



# IIFD

Integrated Intelligent Flight Deck

Steve Young

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# “In a Nutshell”

## Future flight deck systems:

- Increased levels of automation
- Increased availability of electronic (digital) information
- More diverse set of vehicles, missions, and operators
- More stringent avionics performance requirements

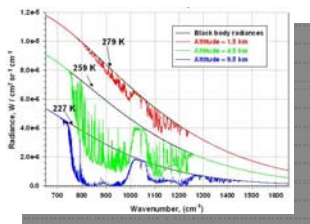
## IIFD performs proactive RDT&E activities addressing:

- Human-automation interoperability
- Information integration, abstraction, and conveyance
- External hazard monitoring
- Design & analysis methods, metrics, and tools

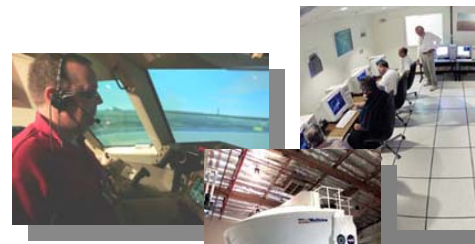


*diagnostic/  
prognostic  
analyses*

*modeling & tool  
development*



*ground-based & lab  
experiments*



*flight sim  
studies*

*flight test  
experiments*



# Topics

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- Goals & scope
- Motivation
- Approach & organization
- Research activities
- Our extended team
  
- Thu & Fri





# Goals

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## Research

To advance knowledge...  
by producing tools, methods, principles,  
guidelines, and technologies, for  
revolutionary adaptive flight deck systems  
that improve safety

*"Risk is inversely proportional to knowledge"*

## Process

Incremental advances over the term  
of the project are peer-reviewed  
and disseminated throughout the community



# Scope

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For aerospace vehicles...

Develop technologies to mitigate operator-, automation-, and external environment-induced hazards of future operational concepts

Address integration of new concepts that may impact flight deck system performance

Foster the development of an improved predictive capability



# Why

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## **Based on recorded event data**

- Accidents, incidents, and precursors continue to occur wherein the pilot, the automation, or the external environment are causal factors

## **Based on analysis by government and industry groups**

- There is a need for flight deck capabilities that can reduce operational risk with respect to these factors

## **NextGen vision implies needs for flight deck safety research**

- More automated functions; Increased flight deck expectations; Less time to “see-and-avoid”; Increased system complexity; Many large uncertainties

