

LIBERATE 2021

# Toward a New Kind of Assistive Robot

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Georgia Tech & Hello Robot



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*Co-founder & CTO, Hello Robot Inc.*

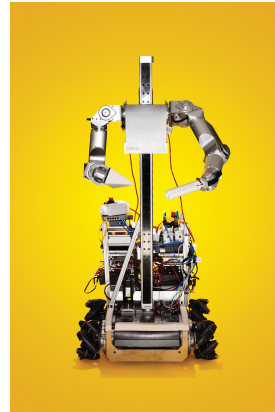
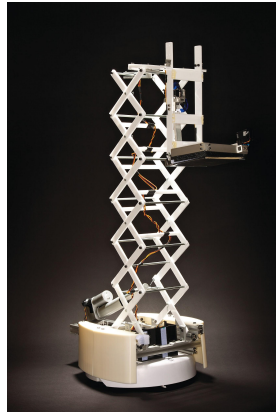
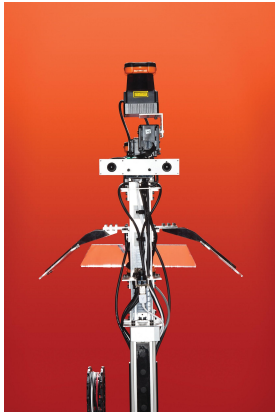
hello robot™

# Conflict of Interest Statement

Charlie Kemp (<https://charliekemp.com>) is both an associate professor at Georgia Tech and the chief technology officer (CTO) of Hello Robot where he works part time. He owns equity in Hello Robot and is an inventor of Georgia Tech intellectual property (IP) licensed by Hello Robot. Consequently, **he receives royalties through Georgia Tech for sales made by Hello Robot. He also benefits from increases in the value of Hello Robot.**

# Mobile Cobots (*Mobile Manipulators*)

- Can assist people with disabilities
- Are becoming commercially viable
- Require research to realize their potential



# Commercial Assistive Robots



**JACO by Kinova**

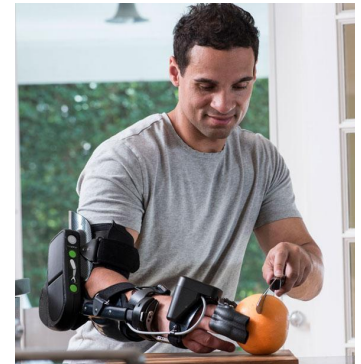
- On your wheelchair
- On a table or desk
- On your body



**DynamicArm by Ottobock**



**My Spoon by SECOM**



**Myomo by Myomo Inc.**

# Mobile Cobots

- Operate independently from the user
- No don/doff
- Assist diverse users
- Potential for mass market product



