STATE OF THE ART IN INDUSTRIAL ROBOTICS

TYPE OVERVIEW ADAPTIVE TECHNOLOGY

George Brancato– FANUC America
george.brancato@fanucamerica.com

Agenda

- What is a robot?
- Why do we need robots?
- What's the latest buzz? Collaborative!
- What if a Collaborative robot isn't the right solution for you?
- Adaptive Technology - Vision - How it can help

What is an industrial robot?

A flexible, re-programmable, multi-axis servo system for mounting your custom tooling to perform repetitive and dangerous jobs

Consists of:

- A mechanical unit (the mover)
- A controller (the brain)
- Software (the instructions)
- Teach pendant (typical)

Major Industrial Robot Types

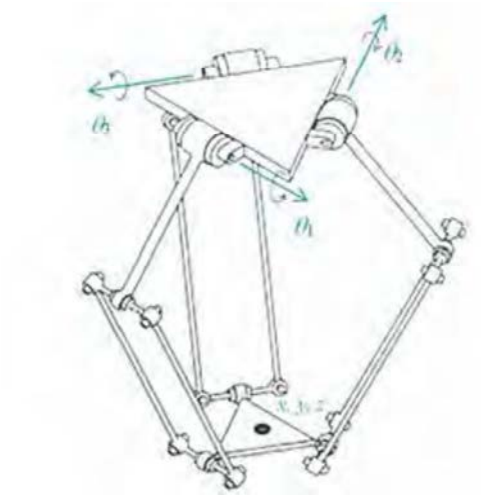
Delta (spider)

SCARA

Articulated

Industrial Robot Varieties

Delta “Spider” “Picker” 3,4, and 6-axis



Industrial Robot Varieties

Delta Robots

- Have very high acceleration & speed
- Can track quick conveyors
- 3-axis (XYZ) very fast transfer
- 4-axis (XYZ and Rotation about Z)
- 6-axis (not as common)

- Typically limited in maximum payload

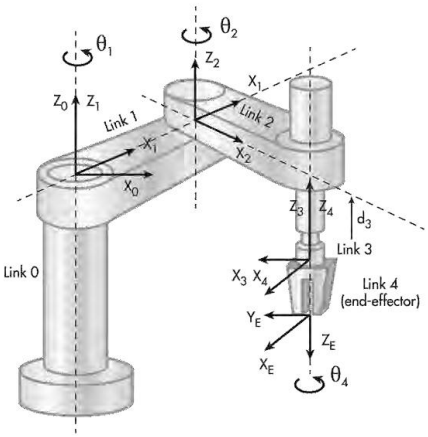
Industrial Robot Varieties

Delta - cartoning

Industrial Robot Varieties

SCARA 4-axis robot

Selective Compliance Assembly Robot Arm



Industrial Robot Varieties

SCARA (XYZ and rotation about Z)

- Low cost
- Simple design
- Fast & accurate
- Can be moved by hand to teach points
- Typically used in assembly & packaging

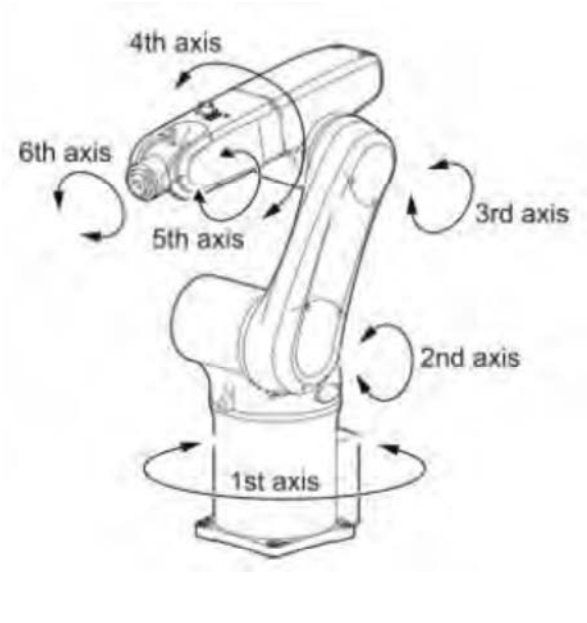
- Limited in tooling orientations
- Cell layout must be “flat”

