728JET - A New Family of Regional Aircraft

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728 New Family of Regional Transport Aircraft

Market Situation

Demand in regional air transport is still growing fast. The hub and spoke system reaches its limits in busy regions. More slots can not be made available at major hubs. Direct links to smaller communities/airfields could avoid congestion at hubs.

Propeller Aircraft are rated as less comfortable, noisy, unsafe and old fashioned. Some fatal accidents in flights under icing conditions are serious arguments. The public not fully understand the real causes:
- insufficient ice protection of critical leading edges in front of control surfaces,
- operational aspects when flying through frizzing drizzle or super cooled droplets at high liquid water content.

New regional transport aircraft must offer comfort and reliability like the modern large Airliners, but operate at lower cost.

In past 10 years period (1989-1998) 2336 aircraft in the capacity range of 40 to 110 seats (1005 turboprops and 1331 jets.) are delivered. Forecast for the next 10 years period is 3710 aircraft in that capacity range, in a split of 560 turboprops and 3150 jets.

Strong cost driven competition forced major airlines to form global alliances and get also control on regional Air transport. The big 4 group: Star Alliance, Wings; Qualiflyer and Oneworld are dominating today’s air transport by serving more than 2800 international cities world-wide, flying more than 600 million passengers a year and a turnover of 110 billion US$ per year. They play an important role now in decision making process on regional aircraft. It is not the small airline any more we are selling to.

Number of OEM’s are down to 3 in the regional jet market. Cost competition and risky investment in new programs limit survival chances to 2 or 3 OEM’s at maximum.

Aircraft Layout

New aircraft have to be overall more attractive than competing one’s already in service. Beside performance and cost, cabin layout has high impact on passenger appeal. Seat width, -pitch, head-, shoulder-, window seat foot clearance and isle width are rated comfort parameters. In 728 design a family of aircraft sizes (55, 70, 100 seats) is considered from the beginning. Trade-off studies advised optimum cabin width of 128 inch in a 5 abreast seat arrangement for tourist- and 4 abreast in first class. It offers more space than today’s regional aircraft and is like A320 or Boeing 717.

The required field-, climb- and cruise performance could best be met by a low wing, below wing mounted engines and low horizontal stabilizer configuration, at lower weight and less drag. With doors front and aft it allows an undisturbed cabin (no emergency exits in between), it provides flexibility for any cabin arrangement from 55 seater 528 to 105 seater 928.

A common wing of 75 sqm with slats, inboard Krüger flaps and single slotted flaps meets performance required for 728 and 528. For 928 wing size will increase to 84sqm by extended wing tips and redesigned inboard section. Fine tuning of wing design by reshaping of pylon leading edge and reduced gap between extended Krüger flap and pylon helped to increase max lift coefficient. Beside a drag cleanup, staggering of fin and tail with fin tuning of rear fuselage reduced drag by 6%. Results are now confirmed by wind tunnel testing.

Power is provided by General Electric CF43-8D Engines with 46,2 inch fan for 728, derated for 528 and -10D derivative with 53 inch fan in a modified nacelle for 928.

Progress in Aircraft Systems

Aiming for reliable low cost operation with minimum time on ground at acceptable pilot work load are arguments for higher system integration and application of new technologies. Here only examples are given.

Avionics

Primus EPIC avionics system from Honeywell with it’s bus systems links all other aircraft systems together, provides reliable data processing, indication, monitoring and control via 2 cursor. It provides additional capabilities for future communication and navigation systems. All systems status data are processed in smart centralized maintenance computer and necessary action after next landing are transmitted to the ground maintenance operation. All needed activities can be prepared before touch down and delays be minimized.
Flight controls

728 family will be equipped with all fly by wire flight controls with pilot fully in the loop. Mechanical inputs from the pilot be translated in electrical signals processed in duplex surface control modules, producing input signals to duplex actuator control units. Hydraulic actuator feed is by triplex power supply. Force feed back to pilot generates familiar handling qualities.

Electric Power Supply

Fly by wire flight controls require 4 independent electric power supply systems. 3 identical generators take power from each engine and APU, the forth generator is driven by ram air turbine in case of power loss in all 3 other supplies. Power is controlled by to 2 integrated primary-, 1 emergency- and 4 secondary control units; this avoids lots of fuses in the over head panel.