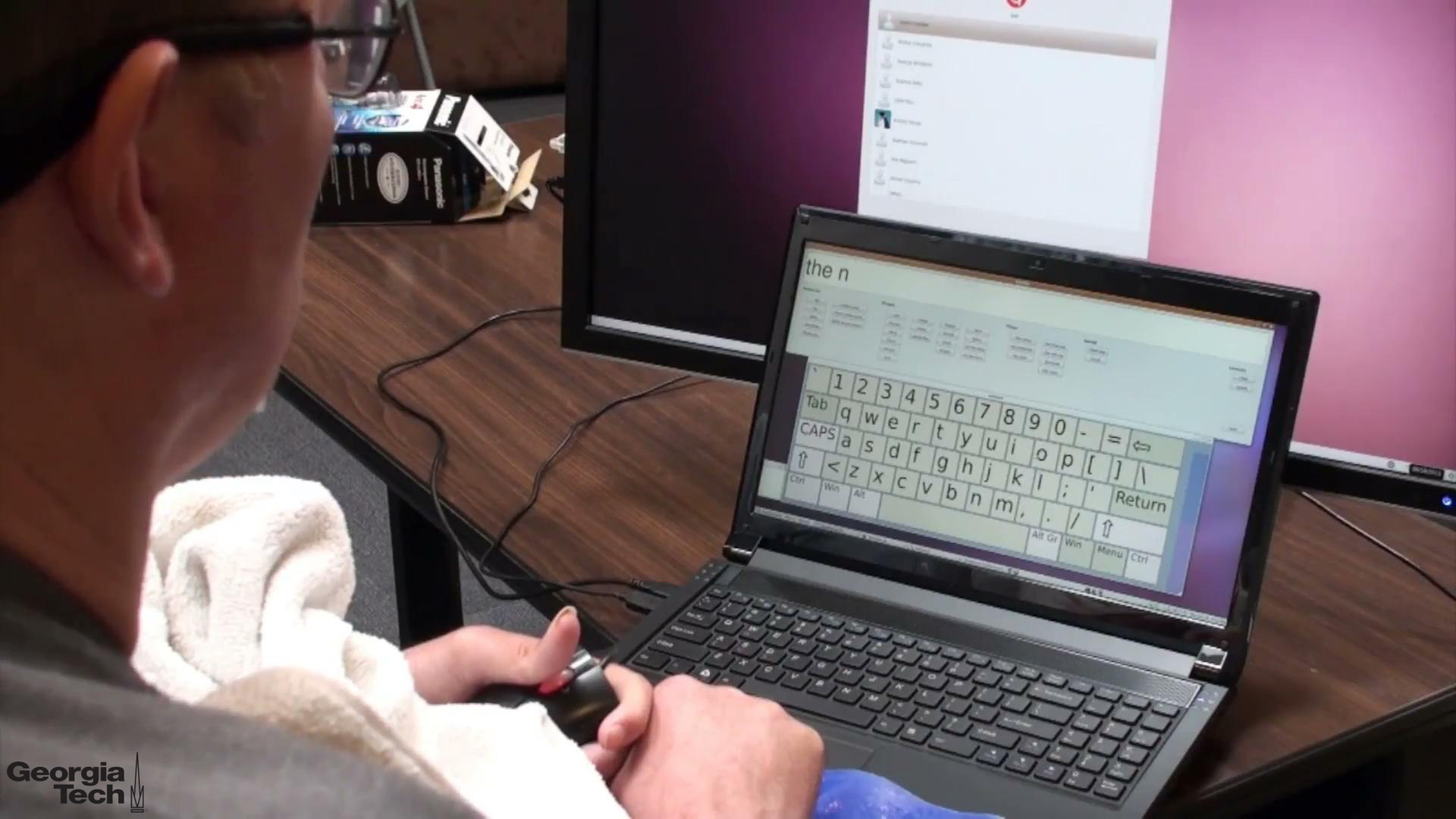
# Mobile Cobots Provide Meaningful Assistance

