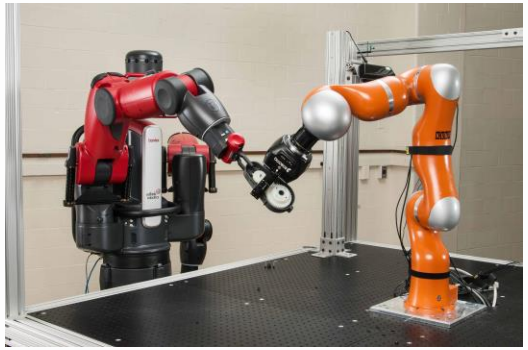
# Measurement Science For Manufacturing Robotics



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https://www.nist.gov/programs-projects/measurement-science-manufacturing-robotics

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# Measurement Science for Manufacturing Robotics

**Reducing risks in adopting new technology and helping spur innovation**

## Core Competencies

**PERCEPTION PERFORMANCE OF ROBOTIC SYSTEMS**

*Assess and Assure Sensor & Perception Systems*

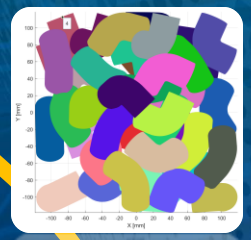
**GRASPING, MANIPULATION & CONTACT SAFETY**

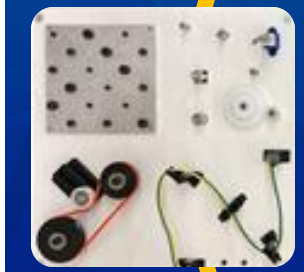
*Assess and Assure Dexterous Grasping & Contact Safety*

**MOBILITY PERFORMANCE OF ROBOTIC SYSTEMS**

*Assess & assure vehicles, mobile manipulators & wearables*









## Enhanced Functionality

**EMBODIED AI AND DATA GENERATION FOR MANUFACTURING**

*Provide validated data & models for AL algorithms*

**AGILITY PERFORMANCE OF ROBOTIC SYSTEMS**

*Easily and rapidly reconfigure and re-task robots*

**PERFORMANCE OF HUMAN-ROBOT INTERACTION**

*Provide foundations for Intuitive and effective interaction methods*

**SOFT ROBOTS AND EMERGING TECHNOLOGIES FOR SME'S**

*Reduce the technical barriers to adopting robots*

NIST
National Institute of Standards and Technology
U.S. Department of Commerce

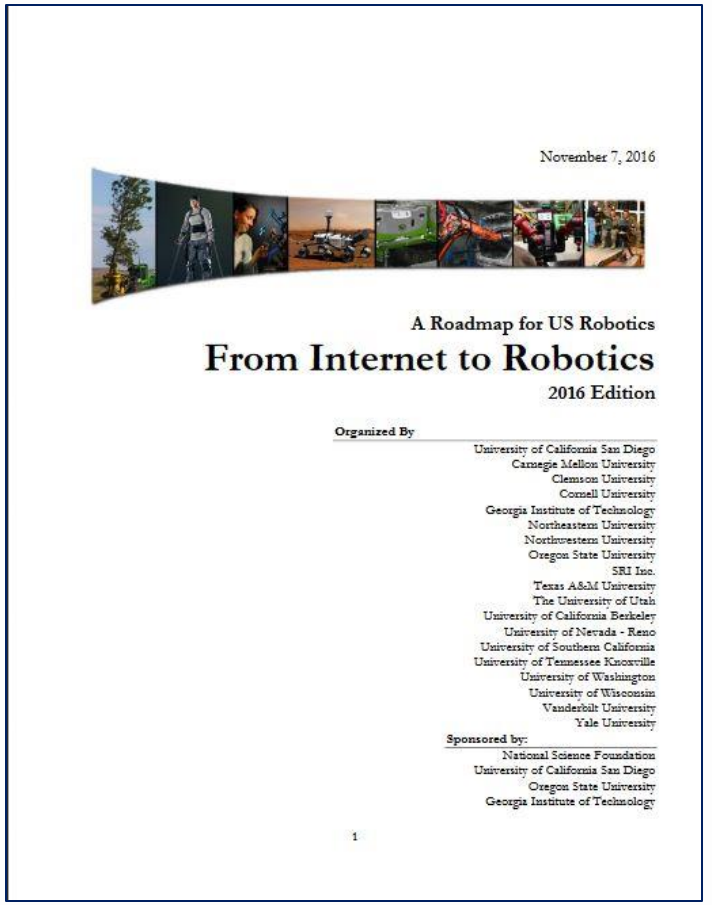
# What is Robot Agility?

- Hardware agility
  - How can different hardware configurations affect a robot's ability to accomplish a variety of tasks?
- **Software agility**
  - **How can a robot be quickly tasked to perform an operation?**
  - **How well can a robot adapt/respond to task failures?**
  - **How well can a robot re-plan when a new goal is provided to it?**
  - **How can we allow for interchangeability of robots without the need for reprogramming?**
  - **How well can a robot respond to changing environmental conditions (e.g., non-fixtured tray moves)?**

C. I. Schlenoff, S. B. Balakirsky, M. Kurwa, "Editorial: Special Issue on Industrial Robot Agility" Industrial Robot Journal, Vol. 43, No. 5, pp. 449-449, (14-Sep-2016)

