Introduction to Automation Implementation

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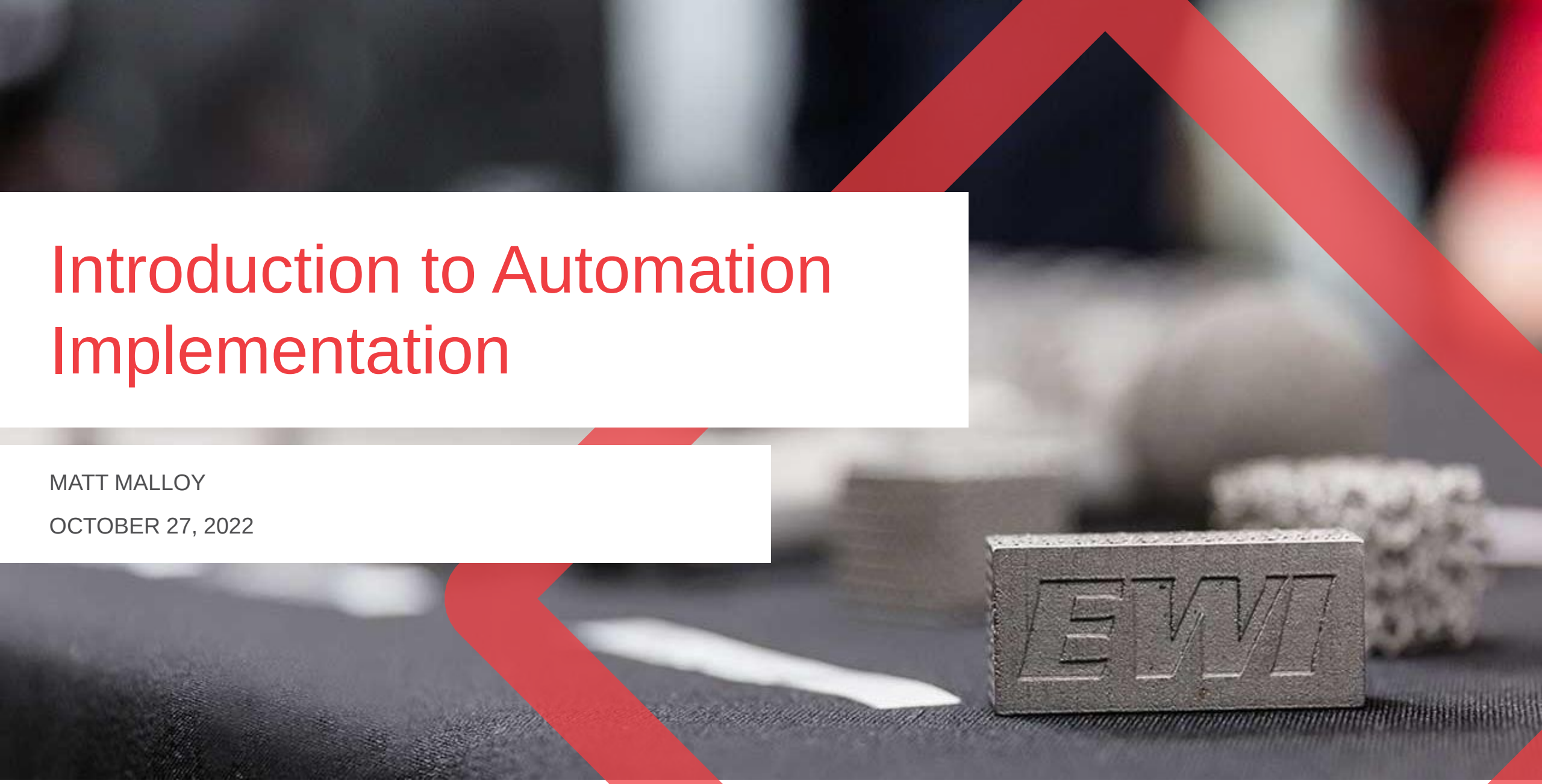
OCTOBER 27, 2022



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We Manufacture Innovation

Outline

- Introduction
- EWI's Automation Program
- Why automate?
- Before you get started
- Primary paths to automation systems
- Applications
- Your first implementation!
- Robot overview
- Robots or cobots?
- Supporting automation components
- Time to start!

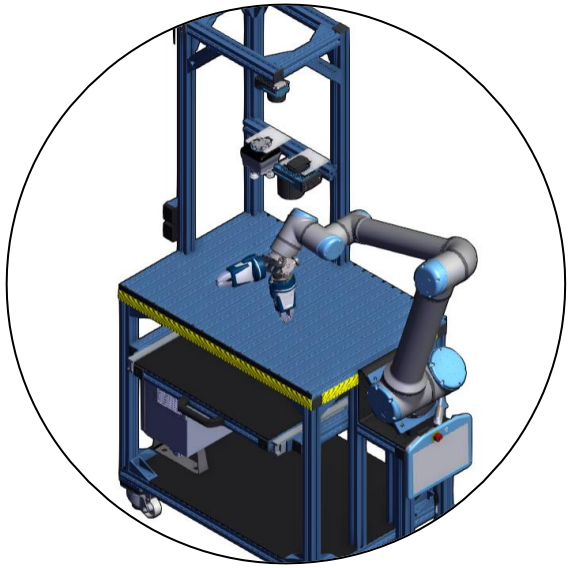
EWI’s Automation Program

EWI Automation Strategy

Tele-Manufacturing

Pioneering new technologies that enable real-time remote control and sensory feedback from robotic systems in manufacturing, fabrication, and service industry environments

Portable Automation Platforms



Novel implementations of cobot and mobile automation technologies to address immediate manufacturing needs and ongoing workforce challenges

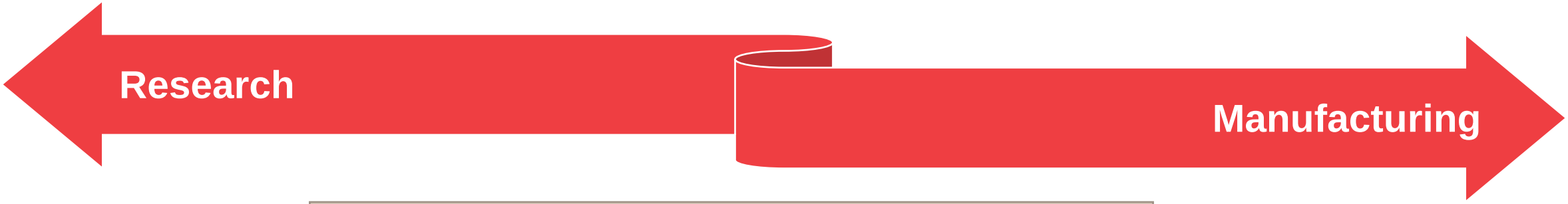
Automation Advisory

Providing expert guidance to identify high-impact automation opportunities for current and planned manufacturing operations, with support from identification to implementation

Automation Training

Training on collaborative and industrial automation systems through structured classes and application/system specific training

What Stage of Development Is Each Component Focused On?