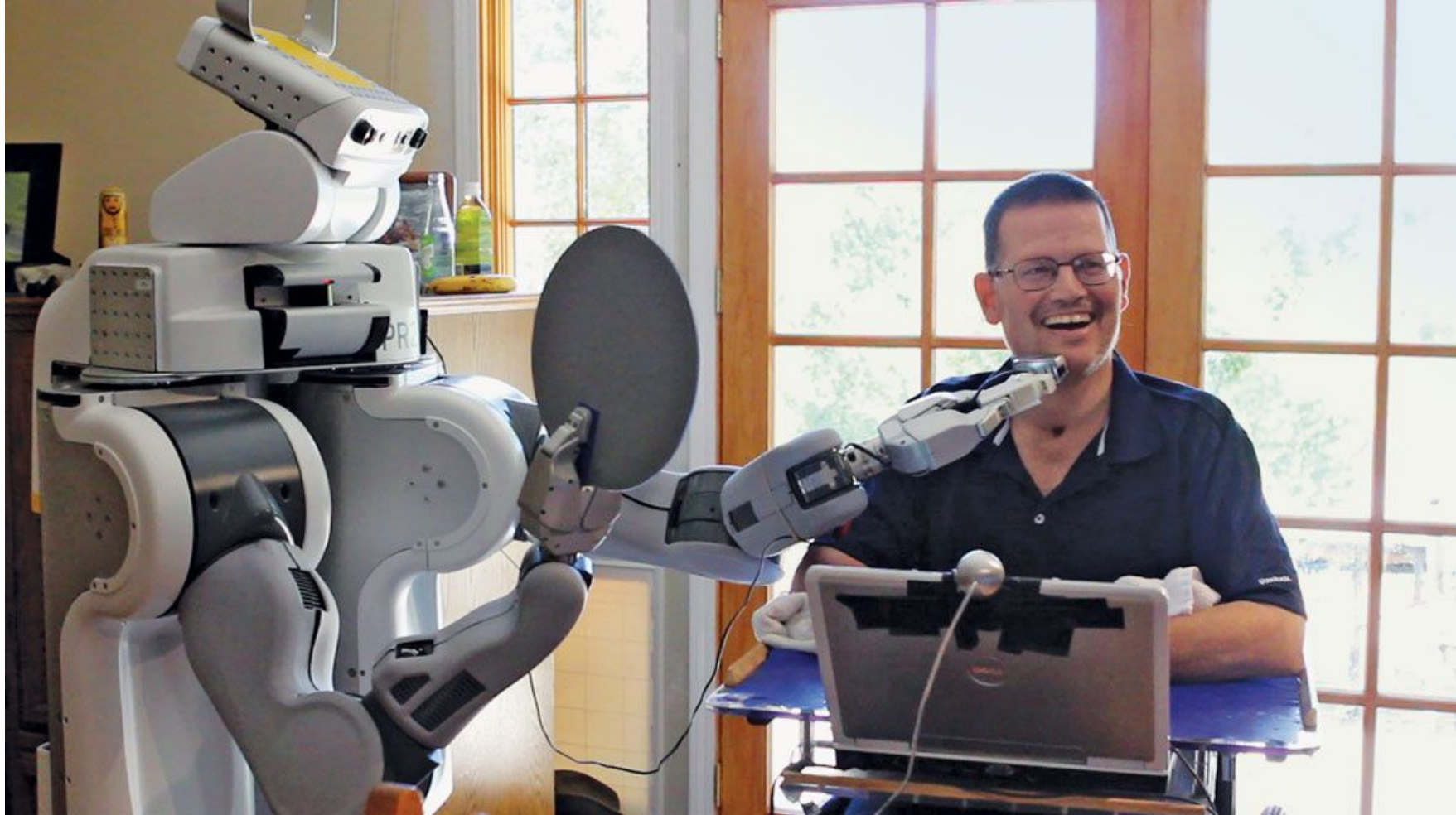


















Main Menu

- Look
- Spine
- Left Hand
- Right Hand
- Drive

Controls

- Step Size
- XS
  - S
  - M
  - L

Position/Rotation

- Hand Position
- Wrist Rotation

- 3D Peek
- Move Aside
- Move to Setup
- Re-zero Skin



Gripper

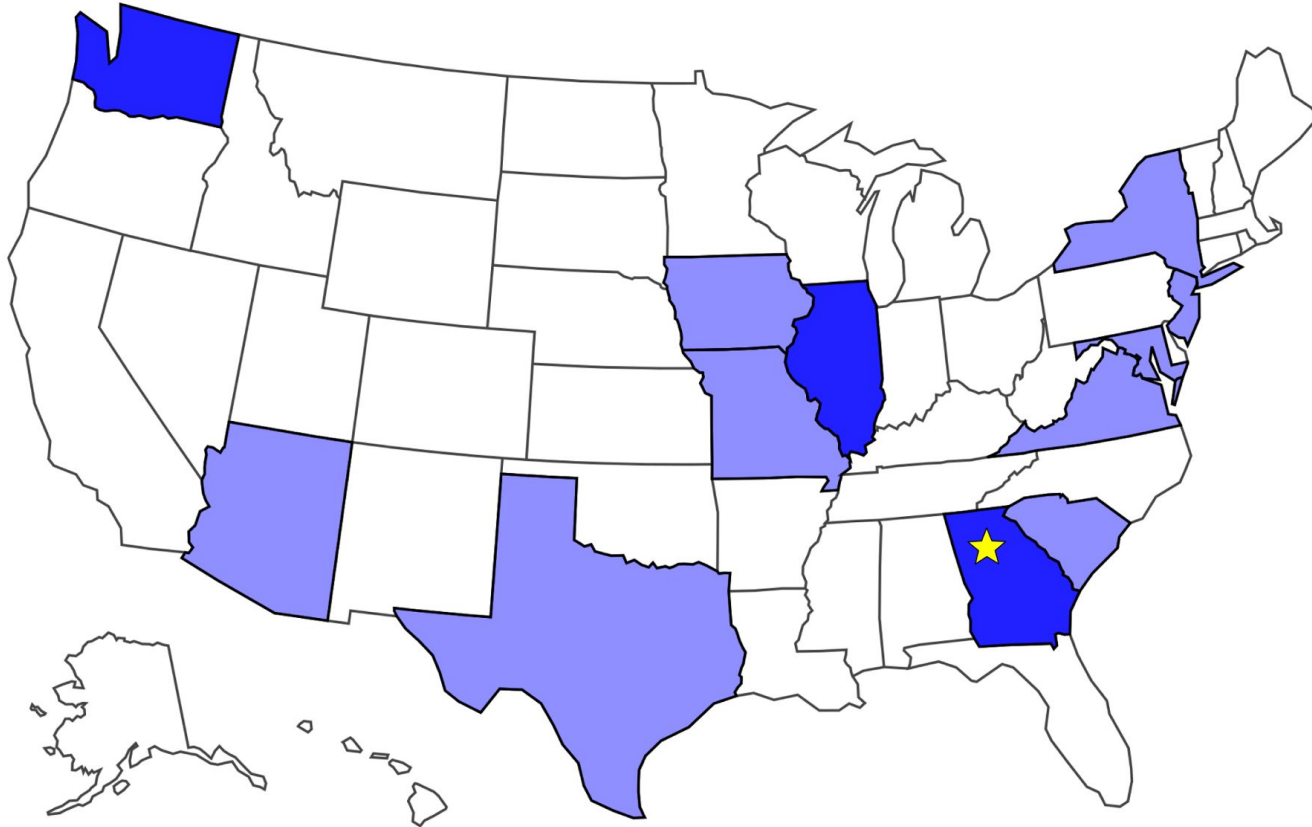
4x



Realtime



# 15 Participants





# Causes of Motor Impairment

6 Spinal Muscular Atrophy (SMA)

3 Muscular Dystrophy (Duchenne/Becker)

3 Spinal Cord Injury

1 Amyotrophic Lateral Sclerosis (ALS)

1 Arthrogryposis

