U.S. DEPARTMENT OF ENERGY | OFFICE OF ENVIRONMENTAL MANAGEMENT

EM Science of Safety: Robotics Technology Thrust

DOE National Cleanup Workshop
September 14 and 15, 2016

Science of Safety

Infusing and integrating scientific and technological advancements into the routines of work planning and execution in a manner that

1) improves safety and quality and
2) reduces the government's liability for cleanup

Robotic Technology Thrust

Working Safer and Smarter Using Robotic Tools

Robotic Technology Thrust

EM is actively promoting the use of advanced robotic technologies as a key mission-enabler

- Work SAFER
- Work SMARTER

EM Robotics: ALARA

- Handling of high-hazard, high-consequence materials and waste
  - Chemical
  - Biological
  - Radiological
  - Nuclear

- Gaining remote access/entry to high-risk areas/spaces
  - Presence (potential) of CBRN materials
  - Unsafe, unstable, or unknown conditions
  - Configurations are hard to reach or beyond reach

Robotics Use: Operations

- Assisting workers perform tasks that are
  - **D**irty (contaminated, toxic, nuisance)
  - **D**ull (routine, labor-intensive, repetitive, mundane)
  - **D**angerous (significant safety and health risks)
  - **D**ifficult (require engineered measures)

- Improving the safety, quality, efficiency, and productivity of facility operations

Robotics Use: 911

- Improving response and recovery from operational upsets, accidents, emergencies, and natural disasters

- Multi-Use and Multi-User Robots
  - Robotic technologies that can be used to support both normal operations and off-normal events
    - Physicist-to-Firefighter and Miner-to-Medic

Wearable Robotic Devices

Wearable, prosthetic-like, exoskeletal, bionic, and other attachable human assistive robotic devices that serve as

1) personal protective equipment (PPE) and/or
2) performance augmentation and amplification devices (PAADs)

Robotic PPE

Robotic PPE is intended to help protect workers from sustaining internal injuries due to forceful or over-exertion, fatigue, hyperextension, over-rotation, abrupt movements, repetitive motion or stress, repetitive or excessive vibration, awkward or prolonged postures, and possibly the latent effects of aging

