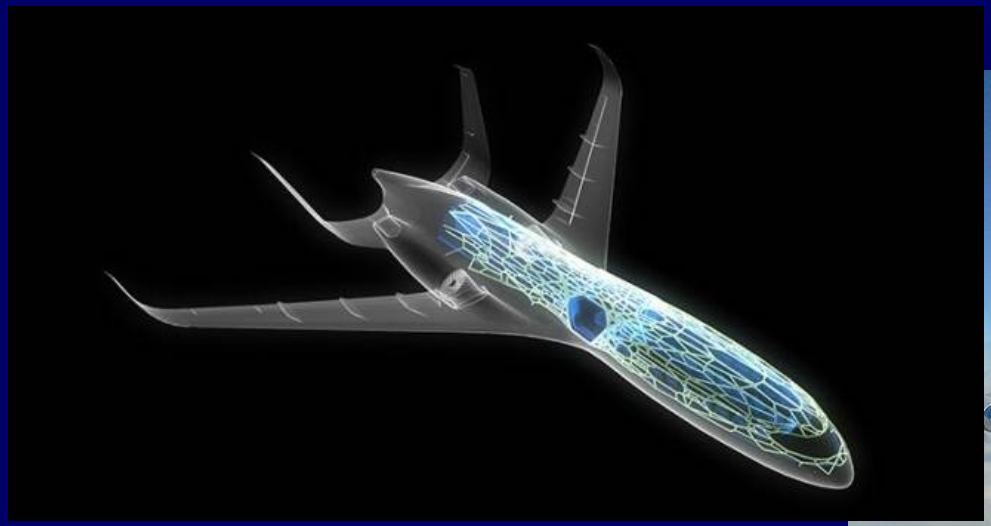
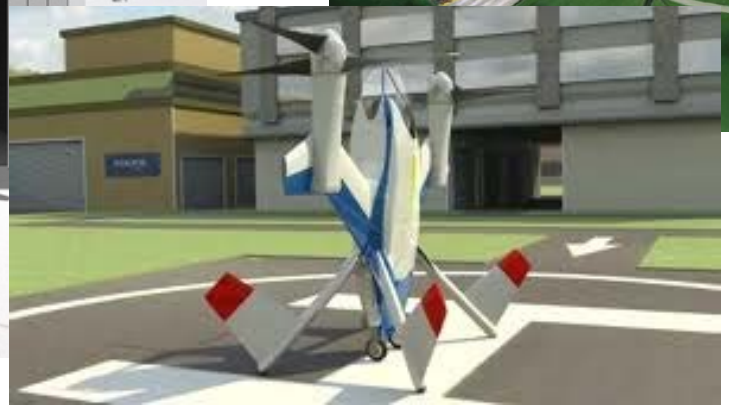
Technology: Opportunities and Challenges



Presentation to: NASA ODM Workshop
By: Wes Ryan, Manager ACE-114
Date: October 21-22, 2015

Objective

- Discuss Trends in Aviation Technology
- Plan & Partnership for Future Action



Past Successes

- AGATE Started New Ideas That Became Reality
- Moving Map GPS, Synthetic Vision, ADSB, etc.
- “Unimaginable” Benefits

Planned Architectural Change

- '90's NASA studies showed new display concepts could enhance single pilot performance
  - Wide format attitude displays
  - Moving GPS maps with weather, terrain, traffic
  - Could make instrument flight look like flying in clear weather

AGATE Enablers

- Industry was ripe for new ideas - New GPS, display, & sensor technology
- Industry ideas & cheaper product costs = fueled change (architectural change)
- Industry/Owners long overdue for change
- Leverage tort liability reform through the General Aviation Revitalization Act, August 17, 1994

AGATE Barriers

- Regulatory agencies resistant to innovation. “We’ve always done things this way”.
- Litigation in the US - Imposed financial burden on manufacturers and the cost of new airplanes
- Oil prices & Deregulation of Airlines
- Commercial ticket prices fell after deregulation
- Key - Production/Certification costs exceeded perception of the value of “new” products (what’s received vs. what it costs)

Early Visions Became Reality

- Investments in technology paid off & proactive steps brought “glass revolution” to GA
- Innovation and change now the norm in GA
- Studies show large safety improvements from integrated flight and navigation information

Late 1990’s Concept

Airplane Panel Today

Examples of “Glass Panels”

The Impact on Safety…..

