Lights-Out Coaster Manufacturing: Automation Suggestions for Purdue's Build @ Scale Lab

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Client Background

Build @ Scale Lab

Construction of the Lambertus Lab was completed in Spring of 2023

Serves the purpose of instructing and educating in the methodologies and principles that pursue Industry 4.0

Designed to be reconfigurable and visualize data captured from individual machines, co-bots, prototype lines, etc.

37 machines, 26 legacy machines

Includes laser additive and nano-bio lab

Problem Statement

The Build@Scale lab **lacks documentation** regarding the current and planned future state of the manufacturing process; this includes a current product design, system capacity, tact times, material handling, co-bot machine interaction and more. Without a plan the manufacturing of the products would be **highly unstandardized and uncontrolled**, making it difficult for the lab to complete and continuously replicate **without heavy manual assistance**.

Discussion

Unique ROI analysis with education being the main goal

Working with new process development without detailed prototype

Industrial solutions exist that use one or two platforms but don't maximize efficiency or cost-effectiveness

Creation of educational opportunities and ability to showcase valuable to client

Cross-platform technology implementation challenges provide opportunities for faculty and students

Methods

Rosie – robotic arm on moving platform

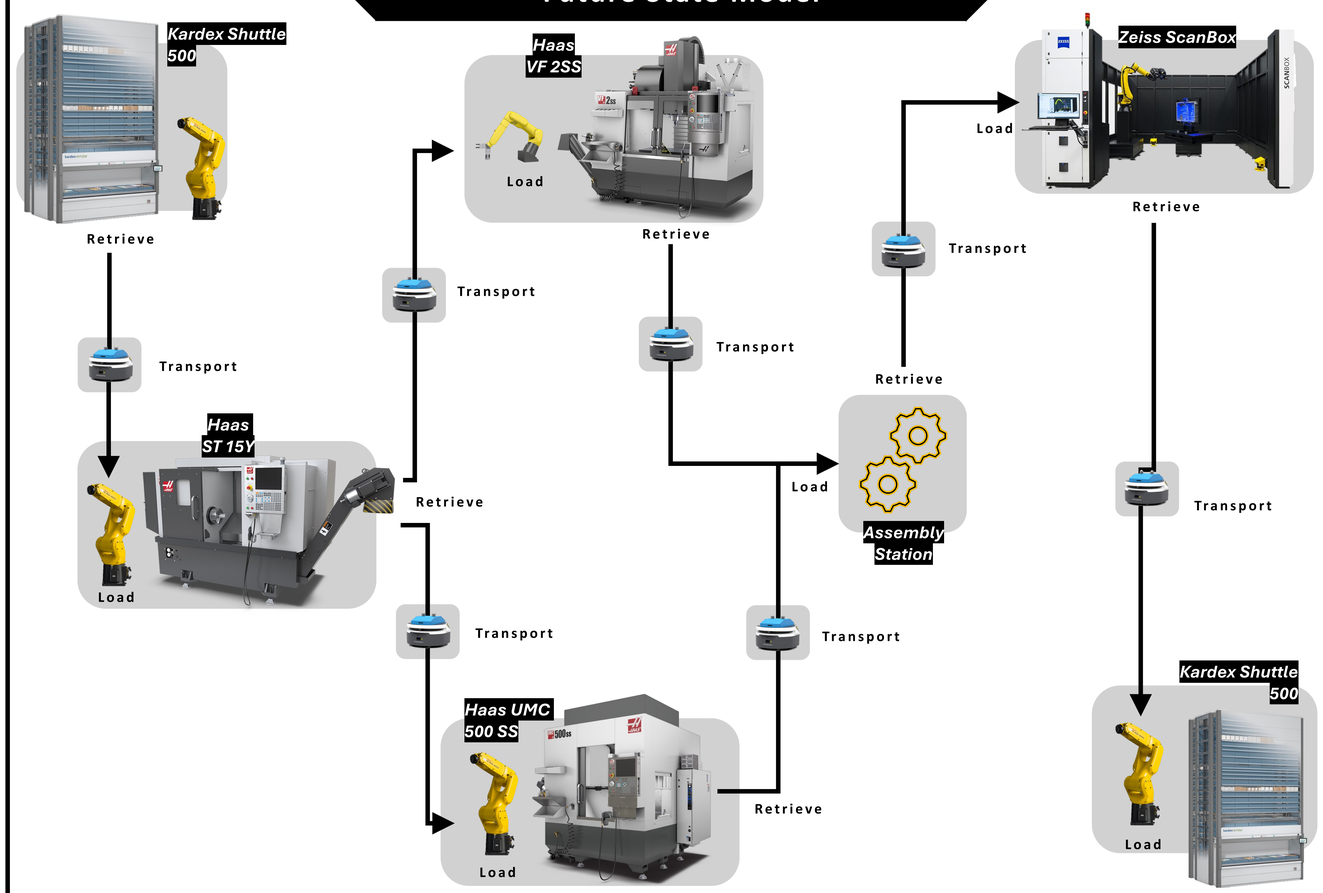
Shadowed industry experts through the lab and learned costs and received quotes for the labs machines

