Collaborative Robot Use Cases in Electronics Manufacturing

Eric Cowan
Industry 4.0 Manager
Continental Automotive Systems

AUTOMATE • 2017

Continental Seguin

- Established: 1972
- Manufacturing: 14 MM Units/Year
- Employees: 1,600
- Building: 340,000 sq ft
- Certifications
  - ISO/TS 16949
  - ISO – 14644-1 (Class 8 & Class 7)
  - ISO 14001
  - OSHA STAR VPP
  - OHSAS 18001
- Americas Center of Competence
  - Collaborative Robotics
  - 3D Printing
  - Big Data
  - Manufacturing Technologies

45 Years of Tradition

Collaborative v. Industrial Robots: TS 15066

Cobots <u>are</u> Industrial Robots,

but <u>not all</u> Industrial Robots are Cobots

Main techniques for Collaborative Robot operation:
- Safety-rated monitored stop
- Speed and separation monitoring
- Hand guiding
- Power and force limiting

AUTOMATE • 2017

Safety with Cobots

Collaborative Robots <u>are</u> Industrial Robots

Safety is Paramount: (see ISO 10218, ISO/TS 15066)

Myths
- Cobots are inherently safe
- Cobots are power and force sensing so it is okay to hit people
- Cobots are quick and easy to deploy, don't worry about the application

Risk Assessments
- Perform as you would for any automation equipment
- Get training and expert help
  - Robotics Industries Association is a good place to start

# Collaborative Robot Applications

- Material Handling
  - De-stacking raw material @ point of use
- Machine Tending
  - Load parts in a machine, close door, push a button
  - Simulate human behavior in a Lean Circle
- Test / Inspection
  - Cameras / Sensors mounted on Cobots take pictures, measurements
- Value Added Processing
  - Assembly, Dispensing, Polishing, Screwing, etc…
- Transport
  - AGVs move material within the factory

Cobot Application: Material Handling

De-stacking PCBs to conveyor @ SMD line
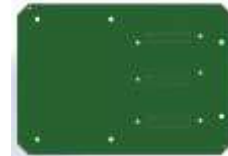
- Implementation
  - Cobot mount to stand
  - SMEMA interface with conveyor
  - Vacuum gripper

AUTOMATE • 2017
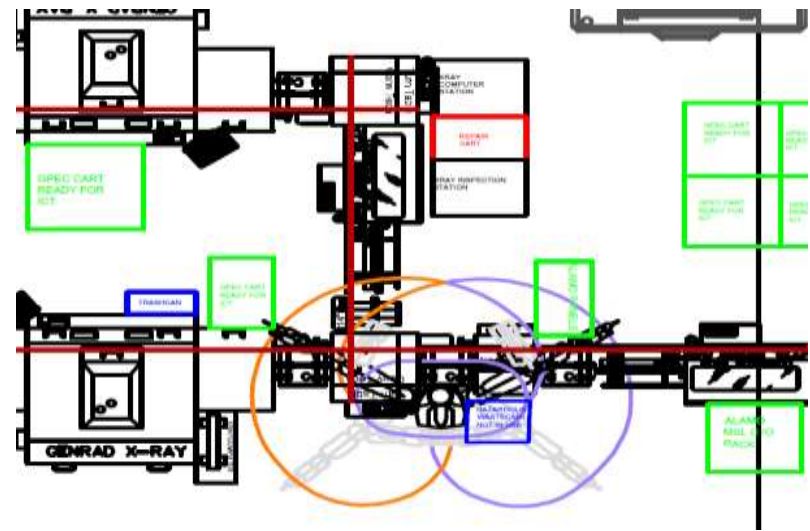
1 UR10 Cobot   Takt Time: 35s

Ergonomics (Eliminate operator repetitive motion)
- 12 hours x 85 units per hr = 1,020 units per shift
- 1020 ups x 5 touch points = 5,100 touch points (●)
- Circle distance 3m x 1020ups = 3,060m per shift
- 3km per shift walking distance
- 15.8kg per shift unit handling (lifting, flipping, twisting)

