



Center for Occupational Robotics Research: Intramural Research

Jacob L Carr, PhD

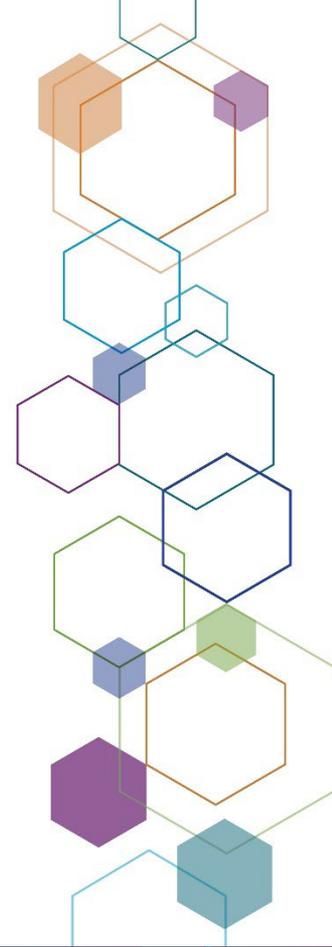
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Outline

- Occupational robotics trends and implications for worker safety and health
- Center for Occupational Robotics Research
- Research
- Partnerships
- Discussion Questions

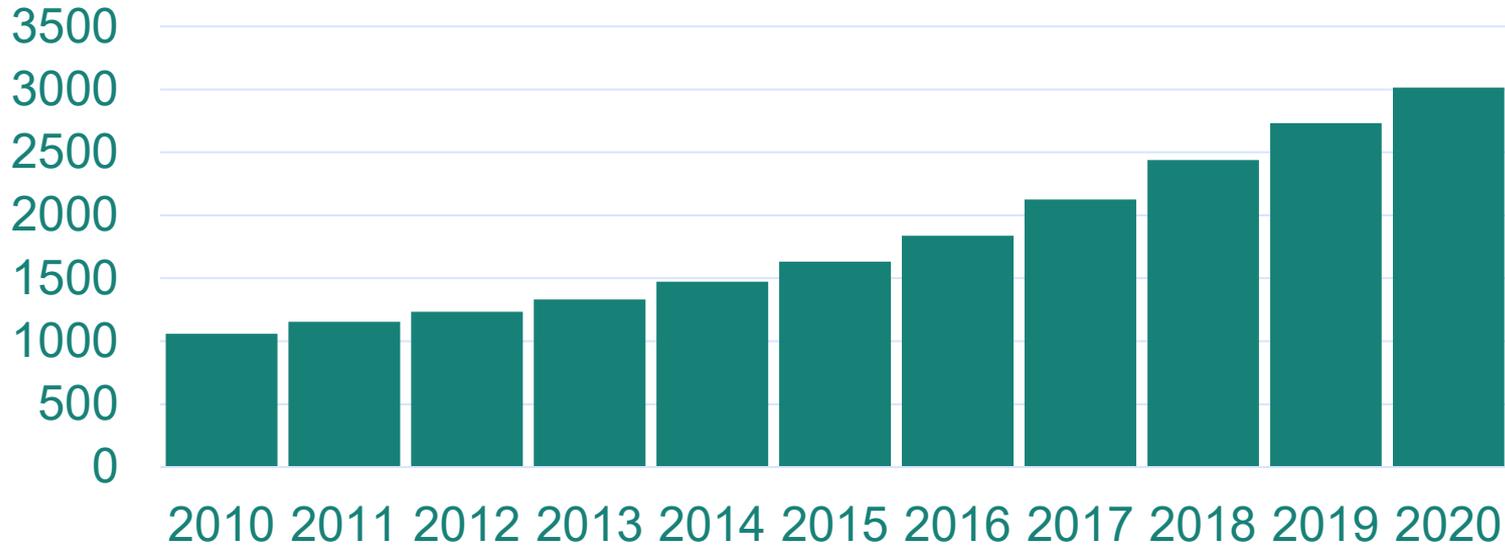




Occupational robotics trends and implications for worker safety and health

Operational Stock of Industrial Robots Worldwide

('000s of Units)



Data source: International Federation of Robotics [2021]. World Robotics Industrial Robots 2021.

Annual Installations of Industrial Robots Worldwide

('000s of Units)



Data source: International Federation of Robotics [2021]. World Robotics Industrial Robots 2021.

