# UW-MSR SUMMER INSTITUTE 2016
# ROBOTICS
## STATE-OF-THE-ART

Dan Bohus & Maya Cakmak

dbohus@microsoft.com, mcakmak@cs.washington.edu

# GOALS FOR TODAY

How can we **make robots more accessible**?

How can we **use robots** to **make the world more accessible**?

# A BRIEF/SPARSE HISTORY

automata
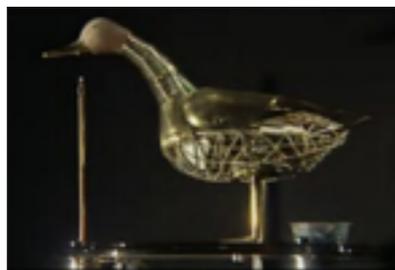


1739

genghis



1989

*last 20 years*

1495
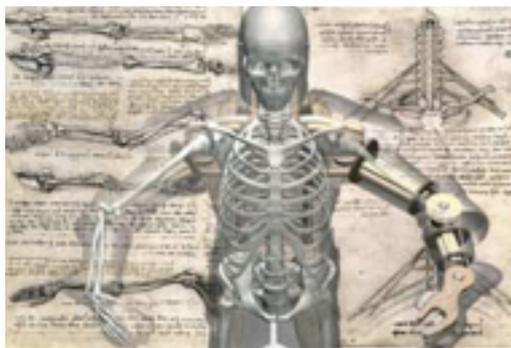


Leonardo
DaVinci

1966



Shakey

1998
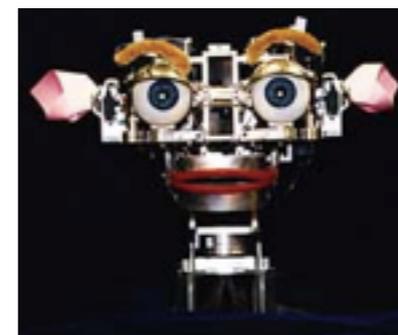


Kismet

# ASSEMBLY LINE ROBOTS



1980s-1990s: Robots replace manual labor in factories