Operational Aspects

Technical efficiency can be measured in weight per passenger and block fuel burn per seat mile. Even with more comfortable fuselage diameter the 728 manufactures empty weight is below competitors aircraft and also is fuel burn. As final result the direct operating cost on example stage length of 500 NM 728 comes out 15 % better in seat mile cost and more or less equal in aircraft mile cost. Cumulate noise level has margin of 15 EPNdB against ICAO Annex 16 requirements. Emissions are fare below of ICAO Annex 16.

Impact of Commonality on Operation

In a mixed fleet of 42 aircraft with the capacity of 728 and 928 as common out of a family versus different models, investment saving can be 14 million US$ and an annual saving of 8.5 million US$.

Summary

Future traffic growth in regional transport can be served by bigger aircraft operated in the hub and spoke system and by more direct links. The 4 major alliances having more and more impact on regional air traffic now. The fierce competition is down to 3 OEM's. Regional aircraft have to offer comfort and operation like airliner but at lower cost. Higher aircraft system integration and fly by wire flight controls are good examples of technical improvements. Design for operational commonality can produce attractive cost savings in investment and operation of different capacity size family of aircraft.
• Is the Hub & Spoke System at its Growth Limits?

• Are More Direct Links Needed to Communities with Smaller Airfields?

• Propeller Aircraft are Out!

• Regional Aircraft must have Comfort and Reliability like Large Airliners

• - But at Lower Operating Cost
## Aircraft Deliveries, 1989 - 2008

### Aircraft Type

<table>
<thead>
<tr>
<th>Aircraft Type</th>
<th>1989 - 1998</th>
<th>1999 - 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>(No. of Seats)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 - 19 Turboprops</td>
<td>920</td>
<td>330</td>
</tr>
<tr>
<td>20 - 39 Turboprops</td>
<td>1,124</td>
<td>230</td>
</tr>
<tr>
<td>20 - 39 Jets</td>
<td>0</td>
<td>600</td>
</tr>
<tr>
<td>40 - 59 Turboprops</td>
<td>703</td>
<td>280</td>
</tr>
<tr>
<td>40 - 59 Jets</td>
<td>393</td>
<td>980</td>
</tr>
<tr>
<td>60 - 80 Turboprops</td>
<td>302</td>
<td>280</td>
</tr>
<tr>
<td>60 - 80 Jets</td>
<td>52</td>
<td>820</td>
</tr>
<tr>
<td>81 - 110 Jets</td>
<td>886</td>
<td>1,350</td>
</tr>
<tr>
<td>111 - 171 Jets</td>
<td>2,609</td>
<td>3,260</td>
</tr>
<tr>
<td>Single Aisle 171+ Jets</td>
<td>764</td>
<td>1,140</td>
</tr>
<tr>
<td>Medium Twin-Aisle Jets</td>
<td>1,501</td>
<td>1,820</td>
</tr>
<tr>
<td>Large Twin-Aisle Jets</td>
<td>479</td>
<td>420</td>
</tr>
<tr>
<td>Total (Aircraft)</td>
<td>9,733</td>
<td>11,510</td>
</tr>
<tr>
<td>Total (Seats)</td>
<td>1,406,845</td>
<td>1,839,626</td>
</tr>
</tbody>
</table>

Source: STG and AvSat (Commuter/Regional Airline News Sept. 6, 99)
- Less Comfortable than Jets
  - Narrower seats, smaller seat pitch, narrower aisle, no standing room in the aisle
  - Too little space for hand luggage
  - Noisier
  - Vibration felt in the cabin

- Unsafe (?)

Turboprops are considered „old fashioned“ and outdated
Conclusions from accidents with turboprops

- Run-back Ice on wing leading edge ahead of aileron
  
  Insufficient chordwise ice protection coverage
  
  Lost control and crashed

- Ice build-up resulted in higher stall speed
  
  Aircraft flown too slow
  
  Lost control and crashed
Increased Requirements in „Code-Sharing” Operations

- Comfort equivalent to airline standard
- Same level of reliability
- All-weather capable (CAT IIIa)
- Turn-rounds in less than 20 minutes
- Airlines put more pressure on manufacturers
- Competition involves larger fleet deals
- Large airlines have more influence on selection & specification of regional a/c
The Four Major Alliances

**STAR**
Lufthansa, United Airlines, SAS, Air Canada, Thai, Varig, SIA, Air New Zealand, Ansett, ANA, (Austrian)

**WINGS**
KLM, Northwest, Aer Lingus, Martinair, Transavia, JAS, Jet Airways, Garuda

**Qualiflyer Group**
Swissair, Sabena, Turkish Airlines, TAP Air Portugal, Crossair, Lauda Air, Tyrolean Airways, Air Littoral, AOM, Air Europe, (Austrian)

