Today's Human Factors Challenges, Tomorrow's Vision

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Federal Aviation Administration

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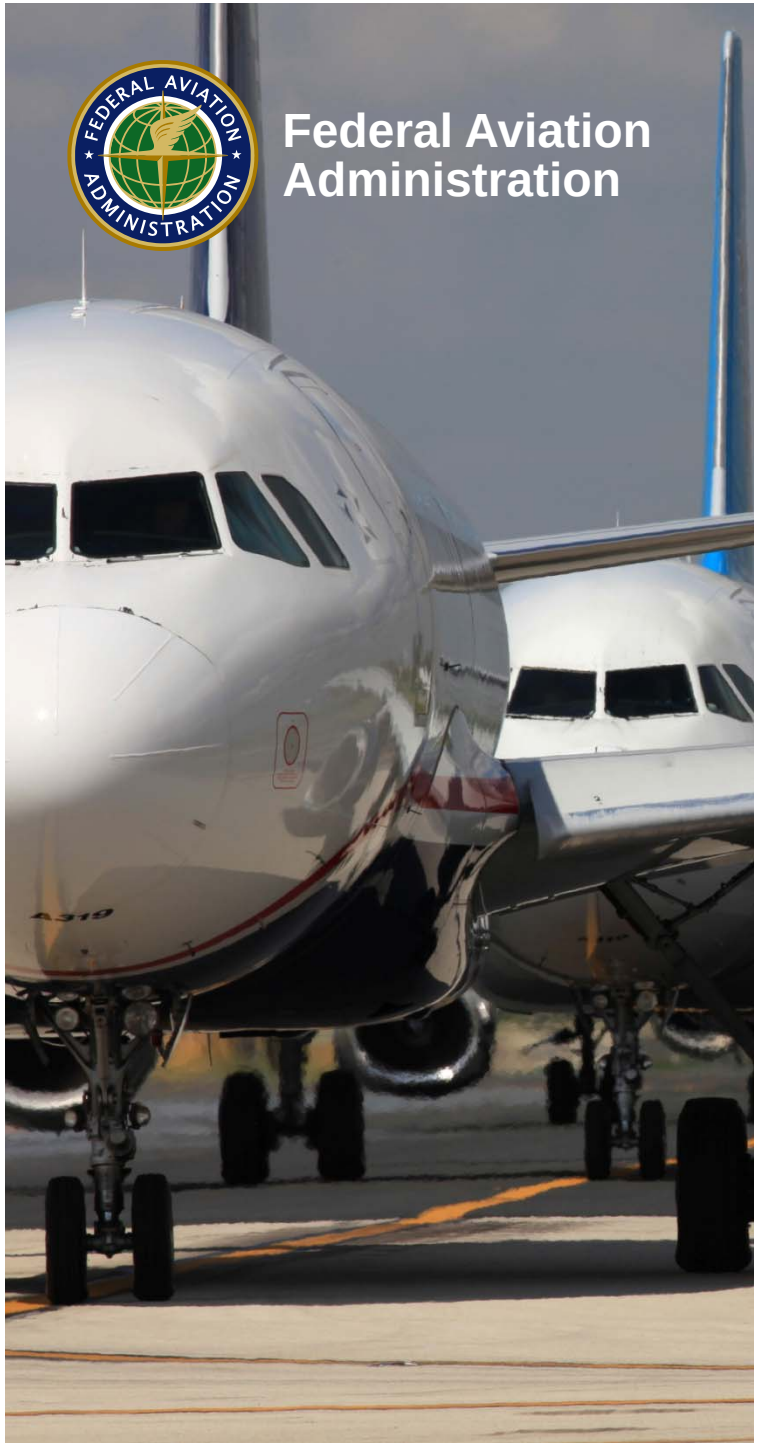
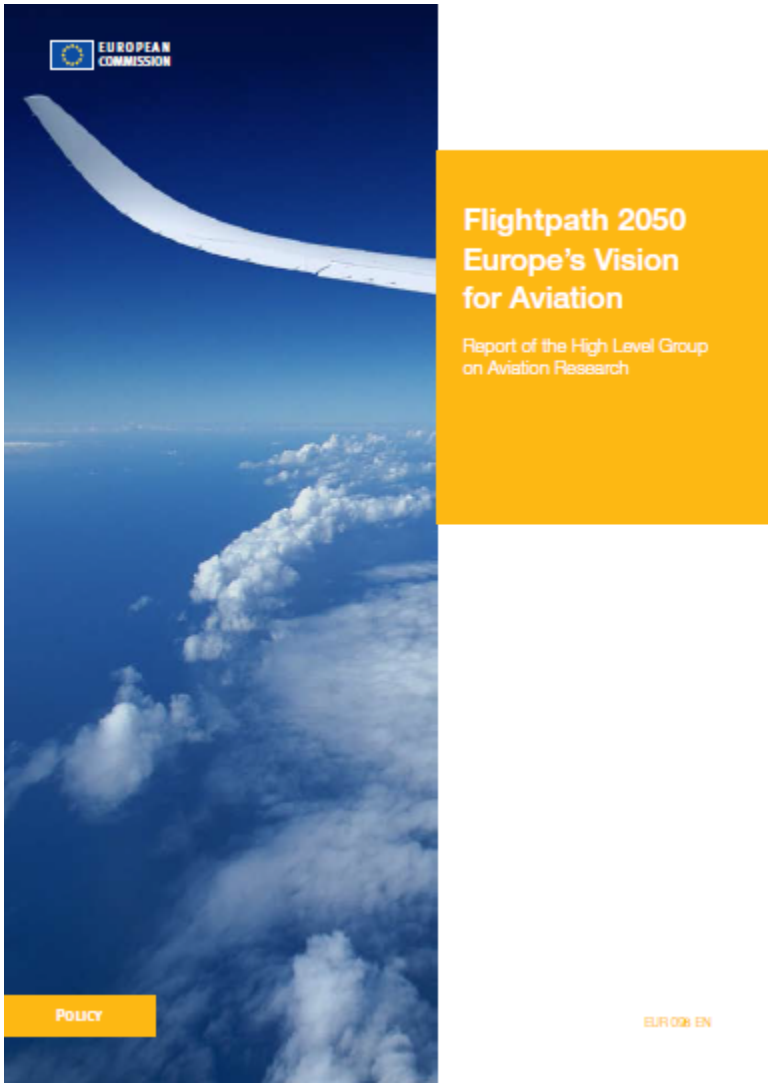


