

**National Workshop on Challenges to Innovation  
in Advanced Manufacturing: Industry Drivers and R&D Needs**

# **Ushering in the Next Generation of Factory Robotics & Automation**

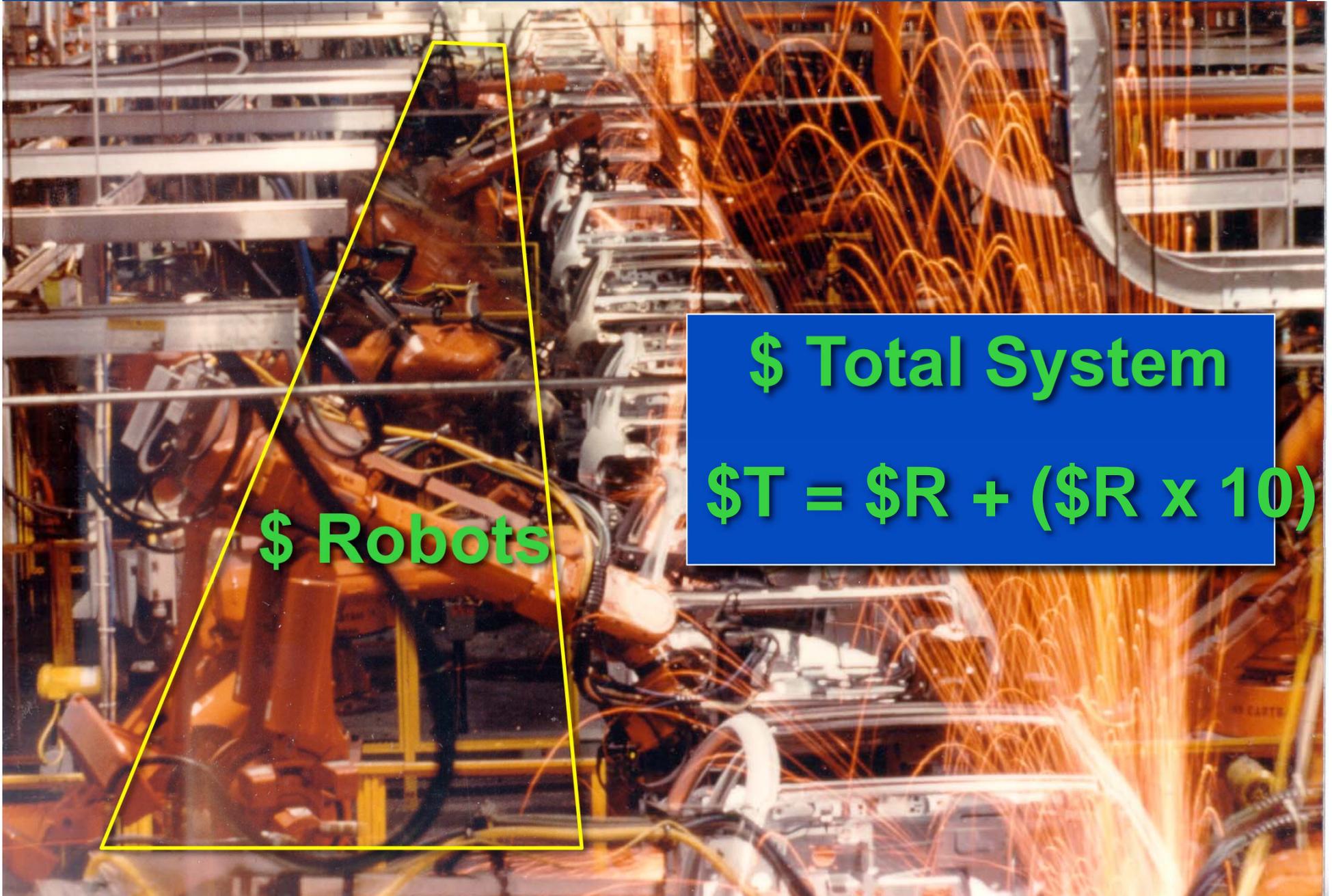
**Leandro G. Barajas, Ph.D.**

Advanced Robotics Group  
Manufacturing Systems Research Laboratory  
General Motors R&D, Warren, MI 48090

**Andrea L. Thomaz, Ph.D. & Henrik I. Christensen, Ph.D.**

Robotics and Intelligent Machines Laboratory  
Georgia Institute of Technology, Atlanta, GA 30332

# Traditional Manufacturing Robotics



**\$ Robots**

**\$ Total System**

$$\$T = \$R + (\$R \times 10)$$

# Next Generation R&A Needs

- Develop technical expertise and manufacturing capability to preserve and develop U.S. industries through the use of cost effective R&A
- Reduce the reliance on fixturing, mechanized structuring, and conventional sense-plan-act programming via flexible perception & learning
- Agree on industry-wide system specifications, capability levels, standards of performance and test methods
- Require overall system performance assessments beyond mechanical & electrical characteristics

# Flexible Perception & Autonomy Inspiration

GM  2007 Darpa Urban Challenge Winner



Enabling Autonomous ~~Driving~~  
Assembly



# Autonomous Assembly Roadmap



- Automatic
- Locating precision
- Limited use to Body Shop and Paint
- Static use of vision and sensing



- Semi-Automatic
- Non-Precision Loc. of parts
- Enhanced Ergonomics

- Social Interaction
- Dexterity
- Human robot Inter
- Vision/Perception



Industrial Robot | C-Flex

Cobots

.... Autonomous Assembly

Autonomy

1. Geometric reasoning to plan an assembly
2. Plan detailed motions
3. Sense to locate incoming parts and tools
4. Bring parts into contact and alignment using dexterity
5. Monitor progress re-planning sequence and motion
6. Indicate success or failure
7. Learn to perform more efficiently with practice
8. Generalize the geometric reasoning and learned behaviors on one task to help in executing other similar tasks

Technology Thrusts

## A path to Autonomous Assembly



General Motors R&D

# Why Robots with Human-Like Capability?

- Enhance and complement the role of humans on the assembly line
- Reduce or eliminate worker time spent on routine, non-critical, dangerous, and/or repetitive functions
- Compensate for human physical, environmental, and cognitive limitations
- Take advantage of manual processes existing infrastructure
- Allow planning of operations to maximize the capabilities and efficiency of humans

## Next Generation R&A Drivers

- High-level flexible perception
- Highly flexible & dexterous robots/end-effectors
- Safe integration & harmony with people who are also performing tasks in the assembly process
- Pervasive use of intelligent R&A that can be as flexible and as easily “trained” as people
- Rapid “reassignment” of automation resources via social interaction rather than programming

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## **Questions?**

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