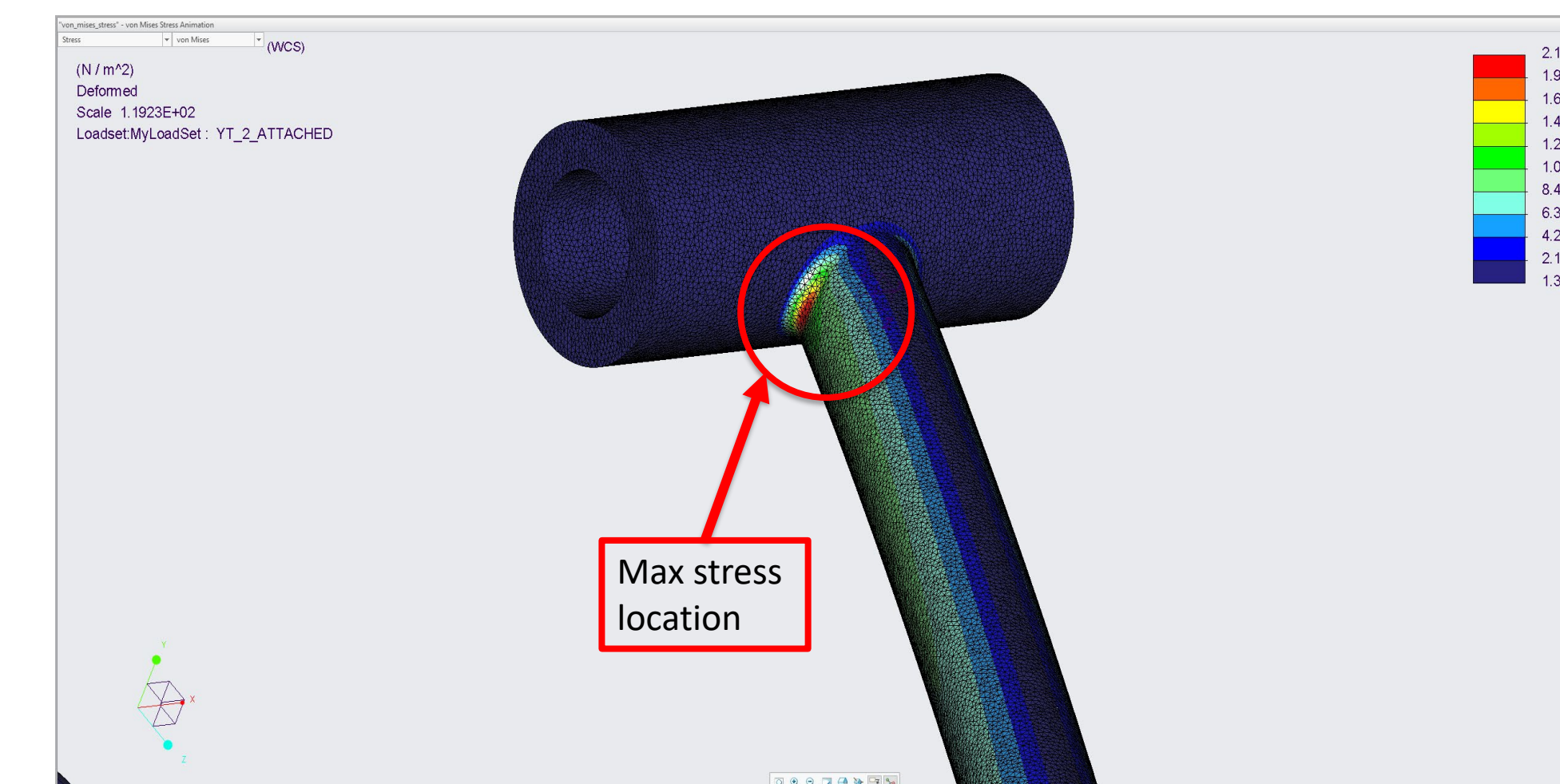


Figure Caption: Simulation results of when the AGV is pulling 99.8 N of force on the yellow tug. FEA results were made before the yellow tug was altered multiple times. These changes are negligible due to some features that were not changed

