Future Aero Engine Designs
(caught) between politics, fleet operations, commercial realities and technology

Keynote Nico Buchholz
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General Overview
Next hour or so....

• The presenter – background or bias?
• Realities from the operator perspective
• Provoking topics
• Outlook/challenges
Setting the scene

- The outlook~5% p.a. average
- Economic pressures and consolidation in the supply chain and the customer base
- Large OEMs may disrupt by changing their business model incl more vertical integration
- Production rates will increase
- Electric and Hybrid propulsion challenges; electrification may change the landscape on/of existing players
- Digitalization as change agent? Solving problems but providing new sources of revenue

- Politics may move from short term to truly addressing the environmental challenges in a holistic way rather than patchworking (focus only on noise or $CO^2$ or particular dust or...)
- Aviation is expected to reduce its share of total emissions despite the growth
- Several OEMs work on smarter ways to address mobility (drones,..)

**But**

- Not focussed on specifics like blended wing, coating, cooling material science, other concepts, aero interference, engine type,..
- Focus on fostering progress
History of commercial aviation

- Aircraft
  - 1948: 2290
  - 1998: >15500
  - 2010: ~ 20000
  - 2018: ~24.000

- Passengers
  - 1948: 24 million
  - 1998: 1.5 billion
  - 2018: ~ 4.3 billion

- Passenger journeys
  - 1945: 9 million
  - 1999: 1,5 billion
  - 2010: ~ 2 billion
  - 2018: ??

Future of commercial aviation

Speed, range, size, safety provided economic leaps to foster growth of the industry

= safe affordability?!
Ambitions (example)

Boeing
- Grow services
- Consolidate
- Control life data of the aircraft
- Vertical integration

UTC
- Buying Tier1 and TierX in the value chain
- Counterbalance the Airframe OEM
- Grow revenues

Others including previous
- Investment in digital
- IP Management and impact on profitability through control
- Steady rise of M&A ca 20%
- Supply chain
- Definition of game changing
- Technology
- Business environment
- Lead times and planning “security”
Business influencing factors

• Unpredictable? Complex?
  – Ad hoc changes
  – Disturbances
  – Stable flow
  – Ample planning time
  – Mass production
  – Simple processes
  – collaborations
In 40 years the Aviation Industry has achieved efficiency gains in the order of 70% and still counting*

*: For competitive reasons no more models listed since 2000...
New technologies have delivered more efficient aircraft from platform to platform.
Airliner evolutionary leaps – transportation efficiency gains so far - now we start a new dimension adding cost and size
Today fleet decisions (should) follow a clear process, market requirement, environmental correctness and commercial business case.

Today’s World
- CAPEX & CVA – clear value added
- Concise risk assessments
- Linkage to company value proposition
- Low seatmile cost with high performance / comfort / ecology / …
- Sustainable
- Market driven and flexible
- …but what experience is the passenger after (business, holiday, shopping,..)

1950ies: Pilots
1960/70ies: Engineers
1980ies: Commercial (Marketing)
today: Economic-ecologic awareness
OEW + Payload Revenue & cost = MZFW + Fuel cost = MTOW

Useable Payload is determined by Aircraft Weight and Design.
The Narrowbody Evolution ...faster, further, larger

...driven by engine technology/material science
Operational topics (operators)

- Industrialization of production (building machines, aviation, airlines) – *today similar volumes but huge cost differences in Aviation*
- Design for standard production
- **Maintenance cost now become delay cost (EU rules)**
- Data quality and reliability (*predictions*) to drive the business
- Price elasticity
- Unlimited/unconstrained operation at lowest cost....
- PMA
Realities OEM (Airframe/Engine) vs Airline

- Engines: Majority of margin generated by future spare parts sale, i.e. normally customer acts (if not careful) like a bank providing a loan
- Airframe: Balanced cash flow
A perspective on today’s definition of „Game Changing“
Leveraging technology: 1963-1988 „produced“ 25% COC improvement, The NEO/MAX "only" achieves less than half of this

Major improvements:
- 2- vs. 3-Man Cockpit - 23%
- Fuel-Consumption-Reduction - 39%
- Maintenance - 20%
- Fees (weight & noise) - 21%

Remarks:
• 500 NM Mission
• 150 Seats (both aircraft)

Sources: Lufthansa Fleet Management 2013 & European Business School
The Airline
Costs predictably happen... Revenues are more volatile: costs... and technology

...and which drive competitive positioning related to the aircraft
...noise, weight and technology are the key drivers
Cash-cost still dominate but all cost elements grow
COC are technology driven

Invest per seat has increased by about 30% over 20 years thus neutralising many cash cost benefits

100% 120% 135%
1989 2000 2009

This trend is accelerating as OEMs
• require funding for future technology/research
• get pressure from the finance community/investors
• want to take part in operator benefits through „value pricing“
This also drives new business models for operators & OEMs

Other industries do better!? Example from consumer goods
Squaring the circle from the airline ops view

Conflicting Interests

Homogeneous fleet vs Operational flexibility
Economies of Scale vs Product differentiation
Fleet commonality vs Risk mitigation/-spread
Innovative aircraft vs Low capital expenditure
Fast airport turnaround vs economies of scale

Plus

Determine a low complexity fleet, market driven multiple aircraft sizes offering high flexibility in operation and performance while being state of the (technical) art and sustainable highly economical with the smallest possible environmental impact and a positive passenger experience.

