

# Getting Started with Cobot Automation

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April 4, 2023



# Agenda

1. Background
2. Manufacturing Labor
3. First Projects
4. Risk Management
5. ROI & Justification
6. DIY or Integrator?





We want to create a world  
where people work with  
robots,  
not like robots

# Universal Robots in numbers

**800+**

Distributors &  
Integrators

**20+**

Offices

**1000+**

Employees

**50,000+**

Cobots sold

**40%**

Cobot market  
share

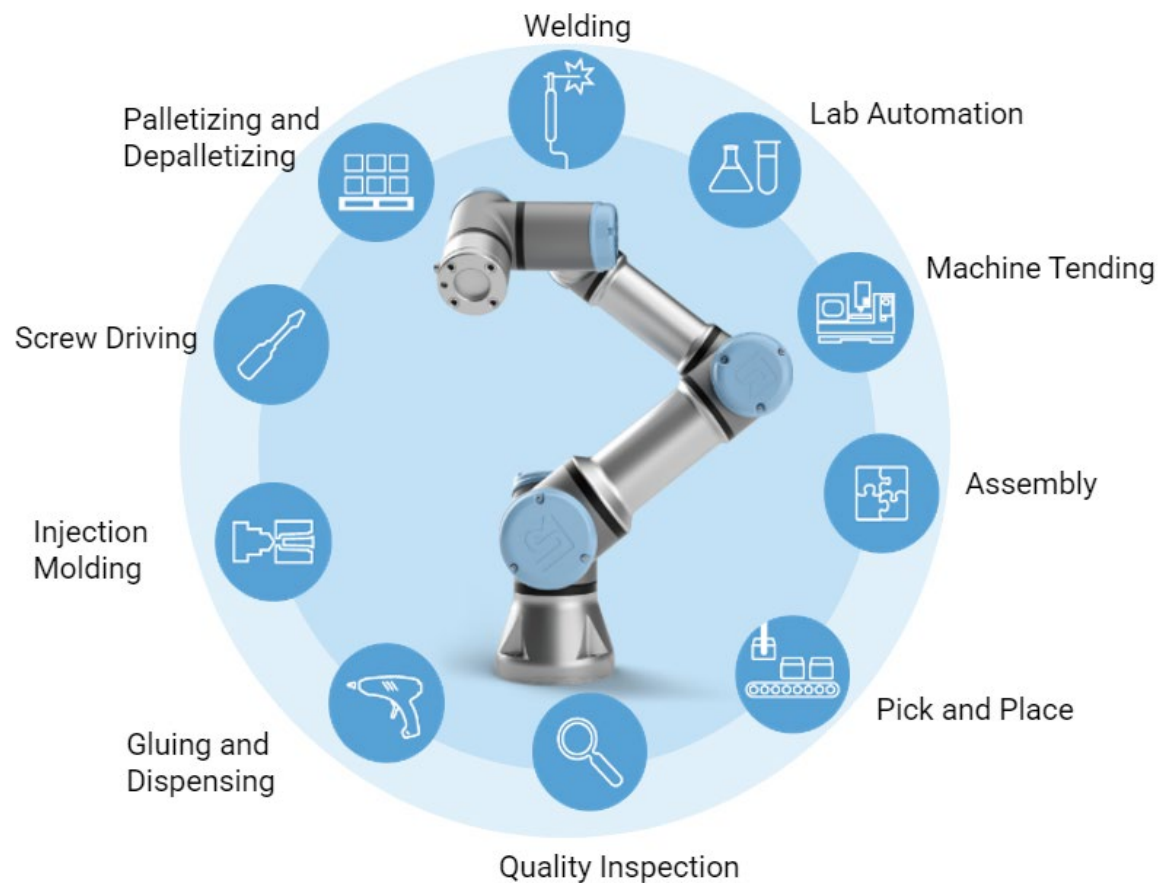
**400+**

UR+ products

# A global company



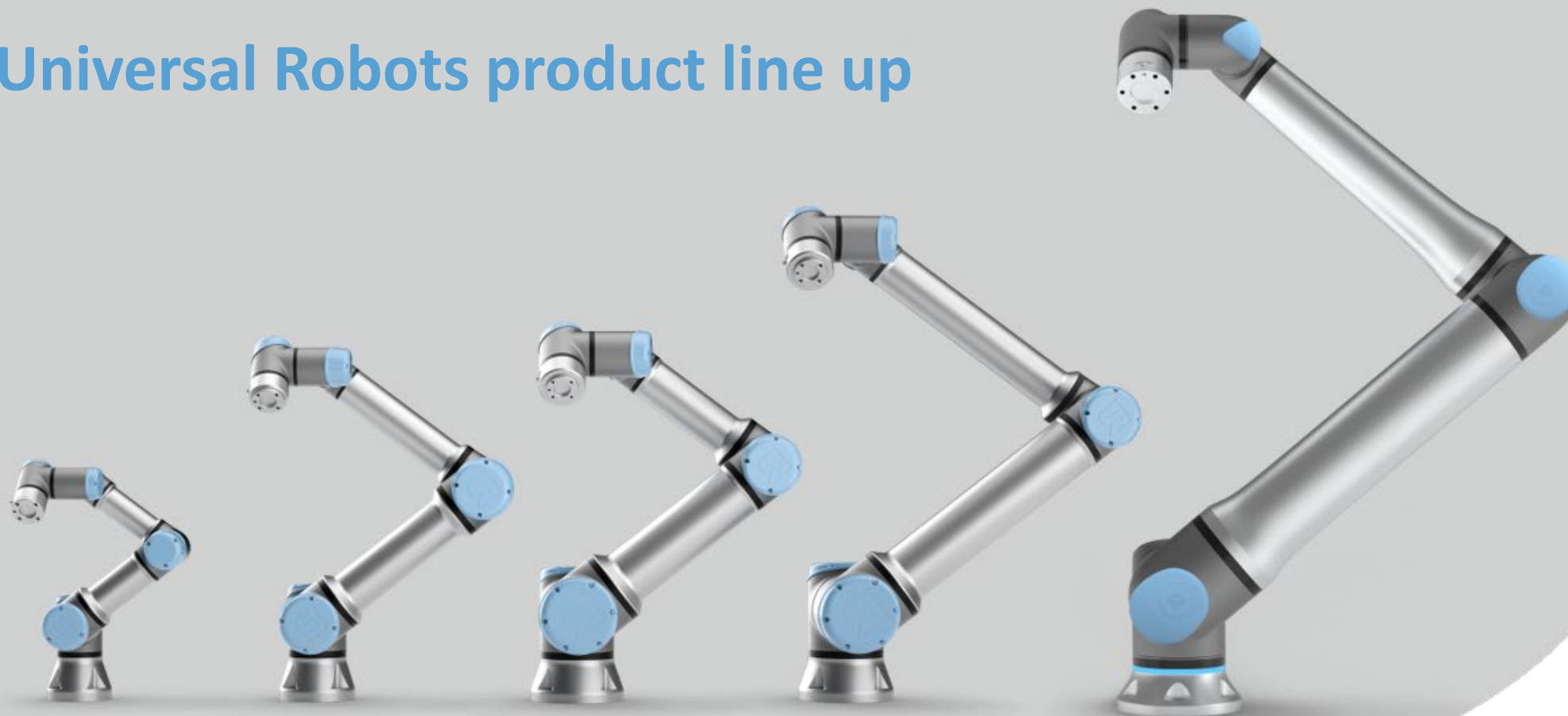
# Where are the cobots?



- Everywhere.
- All applications.
- All industries.

## What is next?

# Universal Robots product line up



Payload: 3kg (6.6 Lbs)  
 Reach: 500mm (19 in)  
 Weight: 11kg (24 Lbs)  
 Repeatability:  $\pm$  0.03mm

Payload: 5kg (11 Lbs)  
 Reach: 850mm (33 in)  
 Weight: 20 kg (45 Lbs)  
 Repeatability:  $\pm$  0.03mm

Payload: 16kg (35.2 Lbs)  
 Reach: 900mm (35 in)  
 Weight: 33 kg (73 Lbs)  
 Repeatability:  $\pm$  0.05mm

Payload: 12.5kg (28 Lbs)  
 Reach: 1300mm (51 in)  
 Weight: 33 kg (73 Lbs)  
 Repeatability:  $\pm$  0.05mm

Payload: 20kg (44 Lbs)  
 Reach: 1750mm (68.9 in)  
 Weight: 64 kg (141 Lbs)  
 Repeatability:  $\pm$  0.05mm