Industrial Robot Varieties

SCARA

Industrial Robot Varieties

Articulated robot (4~6 axis)



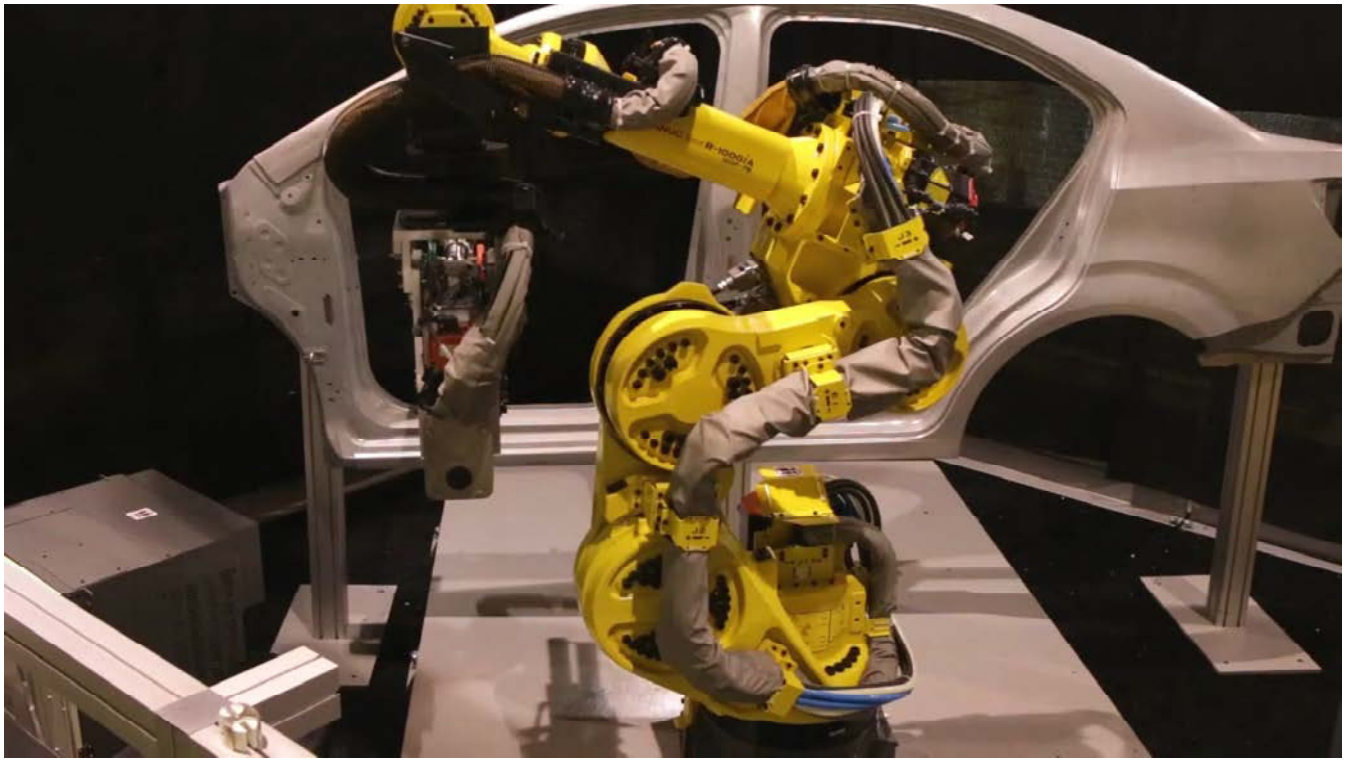
Industrial Robot Varieties

Articulated robot

- Full range of motion, like your hand
  - Flexible position <u>and</u> orientation
- Reliable drive train
- Easy to apply multi-function tooling
- Can accommodate a variety of cell layouts and misalignment (not everything needs to be flat as with a SCARA)
- Welding, Packaging, Palletizing, Machine Tending, General Handling

Industrial Robot Varieties

Articulated robot - sheet metal fabrication



Why do we need robots?