# CLEANING ROBOTS



2000s: More than 14 million home robots sold by iRobot

# FABRICATION FOR EVERYONE



2000s-2010s: Reduction in cost, increase in capabilities of fabrication tools

# OPEN SOURCE ROBOTICS



2010s: Researchers have common robot platforms and share robotics software

# A BRIEF/SPARSE HISTORY

automata
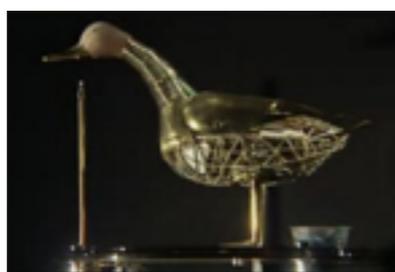


1739

genghis



1989

*last 5 years*

*last 20 years*

1495



Leonardo
DaVinci

1966



Shakey

1998



Kismet

# NATIONAL ROBOTICS INITIATIVE
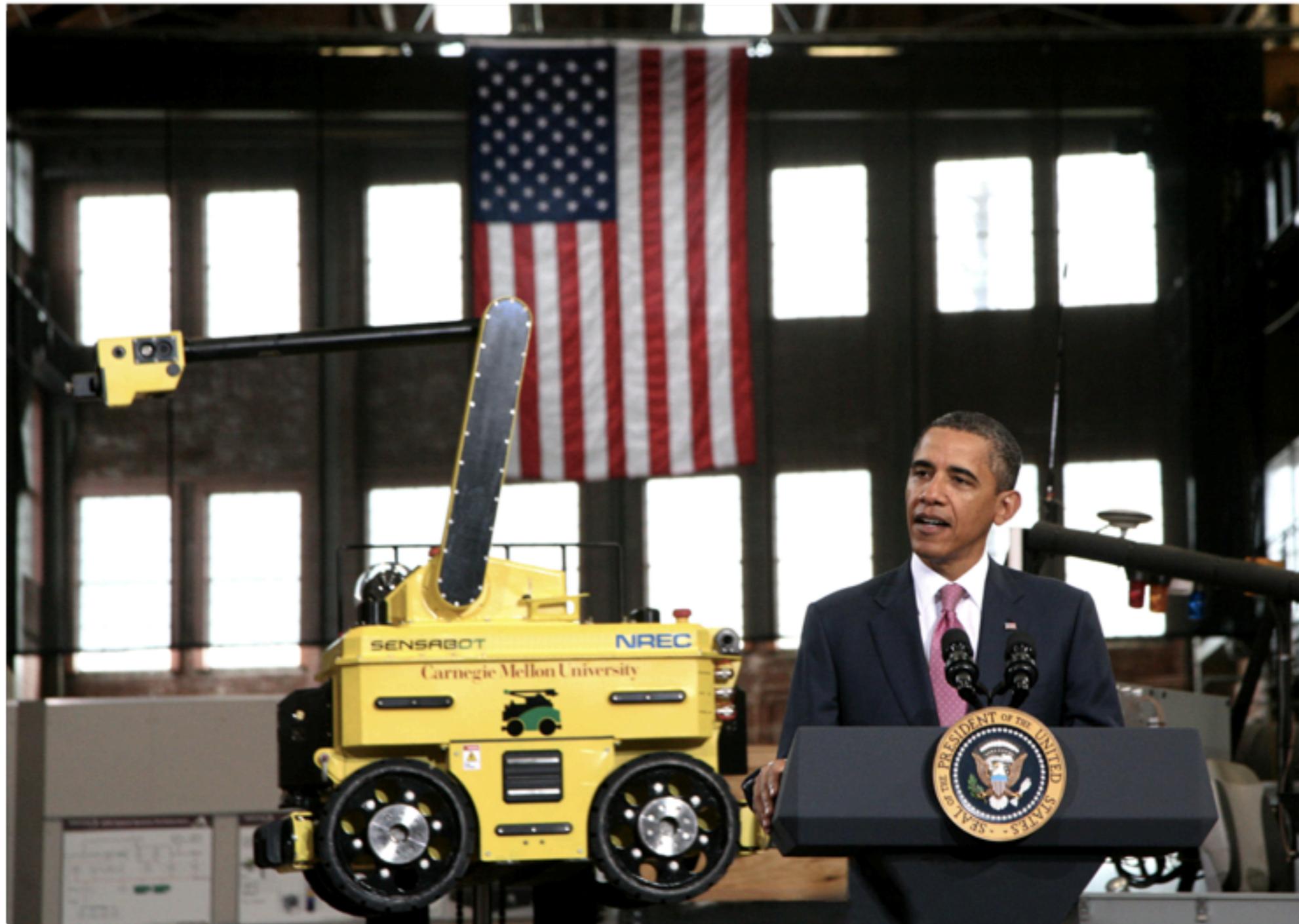
# ROBOTICS JOBS
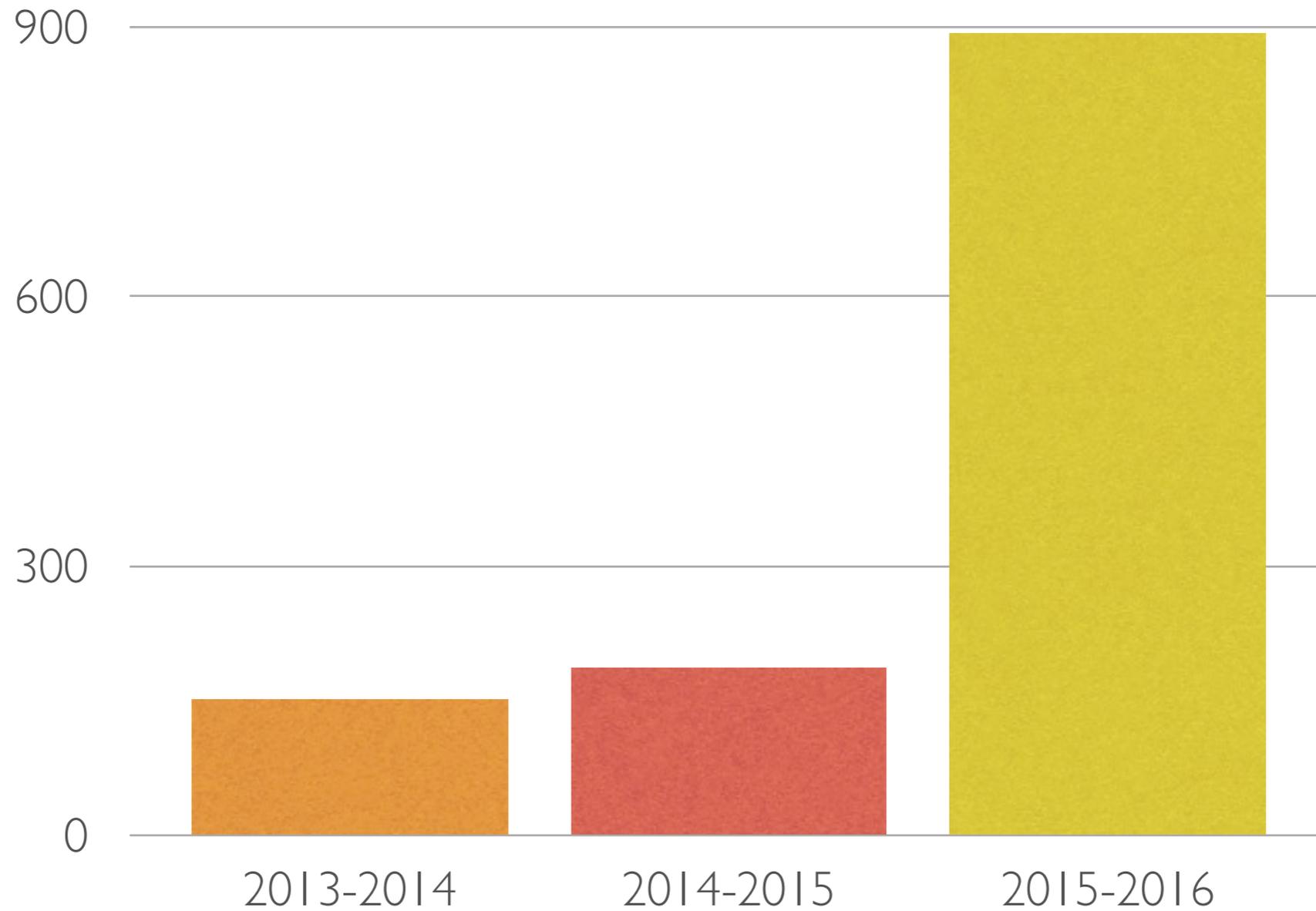