Client consultations beyond the team's primary client contact

Discussed limitations to the machines and resources in the lab that the team had access to

Spent time researching additives to the lab's machines to develop the best option for the team's process

Future State Model



Suggestions: Transport to VLM

Good Suggestion: Human assisted co-bot transportation. This suggestion requires significant human interaction during transportation of material. Ignores "Lights-Out" goal of the lab but drastically reduces start-up time. This is recommended during the prototyping of the final coaster designs.

Better Suggestion: Time-based cobot programming is a fully autonomous option that keeps human interaction in the lab limited to maintenance. This suggestion has all cobots move based upon fixed paths and production schedule. Data will be collected to monitor and improve transportation of materials.

Best Suggestion: Sensor-based co-bot programming is a fully autonomous option that builds upon the time-based programming by introducing more sensors. The increased number of sensors provide for more points of data collection and allow for transporting co-bots to account for more environmental scenarios throughout the lab. This will drive for more optimizable points.

Suggestions: Retrieve from Haas ST15Y

Good Suggestion: The good suggestion for retrieving from the ST15Y is not available. This is because the raw material is purchased in sliced disks, so the use of the ST15Y is not required. This step would be by-passed, and the disks would go straight to the 3 or 5 axis mill. This option would save time buy Is more expensive due to the raw material costs.

Better Suggestion: The better suggestion for retrieving from the ST15Y would be to purchase the Haas Part Catcher for $3,195 and pair it with time-based co-bot programming. For this to be successful the disks need to be deposited in an orderly manor for Rosie to retrieve them. This would offer a fully autonomous process, however if the process fails the co-bots would not be able to work around it.

Best Suggestion: The best suggestion for retrieving from the ST15Y would be to purchase with the Haas Part Catcher for $3,195 and pair it with senor-based co-bot programming. For this to be successful Rosie would need to be trained, visually or by touch , to identify the cut coasters in a depository. This would be fully autonomous but take the most additional setup. It would also be the most risk adverse suggestion.

Suggestions: Load Haas UMC 500S

Good Suggestion: This material loading option for the UMC 500ss 5-axis mill involves human operators loading each part by hand. No robots are utilized in this option; instead, all the loading tasks are done by operators, reducing the production rate and limiting batch sizes due to human effort. This setup does not need new data collection points since it relies on human monitoring for all required tracking.

Better Suggestion: A robotic arm loads material into the mill, ensuring accuracy, minimizing human involvement, and using time-based programming. Real-time data on load times, robotic performance, and error rates optimizes processes. Semi-automation enhances production speed, precision, and student learning in robotic programming. Haas integrators install this within the Haas ecosystem.

Best Suggestion: The best approach integrates different brands to load and fix sliced coasters to the mill using sensor-based programming and a lights-out system with self-centering vises, pneumatic chucks, and a CNC vise actuator. This setup automates clamping, calibration, and positioning, improving precision and efficiency while meeting client expectations. It also provides high educational ROI and valuable experience in advanced automation and robotics integration.

Future Work

Teams that follow could develop a specific plan for utilization rates by using further information on budget, timeline, machining times, and production quantity

An example of this would be if new information was found on machining times, this would help new teams develop how machines are loaded and how production is batched

Sources

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