**oneworld**
British Airways, American Airlines, Canadian Airlines, Cathay Pacific, Qantas, Finnair, Iberia, (LanChile, Aer Lingus)

**Alitalia**
The 10 Year Market (Estimation: No. of Aircraft x list prices, in US $ Billions)

<table>
<thead>
<tr>
<th>Seats</th>
<th>US$ Billions</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>15.3</td>
</tr>
<tr>
<td>30</td>
<td>(30 - 40 Seat Combined)</td>
</tr>
<tr>
<td>40</td>
<td>22.1</td>
</tr>
<tr>
<td>50</td>
<td>26.6</td>
</tr>
<tr>
<td>60</td>
<td>24.1</td>
</tr>
<tr>
<td>70</td>
<td>41.7</td>
</tr>
<tr>
<td>80</td>
<td>117,500 lb. (30 - 40 Seat Combined)</td>
</tr>
<tr>
<td>90</td>
<td>93,000 lb.</td>
</tr>
<tr>
<td>100</td>
<td>75,000 lb.</td>
</tr>
<tr>
<td>110</td>
<td>51,000 lb.</td>
</tr>
<tr>
<td>120</td>
<td>45,415 lb.</td>
</tr>
</tbody>
</table>

Aircraft Models and Details:
- **Bombardier**
  - BRJ-X 110: 117,500 lb.
  - CRJ 900: 72,500 lb.
  - CRJ 200: 51,000 lb.
- **Embraer**
  - ERJ-140: 44,313 lb.
  - ERJ-145: 45,415 lb.
  - ERJ-170: 75,000 lb.
  - ERJ-190-100: 93,000 lb.
  - ERJ-190-200: ~105,000 lb.
  - ERJ-140-100: 41,890 lb.
- **Fairchild Aerospace**
  - 928JET: 98,105 lb.
  - 728JET: 76,852 lb.
  - 528JET: 68,321 lb.
  - 428JET: 44,533 lb.
  - 328JET: 33,510 lb.
- **Airbus**
  - A318: ~125,000 lb.
  - A320: 144,500 lb.
  - A330: 190,000 lb.
- **Boeing**
  - B737-600: 121,000 lb.
  - B737-700: 144,500 lb.
  - B717-200: 121,000 lb.
Manufacturers are Reacting

**Bombardier**
- CRJ 200
- CRJ 700
- BRJ-X-90
- BRJ-X-110

**Embraer**
- EMB 145
- EMB 135
- EMB 140
- EMB170
- EMB 190

**Dornier Luftfahrt**
- 328JET
- 428JET
- 728JET
- 928JET
- 528JET
# 728JET Family Members

<table>
<thead>
<tr>
<th>5-abreast</th>
<th>Seats</th>
<th>Designations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>55-65</td>
<td>528JET</td>
</tr>
<tr>
<td></td>
<td>70-80</td>
<td>728JET (Ref. Design)</td>
</tr>
<tr>
<td></td>
<td>95-110</td>
<td>928JET</td>
</tr>
</tbody>
</table>
Cross-Section 5-Abreast – 128 in

- 64 in (1.63 m)
- 43 in (1.09 m)
- 18 in (0.46 m)
- 1 in (0.025 m)
- 3 in (0.07 m)
- 19 in (0.483 m)
- 128 in (3.25 m)
- 84.3 in (2.14 m)
- 33.5 in (0.85 m)
Cross section comparison

- **728J ET**
  - 18 in
  - 19 in
  - 128 in

- **CRJ -700/900**
  - 17.3 in
  - 16 in
  - 100.5 in

- **ERJ -170/190**
  - 18 in
  - 19 in
  - 108 in

- **Boeing 717/DC9/MD80 series**
  - 17.9 in
  - 19 in
  - 123.2 in

- **BAe146 (5 abreast)**
  - 18.7 in
  - 21 in
  - 134.5 in

- **Fokker 70/100**
  - 17.4 in
  - 19 in
  - 122 in

- **Boeing 737**
  - 17 in
  - 20 in
  - 139.3 in

- **Airbus A 320**
  - 18 in
  - 19 in
  - 146 in

- **BAe146 (6 abreast)**
  - 17 in
  - 16 in
  - 134.5 in
728JET vs CRJ/ERJ – Cabin Cross Section

