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AVIATION OPERATIONAL MEASURES FOR FUEL AND EMISSIONS REDUCTION WORKSHOP

Fuel Efficiency Board & Event Measurement System

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Flight Operations Panel
Ottawa, 5-6 November 2002

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Fuel Efficiency Board - Mission

✈The primary goal is to **reduce fuel consumption** & cost without compromising safety, community noise & emissions and optimize the operational weight of the aeroplane.

✈We have identified several fuel conservation measures through elaborated operational & technical solutions, holistic procedures, a progressive behavior within **swiss** and are the **competence center** for operational opportunities in regard to fuel & emissions savings.

✈The Fuel Efficiency Board was established in June 2000 (swissair, until the collapse of our company).

Fuel Efficiency Board - Mission (cont.)

✈Lead: Flight Operations, a committee comprising ten specialists from within **swiss**, having full support from our management.

✈We identified recurring fuel savings in the order of magnitude of **6⁺ Mio$**; equivalent to **20'000⁺** tons of **fuel** or 60'000⁺ tons of **CO^2** emissions (corresponding to a 'market value' of plus 600'000$, assuming a minimum penalty of 10$ per t CO^2).

✈We are on-track and confident even exceeding this goal implementing new ideas and assuring best practice. Improving the **process** is a necessary condition in order to save fuel and reduce emissions.

Fuel Efficiency Board - Mission (cont.)

✈For the time being we are forced to minimize our efforts - lack of resources, new company etc. - and decided to concentrate our work mainly implementing the **Event Measurement System** (EMS) and to operational measures for fuel savings in the cruise phase of flight (this was already my strong message in Madrid!).

✈These operational opportunities are effective, quantifiable, sustainable and the most immediate way to minimize aircraft emissions and increase the mission payload.

✈Operational measures also present fewer of the legal, economic and technical challenges that are associated with other approaches.

Some facts (order of magnitude)

- **+1% fuel** consumption A330 or A340 fleet ⇨
  - **1⁺ Mio$ / y** recurring costs.

- **+100kg** aircraft **weight increase** A340-300 ⇨
  - **500’000⁺ $ per year** recurring costs (complete A340 fleet; fuel & cargo).

- **+/- 1/100 machnumber** A340-300 (0.82 ⇔ 0.83) ⇨
  - +/- **0.7 min** per flighthour ⇨
  - +/- **5% fuel burn**.