Benefits
- Operator redeployed to higher value add position
- OEE increased
- Fixture life increased > 4x
- ROI < 1 year

Before

After

AUTOMATE · 2017
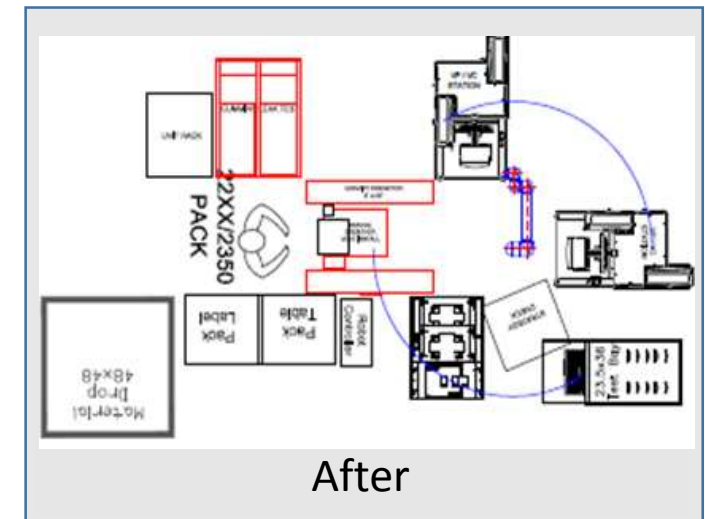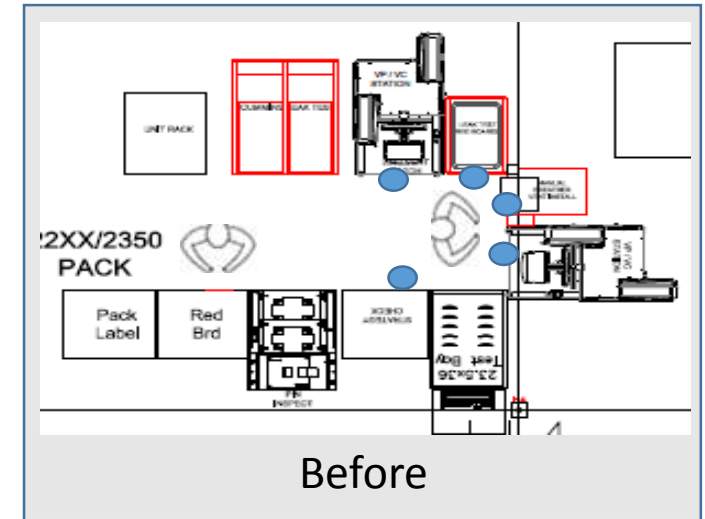
Cobot Application: Lean Circles (Pack area)

Safety:
- 2 Area Sensors (base of Cobot)
- Padding on machines for operators
- Safety Plane (ceiling protection)
- Operator separation

Area modifications:
- Gravity Feed convey units in/out
- Fixture modifications for load / unload

Operator

Area Sensor

AUTOMATE · 2017

Cobot Application: Lean Circles (Pack area)

Video of Pack Cobot
- Repetitive movements
- Improved Ergonomics
- Operator Separation
- Gravity feed in / out
- Enough space to run manually
- Safe Plane to avoid ceiling

Cobot Application: Lean Circles (Back End area)

2 UR10 Cobots   Takt Time: 30s

Ergonomics (Eliminate operator repetitive motion)
- 1,200 units per shift
- 6,000 touch points (●)
- Circle distance 8m
- 9.6km per shift walking distance
- 5,400 kg per shift unit handling (lifting, flipping, twisting)