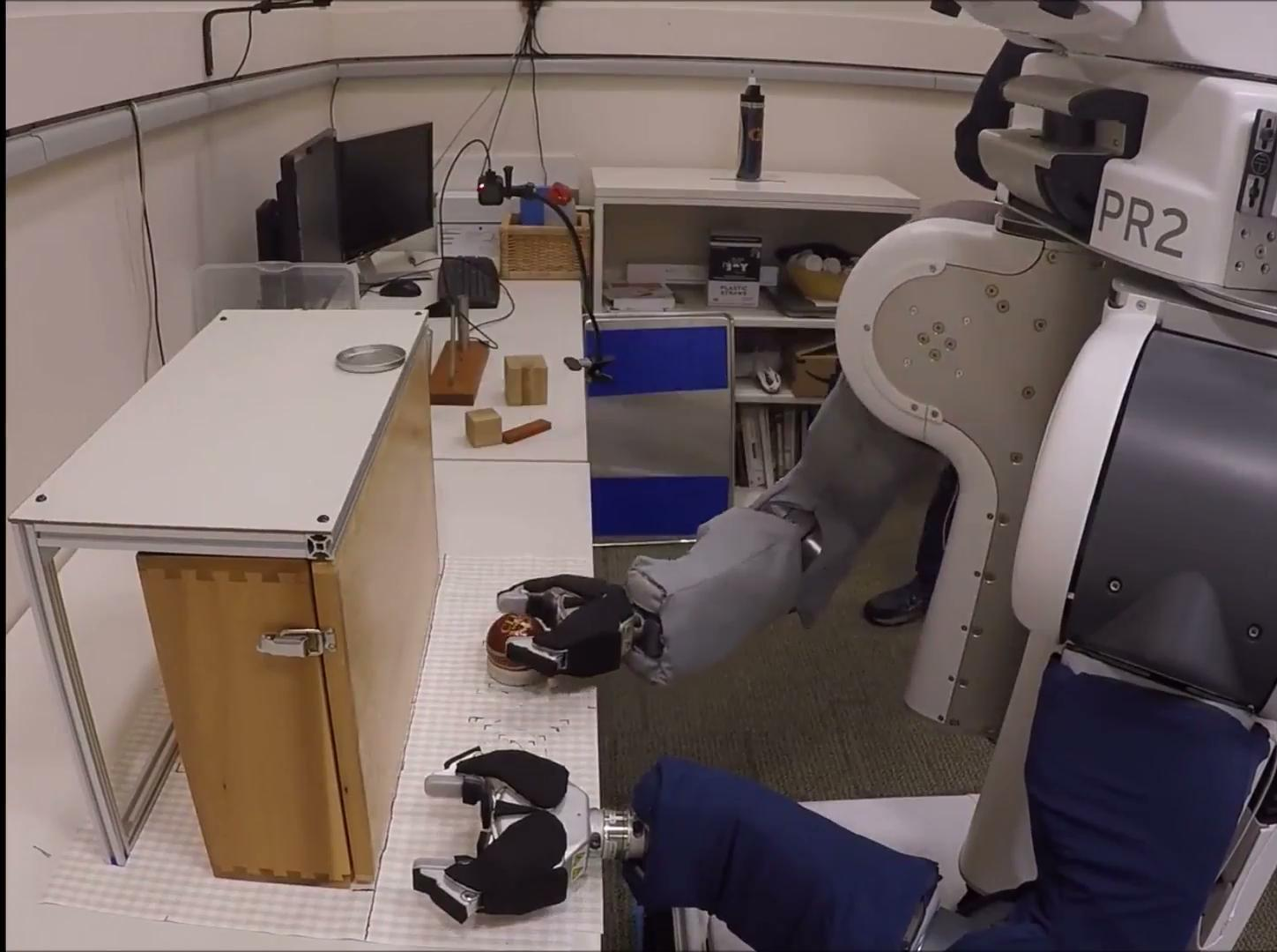
1 Dejerine-Sottas

**ARAT Threshold: 9/57 with best arm**

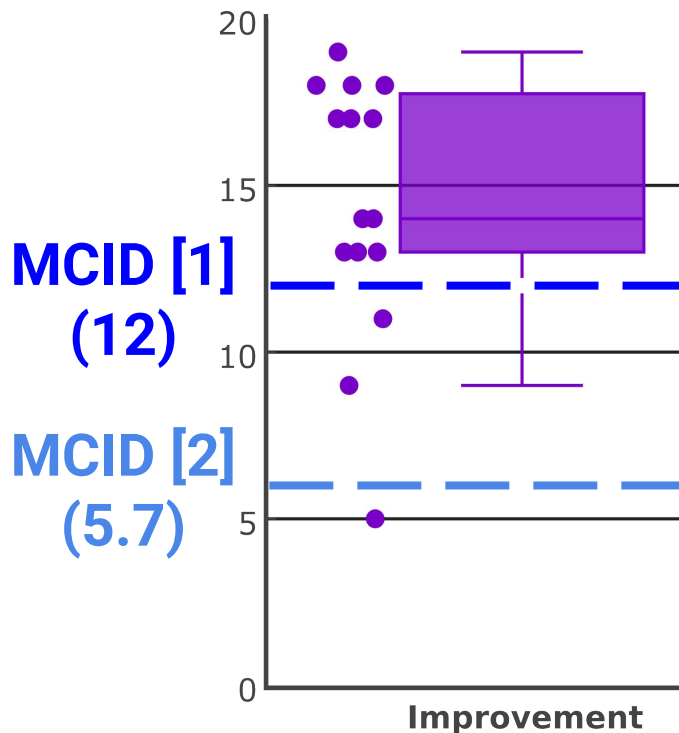
# Computer Access Devices

- 4 – Trackball
- 3 – Touchpad
- 3 – Head-mouse (TrackerPro, 2x HeadMouse Extreme)
- 2 – Standard mouse
- 1 – Eye-gaze (Tobii)
- 1 – Touchpad w/Stylus held in mouth
- 1 – Speech (Dragon MouseGrid)

40x



# Improvement Exceeded Conservative Minimal Clinically Important Difference (MCID)



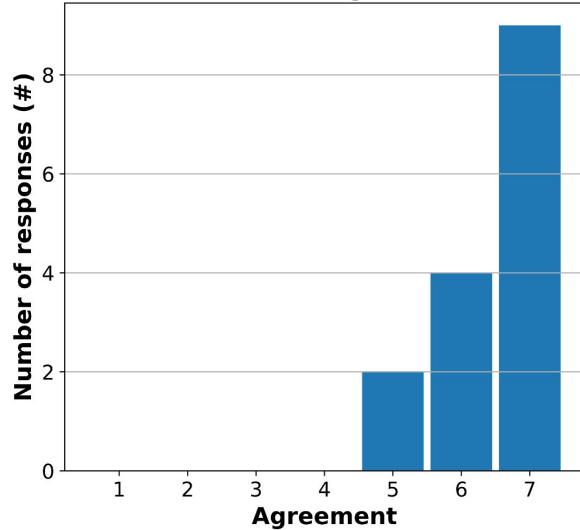
1-tailed Wilcoxon signed-rank test vs MCID:  $W=96$ ,  $p=.021$

[1] C. E. Lang, D. F. Edwards, R. L. Birkenmeier, and A. W. Dromerick, "Estimating minimal clinically important differences of upper-extremity measures early after stroke," Archives of physical medicine and rehabilitation, vol. 89, no. 9, pp. 1693–1700, 2008.

[2] J. H. Van der Lee, V. De Groot, H. Beckerman, R. C. Wagenaar, G. J. Lankhorst, and L. M. Bouter, "The intra- and interrater reliability of the action research arm test: A practical test of upper extremity function in patients with stroke," Archives of physical medicine and rehabilitation, vol. 82, no. 1, pp. 14–19, 2001.