Traditional robots have been widely used for decades

- Fixed in place or caged to keep the robots away from humans
- Widely used for welding, painting, assembling, testing, and many other applications

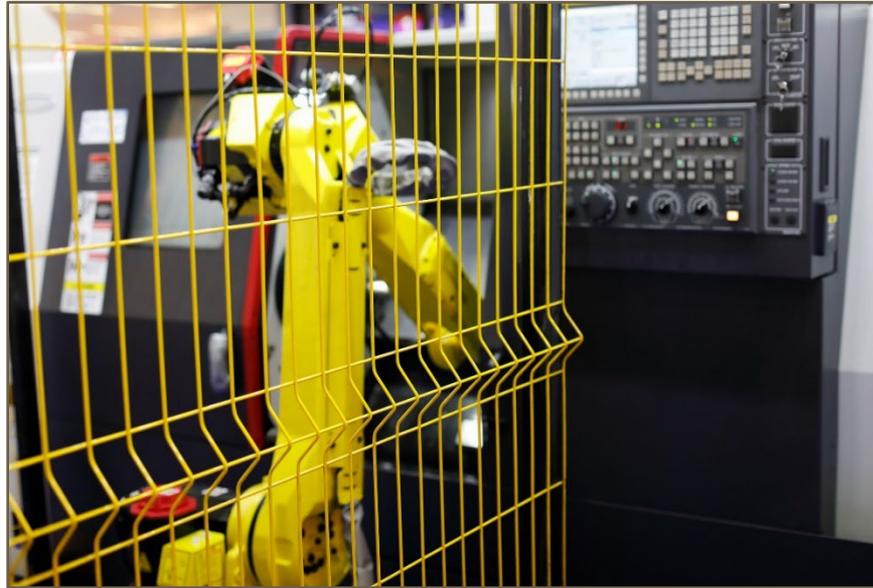
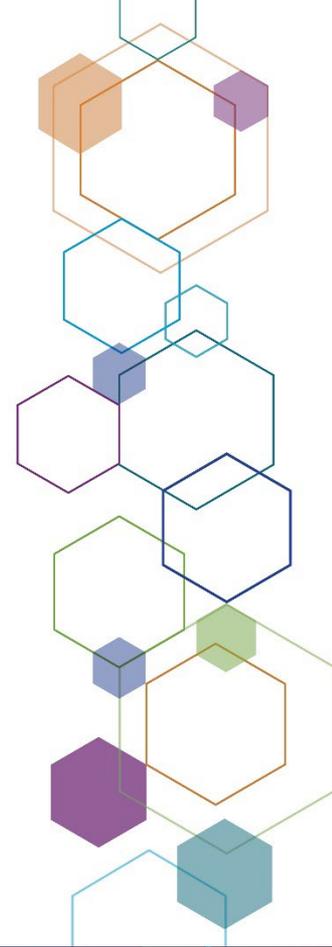


Image by © Gennady Kurinov/Getty Images



Traditional robots have a good safety record

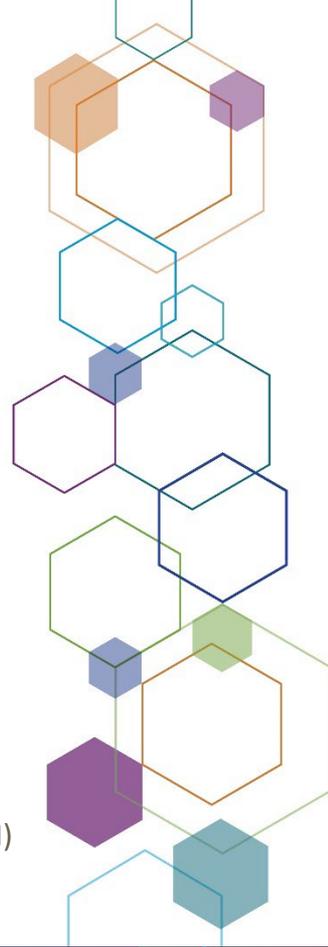


Image by © 2016 Thossaphol/Getty Images

- Estimated 61 robot-related deaths, 1992-2015, CFOI*
 - Identified using keywords
- < 1% of more than 190,000 workplace injury deaths during that timeframe**

*Unpublished analyses by NIOSH. Through a MOU with BLS, NIOSH received Census of Fatal Occupational Injury (CFOI) research files with restricted access requirements. Views expressed herein do not necessarily reflect the views of BLS.