Tele-Manufacturing
(Primarily targeting government and large organizations)

Portable Automation Platforms
(Primarily targeting small and medium manufacturers)

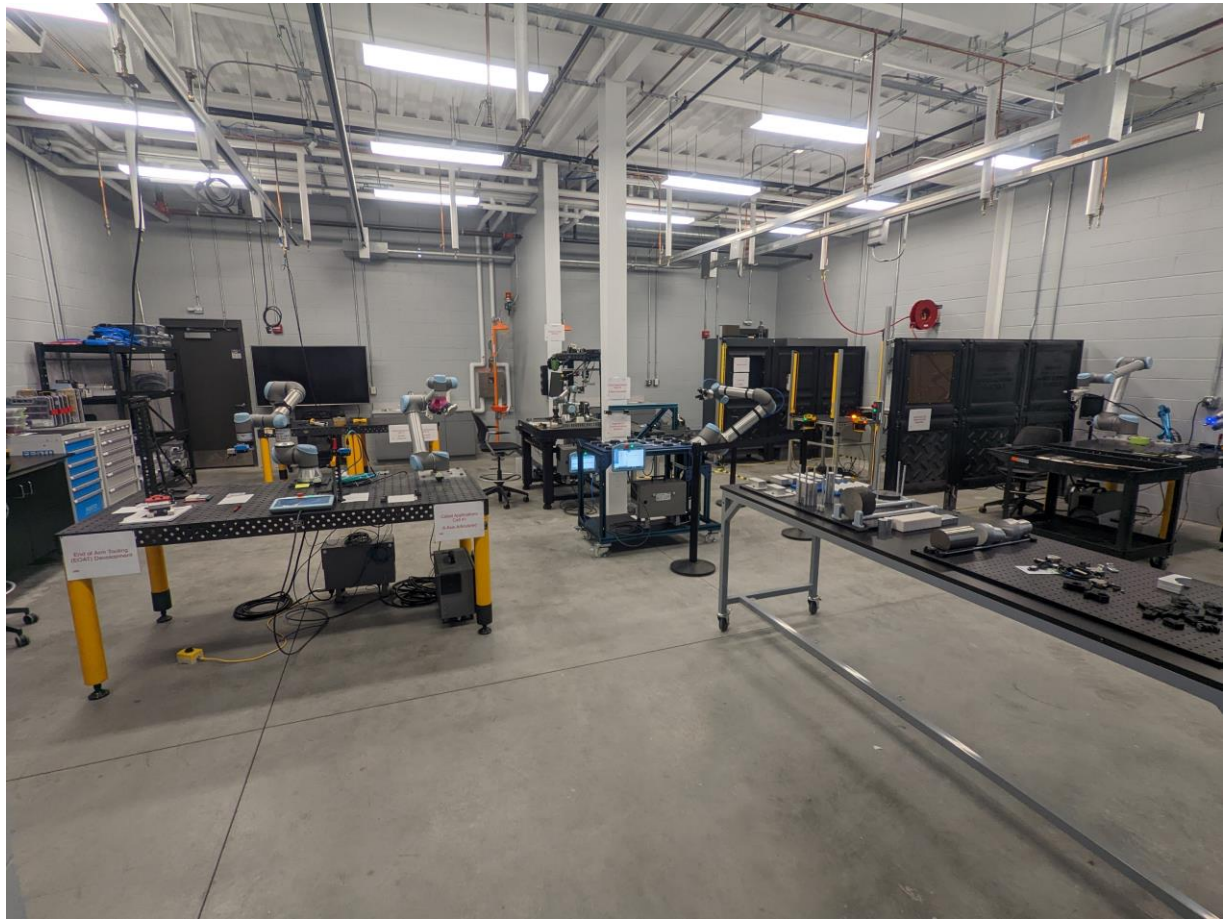
Automation Advisory

Automation Training

Available Resources

- Wide assortment of automation technologies at Buffalo, NY and Columbus, OH locations
  - Industrial robots
  - Collaborative robots (cobots)
  - End-of-arm-tooling
  - Sensors and vision systems
  - Conveyors, pneumatics, safety systems, etc.
  - In-house 3D printing for rapid prototyping of supporting components
- EWI experts in automation and process technologies

Examples of Cobot and Automation Training Labs



Why Automate?

Why Are Companies So Interested in Automation Now?

- Increasing rate of retirement of the highest skilled workers
- Shortage of incoming skilled workers, especially around welding and machining
- Increasing difficulty of finding reliable long-term workers for repetitive tasks

- Pandemic recovery
- Covid is temporary but it has changed attitudes around how companies operate and how people work

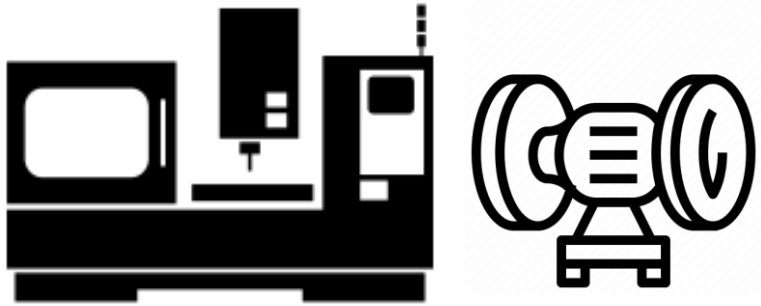
- 1st pass and final yield improvement
- Rework and scrap reduction
- Increasing rate, frequency, and need for quality inspections – for both incoming outgoing parts and materials

- Increasing production demands
- Consistent and reliable production and fabrication
- EHS concerns
- Futureproofing

Top Industry Trends

Addressing skilled labor shortages

Industry 4.0 – Sensors & Applications



Automating Repetitive Processes Beyond the Basics

(Such as Machine Tending with Part Finishing and Inspection)

Working Remotely

Levels of Automation

Level	Technology	Automation Resources
1	No automation of any kind, including for machine tools	Limited maintenance support
2	Some CNC technology, conveyors, and PLCs	CNC programmers and maintenance techs
3	Limited number of robots on site, likely installed by others	Maintenance staff capable of supporting robotic systems
4	Higher number of robotic systems in operation, mostly on normal work shifts. No or limited IoT technologies. Some initial exploration of other automation technologies (such as AMR's)	Team members capable of installation and programming, but likely not development and building of new automation systems
5	50% or more of processes automated with some systems running lights out. IoT technologies used throughout the factory, as well as other advanced automation technologies	Internal system integration team

Getting Started

The Primary Paths to Automation

- Most automation solutions are custom – they are rarely off-the-shelf.
- Creativity is key.
- Pay careful attention to safety, documentation, and other fundamentals.

- Who can help you get there?
  - In-house team
  - Value-add distributors
  - System integrators

But before you start…

Our Advice For Your First Automation Implementations

- Focus on your process first!
- Start with simple and well-defined applications for your first automation solutions
- Research and learn
- Get some wins before moving onto larger automation projects

- *Technology makes almost anything possible in the factory, but you'll increase your chances of success with realistic goals and implementations.*
- *Realize there are usually many ways to reach your advanced manufacturing goals – there is rarely a single right way.*

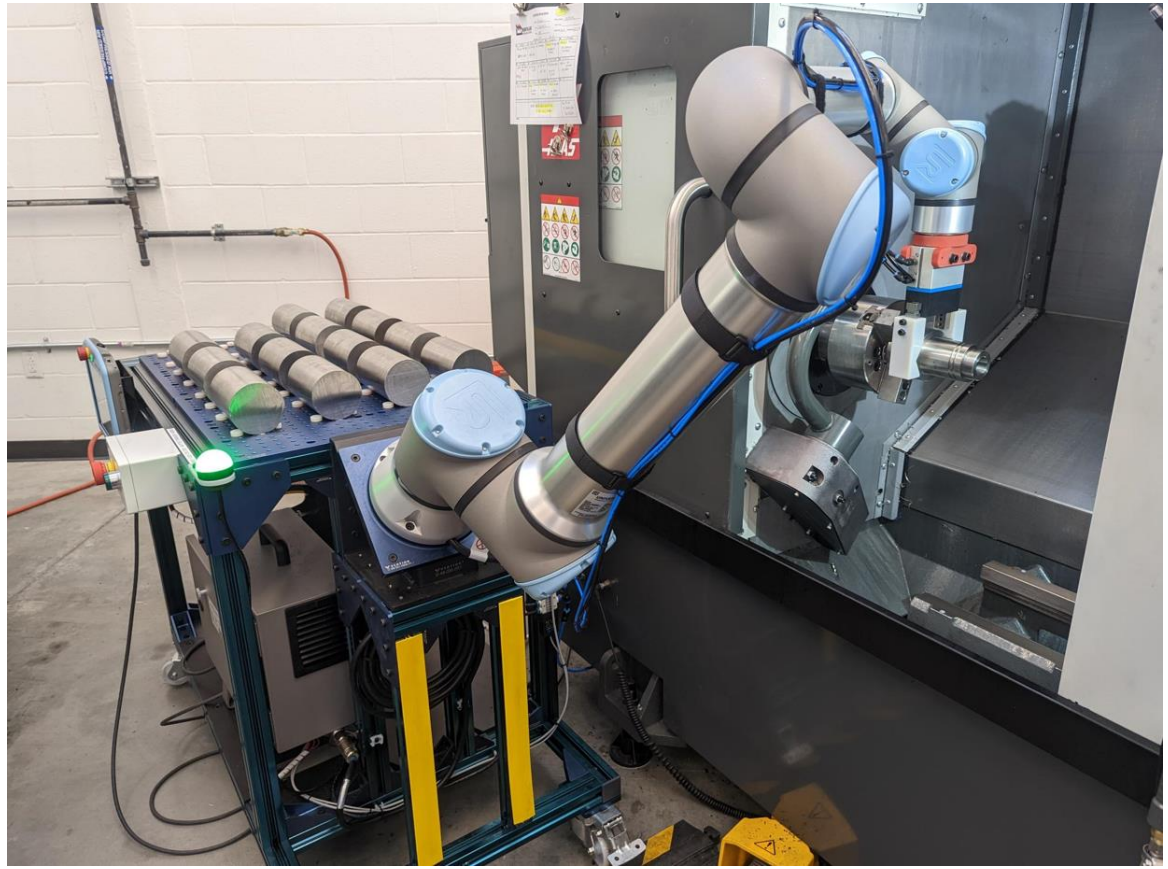
Applications

Application Tiers (Roughly)