Source: EBS, WHU lecturing material, Lufthansa Fleetmanagement
Due to different product life cycles there will be an era without economies of scale starting now (example long haul).

danger of uncontrolled yield erosion; market growth necessary to achieve "unit cost"

with introduction of "new A/C technologies" no inherent growth necessary to retain unit cost level

Sources: Buchholz, Lufthansa Fleet Management 2013 & European Business School
Economies of scale and customer needs – the reality!

- The challenge of changing algorithms…..
- Smaller lower cost aircraft paired with more airports triggered a change in network structures
A typical LH intercontinental flight transports >>50% transfer passengers, coming from all over Europe

Source: Lufthansa Fleetmanagement, 2013
Some evaluation points

- **Performance Data**
  - Range, Speed, Take-off and Landing Capabilities

- **Cash Operating Cost**
  - Fuel, Fees, Maintenance, Emission Cost

- **Technology and flexibility**

- **Environmental issues**
  - Noise-, CO₂- and pollution emission

- **Cabin Product**
  - Cabin comfort, seat width

- **Fleet Strategy**

- **Industry Politics**

- **Risk assessment**

- **Assessment of competitors**

- **Infrastructure issues**

Red: denotes directly engine related

Sources: Lufthansa Fleet Management 2013 & European Business School
supply chain margins – airlines generate cash

Margins:

Hurdle for Financial Investment

16% 13% -6 --10% -5 +3% 8 -18% 11 -14% 10 -13%


ROCE normatif de la chaîne de valeur du transport aérien – Tous les acteurs, qui peuvent être des filiales des compagnies, se nourrissent de l’activité de transport.
What is really driving Airlines?
Influencing and Stakeholders

Fleet/engines/aircraft are just **tools**...

- « reinvent » flying
- Passenger centric
  
  • **Research**
    - Future Technologies
    - Innovative Solutions
    - Mobility patterns
  
  • **Environment**
    - Noise
    - Emissions
    - ETS
  
  • **Regulations**
    - Open-Skies
    - Traffic Rights
  
  • **Manufacturers**
    - Technology
    - Aircraft
  
  • **Airline**
    - Business Model
    - Fleet Strategy
    - Cost Structure
    - Risk
  
  • **Infrastructure**
    - Congestion
  
  • **Market**
    - Network
    - Economy, Competition
    - Passengers
    - Consumer patterns
    - Population growth
  
  • **Manufacturers**
    - More electric / solar
    - Hi Integrated Systems & Big Data
    - Weight (20%) and reliability
    - Aero configuration close to 10% (shape and morphing wing)
    - Speed, range
    - Additive manufacturing
    - Engines
    - ....
The road to success – decide on a target.....
Similar from wherever you look

UNDERSTAND THE METRICS...

Results

Escalation
Inventory
Aftermarket participation
Working Capital
Payment Terms
base pricing and consumption

...AND MORE

Customer satisfaction (who is the customer)
integrity
Supplier performance & quality
Service quality
$$
Productivity
cost
Everything is relative .... but life cycle counts
10 years ago... still valid today even if on lower level
The easy summary

delivering on time on budget on promises within a long term
global legal framework at
low cost and no environment impact
Focus:
What do/did YOU expect from this session?
During a presentation relating to the „Blended wing body“ experts are shown a risk list which they acknowledge as possible showstopper:

- complex flight control architecture, severe hydraulic requirements
- large auxiliary power unit requirements
- new class of engine installation
- flight behaviour beyond stall
- high floor angle on take-off and approach
- acceptance by the flying public
- performance at long-range
- experience and database for new class of configuration limited to military aircraft

But: This list is based on a Douglas Memo prior to launching the DC-8 in the 1950s questioning if this is an acceptable risk
Strategy equals execution. All the great ideas and visions in the world are worthless if they can't be implemented rapidly and efficiently. So crucial is to build the link to make them operational AND selling its benefits.

*Words of Wisdom? Focus!?!*

We are at the forefront of technology (ABS,...) but a "boutique" production system which has to face fierce truly global competition – how do we maintain this?
Thank you
Disclaimer and references

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