

NASA Research Addressing Key Issues in Flight Deck Automation for NextGen

J. Raymond Comstock, Jr.

Crew Systems and Aviation Operations Branch

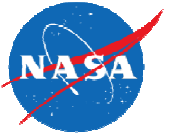
NASA Langley Research Center

Hampton, Virginia 23681-2199

james.r.comstock@nasa.gov

757-864-6643

Flight Deck Automation focused projects



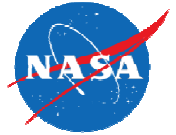
NASA Aviation Safety Program research

- innovative algorithms, tools, concepts, and technologies
- from discipline, subsystem, and system levels

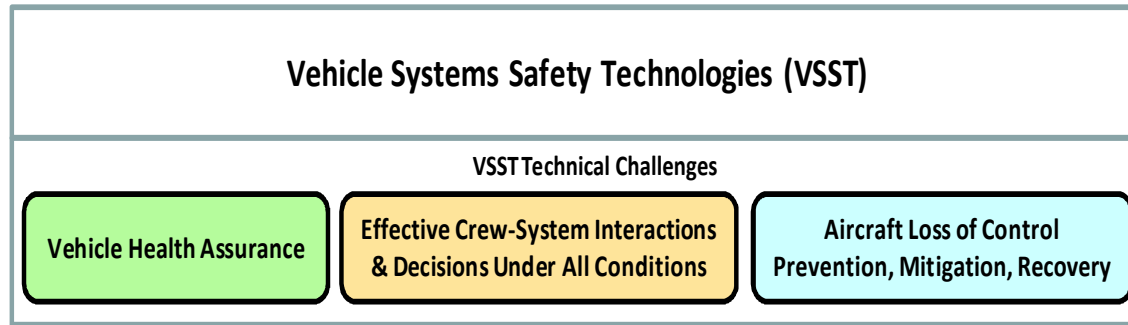
Key Projects

- **VSST** - the *Vehicle Systems Safety Technologies* Project addresses maintaining and improving the intrinsic safe flight of the aircraft, by developing tools and technologies to enable robust vehicle designs and to solve vehicle operation-related concerns
- **SSAT** - the *System-Wide Safety and Assurance Technologies* Project identifies risks and provides knowledge required to safely manage increasing complexity in the design and operation of vehicles and air transportation systems, including advanced approaches to enable improved and cost-effective verification and validation of flight-critical systems