** Data from publicly available CFOI data.

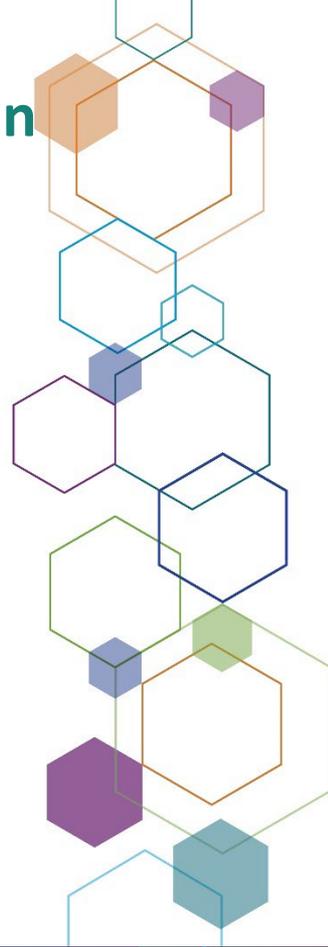


Collaborative robots are becoming increasingly common



Assembly of single sockets with child safety lock

Video source: <https://cobots.robotics.abb.com/en/robots/yumi/>



Collaborative and Traditional Industrial Robot Sales

('000s of Units)



Data source: International Federation of Robotics [2021]. World Robotics Industrial Robots 2021.

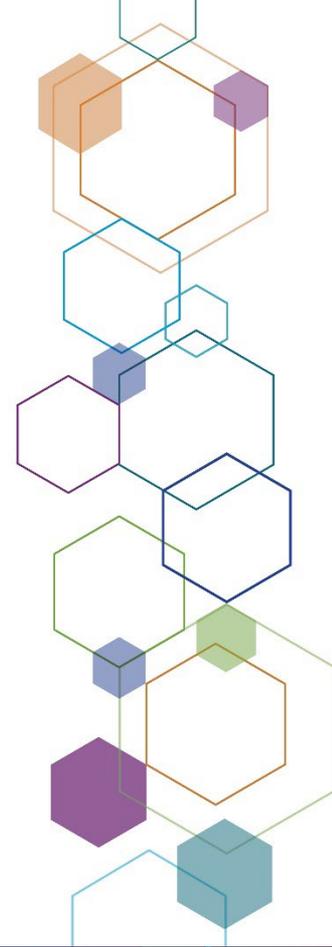
Robots are being worn by workers



Image source: NIOSH Science Blog:
blogs.cdc.gov/niosh-science-blog/2016/03/04/exoskeletons/



Image by © Gorodenkoff Productions OU/Getty Images



Robots are being used in spaces shared with humans



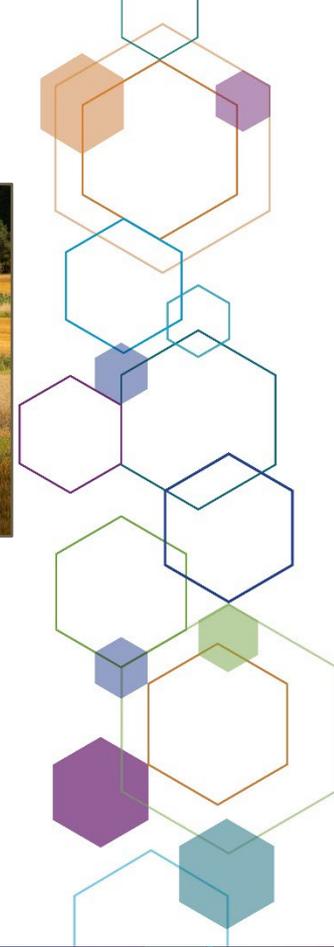
Image by © 2015 pixone/Getty Images



Image by © 2017 Evgeneiy& Karina Gerasimovi/ Getty Images



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Service Robots for Professional Use

Top 5 Applications: Unit Sales ('000s of Units)



Data source: International Federation of Robotics [2021]. World Robotics Industrial Robots 2021.