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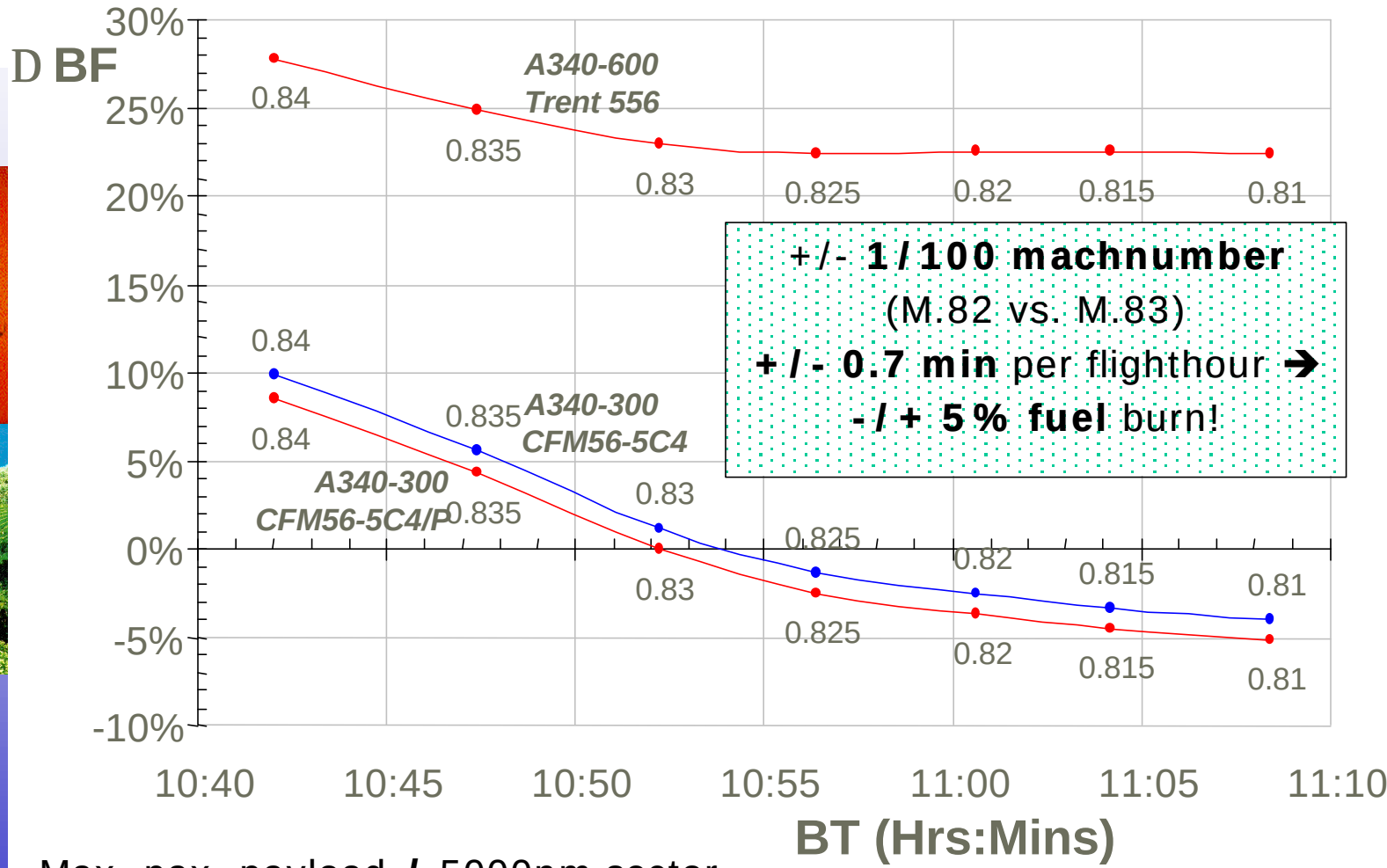
A340-300 ... time versus fuel trade-off ... fuel savings!



Max. pax. payload / 5000nm sector

+1% fuel burn A340 fleet = +1Mio$

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Problem & Solution

✈Problem: Lack of operational-technical **facts & figures** in order to 'convince' our flight crews & management – improve the overall cost & environmental awareness –, provide evidence of the **potentials** and **control** the recurring benefits.

✈Solution: Implementation of the **Event Measurement System** (ADAS analysis tool, mainly fuel flow, speeds, times, air & ground distances, winds, weights etc.) + additional flight information and know-how / confidence.

➔ conclusion: '**hardware**' + '**software**' plus **continuity**.

Event Measurement System

✈The **EMS** – a tremendously powerful tool designed for flight operations & maintenance quality assurance – not only detects events, but also measures the engineering and operational parameters of the flight.

✈This expert system gives an airline the ability to understand how the aircraft are flying and allows Flight Operations & Postholder Maintenance to easily support the information requirements of the various engineering departments.

✈We expect the EMS to become the core element of our statistical & operational analysis tool / competence center ⇔ link Flight Operations DWH.

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Aircraft Data Acquisition System (ADAS)

ADAS

Mandatory Parameters

FDR

Required Parameters

Engine and Aircraft System Data

Additional Parameters Optional Recording

Mandatory / Crash Proof Recording

- Triaxial Accelerometer
- Data Management Unit
- approx. 1‘500 Parameter recorded every second!

- Cockpit Voice Recorder (CVR)
- Flight Data Recorder (FDR)
- approx. 250 Parameter

