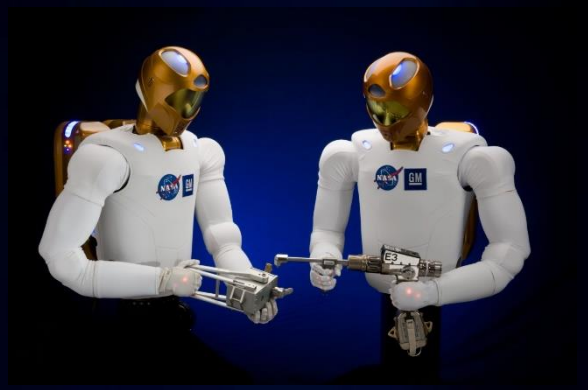
NASA Robotics

And Solutions for Nuclear Cleanup Applications



Dr. Rob Ambrose

NASA JSC Engineering

Overall Themes

Common Needs for NASA and Nuclear Cleanup Robotics

- Radiation tolerant systems
- Dirty environments
- Dangerous tasks
- Handling high consequence materials
- Wearable robotics
- Remote operations

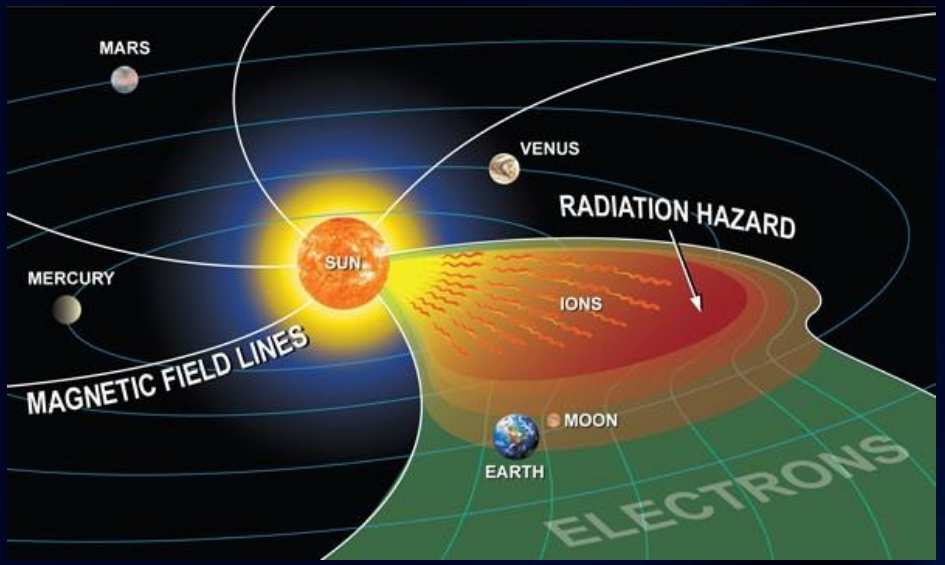
Other Observations on Cleanup Applications

Radiation Tolerant Robotics

NASA and DOE are rare in dealing with radiation

Both have key needs

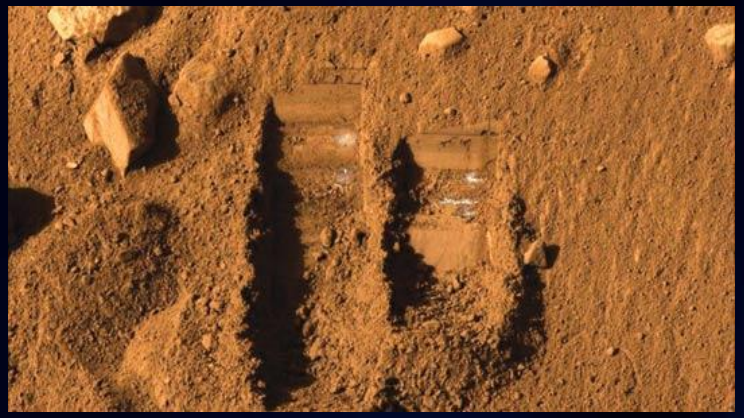
- Avionics challenges
- Material degradation
- Clean up after work



