

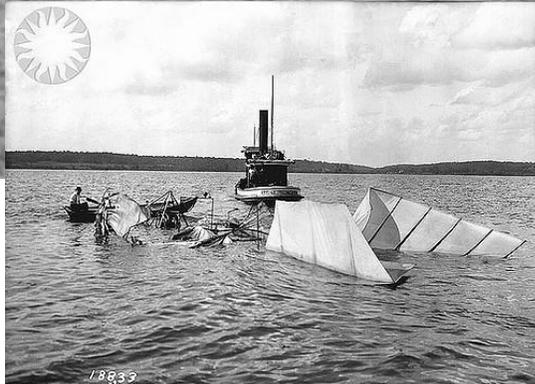
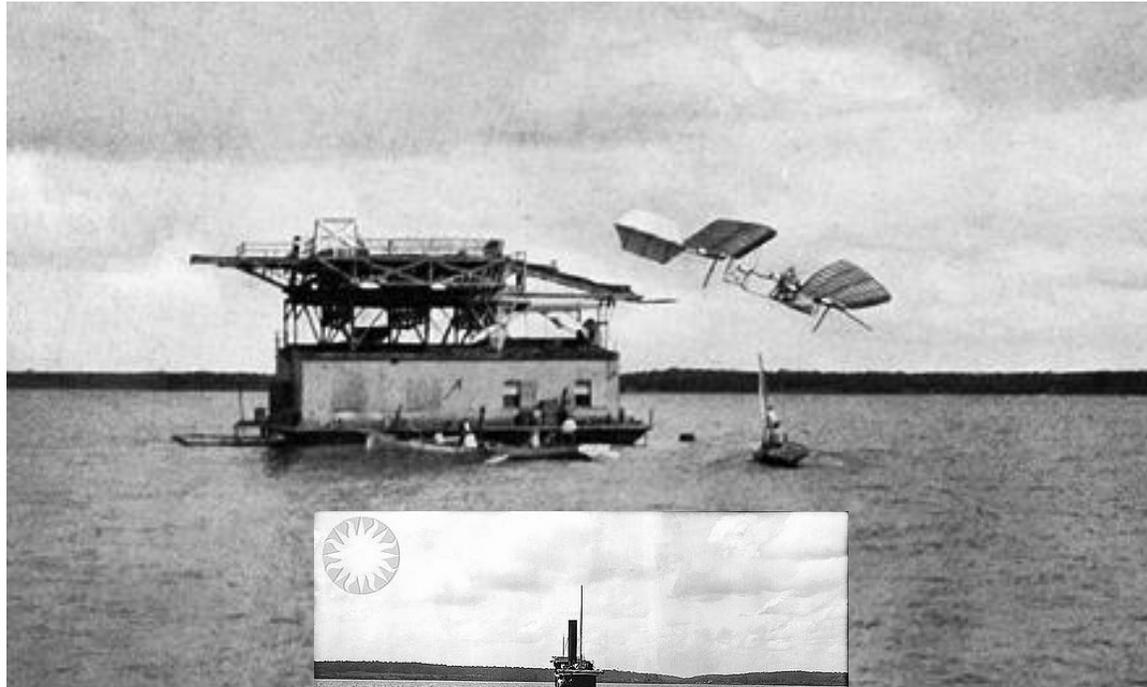
The Future in Aerospace, Considering Technology & Innovation in Context

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May 21, 2018

10th National Aviation System Planning Symposium;
21st Century Challenges in Aviation System Planning

Envisioning the Future



Envisioning the Future

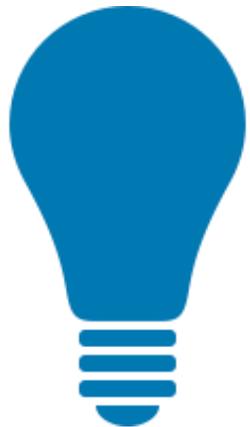


Source: <https://utm.arc.nasa.gov/index.shtml>



Images: NASA; iRobot, toolsngadgets.com; apple, macworld.co.uk; BGR.com, Oliur Rahman, Pexels; apple face time, buinessinsider.com

Innovations and Disruptions



Innovation

- ✓ New idea, device, or method
- ✓ Result of a process that brings together various novel ideas in a way that affects society

Disruptive Innovation

- ✓ Innovation that creates a new market and can eventually disrupt an existing market
- ✓ Occurs when an innovator brings something to market that is simple, convenient, accessible, affordable, and meets a need¹

Major themes cutting across multiple technology trends

Future Fleet

UAV's, Personal Air Vehicles, Supersonic Bizjets, high-altitude balloon & airships