# of search results "[robotics-worldwide] [jobs]" within 1, 2, and 3 years of March 2016

# INVESTMENTS



**Drone Investment Activity**
Q1'12 - Q4'15

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q1'12 | Q2'12 | Q3'12 | Q4'12 | Q1'13 | Q2'13 | Q3'13 | Q4'13 | Q1'14 | Q2'14 | Q3'14 | Q4'14 | Q1'15 | Q2'15 | Q3'15 | Q4'15 |
| $0 | | | $8 | | $16 | $36 | $8 | $6 | $15 | $67 | $23 | $69 | $110 | $140 | $131 |
| 1 | | | 3 | 2 | 4 | 6 | 3 | 5 | 7 | 11 | 12 | 13 | 19 | 20 | 22 |

■ Amount ($M)  ── Deals

CB INSIGHTS

www.cbinsights.com
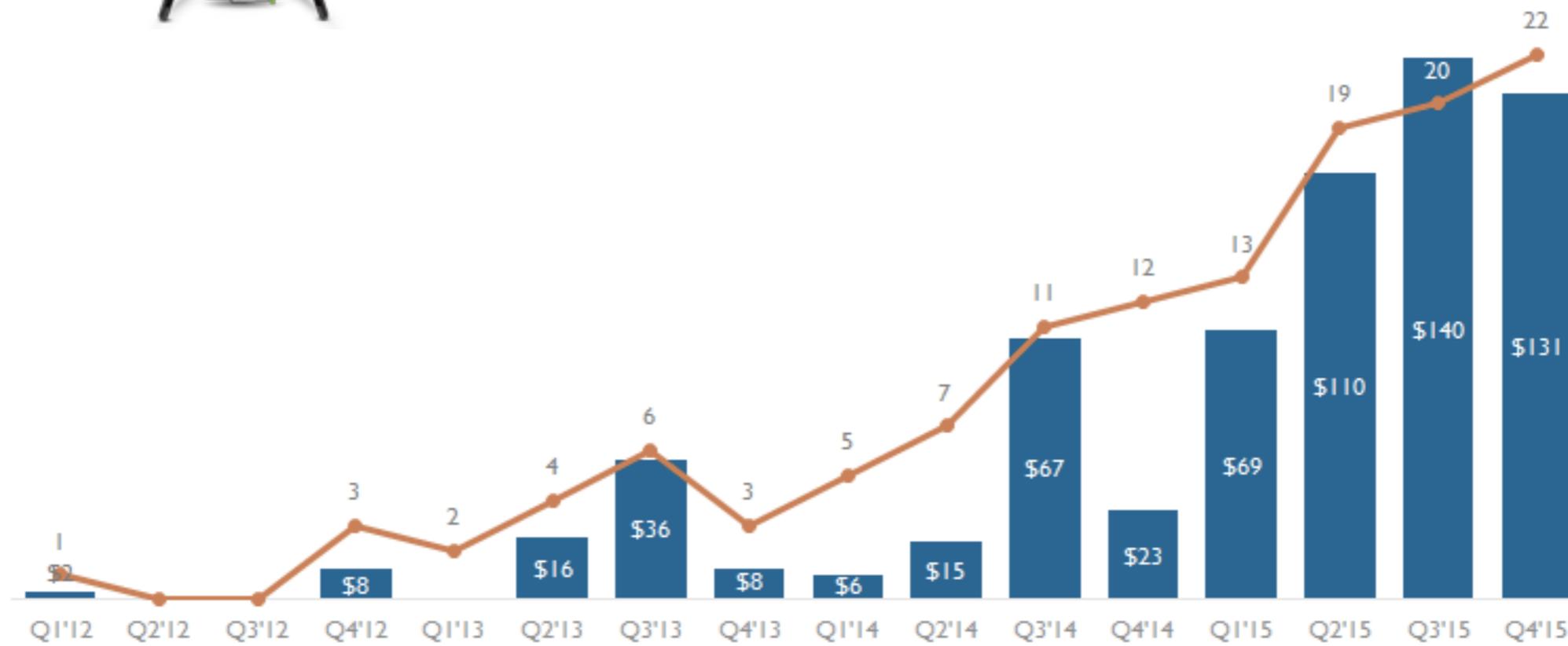
# INVESTMENTS

2012: Amazon purchased Kiva systems for $775M

# INVESTMENTS

## 2014: Google buys eight robotics companies
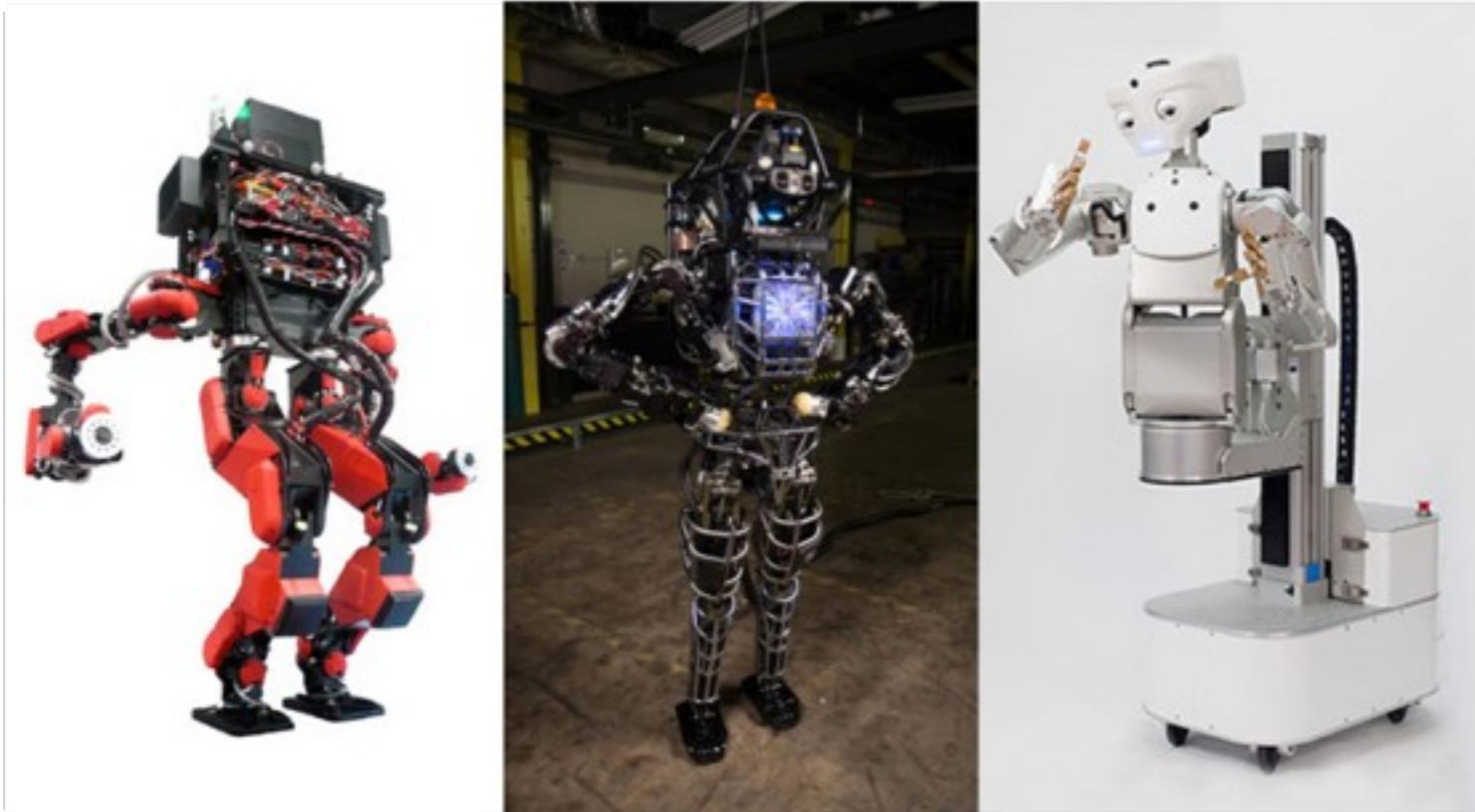


Schaft Inc.
Industrial Perception, Inc
Redwood Robotics
Meka Robotics
Holomini
Bot & Dolly
Boston Dynamics*
DeepMind Technologies