CNBC

MARKETS BUSINESS INVESTING TECH POLITICS CNBC TV

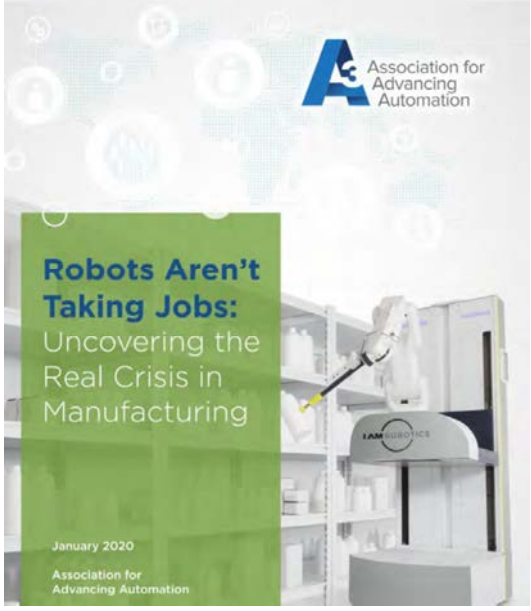
ECONOMY

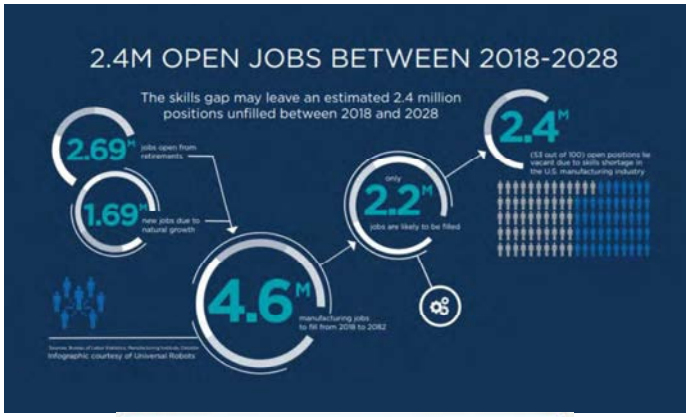
It's never been this hard for companies to find qualified workers

PUBLISHED WED, FEB 19 2020•6:58 AM EST | UPDATED WED, FEB 19 2020•11:07 AM EST

KEY POINTS

- About 7 in 10 companies reported talent shortages in 2019, the worst level ever, according to Manpower Group.
- The level is more than three times higher than a decade ago.





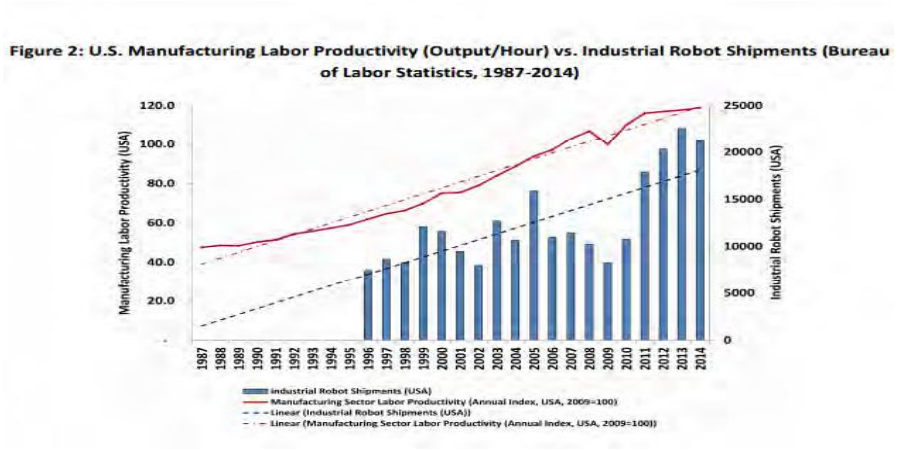
In 2017, the International Federation of Robotics published a positioning paper on the impact of robots on employment. "Automation has led overall to an increase in labor demand and positive impact on wages. Whilst middle-income / middle-skilled jobs have reduced as a proportion of overall contribution to employment and earnings – leading to fears of increasing income inequality – the skills range within the middle-income bracket is large. Robots are driving an increase in demand for workers at the higher-skilled end of the spectrum, with a positive impact on wages. The issue is how to enable middle-income earners in the lower-income range to upskill or retrain."