Connected world

Smartphones, Cloud computing, IoT (Internet of Things), Air-Ground data link, V2V, V2I



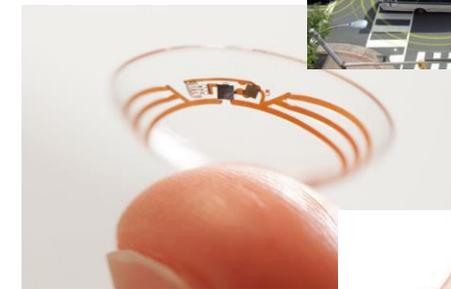
Autonomy

Self-driving cars, UAV's, Robotics



Intuitive Interfaces

Smartphones, voice and gesture recognitions, Haptic interfaces



Data and CPU

Smartphones, IoT, Big Data mining, Virtual assistants (Siri) and AI



Future Fleet, Different Demand

Technology
Trends

Description: New Vehicles

Commercial space

SST bizjets

Hybrid/electric aircraft

Big and small UAVs

Personal Air Vehicles (PAVs)

High Altitude Long Endurance
(HALE)

Other new entrants

Contributing Factors

Demographics

Economy

Technology (e.g., Autonomy
and Connected System)

Security

Description: Different Demand

Shifts in air carrier O/D

New hubs

Distributed demand for UAVs and PAVs

Impact

Changes in level of traffic

More challenging ATM (mix of
vehicle speeds, new procedures)

Challenges

Need to redeploy assets – expand some
facilities, shrink others

Distributed workforce

Need to work with new entities (e.g., UAV
service providers, commercial launch services)

Need to obtain revenue from commercial space,
electric aircraft (no fuel tax)



Source: www.aerionsupersonic.com

Connected System

Technology
Trends

Description

Digital data flows freely between nodes in the air and on the ground
“SuperSWIM”
Air-ground, ground-air, ground-ground, air-air

Contributing Factors

Processing capability
Communications bandwidth
Cyber security concerns
Availability of backup systems

Data might include:

Weather
Vehicle status (including location and planned trajectory)
Requests and coordination
Commands and restrictions

Impact

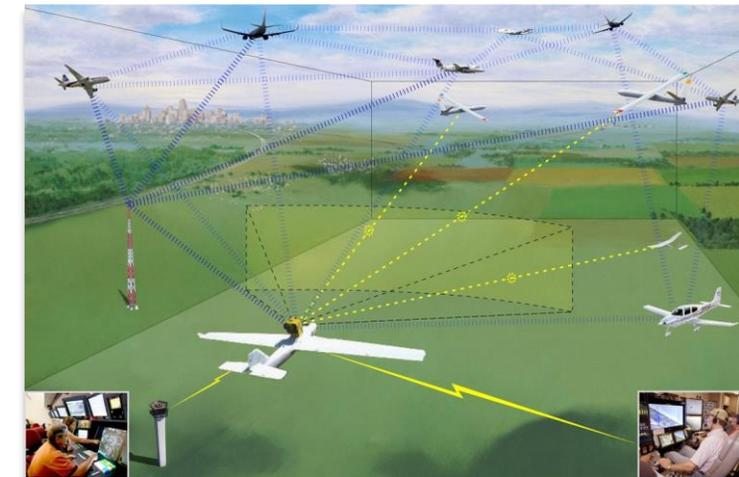
Greater information flow between vehicles
More cooperative decision making *without* ANSP involvement
Change in ATM paradigm

Challenges

May reduce the role of ATM by enabling more airborne autonomy (whether or not individual vehicles are autonomous)



Source: www.airbus.com, copyright Airbus S.A.S.



Source: www.nasa.com

Autonomous Vehicles

Technology
Trends

Description

Autonomous vehicles are vehicles which are capable of directing themselves. Vehicle determines trajectory in real time without control by ATM

Contributing Factors

New Technology: artificial intelligence, sensors for navigation, surveillance, ...
Reduce human errors thus improve safety

Trends

UAVs
Autonomous PAVs
Cargo drones
Air carriers

Impact

Extends VFR flight paradigm to more operators

Reduced ATM role

Challenges

Policies, procedures, liabilities...
Security
Risk management (insurance)
Transition phase (integrating unmanned with manned system)

Technical Challenges

Processing capability, bandwidth/comm
Coordination with other vehicles
Trust in safety (passengers, operators)

A More Intelligent System

Applying Advances in Consumer Electronics

Technology
Trends

Description

Consumer-driven advances in electronics will continue, e.g.,

- CPUs (more powerful)

- AI (virtual assistants)