AI is making robots more intelligent

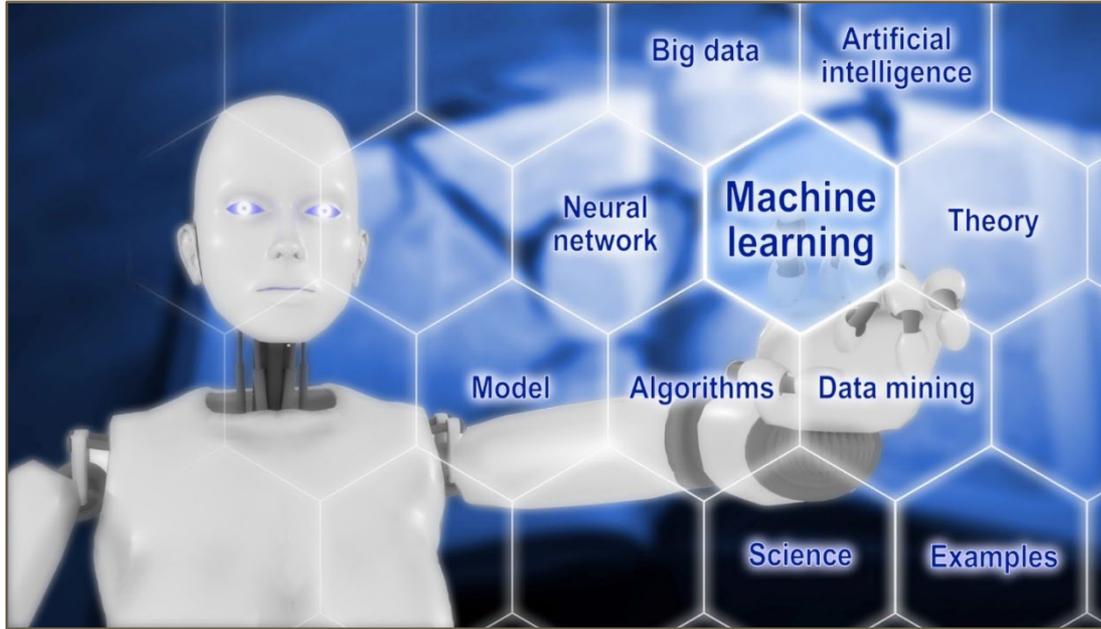
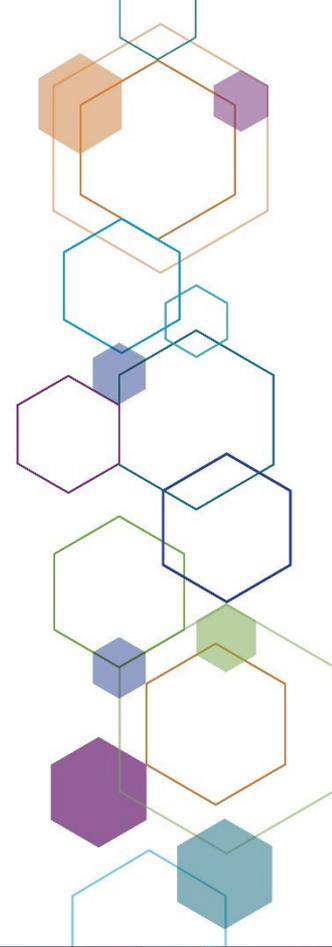


Image by © 2016 Michael Borgers/Getty Images



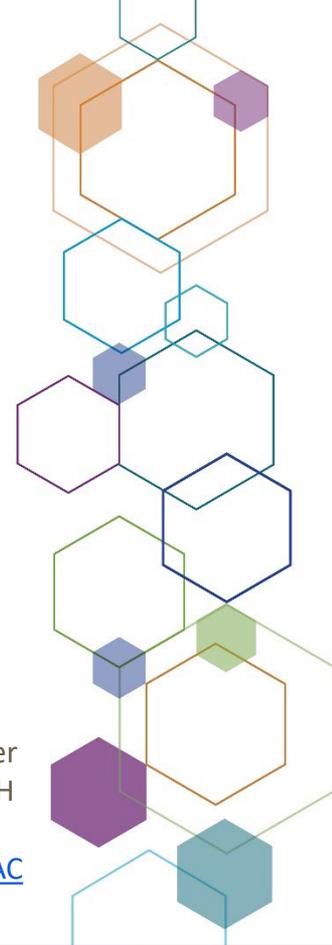
Case Study

Worker crushed by robotic forklift



Washington State Fatality Assessment and Control Evaluation (FACE) Program [2018]. Warehouse worker crushed by forks of laser guided vehicle. Supported in part by NIOSH cooperative agreement.

