BeltUp!

Alex, Joaquin, Julie, Anna, Charlotte, Zakir

What problem are we solving?

We are aiming to provide a convenient and affordable option for belt storage

1. Many modern belt holders have 10 slots
2. Can often be expensive ($35+)
3. Can be used for 2-3 belts without taking up excessive space

   Ex: College students

Amazon

Etsy

Amazon

Introduction Continued

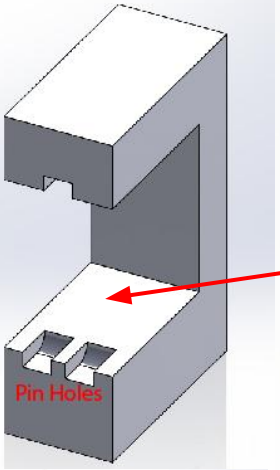
ADML is useful due to the simple design

→ ultimately reducing production cost and manufacturing time

→ Requires precise cutting (holes)

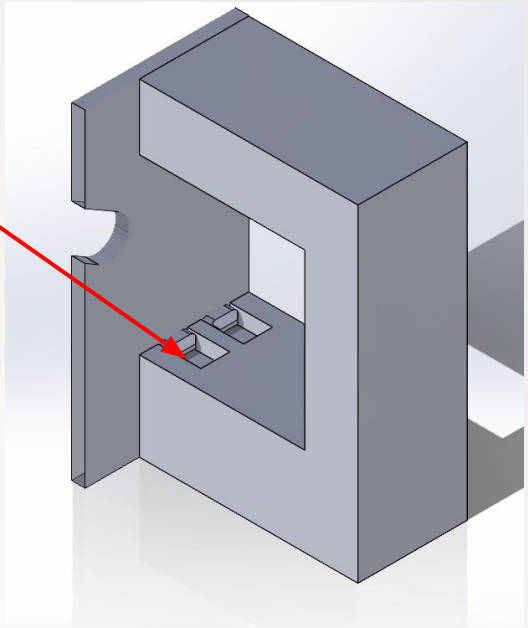
Our product provides an affordable and user friendly solution to a common problem.

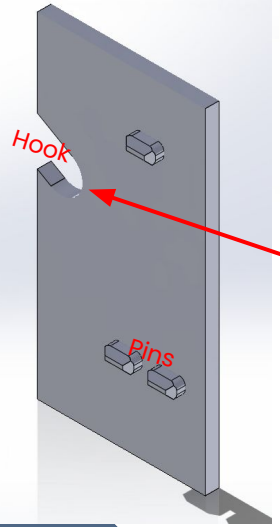
Product Design (CAD)



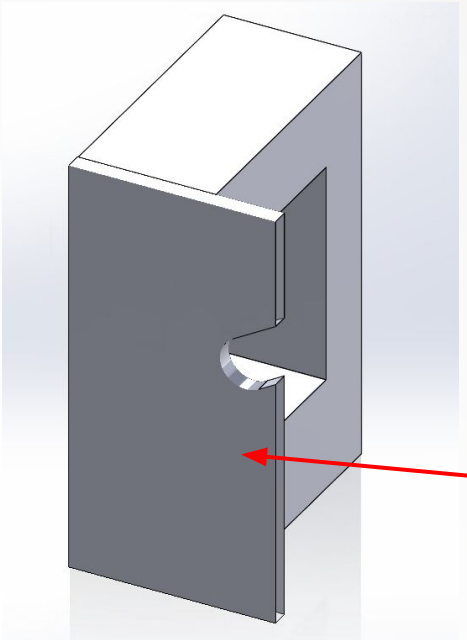
Area to store belts (about 1.51" x 1.59" of storage space)

