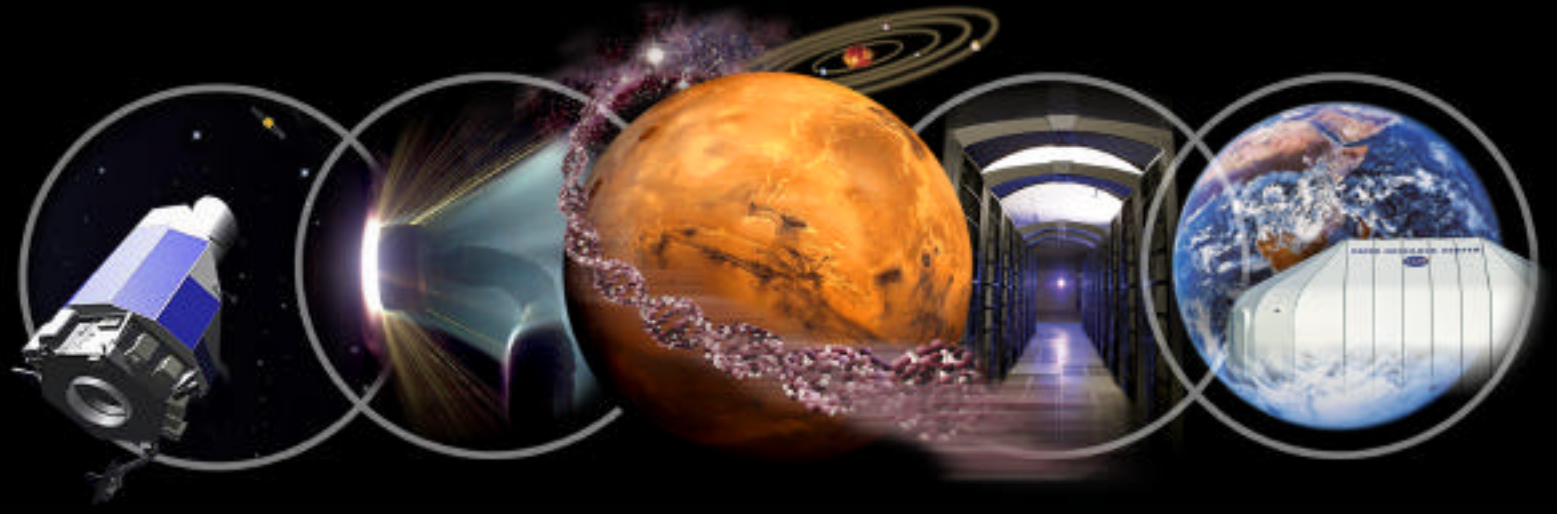
Discovery ➲ Innovation ➲ Solutions



Human Factors Research & Technology for Exploration

Dr. Patricia M. Jones, Division Chief (Acting)

Human Factors Research and Technology Division

Ames Exploration System Technology Partnerships Forum

July 22-23, 2004

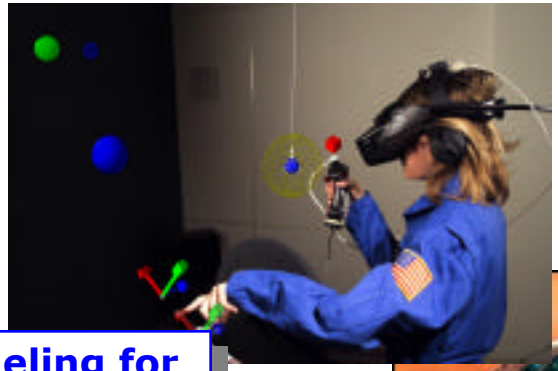
Visibility ➲ Excellence ➲ Impact

Ames Research Center

Ames: A Science and Technology Center for Exploration

1. Space & Aero Human Factors

- Fatigue, Workload
- Automation, Training
- Air-Ground collaboration
- Crew decision-making
- Risk perception
- Cockpit Displays



2. Computational Modeling for Design

- Sensory, motor, cognitive
- Human-machine interaction
- Team / collaboration
- Design tools