*for sale

# AREAS OF PROGRESS



Sensors

Perception

Planning

Interaction

Learning

Control

Actuators

# DOMAINS OF PROGRESS



self-driving cars

indoor navigation
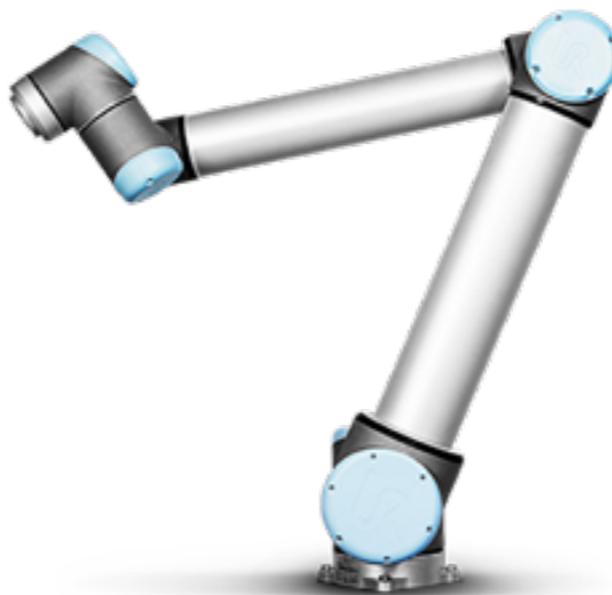
search&rescue

manipulation