- Prototyped many new concepts
  - Moving Maps, Weather, GPS Navigation, SVS, Highway in the Sky or Pathway
- Result: **40%** reduction in Alaska GA accidents (FAA Capstone Report)
    - Continue to see further reductions in accidents

Planning The Next Leap

- Look Ahead to 20+ Yrs
- Encourage New, Safer Designs While Reducing Cert Cost
- Improving Access - Reduced Need for Training/Skill - Virtual CoPilot
- Transform entry level GA airplanes & transportation for 21st century
- Risk Based Decisions & Performance Driven Requirements
- Personalized Transportation Services, but at a Faster Pace

Analyzing Trends

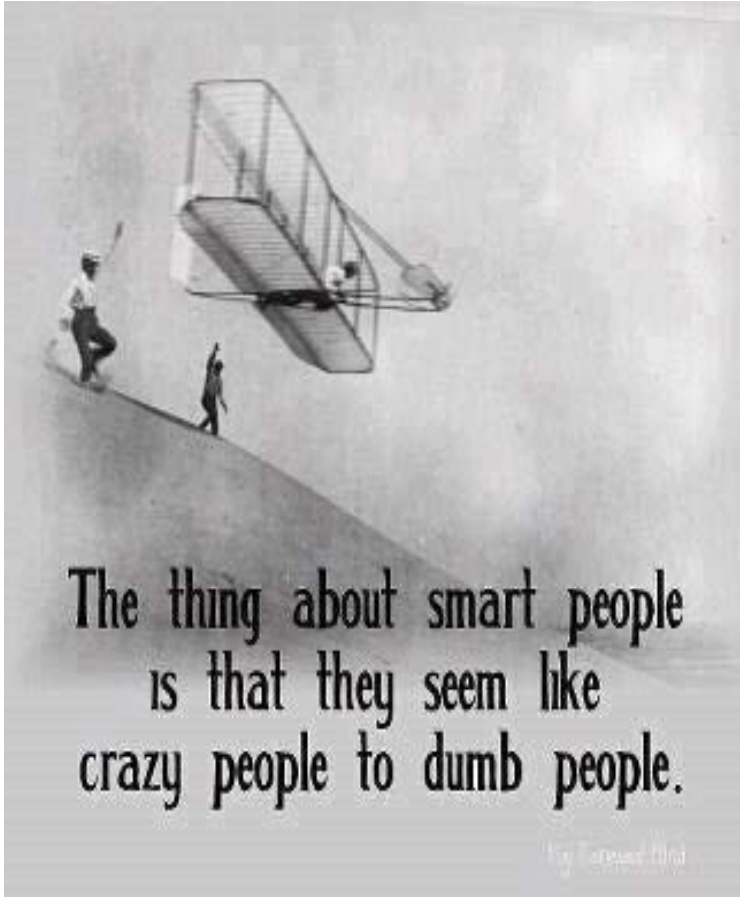
- Portables & Connected Devices
- Hybrid Avionics
- Auto Collision Avoidance - Air/Gnd
- Easy Button - Auto Landing
- Optionally Piloted Vehicles, UAS
- Electric & Hybrids

New Building Blocks

- Better Sensors, Electronics & “Smart” Materials, Automation
- Multi Rotor Hybrid Propulsion for Powered Lift – VTOL
- Active/Passive/Adaptive Systems
- Radical Configurations
- Advanced Flight Control