By taking the repetitive and dangerous jobs, robots have allowed workers to advance into more skilled roles. While these laborers may require additional training, companies often provide it because they value and want to keep their employees. Floor production workers are often the ones closest to the product development, and its successes and challenges. Robots give laborers the opportunity to learn more advanced skills to move up in pay-grade and quality of work-life. Several new jobs have been created because of robots, and will continue to be created, such as a robotics engineer, robot technician, data analyst, and an artificial intelligence business development manager.

By taking the repetitive and dangerous jobs, robots have allowed workers to advance into more skilled roles.

https://www.a3automate.org/wp-content/uploads/2020/01/Robots_Are_Not_Taking_Jobs.pdf

Correlation between robotics implementation & employment growth



For every robot installed 4-5 **new jobs** are created in the Manufacturing Ecosystem

Robotic Industries Association
robotics.org


The skills gap
#1 Concern from 82% of Advanced Manufacturing CEO's:
US Skilled Talent Shortage – 2015 marked a 7-year high
• Lack of applicants / no applicants -- 35%
• Lack of technical competencies or hard skills -- 24%
• Lack of experience – 22%


The skills gap
50% of all employers say talent shortages
significantly impact their business

What's the latest buzz?

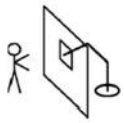
Collaborative!!

- A new type of robot
- Easy to use
- Easy to redeploy / move
- Low cost
- Safe
- No fencing required

What is Collaborative?

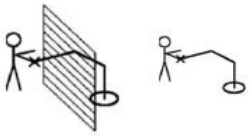
4 Types of Collaborative Operation Per ISO Std.