- Voice recognition (smartphones)

- Displays (Ultra HD TV)

Impact

Changes in controller work characteristics

Better information readily available

High capabilities at reasonable cost

VR may reduce need for business travel

Contributing Factors

Consumer demand (can drive research and development, lower cost)

Economics -- Off-the-shelf equipment may save money

Developing suitable procedures and applications

Might manifest in aviation as

Controller/pilot associate (embedded AI)
for routine tasks, area knowledge,
recommendations

Virtual Reality or Augmented Reality

Improved user interfaces

E.g., touch/haptic



Source: NASA

Challenges

Certification standards (including safety, human factors)

Application of AI or VR will affect workforce

- May improve controller productivity

- But need to keep controller “in-the-loop”

Technology and communication may allow a distributed workforce

- Greater flexibility to handle facility failures

Curb-to-Curb Security

Surveillance and Tracking vs. Privacy

Technology Trends

Description

Advanced technology will be used to track vehicles, passengers, and cargo

Early detection of anomalies

Impact

Reduced risk of security incidents
Quicker, less obtrusive scanning of passengers and cargo at airport
Global aircraft tracking
Increased oceanic route capacity



Picture Credit: Future Travel Experience, <http://www.futuretravelexperience.com/>

Contributing Factors and Trends

Global unrest and terrorism
Improved biometrics
Big Data
Increasing privacy concerns

Challenges

Detecting and tracking nonresponding aircraft
Determining malicious intent (and resolving)

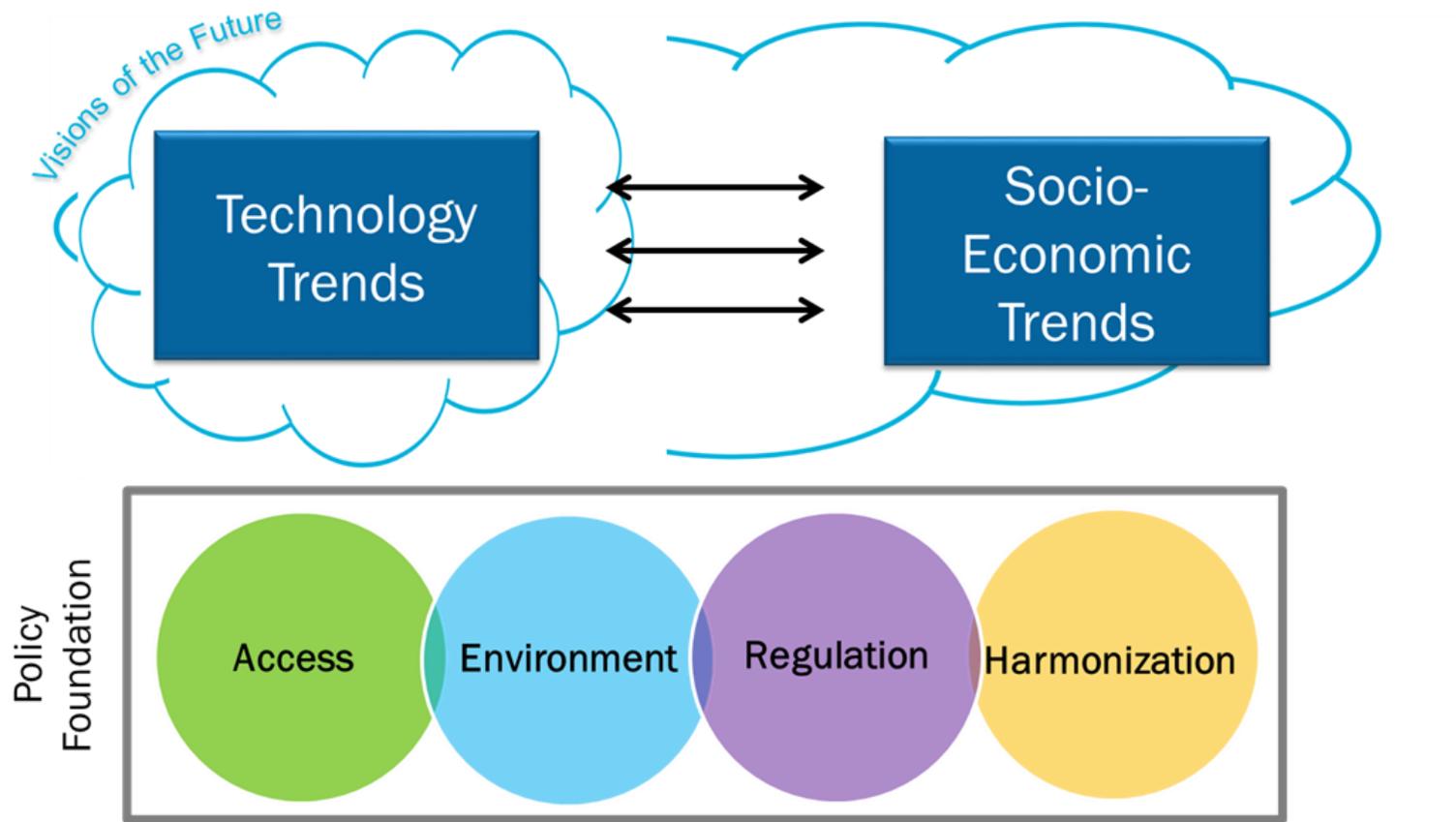
Effective yet unobtrusive passenger screening