Knocking Down Barriers

- Confluence of Technology & Demand -The Time is Right
- Technology – Evolution vs. Revolution
- Regulatory – Pace, Risk Aversion
- Societal – Reliance on Technology/Automation
- Counter Zero Risk Mentality & “Removal of All Uncertainty”



Apply Risk-Based Oversight


•Part 25 Transport Category Passenger Aircraft


•Large Part 25 Business Jets


•Part 23 Commuter Aircraft


•Part 23 Business Jets


•Part 23 Light Jets, Twins


•Part 23 Single Engine


•Light Sport Aircraft


•Amateur Built


•Models


•Toys

Society's Demand for Safe Outcomes

Societally Accepted Risk & Desire for Low Cost

Zero Risk

No Operations

No Innovation

•Level of FAA Certification Rigor, Oversight, Involvement

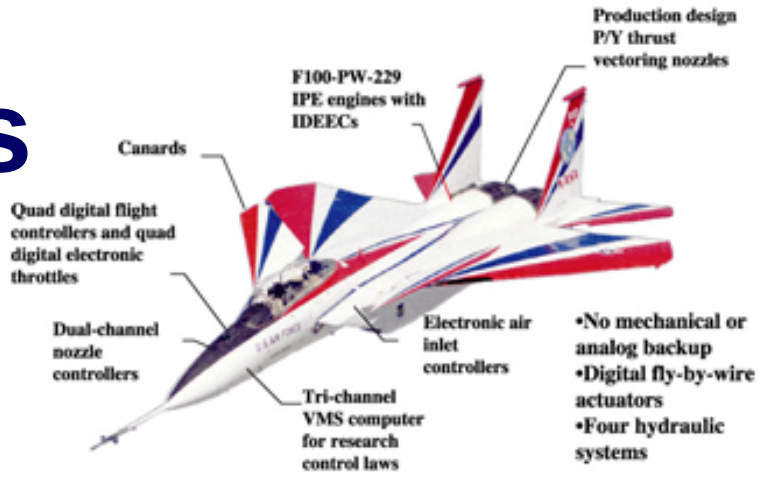
The Time is Right…..

- Next Big Leap in Transportation
- Address Remaining Root Causes of GA Fatalities
- Reduce Accidents & Costs

Electric Propulsion

- Identify & Prototype Tech
- Hybrid/Electric Power
- EGATE? - Electric General Aviation Transportation Experiment
- Multi-stage Motors - Motor Controllers
- Efficient Multi-Modal Flight – VTOL or Conventional
- Batteries & Super Capacitors

Integrated Controls



- Whole Aircraft
  - Integrated Systems
  - Avionics, Propulsion, Flight Path Management, Configuration Management
  - Follows Intended Point to Point Flight Path
  - Controls Thrust, Aero, Configuration, System
- Rely on Safety Net & Mitigations
  - Whole Aircraft Parachute
  - Safe Degraded Modes – Self Protection
  - Auto-recovery – Panic Button

Pilot Skill

- Contrasting Technology
  - Legacy Instruments – Federated
  - Modern Device – Intuitive Interface
- Expected Skill – Pilot “on” the Loop
  - Controls “fly” but direct flight path control by DFCS, not the pilot
  - Clear System Status and Pilot Expectation
  - Pilot Pulls the “Rip Cord”

Recent FAA Efforts

- Small Airplane Safety Enhancement Program, R&D
  - Proactively embrace technology to enhance safety
  - Manage reasonable risks
  - Right-sizing regulations
  - Success - AOA systems in GA
  - New Attitude Indicator Policy