Flightpath 2050

- **Societal and market needs**
- **Industrial leadership**
- **Environment and energy**
- **Safety and security**
- **Prioritizing research**



http://ec.europa.eu/transport/modes/air/doc/flightpath2050.pdf

Characteristics of Civil Aviation

- **Dynamic**
- **Complex**
- **Market driven**
- **Rapidly changing technology**

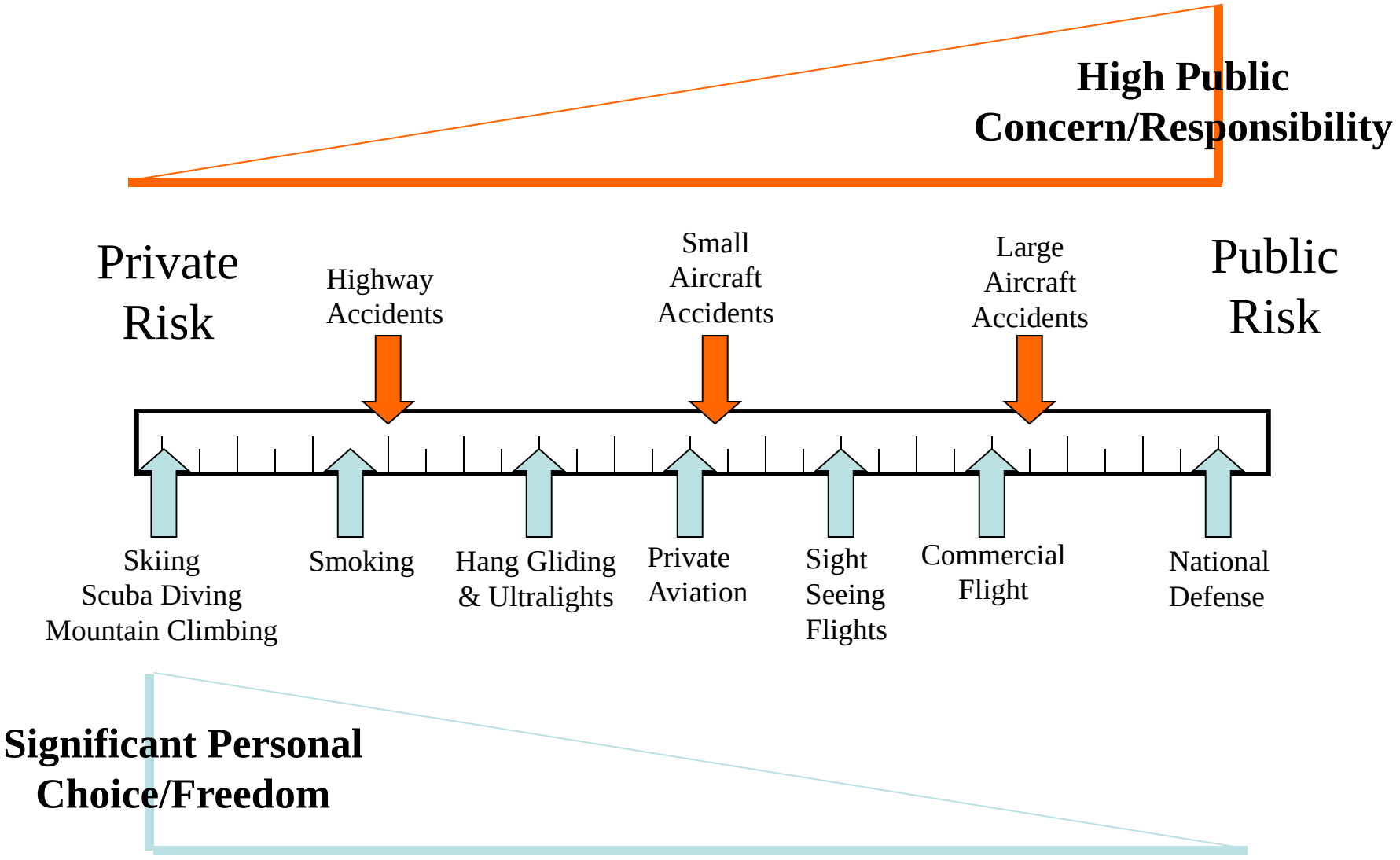
Outline

- **Challenges**
- **Vision**
- **HF R&D to support the vision**

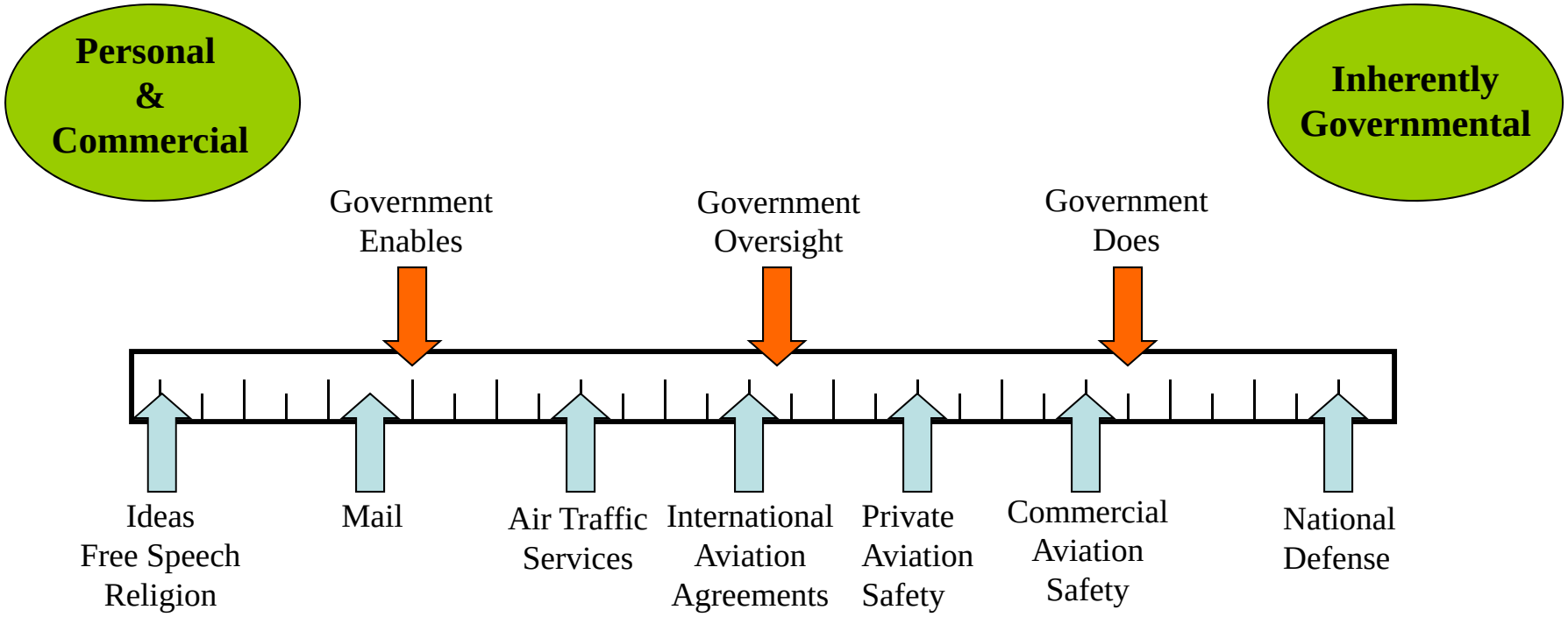
Challenges for Aviation Safety

- **Societal expectations for safety**
- **One size does not fit all**
- **Increasing amounts and types of operational data**
- **Pressures: economic, security, environmental**
- **Changing workforce demographics**
- **Changes in technology and operations**
- **Where to put risk mitigation**

