Implementing Cobots in Small and Midsize Plants

Leveraging Lean Robotics
Agenda

• Robotics in manufacturing – WHY + HOW
• Cobot vs. Robot – what’s right for you?
• Identify your opportunities
• Real manufacturing implementations
• Lean principles + robotics implementation
• Top 5 tips for implementation success
Business Challenge Discovery

- Labor utilization – costs associated with hiring, overtime, and training
- Yield or scrap – costs associated with errors, subsequent processes, customer rate of return
- Unpredictable production capacity – machine uptime and capacity utilization, cycle times, operator staffing
- Opportunity costs – increased machine capacity and utilization can defer large capital investments
Why would I consider robotics?

- Dull, dirty, dangerous tasks
- Production bottlenecks
- High rework/quality problems
- Part traceability and date/lot code verification
- High precision/dexterity tasks
- Health or Excessive Repetitive Motion Injuries (RMI)
- Difficulty finding skilled workers
Are robots stealing jobs?

Manufacturers are not bringing in robots to replace people – they are bringing in robots because they don’t have enough people.

What else are we hearing?
Keep pace with competition, grow business, maintain workforce, manage fluctuations.

Types of Robots

Articulated

Cartesian

SCARA

Delta/Parallel
Articulated

- Flexibility
- Dexterity
- Mounting
- Reach / Payload

- Cost
- Precision (at “max”)
- Relative speed

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Cartesian

- Custom
- Cost
- Reach / Payload
- Footprint

- Dexterity
- Exposed mechanisms
- DIY challenge
- Large structure

PICK AND PLACE  ■  DISPENSING  ■  ASSEMBLY  ■  INSPECTION

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SCARA
Selectively Compliant Articulated Robot Arm

- Speed
- Precision
- Cost
- Footprint

- Reach / Payload
- Dexterity
- Fixed motion

PICK AND PLACE  ASSEMBLY  INSPECTION  PACKAGING  DISPENSING

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Delta/Parallel

- Speed
- Cost
- Mounting

- Reach / Payload
- Flexibility
- Dexterity
- Maintenance

PICK AND PLACE  ASSEMBLY  INSPECTION

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Cobot vs Robot

• Small & flexible
• Similar speed as human
• Fast set-up
• Easy to use
• Limited payload and reach
• Safe alongside workers
• Low upfront costs and fast ROI

VS

• Large, Fixed Equipment
• Typically requires safety cage/barriers
• High-volume, high-speed production
• Complex integration and programming
• Wide range of payload and reach
• Difficult to change/redeploy
• High deployment costs

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Collaborative Robots

• Robots designed to “collaborate” with or in close proximity to human operators.

• Many applications operate without need for safety cell. Collaborative APPLICATION?

• Utilize user-friendly graphical interface, teach pendant, for programming

• Relatively lower cost and easier to implement -> Faster ROI potential

• Can still require integration into operational processes/machines

Can be ideal “first step” into robotics
Typical Industrial Robotics Applications

- Packaging & Palletizing
- Screw Driving
- Injection Molding
- Gluing/Dispensing & Welding
- Lab Analysis
- Machine Tending
- Assembly
- Pick & Place
- Quality Inspection

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How common is your application?

<table>
<thead>
<tr>
<th>Application Areas</th>
<th>% of Cobots Sold*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pick &amp; Place (Transferring)</td>
<td>21%</td>
</tr>
<tr>
<td>Machine Tending</td>
<td>16%</td>
</tr>
<tr>
<td>Material Handling</td>
<td>16%</td>
</tr>
<tr>
<td>Packaging &amp; Palletizing</td>
<td>7%</td>
</tr>
<tr>
<td>Assembly &amp; Screwing</td>
<td>13%</td>
</tr>
<tr>
<td>Inspection</td>
<td>4%</td>
</tr>
<tr>
<td>Welding</td>
<td>1%</td>
</tr>
<tr>
<td>Others</td>
<td>22%</td>
</tr>
</tbody>
</table>