**CRJ -700/900**

17.3 in
0.44 m

16 in
0.40 m

74.25 in
1.89 m

100.5 in
2.55 m

**728J ET**

18 in
0.46 m

19 in
0.48 m

84.3 in
2.14 m

128 in
3.25 m

**ERJ -170/190**

18 in
0.46 m

19 in
0.48 m

78 in
2.00 m

108 in
2.74 m

Business Class Arrangement
(with Convertible Seats)
728JET Cabin Layout for 70 Passengers

70 Seats at 33” Seat Pitch

D1 = Passenger Door (Typ C)
A = Attendant Seat
W = Wardrobe
SE = Service Door & Emerg. Exit (Typ C)
E = Emergency Exit (Typ C)
G = Galley
L = Toilet & Lavatory
S = Storage

3 + 1 full size trolleys
3 full size trolleys

airstair housing
space for multi-purpose arrangements
avionics
728JET Mixed Class Cabin Layout 12/55 Passengers

67 Seats – 12 Seats at 34" and 55 Seats at 33" Seat Pitch

D1 = Passenger Door (Typ C)
A = Attendant Seat
W = Wardrobe
SE = Service Door & Emerg. Exit (Typ C)
E = Emergency Exit (Typ C)
L = Toilet & Lavatory
G = Galley
S = Stowage
928JET Cabin Layout for 95 Passengers

95 Seats at 33” Seat Pitch

- 3 + 1 full size trolleys
- 3 full size trolleys + 3 half size trolleys
- airstair housing
- space for multi-purpose arrangements
- optional third flight attendant seat
- avionics

D1 = Passenger Door (Typ C)
A = Attendant Seat
W = Wardrobe
SE = Service Door & Emerg. Exit (Typ C)
E = Emergency Exit (Typ C)
L = Toilet & Lavatory
G = Galley
S = Storage
528JET Cabin Layout for 55 Passengers

55 Seats at 33" Seat Pitch

D1 = Passenger Door (Typ C)
A = Attendant Seat
W = Wardrobe
SE = Service Door & Emerg. Exit (Typ C)
E = Emergency Exit (Typ C)
L = Toilet & Lavatory
G = Galley
S = Storage

3 full size trolleys

 optional space for multi-purpose arrangements

airstair housing

avionics

FL 99 Fl 002 E – 2000-01-14-SvK/AR
**CF34-8D – Propulsion System Family**

<table>
<thead>
<tr>
<th>Propulsion System Features</th>
<th>CF34-8D3</th>
<th>CF34-8D1</th>
<th>-10D</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Fan Diameter</td>
<td>46.2&quot; Base</td>
<td>46.2&quot; Base</td>
<td>53&quot;</td>
</tr>
<tr>
<td>• Nacelle</td>
<td></td>
<td></td>
<td>Larger Nacelle with Common Features/Architecture</td>
</tr>
<tr>
<td>• Booster Stages</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>• HP Compressor</td>
<td>Base</td>
<td>Base</td>
<td>Derivative CFM-56</td>
</tr>
<tr>
<td>• Combustor</td>
<td>Base</td>
<td>Base</td>
<td>Derivative CFM-56</td>
</tr>
<tr>
<td>• HP Turbine</td>
<td>Base</td>
<td>Base</td>
<td>Derivative CFM-56</td>
</tr>
<tr>
<td>• LPT Turbine</td>
<td>Base</td>
<td>Base</td>
<td>New Design</td>
</tr>
<tr>
<td>• % Identical with CF34-8D3</td>
<td>Base</td>
<td>100%</td>
<td>Minor commonality only</td>
</tr>
</tbody>
</table>

**Performance**

- Installed Thrust (lbf)*
  - APR Take-off 13,575*
  - Normal T/O 12,500

* Take-off ratings are installed SLS, flat rated to ISA+15°C except for the CF34-8D3 APR rating which is flat rated to ISA+9°C

Derate -8D3

Derate -8D3

18,000-20,000 exact requirments at a later date
Wing Configuration Changes

- Revised slat configuration
- Revised spoiler configuration
Aerodynamic Efficiency, Polar 1.4
Mach Dependant Drag Due to the Wing

\[ \Delta C_{D\text{m}(\text{wing})} \]

\[
\begin{align*}
\Delta C_{D\text{m}(\text{wing})} & \text{ [cts]} \\
\text{WT: Old conf., anl005/ (WB1+BF1+TFN+FTF1+VT1) - (B1+BF1+VT1), M7.5, Z-sting} \\
\text{WT: Old conf., anl006/ (W+B+TFN+FTF) - (B), M7.2} \\
\text{WT: Updated conf., anl008/ (W2+B2+BF18+TFN+PY2+FTF2) - (B2+BF18), M7.5, 5°-sting} \\
\text{Polar 1.4} \\
\text{Polar 1.0} \\
\text{Polar 1.4, excluding Re correction} \\
\text{Polar 1.0, excluding Re correction}
\end{align*}
\]

