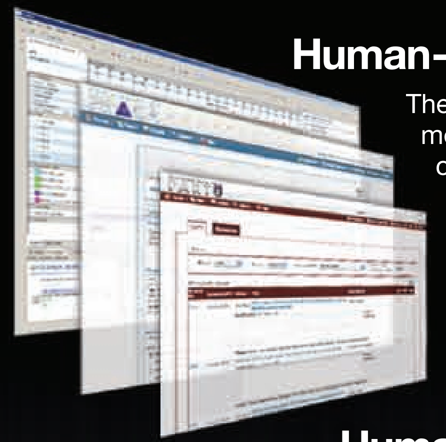

Human-Machine Interaction

The Human-Machine Interaction Group contributes to the development of measurably better NASA software through careful application of human computer interface methods. The group follows an iterative process that consists of user research, interaction design, and usability evaluation. It is commonly assumed that HCI is exclusively focused on the interface. We are focused on the users and their goals in order to build the right tool which means that we are focused on functionality as well as the interface.

Human Performance

The Human Performance Group aims to maximize the health, productivity and safety of crew members in space by modeling human performance, developing tools for evaluating performance, and creating countermeasures to mitigate performance deficits. The group includes labs that focus on virtual environments, acoustic displays, human cognition, performance modeling, psychophysiology, and vision science.

Integration and Training

The Integration and Training Group develops and evaluates methodologies for the integration of human factors principles into aviation safety and training. The group includes labs associated with flight deck procedures, cockpit displays, air traffic management, and team decision making.

The Human Systems Integration Division advances human-centered design and operations of complex aerospace systems through analysis, experimentation, and modeling of human performance and human-automation interaction to make dramatic improvements in safety, efficiency, and mission success.

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NASA Ames Research Center
Human Systems Integration Division
Mail Stop 262-1
Moffett Field, CA 94035
http://humansystems.arc.nasa.gov

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National Aeronautics and Space Administration

Human Systems Integration Division

Advancing Human-Centered Design and Operations of Complex Aerospace Systems

2013

National Aeronautics and Space Administration
Ames Research Center, Silicon Valley, CA

Dr. Alonso Vera
Division Chief

Advanced Human-Centered Design and Operations of Complex Aerospace Systems

People are the most critical element in system safety, reliability and performance. Their creativity, adaptability and problem-solving capabilities are key to resilient operations across the gamut of aerospace applications. Advances in computing power and communications, increased automation and access to distributed information resources for collaboration, monitoring and control, all contribute to new challenges for humans as critical decision-makers in complex systems.

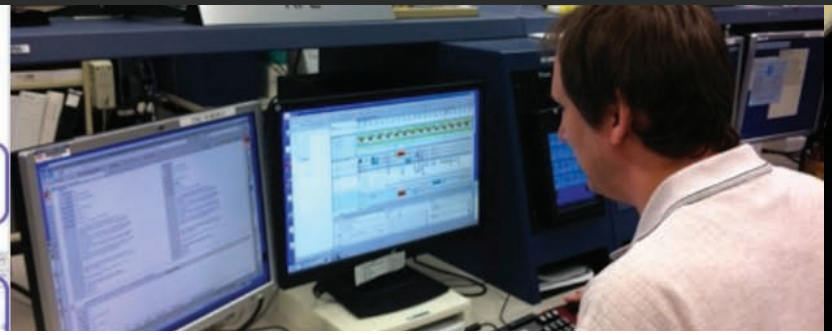
In aviation, people are the backbone of a national aviation system that is straining to meet growing consumer demands. In space, long-duration missions and reusable launch vehicles will increase the requirement for safe and effective human performance in the harsh environments surrounding our planet. Human-centered design must address the need for safe, efficient and cost-effective operations, maintenance and training, both in flight and on the ground.

The Human Systems Integration Division is creating and applying a new understanding of how individuals and teams assimilate and act on information in pursuit of goals critical to the success of NASA missions.

Strategic Goals

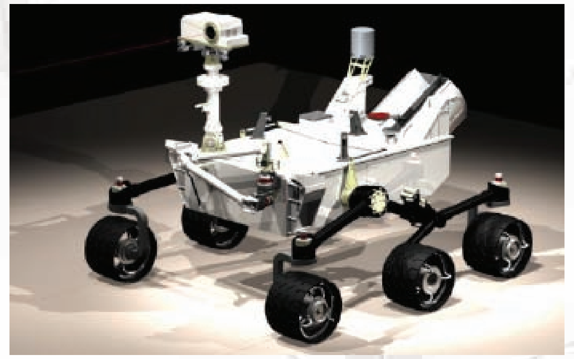
- To advance our fundamental understanding of how people process information, make decisions and collaborate with human and machine systems.
- To enhance aviation safety and performance by designing human-centered automation and interfaces, decision support tools, training, and team and organizational practices. The Human Systems Integration Division is creating and applying a new understanding of how individuals and teams assimilate and act on information in pursuit of goals critical to the success of NASA missions
- To extend human capabilities in space by advancing our knowledge of human performance during space missions and developing tools, technologies and countermeasures for safe and effective space operations.