social robots

# SEARCH & RESCUE
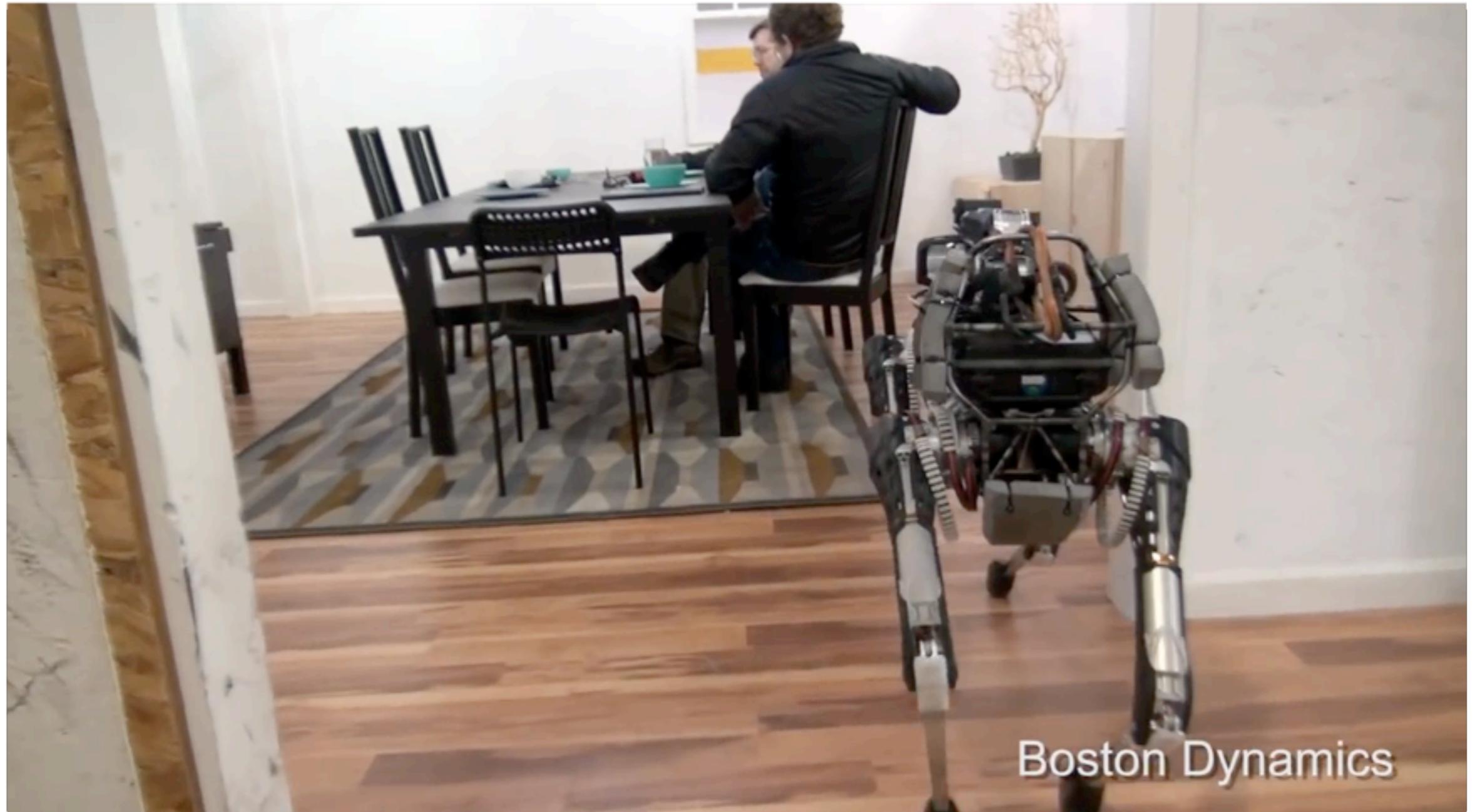


Boston Dynamics

# SELF-DRIVING CARS



Google self-driving car

https://www.youtube.com/watch?v=TsaES--OTzM
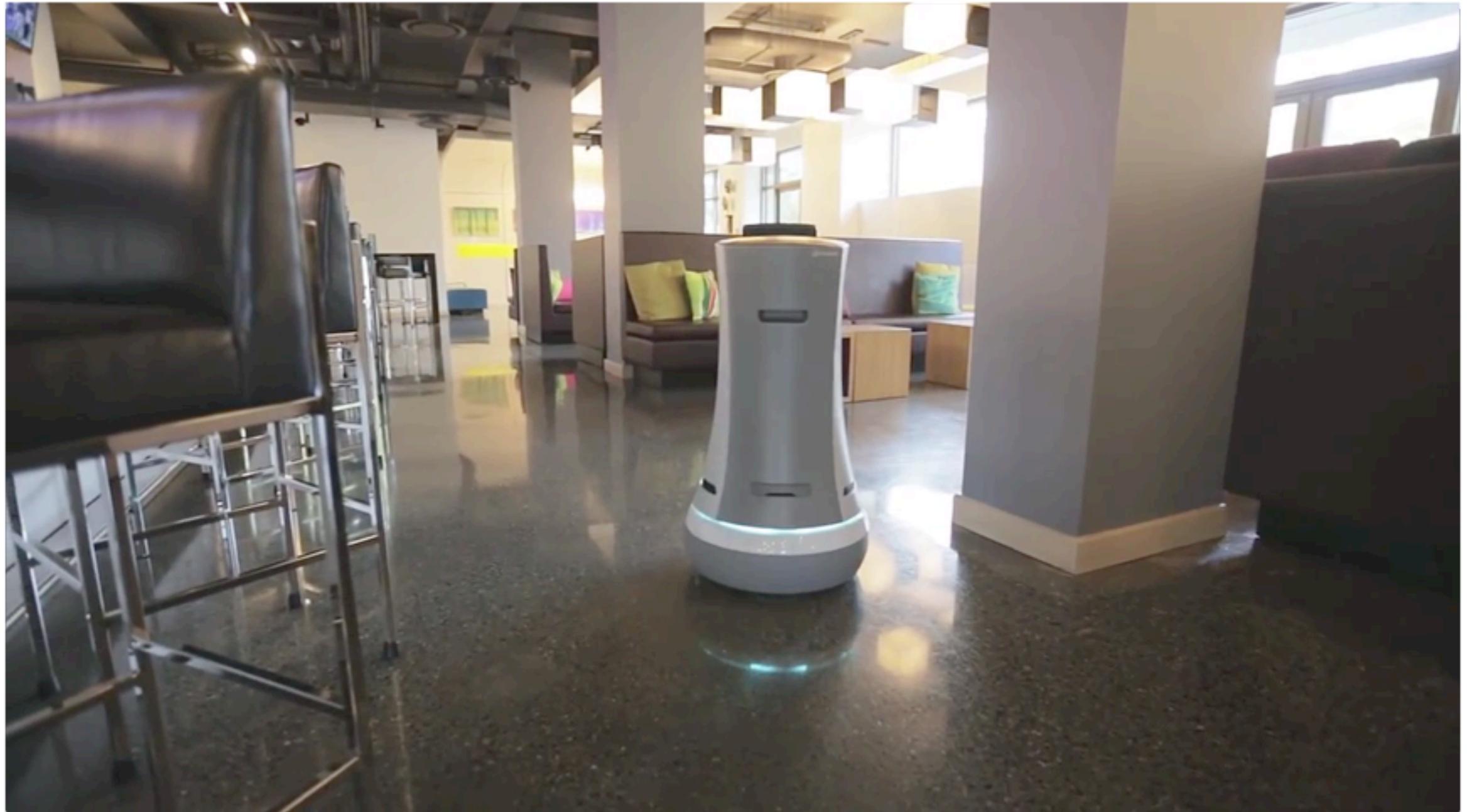
# INDOOR NAVIGATION



