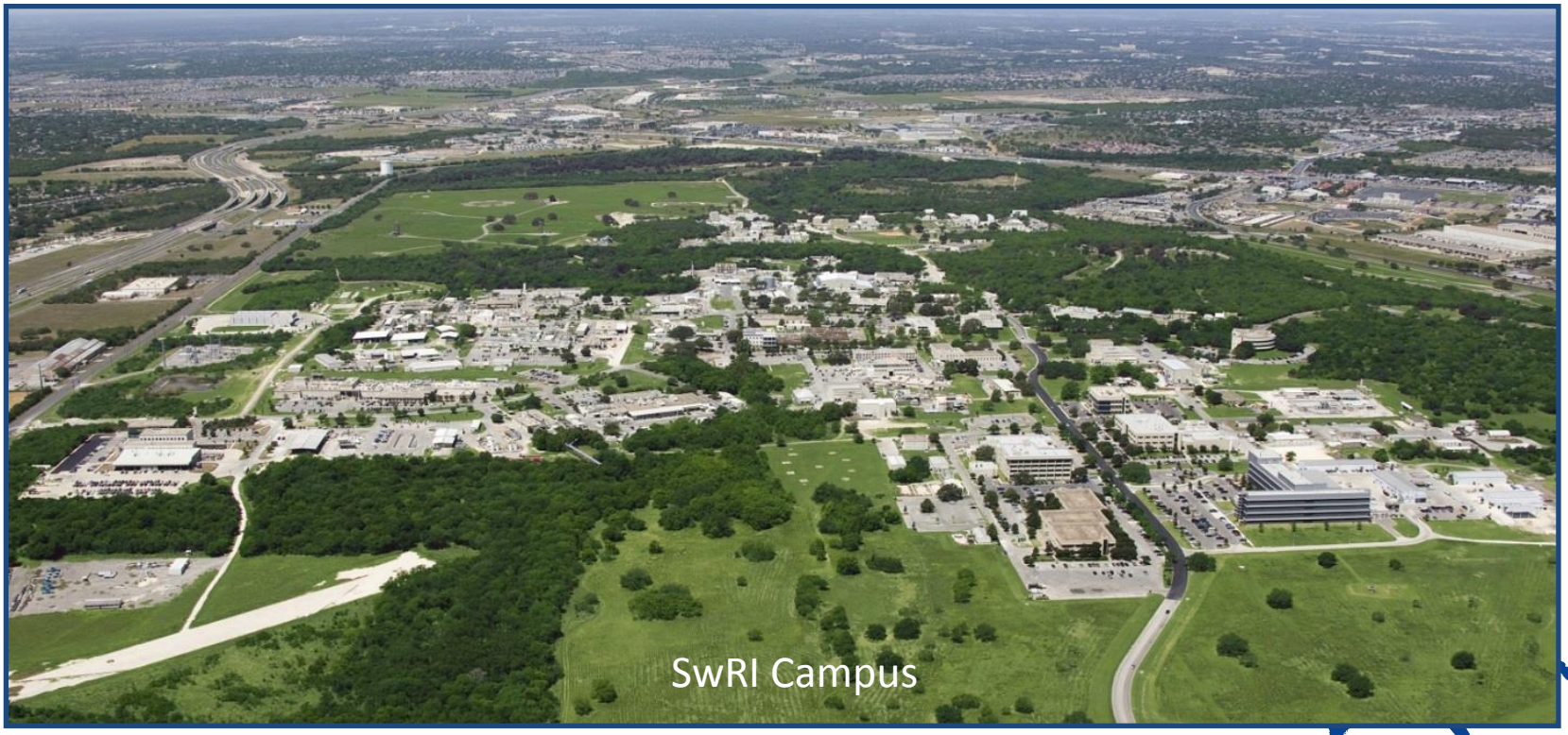
SOUTHWEST RESEARCH INSTITUTE

New Technologies Enabling Advanced Robotics Solutions for Industry

March 1, 2017

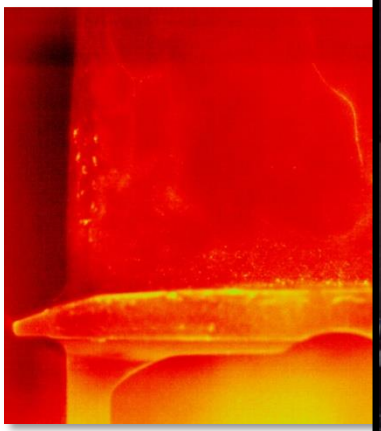
About SwRI

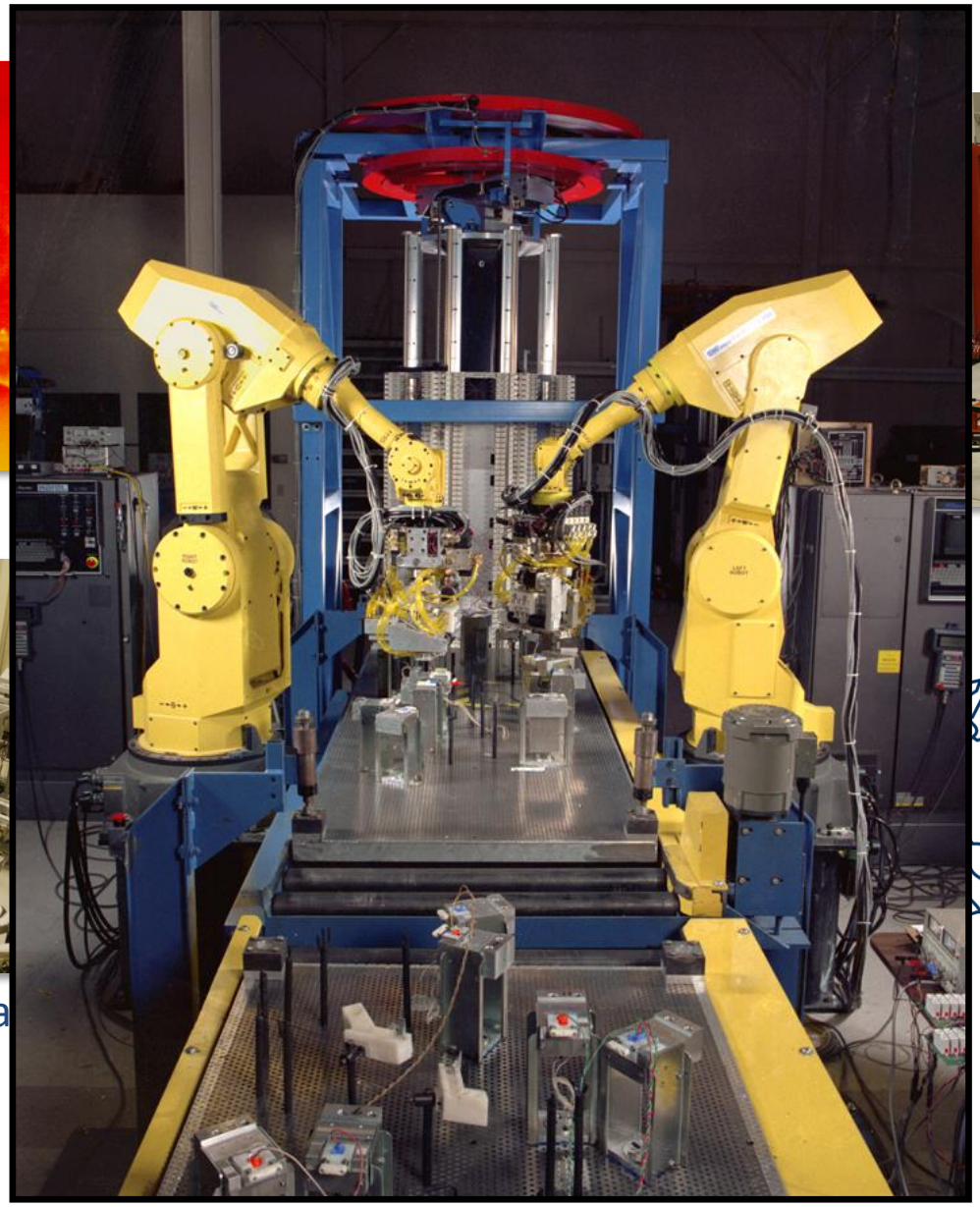
- Nonprofit
- Applied RDT&E
- Established in 1947
- 1200 acres footprint
- Multidisciplinary Problem Solving
- Staff: ~2,600
- Revenue: $559M in 2016

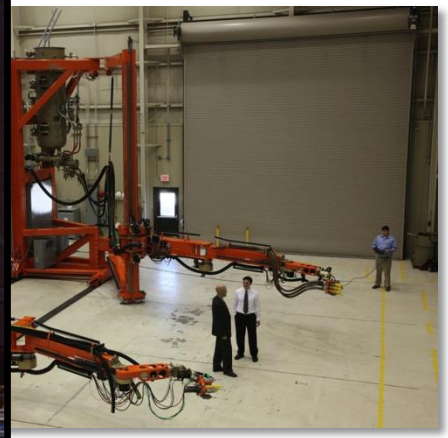


SwRI Campus

Robotics and Automation







Industrial Automa
and Controls

ROS®
industrial

Advanced Robotic
Software

Presentation Overview

- Opportunities for Industrial Robotics Applications
- Perception and Planning
- Mobility for Industrial Robots
- Human-Robot Interaction
- Advanced Software for Industrial Robotics

