AEROMEDICAL ASPECTS OF THE U.S. ARMY'S FUTURE VERTICAL LIFT PROGRAM

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FUTURE VERTICAL LIFT OVERVIEW

Future Attack Reconnaissance Aircraft (FARA)

Future Unmanned Aircraft Systems (FUAS)

Future Long Range Assault Aircraft (FLRAA)

Modular Open System Architecture (MOSA)

WHAT ARE AEROMEDICAL ISSUES IN THE FUTURE VERTICAL LIFT PROGRAM?

		Frequently Cited FVL Aeromedical "Issues"	
1	**Future Attack Recon Aircraft (FARA)**	Speed Maneuverability	Mission Length Cognitive Workload
2	**Future Unmanned Aircraft Systems (FUAS)**	*Fatigue*	
3	**Future Long-Range Assault Aircraft (FLRAA)**	Speed Maneuverability **En Route Care**	Mission Length Cognitive Workload **Motion Sickness (PAX)**
4	**Modular Open System Architecture (MOSA)**	*Mission Systems*	

What are the Aeromedical Issues in the Future Vertical Lift program?

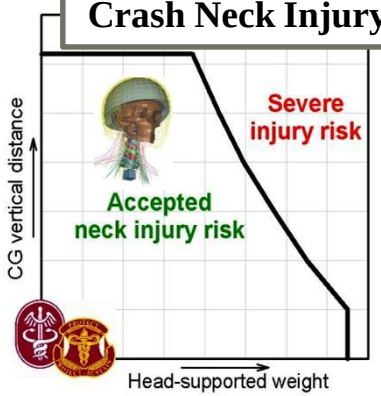
FVL Program	FVL Characteristics	Aeromedical Issues
FARA/FLRAA (common elements)	Speed/ agility → Acceleration	→ Sustained Gz
		Whole Body vibration
		Gx impact crash vector → Spinal Injury / Seat Specs
	Mission length	→ Acute/Chronic fatigue
		Musculoskeletal sx
	System complexity	Cognitive overload / Cognitive fatigue
		Maintaining cognitive performance
		Enhancing performance
		Operator biomonitoring / autonomy
FUAS	Mission length → Fatigue	→ Cognitive underload
FLRAA (MEDEVAC)	En Route Care / Flight Environment	→ Vibration, Space, Fatigued Provider → Medical AI
FLRAA (PAX)	MDO	→ Closed Loop Systems
	Warfighter transport	→ Motion sickness
MOSA	Mission systems	Helmet / Displays / Optics / ALSE / Multisensory displays → Head-Supported Mass Neck pain, Medical stds