“Personal” vs. “Public” Risk Assumption

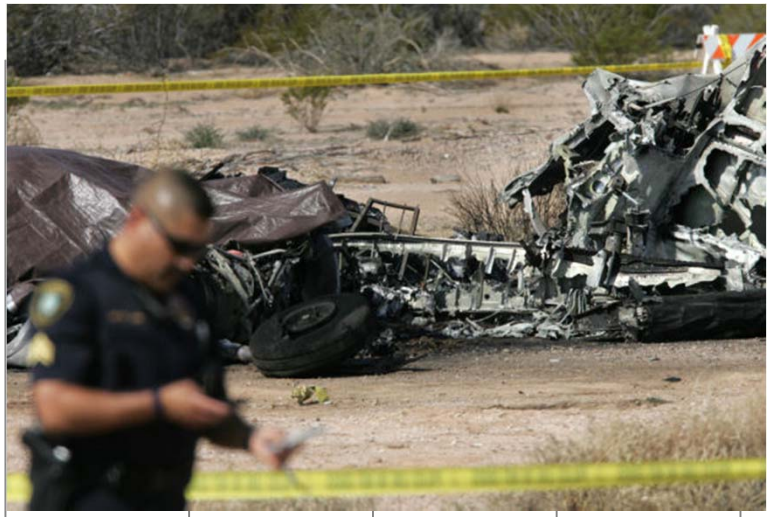


Governmental Role

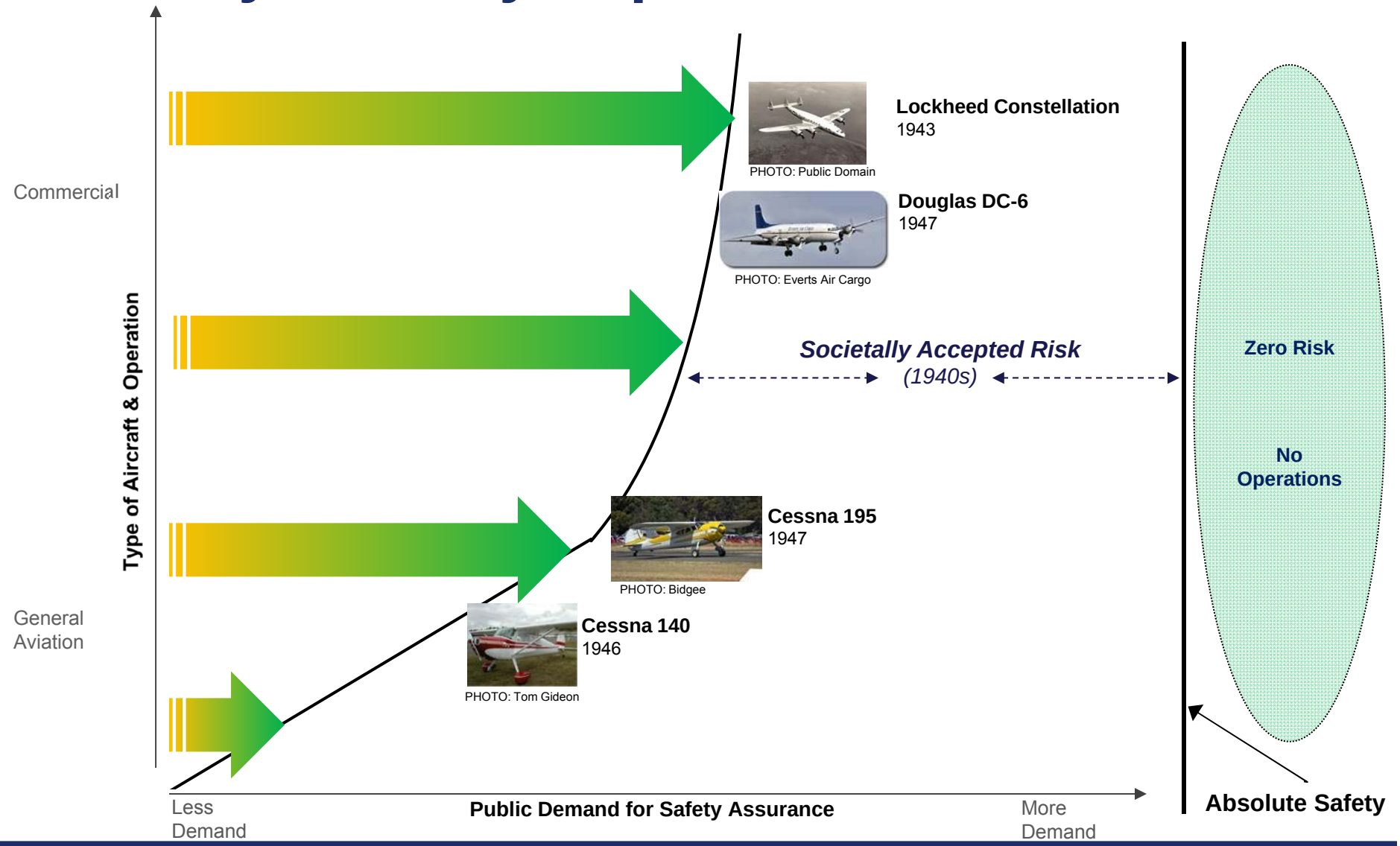


U.S. Aviation Fatal Accident Rates

Annual Average from 2005 through 2009

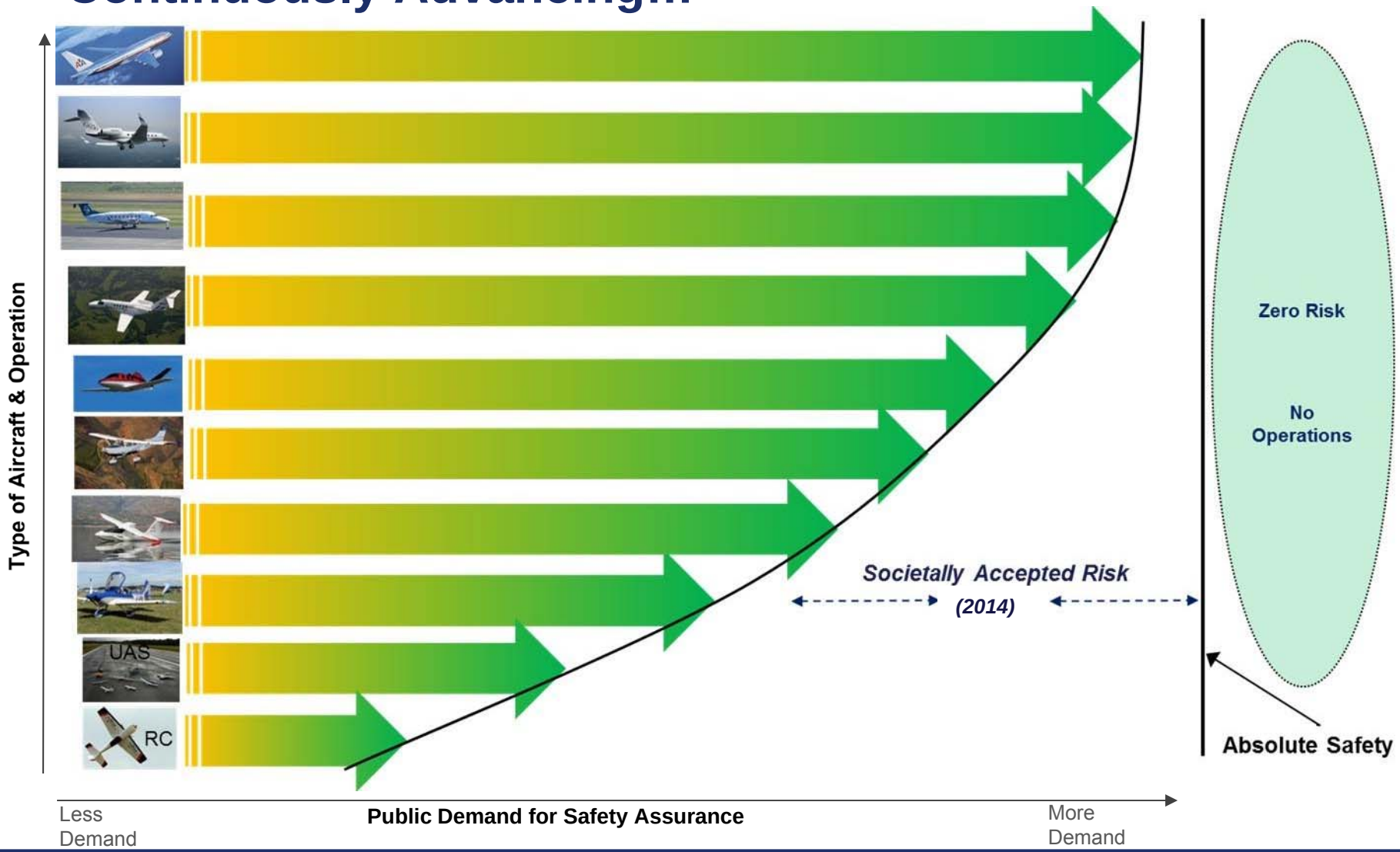


