Enabling Space Exploration: Humans & Robots-Hand in Grip

Prof. G. Scott Hubbard
Stanford Univ.
Space Exploration: People or robots?

This is a false dichotomy

The ratio of robots to humans will change

At some point the human being will become the dominant tool for exploring Mars
Human/Robot Comparison

It takes the MER rover a day to do what a field geologist can do in about 45 seconds. -- Steve Squyres MER 2003 PI

The Opportunity rover has driven 40km in 11 years. It cannot collect rocks.

Apollo 17 comparison

Drove 36 km in 20 hours of EVA (less time driving)
Collected 110 kgs of rocks from 30 sites
Why Human Scientists on Mars?

To discover and experience

Robotic Missions:
Provide the basic data: topography, geology, meteorology

Lay the groundwork: the salty sea has been demonstrated

Narrow the field

Fixed-not opportunistic

Cannot assign or assess meaning

Humans will take exploration the next steps:
Make sense of the complex

Make decisions

Choose the right spots

Perform the right tests

Interpret results on the spot and able to follow through opportunistically
Where we’re headed

International Space Station Remote Manipulator System from Canada

Humans augmented by robots

Robots augmented by humans

Partnerships

A Mars Exploration Rover

Human/robot interaction studies in Mars analog environments
Challenges

• Will machines become more like humans?
• Will humans become more like machines?

Computer Science is enhancing machine capability to function in novel, unstructured, complex environments.

Machines are augmenting human abilities.
Future Visionary Partnerships