FEA Analysis Convergence of the Yellow Tug

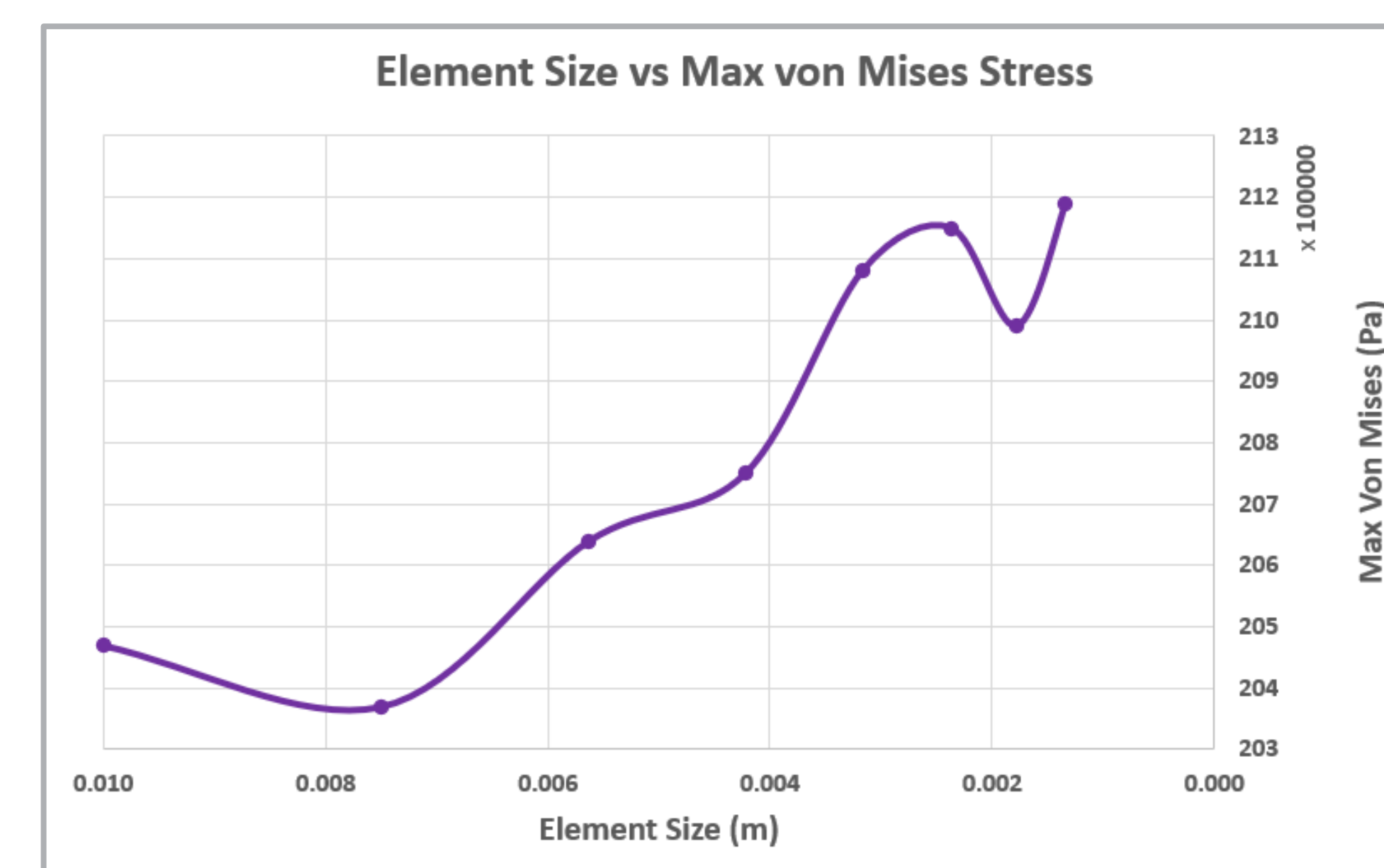


Figure Caption: Convergence of the maximum stress as a function of element size

Minimum Required FOS	Minimum FOS Forward	Minimum FOS Backward
6	10.14	10.17

Original Time Cycle

Iterations	Time (sec)	Total in 30 min cycle	Total in 60 min cycle	Total in 8 hr day	Total in 5 day work week
1	13	-	-	-	-
2	11	59	118	15.73	78.66
3	18	Seconds	Seconds	Minutes	Minutes
4	17	-	-	-	-

New Time Cycle

Iterations	Time (sec)
1	2.38
2	1.83
3	2.09
4	3.11
5	2.04
6	1.84
7	1.79
8	1.85
9	1.55
10	3.23

Figure Caption: These time cycles were recorded as soon as the tug came into contact with the ramp and time stopped when pin has dropped.

SUMMARY AND CONCLUSIONS

- The newly designed automated disengaging system, which includes the combination of yellow tug and hitch, needs less than 2 seconds compared to the current manual system, which requires 15 seconds to manually hitch and drop the pin. This process improvement will have a significant reduction in downtime and make the assembly line smoother
- This automated design process also reduces severe fatigue for the operator, who currently has to move a 500 lb. carts by crouching up to 90 times in a single workday

The following items were delivered to Kubota:

- Working prototype
- Full drawing packet with individual parts and assemblies
- FEA Results
- Passing factor of safety
- Time cycles showing improvement

FUTURE WORK

- The newly designed hitch and tug along with the redesigned pathway will be implemented onto the K1 assembly line
- For any improvements need to be made, the parts on the tug needs to be more refined and cleaner to where some parts in two can be combined into one piece

TEAM & ACKNOWLEDGEMENTS

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