Society's Safety Expectations – Circa 1945



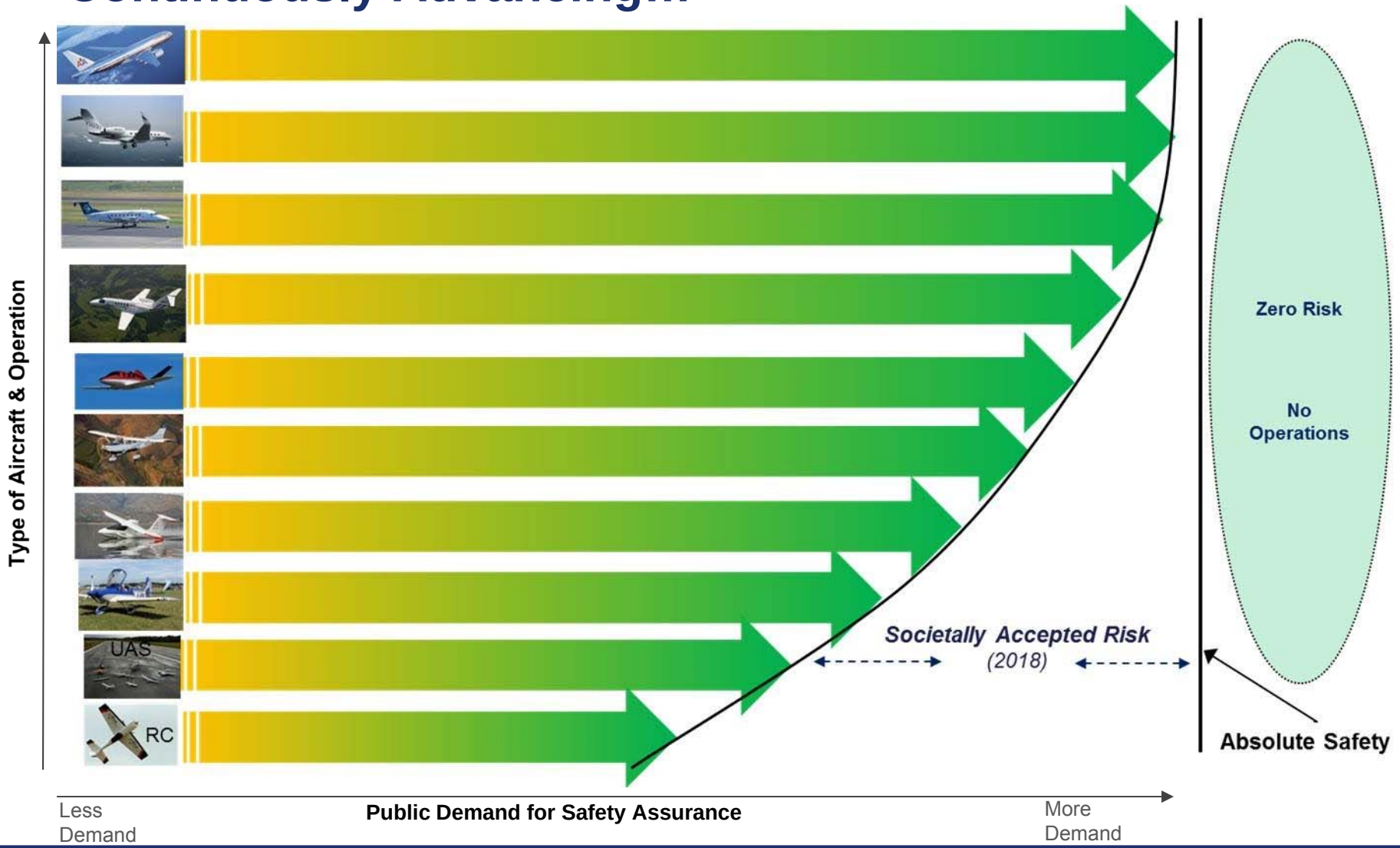
Society's Safety Expectations – Today

Continuously Advancing…



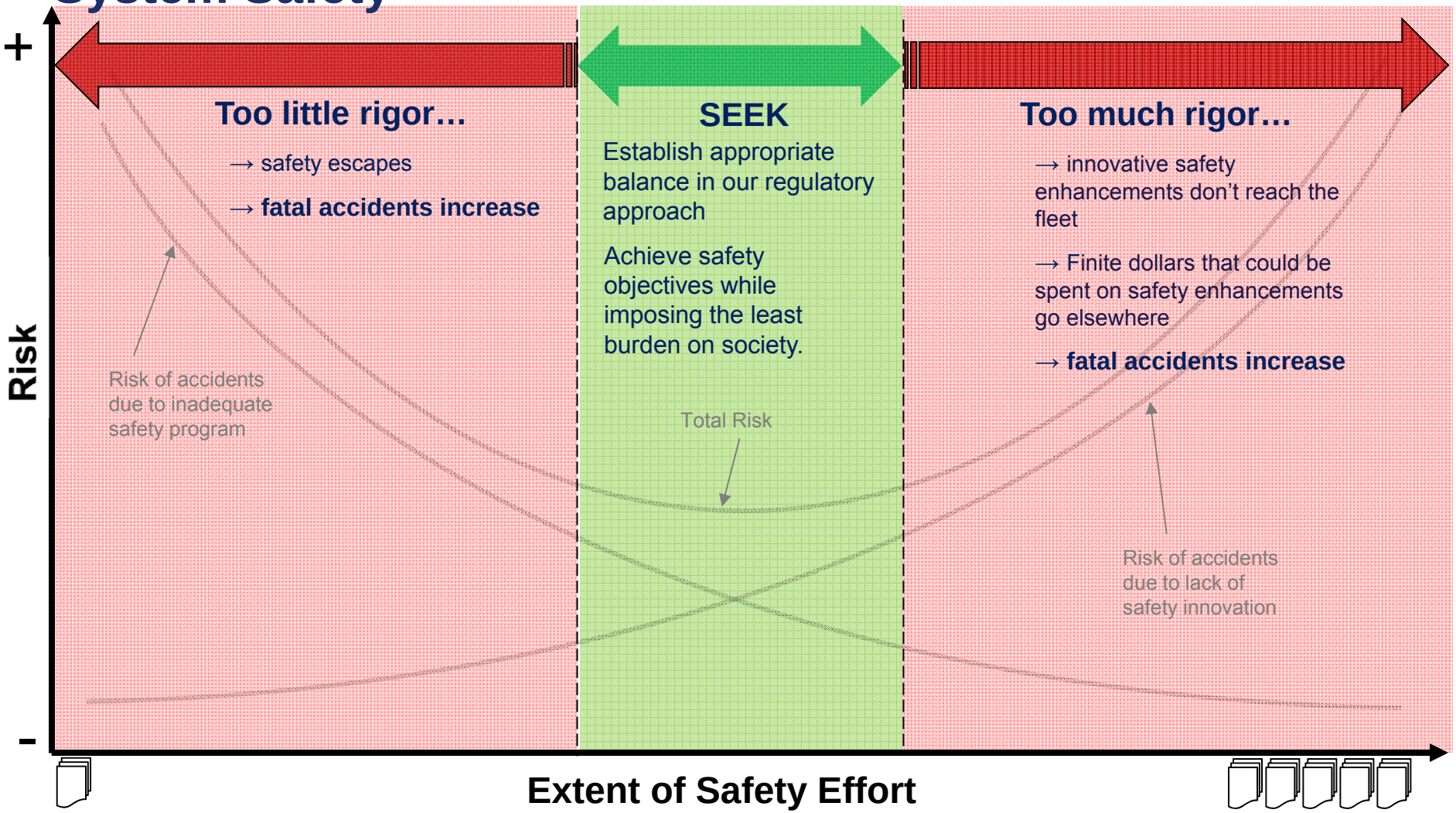
Society's Safety Expectations – 2018

