

ICS

INTEGRATED COCKPIT SENSING

Monitors, Integrates, Stores, Analyzes, & Alerts



DESIGNED TO EXPLAIN THE PREVIOUSLY UNEXPLAINABLE



FOR THE NEXT GENERATION of aviators, aircraft will reach new levels of performance and pose increasing physiological challenges. Keeping the aviator safe while performing at the highest levels requires a fuller knowledge of the human in high-performance flight in order to build both human and machine survival into the aircraft's design.



National Commission on Military Aviation Safety. (2020). Report to the President and the Congress of the United States

Program Summary

The Challenge

The DoD has ongoing concerns regarding physiological events affecting pilots of training, fighter, and attack aircraft, with both the USAF and USN grounding aircraft and expending considerable resources in search of root causes and solutions. Ongoing research and development efforts are seeking to improve the basic scientific understanding of physiological performance in these environments, along with efforts to develop physiological sensors that are effective in the cockpit for assessing pilot state and detecting conditions conducive to **unexplained physiological episodes** (UPEs).

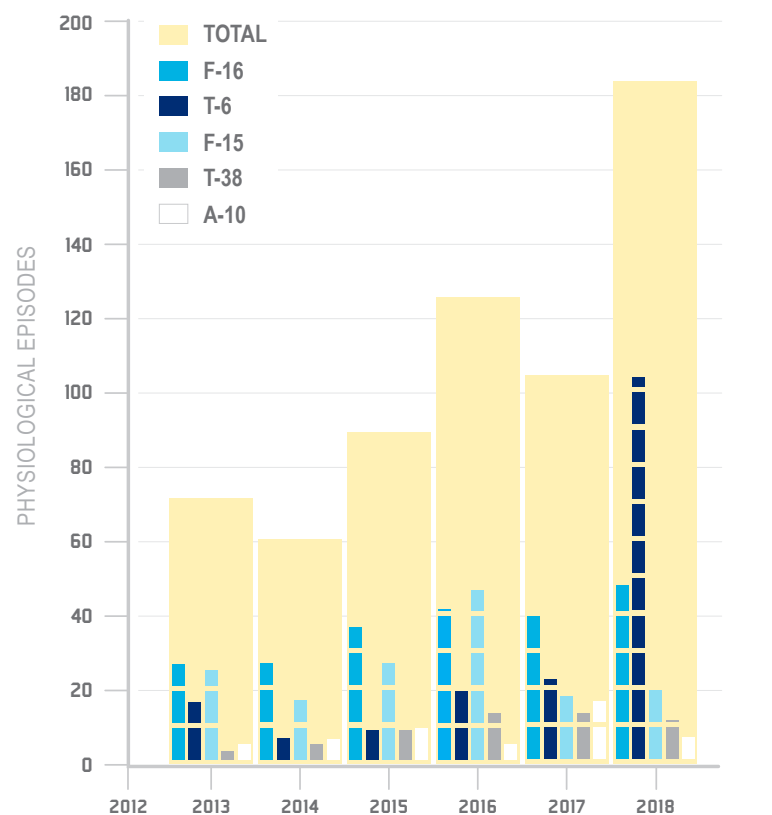
The Opportunity

Cockpit sensing remains a key gap, as there are no fielded solutions to provide data for root cause analysis, which in turn could drive pilot decision making as well as resource prioritization for life support systems modification.

Our Solution

The ICS program's objective is to experiment, develop, prototype, and demonstrate a prototype integrated sensor suite capability for effective cockpit sensing, including pilot physiology and cockpit environments matured to Technology Readiness Level (TRL) 7 for program office transition in a standalone form factor that does not require aircraft power or data feeds.

USAF Physiological Episodes in Fighter and Trainer Aircraft: FY 2013-2018*



Plot derived and replotted from NCMAS Data

718
TOTAL
UPEs
WITHIN 6 YEARS

The most effective means to understand and prevent future unexplained physiological episodes is to gather and evaluate data on what is happening real time to aircrew during actual flight, from initial aircraft development throughout the operational life cycle – a "black box" for the pilot.*

The ICS System is designed to improve pilot safety and performance by explaining the previously unexplainable

Managed by AFRL in partnership with AFLCMC

The ICS system supports evaluation against Key Performance Parameters (KPPs) for Force Protection*:

- Breathing air pressure and oxygen levels
- Pressurization
- G-force loading
- Temperature limits
- "With the vital need for data collection to enhance predictive initiatives, the force protection KPP should also include ... biometric sensing for the aircrew."



The Integrated Cockpit Sensing system provides *onboard analytics* and *alerting* to the pilot without significant additional workload.

Provides *real-time data* based on measurement of pilot vital signs, air quality, cockpit environment, and respiratory function – reducing mishap probability.



Provides *post flight analysis*, aiding in root cause analysis and reducing prolonged aircraft grounding and providing data to *improve after action reviews* and *pilot training*.