<http://www.lni.wa.gov/Safety/Research/FACE/Files/WorkerCrushedByLGVForks.pdf>



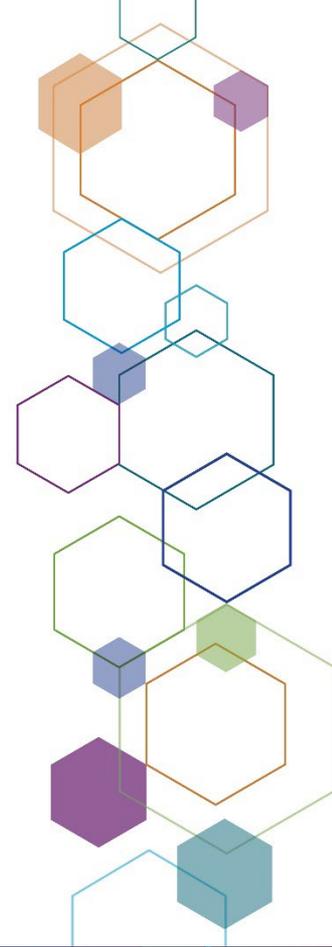
Case Study

Workers crushed by demolition robot



Washington State Fatality Assessment and Control Evaluation (FACE) Program [2019]. Workers Severely Injured Using Demolition Robots. Supported in part by NIOSH cooperative agreement.

<https://lni.wa.gov/safety-health/safety-research/files/2019/DemolitionRobotAlert.pdf>



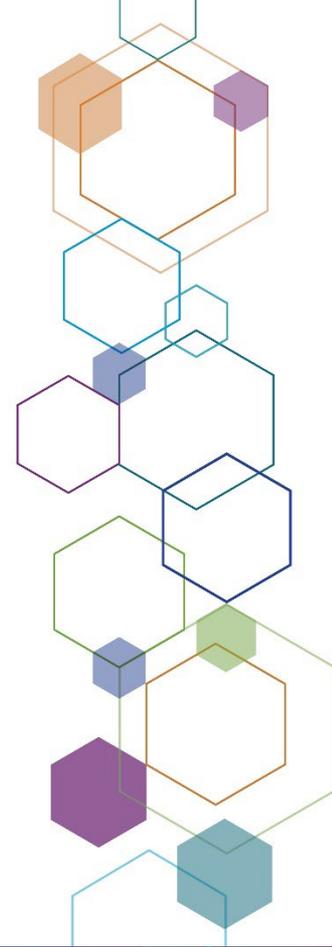
Emerging robotic technologies present potential to prevent injury as well as concerns for new hazards

Potential

- Reduced human exposure
- Augmented human capabilities

Concerns

- Increased interaction between humans and robots
- Rapid advances may outpace standards and regulations
- Psychosocial impacts of a changing workplace



Emerging robotic technologies present potential to prevent injury as well as concerns for new hazards

Examples of potential to reduce exposure to hazards

Welding

Traditional robots

Search and rescue

Mobile robots

Heavy lifting
Repetitive motions

Exoskeletons

Inspections

Drones

Examples of potential to introduce hazards

Maintenance injuries

Unintended contact with workers
Ignition of explosive atmospheres

Unintended loading on body
Impacts on balance

Distraction for workers in area

Center for Occupational Robotics Research



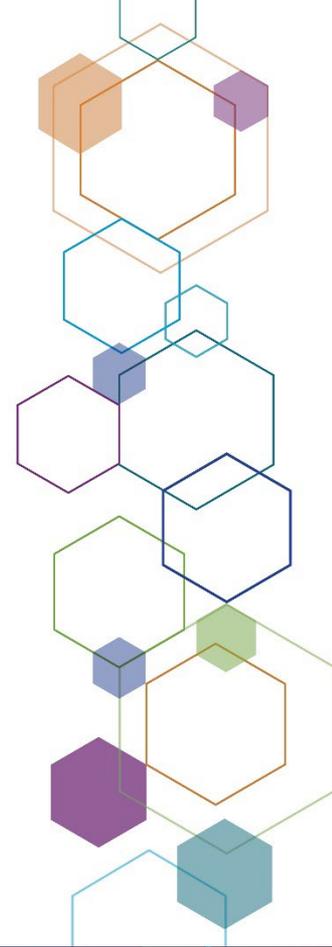
Center for Occupational Robotics Research (CORR)

- NIOSH virtual center established in September 2017
- Includes researchers from divisions and branches throughout NIOSH with a wide range of expertise
- Encompassed within the NIOSH *Future of Work* Initiative, which was launched in 2019

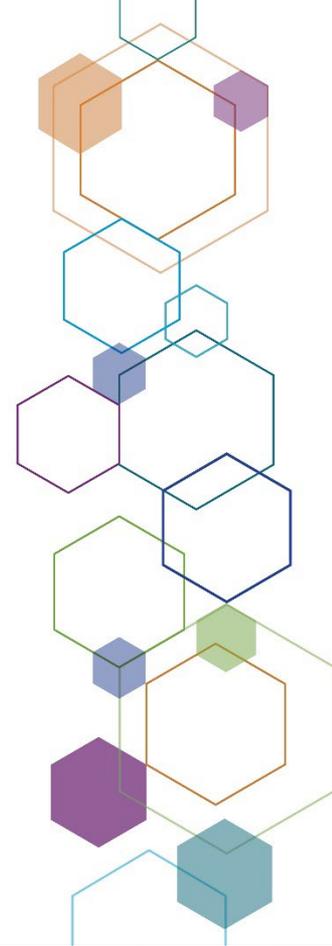


CORR Mission

Provide scientific leadership to guide the development and use of occupational robots that enhance worker safety, health, and wellbeing.