Continuously Advancing…



Applying the Safety Continuum

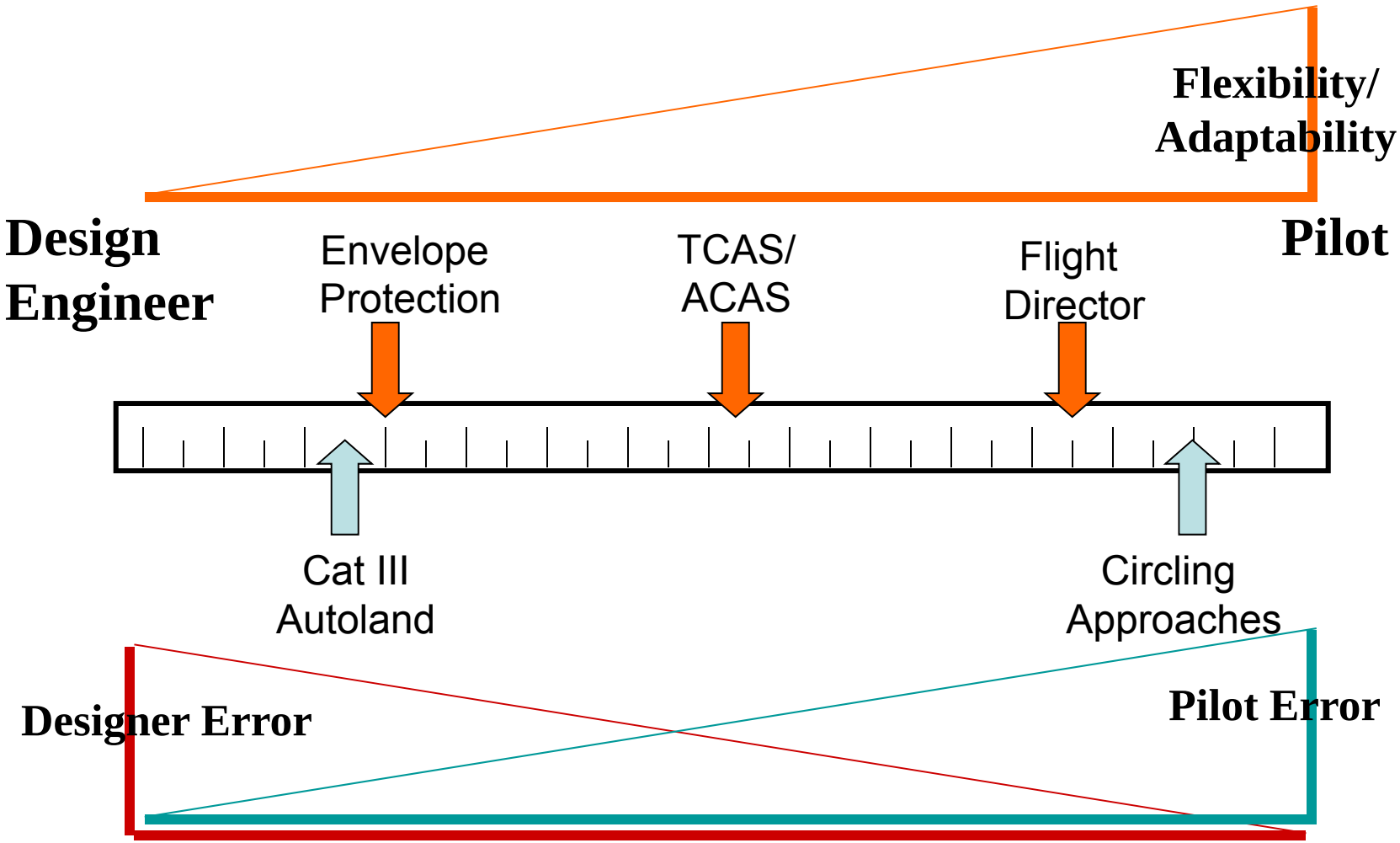
System Safety



Challenges for Aviation Safety

- Societal expectations for safety
- One size does not fit all
- **Increasing amounts and types of operational data**
- **Pressures: economic, security, environmental**
- **Changing workforce demographics**
- **Increase in “non-routine” operations**
- **Understanding current operations**
- **Changes in technology and operations**
- **Where to put risk mitigation**