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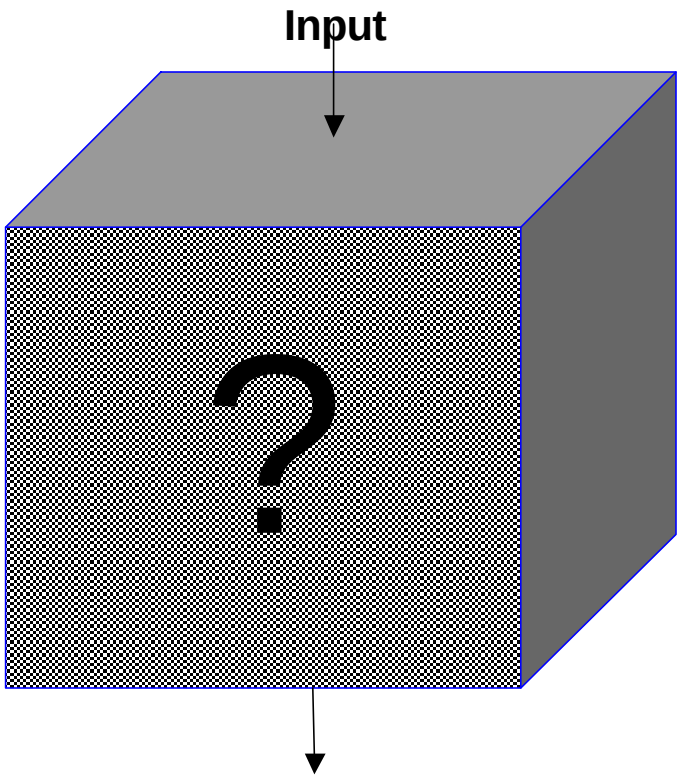
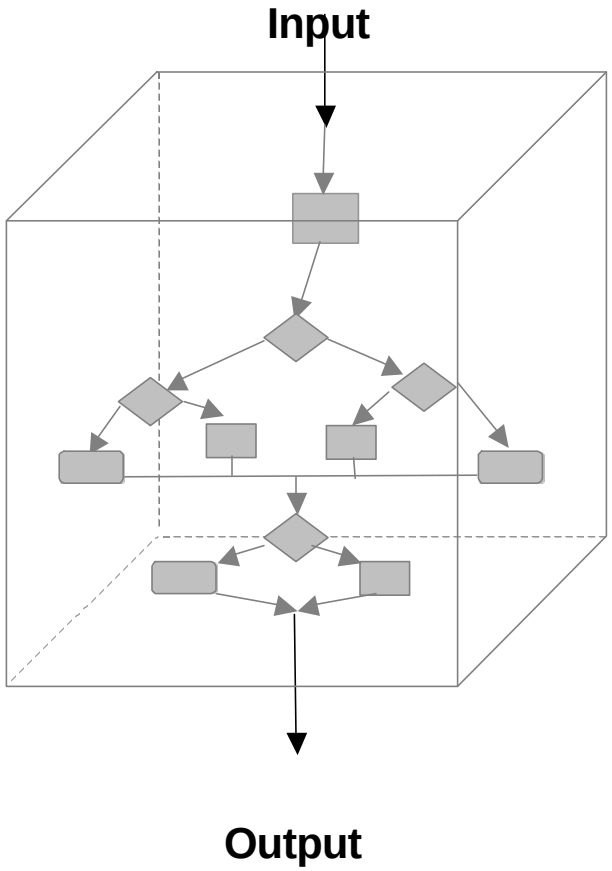
Event Measurement System (cont.)

Black Box



Transparent



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Flight Data Warehouse

Automated Parameter Measurement APM

APM Tester

Explorer

Flight Data Viewer (Plot/List)

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Event Measurement System (cont.)

✈Flight Data Warehouse & Analysis

- collecting the flight data and preparing it for analysis and exploring the database of results.

✈Event Detection

- automatically searching all incoming flight data for events predefined by the user (configuration library).

✈Parameter Measurement & Flight Data Viewer

- software to detect and measure virtually every aspect of a flight;

e.g. average true airspeed during climb in function of climb rate, average machnumber for the first five flighthours after top of climb etc.

Event Measurement System (cont.)

- **Measurements not only re. fuel, but:**

speeds, times, holdings, systems-performance,

malfunctions & monitoring,

communications / navigation,

statistical air & ground distances, routes, winds,

weights, center of gravity, temperatures,

thrust settings, engine emissions,

empirical values, key performance indicators,

etc. ...

& ... **fuel flow, fuel used, fuel on board, ferry fuel,**

fuel bias etc.