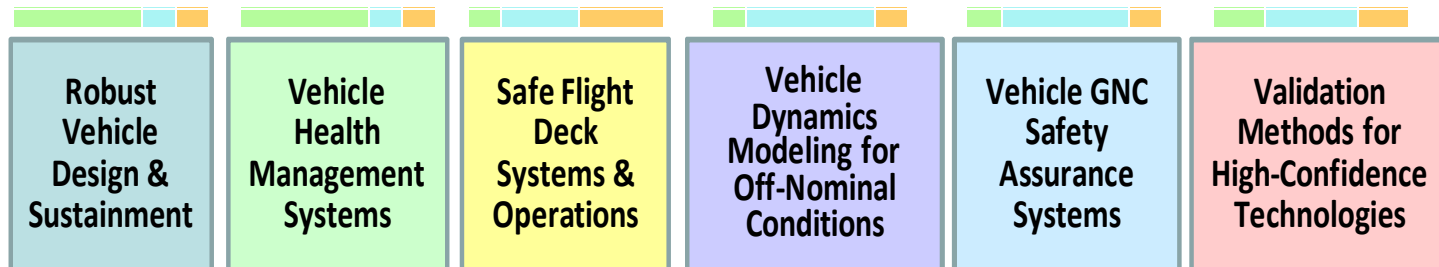
VSST Project Technical Organization



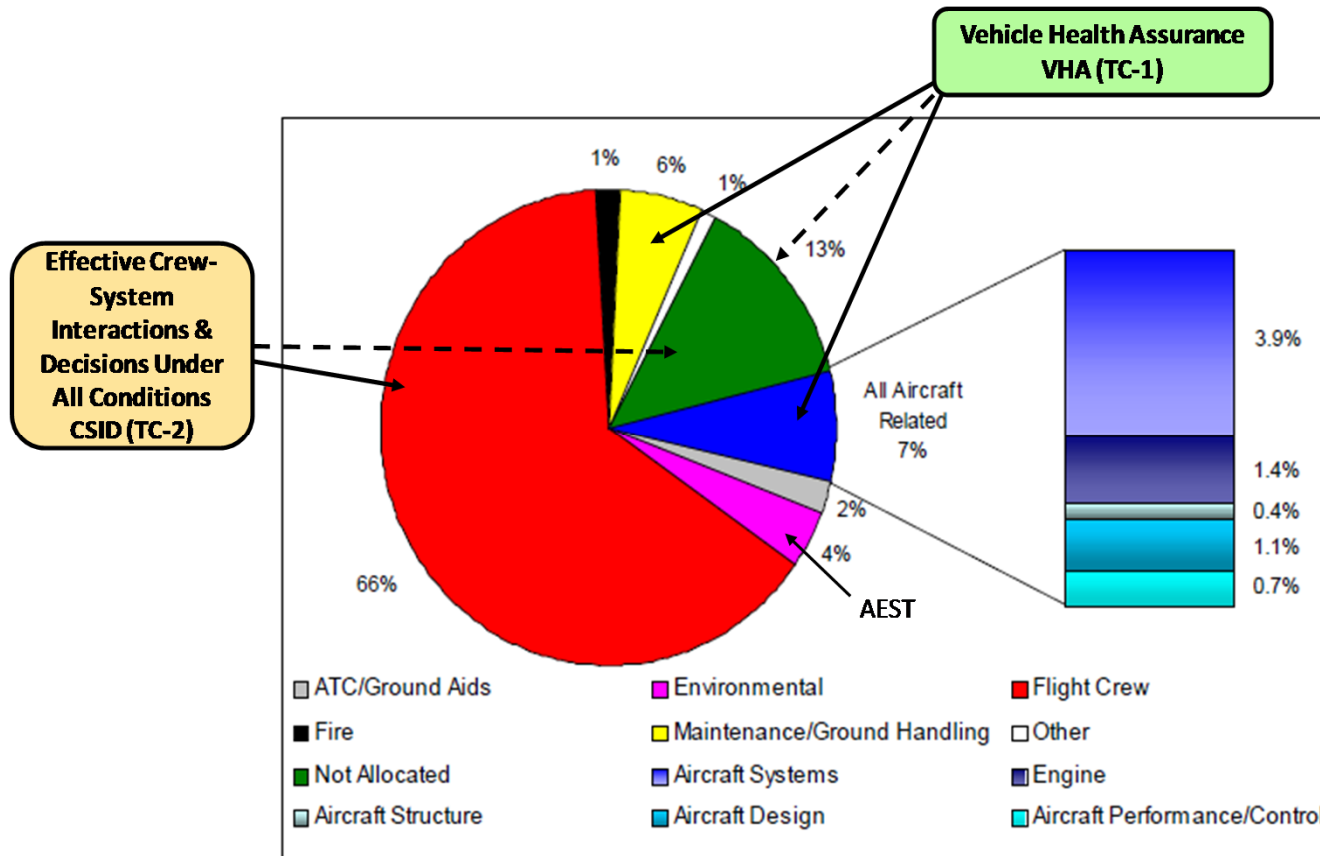
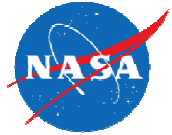
VSST Project:



Research Areas:



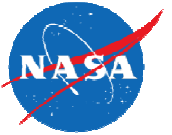
VSST Addressing Accident Causal Factors



Breakdown of world-wide fatal accidents by causal group (for primary causal factors only) for the period 1997 to 2006 (ref: Global Fatal Accident Review, UK CAA, 2008)

VSST Technical Challenges Related to Primary Causal Factors of Accidents

High-Integrity Integrated Alerting and Notification



aka: HI-IAN

POC: Steve Young, NASA Langley

*Partners: Aptima, Boeing, Ohio Univ., RTCA,
Rockwell-Collins, Univ. of Iowa*

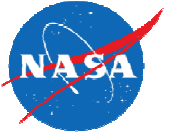
This research will...

- Explore new methods of integrating information, given NextGen data communications capabilities
- Compare against traditional segregated (or less integrated) methods
- Metrics/questions
 - Integrity (Can it be trusted? How much? How to achieve high levels?)
 - Utility (Useful and usable? Timely?)
 - User Requirements (Filling a gap? Reducing a risk?)