**UR3e**

**UR5e**

**UR16e**

**UR10e**

**UR20**

# Traditional Automation

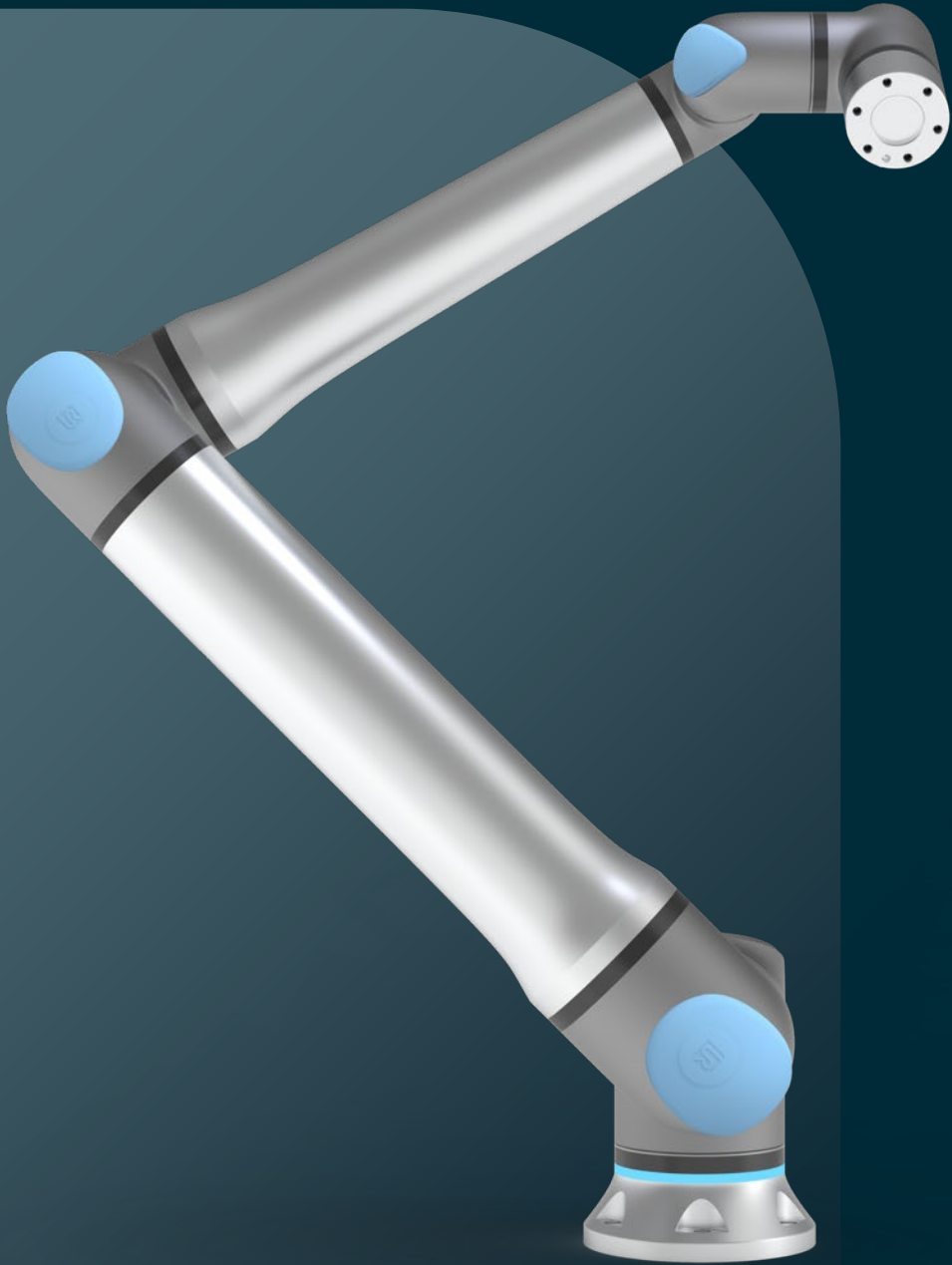


ROI in Plastics

# Collaborative Automation







# Industrial Cobot Basics

**Collaborative & safe**, able to safely operate alongside humans in shared space.

**Easy to program** - no previous coding / robotics / automation experience required.

- **Fast Setup** – 120v power, simple out-of-box experience.

- **Flexible & Versatile** – easy to redeploy into new applications or new production runs.

**Total System Cost** typically 1/3 to 1/2 of traditional automation. Economically viable in high mix / low volume operations

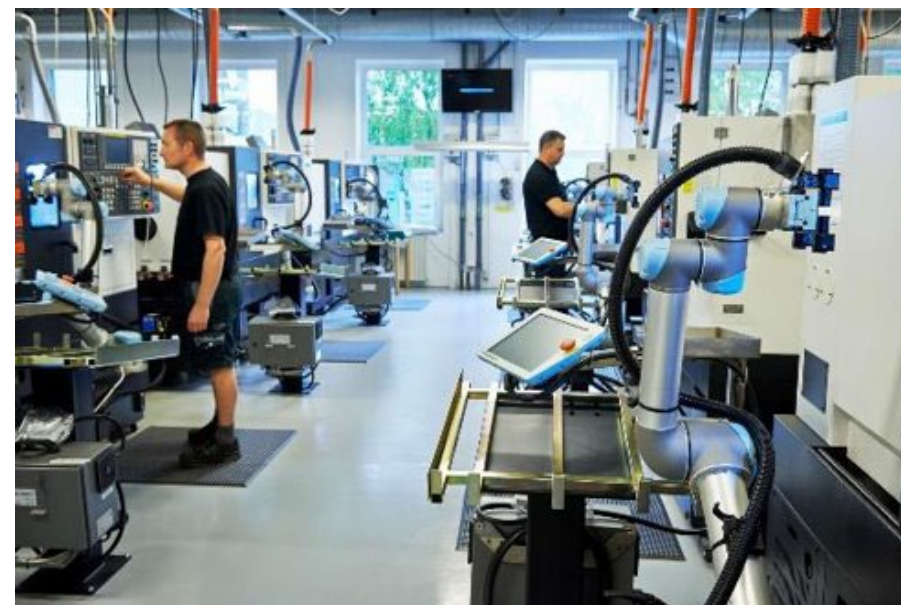
# Safety Function to Meet Individual Plant Requirements



**17 safety functions**, all EN ISO 13849-1, ISO 10218-1 Cat. 3, PL d, certified by TÜV NORD

- Configurable stopping time & stopping distance
- Joint position limits
- Pose limit, tool orientation limit, safety planes, safety boundaries
- Safe home
- Force limiting (TCP)  
Elbow safety (force, speed, boundary restriction)

# All-or-nothing VRS Incremental Automation



## Cobots are Reaching New Classes of Customers

- New to automation
- No robot engineers
- Small and medium enterprises (aka SMEs)



In 2021, there were 292, 825 factories in the US. Approximately 91% had less than 100 employees.

# Traditional Automation Customers





# The Manufacturing Labor Shortage Just Won't Go Away

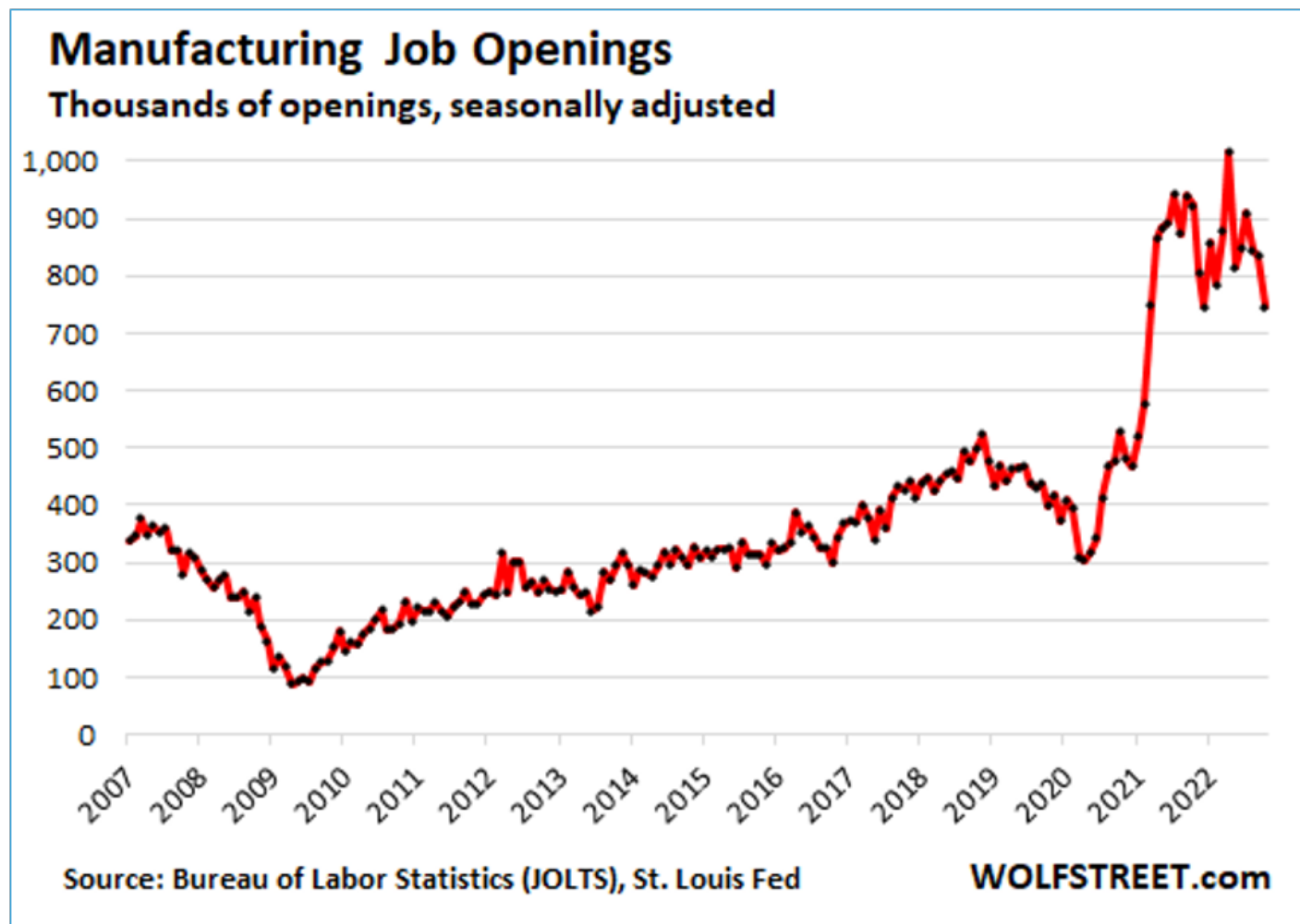
**Figure 5: Primary Current Business Challenges, Fourth Quarter 2022**