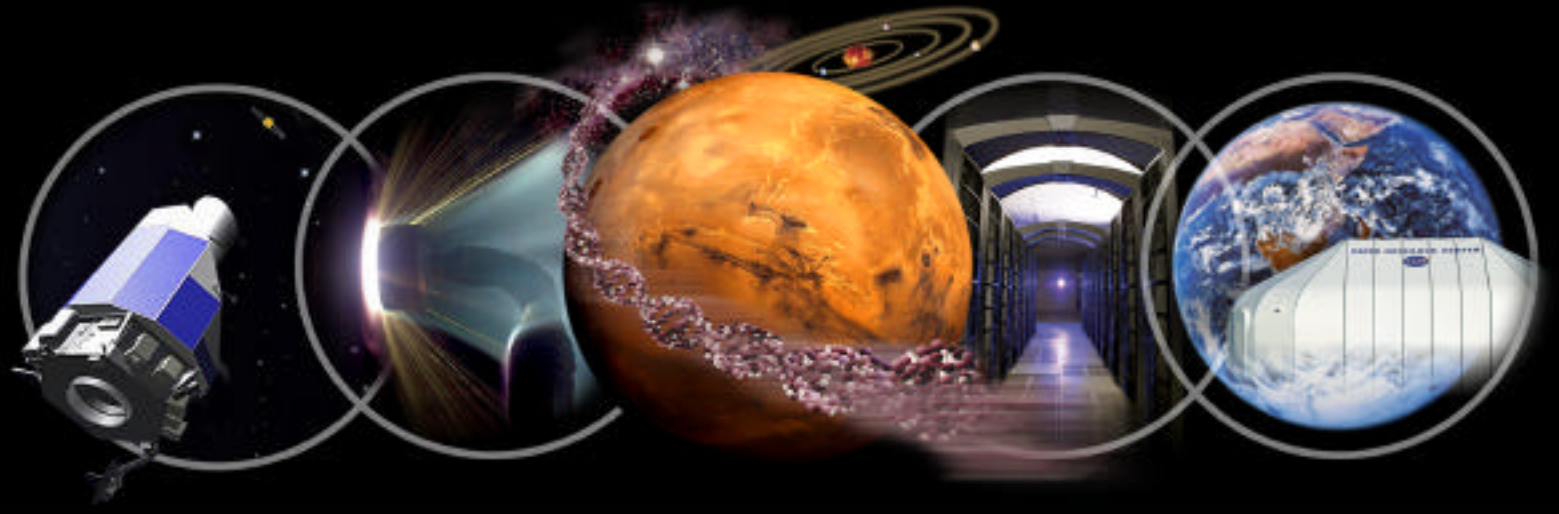
3. Multi-modal Integration

- Advanced displays
- Virtual reality systems

4. IT Decision Support Tools

- System monitoring & evaluation
- Data mining & visualization

Discovery ➲ Innovation ➲ Solutions



Human Factors for Autonomous Systems and Robotics

Drs. Mary Kaiser and Alonso Vera
Human Factors Research and Technology Division

Ames Exploration System Technology Partnerships Forum
July 22-23, 2004

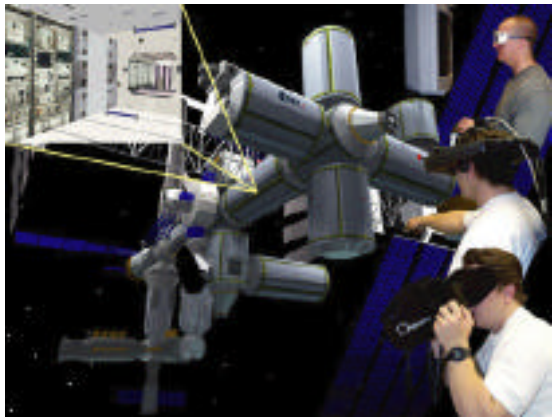
Visibility ➲ Excellence ➲ Impact

NASA

Ames Research Center

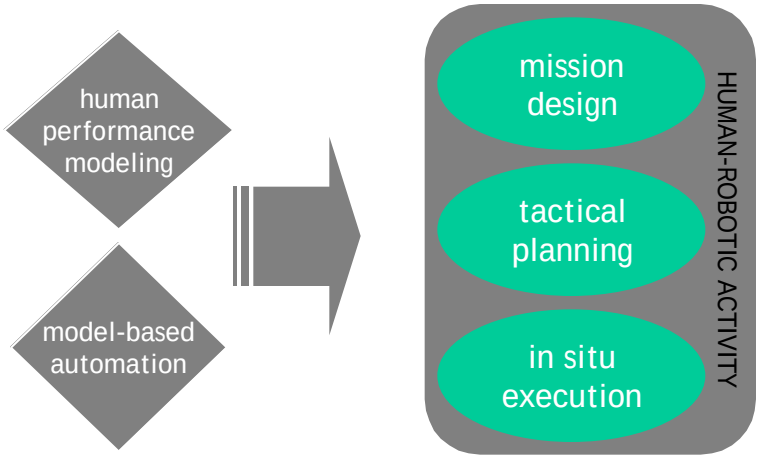
Human-Centered Interfaces for Teleoperations