Slots to hold clear cover in place



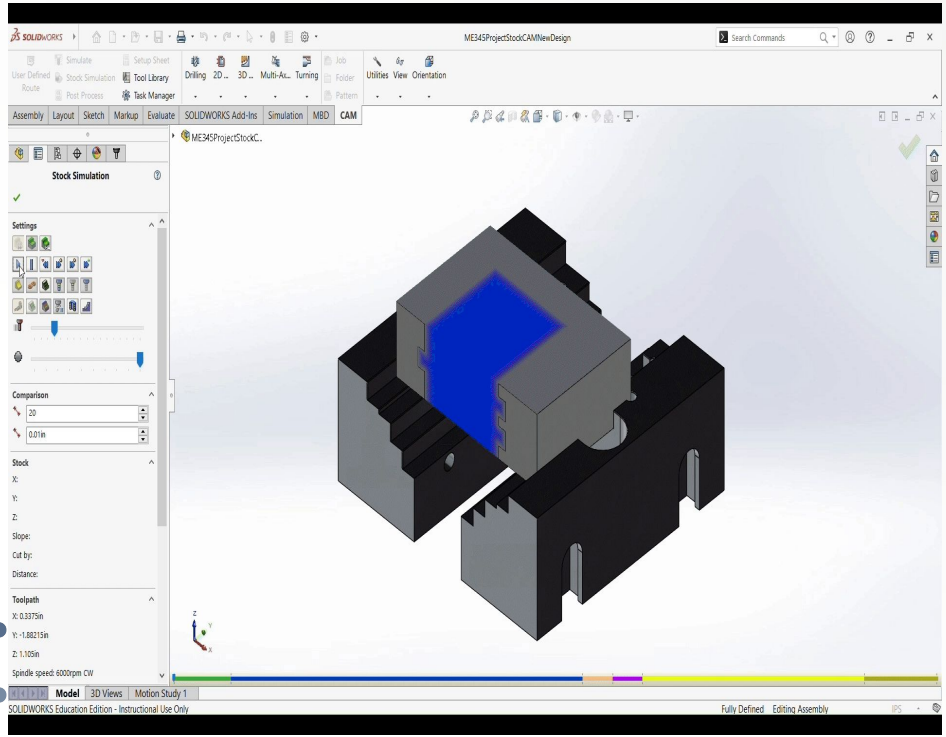


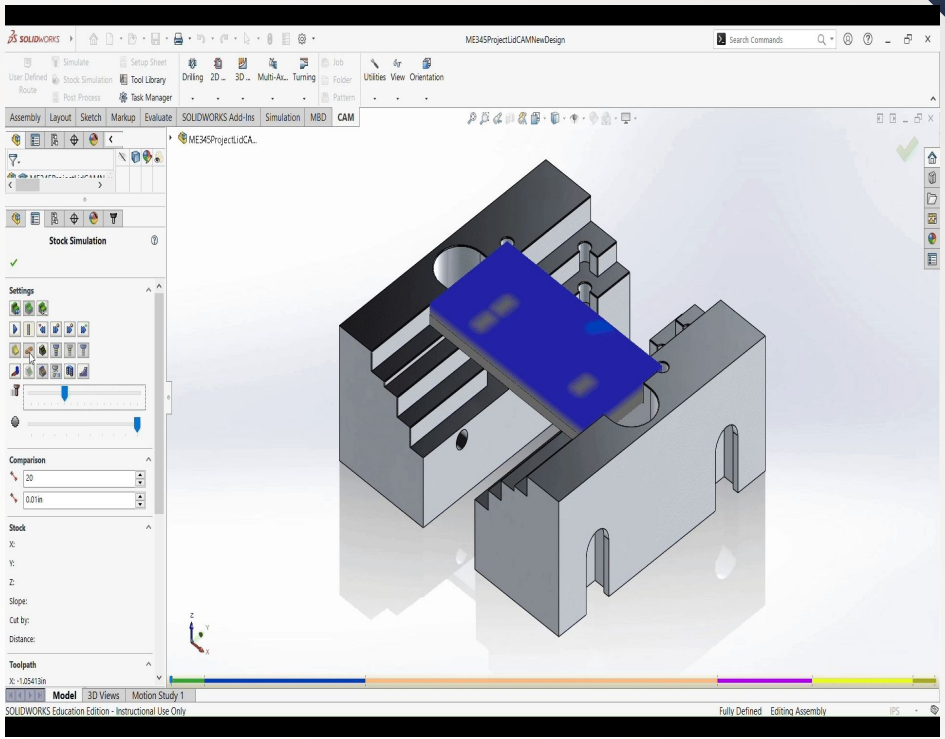
Extra storage for jewelry/necklaces



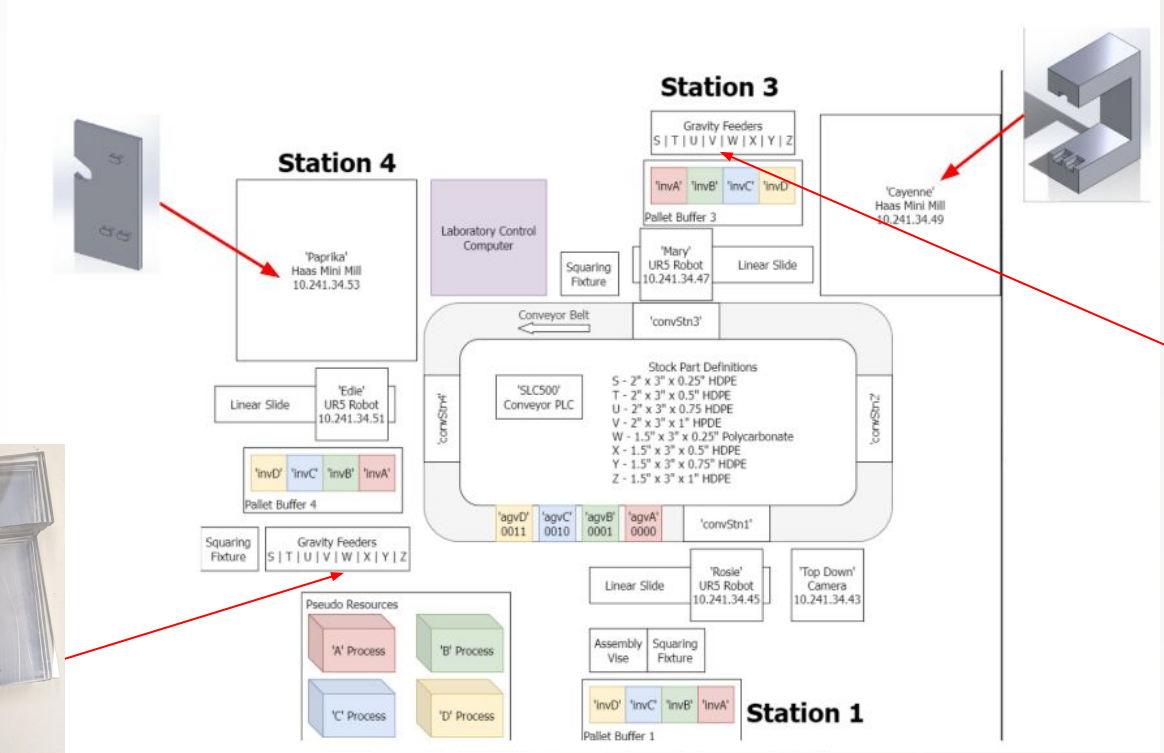
"Clear" acrylic cover

Product Design (CAM)





Manufacturing Strategy



CIM Control – BUMES Scripts

Overview of BUMES Code

1. Start with pallets at **Rosie's** station and pick them up and put onto conveyor belt
2. Move pallet B to **Mary's** station (Body) and pallet A to **Edie's** (Lid) station and move to inventory
3. Collect stock at **Mary's** station and mill (**Cayenne**) + ready conveyor belt for pickup
4. Collect stock at **Edie's** station and mill (**Paprika**)
1. Move pallet to **Rosie's** station and ready body for assembly (invB)
2. Collect finished lid from **Paprika** and load onto pallet then conveyor belt
3. Move pallet to assembly area (invA)
4. Complete flipping process for body and place into floor vise
5. Complete same flipping process for lid and place onto body
6. Place finished product into bin