Both challenge human health

Dirty Environments

NASA and DOE-EM need outdoor (field) robotics



Operating in dirt

- Mechanisms challenges
- Material degradation
- Clean up after work
- Handling dirt

Both challenge human health

Dangerous Tasks

Dangerous Chemicals

Dangerous Radiation

Dangerous Sharps

Distance to Safety

Airlocks, Tunnels, Suits
Extraction Difficulties
Transport to Medical Treatment

Handling High Consequence Materials

Dangerous Materials

Expensive Objects

One-of-a-Kind Samples

Avoiding Inadvertent Drops

- Explosions
- Contaminations
- Cleanup Costs

Wearable Robotics

Improve Safety

Extend Careers

Level Playing Field

Embraced by Workers

This is unusual in my history
Aging workforce
Medical/legal costs

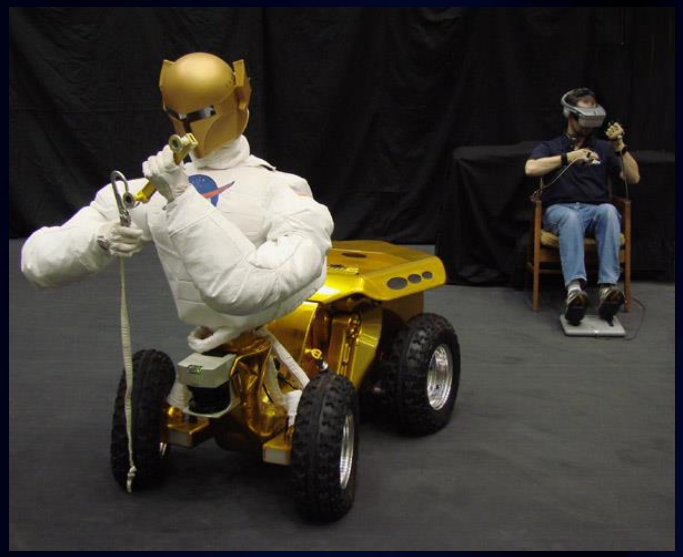
Remote Operations

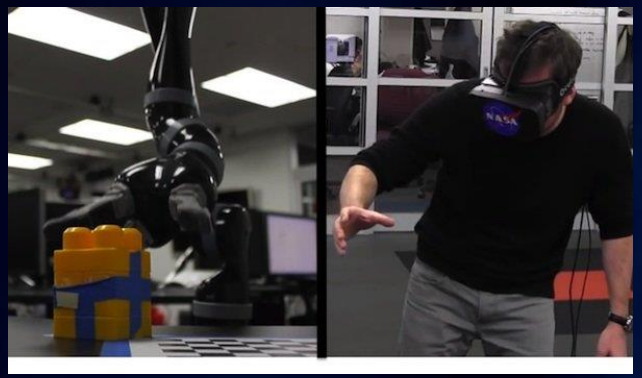
Communications Challenges

- Distance
- Noise
- Denied Areas

Employ Human Judgement

- Provide Data
- Context
- Decision Making Options





DOE-EM Robotics Applications

DOE-EM Study Team Site Visits

WIPP

- Tunnel mobility, inspection, monitoring, logistics
- Manipulation with long reach, pallet handling

Idaho Falls

- Dry material handling, “silo” access, barrel processing
- Liquid handling, monitoring, processing

Savannah River

- Canyon operations, inspection, and D&D
- Tunnel access, glove box operations, manipulation

Hanford (so, so many….)

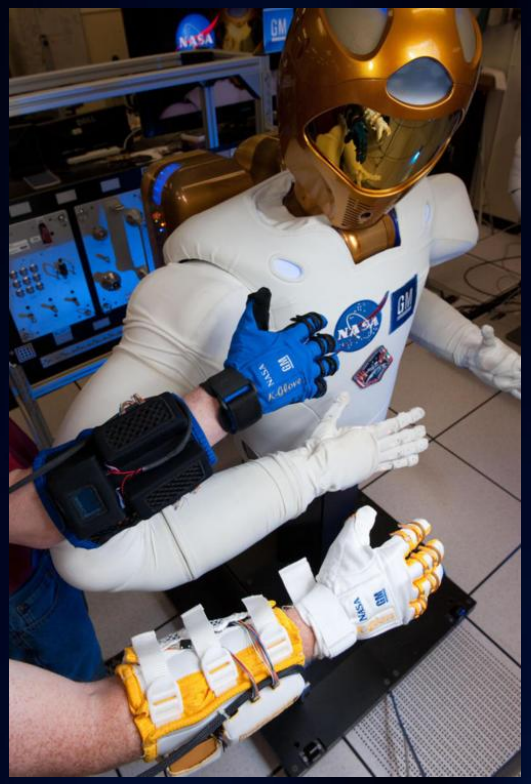
- Underground tank inspection, material handling, D&D
- PUREX tunnel inspection, access, D&D, emergency response
- Canyon operations, inspection, servicing, life cycle planning