*Note: Respondents were able to check more than one response; therefore, responses exceed 100%.*

Source: National Association of Manufacturers Survey December 2022

# November 2022: 750,000 Manufacturing Job Openings



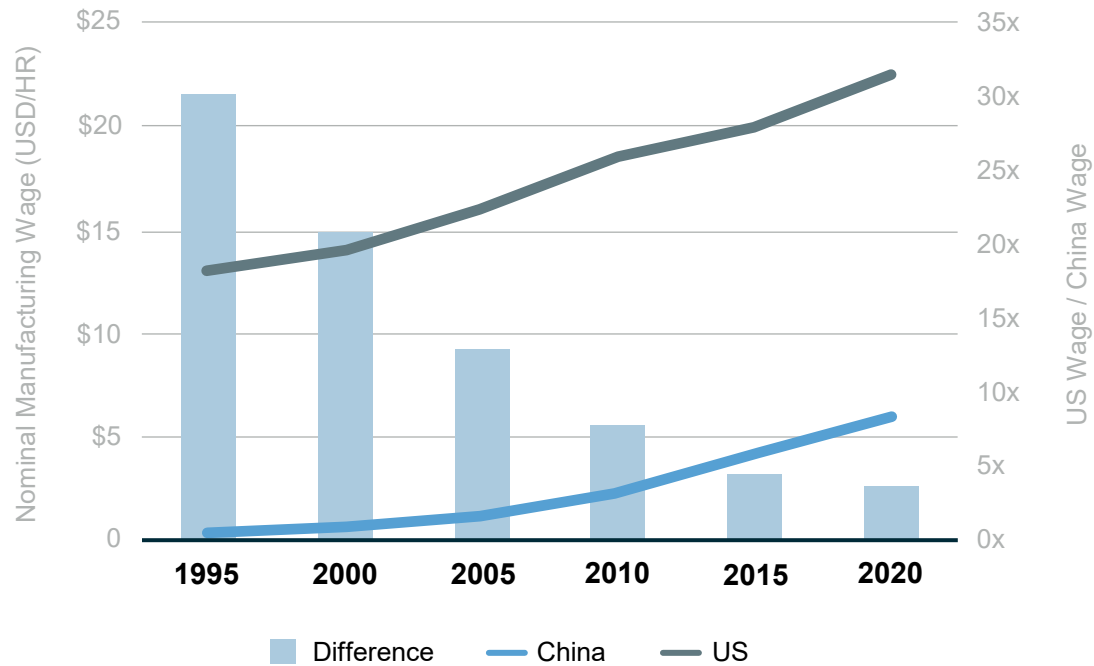
Current job openings are down from January 2021 peak of 1,000,000, but still 50% higher than pre-pandemic levels.

# Reshoring Driving Growth in US Manufacturing

## Wage differences decrease and shipping costs increase



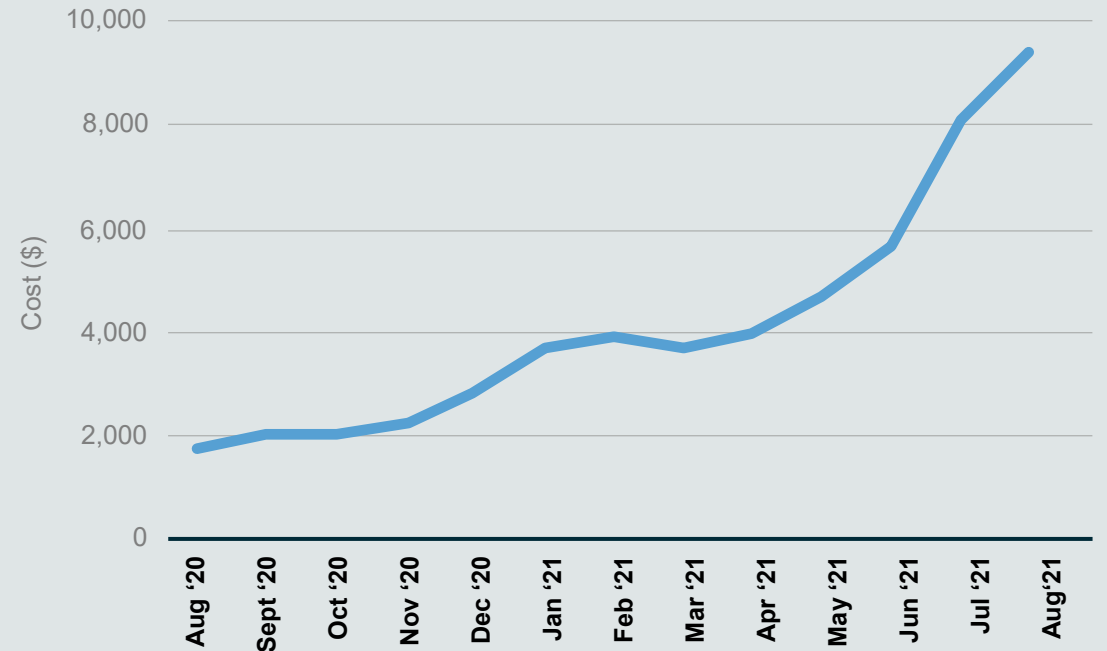
Wage differences between China and US decreased from 30x in 1995 to ~3.5x in 2020



Source: US Bureau of Labor Statistics Report  
China: Trading Economics



Shipping cost from China to US increased 5x from 2020 to 2021

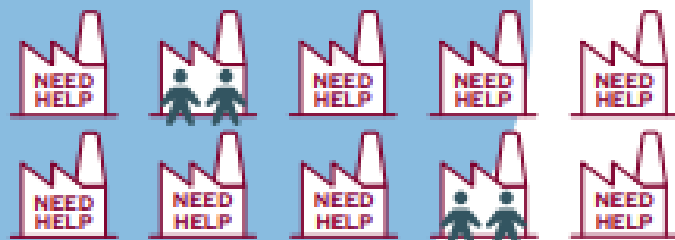


Source: Interact Analysis: MIO Report, Sept 2021



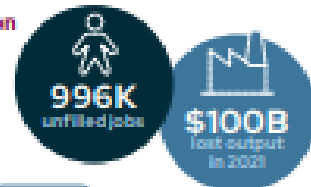
# Solving Manufacturing's #1 Challenge: Labor Shortage

Over 80% of US manufacturers struggle to attract and retain a quality workforce.



## Where are the workers?

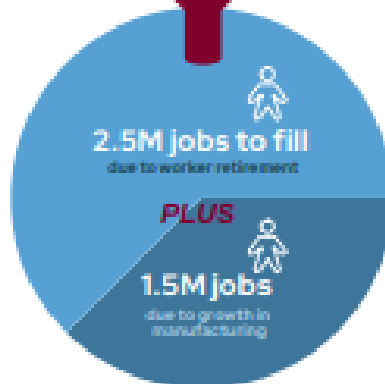
> The Great Resignation hit manufacturing hard.



> Nearly half of all Millennials, GenXers, and GenZers are not interested in manufacturing jobs.

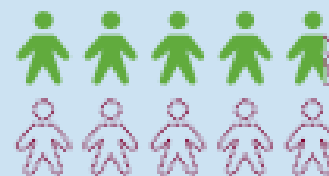


> 10,000 Baby Boomers retire every day in America.