- Robot Applications can be broken into tiers of difficulty.
- When looking at applications look at the lowest tier first.
  - Get the success
  - Learn your lessons
  - Repeat until you feel comfortable before moving on to the next tier.
  - The last thing you want is a monument in storage.
  - Your first couple of projects may not have the best ROI.

Tier 1 – Easier Applications

- Machine tending
- Material handling
- Assembly
- Palletizing
- Packaging

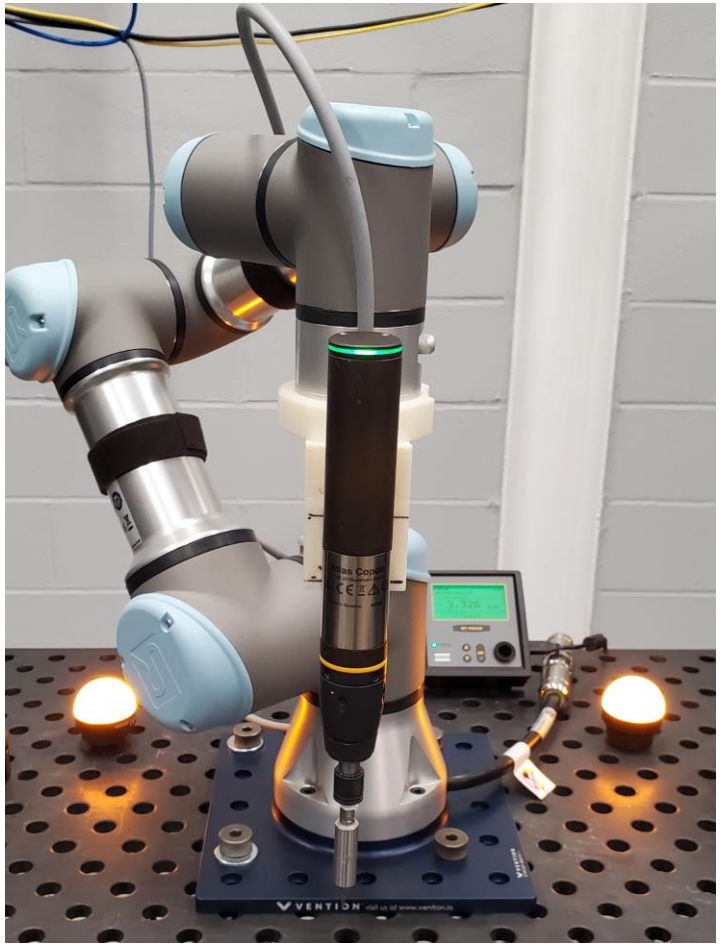


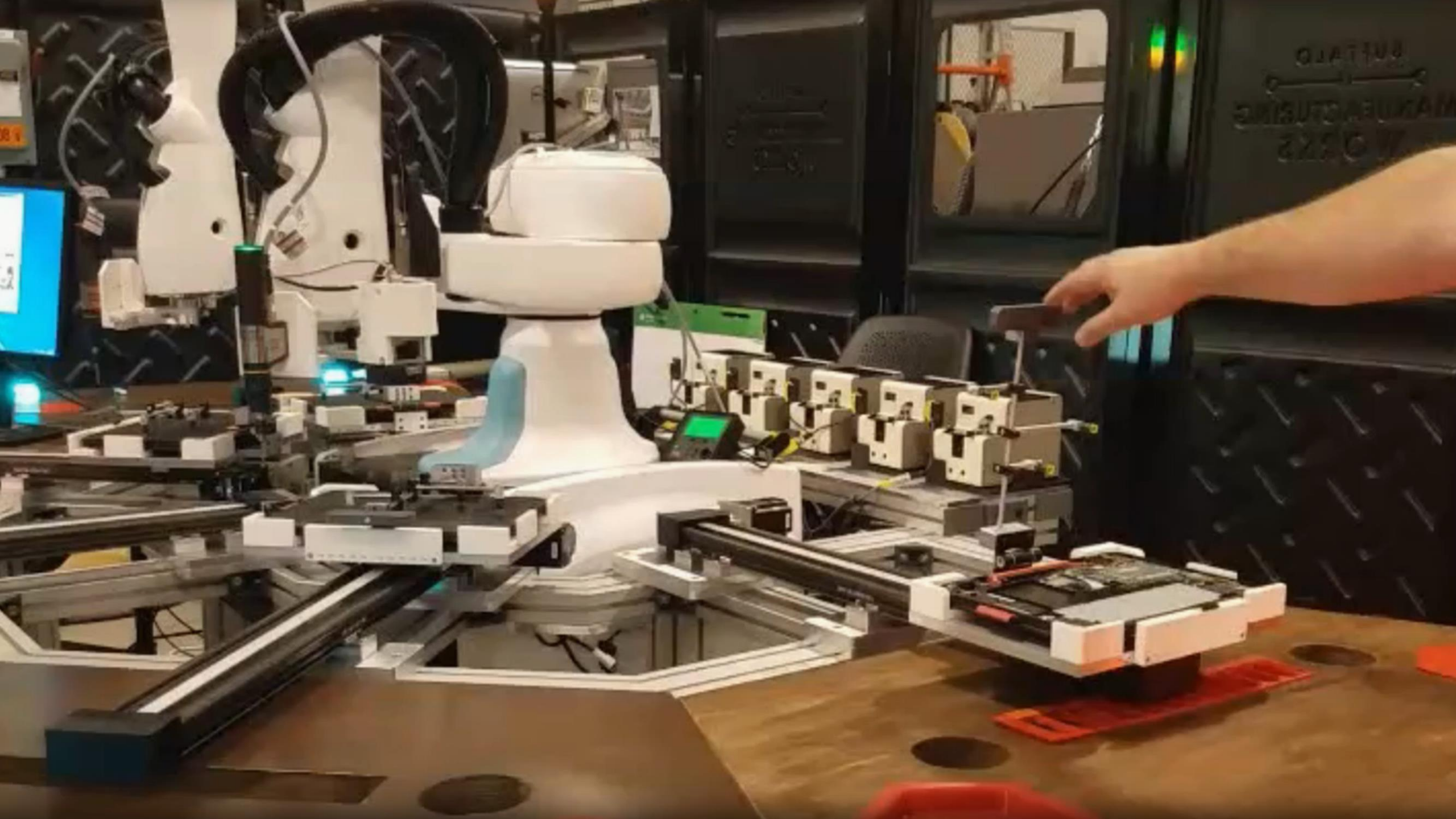

HAAS


FANUC Robot SR-6iA

Tier 2 – Medium Difficulty Applications

- Vision guided material handling
- Dispensing
- Material removal, without force feedback
- Inspection
- Screwdriving