Benefits
- Operator redeployed to higher value add position
- OEE increased
- Fixture life increased > 3x
- ROI < 1 year
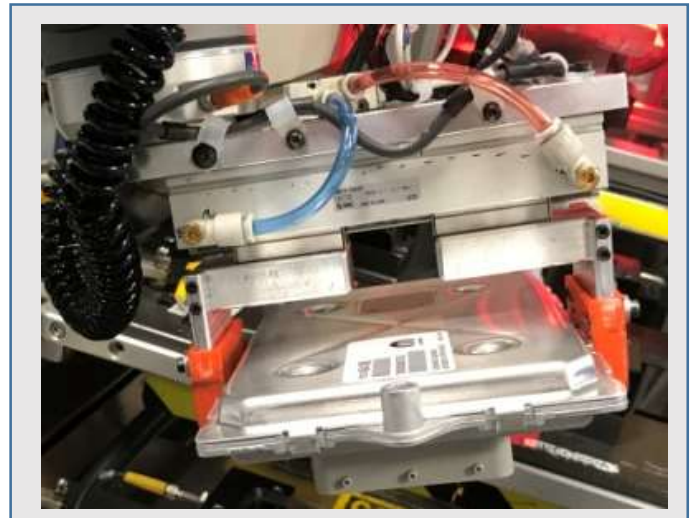

Before

After
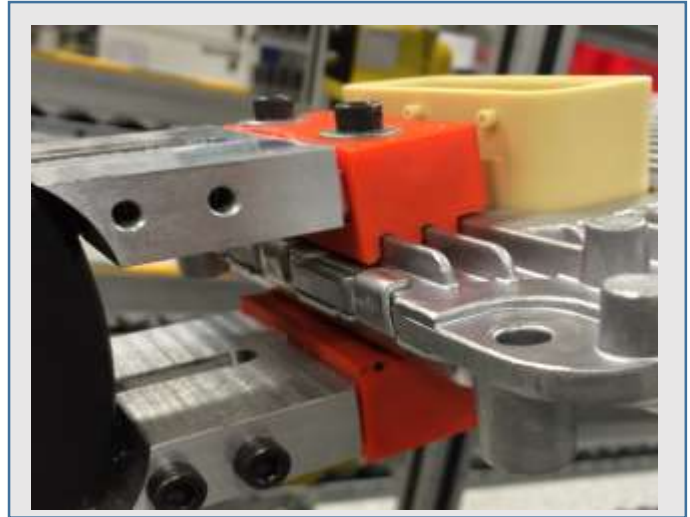
AUTOMATE • 2017
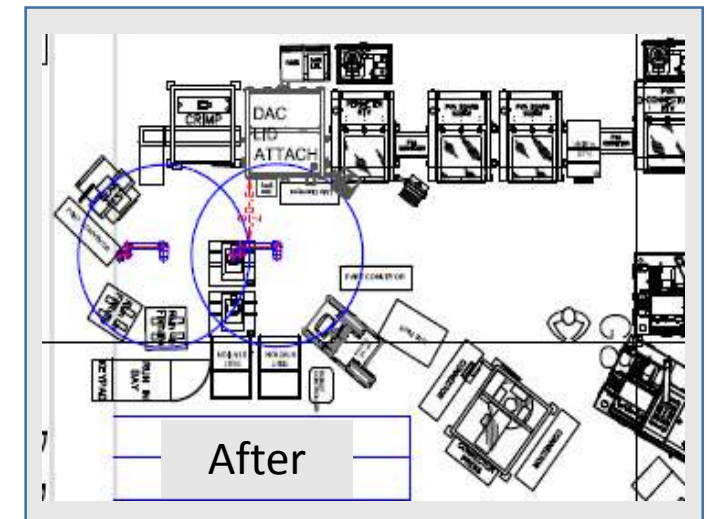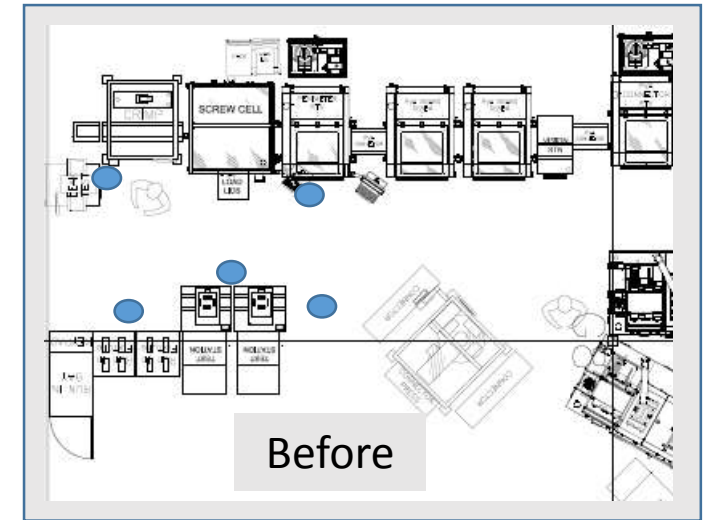
Grippers
- 3D print design
- Custom design for each product
- Quick iteration