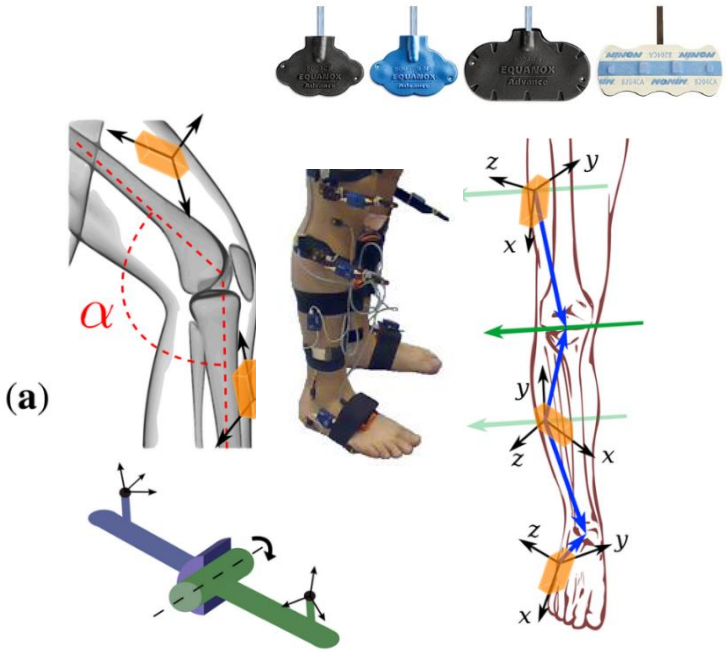


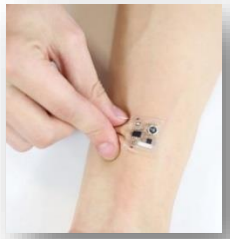


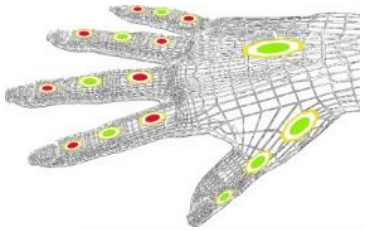


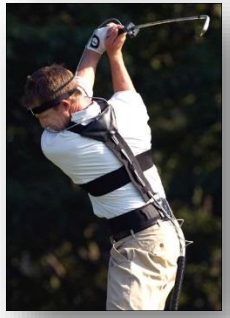

"Smart" Robotic PPE

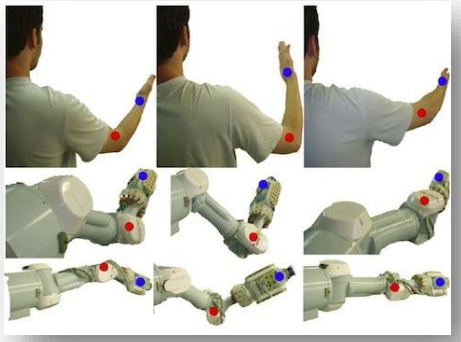
Integrating anatomical sensing devices, brain–computer interface devices, and biomechanical sensors to create "smart" robotic PPE











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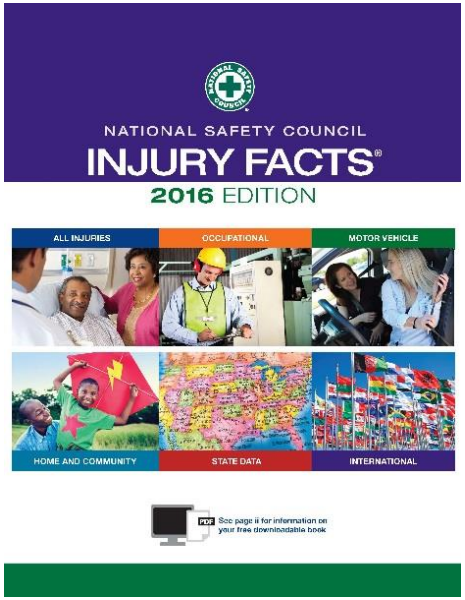
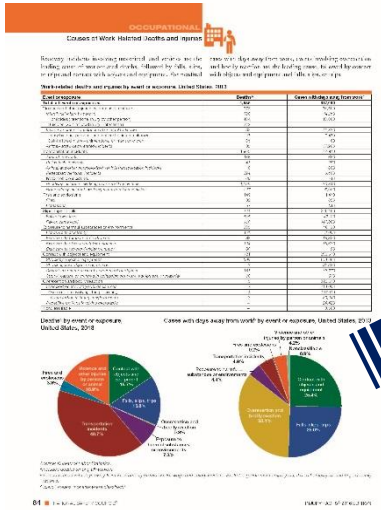
Preventing Internal Injuries

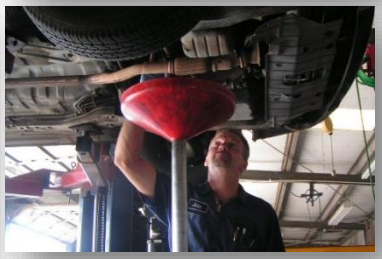


Cases with days away from work by event or exposure. *United States, 2013*



Performance-Enhancing Devices

Robotic performance augmentation and amplification devices are intended to enable workers to more easily perform tasks that are physically stressful or demanding, mentally taxing, ergonomically challenging, or even beyond human capability

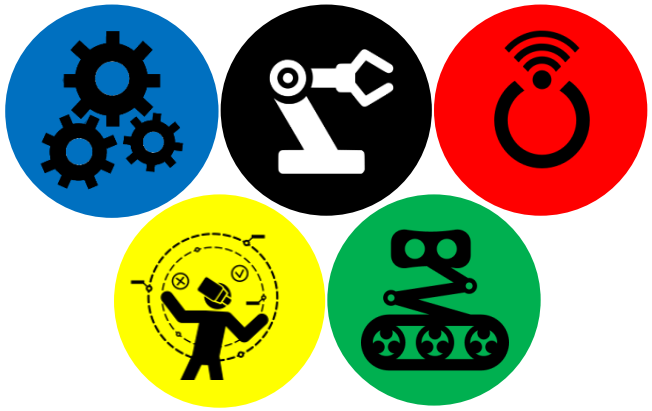


Robotic Technologies Test Bed

Portsmouth Gaseous Diffusion Plant Deactivation and Decommissioning Project

"The Challenge"

- Catalyze the Science of Safety initiative
  - Demonstrate relevancy and utility of robotic technologies
- Key Features
  - Enhance worker safety
  - Improve worker performance
  - Conduct demonstrations in the field
  - Have workers operate robotic devices
  - Gain worker feedback
  - Complete by summer's end