Approaches

- Evolutionary: Updates to EICAS, PFD and MFD (ND) Symbolology and Aural Alerts (e.g. build on current Boeing 787 architecture)
- Revolutionary: e.g. Conflict Probes or “ALARMS”
 - Perform predictions for a range of states
 - Include uncertainty of information
 - Interventions and hazards are aggregated and prioritized

Displays and Decision Support (DDS)



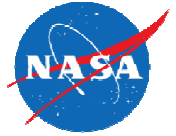
POC: Randy Bailey, NASA LaRC

Partners: FAA, Intersense, Gulfstream, RTCA

- *NextSafe-2 Objective*: Evaluate *Flight Deck Technologies* to Support Emerging NextGen Merging and Spacing Operations/Interval Management
 - Flight Deck Interval Management (FIM) Paired Dependent Speed (PDS) Technologies for Delegated Airborne Spacing and Delegated Separation



Displays and Decision Support Partnerships

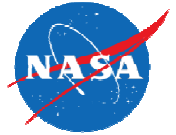


NextSafe Research Studies

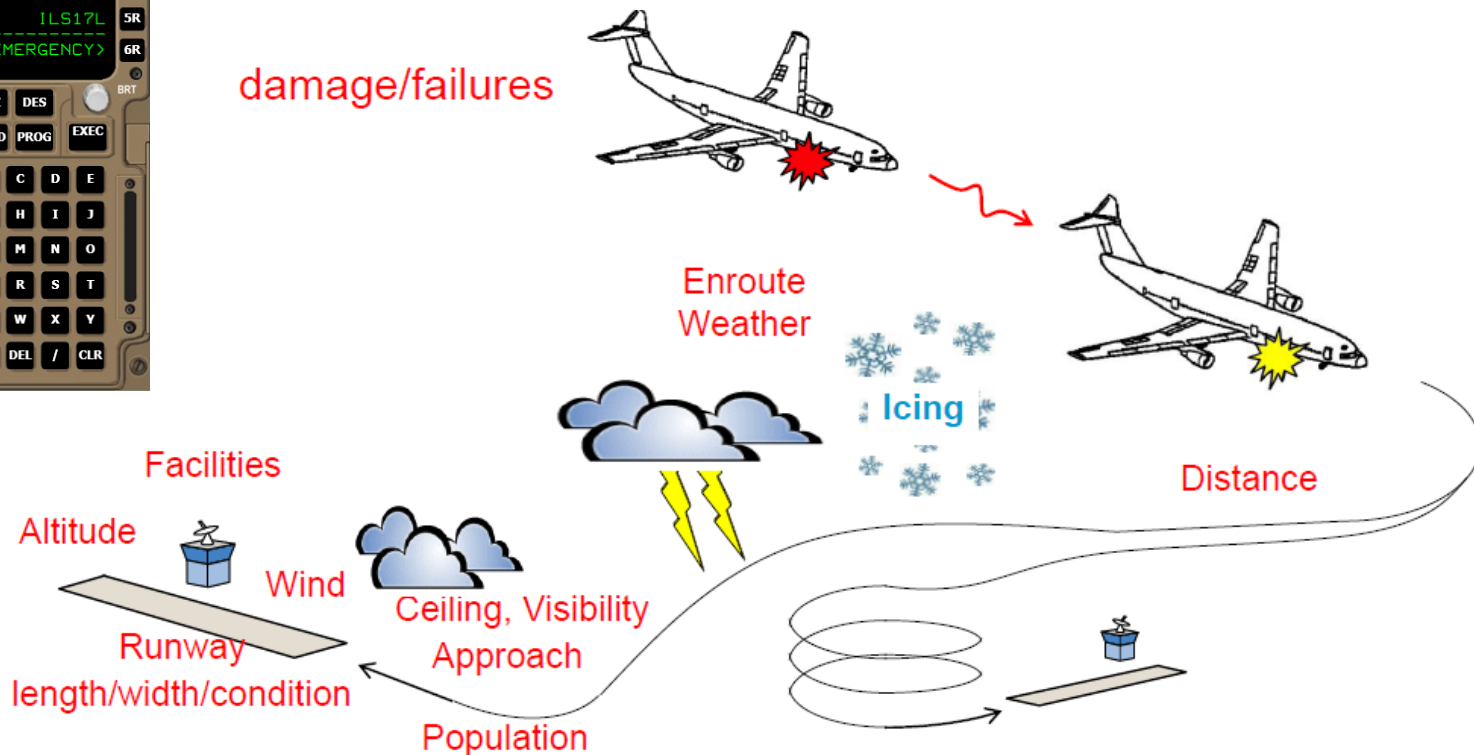
- NASA Airspace Systems Program
- FAA
 - AFS-410
 - AJP-61
 - ADS-B Aviation Rule Making Committee
- RTCA Committees
 - SC-186
 - SC-206
 - SC-213