*2018 data provided by Universal Robot

Cobot Application Diversity

- Material Movement: 60%
- Assembly & Screwing: 23%
- Inspection: 4%
- Other: 13%

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Accutrex Products – Canonsburg, PA
Western PA Robotics Implementations

- Industry: Contract Metal Fabrication (high-mix, low volume)
- Application: Machine tending, welding
- Challenge: Maintain workforce level & increase production. Stay ahead of technology curve and fill skills gap.
- Solution: Flexible solution to service different cells. 10kg payload cobot on mobile stand
- Result: Existing ERP/production staff identifies opportunities and program new jobs. Wide range of implementation applications, expect to purchase additional robot(s)
Richardson Cooling Packages – New Castle, PA

Western PA Robotics Implementations

- Industry: Industrial Equipment Components
- Application: Welding
- Challenge: Long lead times & high inventory; Manual welding cost prohibitive
- Solution: Reshore; Robotic welder with line laser w/ rotating fixture
- Result: Successfully reshored product, implementing two more robotic cells
Sepco – Erie, PA
Western PA Robotics Implementations

• Industry: Machine tool
• Application: Load/unload CNC machining center
• Challenge: Increase plant capacity and remove operator from dirty job
• Solution: Cobot with custom EOAT and feeding system
• Result: 40% increase in machine production and 6 month ROI
Du-Co Ceramics – Saxonburg, PA
Western PA Robotics Implementations

• Industry: Ceramic part manufacturing
• Application: Loading and stacking saggars for sintering furnace
• Challenge: Increase press capacity with existing workforce
• Solution: Integrated, dedicated robotic cell that includes multiple automation technologies
• Result: Successfully handle multiple parts and led to additional automation cells throughout plant
Hardware Manufacturer – Southwest PA
Western PA Robotics Implementations

• Industry: Commercial building hardware
• Application: Machine tending, packaging, material removal, material handling
• Challenge: Improve efficiency & production of existing workforce
• Solution: Utilize robotics to reallocate workforce to value-added tasks, improve efficiency
• Result: Implemented 18 robotic cells, increased satisfaction of workforce
Hardware Manufacturer – Southwest PA
Western PA Robotics Implementations

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The challenge is not the robot.
“It's the ROBOTIC CELL!”
Deployment execution impacts the ROI
What if robot cell deployment was simple?

Less complex

More skills

Lower cost

Start Production Faster

More robots

Higher ROI

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The Goal

Lean Robotics

Design
Integrate
Operate

Value added
Non value added

Robot starts production
Robot starts production faster

More production time

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Start simple
Application Prioritization Approach

- Evaluating complexity and impact can be subjective
- Helpful to break each into associated factors

Complexity
- Application/Task
- Part Size/Manipulation
- Consistency/Part Variation
- Integration
- Precision
- Cycle Time
- Cost

Impact
- Volume
- Part Value
- Health & Safety
- WIP
- Production
- Cycle Time
- Quality

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Project summary:
- Scope
- Objective
- Team
- Timeline

Plans and equipment for robotic cell
Start with the end goal in mind

- The robot – reach, payload, speed, repeatability
- Tooling – tooling on robot and elsewhere in cell
- Sensors – closed loop control, logic, vision
- Safety measures – require risk assessment
- Software – external software required

1. How does the customer define value?
Compare manual to robotic

- High level cell concept
- Robotic layout
- Robot task map
- Validate with people who know current process
  - Anything missing, exceptions we won’t be able to handle, agree with KPI’s?
## De-risk the concept