1) **5.10.2: Safety rated monitored stop**



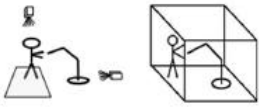
Hand-off window

2) **5.10.3: Hand guiding**



Guided teaching
Guided lift assist

3) **5.10.4: Speed and separation monitoring**



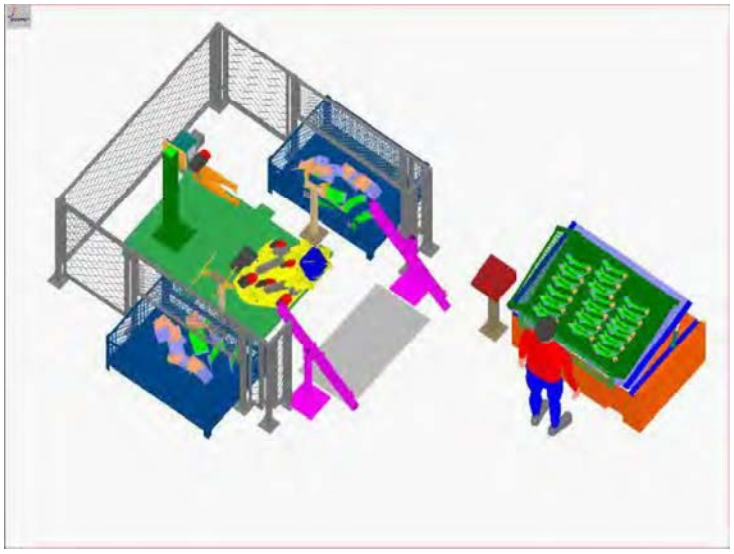
Inspection

Part replenishing and finished part removal

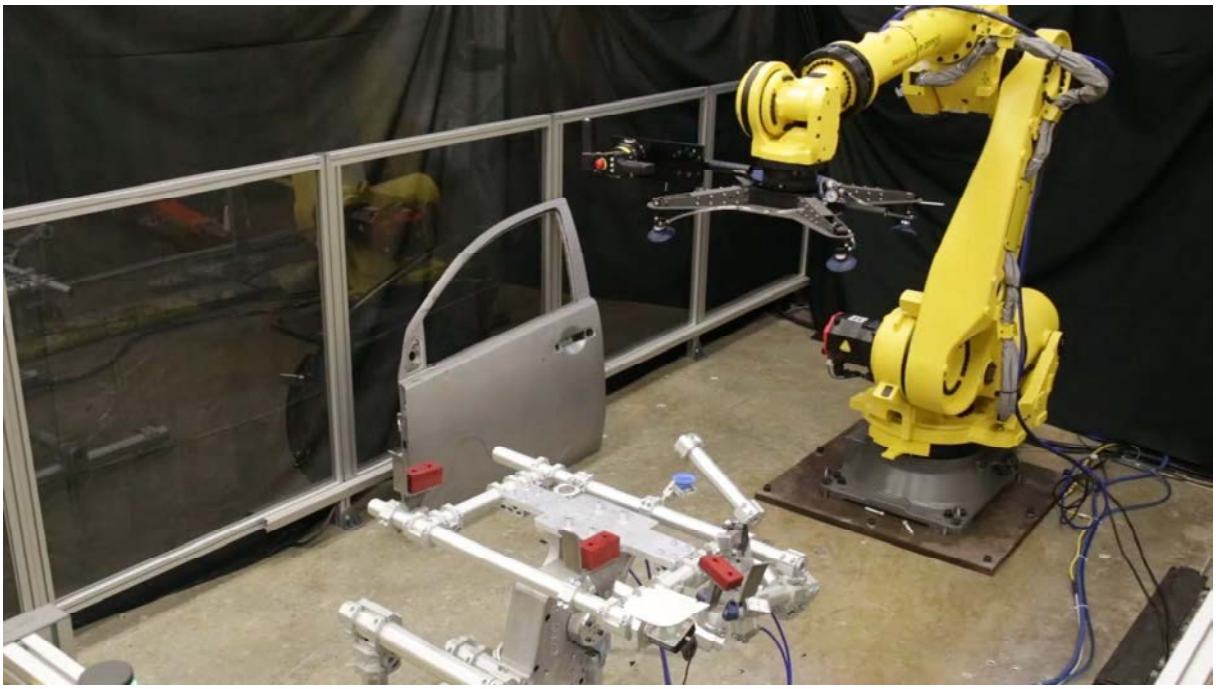
4) **5.10.5: Power and force limiting by inherent design or control**

NEW type of robot!

1) Safety-Rated Monitored Stop



2) Hand Guiding: standard robot



3) Speed and Separation Monitoring

4) Hand Guiding: force-limited robot

4) Power and Force Limited Robots

Collaborative Robotics
What's the reality?

A new type of robot = Yes

Robot design MUST inherently limit force via:

- A small drive train and safety sensors in each axis

- Standard robot: Limit force with safety force sensor

Collaborative - What's the reality?

Easy to use = Yes and No

Yes

- New user interfaces and tutorials and hand guiding make it easier but this isn't the hard part

No

- Integrating to other devices and machines can be confusing

- Still requires Risk Assessment

Collaborative - What's the reality?

Easy to redeploy = Yes and No

Yes

- Some models are light and easy to move

No

- Still requires Risk Assessment of new application

Collaborative - What's the reality?