Trajectory Generation In Off-Nominal Conditions

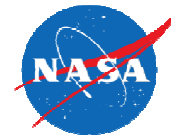


POC: David Smith, NASA Ames



**Find the best landing sites and routes
for the aircraft**

Closely Spaced Parallel Operations: Automation Design and Procedures



POC: Sandy Lozito, NASA Ames

Objective

To investigate integrated procedures for flight deck and air traffic control in the terminal area for simultaneous approaches

- Levels of flight deck automation
- Roles of the air traffic controller and the flight crew in pairing aircraft and monitoring their conformance

Concept

Technology assumed (Far Term 2025)

- Differential Global Positioning System (DGPS)
- Augmented Automatic Dependent Surveillance-Broadcast (ADS-B)
- Augmented cockpit display
- Required Navigation Performance (RNP) levels

Aircraft are provided 4D trajectories and managed simultaneously to the coupling point, 12 nmi from threshold

- Coupling point is when the automation of the two aircraft are sharing data and are linked to one another through the aircraft automation

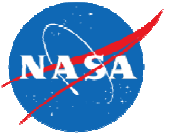
Maintain precise time separation of 5-25 s

Speed adjustments only to meet Required Time of Arrival (RTA)

Prototype / Candidate Tools and Displays under test

for both Flight Crew and Controller

Variable Autonomy Interface System Research



POC: Ken Goodrich, NASA Langley

Goal:

Fluid blending of manual and automated flight:

Integrated interface leveraging manual flying skills/interactions

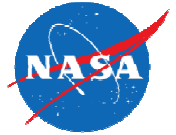
- Safety contribution
 - More effective crew-system interactions and decisions
 - Loss-of-control prevention and mitigation
- Operational benefits
 - Reduced automation training / Enhanced single-pilot ops / UAS applications
- Path to more autonomous vehicles while enabling flexible human interaction