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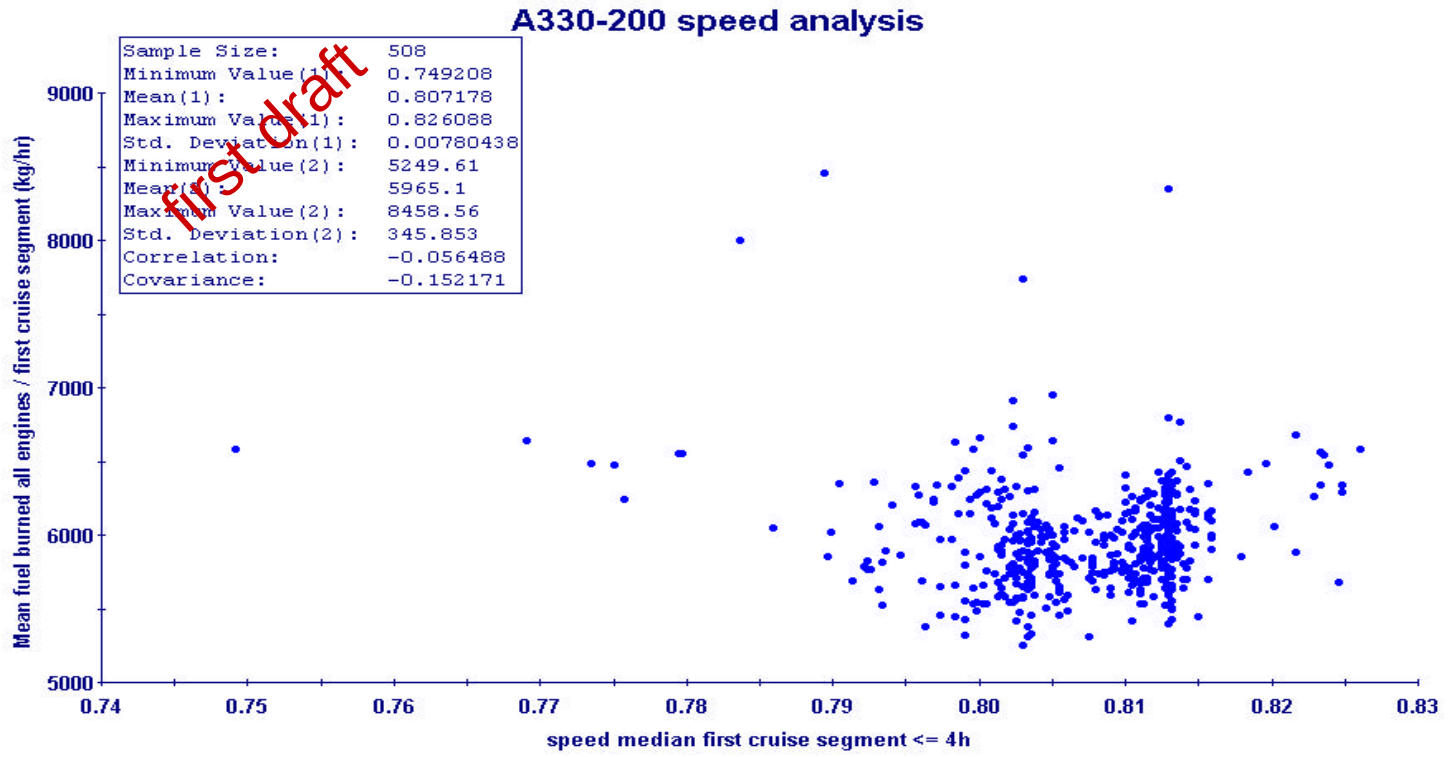
A330-200 cruise speed analysis vs. fuel per flighthour