Build The Path

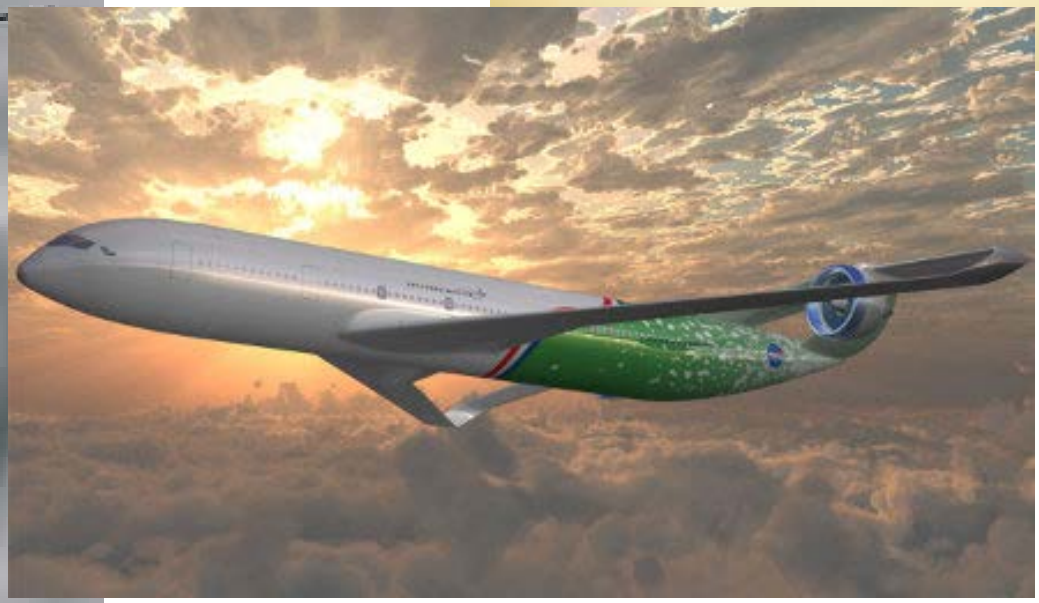
- Partnerships
- R&D
- Prototyping
- Leverage UAS
  - Controls
  - Air Traffic Integration
  - Sensors/Motors/Batteries/Etc.


ICON

“Take Away” Lessons

- Innovation Takes Action!
- Shared role in future industry success
- Must consider the impact of regulations - overregulation
- Primary focus - promoting safety, but receptive to new ideas & new technologies
- We **must be** willing to be **innovators as well as regulators** – We learn from past, but shouldn’t fear change

Discussion……



Supporting

Links for reference:

Collins Auto-land
http://www.youtube.com/watch?v=6jRS8st2mts

Athena/Collins Adaptive Reconfigurable Controls
http://www.youtube.com/watch?v=PTMpq_8SSCI&feature=player_embedded
http://www.youtube.com/watch?v=UWUkn7gyBQA

NASA Concept
http://www.youtube.com/watch?v=I_KloqLa2Og&feature=g-vrec

Premise

- Disruptive technology, calculated risk, and entrepreneurial thinking can:
  - Completely change a particular industry
  - Launch new companies to the front of their niche
  - Be a key catalyst for economic growth
  - Be introduced into safety critical industries by managing risk