Low cost = Yes and No

Yes

- Smaller models can be the same price range as standard industrial robots $25k~$50k

No

- Like anything you buy there are different manufacturers and levels of quality. There are some collaborative robots in the market that have a shorter design life and are more of a disposable commodity with a useable life of 3-5yrs
- Think about the replacement costs

Collaborative - What's the reality?

Safe = Yes and No

Yes
- When deployed properly with Risk Assessment

No
- The "process" may not be collaborative, what is the robot handling; e.g. blades, pointed items, clamps, high-speeds
- Plant is ultimately responsible for safety

Collaborative - What's the reality?

No Fence Required = Yes and No

Yes
- When deployed properly with Risk Assessment

No
- Some robot speeds and processes are not safe
- I have seen some collaborative robots installed and then after the risk assessment they determined they needed fencing, so now you have a slow robot inside of a fence…
- Plant is ultimately responsible for safety

Collaborative - What else?

- Generally slower
- Not able to impart higher assembly forces
- Limited in Payload

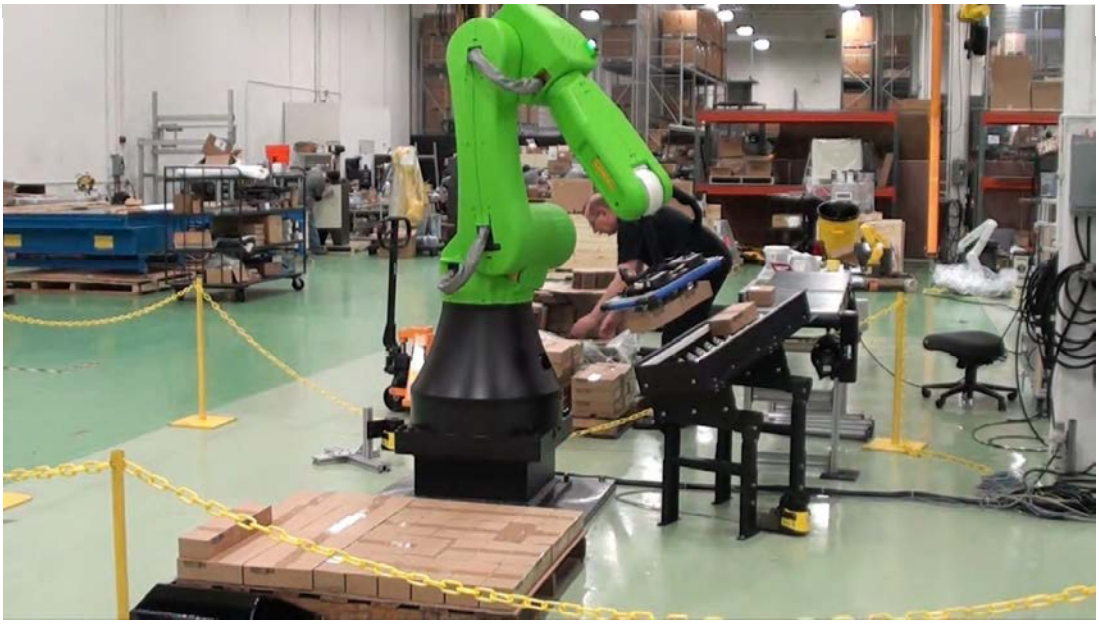
Do you need collaborative?

- What about fenceless with area scanner?
- Do operators need to be right in the robot's way for entire process, or only occasionally?
- Do you need higher throughput?
- Are your parts heavy?

Use Case: emptying dangerous materials

Use Case:
CNC Mill Tending

Use Case: palletizing
lower rate, higher value worker



Use Case: Part inspection

Collaborative Robotics Summary

- A new tool to help with labor shortages
- Allows a possible easy entry into robotics
- Different solutions exist
- Standard industrial robots can be used collaboratively too
- Requires risk assessment – Safety is up to you!
- Not a fit for all applications
  - Slower
  - Can't impart higher forces
  - Limited Payload
  - Part or process is dangerous

So what if a Collaborative robot can’t do the job safely or at all?