Human-Machine Interaction >>



Score Activity Planning Tool Successfully Deployed to International Space Station Operations

On December 5, 2011, Real-time Planning Engineers in the International Space Station (ISS) Mission Control Center transitioned to using the Ames-developed planning tool Score for flight operations. Score is now the primary planning tool used by flight controllers to process all real-time changes to the integrated crew and ground schedule for the ISS. The Score planning tool is a major component in a next-generation planning system slated for use across the agency and internationally. This deployment is the first major milestone in a phased rollout that aims to completely replace legacy ISS planning tools worldwide by 2014. Score is an adaptation of the Scheduling and Planning Interface for Exploration (SPIFe) toolkit, which has provided activity planning and modeling support for several flight projects and mission analogs across the agency since 2004. Score was designed and developed by members of the Human-Computer Interaction group and the Ensemble development team, a collaboration between the Ames Human Systems Integration Division (Code TH) and Intelligent Systems Division (Code TI).

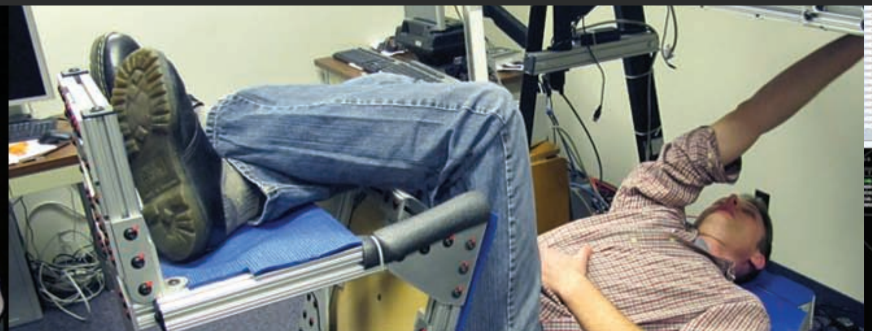


Planning Tool on the Mars Science Laboratory (MSL)

The Mars Science Laboratory (MSL) Mission, launched in November 2011, will rely on an integrated planning tool developed by NASA Ames Research Center in collaboration with the Jet Propulsion Lab. MSLICE (Mars Science Laboratory InterfaCE) will be an integral part of the daily science planning and commanding process for a distributed team of mission scientists and engineers. Ames' contribution to MSLICE provides critical resource modeling and activity planning capability, ensuring that mission scientists can work closely with rover and instrument engineers to create plans that maximize science return from the limited resources available to the spacecraft. The Human Systems Integration Division (TH) and the Intelligent Systems Division (TI) at NASA Ames Research Center collaborated to design and develop the planning and scheduling software for MSLICE.

Point of Contact: Michael McCurdy, Michael.McCurdy@nasa.gov, 650-604-3291, Human Systems Integration Division, NASA Ames Research Center, NASA

Human Performance >>



Human Performance Data Collected in the 20-G Centrifuge

In October 2011, data collection began at the 20-g centrifuge at NASA Ames Research center for the protocol titled "Combined whole-body vibration plus G-loading effects on human visuomotor performance". The goal of this study was to fill some of the current knowledge gaps in our understanding of human performance that are hampering robust vehicle design and mission planning. The ultimate goal is to use these data to begin developing/validating predictive computational models of human sensorimotor performance that can be used by future mission and vehicle designers planning for human exploration beyond low-earth orbit.

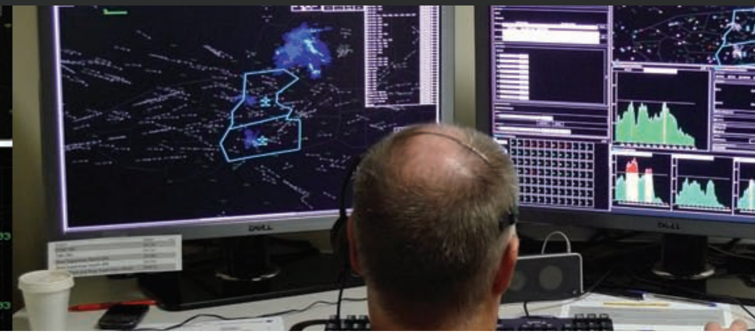
As it plans for human exploration beyond low-earth orbit, NASA intends to have human crews fully engaged in mission-critical activities (e.g., display monitoring, re-setting of switches, pushing buttons) during all phases of flight including launch and re-entry, periods where the crew will be subjected to significantly elevated gravito-inertial and vibration loads. To properly design the interface systems and plan crew operations, mission managers will need to predict how human performance may be altered during these phases of flight.