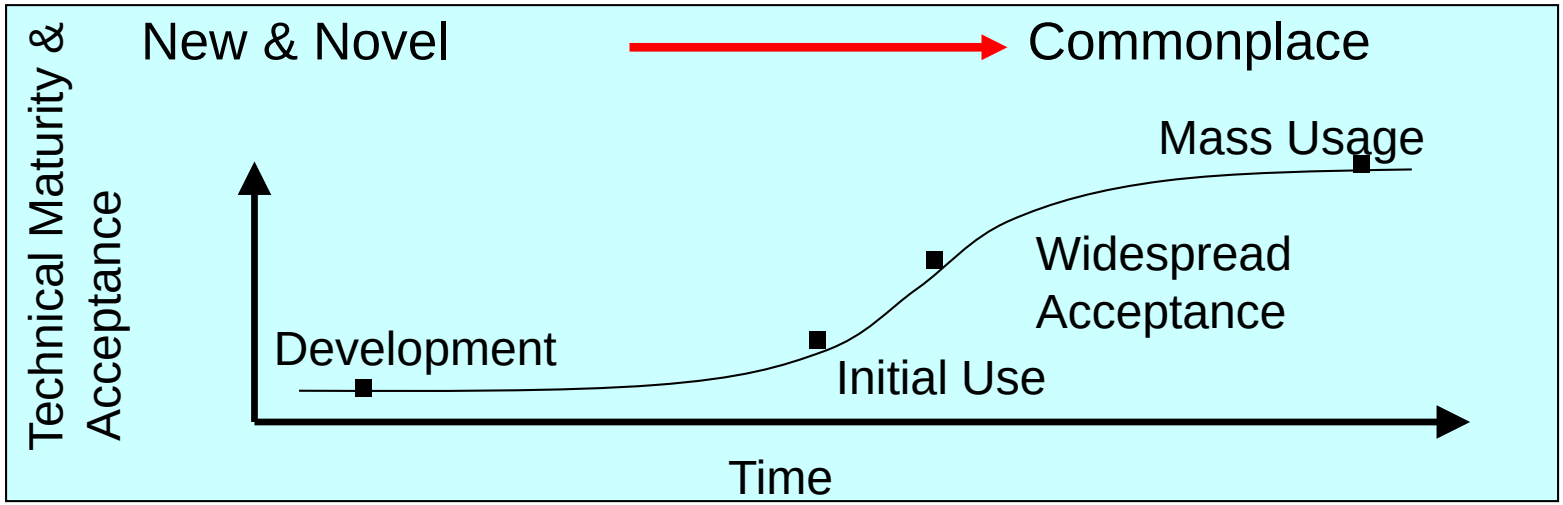
* FAA does not endorse a particular company or product

Case Study - Aviation

- Technology & innovation from 90's to now in General Aviation
  - Addressed barriers to innovation that existed in established, regulated industry
  - Combined efforts by industry and FAA to bring innovation & enhanced safety to aviation – AGATE
  - Cultivate attitudes & habits that lead to safe innovation

Technology Implementation

- Typically follows an S-curve* for wide spread acceptance and use *Abernathy, W.J. and Utterback, J.M. – Patterns of Innovation in Technology, Technology Review 1978



- GPS, Cell phones, I-pads, etc. have followed similar curve, with different slopes

“Luddite” Reaction to Change

- In the mid 1990’s
- S-curve mentality was forcing small airplanes to wait until older/used equipment is cheap
- Lead to stagnation = airplanes unchanged for essentially 40+ years
- Few examples of “new technology” - Little innovation or new product development
- Companies & FAA entrenched in S-curve - Were ignoring new technology potential

Luddite" is a term describing those opposed to industrialization, automation, computerization or new technologies in general.