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Industrial Robotics Market

Interesting 2015 Statistics:

- 253,748 robots sold – highest ever recorded
- China now biggest market with 27% of the supply
- Estimated 12% growth per year in units through 2019

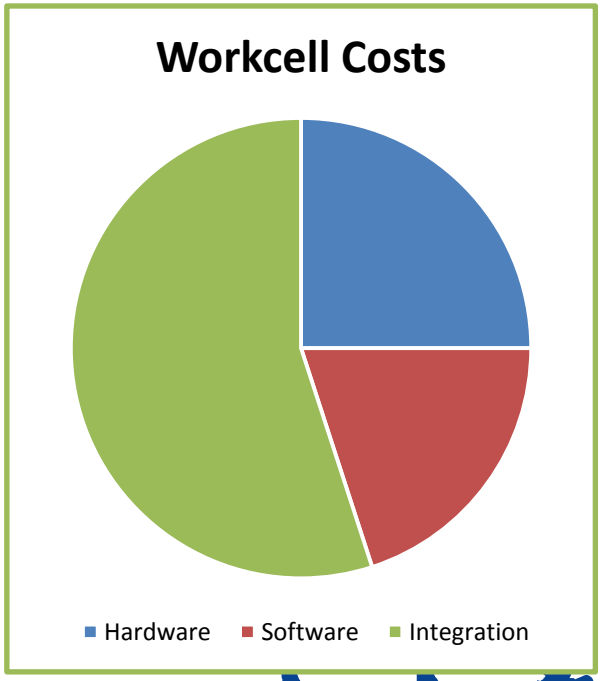
Robot Density (Robots per 10K Workers)	
Rep. of Korea	531
Japan	305
Germany	301
USA	176
World Avg.	69
China	49