Humans will team with remote robotic partners in a variety of control regimes, each with unique interface requirements, including:

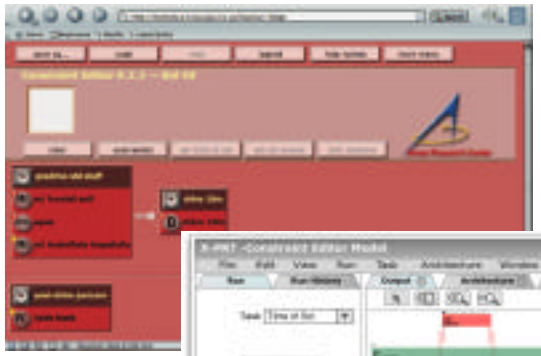


- Direct, inner-loop control
  - Multi-modal interface (integrated visual, tactile, and auditory displays)
  - Compensate for divergent gravitational-inertial environments of operator and robot and transmission delays
- Supervisory control of coordinated robot squads
  - Provide situational awareness of current and future status
  - Support graceful transition of control mode

High Resolution Human Performance Modeling for Human-Robotic Teaming

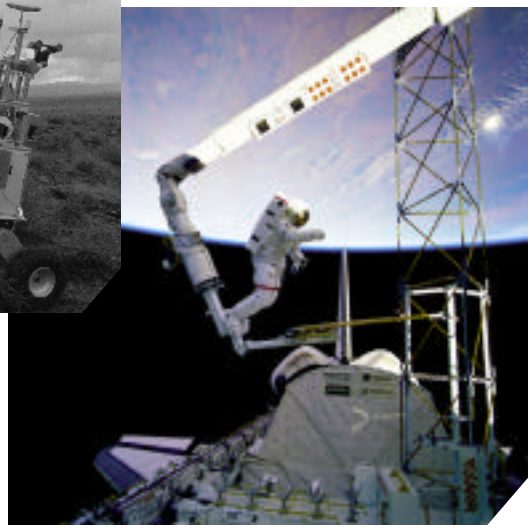


Modeling human performance for safe, reliable, and efficient human-robotic team activity