Mach Number
Mach Dependant Drag Due to the Fuselage Body

\[ \Delta C_{D\text{M(body)}} \] vs Mach Number
Drag Reduction Due to Configuration Changes

\[ \sum \Delta \text{drag} = -16.5 \text{ cts} \]
728JET – 3 View

Wing Area  807 ft²/75 m²
Aspect Ratio  9.81
Sweep  23.5°
928JET – 3 View

<table>
<thead>
<tr>
<th>Wing Area</th>
<th>904 ft²/84 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspect Ratio</td>
<td>9.83</td>
</tr>
<tr>
<td>Sweep</td>
<td>23.5°</td>
</tr>
</tbody>
</table>

101 ft 7 in / 30.96 m

32 ft 1 in / 9.77 m

94 ft 6 in / 28.81 m
# Leading Particulars, Weights & Performance Summary

<table>
<thead>
<tr>
<th>Designation</th>
<th>528JET</th>
<th>728JET</th>
<th>928JET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity (33&quot;/31&quot; pitch)</td>
<td>55-65</td>
<td>70-80</td>
<td>95-110</td>
</tr>
<tr>
<td>Cross Section</td>
<td>5-abreast</td>
<td>5-abreast</td>
<td>5-abreast</td>
</tr>
<tr>
<td>Powerplant</td>
<td>General Electric CF34-8D1</td>
<td>General Electric CF34-8D3</td>
<td>General Electric CF34-10D</td>
</tr>
<tr>
<td>T/O Power Rating (normal)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Max. Take-off Weight</td>
<td>11,880 lb</td>
<td>12,500 lb (13,575 lb APR)</td>
<td>18,000-20,000 lb**</td>
</tr>
<tr>
<td>– Max. Payload</td>
<td>30,990 kg/68,320 lb</td>
<td>35,200 kg/77,601 lb</td>
<td>44,500 kg/98,106 lb ER to be issued later *</td>
</tr>
<tr>
<td>Range (with IFR reserves)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100kg/pax, FL370, M=0.78, ISA</td>
<td>55 Pax / 65 Pax, 1,520 nm / 1,230 nm</td>
<td>70 Pax / 80 Pax, 1,660 nm / 1,340 nm (= 2,140 nm / 1,820 nm)*</td>
<td>95 Pax /110 Pax, 2,000 nm / 1,620 nm</td>
</tr>
<tr>
<td>Max. Cruise Speed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISA, 95% MTOW, FL350</td>
<td>467 KTAS (M≈0.81)</td>
<td>464 KTAS (M≈0.805)</td>
<td>462 KTAS (M=0.8)</td>
</tr>
<tr>
<td>$M_{MO}$ / $V_{MO}$</td>
<td>0.81/335 KCAS</td>
<td>0.81/335 KCAS</td>
<td>0.81/335 KCAS</td>
</tr>
<tr>
<td>Take-off Field Length</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Std. version, ISA, SL MTOW)</td>
<td>4,200 ft</td>
<td>5,200 ft</td>
<td>5,530 ft</td>
</tr>
<tr>
<td>Single Engine Service Ceiling</td>
<td>21,000 ft</td>
<td>20,200 ft</td>
<td>to be issued later</td>
</tr>
<tr>
<td>Landing Field Length</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Std. version, MLW)</td>
<td>4,200 ft</td>
<td>4,300 ft</td>
<td>4,630 ft</td>
</tr>
<tr>
<td>Hot&amp;High Performance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climb-limited T/O Wt.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Std. version, ISA + 20°C, 5,000 ft)</td>
<td>MTOW</td>
<td>MTOW</td>
<td>MTOW</td>
</tr>
</tbody>
</table>

* ER version   ** exact requirement will be issued at a later date
Payload/Range Diagram for 728JET

CRUISE Ma=0.78
@ FL 370
ISA, NO WIND
IFR RESERVES

OWE 20797 kg
MTOW 35200 kg
MZFW 30300 kg
max. fuel 10100 kg
Pax weight 100kg each

80 Pax
75 Pax
70 Pax

Payload [kg]
Distance [nm]
Primus *EPIC* Avionic System (Honeywell)