## That's 4 million open jobs.

What's more, 53% of those jobs require talents or skills that are hard to find in the labor pool.



That means 2.1 million jobs will go unfilled.

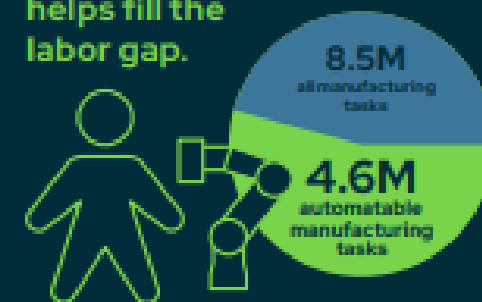
Source: Bureau of Economic Analysis, Bureau of Labor Statistics, Bureau of Economic Analysis, Bureau of Economic Analysis, Bureau of Economic Analysis

## Meanwhile?

Onshoring drives growth opportunities for U.S. manufacturers.



## Collaborative automation helps fill the labor gap.



And provides safer, more fulfilling technology jobs.

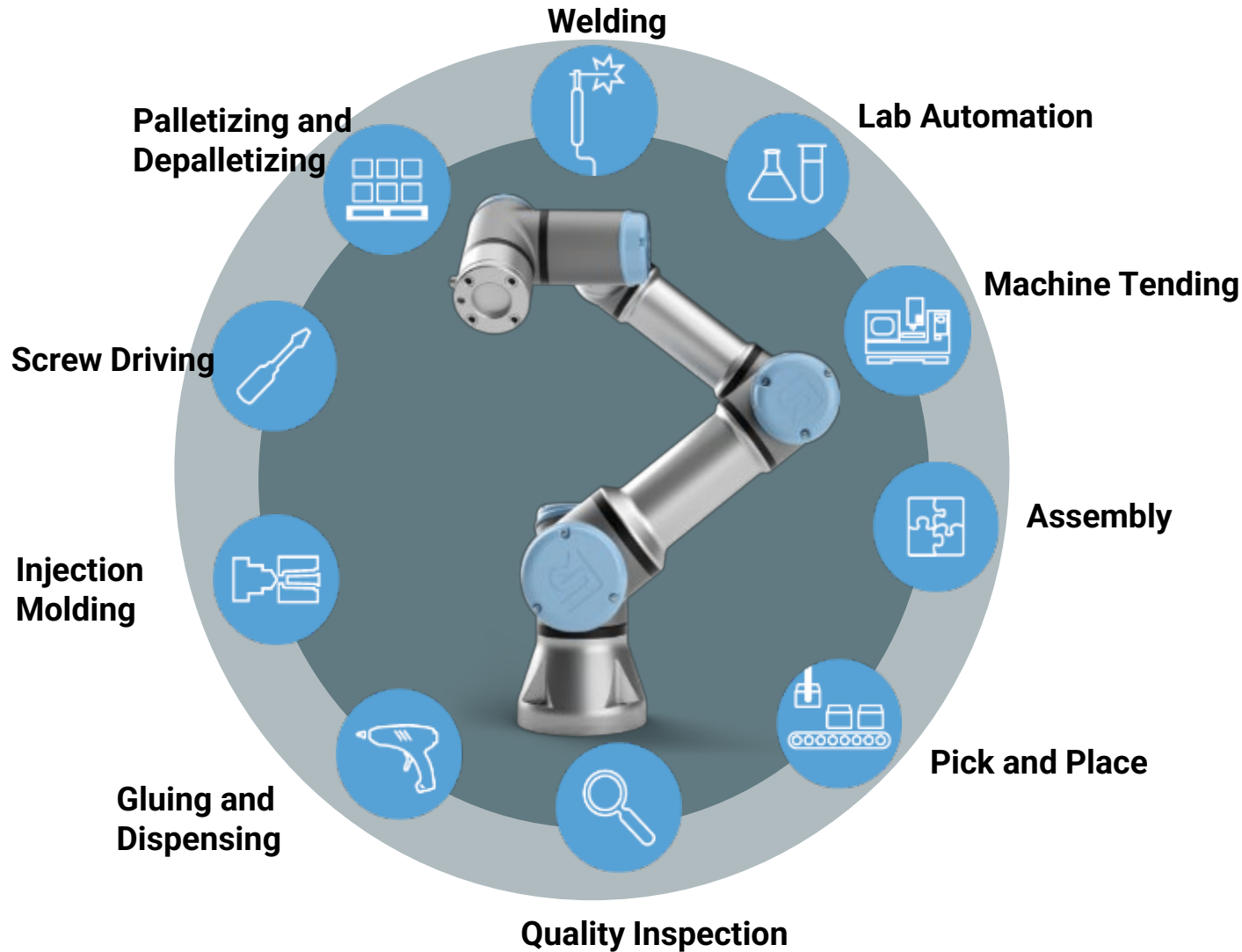
Almost 70% of WORKERS believe automation offers an opportunity to qualify for more skilled work.

57% of EMPLOYERS say the goal of automation is to augment human performance and productivity.

Discover how cobots can help.



# Where to Start?



- Business Challenges
- Manufacturing Labor
- Motion Classes
- Part Presentation
- Risk
- ROI

# Find the Business Problem

## Improving the Bottom Line:

Increase machine utilization, OEE, OLE.

Avoid buying additional machinery, increasing floor space.

Reduce Cost-of-Quality

Reduce overtime & hours worked. Avoid adding a 2<sup>nd</sup> or 3<sup>rd</sup> shift.

Lower costs, increase margin or lower prices to gain market share.

## Increasing the Top Line:

- Increase output without increasing manufacturing labor.
- Increase capacity to maintain & grow with current customers.
- Increase capacity to add new customers.
- Expand product lines

# Where to start: The Factory Tour

## Human Tasks That Are...

- Dull, Dirty and Dangerous
- Difficult to Staff
- Workers Comp Claims
- Highly Repetitive
- Inconsistent Quality
  
- Dull, Dirty and Dangerous



# Coarse vs. Fine Movement

## Coarse Movement

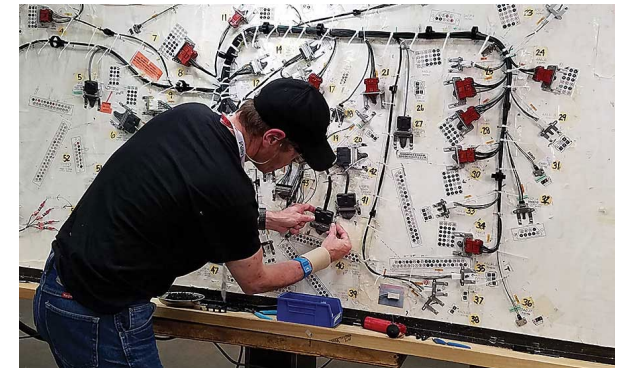
- Gross Motor Skill Movements, Large Muscles, Arms, Legs, Torso etc.
- Moving Boxes, Holding Torque & Glue Guns, Stacking, Packing, Transferring etc.

## Fine Movement

- Small Movements, Small Muscles, Fingers, Toes, Wrists etc.
- Tying, Threading, Sewing, Folding, Wrapping, Manipulating Flimsy or Compliant Material To Fit

