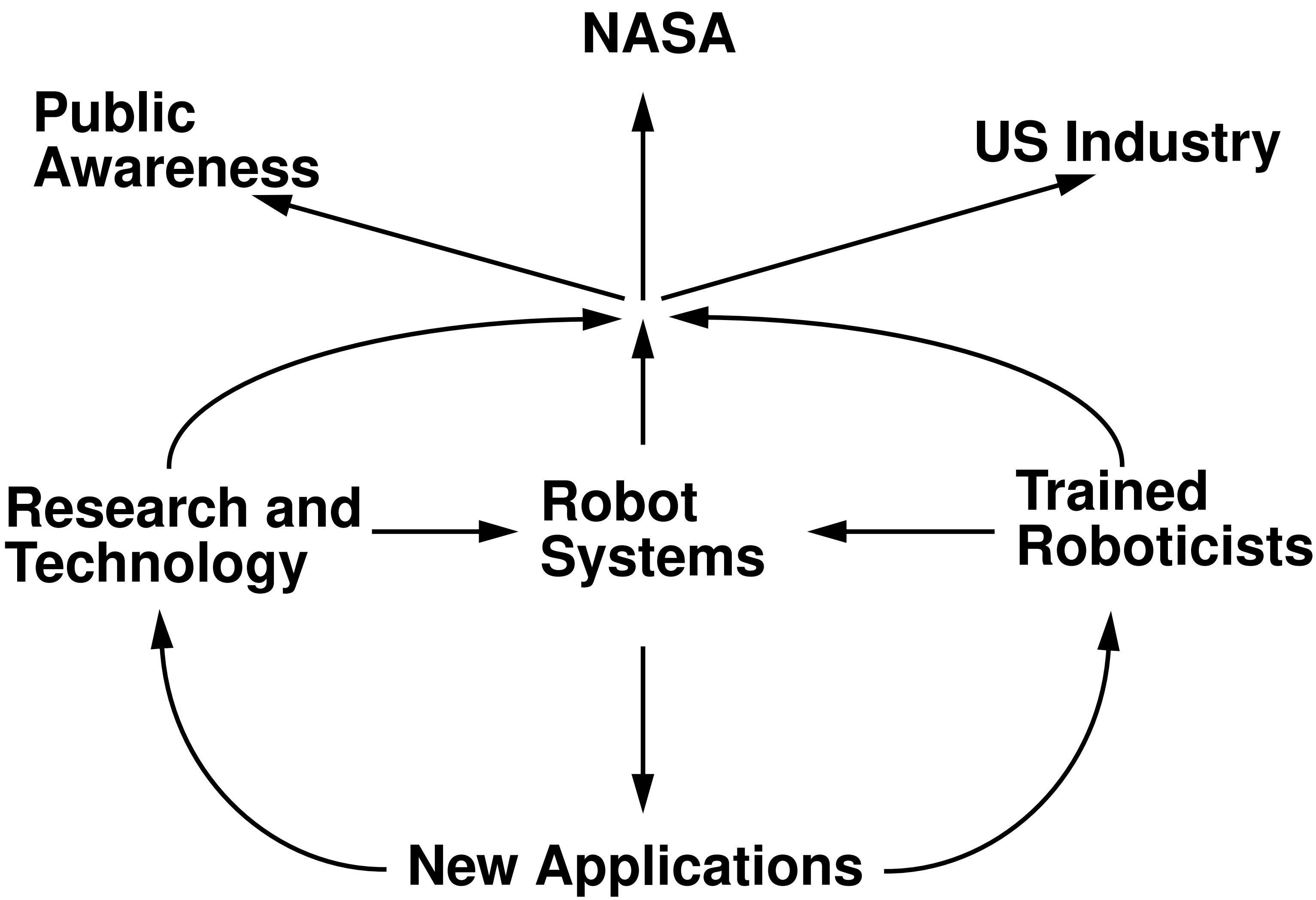
The Robotics Institute
Carnegie Mellon University

Role in Robotics and Space



Perceived Role

Educational Focus:
- Robotics Ph.D. Program
- Departmental Collaboration (MechE, EE, CS, Art, ...)
- Undergraduate Robotics

RI Research:
- Create Fundamental Technology
- Develop Operational Robots
- Catalyze Robotics Industry

NASA Focus
- Lunar Robotics
- Commercialization

Fulfilling NASA's Long Term Needs

- Planetary Robotics
- Autonomous Systems
- Robotics Commercialization
- Robotics Leaders

Program Size and Diversity

RI: $22M Annual Funding (230 people, 45 Faculty, 85 Ph.D.)

NASA Supported: $2.0M

- **Telerobotics Grants:**

  Lunar Robotics Technology, Lunar Rover Demonstration, Integrated Robot Architecture, Range from Defocus, Lunar Telescope, Augmented Reality, Haptic Perception

- **Commercialization Grants:**

  Robotics Engineering Consortium Initiation, Automated Harvesting

- **New Millennium Grants:**

  Autonomous Systems, Fast Prototyping

- **Others:**

  Graduate Fellowships

  NASA Research Fellow

Program Scope

Thrust Areas with National/Worldwide Leadership

- Computer Vision - Sensors, Processing, Image Understanding
- Navigation - Mapping, Driving, Exploration
- Machine Intelligence - Planning, Learning, Knowledge Methods
- Field Robotics - Configuration, Perception, Operational Control
- Robotics Commercialization - Mining, Excavation, Nuclear, Agriculture, Scanners, ATM
- Robotics Graduate Education - Curriculum and Research in Perception, Cognition, Manipulation, Mobile Robots

Concepts and Approaches Developed

Direct Drive Manipulation

Visual Servoing

Interest Operators

Evidence Grids

Omni-directional Locomotion

Task Control Architecture

Unmanned Road Following

Position-Based Ground Navigation

Navigation Planning

Ranger, Morphin, Safeguarded Driving

Autonomous Walking

Circulating Gait

Concepts and Approaches (2)

Autonomous Gait Planning

Spherical Range Sensing

Panospheric Visualization

Corridor Mapping and Navigation

Mobile Subsurface Mapping

Mobile Nuclear Work Systems

Automated Excavation

Integrated Lander-Rover

Long Distance Lunar Excursion

Speech Understanding

Machine Translation

Computation Sensors

Concepts and Approaches (3)

Light Stripe Range Sensing

Self Mobile Space Manipulator

Laser Terrain Modeling

Image Registration

Case Based Reasoning

Opportunistic Scheduling

Intelligent Bending Wearable Computers

VuMan

Field Servicing

Modular Robotics

Stereo Machine

Face Recognition

Technology Transfer

Persistent programs in thrust areas develop deep expertise, critical mass, component technologies

Archetype robots increment component technologies, evolve systemics, manifest meta capabilities, symbolize possibility, necessitate invention

Products and operations mature components, create needs, create money, fulfill enterprise

Products from NASA Programs (1996)

Robot Harvesting

RoboCrop Following

Desert Rover

Panospheric Camera

Transformer Steer/Deploy

Skyline Position Estimation

Region-based Navigation Planning

Robotics Engineering Consortium Facility

David Wettergreen, Ph.D.

Long Term Objectives

LunaQuest Mission and Follow-ons

Lunar Work Machines

Human Lunar Return Precursors and Support

Lunar Interferometric Telescope

Lunar Circumnavigation

Terrestrial Work Systems

Continental Traverse (Antarctica?)