Stagnation - Status Quo

1920's

1940's

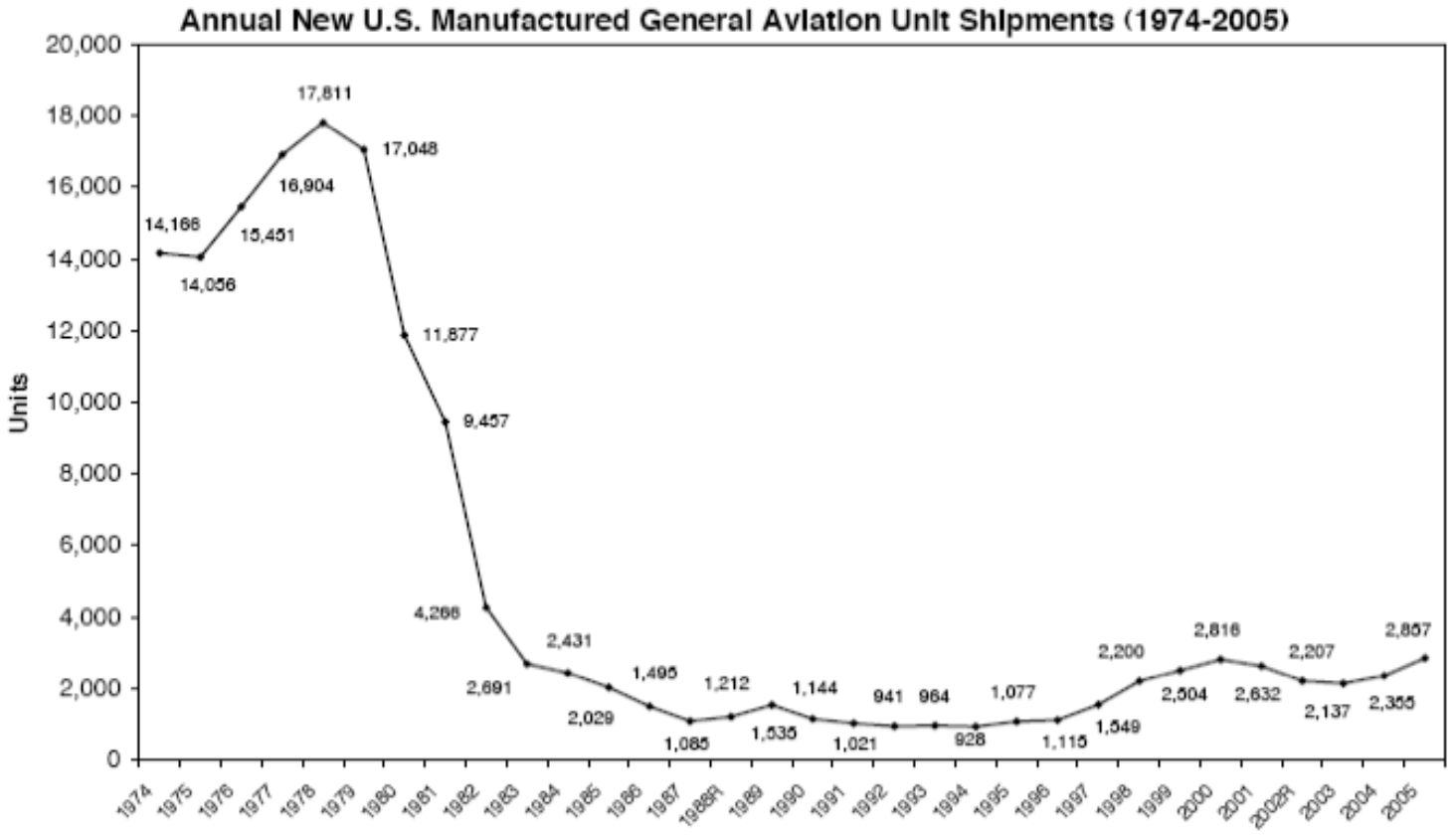
1970's

1990's

Increasing complexity with few improvements

Struggling Industry - ‘70 on

SHIPMENTS OF AIRPLANES MANUFACTURED IN THE U.S.



Source: GAMA

Response - Planned Evolution

- Worked with industry to revitalize GA through **Architectural Change**
- Created more appropriate regulatory burden for Small GA airplanes & streamlined approval process
  - Stopped enforcing one set of requirements for all aviation systems - Boeing 787 vs. Small Cessna
  - Recognized potential safety benefits of new technology – advocated the use of new displays

Managed Risk, Not Zero Risk

- Took managed risk approach to new systems & equipment
  - New systems speculated to be more reliable than old systems, but had no service history in flight
  - Retained old instruments as back-up
  - Controlled release of technology in Alaska under “Capstone” program

AGATE Impact on Safety….

Washington, DC – March, 2007 - The state of civil aviation safety continued to improve in 2006, according to statistics released today by the National Transportation Safety Board. The number of accidents in all segments of civil aviation in 2006 were less than in 2005, with general aviation recording the lowest number of accidents and fatal accidents in the 40 years of NTSB record keeping.