## Primary Targets?

Coarse Movement



# Throughput versus Cycle Time

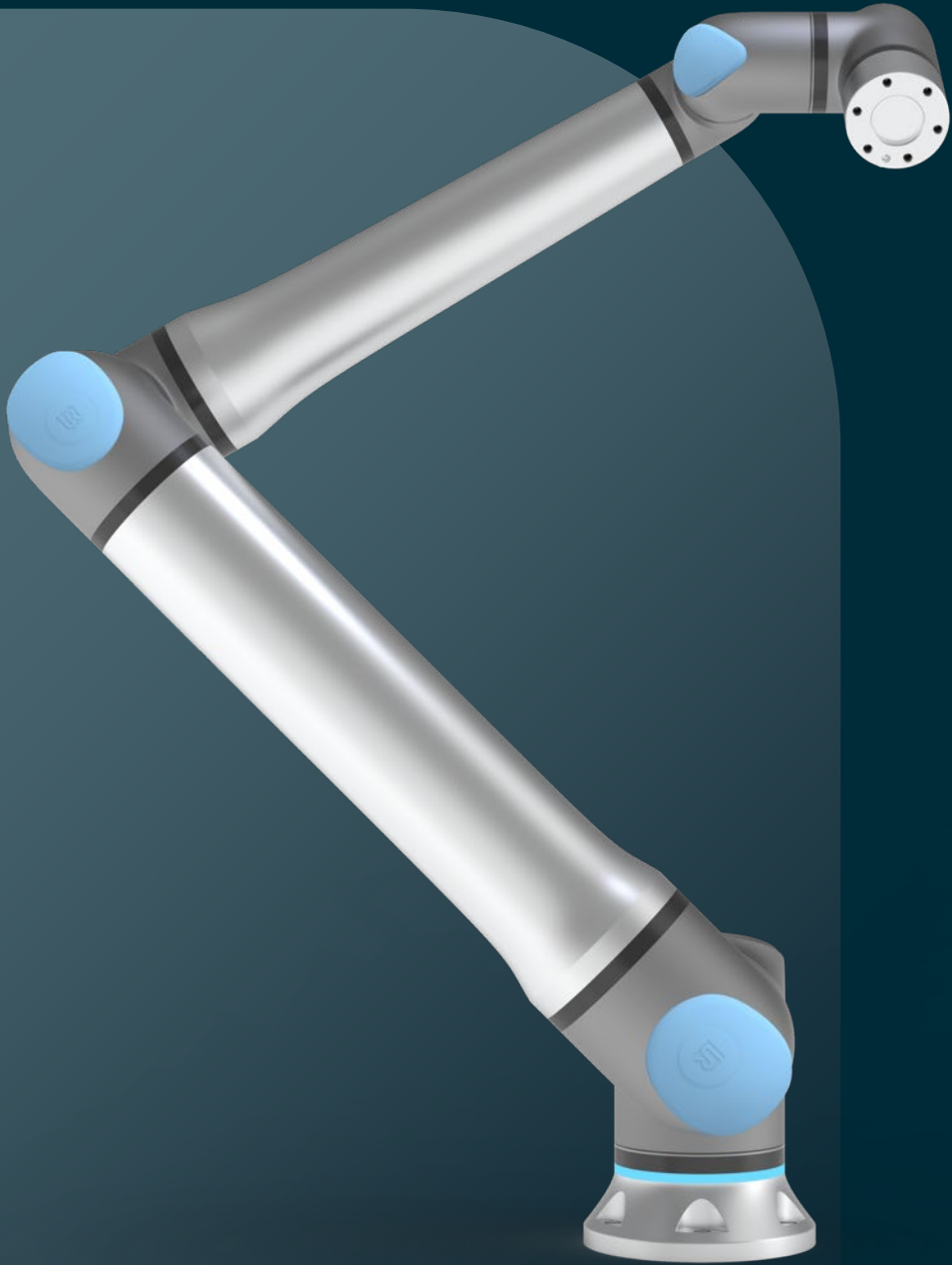
- Cycle times are important, but total production is what counts
- Collaborative robots are not “*superhuman*”
- Built to preform Human Speeds & Payloads:
  - 6-10 cycles per min or less
  - Payloads Under 44 lbs.
- Production improvements from:
  - Consistent cycle times, quality improvements
  - Unmanned production at breaks, lunches, shift changes, extended work hours

# Parts and Presentation

## Positive Part Locations Preferred!

- Flat tray
- Located Tray
- Pegboard
- Conveyors
- Drawers
- Bowl Feeder
- Blow Feeder
- Re-Gripping Stations





# Final Selections

Pain Factor + ROI

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Degree of Difficulty

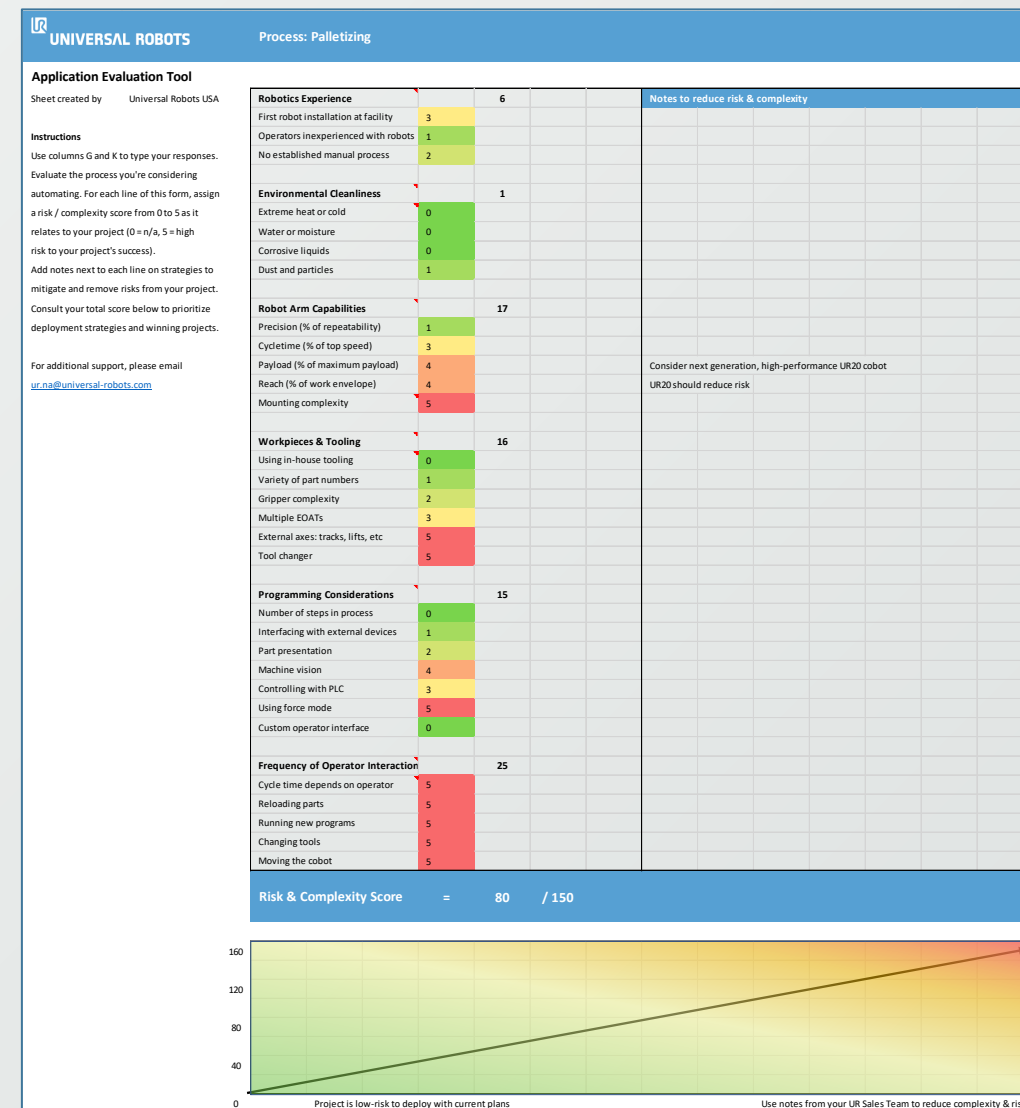


# UR Application Evaluation Tool

Captures and quantifies application risk in 6 key areas:

- Experience with Robots
- Environmental
- Robot Capabilities, Performance
- Tooling & Fixturing
- Programming
- Operator Interactions

Email [tla@universal-robots.com](mailto:tla@universal-robots.com) for a copy.

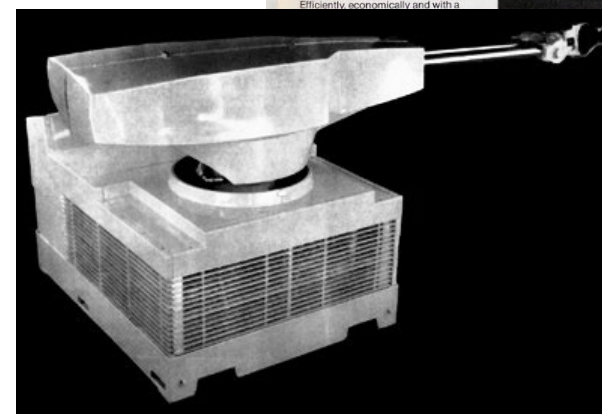


# Cobot ROI: breaking new barriers

1970's/80's/90's primary investment motivation: remove labor.

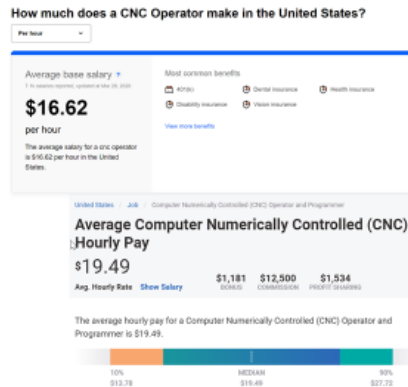
Secondary benefits such as improved process, quality were not routinely counted in ROI calculations.

Flash forward: Current cobot investments are routinely delivering <1 year returns.