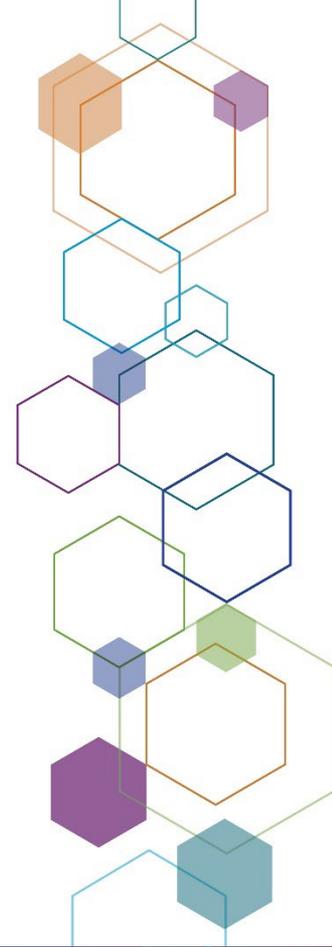


CORR Laboratories



Scope of CORR Research

- Traditional industrial robots
- Emerging robotic technologies, such as:
 - Collaborative robots
 - Co-existing or mobile robots
 - Wearable robotics or powered exoskeletons
 - Remotely controlled or autonomous vehicles and drones
 - Robots that increasingly use advanced artificial intelligence





CORR Research

Research Focus Areas

- Identifying opportunities to better protect worker safety and health using robotics
- Increasing understanding of human and robot interactions to ensure human worker safety
- Improving the ability to identify and track injuries and fatalities involving robotics
- Providing guidance on working safely with robotics