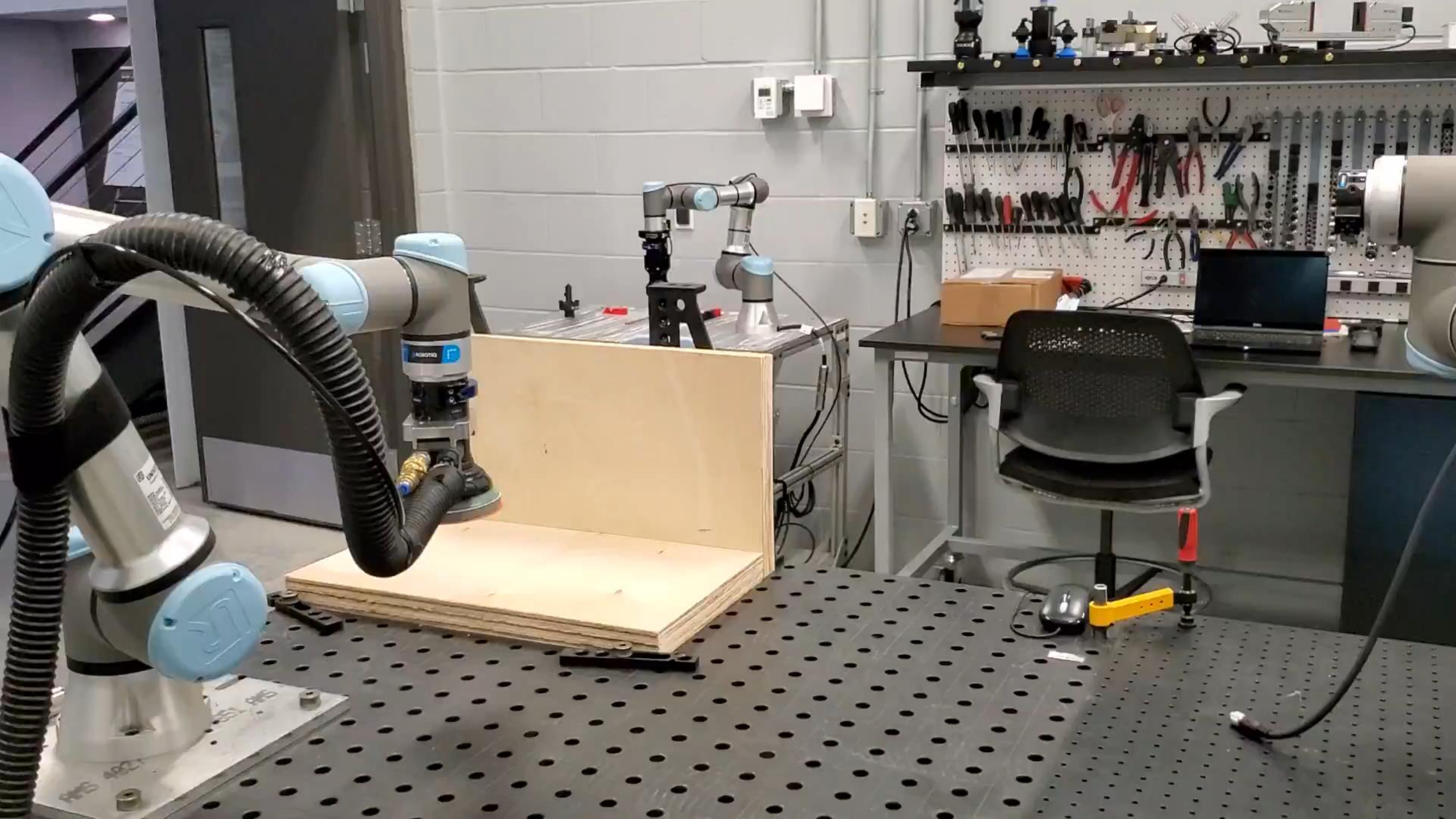




Tier 3 – Harder Applications

- Random bin picking
- Welding with guidance
- Adaptive griding
- Conveyor tracking with vision guidance
- Continuous force feedback

However, the rapid pace of development over the last several years is making some difficult applications much easier to develop….




PRIORITY

Why Use Robots?

Why Use Robots?

- Labor challenges
- Reduced cost of automation
- Long term cost benefits
- Ease of use of current technology

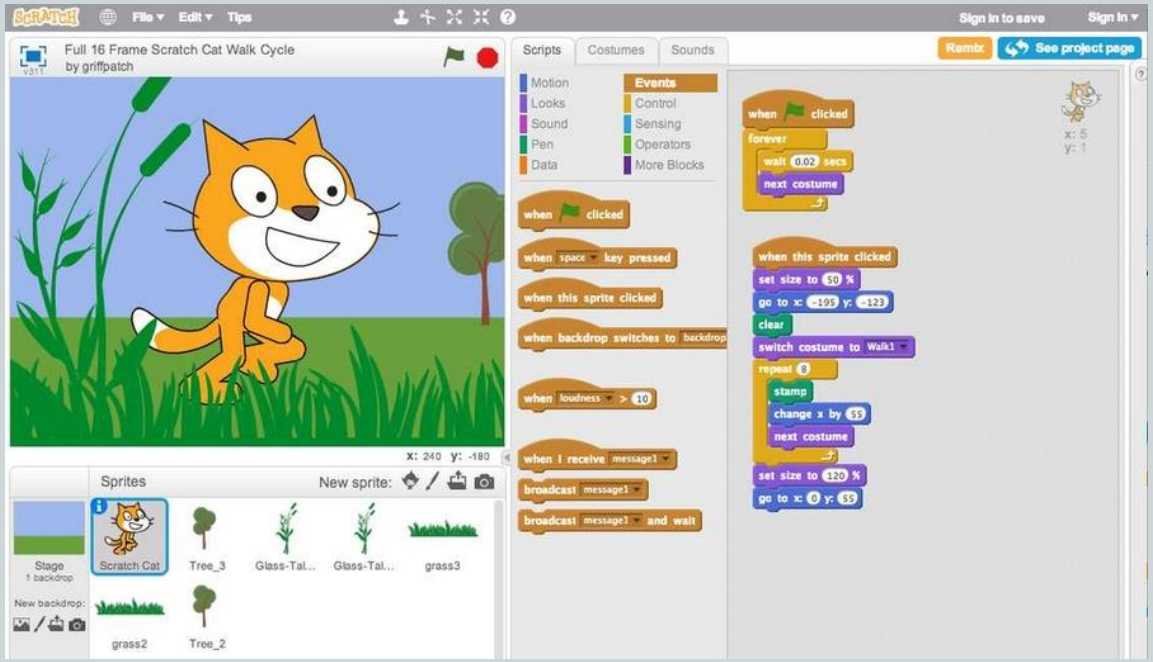
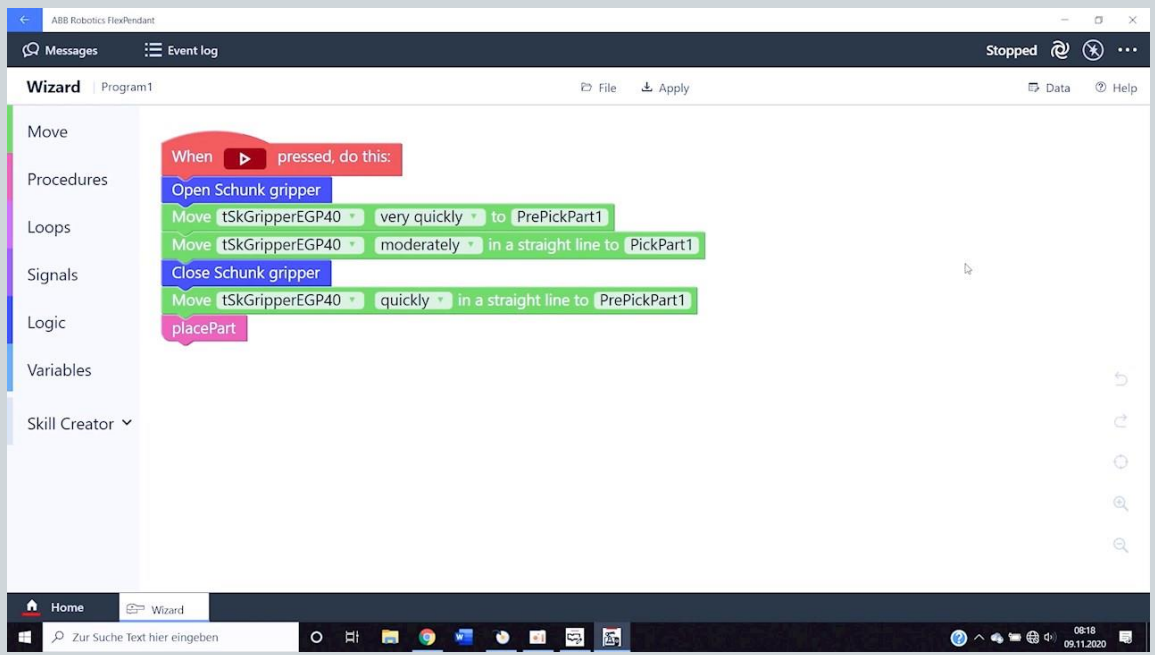
Labor Challenges

- Finding both skilled and unskilled labor is the number one problem of manufactures today.
- The challenges of hiring, including retraining, is resulting in loss of production and quality issues.
- The 4Ds: dirty, dull, dangerous, demanding work is causing a high percentage of new hire turnovers.
- Cost of workman's comp due to ergonomically challenging work.
- Getting constant predictable output is a challenge through the shift.