Case Study: Human-Robot Teams

- NASA GM Partnership
  - Safe robot for working with people
  - Focused on jobs that hurt workers
- Robonaut 2 Development
  - What if you could work next to a robot, safely
  - Developed multiple Robonaut 2's
- Applications to Cleanup
  - Glovebox manipulation
  - Assembly, decommissioning, contingency tasks

Case Study: Robotic Gloves

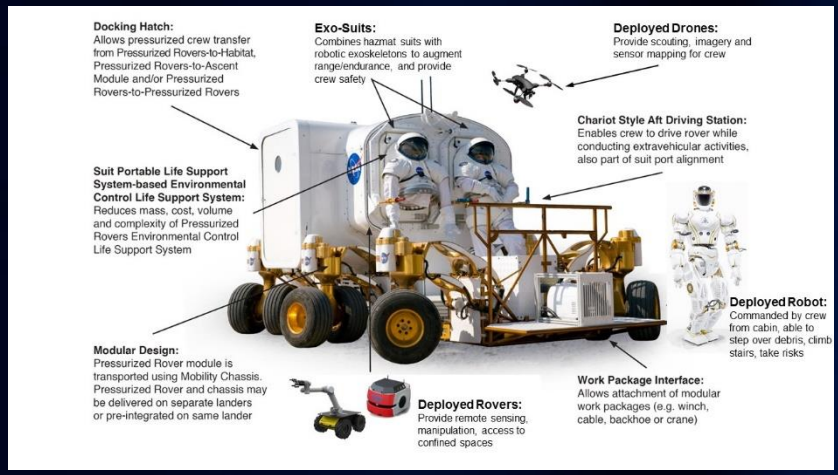
- NASA GM Partnership
  - Safe robot for working with people
  - Focused on jobs that hurt workers
- Glove Spin Off
  - What if you could wear the robot hand?
  - Developed the Robo Glove
- Partnered with DOE
  - How would DOE workers use a glove?
  - Now working other applications.



Case Study: Robotic Off Road Vehicle

- NASA Lunar Rover
  - Pressurized Cabin
  - Radiation Shielded
  - 2 Crew for 2 Weeks
  - 200 Km Range
  - Can carry robots on outside
  - Humans egress thru suit ports

- 2nd Generation in Design
  - Able to operate in contamination
  - Looking for partnerships

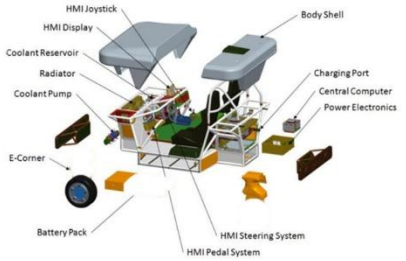


https://www.youtube.com/watch?v=xSVupWflmG4

Case Study: Small, Agile Vehicle

- Modular Robotic Vehicle
  - Separate Wheel Modules
    - Steering
    - Suspension
    - Drive
  - Drive-by-wire Cockpit
  - All electric design
  - Intrenisic safety by design
- Cleanup Applications
  - Maneuverable inside tunnels, buildings
  - Able to carry manipulators, forklifts
  - Manned and unmanned operations

- Design speed: 64 kph (40 mph)
  - Currently computer limited to 25kph (15mph)
- Curb weight: 900 kg (2000 lb)
- Footprint: 2.15 x 1.55m (7' x 5')
- Drive-by-wire without mechanical backup



Thank You

robert.o.ambrose@nasa.gov