- Enhanced Synoptic and Indications
- Enhanced System Operation by using Smart Cursor Device
- High redundancy for System Operation
- Maximum reduction of Overhead Aircraft System Controls
- High System Integration in Avionics and Aircraft Utility Systems (to reduce LRU's, Weight and Power Consumption)
- Cursor Guided Pilot Procedures in case of Aircraft System Failure
- Autopilot for CAT II as standard
- Optional CAT IIIa/b capability by Autopilot (with Auto Land)
- Smart Centralized Maintenance Computer
- System to reduce troubleshooting (with optional data link)
- No System Limitations to interface with future Navigation and Communication Systems (with provisions for enhanced vision system)
- Dispatch with one panel out
Baseline Avionics
Beneficial Advancements of the Avionic System

- **Integrated Utilities**
  - Centralize systems and functions

- **Minimize Data-Source and - Processors**
  - Centralize important aircraft data

- **Minimize Paper in Cockpit**
  - Automate procedures and checklist for pilots and maintenance personnel

- **Commanding of other A/C Systems via Cursor Control Device**
  - Reduce number of controllers in the panels
System Configuration:
- Generation:
  (2) Main Engine (IDGs)
  (1) APU (AUX GEN & Seal Plate)
- Primary Distribution:
  (1) Left Integrated Control Center
  (1) Right Integrated Control Center
  (1) Emergency Integrated Control Center
  (1) EXT AC Current Transformer Assy
- Secondary Distribution:
  (4) Secondary Power Distribution Assy
- Emergency Power:
  (1 each) Ram Air Turbine,
  Generator Control Unit, Ejection Jack,
  Restow Pump, Uplock
  (1) Static Inverter
  (2) Batteries & Battery Contactor Units
General Overview
Aircraft Plan View
Yaw Cockpit Control Module

Legend:
- P-ACE=Primary Actuator Control Electronic's
- PCU=Power Control Unit
- NWS=Nose Wheel Steering

First Officer's Pedals
LVDT
Rudder Interconnecting
Brake Control System
LVDT

Captain's Pedals
LVDT
Rudder Interconnecting
Outer Shaft
Inner Shaft
LVDT

RUDDER Module

Feel Spring

Irreversible Brushless Trim Motor

Trim RVDT

6 RVDT Outputs

Trim position indication to EICAS

2 RVDT outputs

Nose Wheel Steering

Dimming Supply
28 V
5V

Trim Control Panel

Upper PCU
Center PCU
Lower PCU

P-ACE
P-ACE
P-ACE

Legend:
- P-ACE=Primary Actuator Control Electronic's
- PCU=Power Control Unit
- NWS=Nose Wheel Steering

Proprietary Information
Weight/Max Pax (kg)
Index Blockfuel per Seat - Comparison
Stage Length 500 nm

<table>
<thead>
<tr>
<th>seats</th>
<th>728JET</th>
<th>528JET</th>
<th>928JET</th>
<th>ERJ 145 ER</th>
<th>RJ 200</th>
<th>RJ 700</th>
<th>ERJ-170</th>
<th>Fokker 70</th>
<th>Avro 85</th>
<th>Avro 100</th>
<th>ERJ-190-100</th>
<th>ERJ-190-200</th>
<th>Fokker 100</th>
<th>Boeing B 737-500</th>
<th>Boeing B 737-800</th>
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<th>Airbus A 318</th>
<th>Airbus A 319</th>
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<td>29.6</td>
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[Blockfuel per Seat 01-13-00 / Chart Blockfuel per Seat (2) 13.01.2000]
Delta COC per Seat / per A/C nm - Comparison

Stage Length 500 nm

728JET Family Seating Layouts

<table>
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<tr>
<th>seat pitch</th>
<th>528JET</th>
<th>728JET</th>
<th>928JET</th>
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<tr>
<td>31 inch</td>
<td>65</td>
<td>105</td>
<td>max. capacity</td>
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<tr>
<td>32 inch</td>
<td>60</td>
<td>80</td>
<td>standard comfort</td>
</tr>
<tr>
<td>33 inch</td>
<td>75</td>
<td>100</td>
<td>high comfort</td>
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</table>

DOC & Economics for Presentation / Chart Delta COC (500 nm)  17.02.2000
Certification Flight Noise