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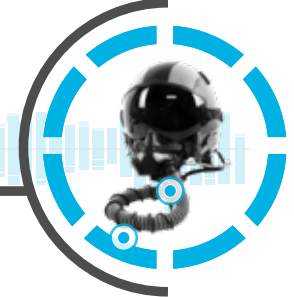
LIFE SUPPORT SYSTEM PERFORMANCE



COCKPIT & FLIGHT ENVIRONMENT

REAL-TIME MONITORING & ALERTS

- AIR QUALITY
- ALTITUDE
- OXYGEN
- PRESSURE
- TEMPERATURE
- PILOT NOTIFICATIONS



HELMET-BASED SENSING



- Real-Time Monitoring
- Blood Oxygen Saturation
- Heart Rate
- 3-Axis Acceleration
- Cabin Altitude

BASE LAYER SENSING



- Real-Time Monitoring
- Heart Rate
- Respiration Rate
- Core Body Temperature
- Acceleration

ICS PROCESSOR



- Real-Time Data Processing
- Onboard Analytics
- Data Repository
- Monitors
- Integrates
- Stores Real-time Data
- Analyzes
- Alerts & Notifications

LIFE SUPPORT SENSING



- Real-Time Monitoring
- Oxygen
- Air Flow
- Respiration
- Air Pressure
- Cabin Pressure
- Air Temperature
- Air Humidity

Development Priorities

- IMPROVE PILOT SAFETY AND PERFORMANCE
- COMPREHENSIVE SENSING CAPABILITIES
- MINIMIZE PILOT WORKLOAD
- OPEN SYSTEM DESIGN FOR:
 - Sensors
 - Analytics
 - Multimodal Alerting Interfaces
 - Data Storage
- RELIABILITY, ACCURACY, AND VALIDITY
 - System Verification in Simulated and Actual High-Performance Flight Conditions.
- TRANSITION
 - Technical Data Package with Unlimited Rights to the Government.

Development Team

- Air Force Research Laboratory, 711th Human Performance Wing, Airman Biosciences Division (711HPW/RHB)
- Ball Aerospace
- Operator Performance Laboratory (OPL), Iowa Technology Institute (ITI)
- Lockheed Martin
- Collins Aerospace
- Aptima
- Elbit Systems
- Eaton Mission Systems Division



Sensing Capabilities



PILOT PHYSIOLOGY

- Blood Oxygen Saturation
- Blood Perfusion
- Heart & Pulse Rate
- Heart & Pulse Rate Variability
- Estimated Core Temperature
- Skin Temperature



AIR QUALITY

- Oxygen Partial Pressure
- Carbon Dioxide Partial Pressure
- Air Flow
- Air Pressure
- Air Temperature
- Air Humidity
- Mask Pressure



FLIGHT ENVIRONMENT

- Acceleration
- Altitude
- Cabin Pressure / Altitude
- Cabin Temperature
- Time Synchronization



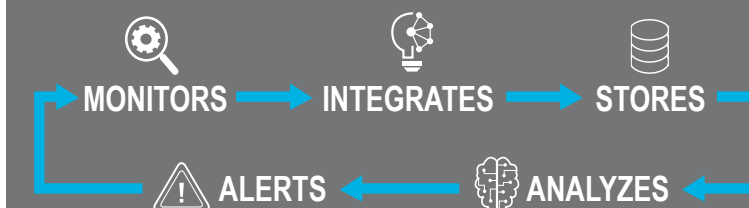
RESPIRATORY FUNCTION

- Respiration Rate
- Work of Breathing

Processing + Data Repository



ONBOARD ANALYTICS



DATA REPOSITORY

- Stores real-time data
- Supports analytics development
- Supports discovery of root cause and corrective action investigations
- Stores performance data further defining UPEs

Outcomes + Applications



DEFINE the "Unexplainable"

Reducing number of Physiological Mishaps



INCREASE Mission Effectiveness

Reduce Groundings, Keep Planes in the Air



REDUCE Logistics Cost

Fewer Aircraft Tear Downs



IMPROVE Training

Better After-Action Reviews

The most effective investment in preventing physiological episodes occurs in the design, development, and test phases. Instrumentation that monitors the pilot in flight as part of the weapons system provides early problem detection and at the lowest cost to resolve human-machine interface problems.

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POINTS OF CONTACT

Capt Carlos Esguerra

ICS Program Manager

Air Force Research Lab
711 Human Performance Wing

carlos.esguerra@us.af.mil

Chris Dooley

ICS Lead Engineer

Air Force Research Lab
711 Human Performance Wing

christopher.dooley.9@us.af.mil

Ethan Blackford

Program Manager

Ball Aerospace

ethan.blackford@ballaerospace.com

LEARN MORE
ABOUT ICS'S
MISSION TO
REDEFINE
PILOT SAFETY



ICS

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