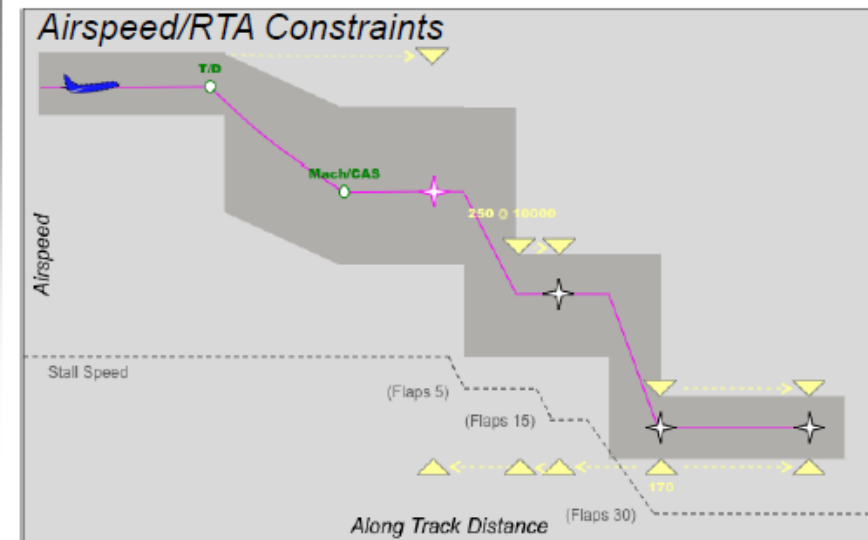
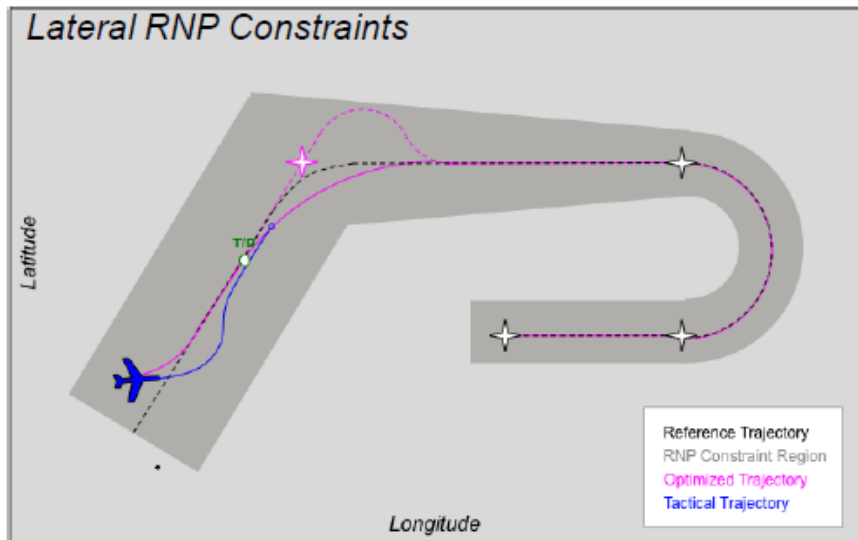
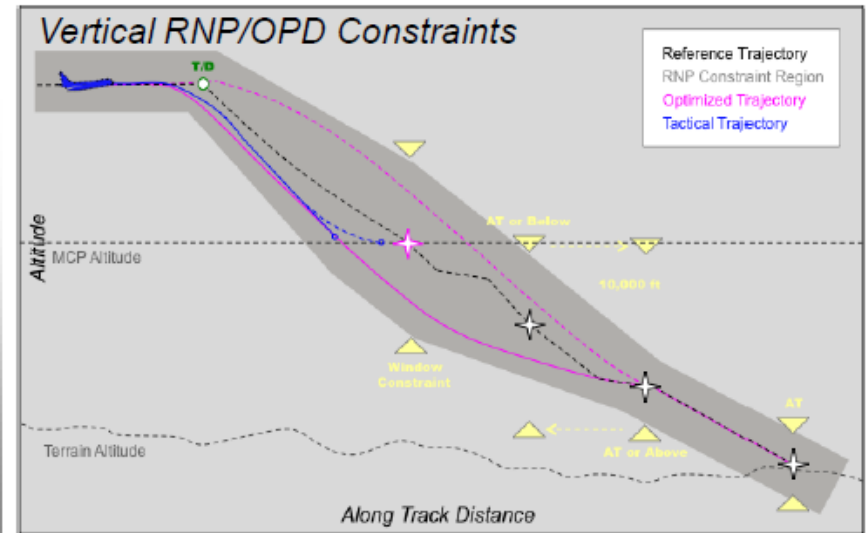
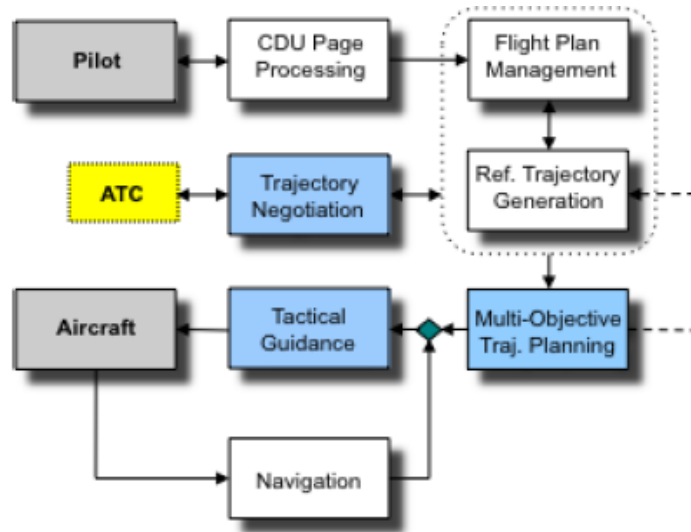
Summary:

- Emerging, highly-automated vehicles require and enable more effective and flexible user interaction than supported by current automation
- Variable Autonomy, Haptic Flight Control provides possible template for dynamic vehicle control tasks with multi-tasking operator
- Initial concept explorations show promise, including in adverse conditions
- Continuing to refine concept, extend functionality, integrate with other flight deck systems, and increase fidelity of underlying models and evaluations

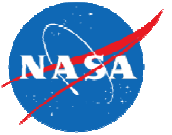
Tactical Flight Management System (T-FMS)