GEAE assumed airframe noise of 86 dB for approach condition.
Emissions

<table>
<thead>
<tr>
<th>Emission Category</th>
<th>ICAO Annex 16</th>
<th>SPEC</th>
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<tbody>
<tr>
<td>CO [g/kN]</td>
<td>118</td>
<td>49.6</td>
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<tr>
<td>UHC [g/kN]</td>
<td>19.6</td>
<td>4.0</td>
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<tr>
<td>NOX [g/kN]</td>
<td>70.2</td>
<td>35.3</td>
</tr>
<tr>
<td>Smoke [SN]</td>
<td>27.7</td>
<td>11.8</td>
</tr>
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</table>
The Situation

Airlines must decide on the future fleet today. The decision for the right equipment must address the following requirements:

• The market requires aircraft of different sizes for flexible scheduling and effective yield management.

• Marketing requires a common product identity.

• Operation requires small numbers of aircraft types and standardization to achieve low operating cost.

• Strategic planning requires aircraft capacity optimization in line with the future development of the business.

• Limited predictability of the future requires high adaptability of the aircraft fleet to changing market requirements, without increasing cost.
Cost Saving Issues

Aircrew

The *common type rating for the 728JET family* aircraft enables pilots to operate each type within the fleet, simplifying crew scheduling. It also reduces the cost for type rating, training and salaries throughout the whole service life of the aircraft and reduces operational constraints, such as crew positioning, dead heading costs, etc. These savings will be even more substantial, should an airline’s route structure require more crews per aircraft.

Simulator

An airline operating its own simulators will necessarily have to have a simulator for each type of aircraft, representing additional high investment. This disadvantage of a non-common fleet can, however, be avoided by out-sourcing simulator training to a specialized pilot training provider.
Cost Saving Issues

**Maintenance**

The required number of maintenance engineers is lower for a common fleet, due to *common type ratings*, resulting in reduced labor costs, coupled with higher efficiency and lower burden as a direct result of the learning curve effect.

**Spares**

The *volume of spares holding* can be decreased for a common fleet without sacrificing dispatch reliability. This means less money is tied up in spares stocks.

**Operation & Administration**

Many administration areas benefit from a common fleet. *Purchasing, spares administration, crew training and planning, catering, ground handling and maintenance planning* will be less labor intensive.
Purchasing Issues

A manufacturer can reduce costs by producing a high number of aircraft of the same type. This results in lower prices for the airlines.

There are more advantages in purchasing a common fleet:

• Purchasing from vendors follows the known patterns

• The evaluation process will be simpler, due to the known profitability and costs of the aircraft and its systems.

• As a manufacturer of a family of aircraft, Dornier Luftfahrt can provide shorter lead-times for the customer and his decision what version (size) his airline should select when exercising options. This improves the reaction time to the challenges of a changing market.
Product Identity

The 728JET family concept offers multiple advantages to an airline:

- **Across the fleet**
  - Same cabin layout in all aircraft
  - Identical service items (galleys, lavatories, ...)
  - Common catering equipment
  - Easier seat assignments/reservations

- The **Commonality of the Cabin Standard** in the aircraft family can be used by Marketing as a unique selling point for the airline.

- A **seamless standard of comfort with the mainline fleet** (e.g. Airbus A320 series) is key to customer loyalty. The same standard, for example, can be kept in seat pitch (31 to 33 in) and seat width (18 in).
Future Development of the Market

Aircraft are sold in an ever-changing market place. An airline, therefore, has to meet the following requirements, which can be met by an aircraft family concept:

• The **composition of the future fleet** can be easily adopted to growth or shrinking of the market’s demands.

• **The planning risk is greatly reduced.**

• Limited predictability of the future requires **high adaptability of the aircraft fleet** to changing market requirements, without increasing cost.
Cost Savings - Executive Summary