# ROI = More than labor savings

## CNC OPERATOR RATES – UNITED STATES 2020



CNC Operator Level I – US Total Labor Cost Estimate ~\$17-\$21 per hour.  
 Labor Cost + 28.8% Insurance & Benefits Average. (e.g. \$25 per hour typical)

## MACHINE TENDING AVERAGE BUSINESS CASE

Current Situation		Tally (per Operator)	
Labor Costs (per hour)	\$ 20	Cost per shift	\$ 160
Hours (per shift)	8	Cost per day	\$ 320
Shifts (per day)	2	Cost per week	\$ 1,600
Days Operating (per week)	5	Cost per year	\$ 76,800
Weeks Operating (per year)	48	Total Per Operator	\$ 76,801
Additional Overheads	\$ 1		
# Operators (per shift)	1		
Yearly Running Costs	\$ 76,801		

Investment	
Collabrative Robot	\$ 45,000
Additional Hardware	\$ 32,000
Total Investment	\$ 77,000

Net Gain	Overall	Per Operator
	Break Even Point (months)	12.0
1 Year Profit	\$ (199)	\$ (199)
2 Year Profit	\$ 76,602	\$ 76,602
3 Year Profit	\$ 153,403	\$ 153,403
5 Year Profit	\$ 307,005	\$ 307,005

### Money Problems?

- Does your end-customer have CapEx or OpEx cash availability problems that are slowing or stopping a sale?
- Are your distribution company's financing capabilities "maxed-out"?

**UR can help via UR Financial Services for A/B/C Risk Level End-Customers!**

Increase EBITDA \$76K to \$307K for every \$77k System!  
 (This example uses a low fully-loaded rate of \$20/hour.)

# UR Justification Worksheet

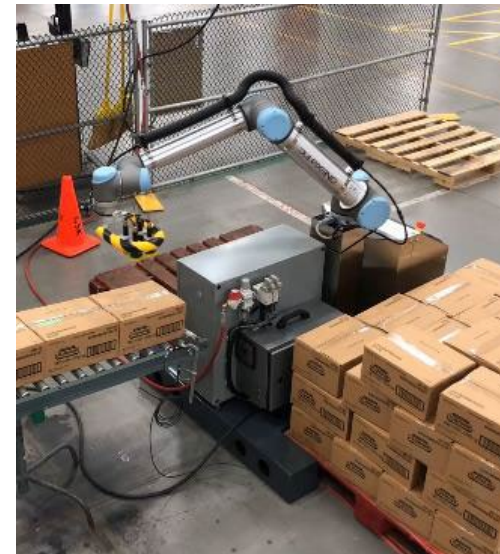
- 10 categories of top line and bottom-line improvement:
  - Labor, quality, capacity, customer satisfaction, floor space, insurance, etc
- Multiple methods to measure.
- Recommendations on where to find the needed information in every company.
- Email [tla@universal-robots.com](mailto:tla@universal-robots.com) for a copy.



UNIVERSAL ROBOTS		UNIVERSAL ROBOTS																																																																									
<b>Justification Calculator</b> Sheet created by Universal Robots USA For The Cobot Expo Date created 7/1/2020  <b>Instructions</b> Use columns F and P to type your responses. Fill as many categories as are appropriate for your company and project. If you do not have detailed cost information, enter conservative estimates based on industry standards.  For additional support, please email <a href="mailto:ur.na@universal-robots.com">ur.na@universal-robots.com</a>		<table border="1"> <thead> <tr> <th colspan="2">Direct Labor Savings</th> <th colspan="2">Some Numbers to Gather Beforehand</th> </tr> </thead> <tbody> <tr> <td>Total annual labor hours saved</td> <td></td> <td>Annual unit production volume</td> <td></td> </tr> <tr> <td>× standard cost per labor hour</td> <td></td> <td>Standard unit cost</td> <td></td> </tr> <tr> <td>or</td> <td></td> <td>Average unit sell price</td> <td></td> </tr> <tr> <td>Total labor savings per unit (hours)</td> <td></td> <td>Standard unit labor hours</td> <td></td> </tr> <tr> <td>× standard cost per labor hour</td> <td></td> <td>Standard labor hour cost, burdened</td> <td></td> </tr> <tr> <td>× annual volume</td> <td></td> <td>Average workers comp claim cost</td> <td></td> </tr> <tr> <td>Total =</td> <td>\$ -</td> <td>Floor operating cost per ft<sup>2</sup></td> <td></td> </tr> <tr> <td colspan="2"><b>Rework Savings</b></td> <td>Warranty cost, % of annual sales, or</td> <td></td> </tr> <tr> <td>Total annual rework hours saved</td> <td></td> <td>Warranty cost, per unit</td> <td></td> </tr> <tr> <td>× standard cost per labor hour</td> <td></td> <td>Annual inventory carrying cost, % standard costs</td> <td></td> </tr> <tr> <td>or</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Current rework costs</td> <td></td> <td></td> <td></td> </tr> <tr> <td>× rework reduction %</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Total =</td> <td>\$ -</td> <td></td> <td></td> </tr> <tr> <td colspan="2"><b>Scrap Savings</b></td> <td></td> <td></td> </tr> <tr> <td>Yield improvement %</td> <td></td> <td></td> <td></td> </tr> <tr> <td>× annual production volume</td> <td></td> <td></td> <td></td> </tr> </tbody> </table>		Direct Labor Savings		Some Numbers to Gather Beforehand		Total annual labor hours saved		Annual unit production volume		× standard cost per labor hour		Standard unit cost		or		Average unit sell price		Total labor savings per unit (hours)		Standard unit labor hours		× standard cost per labor hour		Standard labor hour cost, burdened		× annual volume		Average workers comp claim cost		Total =	\$ -	Floor operating cost per ft <sup>2</sup>		<b>Rework Savings</b>		Warranty cost, % of annual sales, or		Total annual rework hours saved		Warranty cost, per unit		× standard cost per labor hour		Annual inventory carrying cost, % standard costs		or				Current rework costs				× rework reduction %				Total =	\$ -			<b>Scrap Savings</b>				Yield improvement %				× annual production volume			
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# Robot as a Tool

- Embraced by job shops & contract manufacturing (assembly, machining, molding, packaging).
- Fleets of robots deployed based on daily production schedules.
- Rapidly emerging rental market – by the month, week, day and hour – RAAS.



# UR Application Builder

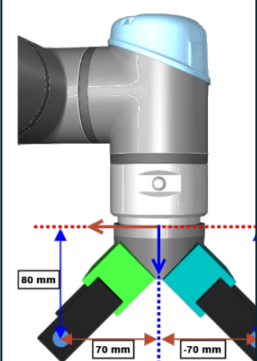
Download your customized solution package

- Program Templates
- How-To Cards
- Functional Simulation

### Machine Tending End Effector | Dual Gripper

**Dual Gripper Benefits**

Having two grippers installed on the robot can offer a significant boost in productivity, as multiple products to be handled in less time, reducing robot movements and saving valuable seconds. In order for this to work effectively, allowing re-use of waypoints and accurate control, you need to set accurate Tool Points (TCPs) for each gripper.



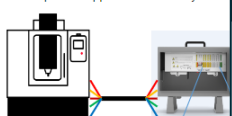
Tool	X	Y	Z	Rx	Ry	Rz
TCP_1	80.0 mm	0.0 mm	70.0 mm	0.0000 / rad	0.7854 / rad	0.0000 / rad
TCP_2	80.0 mm	0.0 mm	-70.0 mm	0.0000	-0.7854	0.0000

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### Machine Tending Digital I/O | Installation

**Connection**

Connect the machine to the robot using a multicore cable, where every signal will have its own wire. Use electrical isolation devices such as relays when the robot and the machine use different power supplies for the I/O systems.



**I/O Setup**

Here you can give meaningful names to signals connected to the Controller I/O to make it easier to use them in the Robot Program. Use the filter **View Digital/Configurable**.

General	Input	Output
TCP	Robot_Axis	Robot_Axis
Mounting	Robot_Axis	Robot_Axis
I/O Setup	Robot_Axis	Robot_Axis
Variables	Part_Load	Part_Unload

**Pro Tip!** Configure an action for the signals **Unload\_Complete** and **Load\_Complete** to change the state of the program when the program is not running.

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### Machine Tending Signal Exchange | Installation

**Signal Exchange**

The most basic signal exchange requires only one wire. The basic signal exchange requires only one wire. The basic signal exchange requires only one wire.

**Template**

```

BeforeStart
Robot Program
  If Part_to_Load# False and Part_Unloaded# False (1)
  InfeedReady# True (5)
  InFEED
  Part_to_Load# True
  Check machine request to be loaded
  If (6)
  Load - TCP_1
  Part_to_Load# False
  Part_in_Machine# True
  If Part_in_Machine# True and Part_Unloaded# False (3)
  Check machine request to be unloaded
  If (7)
  Unload - TCP_2
  Part_in_Machine# False
  Part_Unloaded# True
  If Part_to_Load# False and Part_Unloaded# True (4)
  OutFEEDReady# True (8)
  OutFEED
  Part_Unloaded# False
  Wait: 0.01
  Tool_1_On
  Tool_2_On
  Tool_1_Off
  Tool_2_Off
  Holding_On
  Holding_Off
    
```

**Robot Program**

Use this program template to start building your machine tending application. The yellow nodes are incomplete, read below to understand their function then complete them.