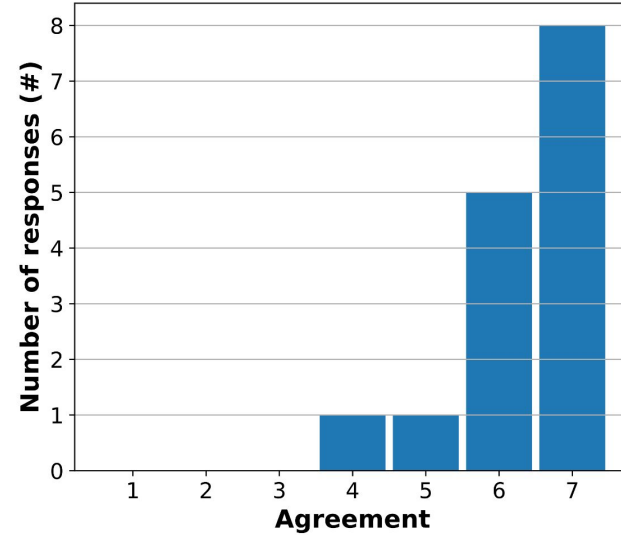
# Perceived Usefulness

## Usefulness - Manipulation Tasks



Wilcoxon signed-rank test vs neutral:  
W=120, p=.000258

## Usefulness - Self Care Tasks



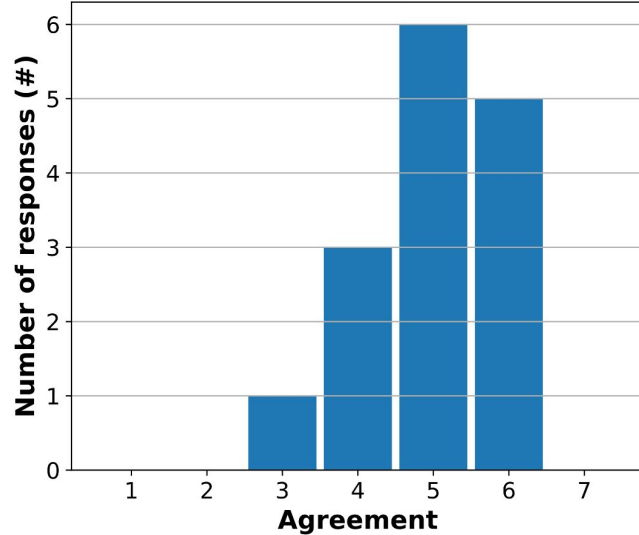
Wilcoxon signed-rank test vs neutral:  
W=105, p=.000402

1: Strongly Disagree  
2: Disagree  
3: Somewhat Disagree  
4: Neither Agree nor Disagree

5: Somewhat Agree  
6: Agree  
7: Strongly Agree

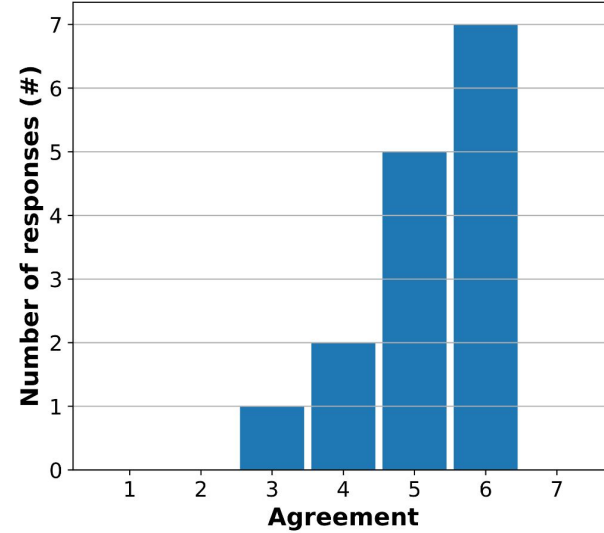
# Perceived Ease of Use

## Ease of Use - Manipulation Tasks



Wilcoxon signed-rank test vs neutral:  
W=74, p=.00264

## Ease of Use - Self Care Tasks



Wilcoxon signed-rank test vs neutral:  
W=87.5, p=.00142

1: Strongly Disagree  
2: Disagree  
3: Somewhat Disagree  
4: Neither Agree nor Disagree