## **National R&D Policy Directive**

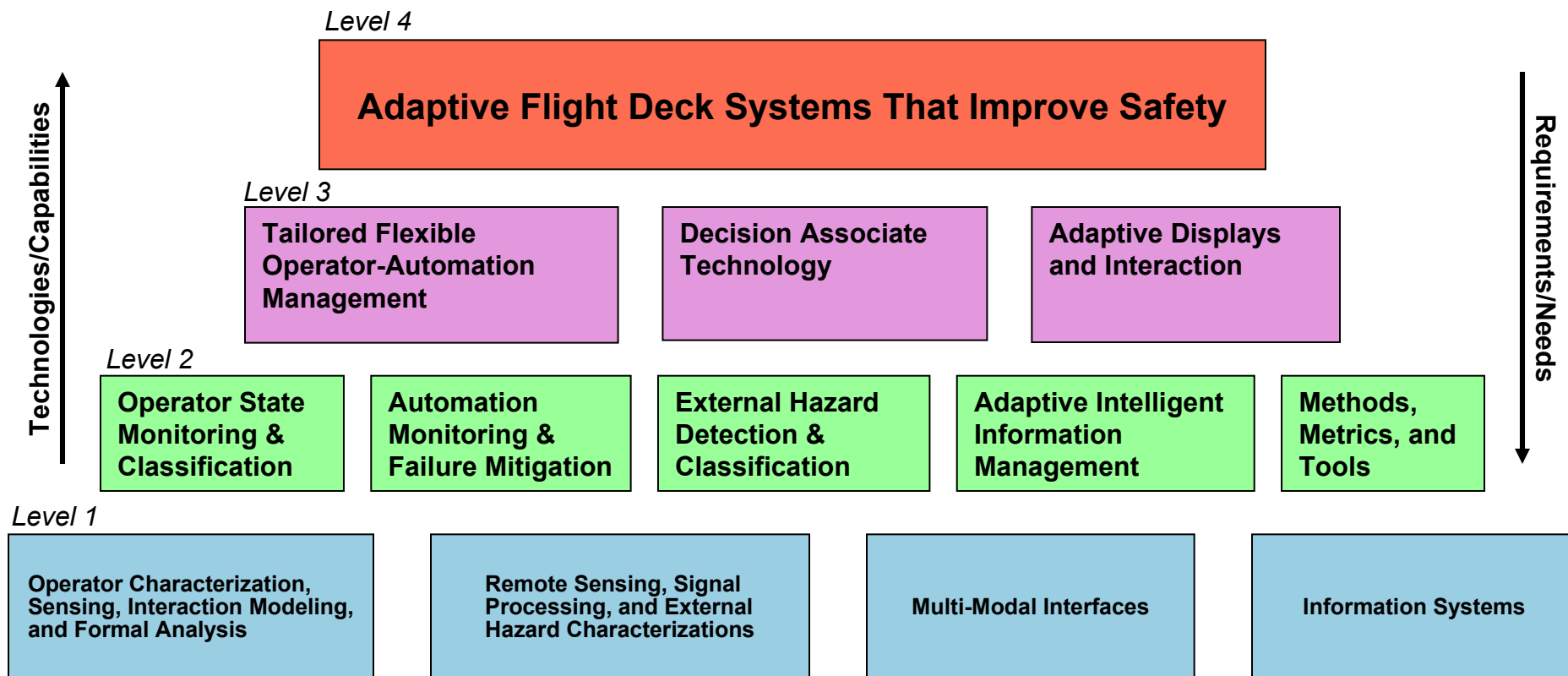
- “Aviation Safety is Paramount”
- NASA role is “broad foundational research” in “key areas”