POC: John Kaneshige, NASA Ames



Automation Design for NextGen Terminal Area Operations



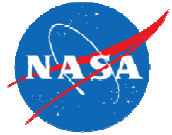
aka: NextDeck

POC: Sandy Lozito, NASA Ames

Partners: Honeywell, Inc. – Bill Rogers

- Examination of future flight deck automation requirements for NextGen
- Focus upon the roles of the pilot and the automation
- Focus upon the terminal area
- General Tasks
 - Develop requirements for NextGen flight deck automation
 - Develop Test Cases (scenario events) representative of NextGen operations in the terminal area
 - Develop two candidate flight deck automation design concepts
 - Evaluate the two automation design concepts
 - Evaluation includes consideration of off-nominal events
- Work scheduled to be completed in June 2011

Framework for the SSAT Project



SSAT - System-Wide Safety and Assurance Technologies

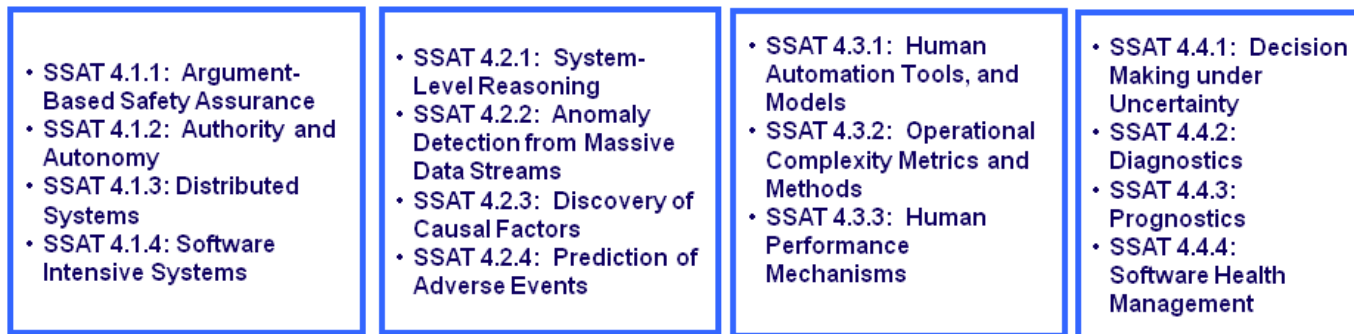
Level 2 – Project Level



Level 3 – Subproject

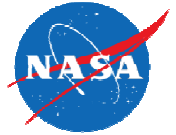


Level 4 – Subproject Elements



“Validated, proactive solutions for ensuring safety in flight and operations”

Automation Design Tools



POC: Mike Feary, NASA Ames

•Increasing Safety of Human – Automation Interaction by Incorporating Human Performance (2020)

•**Goal:** Develop analysis tools that incorporate known limitations of human performance and enable design of robust human-automation systems.

•Technical Challenge Validated

- JPDO R2130, R2138
- NRC 2006 Decadal Survey
- Nat'l Aero R&D Plan Feb 2010

•Human-Automation Tools and Models

- Methods for Development of Interface Requirements (2013)
- Develop Human – Automation Interaction analysis methods and tools (2013)
- Tools for Identification of novel system failures (2014)
- Develop Computational Human Model-Based Safety Design Tools (2014)



Challenge

Theme

•Benefits of Successful Completion

- Methods and tools to help designers trainers and operators predict human performance, and identify, evaluate and resolve Human-Automation Interaction issues, and novel system failures.

•Human Performance Mechanisms

- Methods to determine human functional state (2012)
- Human system modality mapping (2013)
- Improved models of operator information processing and functional status limitations(2014)

•Operational Complexity Metrics and Methods

- Develop executable data extraction and abstraction model (2013)

•Collaboration w/ FAA

•Collaboration w/ASP

•Collaboration w/VSST

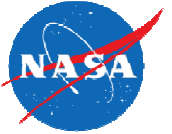
•Fundamental research

- Human performance modeling, perceptual and cognitive performance measurement, physiological measurement, cognitive task analysis, formal methods,



Fundamental Research

Questions



Additional questions? Please contact:

Ray Comstock

**MS-152, Crew Systems and Aviation Operations Branch
NASA Langley Research Center
Hampton, VA 23681-2199**

james.r.comstock@nasa.gov

757-864-6643