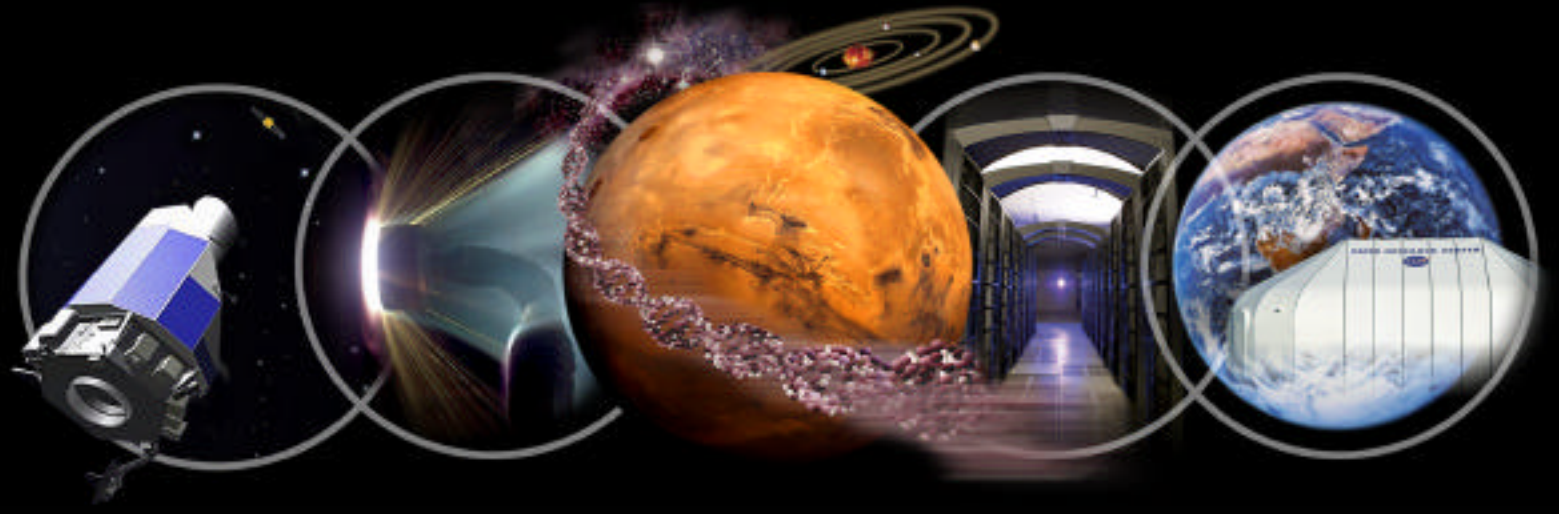


CONSTRAINT EDITOR
automated planning tools

CORE/X-PRT
human performance
modeling tools



Discovery ➲ Innovation ➲ Solutions



Human Factors for Crew Assist and Mission Operations

Drs. AlonsoVera, Roger Remington, Barbara Kanki, Judith Orasanu

Human Factors Research and Technology Division

Ames Exploration System Technology Partnerships Forum

July 22-23, 2004

Visibility ➲ Excellence ➲ Impact

Ames Research Center

Human-Computer Interaction for Mission Planning and Operations

user & task research

Design of reliable tools enabling planning of crew, mission operations, and human-robotic team activity

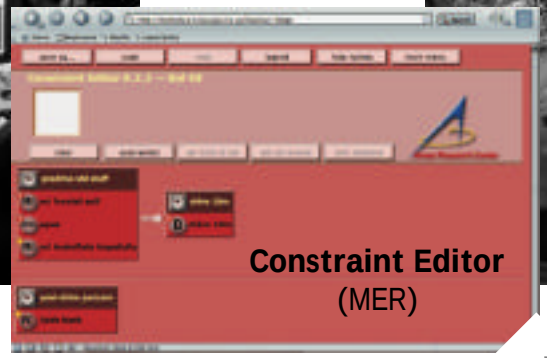
user data collection

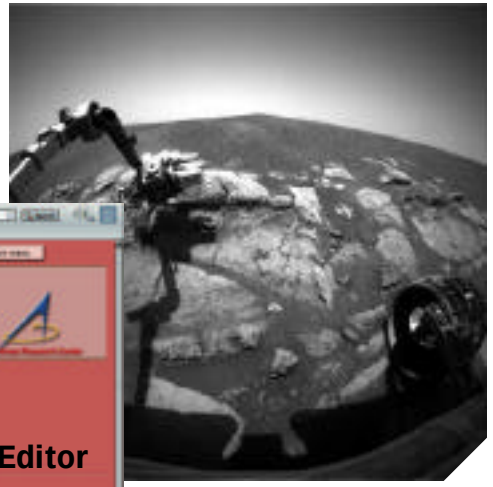
in situ data collection

design → implement → deploy → redesign

iterate

human performance modeling





Mission Ops → Planetary Exploration

Human-Performance Modeling

Computer simulation of human cognitive, motor, perceptual processing

Enables

- Mission requirements for human exploration
- Formal task analysis and "what-if" simulation
- Rapid processing of experimental human performance data
- Simulated Human-in-the-loop engineering design
- Intelligent tutoring and decision support systems able to diagnose and anticipate information requirements of human operators
- Intelligent agents for large-scale simulation

Multiple Human Performance Models used at Ames:

- MIDAS, air-MIDAS, APEX, CATS, ACT-R, among others

Mission Operations Risk Management

Human and organizational risk management through mission life cycle

- System and mission design
- Operations (launch, transit, crew science missions, return, landing)

Risks driven by

- Mission complexity
- Distributed teams
- Limited resources (time, people, money)

Risk occurs on multiple interacting levels

- *Organizational*: Schedule, cost, pressure from government bodies, values, goals, policies, international partners, role conflicts, outsourcing, priority & goal conflicts
- *Team*: Info sharing, false assumptions, big picture, status updates, coordination
- *Individual*: Training, workload, fatigue, morale, attrition

Tools and procedures necessary to handle risk

- System understanding/big picture
- Knowledge transfer tools
  - History and assumptions for multiyear projects
  - Shift logging and handovers
  - Exceptions, plan revisions, and progress
- Organizational culture & climate
  - Problem communication channels
  - Periodic risk assessment (e.g., surveys)

Knowledge Management Across Task/Team Boundaries

Goal: To enhance the effective collaboration, communication and decision-making across interacting organizations and corporate entities, this research develops multi-level interventions related to policies, procedures and practices that support a standard shared framework for the management of distributed knowledge systems.