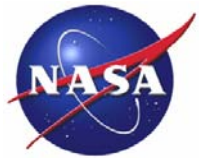


# Approach

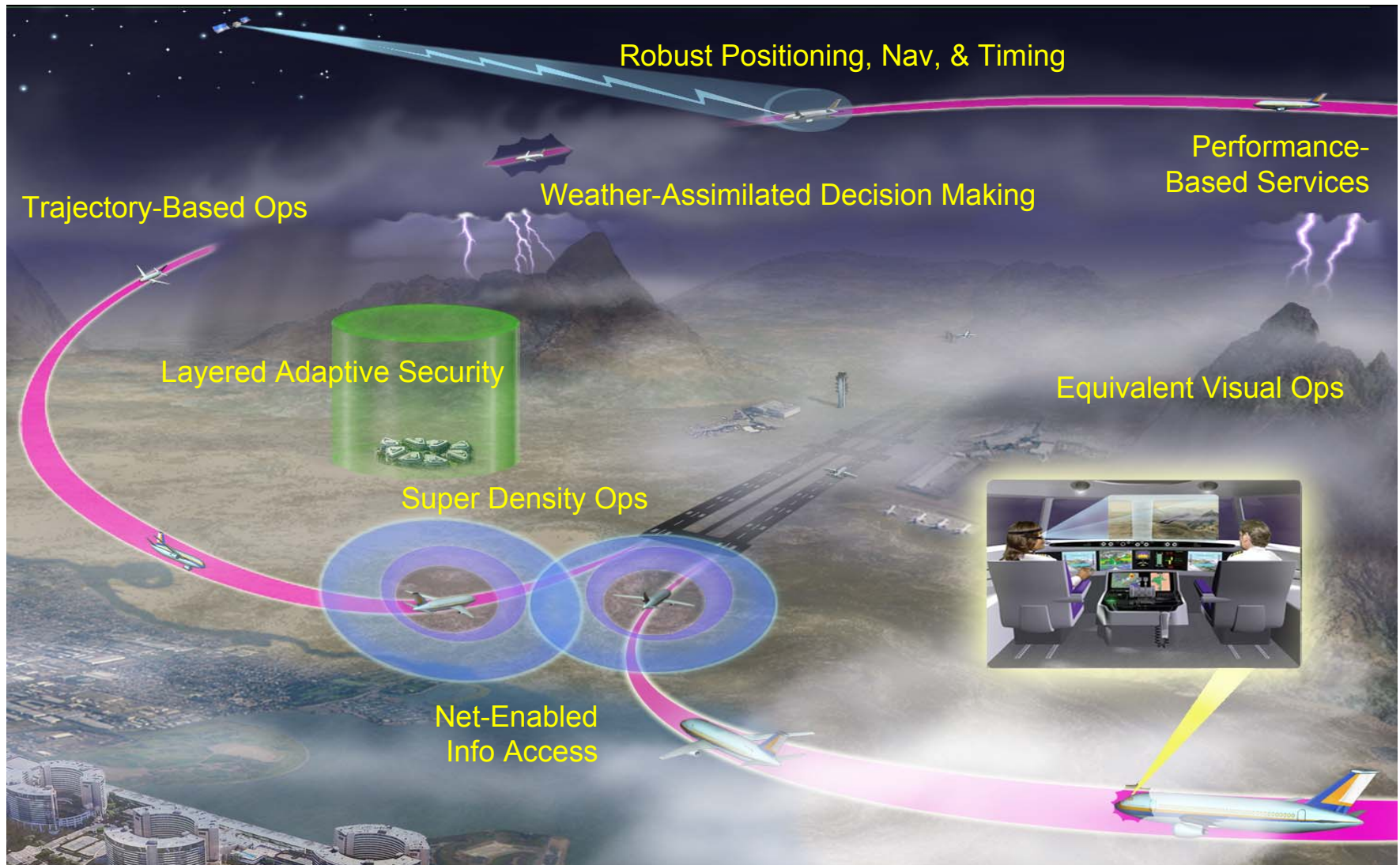
## Predictive Capability Hierarchy\*



\*Oberkampff, W., et. al., "Verification, Validation, and Predictive Capability in Computational Engineering and Physics," Foundations for V&V in the 21st Century Workshop, Johns Hopkins University Applied Physics Laboratory, October, 2002



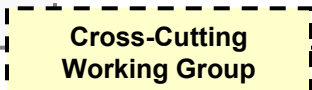
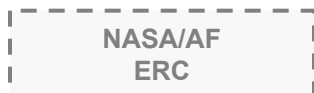
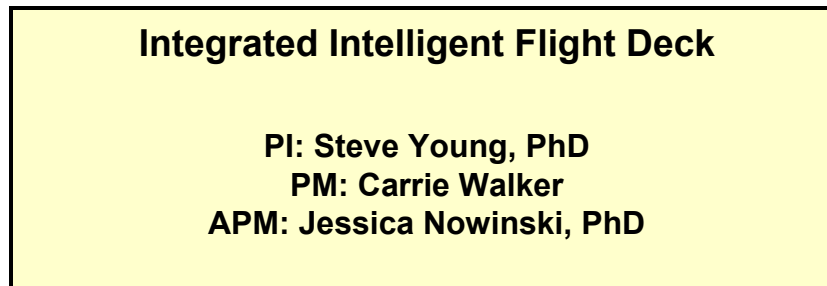
# Application Domain – NextGen