Impact on Safety….

Washington, DC- NTSB – April 16, 2008

While the overall number of general aviation accidents rose from 1,518 in 2006 to 1,631 in 2007, the number of fatalities in 2007 was down from 703 to 491 (a 30 percent decrease), making it the lowest annual total in more than 40 years.

Industry Impact Measurable

- New airplane deliveries on the rise, helped re-establish production of general aviation aircraft
- Stimulated industry & created jobs for airframe manufacturers, the propulsion industry, avionics shops, airports, and supporting industries
- Creating worldwide demand for new aircraft
- Continue to established a viable short-haul aviation system for the United States

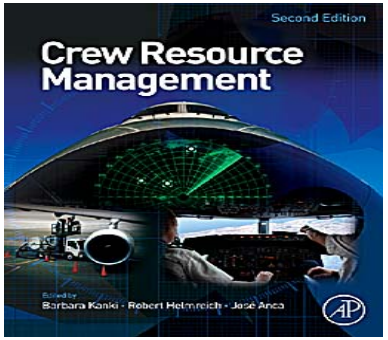
“Take Away” Lessons

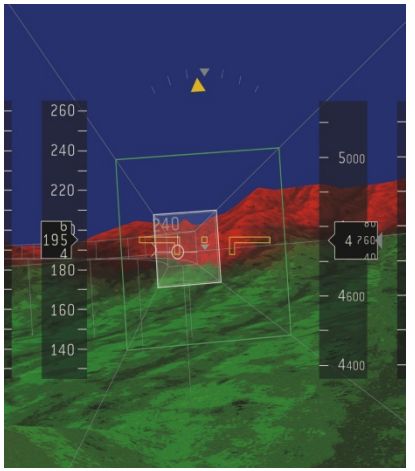
- Avoid stubborn enforcement of process & don’t ignore the product
  - Must focus on product and analyze cost vs. benefit
  - Example - “safe” airplane is a grounded one
- Be willing to work with stakeholders to identify and document safe architectural changes

Never dismiss opportunities or new perspectives

Automation Goals

- Continue to Focus on Better Automation in GA
  - Reduce Workload - Single Crew - Reduce Accidents
  - Intuitive & Consistent Automation Philosophy
  - Reduce Subjective Requirements
- Combined Challenge Due to Rapid Evolution