<table>
<thead>
<tr>
<th>Question</th>
<th>Hypothesis</th>
<th>How confident are you about the hypothesis?</th>
<th>How critical is the answer to concept?</th>
<th>How could you validate it?</th>
<th>Time and $ to validate it?</th>
</tr>
</thead>
<tbody>
<tr>
<td>What question about the concept is still unanswered?</td>
<td>What do you think the answer is?</td>
<td>- Low&lt;br&gt;- Medium&lt;br&gt;- High</td>
<td>- Critical&lt;br&gt;- Not critical</td>
<td>Define test and how you'd measure the result</td>
<td>Estimate the effort to do the validation work</td>
</tr>
<tr>
<td>Ex: Will we achieve target cycle time?</td>
<td>Yes</td>
<td>High</td>
<td>Critical</td>
<td>Robot vendor can provide proof of concept</td>
<td>Robot vendor can validate in 1 week. Will be able to reuse part of program for production</td>
</tr>
</tbody>
</table>
Freeze the MVRC

• Minimum Viable Robotic Cell: Simplest cell that can bring value to your factory floor.
• Get it working before adding any nice-to-haves. Almost always takes longer than expected
• Cobots enable continuous improvement.
• Complexity-cost relationship is not linear
  • Simple can be simple
  • Complex can be extraordinarily difficult, costly and unpredictable
Plans and equipment for robotic cell

Robotic cell and team ready to operate
Integrate

• Offline cell preparation
  • Mechanical installation – assemble components, framing, fixtures, input/output, tooling, grippers,
  • Electrical installation – assemble components
  • Industrial communication – machine and sensor interface
  • Programming – develop high level sequence
• Production line preparation and installation
• Training
• Process – adapt a manual process so it can be done by a robot
Robotic cell and team ready to operate

OPERATE

Parts produced for cell’s customer
Operate

• A well planned, well communicated, and well executed startup
• Monitor performance
• Implement continuous improvement projects
• Celebrate your success and thank people involved
# Sample Implementation Cost

Self integration of basic cobot application

<table>
<thead>
<tr>
<th>Implementation Costs</th>
<th>Operating Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robot Arm &amp; accessories</td>
<td>Preventative Maintenance</td>
</tr>
<tr>
<td>• $33 – 52k</td>
<td>• $200</td>
</tr>
<tr>
<td>End of Arm Tooling (Gripper)</td>
<td>Electricity</td>
</tr>
<tr>
<td>• $2 – 10k</td>
<td>• $300</td>
</tr>
<tr>
<td>Infeed &amp; Outfeed</td>
<td>Total Operating Cost</td>
</tr>
<tr>
<td>• $3 – 20k</td>
<td>• &lt; $500</td>
</tr>
<tr>
<td>Machine Tool Interface</td>
<td></td>
</tr>
<tr>
<td>• $250 – $2k</td>
<td></td>
</tr>
<tr>
<td>Installation, Commissioning &amp; Training Services</td>
<td></td>
</tr>
<tr>
<td>• $4 – 8k</td>
<td></td>
</tr>
<tr>
<td><strong>Total Cost of Implementation</strong></td>
<td></td>
</tr>
<tr>
<td>• ~$61 – 91k</td>
<td></td>
</tr>
</tbody>
</table>

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Lean Robotics Takeaways

• Scope of automation (80/20)
• Simplify MVRC, maximize ROI
• Perfection is expensive and takes a long time
• Focus on incremental improvements to cell – update ROI expectations
• Robotic cell deployment always takes longer than expected
• Robotics is both a capital AND an innovation investment
Where to start - Resources

• Organizational networking
  • MEP center
  • NTMA
  • Local chamber of commerce or development corporations
  • Industry trade shows – ex. Automate, Packexpo, M&T
  • Local industrial suppliers of robots or industrial equipment
  • Local automation integrators
  • Professional associations – IISE, SPE, SME
  • Universities, extensions or alumni associations
  • Networking with other local companies
  • MFG Day
• Industry Associations
  • RIA, Industry Week, A3 Automate, ARM Institute

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Top 5 Tips for Success

1. Leverage all your available resources
2. Start simple – save your high impact (but complex) targets for later
3. Do your homework
4. Make honest, informed decision on level of integration support to engage
5. Have long term view
Implementing Cobots in Small and Midsize Plants

Matt Minner
Senior Technical Consultant

Ben Mintz
Key Account Manager