Source: IFR Statistics

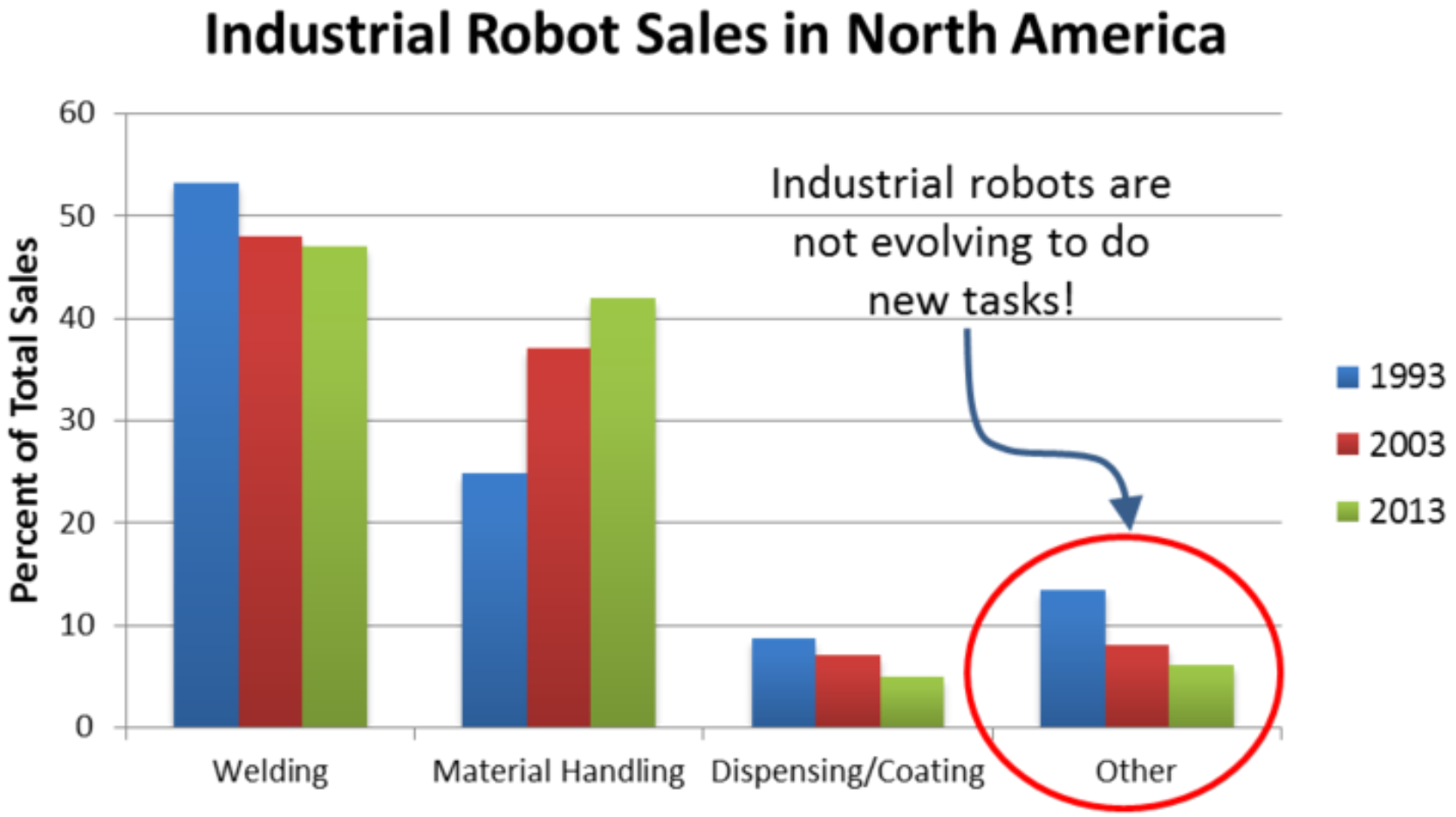
Some Popular Robot OEMs

Interesting RIA North America 2016 Statistics:

- 10% growth in units ordered over 2015
- Automotive market strong
- Strong growth in assembly applications



Industrial Robotics Market



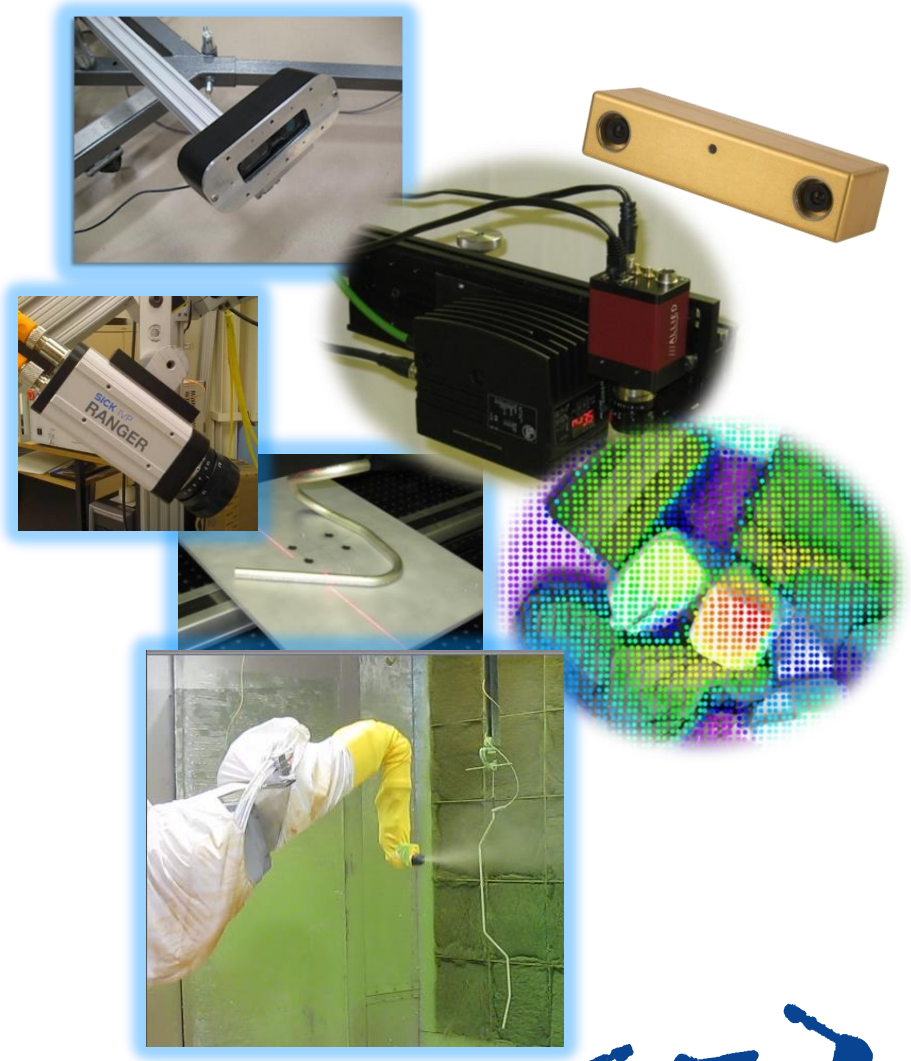
Source: Robotics Industries Association (RIA)

The Opportunities/Industry Needs

- One-off tasks
- Uncertain object pose
- High mix
- Uncertain geometry
- Intuitive programming
- Auto-generated paths
- Robots move to the job
- Shared workspace with humans