Safety:
- 4 Area Sensors (2 per of Cobot)
- Operator separation

Area modifications:
- Gravity Feed convey units in/out
- Fixture modifications for load / unload
- Lid Magazines added Cobot gripping

Cobot Application: Lean Circles (Back End area)

Video Back End Cobots

- Lid magazine move
- Repetitive movements
- Improved Ergonomics
- Operator becomes Water Spider
- Operator takt was 30s
- Water Spider takt is 20m
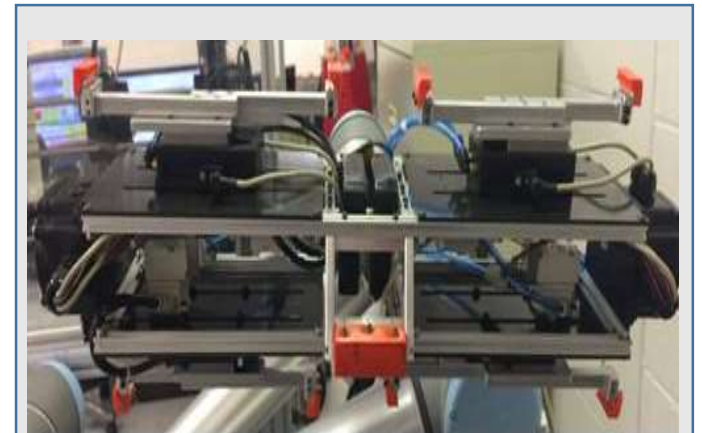
Cobot Application: In-Circuit Test

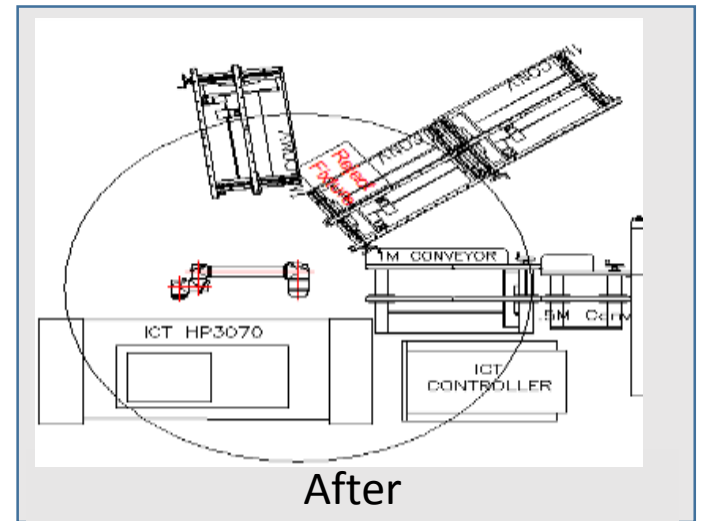1 UR10 Cobot   Takt Time: 40s per unit

Cycle Time considerations
- Dual fixture for test due to long cycle time
- Minimize handling when not testing
- EoAT can handle 4 units at a time