Unlike this application with single gripper, the robot can do multiple tasks, not necessarily always in the same order.

The **Robot Program** main loop constantly checks the status of three variables: **Part\_to\_load** is **True** when the first gripper (Tool 1) has a new part to load the machine, **Part\_to\_unload** is **True** when the second gripper (Tool 2) has a finished part unloaded from the machine, **Part\_in\_Machine** is **True** when there is a part in the machine.


(1) If the robot is not holding a part, before picking a new part, check the variable (5) **Infeed\_Ready**. This could be initialized to **True** to do it immediately, assigned by an operator if a tray or pallet needs to be manually placed first, or triggered by a sensor that detects when there is a part in the infeed.

(2) If the robot is holding a new part and the machine is empty, before running loading the machine, check (6) if the machine is requesting to be loaded.

(3) If there is a part in the machine and the robot is not holding a finished part, before unloading the machine, check (7) if the machine is requesting to be unloaded.

(4) If the robot is holding only a finished part, before placing it, check the variable (8) **OutFEED\_Ready** that could be initialized to **True** to do it immediately, assigned by an operator if a tray or pallet needs to be manually placed first, or triggered by a sensor that detects when there is a part in the outfeeder.

**Pro Tip!** You can use **If True** to skip a condition check, executing the code inside even if you don't have a signal to check.



**UR Academy**

If you're not familiar with UR programming head over to UR Academy to learn the basics: [www.universal-robots.com/academy](http://www.universal-robots.com/academy)

**BeforeStart**

Use this section to move the robot to a starting position, update the value of the status variables and initialize all signals.

```

If Part_to_Load# True and Part_in_Machine# False
If True
Load - TCP_1
    
```

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# The App Store for UR Cobots



- **427 (and counting...)** components, peripherals, accessories, and application kits, engineered to work seamlessly with UR Cobots.
- Tested, validated and certified by UR.
- UR+ products reduce the time, cost and risk in any project.

<https://www.universal-robots.com/plus/>

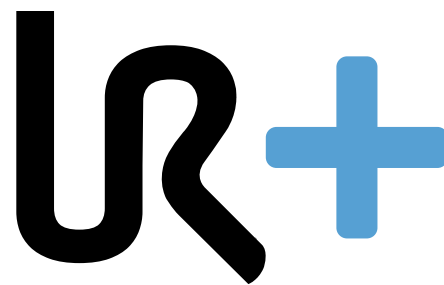
UR+ products:      Components      Kits      Software

Consumers

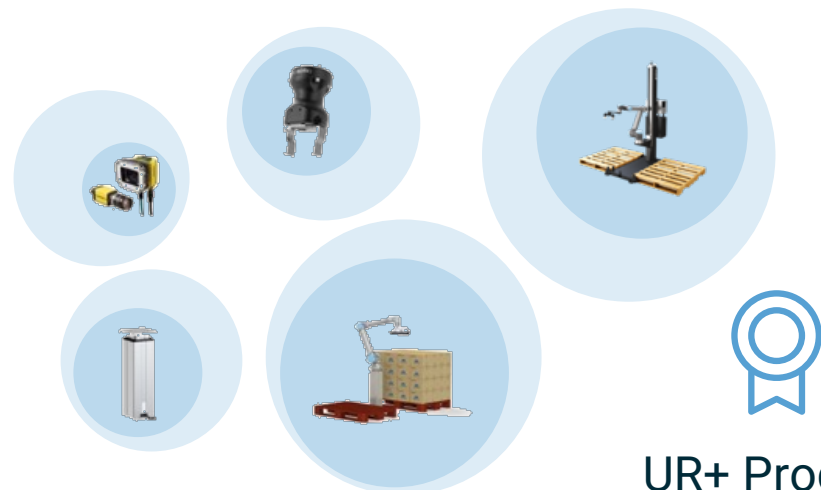
Producers

People with automation needs

Solutions, products,  
knowledge and services  
A powerful ecosystem



“ I am looking for a gripper, a screwdriver or another key product.  
- Customers

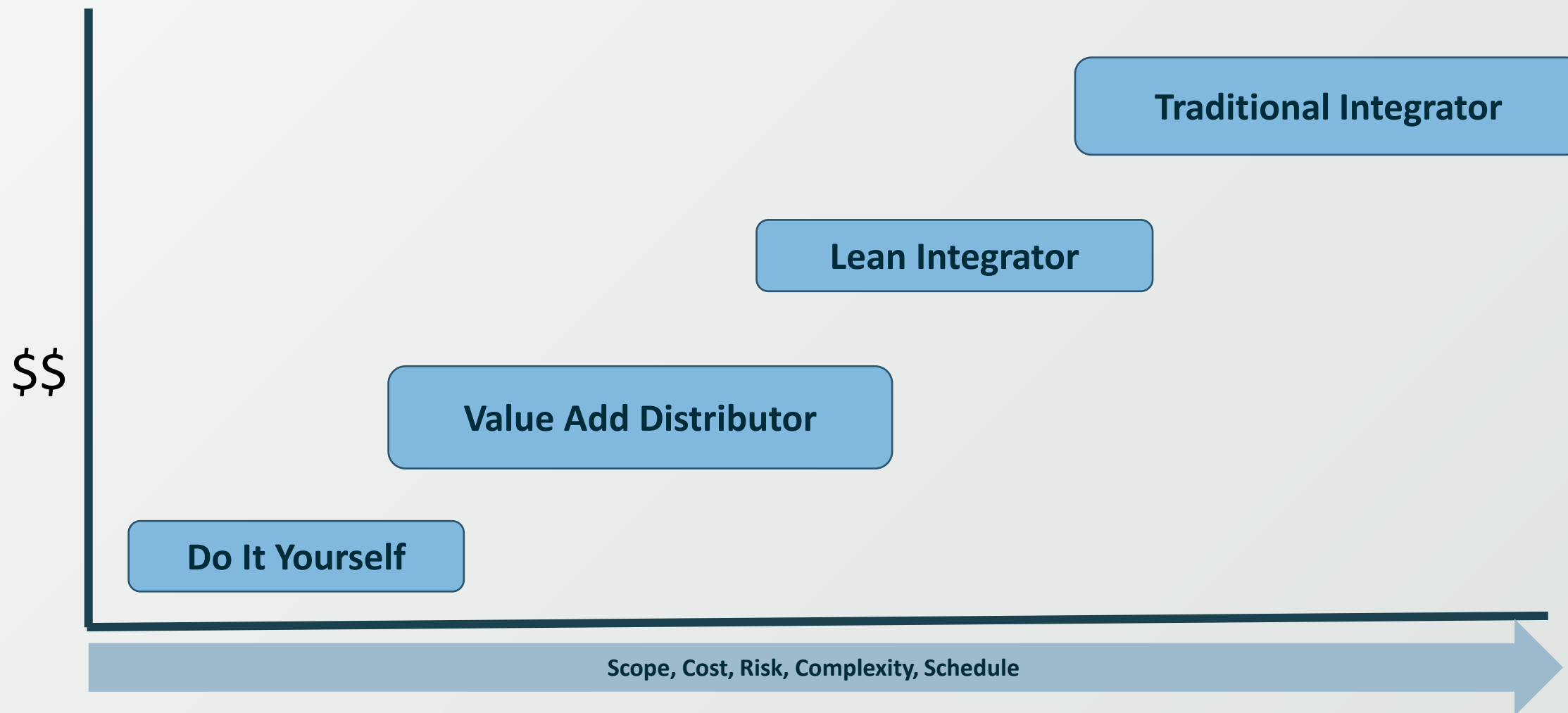


UR+ Product  
Certification

“ I am offering a UR+ product that is compatible and easy to use.  
- Partners

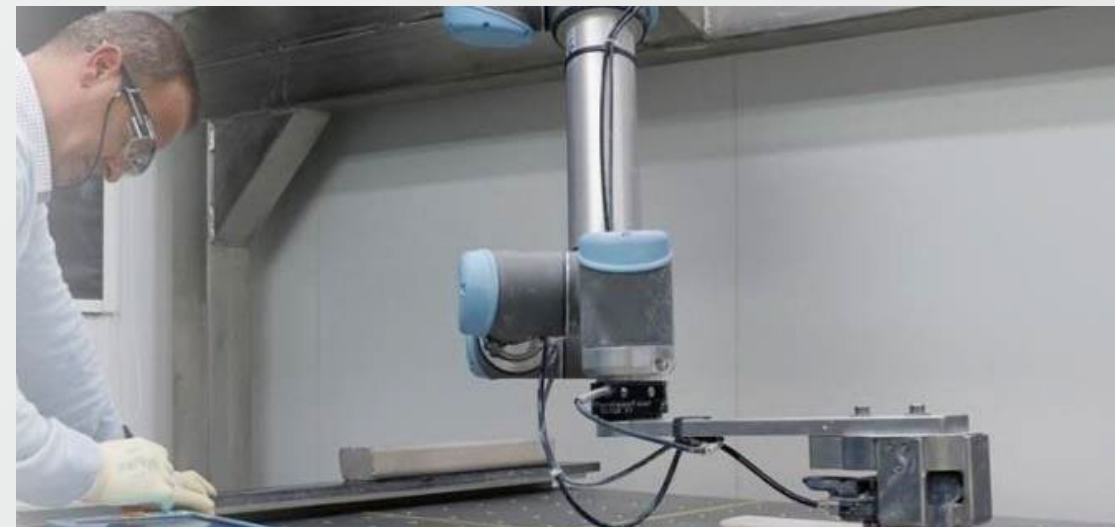


# Major Categories Of Integration



# Value Add Distributors

- Engineering to facilitate sales. Recommend configurations, peripherals, options
- Sales Engineer or Application Engineer is face to customer.
- Typically offers factory certified training, as well as remote and on-site support.
- Do not sell to performance specs.