Robotic Technologies Test Bed

- Portsmouth Gaseous Diffusion Plant, Piketon, Ohio
  - EM's next major decommissioning project
- Flour-BWXT | Portsmouth
  - Decommissioning contractor
- United Steelworkers
  - Local 689 (Portsmouth GDP)
  - Local 550 (Paducah GDP)

PREPARING THE FUTURE
PORTS
D&D PROJECT

Collaborators

UNITED STEELWORKERS USW

APL The Johns Hopkins University APPLIED PHYSICS LABORATORY

Fluor-BWXT | Portsmouth

TEXAS A&M UNIVERSITY

Sandia National Laboratories

Open Source Robotics Foundation

OSWEGO STATE UNIVERSITY OF NEW YORK

Exelon Generation

SRNL SAVANNAH RIVER NATIONAL LABORATORY

PURDUE UNIVERSITY

Carnegie Mellon University The Robotics Institute

NASA NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SwRI SOUTHWEST RESEARCH INSTITUTE

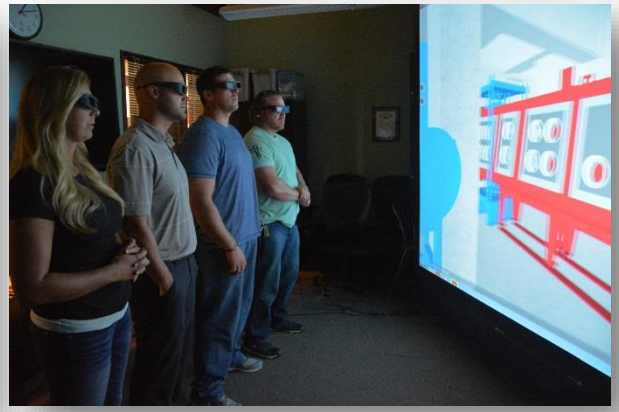
TEXAS The University of Texas at Austin

By the numbers…

- 4-day period
- 24 robotic technologies
- Operated by about 30 USW/FBP workers
- 11 expert roboticists and technologists
  - 2 DOE national labs
  - 2 other federal labs
  - 2 not-for-profits
  - 5 universities
- 9 technologies: near-ready for deployment
- 2 roboticists: began design changes

Highlight Video

Hands-on, on-site demos



Closing Remarks

Perspectives and Takeaways

Next-Generation PPE

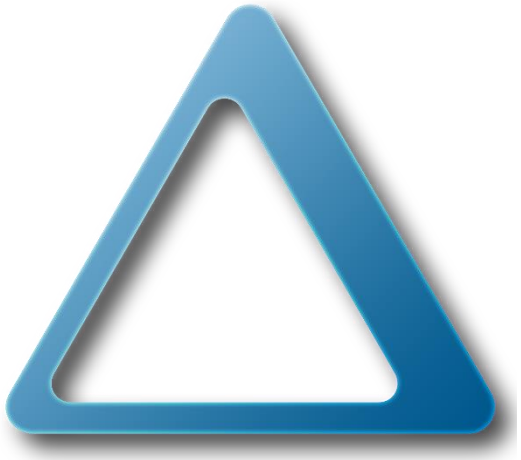
Smart robotic PPE will become as common as hard hats, safety glasses, ear plugs, high-visibility vests, filtered masks, steel-toed shoes, and gloves.

New Tools of the Trade

Robotic technologies will become a common tool in the workers' toolbox.

Human-in-the-Loop

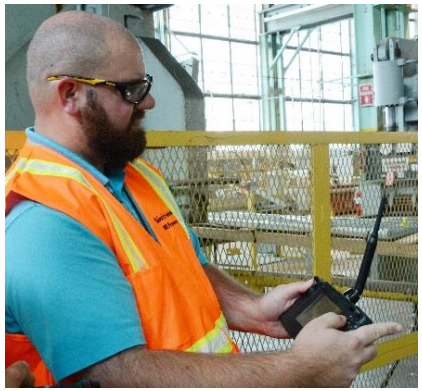
- Worker must be in the loop
- Work place was designed and built for humans
- Work environment is complex and varies
- Work and work conditions are dynamic
- CBRN hazards vary and change
- Technological challenges
  - Sensor technology
  - End-effectors
  - Artificial intelligence



Push Forward

- Establish a robotic technology ecosystem
  - Research and technology development
  - Training, qualification
  - Fitness for service
  - Maintenance, repair, field modifications
  - Good practices, consensus standards, regulations
  - Supply chain
- Plan for the future workforce
  - Apprenticeships
  - STEM pipeline

Maintain Momentum





Safety of Science Coalition





Thanks

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