... first cruise segment <= 4h

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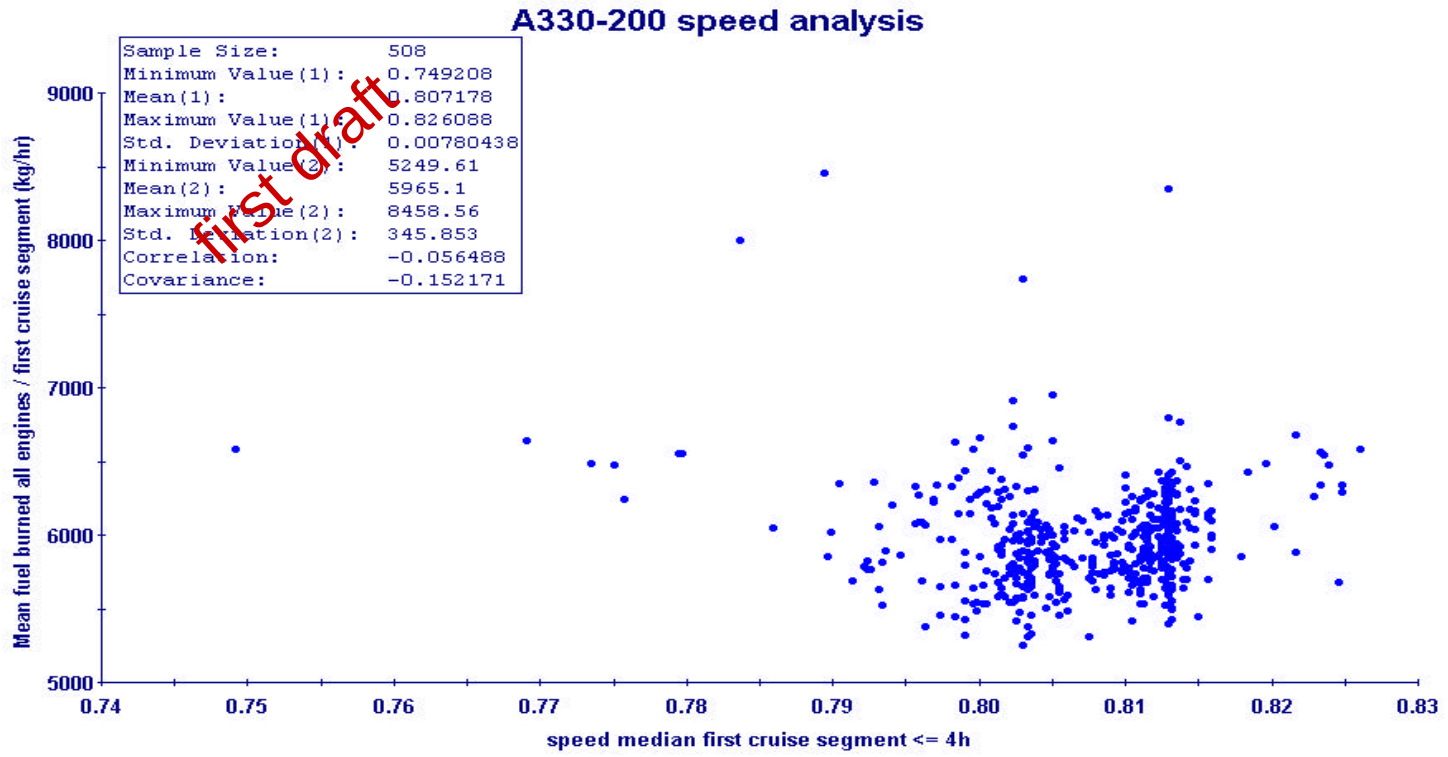
A330-200 cruise speed analysis vs. fuel per flighthour