CIM Table

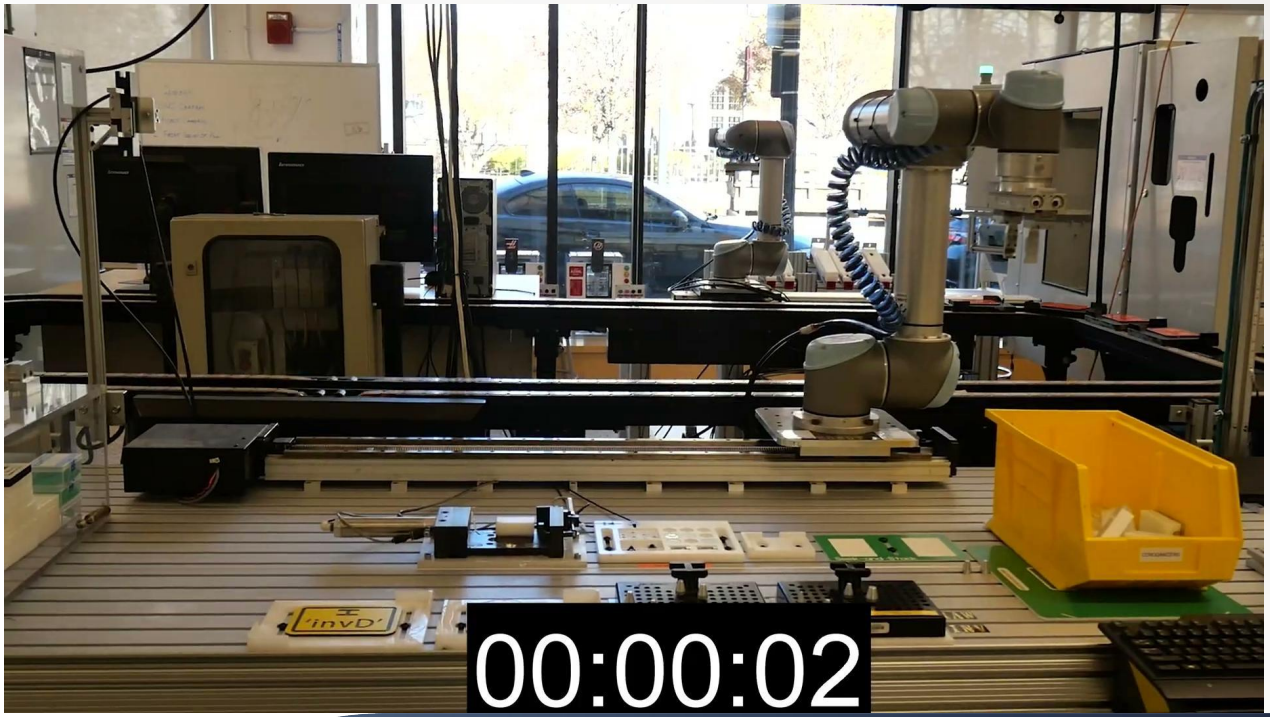
id	process_name	operation_name	task_name	start_time	end_time	Time taken	command
52012	BeltUpboth	1of3	task_0	1733326212	1733326212	0.0	startupTasksComplete()
52013	BeltUpboth	1of3	task_1	1733326213	1733326251	38.1	resourceSeize('convStn1','agvA')
52014	BeltUpboth	1of3	task_2	1733326251	1733326264	12.8	urDashboard('Rosie','me345_admin/_adminCG-invAToPHome.urp', 5)
52015	BeltUpboth	1of3	task_3	1733326264	1733326276	11.8	urDashboard('Rosie','me345_admin/_adminCG-PHomeToConveyor.urp', 7)
52016	BeltUpboth	1of3	task_4	1733326277	1733326277	0.0	resourceRelease('convStn1')
52017	BeltUpboth	1of3	task_5	1733326277	1733326280	2.4	resourceSeize('convStn1','agvB')
52018	BeltUpboth	1of3	task_6	1733326280	1733326291	10.8	urDashboard('Rosie','me345_admin/_adminCG-invBToPHome.urp', 5)
52019	BeltUpboth	1of3	task_7	1733326291	1733326303	11.3	urDashboard('Rosie','me345_admin/_adminCG-PHomeToConveyor.urp', 7)
52020	BeltUpboth	1of3	task_8	1733326303	1733326305	1.8	resourceSeize('convStn4','agvA')
52021	BeltUpboth	1of3	task_9	1733326305	1733326305	0.0	resourceRelease('convStn1')
52022	BeltUpboth	1of3	task_10	1733326306	1733326322	15.9	resourceSeize('convStn3','agvB')
52023	BeltUpboth	1of3	task_11	1733326322	1733326336	14.2	urDashboard('Mary','C6_WEDS_8:00AM/_adminCG-ConveyorToPHome.urp', 2)
52024	BeltUpboth	1of3	task_12	1733326337	1733326347	10.8	urDashboard('Mary','C6_WEDS_8:00AM/adminCG-PHometoInvB.urp', 4)
52025	BeltUpboth	1of3	task_13	1733326348	1733326348	0.0	resourceRelease('convStn3')
52026	BeltUpboth	1of3	task_14	1733326348	1733326356	7.3	urDashboard('Edie','C6_WEDS_8:00AM/_adminCG-ConveyorToPHome.urp', 2)
52027	BeltUpboth	1of3	task_15	1733326356	1733326362	6.2	urDashboard('Edie','C6_WEDS_8:00AM/_adminCG-PHomeToInvA.urp', 4)
52028	BeltUpboth	1of3	task_16	1733326362	1733326362	0.0	resourceRelease('convStn4')
52029	BeltUpboth	1of3	task_17	1733326363	1733326392	28.9	urDashboard('Mary','C6_WEDS_8:00AM/gravityFeederV.urp', 3)
52030	BeltUpboth	1of3	task_18	1733326392	1733326430	38.5	urDashboard('Mary','C6_WEDS_8:00AM/_adminCG-WXYZLoadMill.urp', 15)
52031	BeltUpboth	1of3	task_19	1733326430	1733326434	3.7	resourceSeize('convStn3','agvB')
52032	BeltUpboth	1of3	task_20	1733326434	1733326467	32.7	urDashboard('Edie','C6_WEDS_8:00AM/gravityFeederW.urp', 3)
52033	BeltUpboth	1of3	task_21	1733326467	1733326502	34.9	urDashboard('Edie','C6_WEDS_8:00AM/_adminCG-WXYZLoadMillMakeBody.urp', 15)