Tooling U - SME Workforce Report

Ease of Use

Just One of Many Examples Showing How Companies Are Focusing on Ease of Use

SCRATCH / Code.org	ABB Wizard
	
Scratch - Imagine, Program, Share (mit.edu)	Wizard Easy Programming | ABB Robotics - Application Software Solutions for Robots | ABB Robotics

Robot Overview

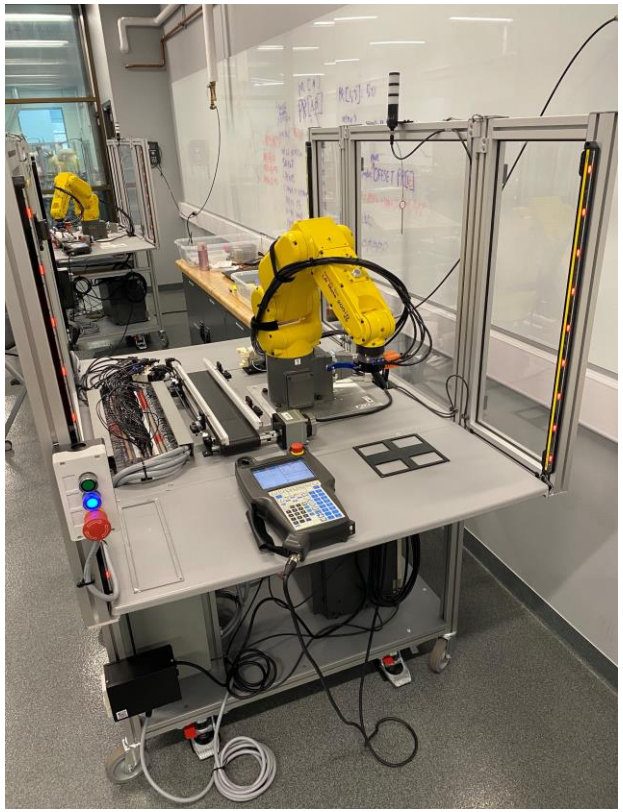
What Is a Robot?

“A robot is re-programmable, multi-functional manipulator designed to move material, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks.”

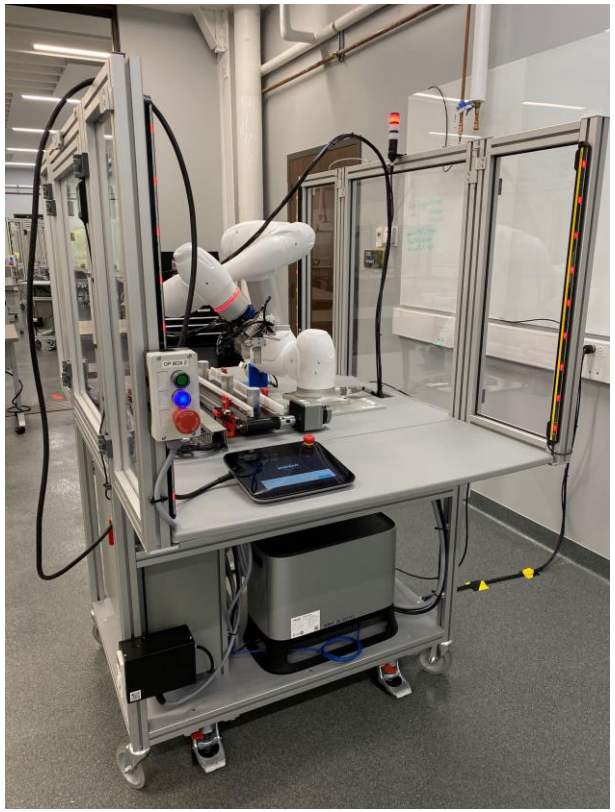
-Robot Institute of America, 1979

Robot Cell

- A number of components that work together to create repeatable motion
- Controller, manipulator, end effector, power supply, sensors, means for programming, etc.



EWI Robotic Training Cell – Fanuc 200iD-4S



EWI Robotic Training Cell – Doosan M0609

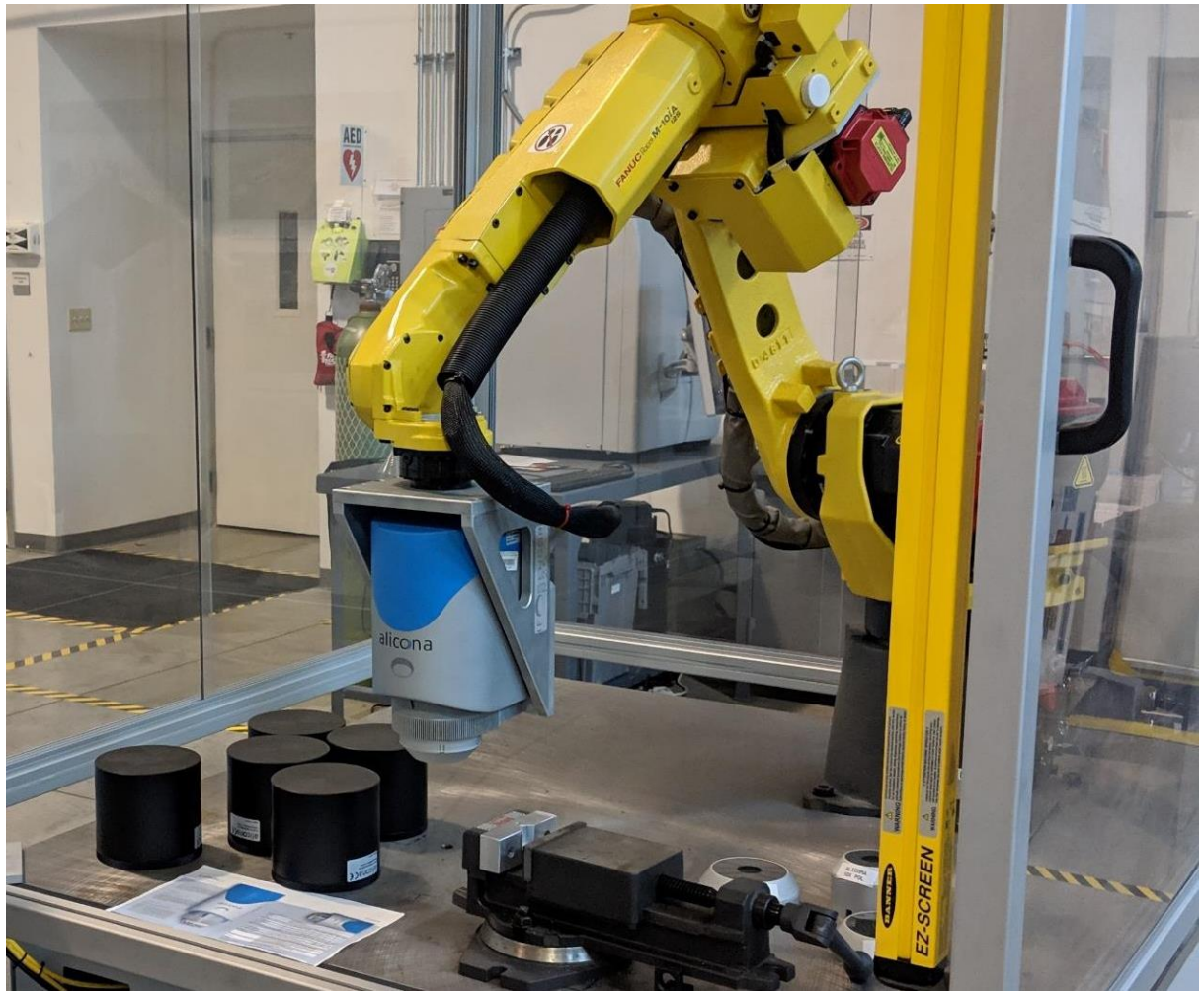
Key Considerations For Selecting a Robot