Benefits:
- Eliminated breakage of standoffs in fixture
- Improved repeatability of process
- Operator redeployed to higher value add position
- OEE increased
- ROI < 1 year

EoAT

After

Cobot Application: In-Circuit Test

Safety:
- 5 Area Sensors
  - 2 base of Cobot
  - 1 for fixture auto open / close
  - 2 aerial sensors preventing reach in to conveyor and landing pads
- Operator separation

Area modifications:
- Fixture auto open / close
- Laser alignment block mounted to bay
- Exit and transfer conveyors
- Vision sensors for board presence

Area Sensors

Area Sensors

Area Sensors

AUTOMATE · 2017

Cobot Application: In-Circuit Test
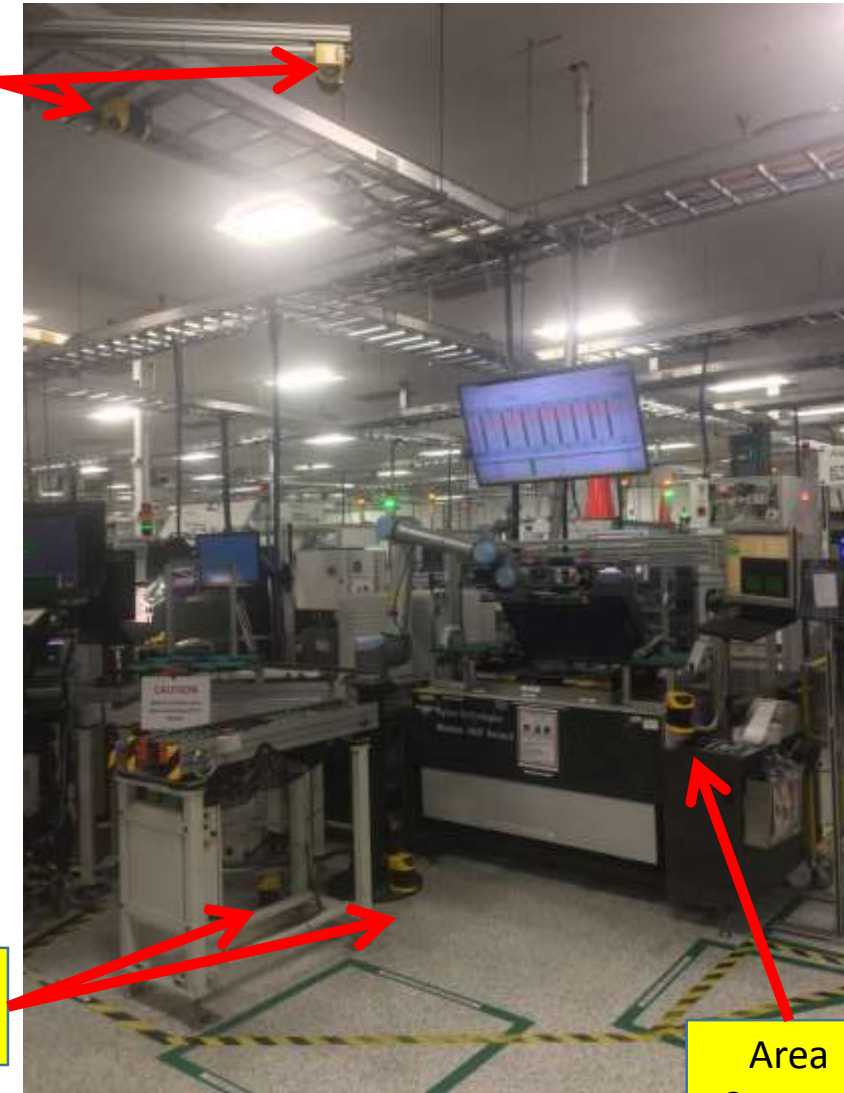
Video of ICT Cobot
- Improved Quality
- Repetitive movements
- Vision Sensors
- Operator Separation
- Conveyor feed in / out
- Enough space to run manually
- Fixture auto open/close
- 5 Area Sensors