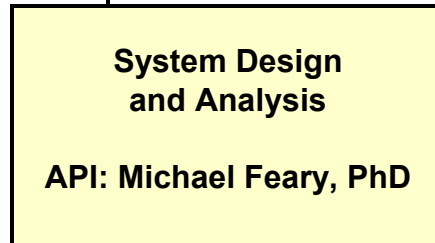
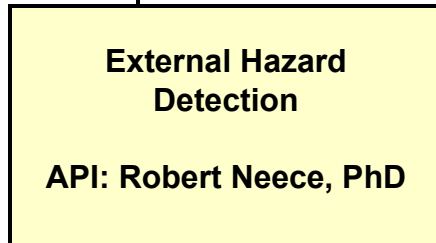
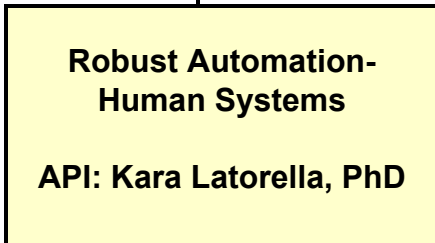
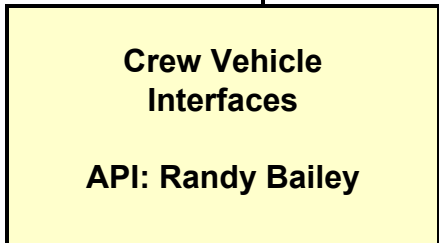
NextGen's Key Capabilities, from "Operational Concept for the Next Generation Air Transportation System (NextGen),"  
Version 2.0, JPDO, June 13, 2007



# Organization



Level Responsibilities:  
• L4: Adaptive Flight Deck Systems

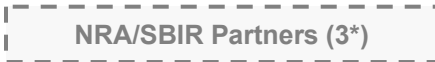


Level Responsibilities:  
• L1: Multi-modal interfaces  
• L2: Information management  
• L3: Adaptive disp. & interactions  
• L3: Decision assoc. tech.

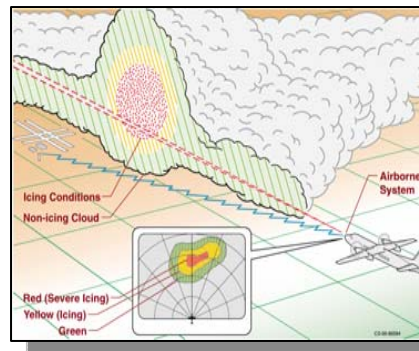
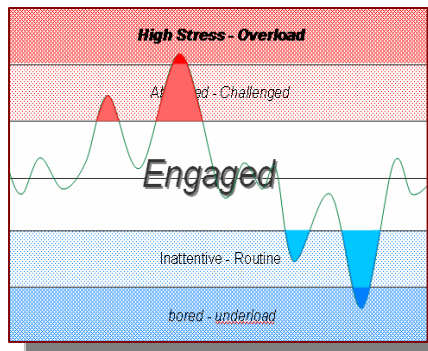
Level Responsibilities:  
• L1: Operator characterization  
• L2: Operator monitoring  
• L3: Operator/auto. management  
• L3: Decision assoc. tech.

Level Responsibilities:  
• L1: Sensor technologies  
• L1: Ext hazard characterization  
• L1: Image processing  
• L2: Haz. ID & classification

Level Responsibilities:  
• L1: Information system modeling  
• L2/L3: Design methods & tools  
• L2/L3: System validation methods  
• L4: Safety/risk analysis



# Research Activities



## Crew Vehicle Interfaces

- ID and prognostication of safety barriers related to CVI
- RDT&E of visual interfaces
- RDT&E of auditory and communicative interfaces

## Robust Automation-Human Systems

- ID and prognostication of safety barriers related to RAHS
- Human error modeling
- Operator state sensing & characterization
- Operator trait ID
- Functional analysis of task requirements
- Operator/automation integration strategies & policies

## External Hazard Detection

- ID and prognostication of safety barriers related to external hazards
- Ext. hazard monitor defn
- Forward-looking interferometric sensing
- LEO sensing methods
- Radar application to runway environments
- SVA image processing methods
- Icing remote sensing

## System Design and Analysis

- HAI design methods
- Information system modeling
- Information integ. & abstraction methods
- Coordinated SA design tools
- Automated traj. execution
- Safety/risk analysis
- ASRS



