INNOVATION IN AVIATION

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INCREDIBLE INDUSTRY ACHIEVEMENTS IN 100 YEARS

City in the Sky:
Over 1 million passengers
Live in this city
Entrance via airports worldwide

Source: http://www.mojvideo.com/uporabnik/rikisuave/slika/flightradar24-in-suncak/489614
AVIATION MAIN CHALLENGES: GLOBAL STRATEGIC OBJECTIVES

• Enhance **safety** global aviation

• **Increase the capacity** and **improve the efficiency** of the global aviation system

• Enhance global civil aviation **security** and **facilitation**

• Foster the development of a sound and **economically viable** civil aviation system

• Minimize the adverse environmental **effects** of civil aviation activities

Source: https://www.icao.int/about-icao/Council/Pages/Strategic-Objectives.aspx
THE CAPACITY GAME: FINDING WAYS TO UNLOCK AVIATION CAPACITY

Global developments:

- Aircraft on order
- Airport usage and limitation
- Traffic demand passengers and cargo
- Growth is mainly passengers; cargo is relatively small in volume
IMPRESSIVE CHANGE/INNOVATION AGENDA IN AVIATION

Innovation data analysis

- Parked
- Taxi
- Takeoff & Departure: takeoff to transition-to-climb altitude and/or gear up
- Climb
- Cruise
- Descent to IAF and/or flaps
- Approach: IAF or flaps to visual reference to landing
- Landing & Taxi to Gate

Sustainability/climate

Innovation flight

Airport innovation
Topics:
1. Air space capacity optimization (SESAR)
2. Airport capacity optimization (APOC, PASSME)
3. Aviation Network optimization (SWIM)
4. Security and safety
5. Process simulation and optimization
6. Aircraft design
7. Intermodal transportation
8. Unmanned Air Cargo
9. Big data analysis
10. Sustainability (Paris Climate Agreements)
11. Communication and data exchange

Remarks on air cargo innovation:
• Strong focus on passengers and air traffic capacity
• Share of air cargo volume is limited (at Schiphol 4% ATM)
• Most cargo transported in passenger aircraft
• Challenges:
  • Ground transportation and intermodal transfer
  • Ground handling
  • Data exchange
  • Quality control
  • Parcel sizes and air containers/pallets
  • Predictability and control of cargo process
AIR CARGO INNOVATION

Objective:
Expansion of Air Cargo in Africa

1. Safe and secure UAS operations
2. Effective UAS operations
3. Integration in existing air space

Others:
1. Standard format packages
2. Data analysis
3. Exchange of data
4. Intermodal transportation

Source: http://www.aircargonews.net/uploads/pics/UNMANNED_CARGO_AIRCRAFT_001_V2.jpg
Objective: reduce travel time

Special interest:
1. Personalised device
2. Luggage handling
3. Forecasting data system
4. Customised interiors
Objective:
Increased airport capacity

Special interest:
1. Standardization
2. Smaller footprint
3. Predictable handling
4. Reduced movements
5. Passenger centric
6. Machine that produces turnarounds
AVIATION: PACE OF CHANGE IS (OFTEN) SLOW

- How to implement Air Cargo innovation or Physical Internet in aviation?

Experience isn’t very promising:

- Collaborative Decision Making (CDM) is fully implemented at 20 airports
  - The concept is introduced in 1998 and first trials in 2000

- Sesar has been defined in 2005
  - Scope to develop and implement technological changes for SES is 30 years

- Smart Security Checkpoint for the Future have been tested since 2012
  - Implementation from components as from 2014, 2017 and 2020
AVIATION: A TECHNOLOGY LEGACY SECTOR

Today disruptive innovations is a trend, but not all sectors can easily be disrupted

• Reason innovation resistance for legacy sectors
  • Locked-in
  • Path dependency
  • Well defined technological/economic/political/social paradigm that resists any innovation that might threaten to disrupt the business models of the stakeholders who benefit from it

Source: Technological Innovation In Legacy Sectors, Bonvillian, Weiss (2015)
BARRIERS IN INNOVATION

1. ‘Perverse subsidies and prices that neglect externalities
2. Favoring existing technology or discourage of new entrants by government or institutions
3. Well-established and politically powerful vested interests
4. Financing support geared to incumbents and reluctant to finance disruptive new entrants
5. Public habits and expectations
6. An established knowledge and human resource structure
7. Aversion to innovation
8. Market imperfections
   1. Network economies
   2. Lumpiness (minimum required size) investments
   3. Split incentives (non-appropriability)
   4. Requirements for collective actions

Source: Technological Innovation In Legacy Sectors, Bonvillian, Weiss (2015)
INNOVATION BARRIERS IN AVIATION