Approach:

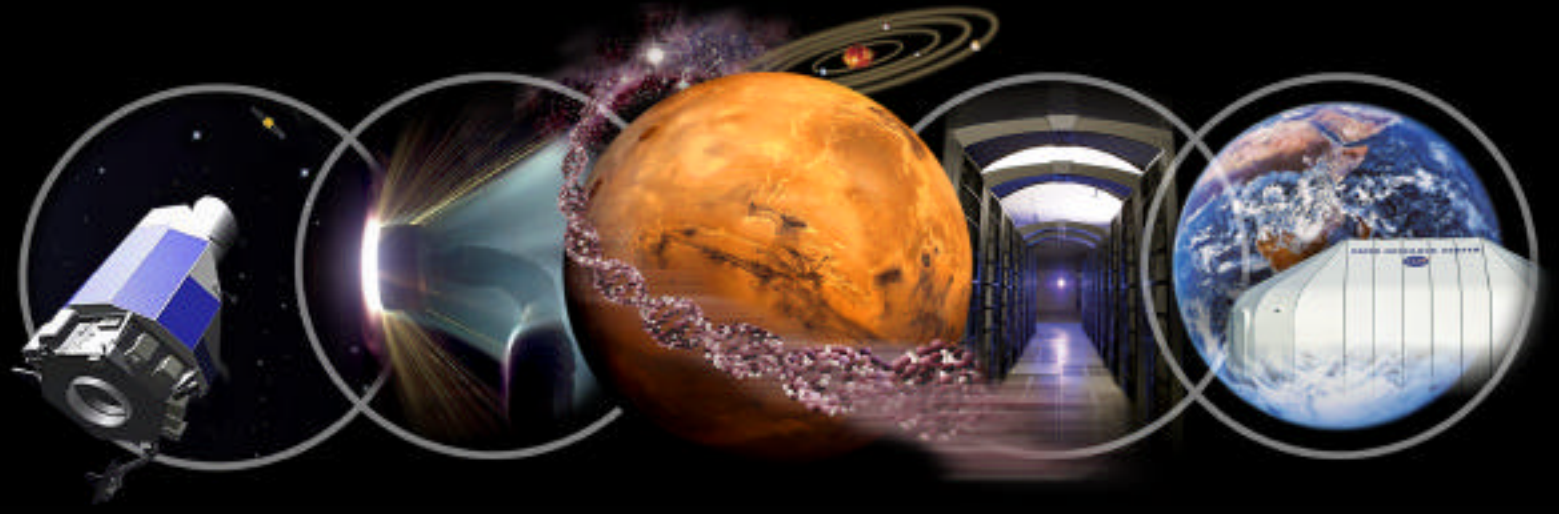
- Develop a systematic process for identifying level of information need by various users, and define the specific formal and informal understanding users maintain in order to make a shared information system work effectively
- Because functional groups often augment their knowledge system in unofficial and undocumented ways, develop a process model that examines all levels of knowledge acquisition, usage and management incorporating information priorities
- Determine knowledge representations and management techniques that can be effectively and consistently used and updated across task/team user groups

Products:

Based on information needs assessment of key task/team groups, develop

1) standard, shared knowledge management enhancements that cross organizational boundaries, and
2) tools for the continual resolution of inconsistencies and tracking of knowledge management upgrades

Discovery ➲ Innovation ➲ Solutions



Human Factors for Integrated Systems Health Management

Drs. Robert McCann and Jeff McCandless

Human Factors Research and Technology Division

Ames Exploration System Technology Partnerships Forum

July 22-23, 2004

Visibility ➲ Excellence ➲ Impact

Ames Research Center

Intelligent Spacecraft Interface Systems (ISIS) Lab

- **In current generation crewed space vehicles, systems health management is performed primarily by teams of human subject matter experts (crew and ground).**

- **On Project Constellation crewed vehicles, health management will be more of a cooperative activity involving mixed teams of crewmembers and onboard intelligent software agents.**

- **The purpose of the ISIS simulator is to define, test, and evaluate operations concepts for cooperative real-time human/machine health management during dynamic phases of flight.**

Research Contacts

- **Dr. Patricia M. Jones,** Patricia.M.Jones@nasa.gov
- **Dr. Judith Orasanu,** Judith.Orasanu@nasa.gov
- **Dr. Mary Kaiser,** Mary.K.Kaiser@nasa.gov
- **Dr. Barbara Kanki,** Barbara.G.Kanki@nasa.gov
- **Dr. Jeff McCandless,** jmccandless@mail.arc.nasa.gov
- **Dr. Robert McCann,** Robert.S.McCann@nasa.gov
- **Dr. Roger Remington,** Roger.W.Remington@nasa.gov
- **Dr. Alonso Vera,** Alonso.Vera@nasa.gov