5: Somewhat Agree  
6: Agree  
7: Strongly Agree

# Limitations

- Slow operation
- Errors
- Depth perception



# Limitations

- Slow operation
- Errors
- Depth perception
- **The robot**

# The Robot Matters



Released in 2010

\$400,000

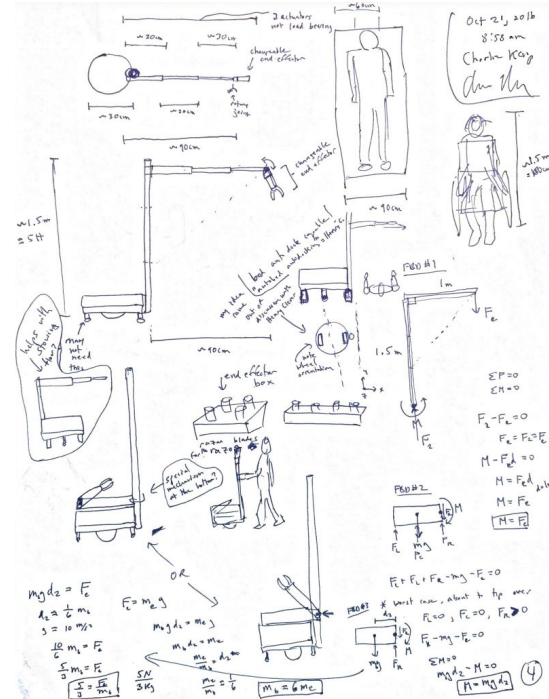
227 kg (~500 lb)

67 cm wide (~2.2 ft)

# Frustration Leads to Invention

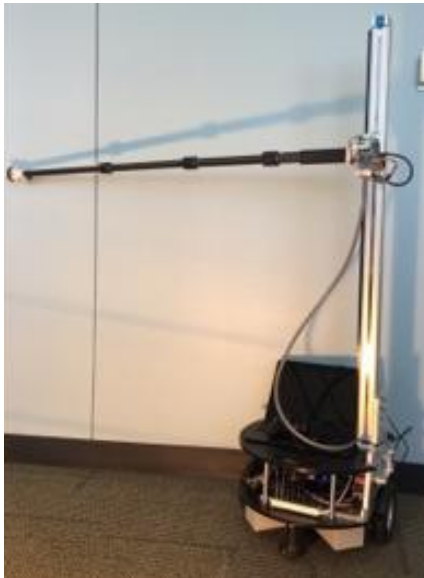
Minimize the actuator requirements while maximizing the capabilities.

- affordable
- compact
- lightweight
- humancentric
- capable



My Initial Georgia Tech Notes  
October 2016

**Georgia Tech's Prototype**  
**March 2017**



**Hello Robot's Product - A Robot for Research**  
**July 2020**



2016	2017		2018	2019	2020
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# Hello Robot's Founding Advisors