Perception and Planning

- Proliferation of 3D sensing creates opportunities
- Fixtureless handling
- picking from piles of objects or multi-part bins
- Enables high-mix low-volume
- Opportunities for path planning and optimization



Perception and Planning

Giving Robots Mobility

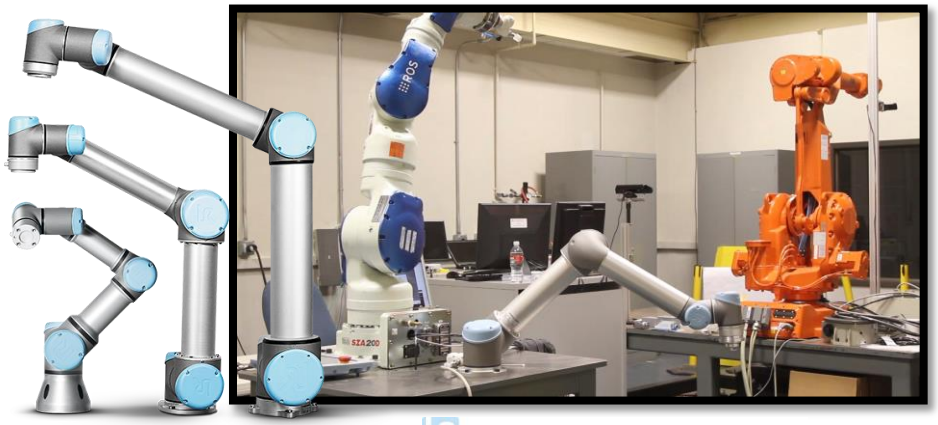
- Traditionally the part is brought to the robot/tool
- Bringing the robot/tool to the part opens up more options for flexible manufacturing

Robot comes to the parts
vs.
parts coming to the robot

Giving Robots Mobility

Human/Robot Collaboration

- Traditional robot systems are guarded for safety reasons
- New robot products are emerging for unguarded applications
- Research needed for safety sensors, compliant joints, and advanced software