- Existing aircraft technology will be in use for the next 15 to 20 years
- Sesar: focus on development and implementation of new technology
  - Projects tend to stop in demonstrator or proof of concept phase
- The aviation systems operates at maximum capacity daily; hardly room for experiments or fundamental change
- Focus on safety and security (mentally) block innovation; the system is geared to be robust and bounce back into balance. *Disruptive innovation requires change and unbalance, thus ‘unsafe’ situations*
- Legacy in airport infrastructure limits the options for change
- Aviation is heavily regulated; regulations favors current situation
- Non-appropriability or split incentives airports won't invest if only airlines benefit, v.v.
- Limited incentives for individual partners to change: local monopolies from ATC, Airline, airport, etc. Best results when operating at maximum capacity
- Global – Local Paradox: global developments needs to be implemented locally
- Changes within the entire sector required
INNOVATION IN AVIATION

**Society/sector problem + sense of urgency**

- Invention
- Invention
- Invention
- Invention

**Transition process**

- Innovation contributing to solving the problem

**Boundary conditions innovation**
- **Sectoral level: Aviation is global business**
- **Disruptive innovation**
- **Conceptual changes in sector**
- **Legacy defines starting point**
- **Transition path includes**
  - **social aspects innovation; often locally defined**
  - **Sabotage/hacking**
CONCLUSIONS AND FURTHER RESEARCH

• Massive innovation in Aviation is required to face the challenges ahead
• Legacy in technology, infrastructure, regulations and market limits pace of innovation in aviation
• Programs like Sesar/Nextgen focus on development and implementation of new technology and operating procedures and need to pay attention to the industry drivers to adapt this new technology
• High focus on the end result; there is growing insight in the importance of the transition path as a crucial part of the innovation process
• Innovation is a cyclic process. Implementation of an invention may require many iterations between stakeholders in order to identify and remove barriers
• Further research needed to understand the role of the transition path in innovation in Aviation
CIM AVIATION
BLEND WITH TECHNOLOGY LEGACY

- Established interests
- Existing technology
- Established knowledge
- Market imperfections
- Financing support
- Government involvement

Aircraft technology and systems to support safe flights

Technological development

Airbus, Boeing, Cesar, Nextgen

Aviation business: Transporting passengers and goods from A to B

Gas, ATC, Handling

Business models

- Past investments in infrastructure
- Business models airline and airports
- Fee structures
- Existing networks
- Ownership of networks
- Financing

Vested interests

Science

- Regulations
- Public opinion
- Environmental concerns
- Security
- Regional interests
- Vested interests

Limited insights in impact of climate and emissions

Social welfare

Economic impact

Climate change

Scarce resources

World City Networks

Society

Connectivity: Economy, quality of life and environment

Regions

Past investments in infrastructure

Established interests

Vested interests

Established knowledge

Financing support
THANK YOU FOR YOUR ATTENTION
WHAT IS INNOVATION?

Innovation = Invention + Implementation

Basis= Schumpeter’s principle of creative destruction is a driver for adaptation and growth (source: Schumpeter)

Main question for a company or organization: “how to ensure continuity or how to define the ability to adapt to (disruptive) innovation and to stay competitive” (Source: Bonvillian and Weiss)
INNOVATION BARRIERS IN AVIATION

• Technology development in aviation is often spin-off of military innovation
• Lumpiness: large scale engineering intensive investments to develop advanced new aircraft type
• Reduced investments in new military aircraft technology
  • No new technology flow to civil aircraft manufacturers, new aircraft based on existing technology (see M. Mazzucato: the Entrepreneurial State)
• Support scheme’s for national carriers
  • Explicit or hidden subsidies and market barriers to support national carriers

• High barriers to enter the airport market
  • Lumpiness, financing, slots, regulations, security, local interests
• Past investments in fleet and airport infrastructure define today’s options for change
• Regulation favors by definition today’s practice and lacks behind new developments
• Innovation in aviation requires sector wide implementation
WHY IS TRANSITION PATH INCLUDED?

- Disruptive innovations in legacy sectors will result in fundamental changes in the entire sector *ie free flight in airspace or emissions reduction worldwide*

- The change cannot be implemented at once; safety and security in aviation and high operational pressure

- Small steps, including trial and error, are needed to explore the route to implement inventions

- We need to unbalance the current system and bring it towards a new (intermediate) equilibrium

- Many stakeholders involved, iterative/cyclic process to manage, role of incumbents (legacy airlines, ATC, etc)

- Managing the transition path for legacy sectors is hardly studied (*Bonvillian and Weiss*)

- Course of transition of sector cannot be predicted in advance (*Schot and Geels*)
AVIATION: FUEL EFFICIENCY AND SAFETY

The fuel efficiency of new aircraft has improved sharply ...

Source: Lee, IATA