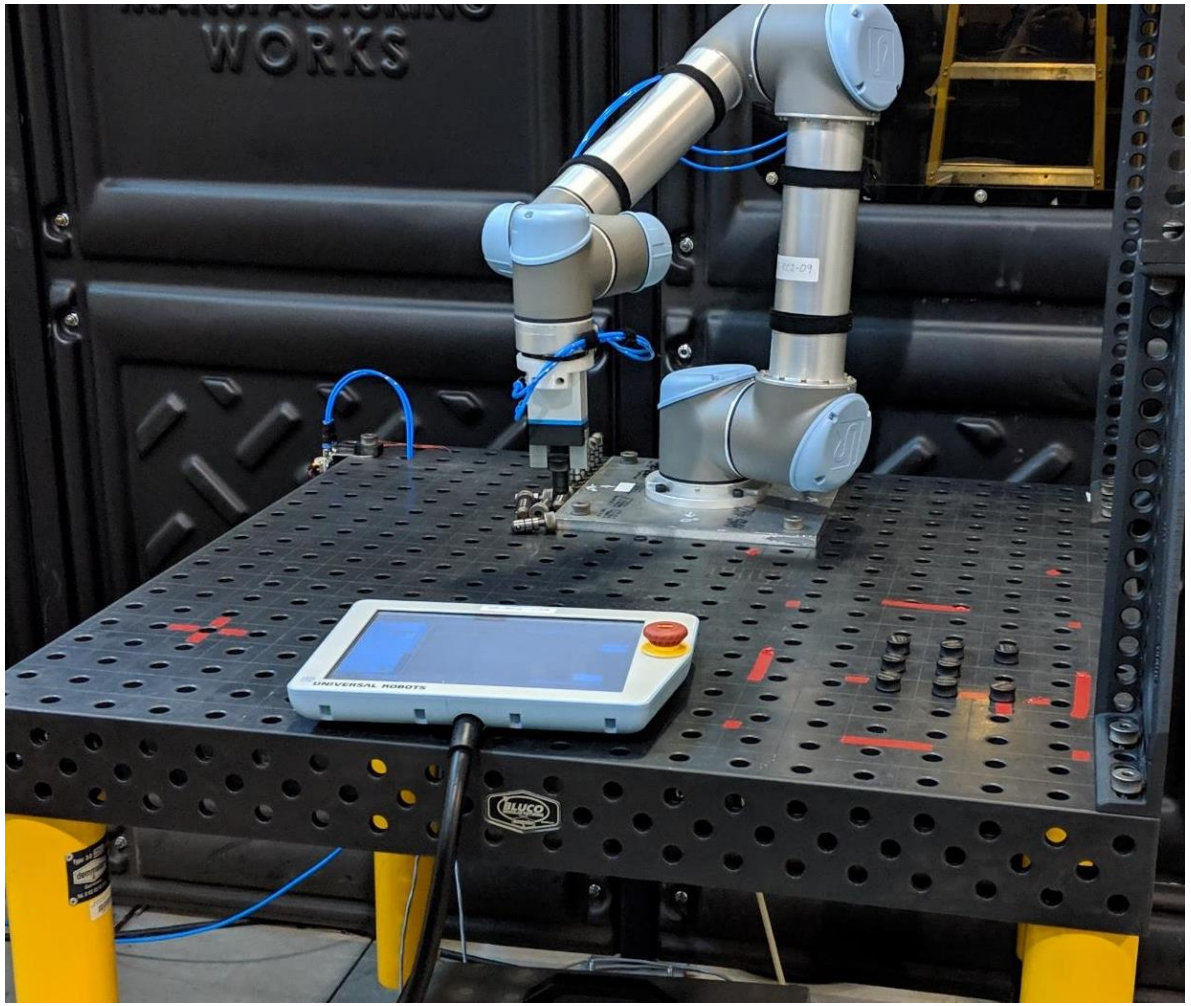
- Application
- Payload
- Reach
- Speed
- Repeatability
- Types
- Industrial Robots vs “ Cobots”