... last cruise segment <= 4h

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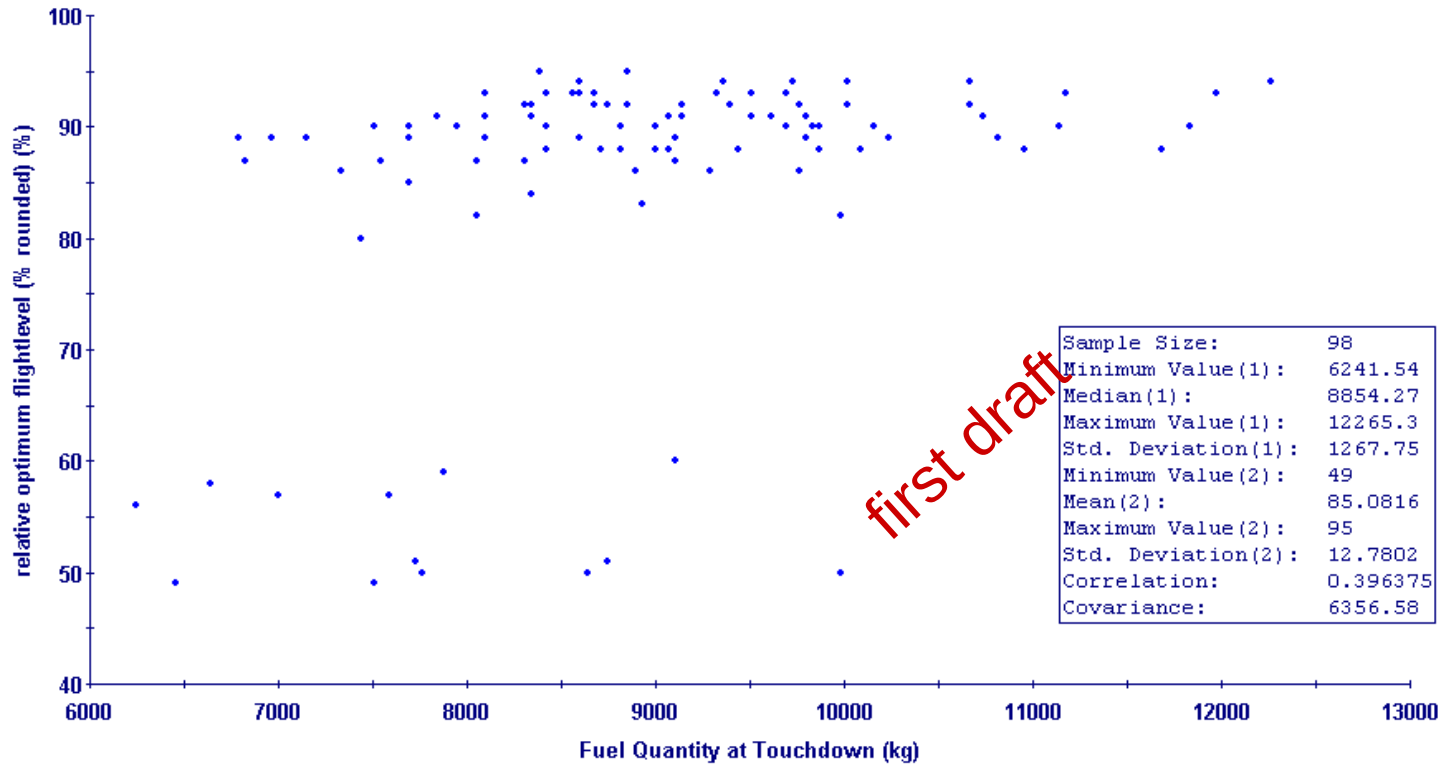
A330-200 remaining fuel ex. AUH, DXB, RUH & DEL



... optimum vs. suboptimum flightlevels

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Fuel Efficiency Board - work done

✈**Aircraft weight** is a major factor in fuel consumption. Apart from the empty weight and the payload (passengers & cargo), the fuel in the tanks and the goods needed for in-flight service contribute to the total weight**.**

✈All parties within our Group are constantly seeking to achieve weight reductions; e.g.

A340-300 introduction / specification and weight guarantees, flexible drinking water replenishment, fitting of a ‘zonal dryer’ system to drive out moisture from the insulation blankets, JAR-OPS fuel policy, ULD weight reduction, excess customer service items etc.

Fuel Efficiency Board - work done (cont.)

- Our work has shown that **weight-saving** measures yield the greatest environmental yield (without causing any 'problematic' sideeffect).

- Initiation of the weight **'controlling'** process A340-300;

- **Cost savings**;

e.g. enhanced fuel ferry tool – 2+ Mio$ per year recurring cost reduction –, new route comparison tool and optimum overflight charges etc.

Fuel Efficiency Board - work done (cont.)

✈**Technical items**; e.g.

A340-300 / CFMI performance retention guarantees, A340 & MD11 engine wash (A320/A330 done), enhanced CG calculation (A340), APU running time etc;

Contribution in the retrofit decision process re. the retrofit of 'enhanced' CFM56-5CP engines ⇨ at least **1% better fuel consumption** and **reduced emissions** (CFMI guarantee / warranties).

fuel additives in order to reduce emissions on ground etc.

Fuel Efficiency Board - work done (cont.)