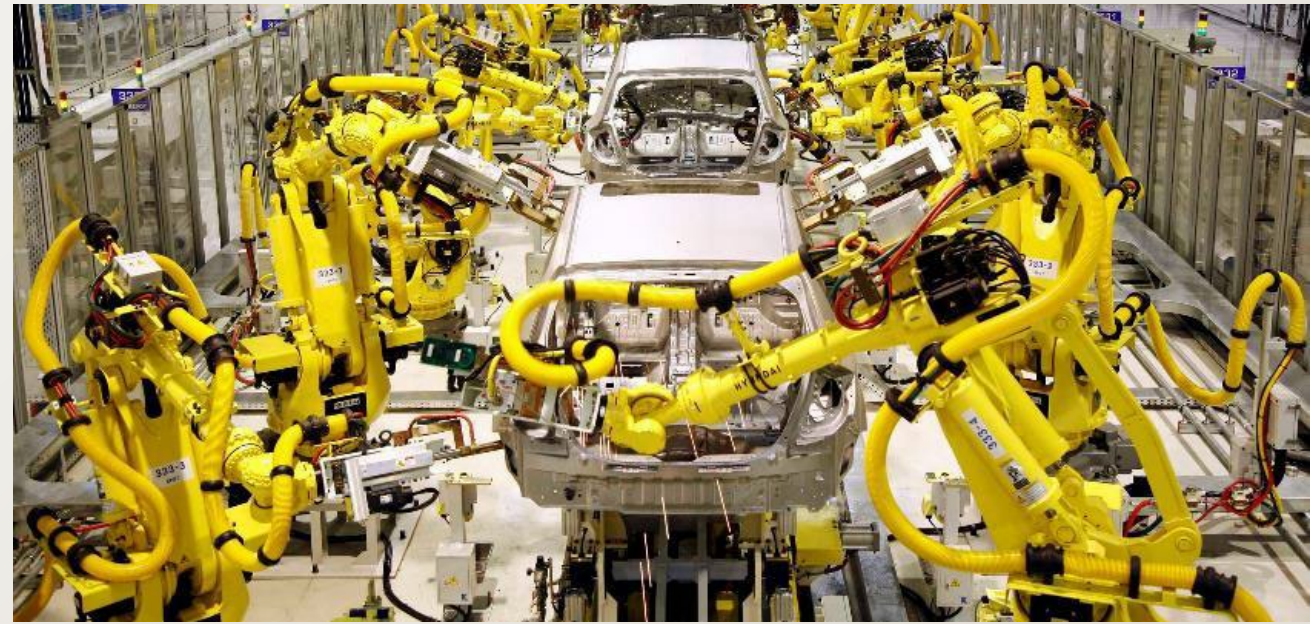
# Lean Integrators

- Small project teams. Cross disciplines. Owner is often the project manager.
- Nimble processes focused on time. Lead time in weeks, not months.
- Constrained growth – big ≠ good!
- Small footprint, low overhead.
- Buy versus Build = Buy.
- Application & Industry focus: “This is what we do.”

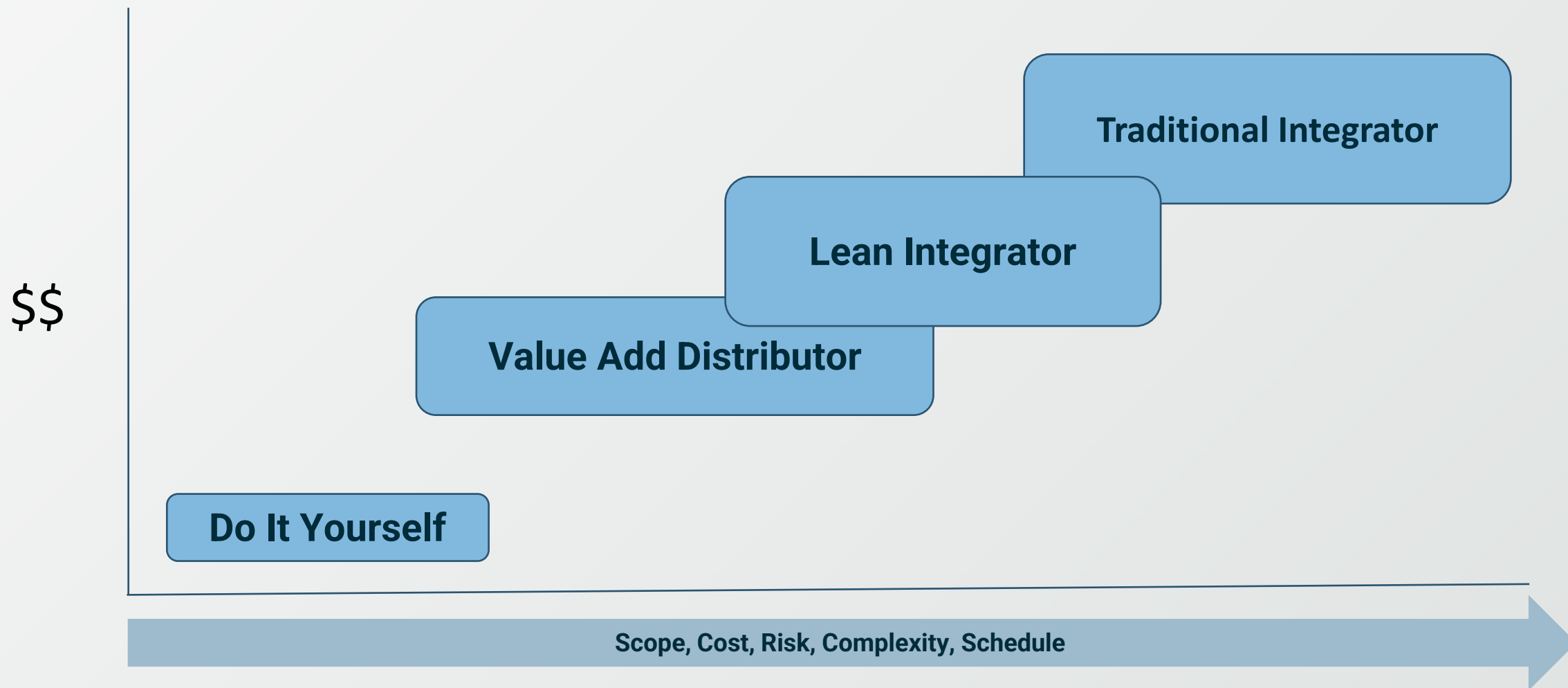


# Traditional Integrators

- Bigger is better. Big teams, big floorspace, big overhead. Big projects!
- Multiple departments:
  - Sales, Proposal Engineering
  - Mechanical, Controls, Simulation
  - Project Management, Supply Chain
  - Production, Quality
- ISO processes built around large-scale project execution. Lead times in months.
- Buy versus Build = Build
- “We can do that!”



# The Reality: "Some" Overlap



# Decision Time

Time to decide what approach is best for your company, your team and your project.

Choosing the integration model is a business decision, driven by 4 key factors:

- Project Urgency
- In-house Resources
- Project Scope
- Project Risk



# Rapid Deployment Robotics

**4 weeks from purchase order to production?**

**How is that possible?**

Robot lead times → Often in stock at local distributor

Reduced engineering → UR+, Application Builder

Reduced programming → Application Builder, Wizards, PolyScope

Reduced training → UR Academy

Reduced site work → 110 V power, no guarding, UR+ mounting systems





## Ready to Get Started?

[www.universal-robots.com](http://www.universal-robots.com) for the UR Academy, UR Application Builder, UR+ Ecosystem, On-Demand educational webinars and 150+ case studies and blog posts about cobot solutions.

[www.universal-robots.com](http://www.universal-robots.com) Get In Touch section to schedule a demonstration at your facility, talk to a cobot automation expert, or find a UR distributor.

[universalrobotsusa@universal-robots.com](mailto:universalrobotsusa@universal-robots.com) to contact your account manager.



# Thank you



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