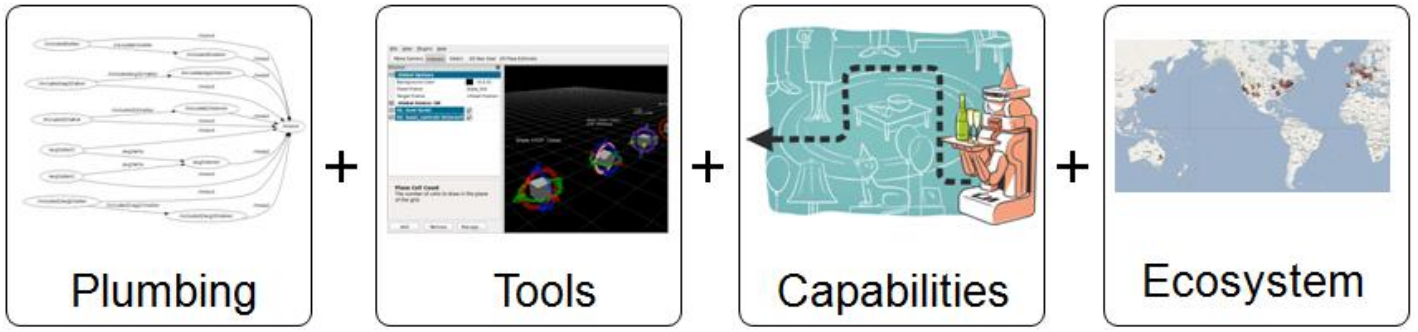


Human Tracking

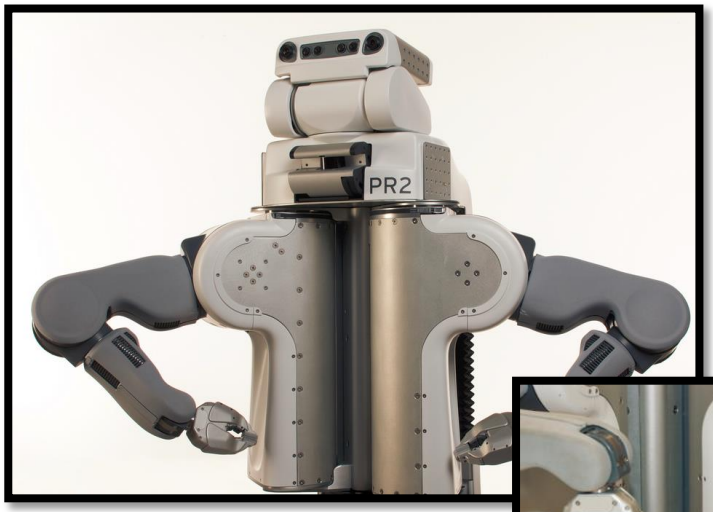
Advanced Software Capabilities

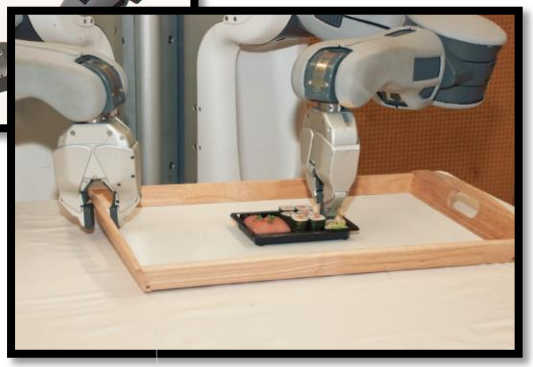
- Open Source Robot Operating System (ROS), an open source software framework full of enablers for advanced robotics

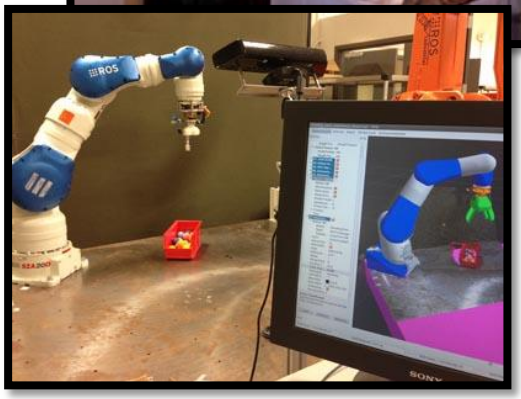
- **ROS-Industrial** is an extension of ROS with a focus on enabling advanced capabilities for industrial robots



Advanced Software Capabilities







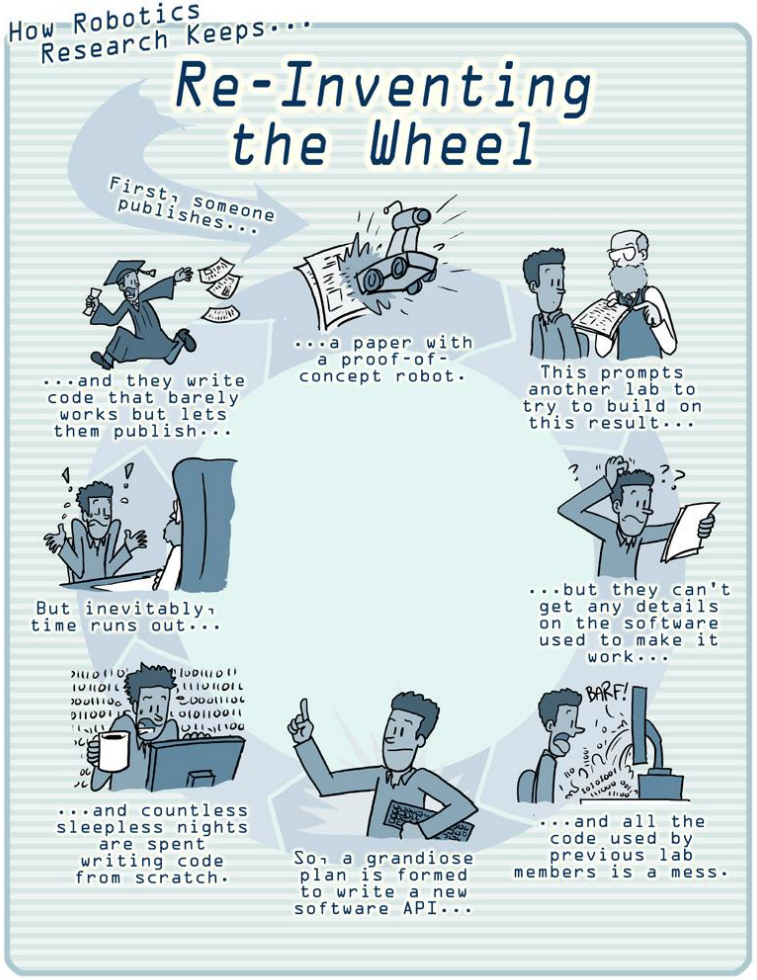
ROS Motivation

Research Robotics Challenges

- Reinvention of the Wheel
- Little Commonality
- Short Lifespan
- Difficult to Compare Results