52034	BeltUpboth	1of3	task_22	1733326502	1733326707	204.8	urDashboard('Mary','C6_WEDS_8:00AM/_adminCG-WXYZUnloadMill.urp', 15)
52035	BeltUpboth	1of3	task_23	1733326708	1733326727	19.3	urDashboard('Mary','C6_WEDS_8:00AM/_adminCG-WXYZToInvB.urp', 2)
52036	BeltUpboth	1of3	task_24	1733326727	1733326734	6.9	urDashboard('Mary','C6_WEDS_8:00AM/adminCG-InvBtoPHome.urp', 6)
52037	BeltUpboth	1of3	task_25	1733326734	1733326749	15.0	urDashboard('Mary','C6_WEDS_8:00AM/_adminCG-PHomeToConveyor.urp', 2)
52038	BeltUpboth	1of3	task_26	1733326749	1733326749	0.0	resourceRelease('convStn3')
52039	BeltUpboth	1of3	task_27	1733326750	1733326777	26.8	resourceSeize('convStn1','agvB')
52040	BeltUpboth	1of3	task_28	1733326777	1733326786	8.6	urDashboard('Rosie','me345_admin/_adminCG-ConveyorToPHome.urp', 4)
52041	BeltUpboth	1of3	task_29	1733326786	1733326796	10.0	urDashboard('Rosie','me345_admin/_adminCG-PHomeToInvB.urp', 2)
52042	BeltUpboth	1of3	task_30	1733326796	1733326796	0.0	resourceRelease('convStn1')
52043	BeltUpboth	1of3	task_31	1733326797	1733326829	32.4	resourceSeize('convStn4','agvA')
52044	BeltUpboth	1of3	task_32	1733326829	1733326894	65.1	urDashboard('Edie','C6_WEDS_8:00AM/_adminCG-WXYZUnloadMillBody.urp', 15)
52045	BeltUpboth	1of3	task_33	1733326895	1733326911	16.4	urDashboard('Edie','C6_WEDS_8:00AM/_adminCG-WXYZToInvA.urp', 1)
52046	BeltUpboth	1of3	task_34	1733326911	1733326918	6.9	urDashboard('Edie','C6_WEDS_8:00AM/_adminCG-InvAToPHome.urp', 6)
52047	BeltUpboth	1of3	task_35	1733326919	1733326926	6.8	urDashboard('Edie','C6_WEDS_8:00AM/_adminCG-PHomeToConveyor.urp', 2)
52048	BeltUpboth	1of3	task_36	1733326926	1733326926	0.0	resourceRelease('convStn4')
52049	BeltUpboth	1of3	task_37	1733326927	1733326940	13.7	resourceSeize('convStn1','agvA')
52050	BeltUpboth	1of3	task_38	1733326940	1733326952	11.7	urDashboard('Rosie','me345_admin/_adminCG-ConveyorToPHome.urp', 4)
52051	BeltUpboth	1of3	task_39	1733326952	1733326963	10.4	urDashboard('Rosie','me345_admin/_adminCG-PHomeToInvA.urp', 2)
52052	BeltUpboth	1of3	task_40	1733326963	1733326963	0.0	resourceRelease('convStn1')
52053	BeltUpboth	1of3	task_41	1733326963	1733327018	54.4	urDashboard('Rosie','C6_WEDS_8:00AM/InvB_bodytoVise.urp', 2)
52054	BeltUpboth	1of3	task_42	1733327018	1733327570	551.7	urDashboard('Rosie','C6_WEDS_8:00AM/InvA_lidtoVise.urp', 2)
52055	BeltUpboth	1of3	task_43	1733327570	1733327570	0.0	endProcess()