Four Main “Types” of Robot

- Cartesian
- SCARA
- Articulated
- Delta

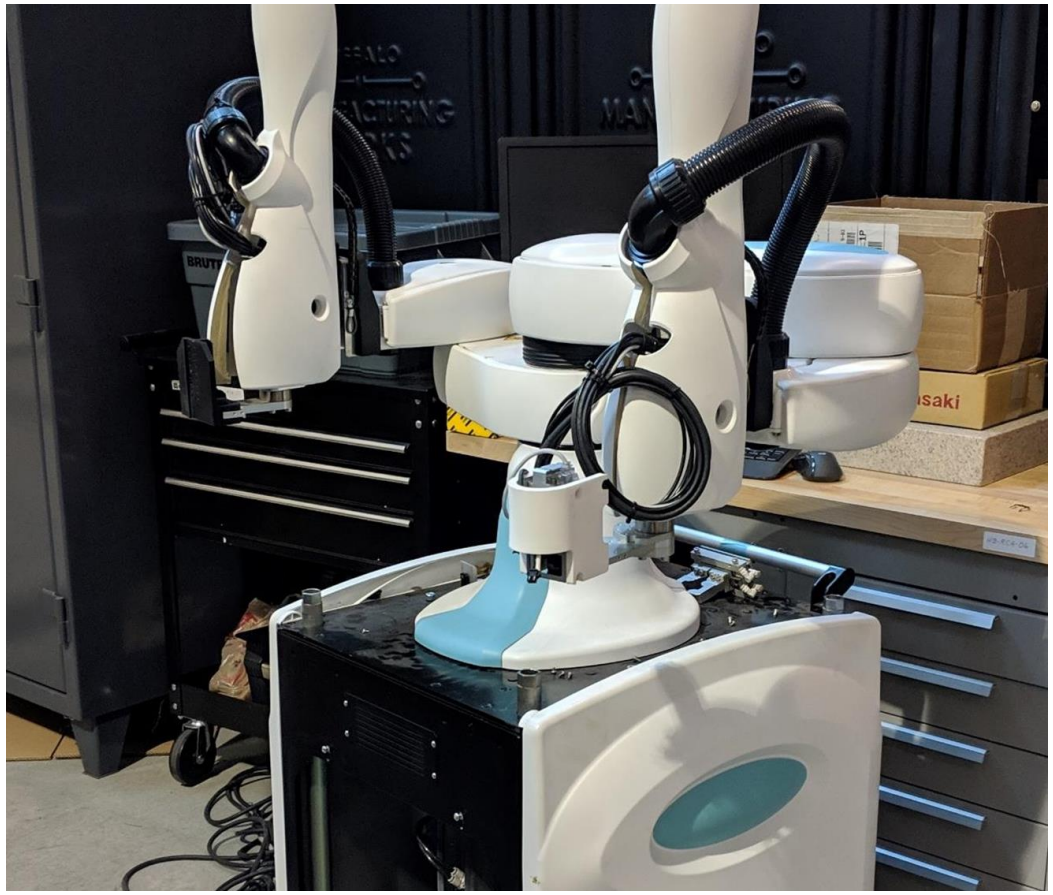
Articulated Robots



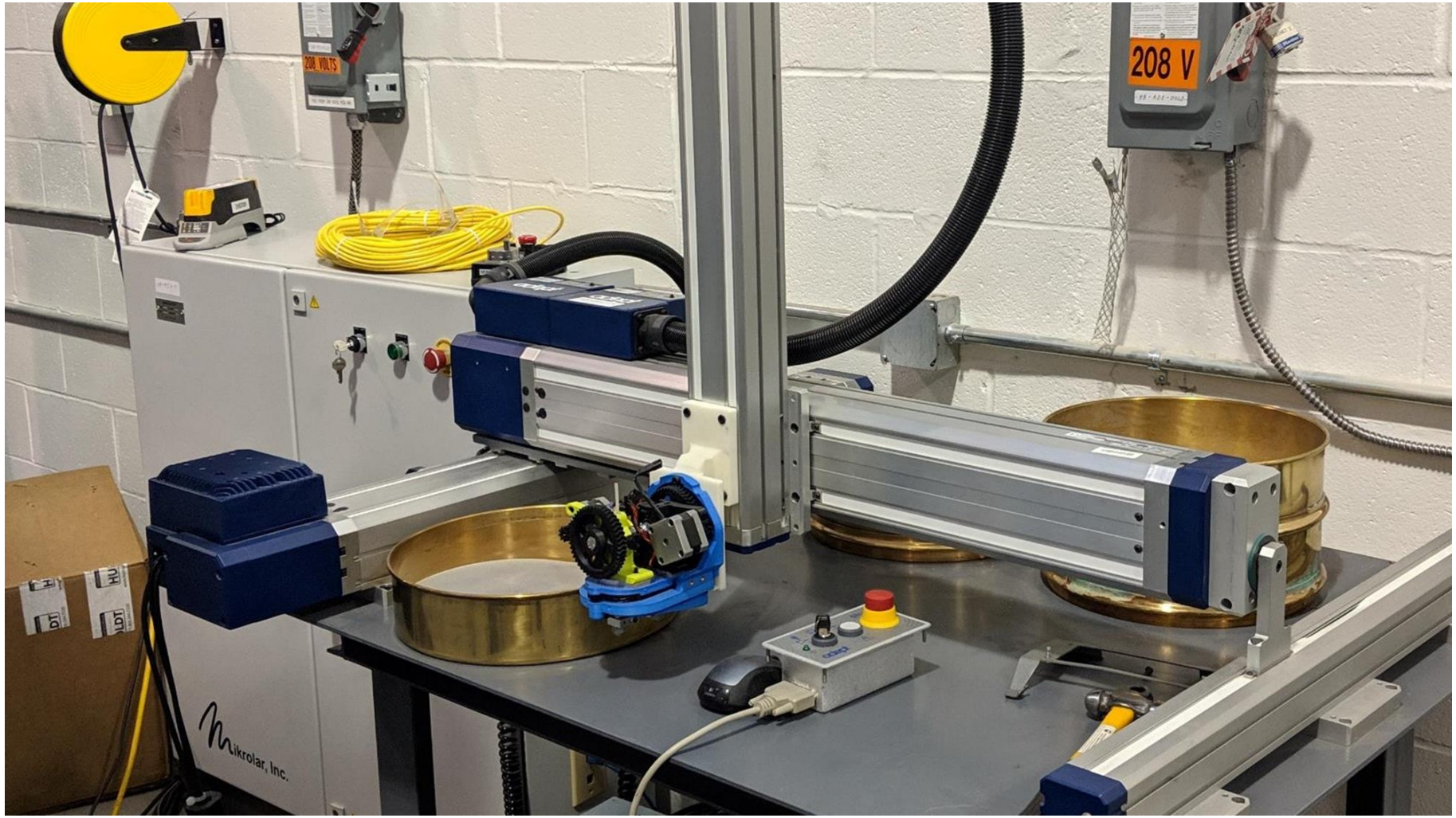


SCARA

- SCARA = Selective Compliance Assembly Robot Arm



Cartesian



Delta

Cobots

Cobots

- According to the international industry standards, there are four classifications of collaborative features for robots
  - Safety monitored stop
  - Hand guided for teaching and lift assist
  - Speed and separation monitoring
  - Power and force limiting (most cobots today)

- *Cobots are still robots – you must think about safety!*

Force vs. Pressure

- Force, not pressure, is typically a controllable parameter for cobots.
- Pressure is the distribution of the force across the contact area, such as a robot gripper or an object being carried by the robot.
  - Pressure = Force / Area
- The pressure of a knife edge or sharp object is going to be much greater that the pressure of a larger, rounded, or soft object.

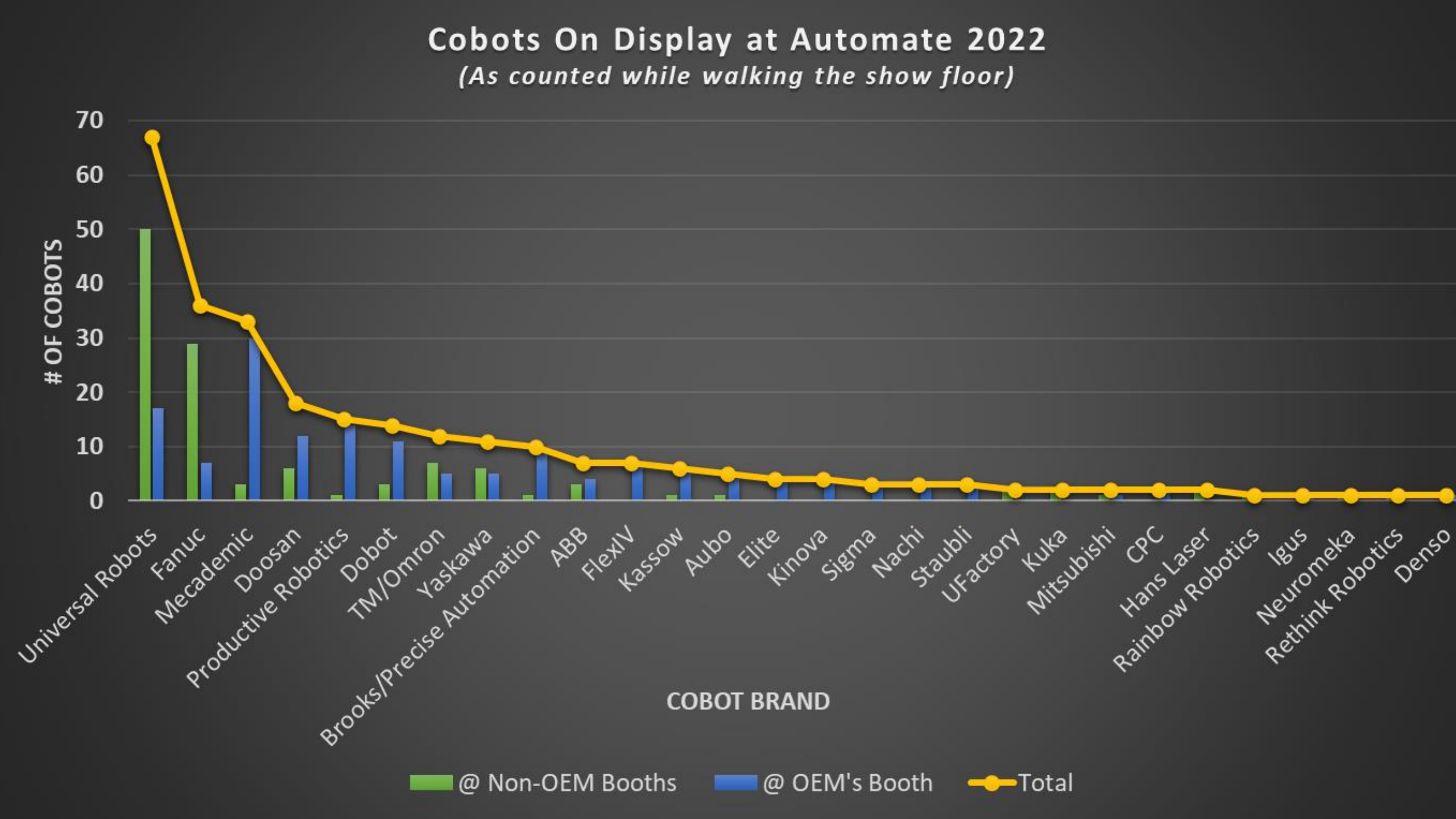
Current Cobot Examples

Universal Robots

Fanuc

Doosan

And many more….


Cobots On Display at Automate 2022
(As counted while walking the show floor)
OF COBOTS
70
60
50
40
30
20
10
0
Universal Robots
Fanuc
Mecademic
Doosan
Productive Robotics
Dobot
TM/Omron
Yaskawa
Brooks/Precise Automation
ABB
FlexIV
Kassow
Aubo
Elite
Kinova
Sigma
Nachi
Staubli
UFactory
Kuka
Mitsubishi
CPC
Hans Laser
Rainbow Robotics
Igus
Neuromeka
Rethink Robotics
Denso
COBOT BRAND
@ Non-OEM Booths
@ OEM's Booth
Total

Why Choose a Cobot?