Surveillance

Basic/
Etiologic
Research

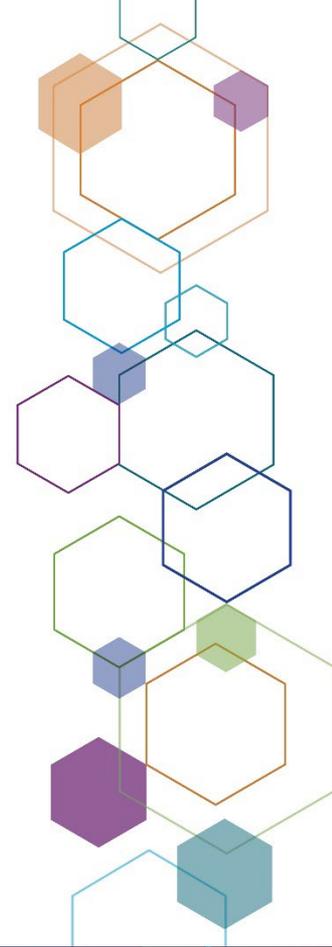
Occupational
robotics
research needs

Intervention
Research

Research
Translation

Examples of Intramural Robotics Research

**Drone Use in
Construction and
Their Effects on
Workers at Heights**



Examples of Intramural Robotics Research



Identification of Hazards and Risk Factors for Demolition Robot Operators

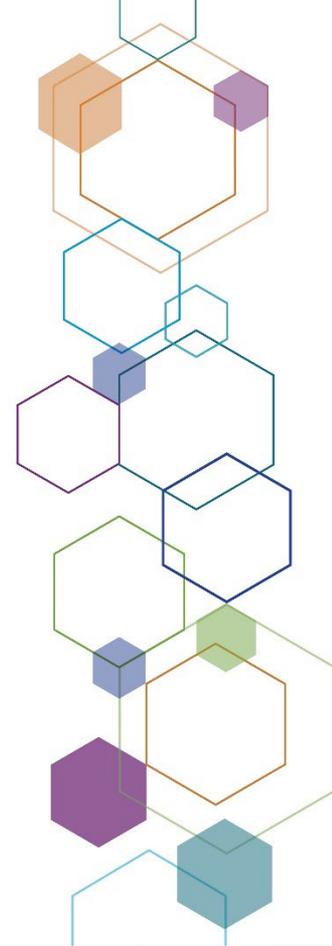
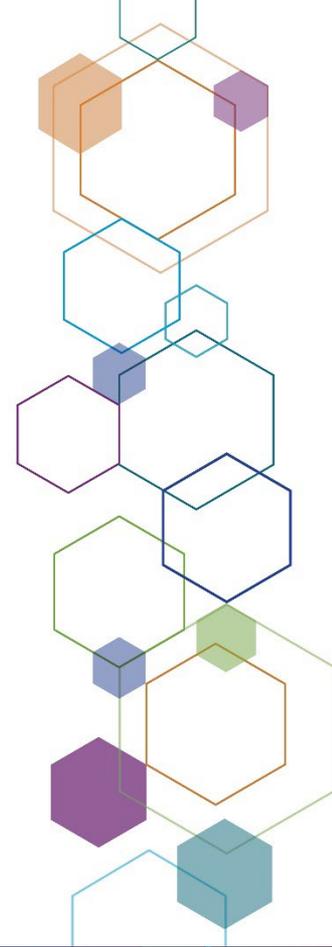


Image source: Washington State FACE Program [2019]. *Workers Severely Injured Using Demolition Robots*. <https://www.ini.wa.gov/safety/health/safety-research/files/2019/DemolitionRobotAlert.pdf>

Examples of Intramural Robotics Research

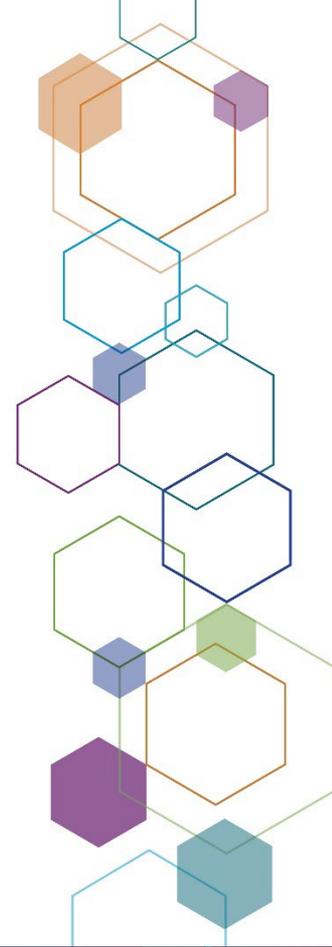
Improving Safety of Human Robot Interaction



Examples of Intramural Robotics Research

Robot-related Interventions: Measuring the Success of an Insurer- supported Grant Program

- Ohio Workers' Compensation program
- 63 case studies of advanced programmable manufacturing automation (includes 17 industrial robot interventions)

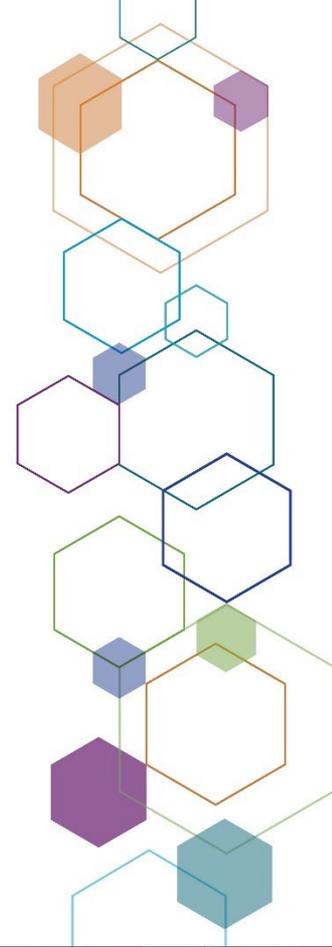




Partnerships

Partnerships are critical to the success of CORR

- Helps ensure relevance of research
- Establishes collaborative research opportunities
- Provides access to field study locations
- Builds pathway to put research into practice





October 5, 2017 signing ceremony for the OSHA, NIOSH, A3 (formerly RIA) Alliance





Image source: arminstitute.org

Research supported through the National Science Foundation (NSF) National Robotics Initiative (NRI):

- Customizable Lower-Limb Wearable Robot using Soft-Wearable Sensor to Assist Occupational Workers
- Transparent and Intuitive Teleoperation Interfaces for the Future Nursing Robots and Workers