USAARL HISTORICAL CONTRIBUTIONS

ISO Jolt Standard

Cockpit Air Bags

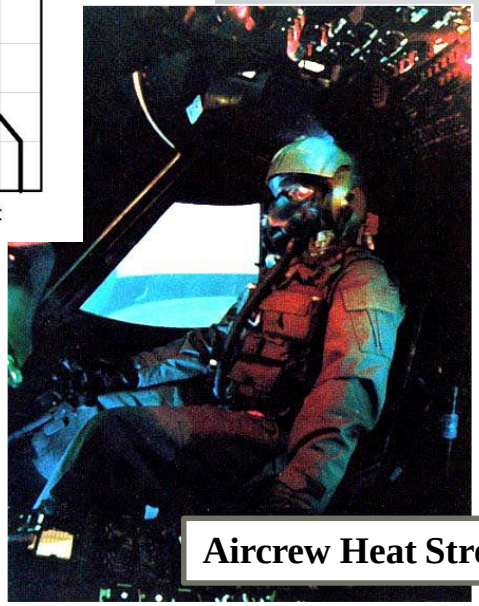
Crash Neck Injury



Crash Helmet Standards

Night Vision Goggles

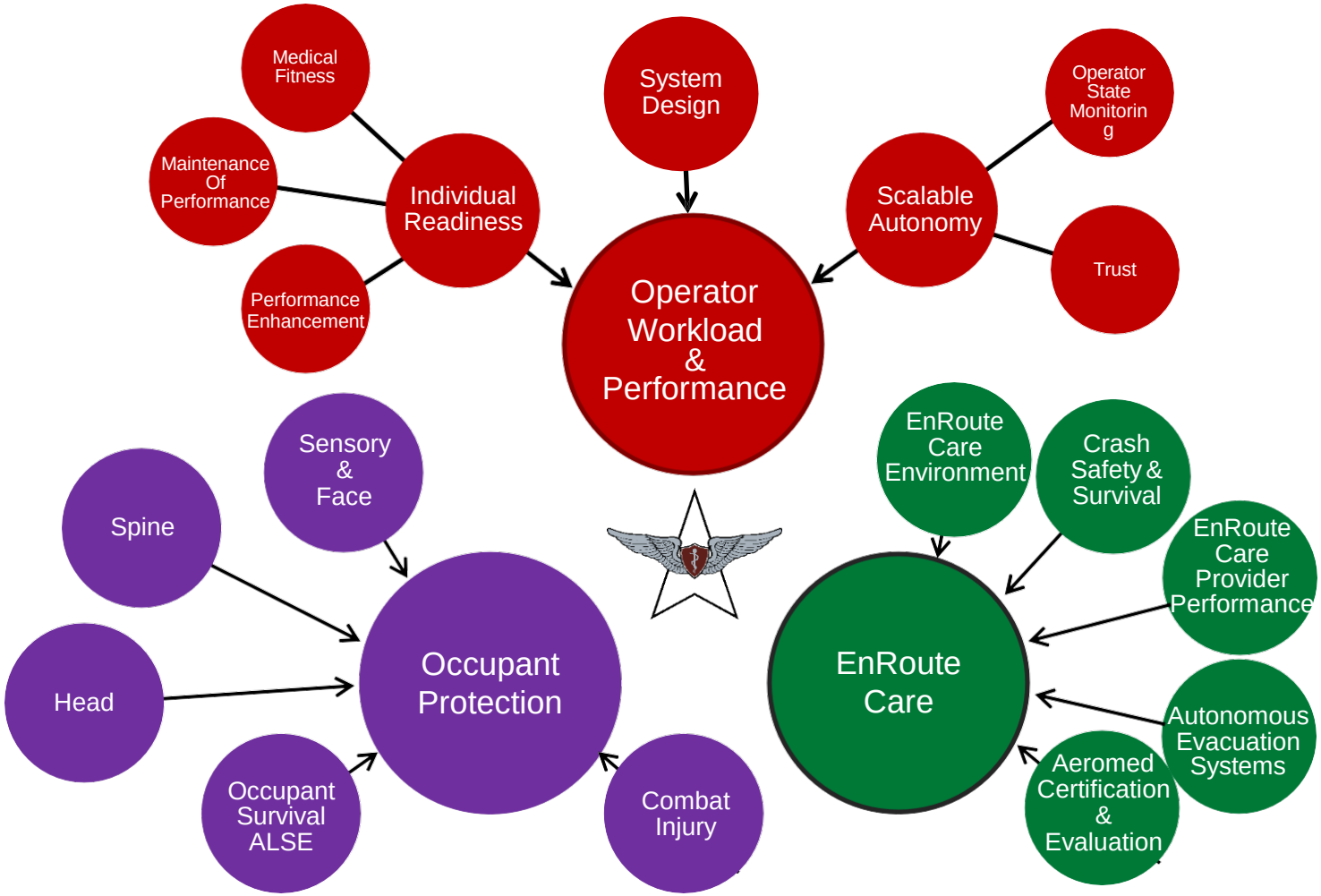
Crash Survival



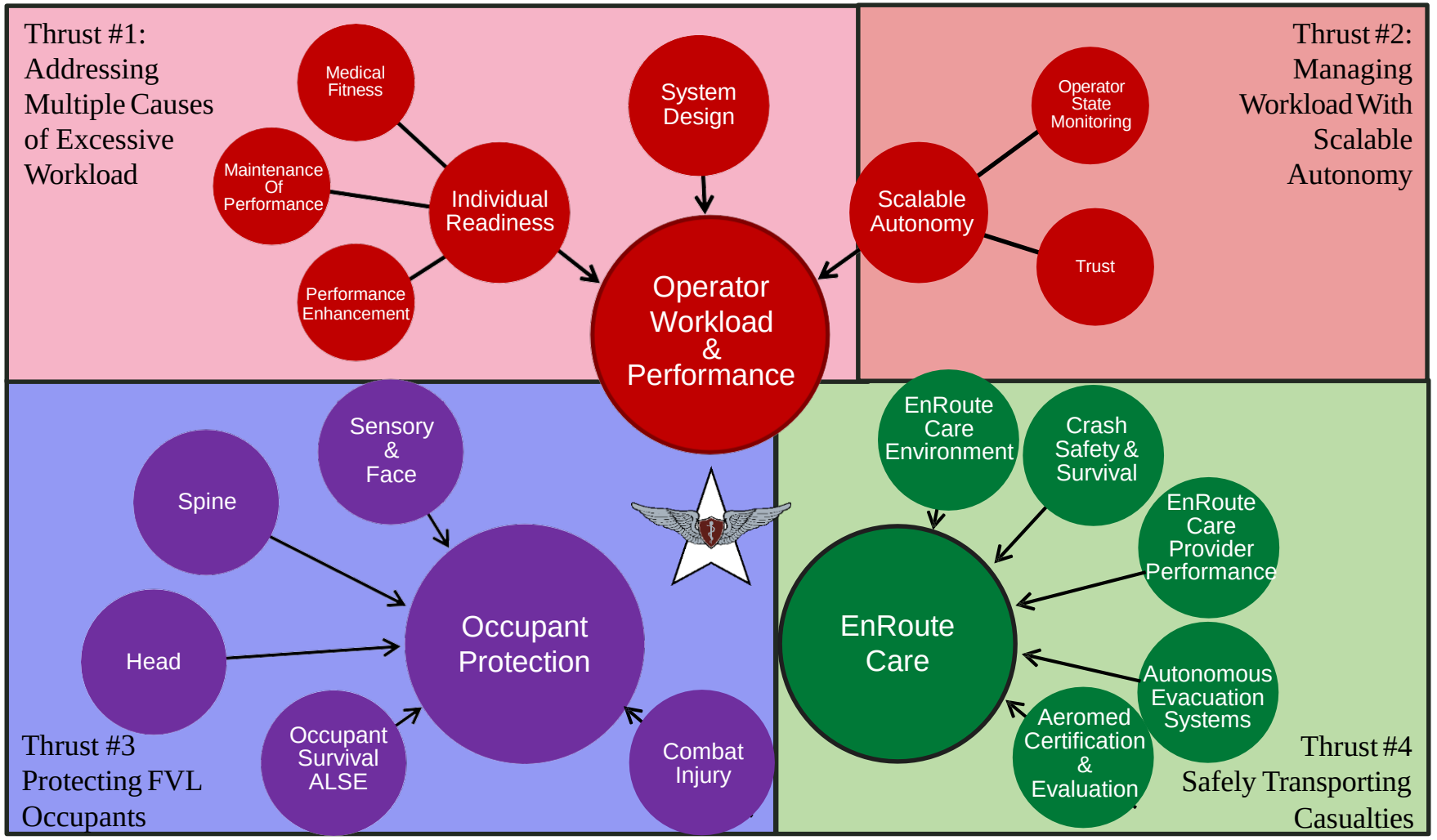
Aircrew Heat Stress

Communication Ear Plugs

Future Vertical Lift Aeromedical Research Program



Future Vertical Lift Aeromedical Research Program

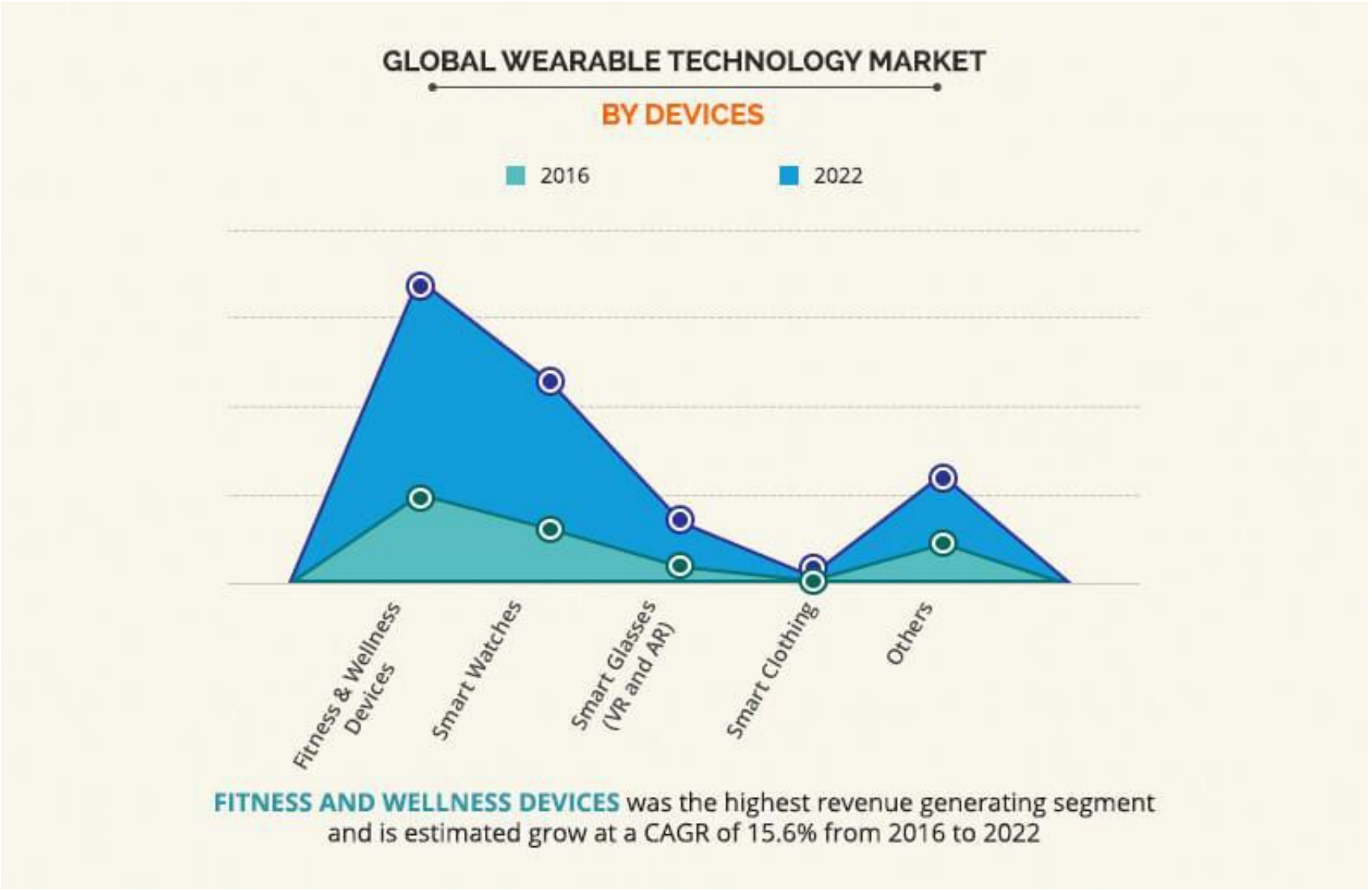


OPERATOR STATE MONITORING TO PREDICT AND DETECT DEGRADED AVIATORS IN REAL TIME

OVERVIEW

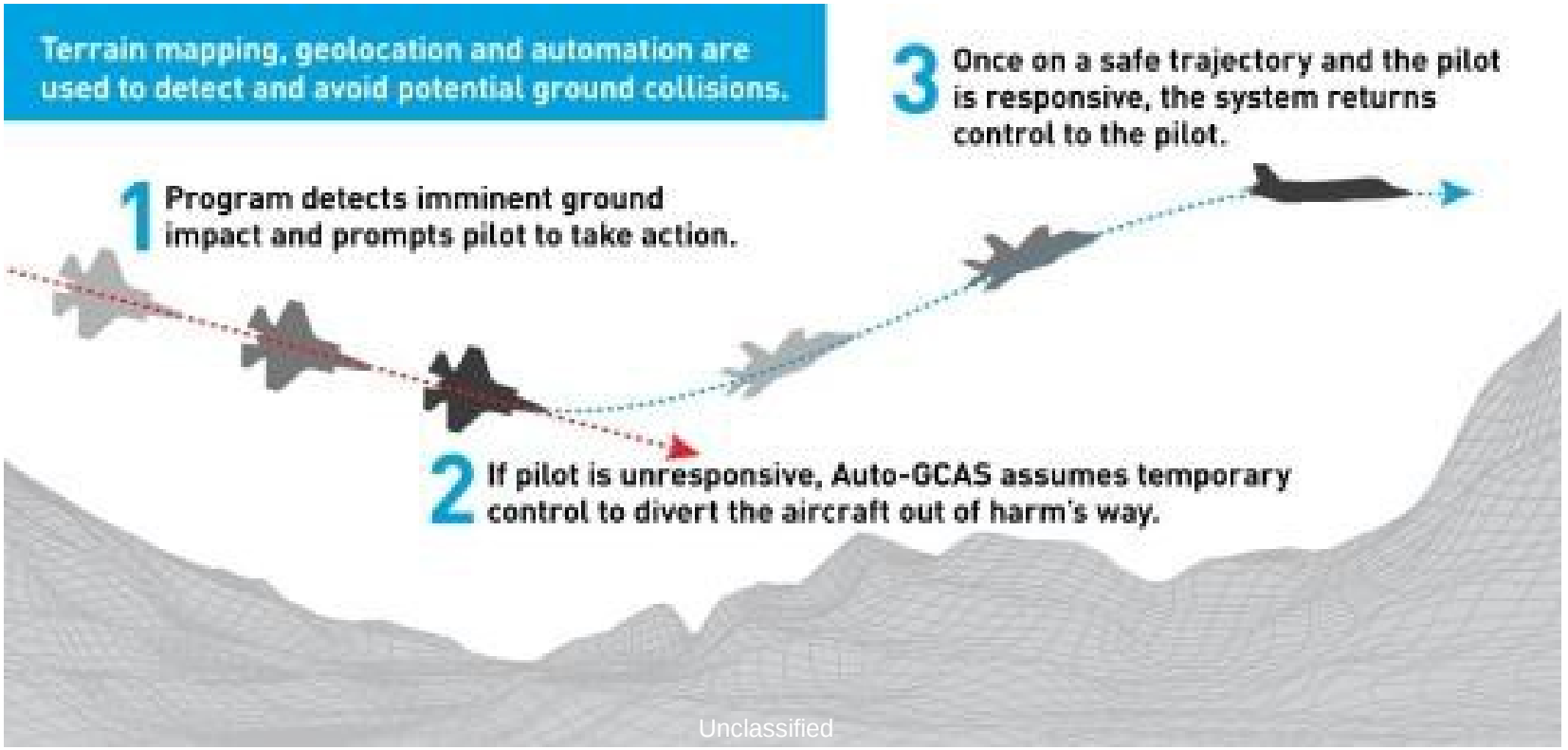