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A framework

Considering Technology Innovation in Context



Trends and Forces Independent of the NAS Will Challenge Our Ability to Keep Pace

Economic

On demand economy with shrinking budgets and aging infrastructure

Societal

Desire for shared ownership models, immediate access

Geo-Political

Increased urbanization, rise of India and China, international instability

Environmental

Legal and social responses to climate change

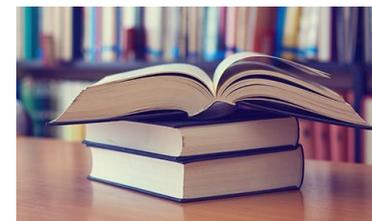
Legal and Regulatory

Regulation adapting to new entrants and discussions of ANSP restructuring



Home > Business > Aviation > India poised to be one of world's largest aviation markets: Airports Council International

India poised to be one of world's largest aviation markets: Airports Council International



The Funding Sources of Innovation are Changing

Socio-
Economic
Trends

Since the launch of Kickstarter in 2009

12 million people have backed a project

\$2.8 B has been pledged

117,964 projects have been successfully funded

Innovation is less centralized and is being dispersed across
new industry players

The Stakeholders are Changing

Socio-Economic Trends



Industry Organizations



Researchers

Maintainers and Providers



Airports



The Innovation Culture Rewards Risk Taking

Samsung battery bust shows pressure of innovation
Edward C. Baig, USA TODAY 7:05 a.m. EDT September 29, 2016

theguardian

Drone sightings near Heathrow prompt police inquiry



electrek

Tesla Model S driver claims his car crashed into a trailer on its own, Tesla says 'Summon' was activated



theguardian

Space
One pilot dead as Virgin Galactic's SpaceShipTwo rocket plane crashes
Virgin Galactic says plane designed for commercial space travel was undertaking test flight in California when 'in-flight anomaly' occurred

THE WALL STREET JOURNAL

TECH
Cause of Earlier SpaceX Rocket Explosion Still Murky
'Less probable causes' now under review, CEO Elon Musk says, after probe eliminated all 'obvious possibilities'

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There is a Need to Merge the Innovation and Safety Cultures

Socio-Economic Trends

Information Technology

Innovation
Revolutionary
Speed to Market
Entrepreneurial
Open
Minimally Regulated

Risk Rewarded



The Future of Aviation



Aviation

Safety
Evolutionary
Proven
Conservative
Proprietary
Tightly Regulated

Risk Avoided

Consumer Expectations are Changing

We prefer technology over dealing with human gatekeepers

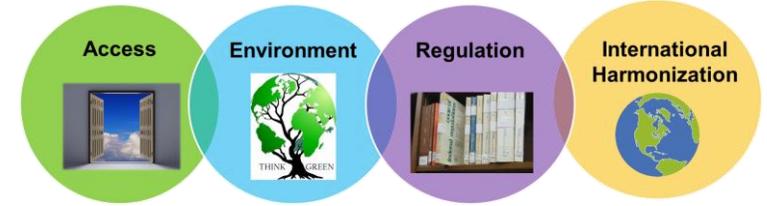
We are concerned with ethical issues, political issues, and values

We expect technologies to simply work

We crave discovery, experiences, and adventure at the expense of ownership

We expect solutions to be crowdsourced and algorithmically tailored to each individual

Policy Foundation: Expanding Challenges



Access

Equity, vehicle performance, business drivers

Environmental

Noise, climate change

Regulation

Certification

Harmonization

Boundaries, and treaties

Enabling the Future

How can we increase the agility of our methods and processes to support the integration of new innovations?

Do our approaches help to close the gap between the IT and aviation safety cultures?

Do we understand the objectives of new and international stakeholders and the benefits their innovations can provide to the aerospace market?

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