Savioke Relay robot

# SOCIAL ROBOTS



Jibo family robot
https://www.youtube.com/watch?v=3N1Q8oFpX1Y
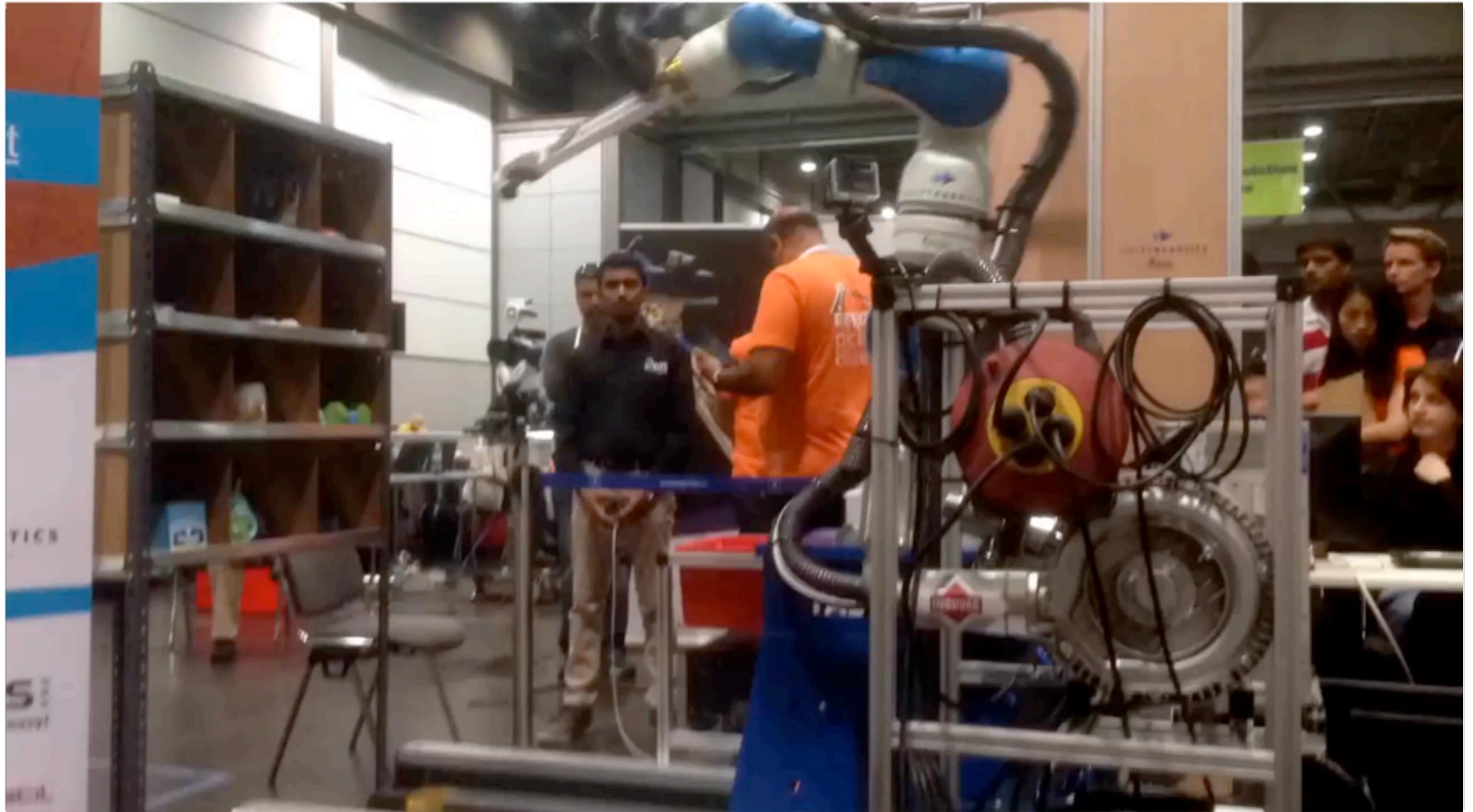
# MANIPULATION