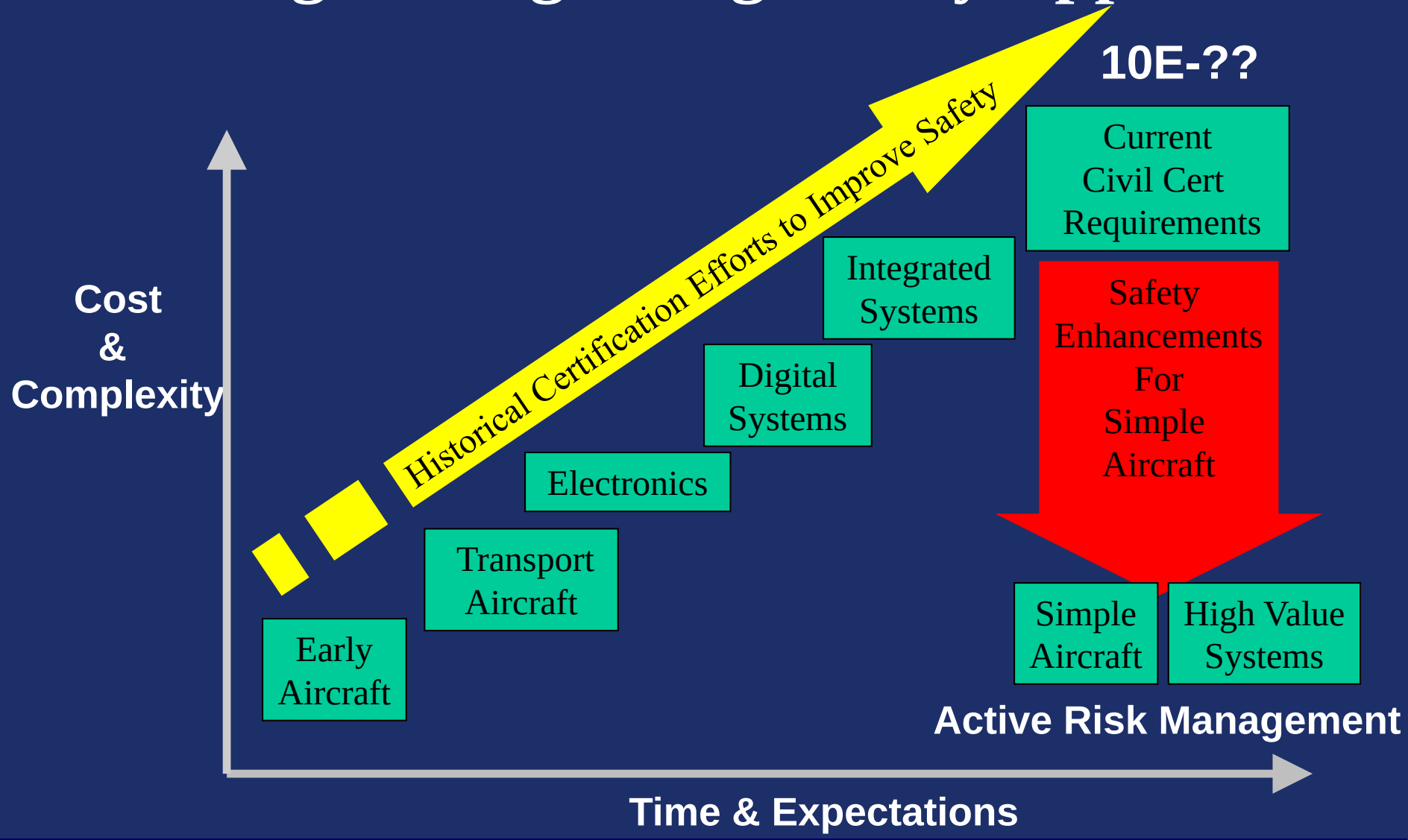




Retrofit Avionics Initiatives

- Challenge: How can we substantially impact safety of existing fleet to prevent Loss of Control, CFIT, etc?
  - Accident statistics flat for legacy GA aircraft for years
  - Past decade = great advances in GA avionics, but primarily for new delivery or new TC aircraft
  - Cost & Cert. rigor are barriers to legacy installations - Surveys
  - When and how deeply we are involved in compliance demonstrations?
  - Seeking Scalability of our level of involvement in the TSO process, ie. Simplified TSOs for Legacy GA?
- Result: Small Airplane Safety-Enhancing Equipment Program

Creating the Right Regulatory Approach



Easy Button – “Auto Land”

- Concept – Digital Parachute, or Pilot Incapacitation Recovery
- Benefit – Automatic Emergency Landing Capability
- Premise – Non-Required Ftn.
- Limitation - Pilot Can Disengage or Override

Easy Button – Conceptual Steps

Optionally Piloted Aircraft

- Concept – “Manned UAS”
- Benefit – Reduction in Crew, Workload, Accidents, Etc.
- Premise – Marriage of GA and UAS Technology for Safety
- Limitation - Prototype for Non-Pax, Cargo, Surveillance, Etc.

Electric Propulsion

- Concept – Manned Electric Flight
- Benefit – Emissions, Noise, Costs of Operations
- Premise – Safely Gain Experience in Exp. & LSA prior to Part 23 Certification
- Limitation - Battery Costs, Endurance, & Hazards