CIM Table – Discussion

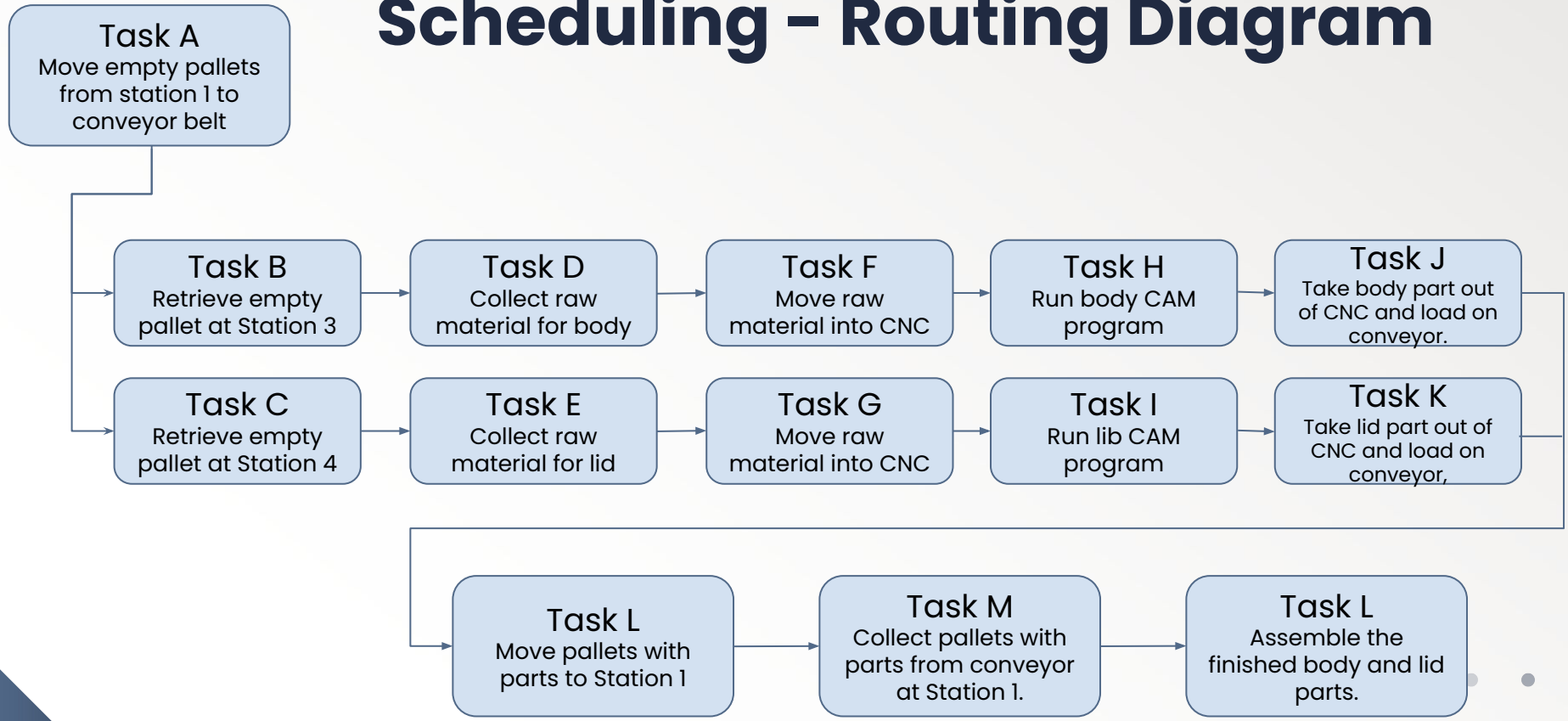
- The longest task took 204 seconds which was the waiting for the milling of the body and the unloading
- Some tasks were optimized such as timing for the conveyor belt
  - Send conveyor to idle station while Paprika is running
- Assembly took a large amount of time as well mainly due to flipping of pieces