# NRA-Based Partnerships

Title	Lead Org.
* Testing and Validation of a Psychophysically Defined Metric of Display Clutter	NC State
Head-Worn Display Systems	Honeywell
Method. to Support Dyn. Function Allocation Policies Between Humans and Flight Deck Automation	Georgia Tech
* Operator State Sensor Investigations, State Classification, and Feedback Algorithms	Iowa
Control of Attention: Modeling the Effects of Stimulus Char., Task Demands, & Ind. Differences	Illinois
Characterization of Airborne Runway Incursion Sensors	RTI
Airborne Phased Array Radar for Microphysics-Based Hazard Detection and Monitoring	Oklahoma
Sensor Technology Model Development and Evaluation for an External Hazard Monitor	Ohio U.
* Hazard Analysis for a Forward-Looking Interferometer	Georgia Tech
Airborne Bistatic Radar for Wind Hazard Detection and Avoidance	ODU
* Smart Sensor Processing for Automatic Runway Hazard Detection	ODU
Designing Human-Auto. Interaction Through Comp. Modeling of Cognition and the Dyn. Flight Env.	Georgia Tech
Automation Interaction Design and Evaluation Methods	George Mason
Proactive Sys. Design and Eval.: Supporting Pilot-Auto. Interaction thru Emp. & Modeling Analyses	Michigan
Advanced Computational Models for the Design of Automated Systems	Aptima





# Other External Collaborations

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## **Air Force**

- AF/NASA Executive Research Committee
- Human Effectiveness Directorate (AFRL/VA)
  - “...conduct RDT&E on integrated flight deck technologies.”
  - Current focus: Autonomous Approach and Landing Capability (AALC) program
  - Status: C-130 flight test in FY08

## **FAA**

- AFS, guidelines related to SVS/EVS
- Aviation Safety Reporting System (ASRS)

## **RTCA & SAE**

- SC-186, Surface traffic alerting guidelines
- SC-206, User requirements for AIS/MET data link services
- SC-213, SVS/EVS guidelines and performance standards
- SAE Aerospace Behavioral Engineering Technology tech committee (G-10)

## **JPDO**

- Safety Working Group, Safety Strategic Plan
- Others indirectly via NASA’s Airspace Systems Program (ASP) collaborations

## **NOAA**

- Weather-in-the-Cockpit Working Group

# Industry/NASA Flight Deck Research Working Group

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## Charter

“...to facilitate knowledge transfer between the NASA and participants representing the aerospace industry. This facilitation benefits the broad aviation community by ensuring that fundamental knowledge and understanding underpins new technology developments. Participants will have the opportunity to receive early insights into NASA-funded technical advances and will be given the opportunity to provide opinions regarding the relevance of NASA-funded research.”

## Mission

“...to identify needed capabilities for future flight deck systems, to track recent advances, and to define challenge problems where research is required to seek insight into how these problems might be overcome.”

## Meeting synopsis

- 3 to date (9/06, 1/07, 5/07)
- Charter revised and adopted
- Research topic list drafted and revised
- Technical interchange
- Find out more via our website





# Other NASA Collaborations

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Org.	Topics
AvSafe/IVHM	<ul style="list-style-type: none"><li>• Architecture analysis</li><li>• Data mining</li></ul>
AvSafe/IRAC	<ul style="list-style-type: none"><li>• Pilot decision support</li><li>• Automation interaction design</li></ul>
ASP/Airspace	<ul style="list-style-type: none"><li>• Trajectory-based automation</li><li>• Reference scenario development</li></ul>
ASP/Airportal	<ul style="list-style-type: none"><li>• Runway incursion prevention and surface routing</li><li>• Reference scenario development</li></ul>
Science Mission Directorate	<ul style="list-style-type: none"><li>• Atmospheric modeling</li></ul>