Where to put risk mitigation

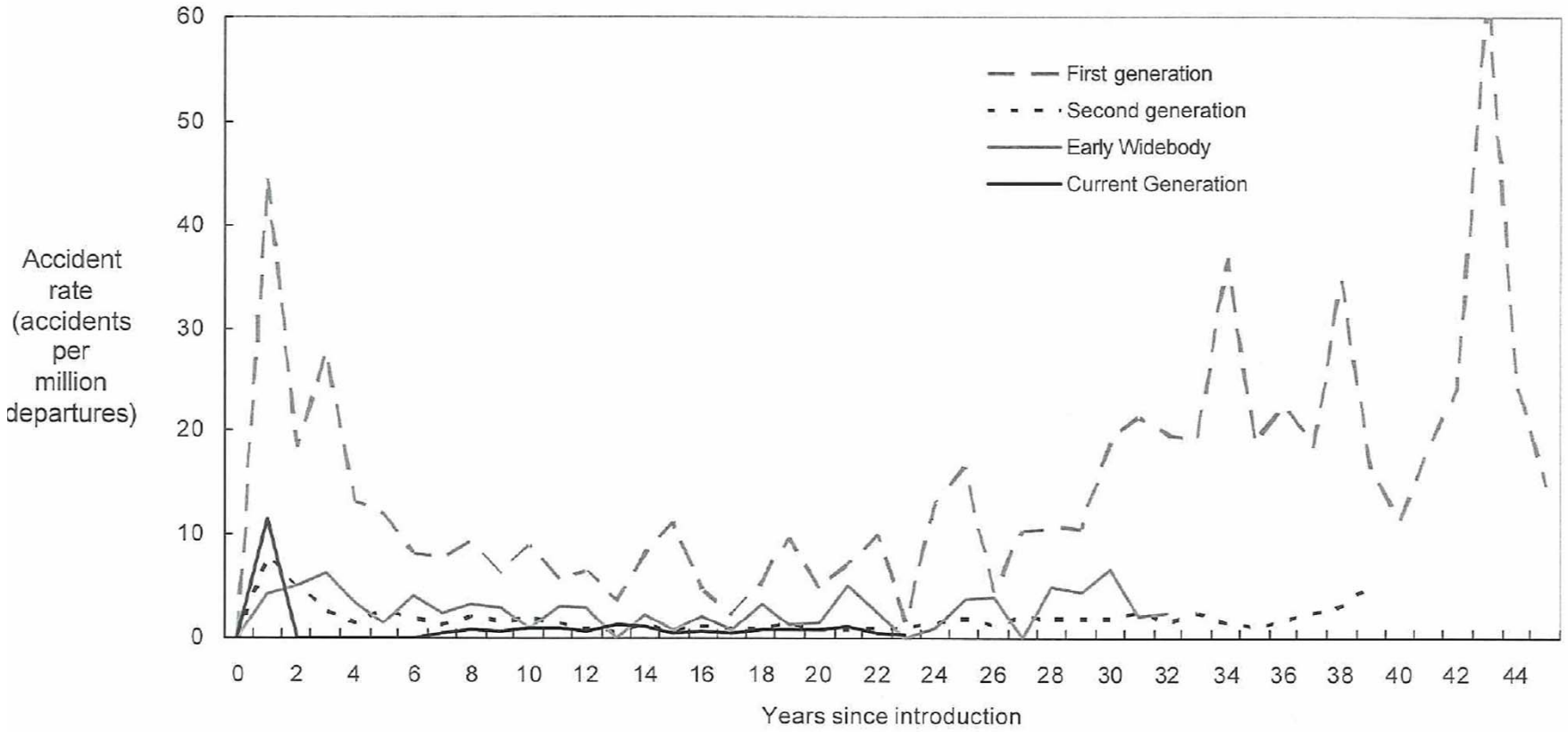


…But the biggest challenge to aviation safety is

Complacency

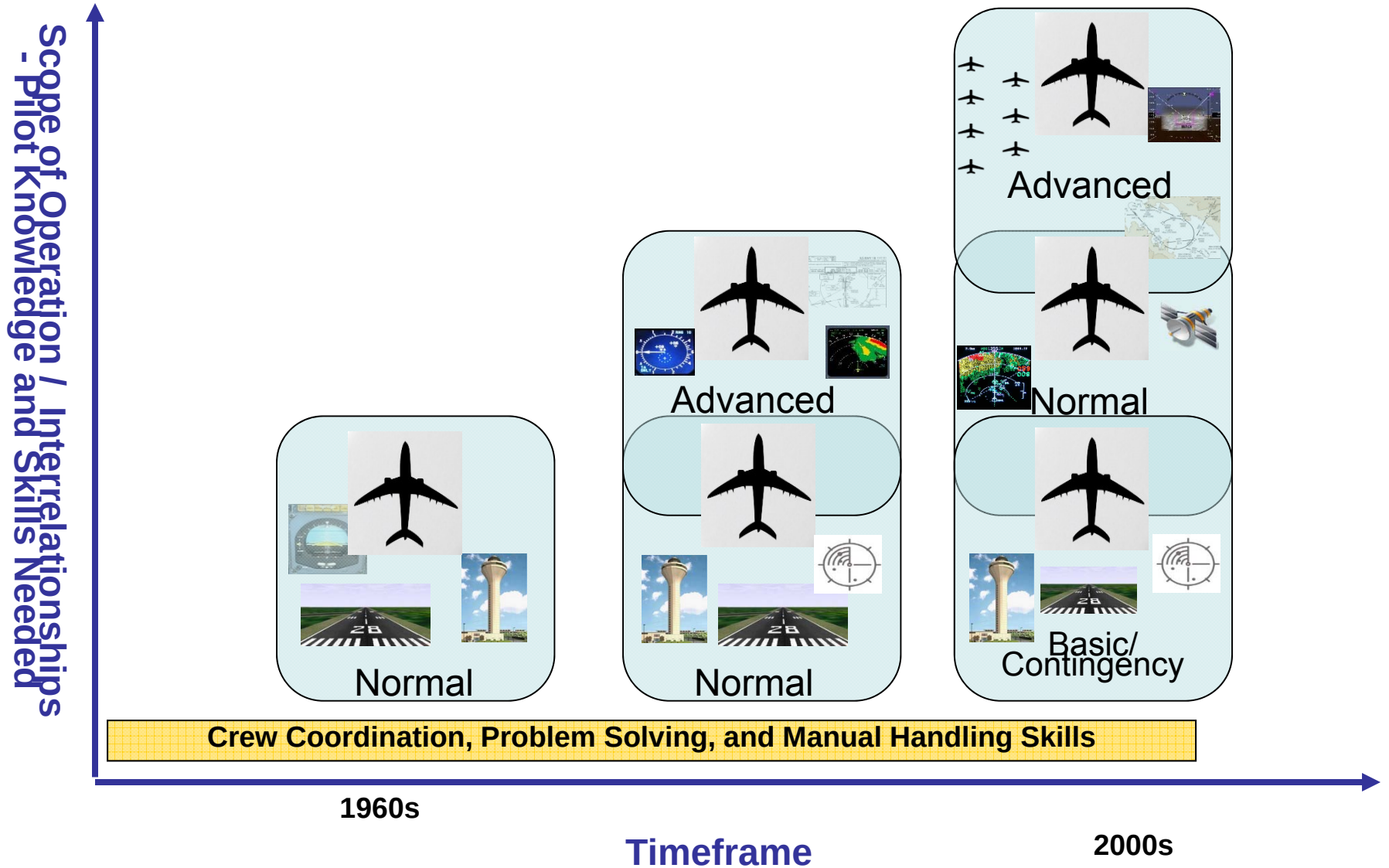
Accident Rates by Years Following Introduction