ARM
ADVANCED ROBOTICS
FOR MANUFACTURING



ASSOCIATION FOR
ADVANCING AUTOMATION

alliance
An OSHA Cooperative Program



DARPA
SUBTERRANEAN
CHALLENGE

NC STATE
UNIVERSITY



WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON

UF | UNIVERSITY of
FLORIDA



Jet Propulsion Laboratory
California Institute of Technology

CORR Participation in Standards Development

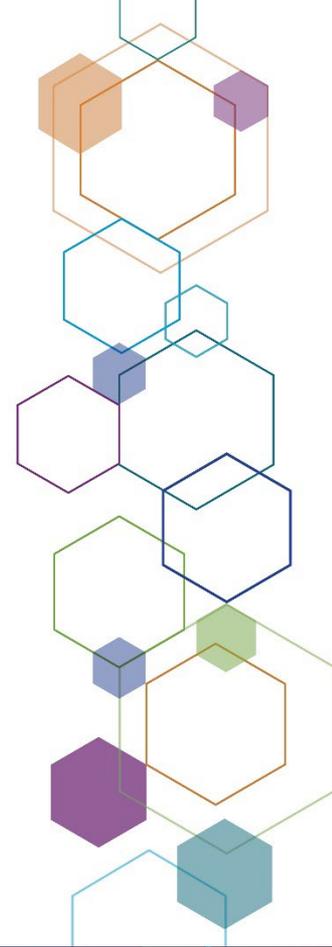
- ANSI/RIA R15.06 – Industrial Robots and Robot Systems Safety
- ANSI/RIA R15.08 – Industrial Mobile Robot Safety (NEW)
- ISO/TC 299– Robotics

Under development

- ASTM F48 – **Exoskeletons and Exosuits**

Pre-Standard

- ANSI **Unmanned Aircraft Systems** Standardization Collaborative Roadmap
- ANSI/ASSP/NSC Z15.3- Safety Management of **Partially and Fully Automated Vehicles** (*Technical report*)



For more information, visit our webpage

cdc.gov/niosh/topics/robotics



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The National Institute for Occupational Safety and Health (NIOSH)

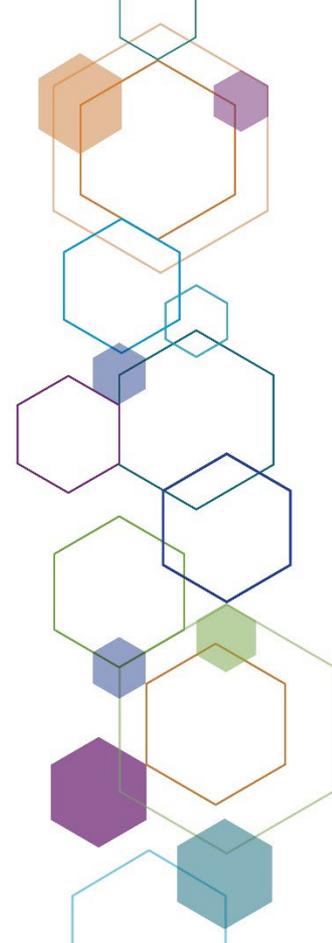
Workplace Safety & Health Topics



Promoting productive workplaces
through safety and health research



ROBOTICS

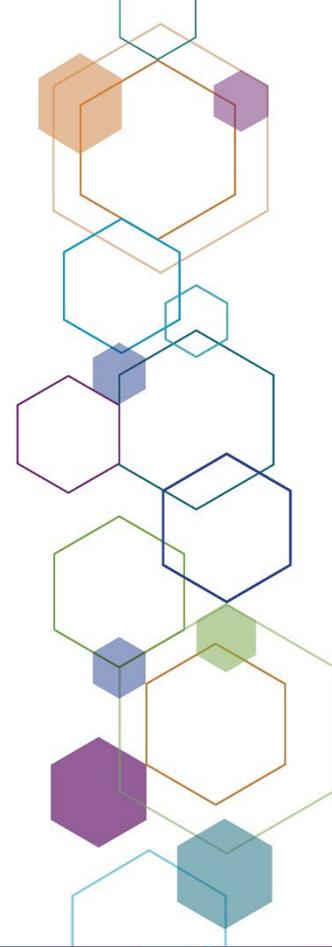




Discussion Questions

Discussion Questions

- What trends exist with new robotics technologies that NIOSH research should aim to address?
- What aspects of robotics in the workplace would it be useful to have health and safety guidance for?



Thank you for your interest and attention!

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www.cdc.gov/niosh/topics/robotics/

For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

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The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