Cobot Application: Lid Attach + Crimp + Test
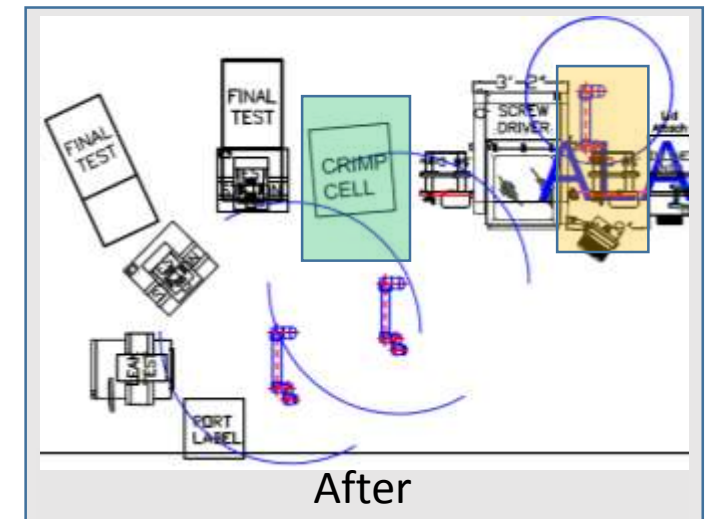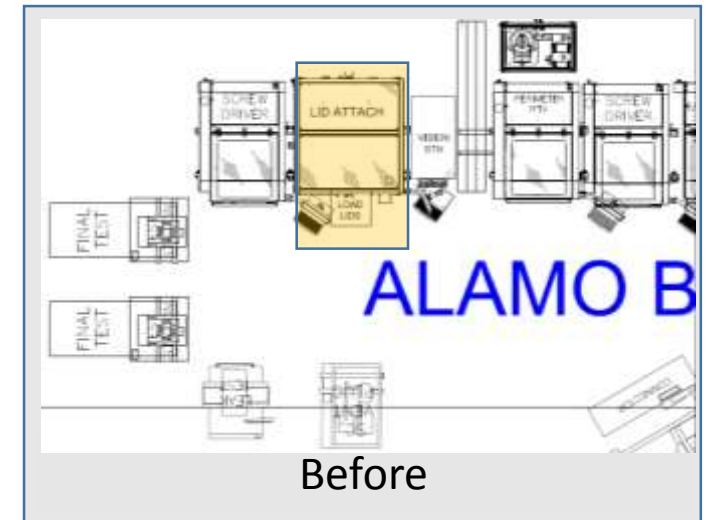
2 UR10 + 1 UR5 Cobot   Takt Time: 30s

Goals:
- Increase line flexibility by adding a Crimp cell
- Reduce size of Lid Attach to accommodate Crimp
- Deploy Lean Circle Cobot for test processes

Benefits:
- Line can run two HW families instead of just one
- Operator redeployed to higher value add position
- OEE increased
- ROI < 1 year

Before

After

AUTOMATE · 2017

Cobot Application: Lid Attach Comparison

Line	Dimensions	Footprint	Moving parts	Capital Cost
C: Legacy 1	2.26m x 1.57m	3.6 m²	30	Baseline
A: Legacy 2	2.2m x 1.8m	3.3 m²	11	Baseline
B: Seguin Cobot	0.73m x 1.93m	1.4 m²	7	~ 50% less

Line C: Legacy 1

Line A: Legacy 2

Line B: Seguin Cobot

Area Sensor

AUTOMATE • 2017

Cobot Application: Lid Attach + Crimp + Test

Video of Alamo Cobots

- Improved Quality
- Repetitive movements
- Improved Ergonomics
- Operator Separation
- Conveyor feed in
- Gravity feed out
- Enough space to run manually
- 3 Cobots working the line