# Why Did We Focus on These Areas?

- Reviewed numerous roadmaps
- Numerous site visits and telecons with industry and organizations
- Feedback at conferences: ICRA, IROS, IEEE CASE
- Discussions in standards groups
- **Common themes:**
  - Robots take a long time to program
  - Robots are incapable of adapting to changing environments
  - Once a company decides on a robot brand, they are tied to that brand because of the large infrastructural cost
  - Training a robot to perform a new task (or a variation of an existing task) is very time consuming and not cost effective unless you have very large lot sizes.
    - Companies have large areas of their shop floor sitting idle because the robots were trained to develop a specific product and the demand for that product is low (even though demand for other products are high)


November 7, 2016

A Roadmap for US Robotics

From Internet to Robotics

2016 Edition

Organized By

University of California San Diego
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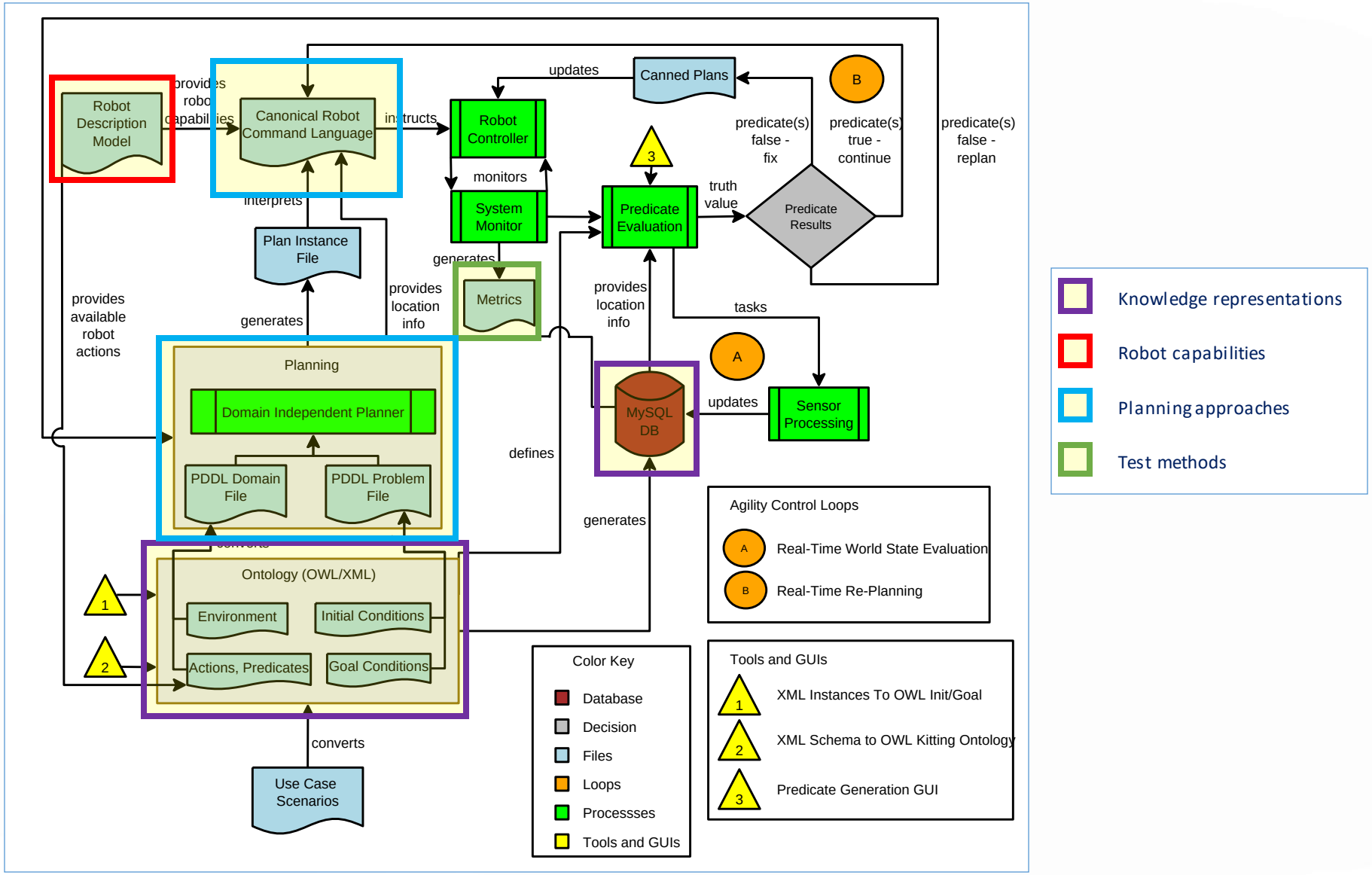
# Big Picture


Robot Description Model
provides robot capabilities
Canonical Robot Command Language
instructs
Robot Controller
updates
Canned Plans
B
predicate(s) false - fix
predicate(s) true - continue
predicate(s) false - replan
3
monitors
System Monitor
truth value
Predicate Evaluation
Predicate Results
interprets
Plan Instance File
generates
Metrics
provides location info
provides available robot actions
tasks
A
Planning
Domain Independent Planner
PDDL Domain File
PDDL Problem File
MySQL DB
updates
Sensor Processing
defines
generates
Ontology (OWL/XML)
Environment
Initial Conditions
Actions, Predicates
Goal Conditions
1
2
converts
Use Case Scenarios
Agility Control Loops
A
Real-Time World State Evaluation
B
Real-Time Re-Planning
Color Key
Database
Decision
Files
Loops
Processses
Tools and GUIs
Tools and GUIs
1
XML Instances To OWL Init/Goal
2
XML Schema to OWL Kitting Ontology
3
Predicate Generation GUI
Knowledge representations
Robot capabilities
Planning approaches
Test methods