ROS

ROS Solves These



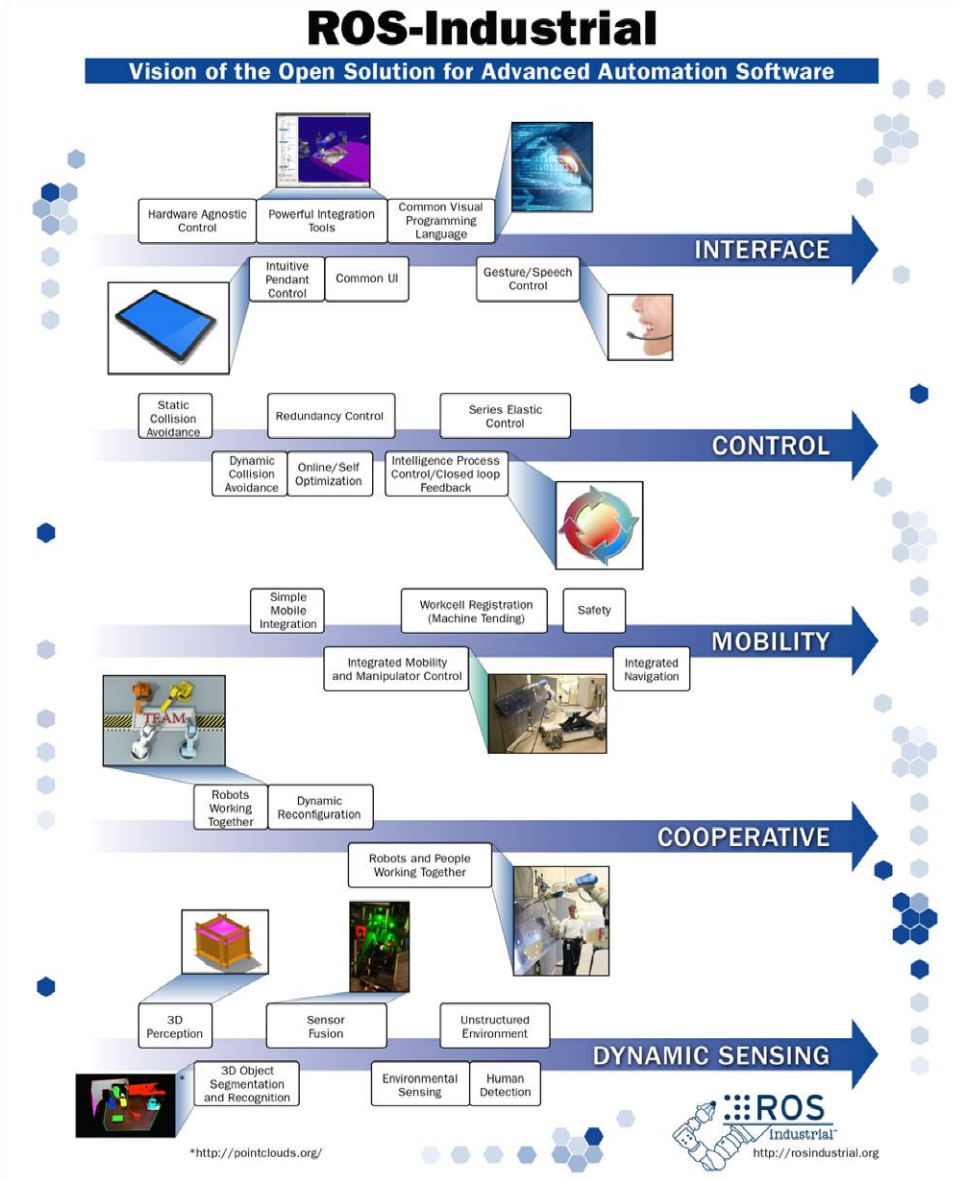
App: Automated Painting

- Automated spray paint processes
  - Reduce emissions (regulation)
  - Reduce exposure (personnel)
  - Reduce cost (materials)
  - Increase quality (consistency)
- Challenges
  - Unconstrained location
  - “Random” part order
  - Real time processing
  - Moving parts