EXPLOSION IN TECH AND INTEREST

EXPLOSION IN TECH AND INTEREST



EXAMPLE: AUTOMATIC GROUND COLLISION AVOIDANCE SYSTEM (AUTO GCAS)

- Human monitoring the aircraft (since the beginning of aviation)
- Aircraft monitoring the aircraft
  - Relevant to this discussion (example)
    - Aircraft is watching for human failure



AIRCRAFT DATA PLUS HUMAN DATA

- Auto-GCAS does not use any data directly from pilot

- Concept for Future Aviation Safety:
  - Combine system data with pilot data
  - Expand range of detected states
  - Take safety of manned aviation to next level

LOTS OF RESEARCH OVER MANY YEARS

Proceedings of the Human Factors and Ergonomics Society Annual Meeting

HFES Systems That Work for Humans

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Article information

Abstract

Thesis | PDF Available

Tools and methods for Human-Autonomy Teaming: Contributions to operator state monitoring and system adaptation

October 2021

Thesis for: HDR

Authors:

Real-Time Monitoring of Cognitive Workload of Airline Pilots in a Flight Simulator with fNIR Optical Brain Imaging Technology

July 2016

DOI:10.1007/978-3-319-39955-3_14

Conference: International Conference on Augmented Cognition

Authors:

International Conference on Augmented Cognition

AC 2014: Foundations of Augmented Cognition. Advancing Human Performance and Decision-Making through Adaptive Systems pp 26-34 | Cite as

Untangling Operator Monitoring Approaches When Designing Intelligent Adaptive Systems for Operational Environments

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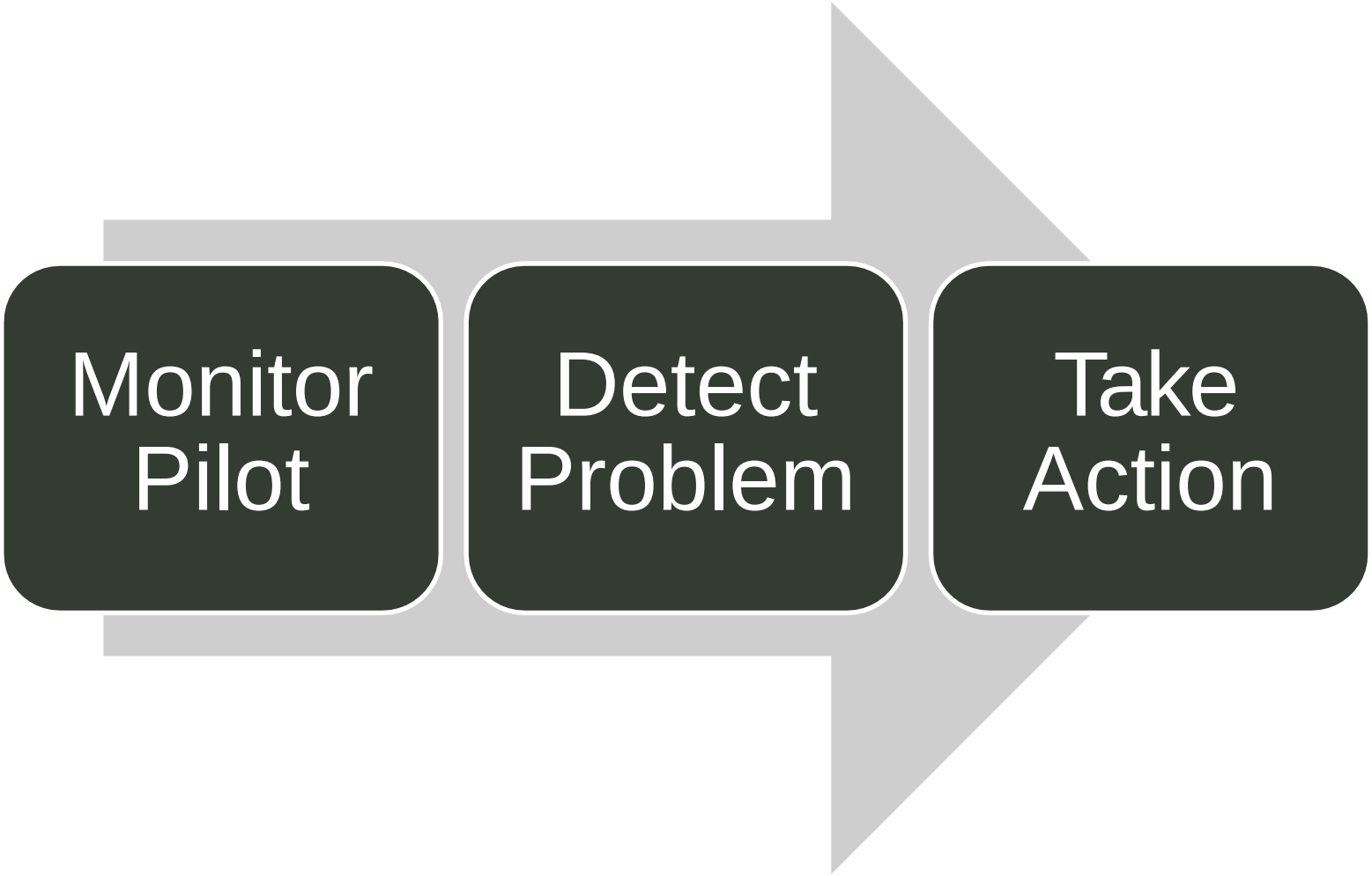
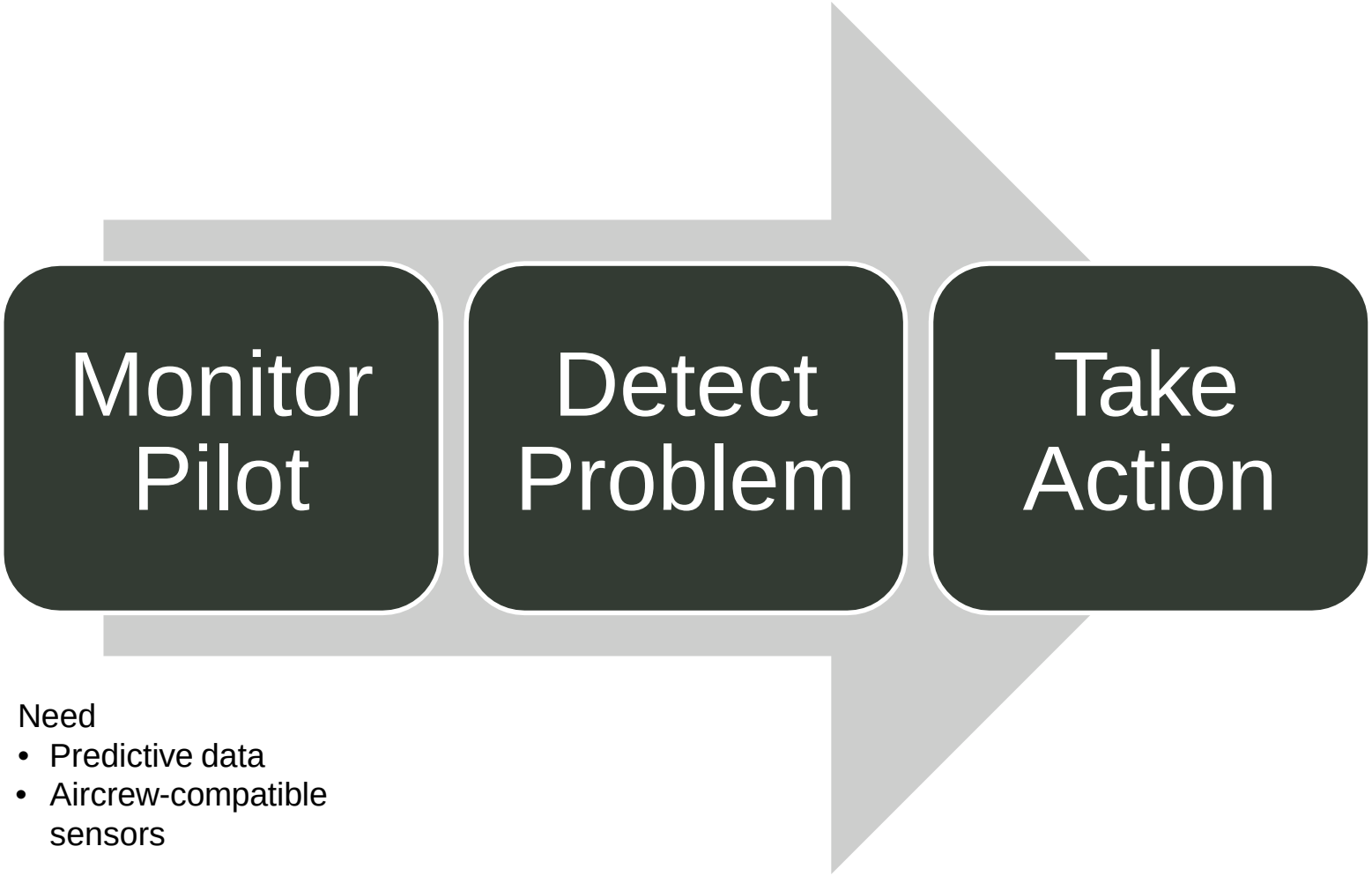
BASIC STEPS IN "OPERATOR STATE MONITORING"