- Potentially easier integration
- Reduced cell controls
- Potentially reduced programing time depending on the application
- Smaller cell footprint
- Robot mobility
- Quicker install times
- Non-integrator channels for purchasing
- All translates to reduced cost bringing these arms into the range of affordability for small and medium manufacturers (SMM’s).

Why Not?

- Limited payload capacities, typically < ~25 KG
- Lower speeds when operated collaboratively
- Not as widely supported by full turnkey integrators (but this is changing quickly now)
- Safety is not correctly considered when deploying the application - the robot may be collaborative, but the application is not.

Supporting Automation Components

Main Components To Think About

- In addition to a robot, your (simple) application will likely need one or more of these supporting components
  - End-of-arm-tooling (EOAT), such as grippers
  - Sensors
  - Controls
  - Electrical components
  - Pneumatic components
  - Custom components, such as fixtures
  - A physical structure to put everything on

EOAT

- The end of arm tooling (aka, the end effector) is the hardware attached to the end of the robot arm.
  - This hardware does most of the work.
- The EOAT can be an off the shelf device or custom designed configuration to meet the application needs.
- End of arm tooling can be
  - Grippers which grasp and move objects.
  - Process tools used to cut, weld, grind, polish, dispense, etc.

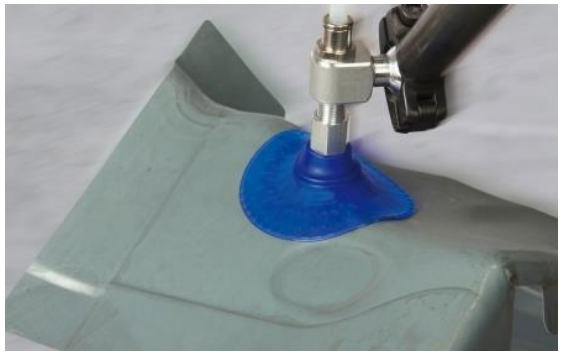
Gripper Examples

Schunk Parallel Jaw pneumatic gripper

Robotiq electric gripper

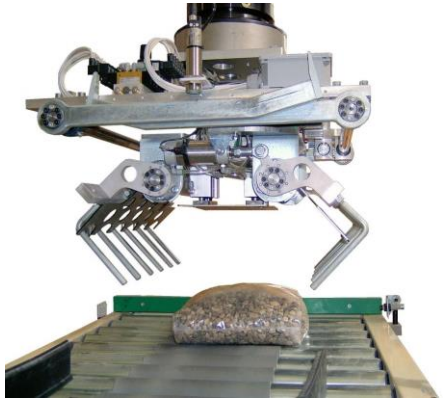
Festo Angular, Parallel Jaw and 3 jaw pneumatic grippers

Soft Robotics pressure sensitive pneumatic grippers



SAXM Suction pad from Schmalz

SPZ layer gripper



Bag gripper from Imeco

Electric vs. Pneumatic Grippers

- With the increased focus on ease-of-use and cobots, many new electric grippers are now available.

Robotiq Electric Gripper

Electric	Pneumatic
Lower grip force	Higher grip force
Heavier	Lighter
No air or electrical cables in most cases	Requires air line
Lots of advanced options such as force control, speed, distance, and measurement	Basic open/close
High cost ($$$$)	Low cost ($)

Festo Pneumatic Gripper

Sensors

- Sensors allow robots to interact, respond, and determine actions based on conditions outside of the robot.
- Sensor selection should be based on :
  - Information needed
    - A process parameter (e.g., temperature, pressure, flow, torque . . .)
    - The presence of an object
    - The distance to a target
    - The position of an object or mechanism for guidance
  - Accuracy required
  - Environment the robot is in
    - Clean
    - Dirty
    - Washdown
    - Food grade

Sensor Types

- Light (Optical)
  - Thru beam
  - Diffuse reflective
  - Laser distancing

- Computer vision
  - 2D, 2.5D 3D
  - Structured light

- Sound
  - Ultrasonic

- Temperature
  - Thermal imaging
  - Pyrometer

- Magnetic fields
  - Inductive
  - Proximity
  - Reed switch

- Mechanical
  - Limit switches
  - Whisker switches
  - Plunger

Safety

Safety

- Regardless of the type of robot used – industrial or collaborative – safety must be a top priority!
- A3 Robotics (www.automate.org) should be your first stop in understanding robot/cobot safety requirements and approaches.
  - Safety courses are offered throughout the year, plus a yearly safety conference.

Business Case

Estimating the ROI

- Companies looking to do their first automation implementation often get stuck on ROI estimations, for a variety of reasons.
  - No standard internal ROI calculation method or template
  - Lack of data to base calculation on
  - Disagreement on what should be included in the ROI calculation
- In addition to the parameters, workforce challenges and safety factors should also be considered in ROI estimations.
  - In some cases these may hold more weight than historical ROI parameters.

ROI Estimation Example

Inputs					
Variable For Total System Costs					
Total System Costs	$80,600				
Robots Qty	1				
Variable For Current Operation Cost					
	Hours/Shift	Shifts/day	Days/week	Weeks/yr	Hours a Year
Robot labor replacment	8	1	5	50	2000
Hourly Burdended Labor Cost	$40				
Annual Labor Cost	$80,000				
No of Operators Removed	1				
% Labor Retained	15%				
Productivity Gain	25%				
Other Estimated Savings		(rework, quality, scrap, space, ergonomics,etc)			

Maintenance	Year 1-5	5	10
Cost	$500	$5,000	$30,000
Operating Cost/h	$0.50		
Inflation	2%		

Year	System Costs	Maintenance Costs	Operating Costs	Labor Savings	Productivity Savings	Other Savings	Yearly Cash Flow	Cumulative Cash Flow
1	80,600	500	1,500	68,000	20,000	-	5,400	5,400
2		500	1,530	69,360	17,340	-	84,670	90,070
3		500	1,561	70,747	17,687	-	86,373	176,443
4		500	1,592	72,162	18,041	-	88,111	264,554
5		5,000	1,624	73,605	18,401	-	85,383	349,937
Totals		7,000	7,806	353,875	91,469	-	349,937	
Breakeven	11.1	Months						

11.1 months

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Case Study Example

- Company is a medical parts manufacturer.
- Company was identified as an Automation Level 3 manufacturer with one collaborative robot and one robot installed by others at the beginning of the engagement.
- EWI visited company in June 2020 and developed a list of possible areas where additional automation could be added.
- The first project on the list was a cobot on a mobile cart to load and unload blocks into a machine tool.

Continued

- Company purchased from a distributor
  - Universal Robot UR10
  - Cart with part drawers
  - Dual end of arm electric grippers
  - CNC interface
  - Software/hardware programming reference
- Distributor only helped with some interfacing during install, while the company handled the programming.
- Increased their capacity by running lights out after shift hours and on the weekends
- Payback was approximately six months.
- Further expanded system with additional parts trays and then additional systems

Okay, What Are You Going To Do?

Where to Start

1. Look at your manufacturing operation to find appropriate tasks.
   - Think in terms of the four D's – Dull, Dirty, Dangerous, Difficult
   - External industry experts can help.
2. Applications exist in your processes
   - Some can be performed with commercially off the shelf (COTS) solutions
   - Some require a customized solution
3. Select a simple process or one that has a history of successful robot installations to start with.
   - For example, palletizing and machine tending are good starting points, while 3D bin picking and continuous path processes are more challenging.
   - Your first attempt must be successful to make way for future projects.

Where to Start

4. Decide who will build the system.
   - Will you contract a professional system integrator or build it in-house?
   - We suggest starting with a system integrator for your first few automation projects.
5. If you pick an integrator
   - You need to be comfortable that the integrator chosen fully understands your process, can supply a comprehensive solution to your automation needs and can support it in the future.
6. If you will build it in-house
   - You will need to consider not only the design, development, and commissioning of the system, but also future support and troubleshooting.
   - Don’t forget about safety

Thank you!

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LinkedIn

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