Amazon picking challenge, 2016

# DOMAINS OF PROGRESS



self-driving cars

indoor navigation

search&rescue
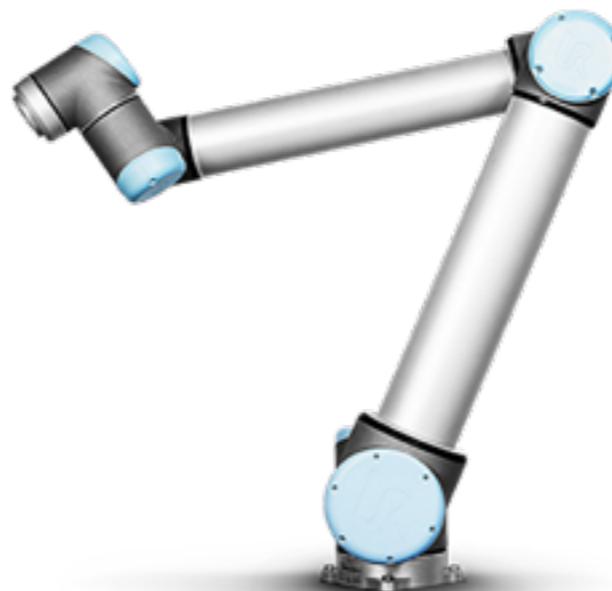
manipulation

social robots

# ROBOTS FOR ACCESS



Telepresence

Navigation

Autism Spectrum Disorders

Manipulation
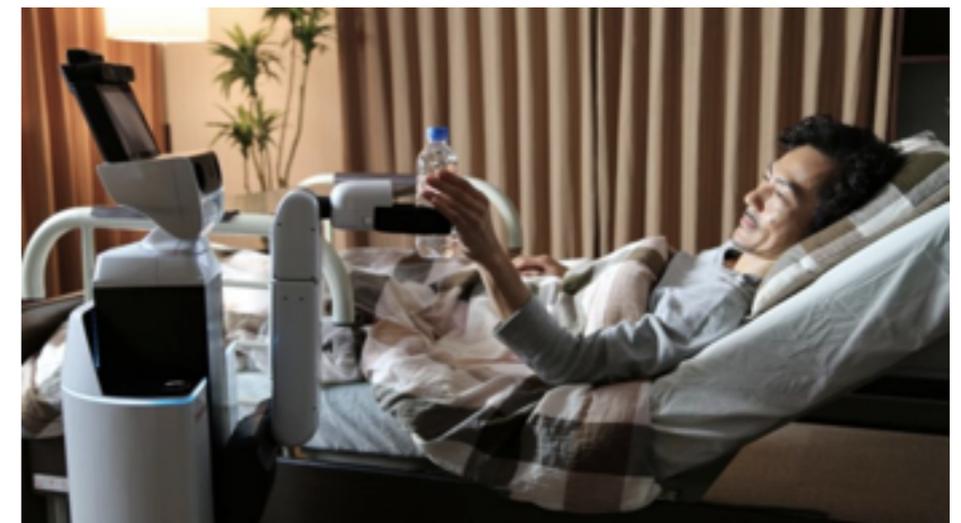
Assistance

# TELEPRESENCE



Henry Evans, giving a TED talk

https://www.youtube.com/watch?v=aClukWXmlV4

# TELEPRESENCE



Henry Evans, viewing his grapevines with his drone

# PHYSICAL ASSISTANCE
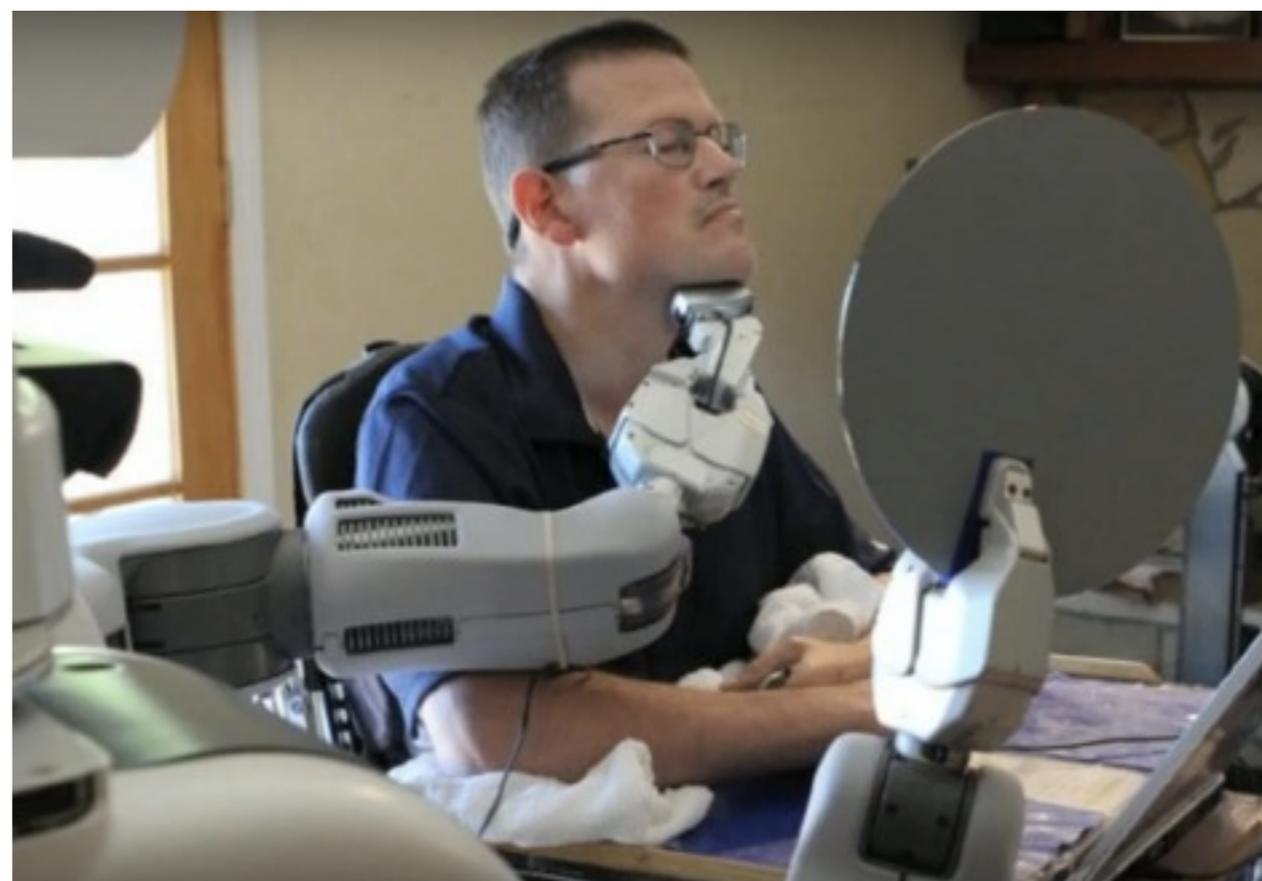


Henry Evans, using the PR2