BASIC APPROACH TO MAINTAINING AIRCREW PERFORMANCE

BASIC STEPS IN "OPERATOR STATE MONITORING"

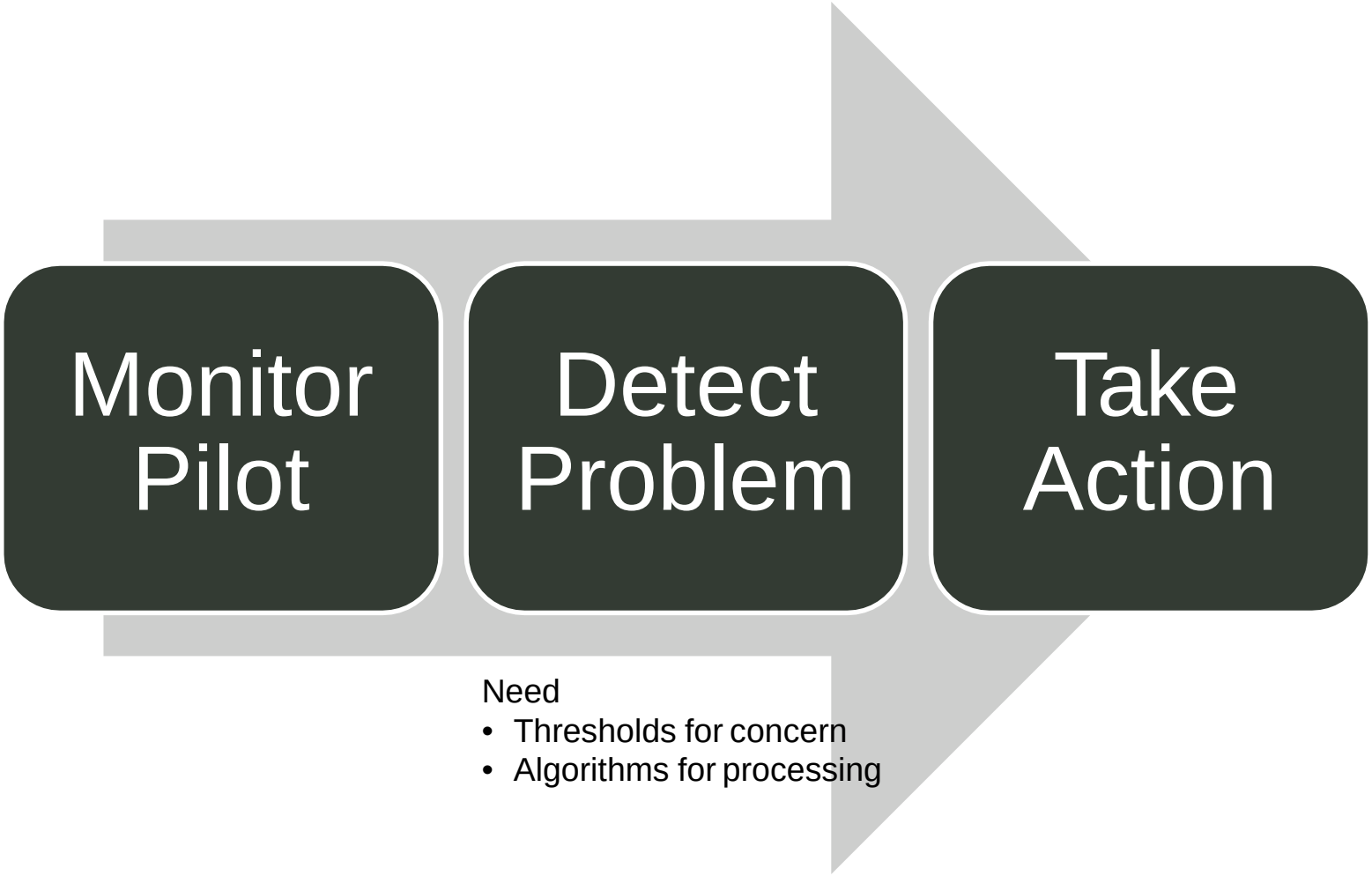


Need
- Predictive data
- Aircrew-compatible sensors

MONITORING THE PILOT

- Data needs
  - Depend on degraded states to be detected
    - e.g, fatigue, hypoxia, excessive workload (or underload)
  - Frequently cited
    - ECG (HR, HRV)
    - EEG
    - Pupillary changes and eye movements
    - Oxygen level in tissue/blood
    - Temperature
- Sensors
  - Myriad vendors with different sensor combinations
  - Compatibility depends on aviation platform environment

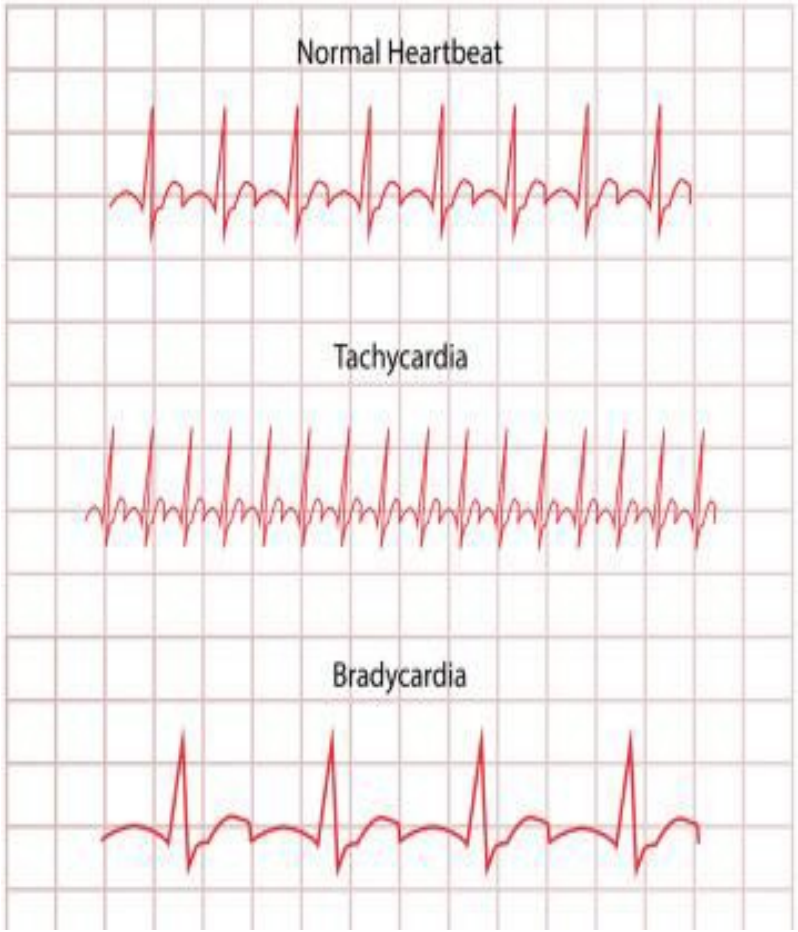
BASIC STEPS IN "OPERATOR STATE MONITORING"



ISSUES WITH DATA PROCESSING AND STATE IDENTIFICATION

- Significant hurdles to overcome
  - Airworthiness certification for opaque systems potentially affecting aircraft
  - Individual differences
    - Within subject variability
      - Ex: circadian variations, mood, caffeine
    - Between subject variability
      - Ex: test pilots vs student pilots – different responses
    - Interfering conditions
      - Medications
      - Health problems affecting data