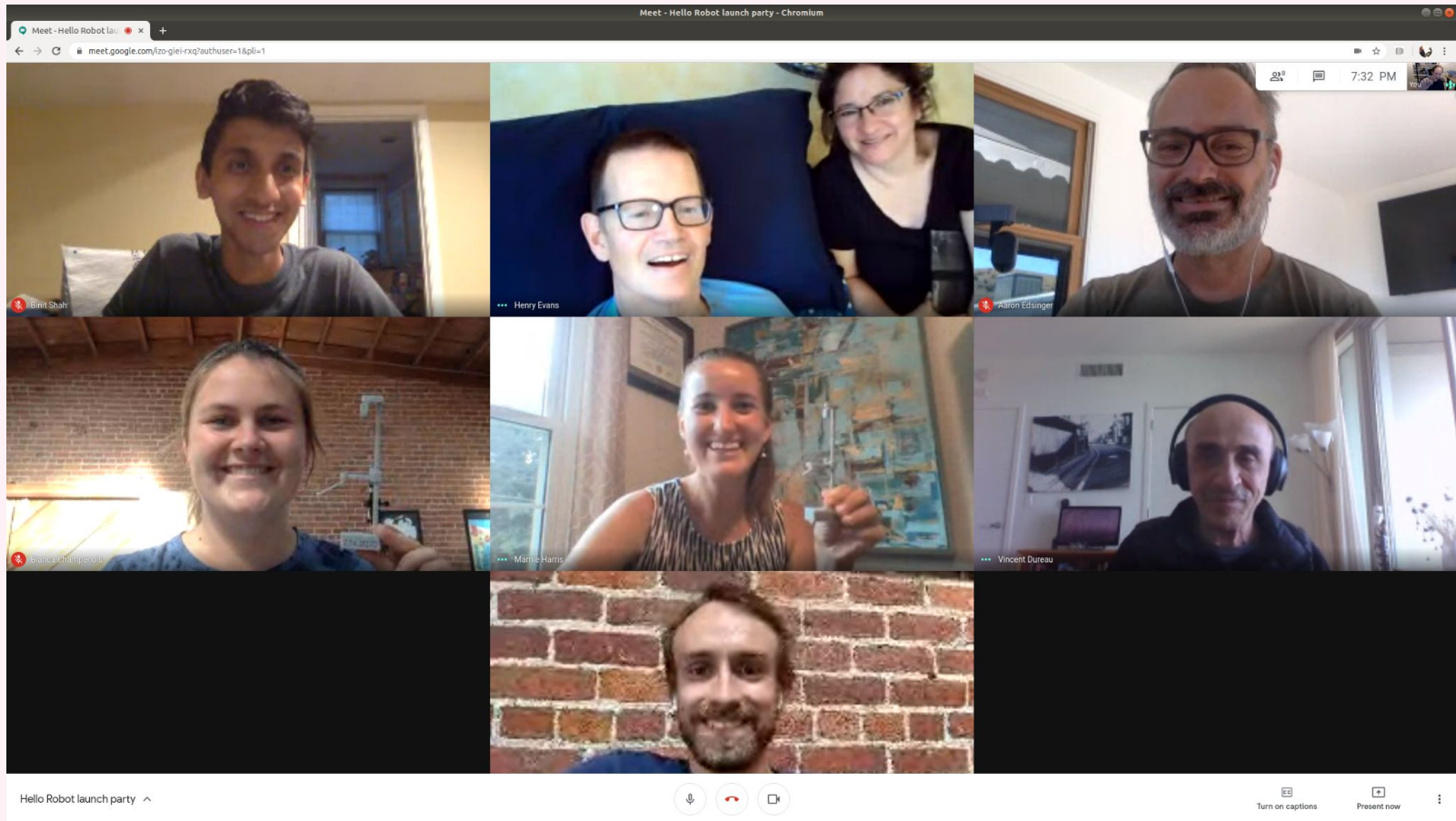


Henry & Jane Evans



Vincent Dureau

# Launch Party, July 2020









# A Successful Launch

14 Jul 2020 | 4:01 GMT

## Ex-Googler's Startup Comes Out of Stealth With Beautifully Simple, Clever Robot Design

Hello Robot's Stretch wants to reinvent how mobile manipulators perform tasks in home environments

By Evan Ackerman and Enrico Guizzo



Photo: Hello Robot

Hello Robot, founded by former Google robotics director Aaron Edsinger and Georgia Tech professor Charlie Kemp, is introducing Stretch, a mobile manipulator that weighs only 23 kg and costs less than \$20,000.

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Tech



Research robot helps with housework and other news



### Hello Robot wins Innovation Award in SVR 'Good Robot' Industry Awards

Stretch from Hello Robot  
CEO: Aaron Edsinger  
Founded: 2017  
HQ: Martinez, CA

Hello Robot has reinvented the mobile manipulator. In July 2020 they launched Stretch, the first capable, portable, and affordable mobile manipulator designed specifically to assist people in the home and workplace. At a fraction the cost, size, and weight of previous capable mobile manipulators, Stretch's novel design is a game changer.

Posted on December 14, 2020 by Andra Key  
Category: Innovation, Media Releases  
Tagged Aaron Edsinger, Charlie Kemp, Good Robot Awards, Hello Robot, Innovation, Stretch, SVR Industry Awards, Winners





8X Teleoperator

# A Win for Inclusive Design

# Hello Robot's Transparency & Openness

US owned & US assembled

Simple Pricing

[hello-robot.com](https://hello-robot.com)

Open Source Code

[github.com/hello-robot](https://github.com/hello-robot)








Open Hardware Accessories

[github.com/hello-robot/stretch\\_tool\\_share](https://github.com/hello-robot/stretch_tool_share)

Open Forum

[forum.hello-robot.com](https://forum.hello-robot.com)

# Hello Robot's Community Event 8 Months After Launch

VIAM

Cornell University

Massachusetts Institute of Technology

Sandia National Laboratories

UC San Diego

UNIVERSITY OF ILLINOIS  
URBANA-CHAMPAIGN

WISCONSIN  
UNIVERSITY OF WISCONSIN-MADISON



# Research Required to Reach Potential

- Versatile and complex emerging technology
- Opportunity to assist diverse people with disabilities
- Broad spectrum of research needed
- What happens in 10 years depends on today