AUTOMATE • 2017

3 UR10 Cobot   Takt Time: 18s

Goals:
- Improve work area for the operator
- Deploy Spatially Aware Cobots
  - Share pick/place locations with human
  - Share pick/place locations with Cobots
- Improve OEE of line

Benefits:
- Operator workload reduced
  - 6km per shift walking distance
  - 7.5k touch points per shift (light unit < 0.3kg)
- OEE increased
- ROI ~ 1 year

Before

After

AUTOMATE · 2017

Cobot Application: 3 Cobots Spatially Aware

Safety:

- Area Sensors
- Plexiglas to avoid reach in/entrapment
- Operator separation
- Safety Planes allow Cobots to interact with one another

Area modifications:

- Gravity feed in
- Moved equipment to enclose space
- Fixed scanners for MES unit scans

Cobot Application: 3 Cobots Spatially Aware

Video of Tejas Cobots
- Improved Quality
- Repetitive movements
- Improved Ergonomics
- Operator Separation
- Gravity feed in
- Enough space to run manually
- 3 Cobots aware of one another
- Shared hand off space

AUTOMATE • 2017

What's Next? Add Vision to Our Systems

Camera Systems
- EoAT mounted or Fixed
- Random location picking
- Random bin picking
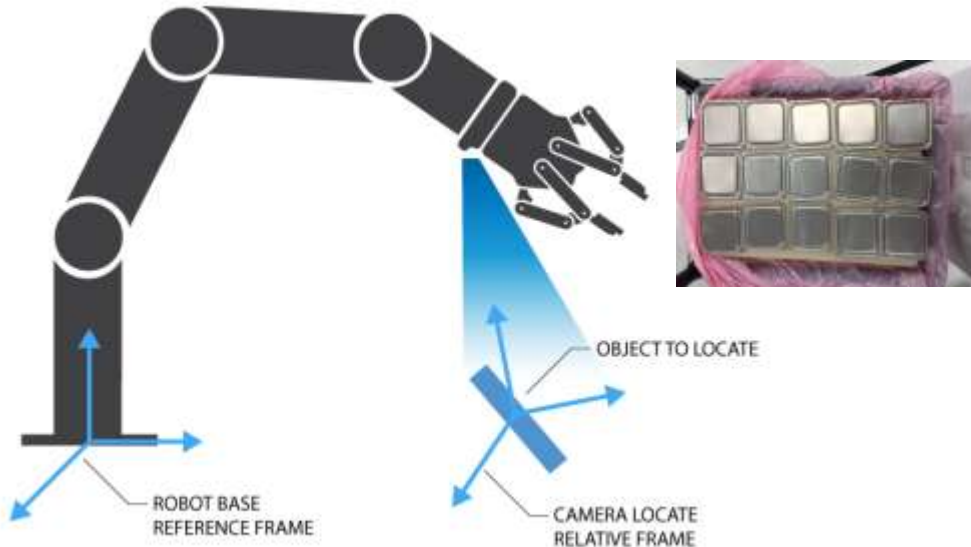
Time of Flight camera system
- Completeness Monitoring
- Distance Monitoring
- Dimensioning of rectangular objects
- Sorting of rectangular objects

OBJECT TO LOCATE

ROBOT BASE
REFERENCE FRAME

CAMERA LOCATE
RELATIVE FRAME

PICK FROM CONVEYOR   INSPECT FOR EMPTY SPOTS   PLACE UNTIL FULL

Source: http://robotiq.com/

AUTOMATE • 2017

Thank you for your attention. Questions?

Eric Cowan
Industry 4.0 Manager

Continental Automotive Systems
3740 N Austin St
Seguin, TX

USA

Telephone: 830.372.7559
Email: eric.cowan@continental-corporation.com

www.conti-online.com