EXAMPLE: HEART RATE

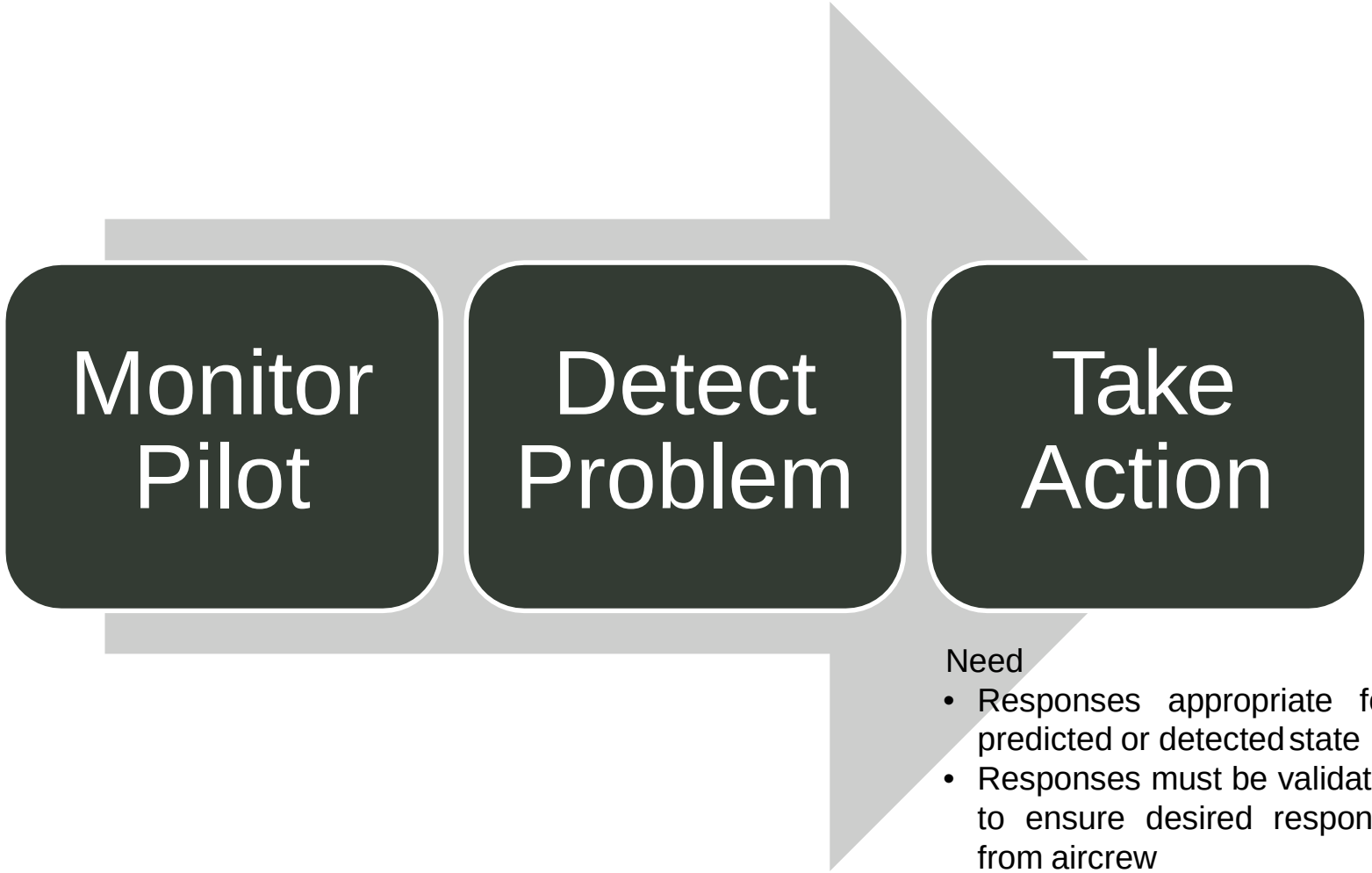


"Normal"

"Stress" for normal aviator
(also dehydration, heat, workload
physical exertion, fatigue)

"Normal" for marathon runner
"Normal" when on certain medications
(even if maximally stressed)

BASIC STEPS IN "OPERATOR STATE MONITORING"



Need

- Responses appropriate for predicted or detected state
- Responses must be validated to ensure desired response from aircrew

ADDITIONAL CONCERNS

- Systems may ultimately need to be individualized
  - May need frequent recalibration
- Monitoring aircrew is complicated
  - Resistance from aircrew
    - Concerns about grounding
    - Health-related uses and privacy concerns
- System MUST NOT interfere with pilot's performance
- System MUST be superior to simple manual control of workload/displays/task allocation by aircrew

WHAT DOES THIS MEAN FOR MILITARY AVIATION SAFETY?

- High potential for increased safety in the future
- Potential benefit to aeromedical certification

- High technical risk in short term
- Must leverage enormous investment in human monitoring around world
  - Industry, Sports, DoD

- Aviation community must conduct research targeted at our environment
  - Physical environment
  - Social environment
  - More rigorous than most other applications

COMMENTS / QUESTIONS?

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