Timelapse

Production Video In ADML



Scheduling – Routing Diagram



Scheduling

MAX THROUGHPUT

Our max throughput is the rate of the bottleneck, which is the cycle time for the Lid Machining process. This results in a TH of 1 part every 299 seconds

STEADY STATE WIP AND CT

Our theoretical steady state WIP was 3.1 parts, with a corresponding cycle time of 15.5 minutes per part

Effective WIP is 3 parts, matches CIM table

INSTANCES NEEDED FOR MAX THROUGHPUT

To achieve the max throughput, the pallets need to be released when the previous product's lid milling operation has 55 seconds left on the machine. This results in releasing new parts every 299 seconds

ASSEMBLY YIELD AND FUNCTIONAL YIELD

Our functional yield was 100%, all the parts that were manufactured were usable, occasional rough edges.

Our assembly yield was 50%, robot arms struggled at times despite chamfers

Implementing Lean Principles

Value	Compact & Inexpensive
Minimize Waste	Efficient Movement and CAM: Saves Stock and Time
On Demand	Just-In-Time and Kanban: Reduces Overproduction and Inventory
TPS	Process Stability, Respect and Communication, Standardization of Work and Understanding
Flow	Manufacturing sequence efficiency

Cost Estimation

Cost per part

→Stock V: 2” x 3” x 1” HDPE
2*3*1 = 6in^3
6in^3 * $0.42in^3
= *$2.52*

→Stock W: 1.5” x 3” x 0.25” Polycarbonate
1.5*3*0.25= 1.125in^3
1.125in^3 * $0.53in^3
= 0.59625
= *$0.60*

Cost per part based on stock:
= $2.52 + $0.60
= ***$3.12***

Cost per hour

From the operating and materials cost given in the project description:
Operating: Robot $1.00/hr, CNC Mill $20.00/hr, Conveyor $1.00/hr
→ 553 seconds CNC
CNC Time (hours) = 553/3600 = 0.1536 hours
CNC Cost= 0.1536 * 20.00
= $3.07
→345 seconds robots
Robot Time (hours) = 345/3600 = 0.0958 hours
Robot Cost = 0.0958 * 1.00
= $0.10
→ 928 seconds of runtime for conveyor
Conveyor Time (hours) = 928/3600 = 0.2578 hours
Conveyor Cost = 0.2578*1.00
= $0.26

Cost per hour based on operating time:
→ Throughput = 928/ 3600
= 3.88 parts/hour
→ $3.07 + $0.10 +$0.26
= $3.43
→ 3.88 parts/ hour * $3.43
= **$13.32 / hour**

Limitations And Future Work

1

Optimizing robot movements

2

Alternating which CNC runs the bottleneck process

3

Reducing non-value added processes (conveyance)

4

Optimizing milling on lid to reduce bottleneck time

References

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