ARMD - Integrated Intelligent Flight Deck Technologies (IIFD) - Mozilla Firefox

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+ RESEARCH ACTIVITIES

+ NRA OPPORTUNITIES

+ OTHER OPPORTUNITIES

+ PEOPLE

+ REFERENCE MATERIALS

+ EVENTS

+ PARTNERSHIPS

REFERENCE MATERIALS

**Scientific Publications**

- + IIFD (October 2006 - Present)
- + Flight Deck Research at NASA

**Other Documents**

- + NASA/NextGen White Paper, June 26, 2007 [PDF 628 KB]
- + IIFD Technical Plan (May 2006) [PDF 6.3 MB]
- + National Aeronautics R&D Policy [PDF 68K]
- + NASA's Response to the National Aeronautics R&D Policy [PDF 100 KB]
- + IIFD Glossary of Terms [PDF 120 KB]
- + IIFD Abbreviations & Acronyms [PDF 92 KB]

**External Documents**

- + Concept of Operations for NextGen, v2.0, June 13, 2007 [PDF 2.59 MB]
- + Joint Planning & Development Office (JPDO): Next Generation Air Transportation System Integrated Plan (2004) [PDF 3.2MB]
- + National Institute of Aerospace (NIA): Responding to the Call: Aviation Plan for American Leadership [PDF 1.8MB]

**ABOUT US**

The Integrated Intelligent Flight Deck (IIFD) Project is one of four projects in the NASA Aviation Program.

*IIFD shares and applies research products (e.g., knowledge) to support industry and govern progression towards more capable and safer flight deck systems.*

IIFD research is based on a vision for future flight deck systems that includes systematic integrated displays and interactions, decision-aiding functions, information management, and human/automation task allocations. The future flight deck system is aware of the vehicle and responds appropriately. The system senses internal and external hazards, evaluates the provides key information to facilitate timely and appropriate responses. The system is robust adaptable to the addition of new functions and information sources as they become available.

To achieve this vision, IIFD comprises a multi-layered architecture that integrates human, automation, and system capabilities. It leverages, and depends on, others to develop flight deck such as degraded vehicle health monitoring, flight deck automation, and flight deck automation.

IIFD addresses, from the flight deck safety, future communications, navigation, Air Traffic Management, and Air Traffic Control. IIFD is being investigated by others either within NASA or other agencies.

IIFD fosters the development of an improved flight deck beyond those that can be validated directly.

**Latest News**

**IIASA Researchers Argue**  
The majority of all aviation accidents are misinterpreted as evidence "The Limits of Expertise" is arguing that accidents can be avoided if system operates.  
[+ Visit Site](#)

**Related Links**

- + Aviation Safety Program
- + Airspace Systems Program
- + Fundamental Aeronautics Program
- + Integrated Vehicle Health Management Project (pdf)
- + Integrated Resilient Aircraft Control Project (pdf)
- + Aircraft Aging and Durability Project (pdf)