The project began by collecting human-performance data during sustained G-loading (chest-to-spine) at 3.8 g with superimposed vibration at 8, 12, and 16 Hz, as well as a no-vibration baseline. The experimental task had three components to it: 1) an initial eye-fixation component (i.e., look at the stationary central red LED) to measure gaze stabilization reflexes as a metric of vestibular function under G-plus-vibration loads, followed by 2) a gaze target-acquisition component (i.e., look at the peripherally flashed target spot) to measure eye-movement reaction-time/detection/localization as a metric of visual processing under G-plus-vibration loads, and finally 3) a rapid manual pointing component (i.e., touch the screen where the target was) to measure hand movement reaction-time/accuracy/precision as a metric of visuomotor function under G-plus-vibration loads. In this way, we can begin to dissect the contributions of each of the major sub-elements (vestibular, visual, and biomechanical/proprioceptive) to the overall impact of G-plus-vibration loading on human sensorimotor control.

A second phase of the study was conducted in February 2012. The original rapid-reaching task run in October had three components to it to dissect the contributions of each of the major sub-elements (vestibular, visual, and biomechanical/proprioceptive) to the overall impact of G-plus-vibration loading on human target acquisition. Preliminary results from the second phase indicate that there are significant increases in response times and decreases in accuracy/precision in our experimental conditions. The new experimental task is a gaze-tracking task to measure visual motion processing and smooth oculomotor control under combined G-loading and vibration.

Point of Contact: Lee Stone, Ph.D.; Leland.S.Stone@nasa.gov, 650-604-3240; Human Systems Integration Division, NASA Ames Research Center, NASA

Integration and Training >>

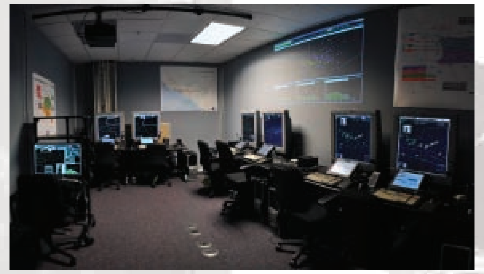


Completion of a Boeing 747 Simulation Study of Pilot Responses to Critical Events

In February 2012, researchers in the Ames Human Systems Integration Division completed a simulation study of airline pilot readiness to respond to critical events such as stalls, wind shear, and engine and instrumentation failures. This study was conducted in the Boeing 747-400 simulator located in the Crew-Vehicle Systems Research Facility (CVSRF) at NASA Ames Research Center. The study included twenty certified commercial pilots from three major United States carriers. During the study, each pilot flew a 2.5 hour mission and experienced thirteen abnormal events. The goal was to study pilots' responses to these events when they were presented in naturalistic and unexpected ways. The results will be used to recommend changes in the way these events are taught and practiced during airline training events.

Point of Contact: Stephen Casner, Ph.D., Stephen.Casner@nasa.gov, 650-604-6908; Human Systems Integration Division, NASA Ames Research Center, NASA

Simulation on Controller-Managed Spacing Tools for NASA's Air Traffic Management Technology Demonstration-1 (ATD-1)



On April 6, 2012, the Airspace Operations Laboratory (AOL) of the Ames Human Systems Integration Division concluded the second of three simulations devoted to the integration of the Controller-Managed Spacing (CMS) tools for NASA's Air Traffic Management Technology Demonstration 1 (ATD-1). ATD-1 is a high priority NASA project within the Aeronautics Research Mission Directorate (ARMD) intended to demonstrate the feasibility of sustained high-throughput, fuel efficient arrival operations using NASA technologies in conjunction with Automatic Dependent Surveillance-Broadcast (ADS-B). The NASA technologies are the Traffic Management Advisor with Terminal Metering (TMA-TM) developed in the NASA Ames Aviation Systems Division, Flight Deck-based Interval Management (FIM) developed at NASA Langley Research Center, and Controller-Managed Spacing (CMS) tools developed in the Airspace Operations Laboratory at NASA Ames.

In this study, four en-route controllers, four terminal-area controllers, one tower controller, nine multi-aircraft pilots, and eight single-aircraft pilots managed efficient arrivals into a major airport under mixed operations. In these operations, FIM automation provides speed commands for some aircraft, and controllers issue speed instructions to the other aircraft using ground automation. The study used improved versions of all ATD-1 integrated components to further investigate CMS tools, procedures, and clearance phraseology.

Point of Contact: Thomas Prevot, thomas.prevot@nasa.gov, 650-604-2441, Human Systems Integration Division, NASA Ames Research Center, NASA