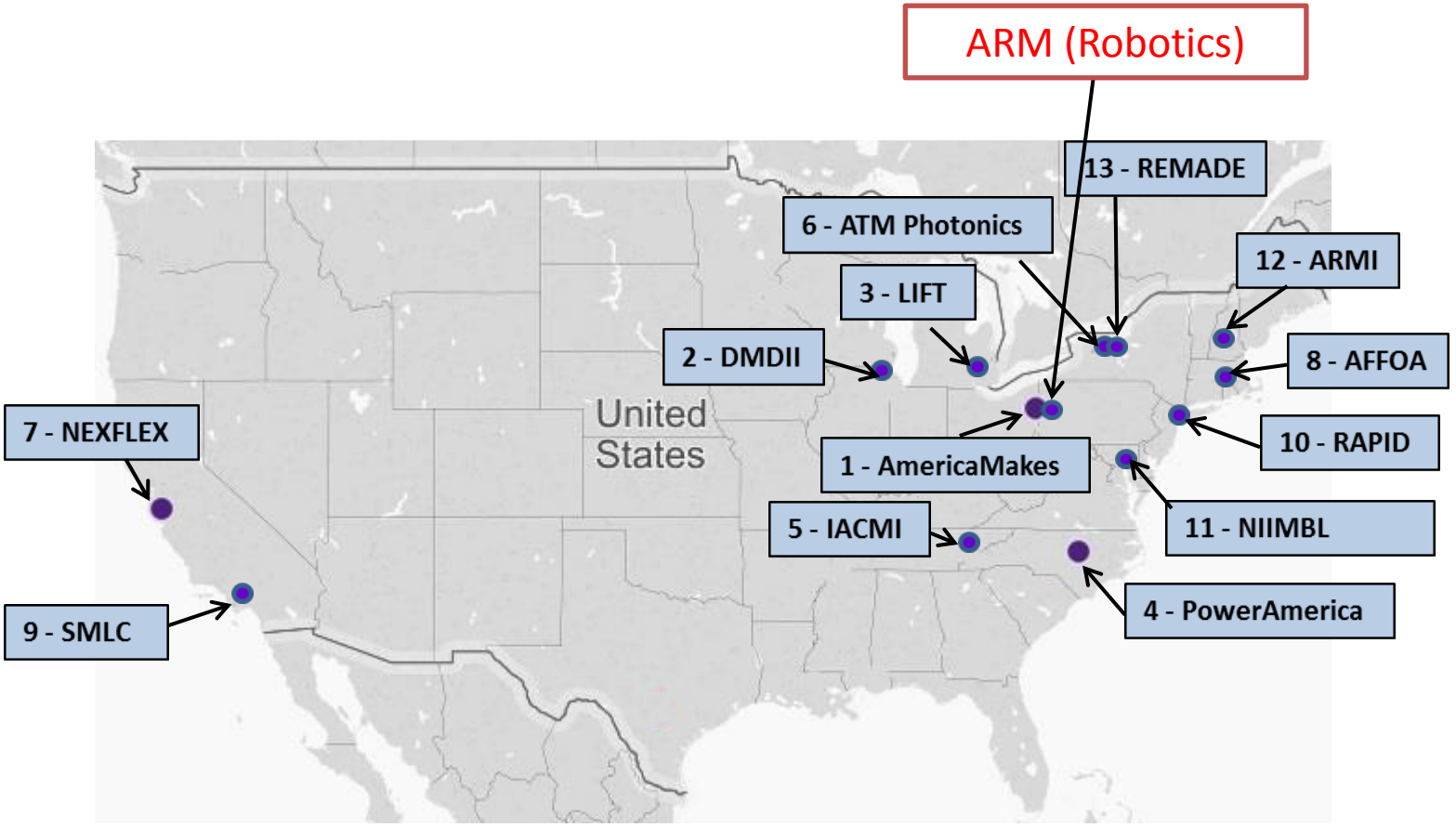
Solution: Automated Painting

- 3D Sensing (ROS/OpenNI)
- 3D Processing (ROS/PCL)
- Process based path planning (SwRI)
- Robot IK solvers (ROS/MoveIt!)
- Robot workcell visualization (ROS/Rviz)
- Distributed system (ROS/Core)
- Data acquisition/playback (ROS/bag)

ROS-Industrial Consortium



Institutes for Manufacturing Innovation



NNMI Institutes for Manufacturing Innovation (IMIs) (14)

Newest Institute in Robotics

Some objectives of the new institute:

- Supporting advanced robotics capabilities for manufacturing
- Standardizing interfaces for cross-platform compatibility
- Modularizing and scaling components to larger systems
- Enabling a collaborative development environment
- Developing the workforce through training curriculum and hands-on classes
- Transferring technology via open-source license
- Providing affordability for small and medium enterprises

In Closing…

- New industrial robotics applications are enabled through innovative software and new technologies
- ROS-Industrial brings advanced software capabilities to advanced manufacturing applications
- Robotics are being applied in new ways to enable advanced manufacturing applications and U.S. manufacturing competitiveness
- Robotics is a growing field and roboticists are in demand – “First Programs” are part of the solution

For More Information

- **SwRI:** swri.org
- **SwRI Robotics:** robotics.swri.org
- **SwRI Manufacturing:** manufacturing.swri.org
- **ROS-I site:** rosindustrial.org
- **ROS-I Software site:** github.com/ros-industrial
- **Ros-I Docs site:** ros.org/wiki/Industrial

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ROS-I Three Year Montage