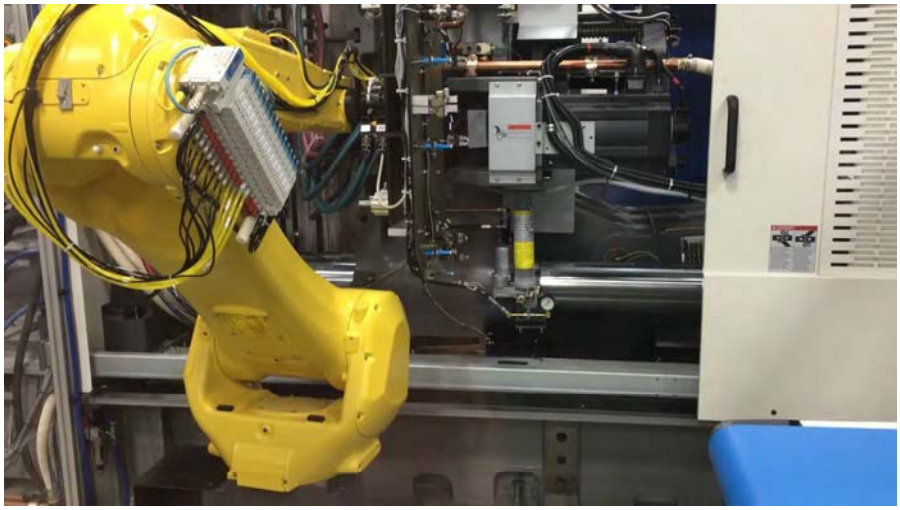
Lets look at some sample systems using non-collaborative robots

Industrial Robot Varieties

Articulated robot - Food Industry

Industrial Robot Varieties

Articulated robot - insert molding plastics



Industrial Robot Varieties

Delta - aligning, defect removal

Adaptive Technology: Vision Guidance

2D Vision Guidance

Historically, parts were fed to robot cells by expensive, dedicated fixtures for precise location

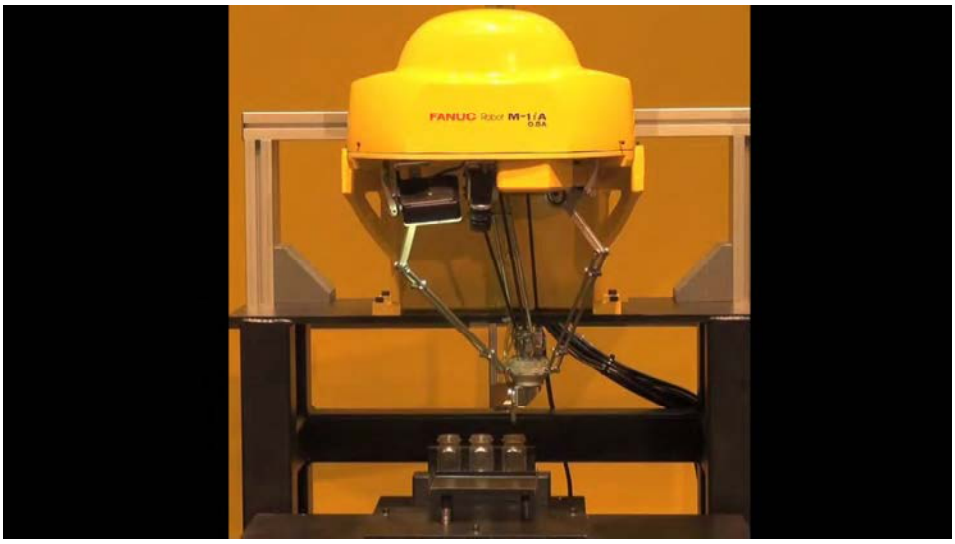
Vision sensors now allow for "grocery store belt" infeed. Robots adapt to location of part

Vision allows for picking from a pallet or bin!