<table>
<thead>
<tr>
<th></th>
<th>Savings</th>
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<tbody>
<tr>
<td><strong>27 x A/C X + 15 x A/C Y</strong></td>
<td><strong>Less Investment Cost</strong></td>
<td><strong>Less Annual Cost</strong></td>
</tr>
<tr>
<td><strong>versus</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>27 x 728+ 15 x 928</strong></td>
<td></td>
<td></td>
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<tr>
<td>Simulator Economics (buy-in of training considered)</td>
<td>0 US$</td>
<td>no simulator required</td>
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<tr>
<td>Aircrew Training (Type Rating) in 2 years</td>
<td>961.000 US$</td>
<td>1,056.100 US$/year</td>
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<tr>
<td>Aircrew Attrition Training</td>
<td></td>
<td>259.000 US$/year</td>
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<tr>
<td>Aircrew Recurrent Training</td>
<td></td>
<td>6,132.000 US$/year</td>
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<tr>
<td>Aircrew Productivity (Crew Cost)</td>
<td>11,305.000 US$</td>
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<tr>
<td>Airframe Spares</td>
<td>1,600.000 US$</td>
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<tr>
<td>Maintenance Training (Type Rating) in 2 years</td>
<td>100.000 US$</td>
<td>0 US$/year</td>
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<tr>
<td>Maintenance Recurrent Training</td>
<td></td>
<td>1,059.300 US$/year</td>
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<tr>
<td>Maintenance Crew Productivity (Crew Cost)</td>
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<tr>
<td><strong>Total Fleet Add. Investment Savings:</strong></td>
<td><strong>13,966.000 US$</strong></td>
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<tr>
<td><strong>Total Fleet Add. Annual Savings:</strong></td>
<td><strong>8,506.400 US$/year</strong></td>
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<tr>
<td><strong>Total Fleet Investment Savings</strong></td>
<td><strong>71,966.000 US$</strong></td>
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</table>
An airline depends on public acceptance. The family concept help to increase this, because an optimized fleet size will result in:

- Lower noise
- Fewer emissions
- Less energy consumption

by being able to use the right-sized aircraft depending on demand.
Selected suppliers for the 728JET components…

Avionics:
- Honeywell

ECS/CPCS:
- Honeywell

Wing:
- CASA

Vertical & horizontal stabilizer:
- CASA

APU:
- Honeywell

Landing gear:
- BFGoodrich

Engines:
- GE

Fuel system
- BFGoodrich

Hydraulics:
- Parker

Electrics:
- Sundstrand

Fuselage:
- FAC Operations

Landing gear:
- BFGoodrich

Flight controls
- Honeywell, Sundstrand, Parker

Electrics:
- Sundstrand

Fuselage:
- FAC Operations

Avionics:
- Honeywell
## Selected Partners for Systems and Built Units

<table>
<thead>
<tr>
<th>System / Built Unit</th>
<th>Selected Partner</th>
<th>System / Built Unit</th>
<th>Selected Partner</th>
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<tbody>
<tr>
<td>APU</td>
<td>Honeywell</td>
<td>Fuselage</td>
<td>FAC Operations</td>
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<tr>
<td>Avionics</td>
<td>Honeywell</td>
<td>Hydraulics</td>
<td>Parker</td>
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<td>Cabin Mgmt. System</td>
<td>Diehl</td>
<td>Hydraulic Tubing</td>
<td>Aeroquip</td>
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<tr>
<td>Cockpit Controls</td>
<td>AVIAC</td>
<td>Ice Warning</td>
<td>BFGoodrich</td>
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<td>Crew Seats</td>
<td>Fischer-Entwicklung</td>
<td>Insulation</td>
<td>Mexmil</td>
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<td>Doors</td>
<td>Eurocopter</td>
<td>Interior Integrator</td>
<td>Hexcel</td>
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<tr>
<td>ECS</td>
<td>Honeywell</td>
<td>Landing Gear/Braking System</td>
<td>BFGoodrich</td>
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<td>Electrics</td>
<td>Sundstrand</td>
<td>Leading Edge Anti-Icing</td>
<td>CASA</td>
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<td>Horz. &amp; Vert. Stabilizer</td>
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<td>Lights</td>
<td>Hella</td>
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<td>B/E Aerospace</td>
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<td>Aircruisers</td>
<td>Powerplant</td>
<td>General Electric</td>
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<td>EVM</td>
<td>Vibrometer</td>
<td>Utilities Management</td>
<td>Honeywell</td>
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<tr>
<td>Flight Controls</td>
<td>Honeywell/Sundstrand/Parker</td>
<td>Stowage Area</td>
<td>Driessen</td>
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<td>AOA</td>
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<td>Kidde Deugra, AOA</td>
<td>Wing</td>
<td>CASA</td>
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<td>Stanley</td>
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</table>
Future traffic growth in regional transport can be served by bigger aircraft operated in the hub-and-spoke system and by more direct links.

The 4 major alliances are having more and more influence on the regional airlines.

The fierce competition is down to 3 OEMs.

Regional aircraft have to offer comfort and operation like airliners, but at lower cost.

Higher aircraft system integration and fly-by-wire flight controls are good examples of technical improvements.

Design of operation commonality can produce attractive cost savings in investment and operation of aircraft sized for different capacities.