✈**Operational measures**; e.g.

further reduction in high speed flying long-haul, ICAO B procedure and Continuous Descent Approach,

enhanced flight plan optimization and variable mach cruise calculation, make use of best available planning assumptions;

e.g. actual zero fuel weight and last minute OFP,

reduction of the remaining fuel on board landing at the home destination etc.

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Reduction in high speed flying long-haul

✈ :

Our MD11 fuel (2000) audit showed an average HSC far above **40%** of which half could be reduced to normal speed resulting in an agreed annual saving of at least **3⁺ Mio$** (cargo penalty not quantified).

Facts & figures re. cruise – above FL 290 – with speeds higher than 'normal cruise' – **machnumber > 0.83** or **> 0.82**:

MD11 (2000) **> 0.83:**

- **~ 30%** to above **50%**
- ð less than **20%** (2001)

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Reduction in high speed flying long-haul (cont.)

A330-200 (2000) **> 0.82:**

- ‘best guess’ **> 30%**
- ð less than **10%** (2002),

✈Goal: Assure **best practice** & **transparency** re. fuel **consumption**, **punctuality** etc.

✈Introduction of a **High Speed Policy** (A320/A330/A340 & MD11 Aircraft Operating and Route Manual):

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Reduction in high speed flying long-haul (cont.)

- **Priority 1** Flight – according to TOI – **High Speed** Procedures apply **whenever possible**.

- **Priority 2** Flight – **High Speed only if so dictated** to meet operational requirements given to the crew via telex, TOI, ACARS or other means.

- Arrival **not** within 'On Time' window, i.e. **STA + 15 min** at the gate.

- Other reasons (e.g. Short Transit Time, Night Ban, Enroute Slot Requirements etc.).

Reduction in high speed flying long-haul (cont.)

✈ the revised ETA is according schedule (unless otherwise instructed by Operations Control).

This holds true especially for our early morning arrivals in ZRH. **Please manage your speed accordingly**"

(Capt. Martin Rau, Chiefpilot MD11, Speed vs. ETA re. our efforts to improve punctuality).

✈This should help many airlines improve their fuel efficiency.

We are convinced that the best way to reduce emissions is based on the assumption to **reduce fuel consumption** mainly in cruise.

Reduction in high speed flying long-haul (cont.)

✈"As the use of **High Speed** procedures leads to an increased fuel consumption, every decision to fly with speeds higher than Normal Cruise shall be made only after careful consideration of **all** factors" (passenger requirements, punctuality, fuel saving etc.) ...

✈"The partial application of high speed procedures (e.g. variable cost index, only high speed **climb** or high speed **descent** etc.) may often be **sufficient** to meet the above requirements".

(quote RM A320/A330/A340)

Reduction of remaining fuel at touch down

✈ :

Our analysis – A330-200 remaining fuel on board at touch down, before and after introduction of the JAR-OPS fuel policy – showed an average reduction of 500 kg per long-haul flight resulting in an agreed annual saving of at least **500'000^{+} $**. etc.

✈An MD11 long-haul survey showed an average **extra fuel** amount for NAT-flights in the order of magnitude of **2.5** t with 'good' & stable forecast conditions.

Reduction of remaining fuel at touch down (cont.)

- It clearly shows that additional savings of approx. **500'000⁺ $** can be reached fleetwide specifically through a reduction of 2.5 t to 1.8 t extra fuel (MD11 fleet).

- Our analysis re. A330 remaining fuel ex. DEL & DXB showed a median equal to **8'400 kg** & **9'200 kg** fuel on board at touch down – incl. **1.5 t company fuel** – with less than **5%** having less than **6.4 tons** remaining.

Reduction of remaining fuel at touch down (cont.)

✈We expect a significant improvement after RVSM (Reduced vertical separation Minima) implementation.

✈**Reliable facts & figures** required in order to identify operational measures and corresponding benefits for fuel savings in the cruise phase reducing the weight of the – extra – fuel in the tanks

⇨ no further recommendations re. a reduction of remaining fuel, company and extra fuel issued for the moment.

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‘soft- vs.. hardware’

‚software’

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& new ideas

reduction in high speed flying

flight plan optimization

reduction in extra fuel

Event Measurement System / analysis tool fuel data

ICAO B procedure

A330/A340 … fuel monitoring

cost & environmental awareness

engine wash

ULD weight reduction

‚hardware’

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Thank you!

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