# MANIPULATION
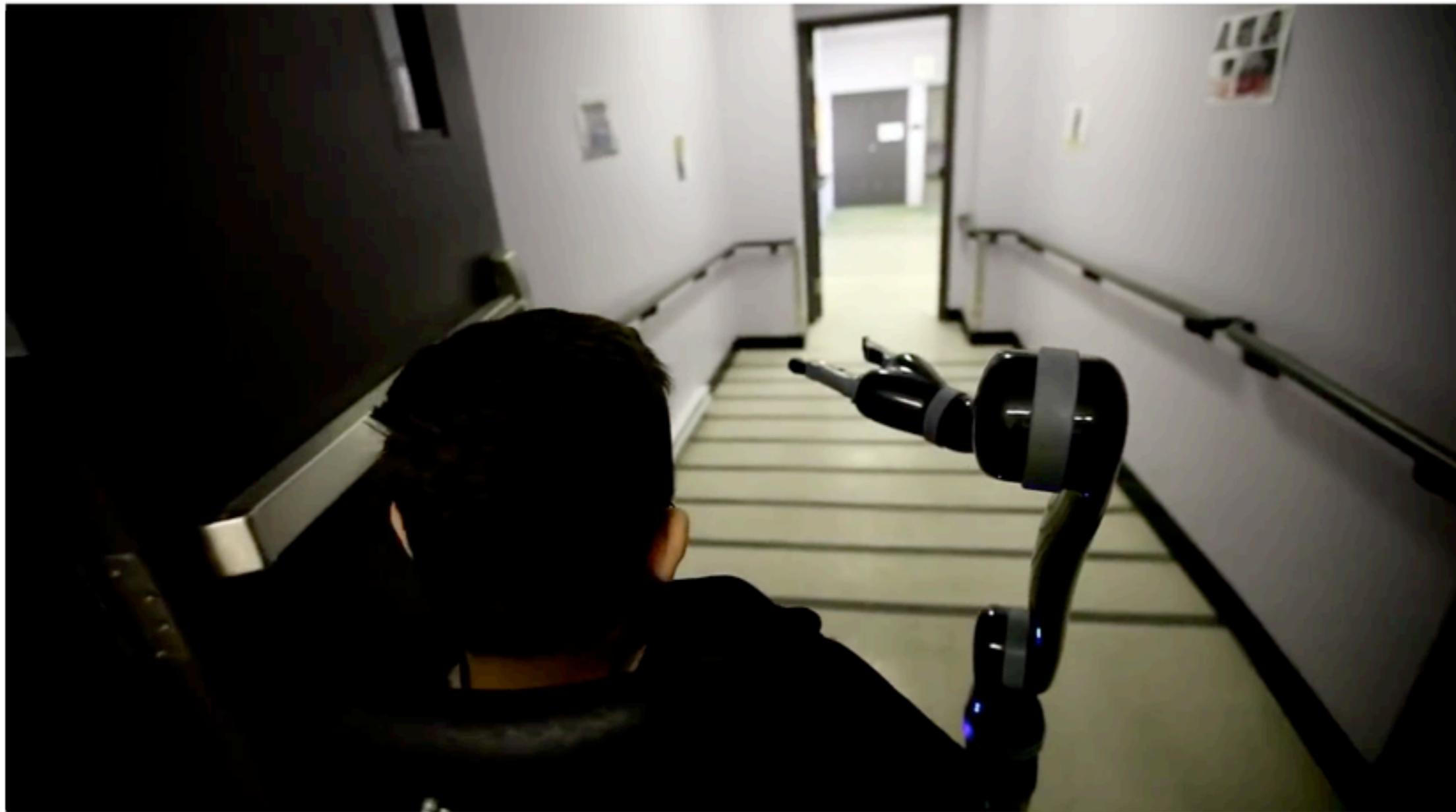


JACO arm, with human tele-operation

https://www.youtube.com/watch?v=iZYxJFROew8

# MANIPULATION



Brad Duerstock, RoboDesk

https://www.youtube.com/watch?v=VhLTE1EAtaQ

# ROBOTS FOR ACCESS

## Strategies for near term impact

human-in-the-loop

semi-structured environments

user and task centered design

customizability, end-user programming

# QUESTIONS

How can we **make robots more accessible**?

How can we **use robots** to **make the world more accessible**?

Dan Bohus & Maya Cakmak

dbohus@microsoft.com, mcakmak@cs.washington.edu