Hull Loss and/or Fatal accidents - Worldwide Commercial Jet Fleet - 1959 through 2003



Challenges for Aviation Human Factors

- **Increase in knowledge and skills needed**
- **HF is much more than research**
- **HF workforce – where will we get them?**
- **Integrating HF into every aspect of aviation**
- **Changing operator roles**
- **Automation/autonomy**


Scope of Operation / Interrelationships
- Pilot Knowledge and Skills Needed
Normal
Advanced
Normal
Advanced
Normal
Basic/
Contingency
Crew Coordination, Problem Solving, and Manual Handling Skills
1960s
Timeframe
2000s

Vision

- **Flexible, robust operations**
- **Human effectiveness through:**
  - Human-centered design
  - Human-systems integration – range of vehicles and operations
  - Increasing resilience
  - Managing complexity
- **Effective aircraft-air traffic integration**
- **Improved integration between ops and safety, maintenance and dispatch**
- **Improved risk assessment**
- **Effective data analysis**
- **Timely and ongoing sharing of lessons learned**

Research needed to support the vision

- **Automated systems & autonomy, including Information automation/EFBs**
- Complexity
- Human-system integrations
- Resilience engineering, especially dealing with non-routine situations
- Human centered design – how?
- Training
- Monitoring
- Flight Path Management
- Human performance “envelope”
- Risk/safety assessments – alternative approaches
- New technology/operations
- Event investigation and data analysis
- Many others

Operational Use of Flight Path Management Systems

Final Report of the Performance-based operations Aviation Rulemaking Committee/ Commercial Aviation Safety Team Flight Deck Automation Working Group

September 5, 2013

Finding 1:
Pilot Mitigation of Safety and Operational Risk

Pilots frequently mitigate safety and operational risks – and the aviation system is designed to rely on that mitigation

- Adapting to changes in operational circumstances
- Managing operational threats
- Mitigating or managing errors
- Mitigating equipment limitations
- Managing equipment malfunctions
- Managing unexpected operational risk

Note: Not comprehensive

Flight Deck Automated Systems

- Automated systems have been successfully used for many years, and have contributed significantly to improvements in safety, operational efficiency, and precise flight path management.
- However, vulnerabilities exist in pilot interaction with automated systems
- Use of automated systems reduces workload during normal ops but adds complexity and workload during demanding situations

Old View

- Automation
- Give the human operator what s/he does best, give the automation what it does best
- Automation causes degradation of basic skills
- Automation should be another “crewmember”
- Automation policy
- More automation reduces risk

New View

- Automated systems
- Human-system integration to enable the human operator
- Lack of practice causes degradation of basic skills
- Automated systems are tools to help the responsible human
- Flight path management policy (or equivalent)
- More automation introduces different risks

Need Effective Synergy of the Human/Automated Systems (from USAF)

- **Main benefits are to extend and complement human performance, not provide a direct replacement of humans**
  - Extend human reach: perception, action, speed, persistence, size, scale, fatigue
  - Permit delegation and reduction of cognitive load – if explicitly designed to do so
  - Expand the adaptive capacity of the human operator (e.g. more options, more flexibility)
  - Synchronize activities of UAS, software, and human operator over wider scopes and ranges
  - Provide operations with denied or degraded comms links

HF-Related research needed to support the vision

- **Autonomy/automated systems, including Information automation/EFBs**
- **Complexity**
- **Human-system integration**
- **Resilience engineering, especially dealing with non-routine situations (including “unknown unknowns”)**
- **Human centered design – how?**
- **Training methodologies**
- **Monitoring**
- **Developing and maintaining “basic” knowledge and skills**
- **Human performance “envelope” including error**
- **Risk/safety assessments – alternative approaches**
- **New technology/operations**
- **Organizational culture**
- **Event investigation and data analysis**
- **Many others**

Some common themes

- **Integration**
- **Effective automated systems/autonomy**
- **Complexity**
- **Revolution in information amount, type, reliability, access, location, ?**
- **Regulatory approvals**
- **Dealing with changes**

The more things change...

Courtesy Safety Operating Systems