Title	Year	Author	Topic
+ Collocation and Pattern Recognition Effects on System Failure Remediation	2007	Trujillo, Annie C; Press, Hayes N.	Handling Non-Normal Situations
+ Crew Procedures for Continuous Descent Arrivals Using Conventional Guidance	2007	Oseguera-Lohr, Rosa M; Williams, David H; Lewis, Elliot T.	Flight Management
+ Terrain Portrayal for Synthetic Vision Systems Head-Down Displays Evaluation Results	2007	Hughes, Monica F; Gtaab, Louis J.	Synthetic Vision
+ A Description of the "Crow's Foot" Tunnel Concept	2006	Parrish, Russell V; Williams, Steven P; Arthur, Jarvis J, II; Kramer, Lynda J; Bailey, Randall E; Prinzel, Lawrence J, II; Norman, R. Michael	Synthetic Vision
+ Adaptive and Adaptable Automation Design A Critical Review of the Literature and Recommendations for Future Research	2006	Prinzel, Lawrence J, II; Kaber, David B.	Human-Automation Systems
+ Automated, on-board terrain analysis for precision landings	2006	Rahman, Zia-ur; Jobson, Daniel J; Woodell, Glenn A.; Hines, Glenn D.	Enhanced Vision; Image Processing
+ Crew and Display Concepts Evaluation for Synthetic Enhanced Vision Systems	2006	Bailey, Randall E; Kramer, Lynda J; Prinzel, Lawrence J, II	Synthetic Vision; Enhanced Vision
+ Dynamic Tunnel Usability Study Formal Recommendations for Synthetic Vision System Primary Flight Displays	2006	Arthur, Jarvis J, II; Prinzel, Lawrence J, II; Kramer, Lynda J; Bailey, Randall E.	Synthetic Vision
+ Human Factors Considerations for Area Navigation Departure and Arrival Procedures	2006	Barhydt, Richard; Adams, Catherine A.	Human Performance
+ Human Factors Considerations for Performance-Based Navigation	2006	Barhydt, Richard; Adams, Catherine A.	Human Performance
+ Improving Situational Awareness for First Responders via Mobile Computing	2006	Betts, Bradley J; Mah, Robert W.; Pappas, Richard; Del Mundo, Rommel; Mckintosh, Dawn M.; Jorgensen, Charles	Multi-Modal Interfaces
+ Multimodal Platform Control for Robotic Planetary Exploration Missions	2006	Jorgensen, Charles; Betts, Bradley J.	Multi-Modal Interfaces
+ Progress in Development of an Airborne Turbulence Detection System	2006	Hamilton, David W.; Proctor, Fred H.	Weather Sensing
+ Real-time Enhancement, Registration, and Fusion for a Multi-Sensor Enhanced Vision System	2006	Hines, Glenn D.; Rahman, Zia-ur; Jobson, Daniel J; Woodell, Glenn A.	Enhanced Vision; Image Processing
+ Small Aircraft Transportation System Higher Volume Operations Concept	2006	Abbott, Terence S.; Consiglio, Maria C.; Baxley, Brian T.; Williams, Daniel M.; Jones, Kenneth M.; Adams, Catherine A.	Operations
+ Study of Synthetic Vision Systems (SVS) and Velocity-vector Based Command Augmentation System (V-CAS) on Pilot Performance	2006	Liu, Dahai; Goodrich, Ken; Peak, Bob	Synthetic Vision

Done



# IIFD Technical Track (Thu/Fri)

**Objectives: Team-building, exposure, dissemination, invitation**

◆ **Session 1, Thu, 0800-0945**

Crew-Vehicle Interfaces (4)

Chair: Randy Bailey

◆ **Session 2, Thu, 1000-1200**

System Design and Analysis (4)

Chair: Mike Feary

◆ **Session 3, Thu, 1315-1515**

Robust Automation-Human Systems (4)

Chair: Kara Latorella

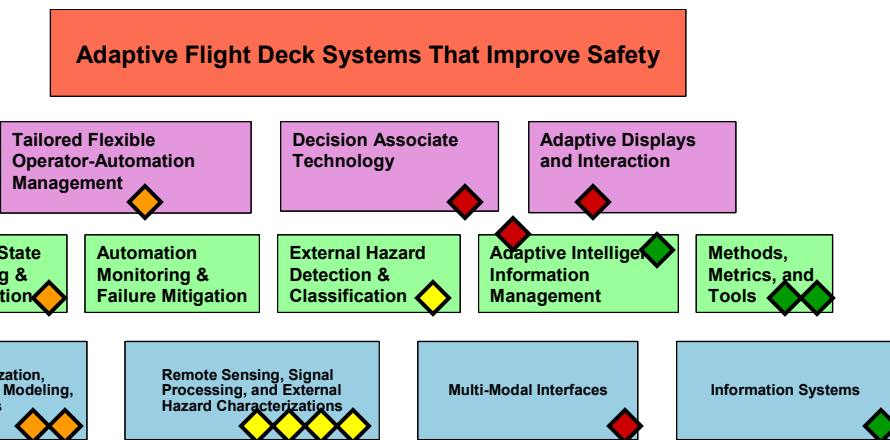
◆ **Session 4, Thu, 1530-1730**

External Hazard Detection (5)

Chair: Robert Neece

**Session 5, 0800-0930, Fri**

“The 3 C’s: Collaboration, Coordination, and Communication”



**Session X, 1900-2100, Thu**  
IIFD SOCIAL EVENT!  
Kitchen-K Restaurant, Kitchen-K.com