Vision allows quick changeover, error-proofing and lower cost parts infeed

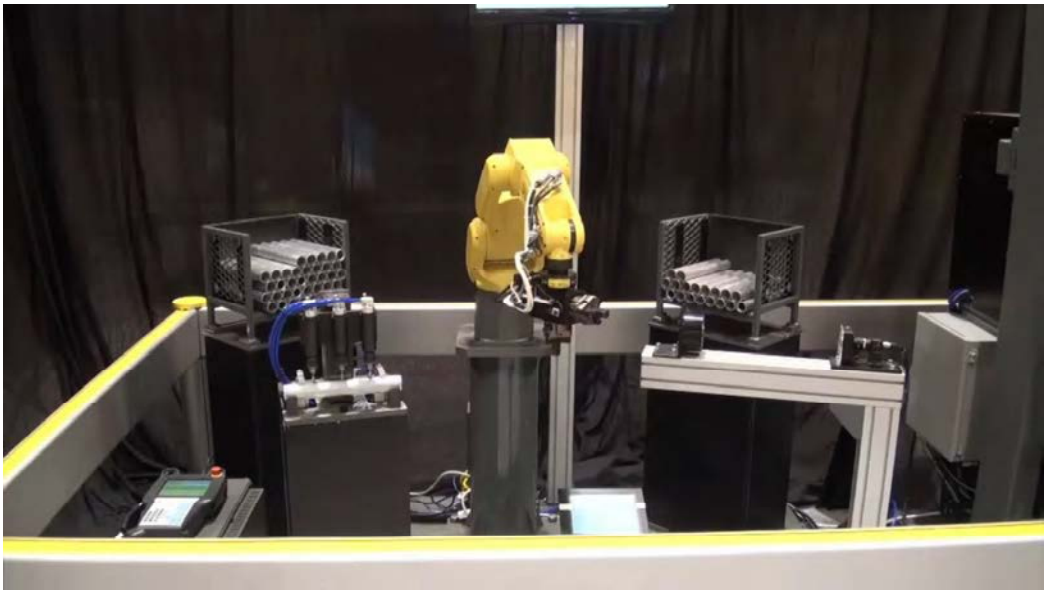
2D Vision Guidance

Delta - 6-axis sorting with color vision



2D Vision Guidance

2D Vision Guidance



3D Vision Guidance

The keys to robotic automation – numbers don't lie

1. Operator Savings
2. Increase Productivity/Spindle Utilization
3. Reduced operation costs
4. Increased employee satisfaction/retention
5. Ability to perform secondary ops
6. Improved Ergonomics / Safety
7. Increased Quality
8. Eliminate Fixtures
9. Reduced CapEx and floor space
10. Ability to run lights out

Systems Integration:

How much does it cost?

- **What are you attempting to do?**
- **How big is your part?**
- **What are you trying to reach?**
- **How complex is your process?**
- **Who is integrating the unit?**

Rule of Thumb

Take the list price of the robot and multiply it by a factor of between two or three for low-to-moderate difficulty systems

Building the business case

An automation project must be tied to a business case with clearly defined reasons to automate, clear objectives and very clear definition of what success looks like

- ***Why*** are you considering automation?
  - Quality
  - Ergonomics
  - Throughput
  - Workforce issues / High Turnover
  - Safety
  - Cost reduction
  - Employee satisfaction

- ***What*** process are you automating?
  - Entire process or smaller portions of a larger process?
  - Is this process new to your company?
  - Your process needs to be stable or you may need advanced technology to compensate i.e. vision, force sensing

Process Studies

"The Human Touch"

Vital steps in the production process often go unnoticed and undefined since they are typically developed by the operators themselves to make the process *smoother*!

Ask an operator or line foreman to create a step-by-step listing of what he/she does to create a finished product before planning automation

- **Visual inspection and "touch-up"**
- **Machine or fixture cleaning**
- **Light material removal**
- **Product staging**
- **Manual operations that are difficult to qualify**

Rise of the robots

Questions?