Karl-Heinz Rendigs
Materials & Processes
Airbus Germany, Bremen

Presented by Michael Niedzinski
Director of Technology & Standardization USA

Airbus and Current Aircrafts
Metal Technologies
Contents

- Airbus General
  - A400M
  - A380 Basics
  - A380 Developments
    - Laser Beam Welding
    - Aluminium
    - Aluminium Forgings
    - Titanium
    - Composite and Hybrid Materials
  - A350 Developments
    - Friction Stir Welding
    - Metallic Perspectives
Structure of EADS

EADS

Airbus

Military Transport A/C

Aeronautics

Space

Defence and Civil Systems

Military Aircraft

Eurocopter

ATR

Sogerma/EFW

Socata

Ariane Space

Astrium

AM Launchers

Defence Electronic

Systems, Services & Telecoms

Missiles/MBD/AM

Missiles/LFK
The Ownership System of Airbus (SAS)

Airbus is a company under French law (SAS).
Employees in Europe

**Airbus UK**
- Méaulte: 1,203
- Broughton: 5,139
- Filton: 4,303

**Airbus Deutschland**
- Hamburg: 10,513
- Bremen: 3,203
- Nordenham: 2,247
- Stade: 1,514
- Varel: 1,265
- Laupheim: 1,069
- Buxtehude: 353

**Airbus España**
- Getafe: 1,991
- Illescas: 501
- Cadiz/Puerto Real: 509

**Airbus France**
- Méaulte: 1,203
- St. Nazaire: 2,303
- Nantes: 1,938
- Toulouse: 10,861

**Subsidiaries (USA, etc.) & others**
- 641

*active workforce + apprentices 06/05*
Some 9350 permanent Engineering employees are presently working in Centres of Competence (CoC), Centres of Excellence (CoE) and Central Engineering Centres (CEC). Including subcontracting this sums up to over 17000 people.
Airbus Product Range

A400M

A380

A340-600

A340-500

A340-300

A330-300

A330-200

A300-600

A310

A321

A320

A318

A319

A350-800

Competitive Product Range
(more than 5,500 Orders and more than 3,900 Deliveries)
• WHERE DOES ALCAN FIT INTO AIRBUS PROGRAM?
• WHAT IS MY ROLE?
• HOW DOES METALLURGY RELATE TO AIRCRAFT PROGRAMS?
Overview of Alcan Material Used on Recent Airbus Programs

- **Wing Box & LE/TE ribs**: 7449 T7651 plates
- **Lower Wing Skin**: 2024A T351, 2027 T351
- **Wing Spars**: 7040 T7651
- **Upper Wing Skin**: 7449 T7951, 7056 T7951
- **Fuselage stringers, seat rails**: 7349-T6/T76 alloy
- **Main deck Floor Beams**: 2196-T8 (Al-Li)
- **Lower structure**: 2027 plates & stringers
- **Upper & Lower Wing stringers**: 7449 & 2027 alloys
- **Lower shell panels**: 6056-T78/6156-T6 (weldable)
- **Main Frames, Fittings…**: 7040 T7451 plates

Aircraft Parts Manufactured with Alcan Material
Alcan Issoire Workshops
## Alcan Issoire Plant – Essential Data

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Workforce</strong></td>
<td>1,514 people</td>
</tr>
<tr>
<td><strong>Output</strong></td>
<td>95,000 tons</td>
</tr>
<tr>
<td><strong>Net sales 2005</strong></td>
<td>500 Million €</td>
</tr>
<tr>
<td><strong>Export</strong></td>
<td>Almost 75% of total production</td>
</tr>
<tr>
<td><strong>Facility area</strong></td>
<td>90 hectares</td>
</tr>
<tr>
<td><strong>Facility area under roof</strong></td>
<td>24 hectares</td>
</tr>
<tr>
<td><strong>Plant startup</strong></td>
<td>1949</td>
</tr>
</tbody>
</table>
Alcan Issoire – Wing Production Steps
Alcan Issoire – Aircraft Plate Production Steps
Contents

- Airbus General
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  - Metallic Perspectives
General Arrangement

- Four 10,000 shp class Turboprop Engines
- High Cruise Speed Mach 0.68 to 0.72
- Cruise Ceiling (normal operations) 37,000 ft
- Ferry Range 5000 nm
- MTOW 130 tonnes
- Maximum Payload 37 Tonnes
European Staff Requirement (ESR)

The harmonised and endorsed requirements of eight European air forces (BE, FR, GE, IT, PL, SP, TU & UK) for their next generation of strategic & tactical airlifters.
A400M Launch Nations

A firm launch base of 180 aircraft for seven Nations

Belgium 7  France 50  Germany 60  Luxemburg 1  Spain 27  Turkey 10  UK 25
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Comparison A380 with A319
Airbus aircraft: Fuselage Cross-Sections

A380
- 6.95 m
- Ø 5.64 m

Wide Body
- 8.47 m

A319
- Ø 3.95 m

Narrow Body
A380 Components Scale

A320 & A380 Section 21 Comparison

A380 Internal Wingbox structure
A380 Transport System
A380 Fuselage Section Transport to Toulouse
A380 New Final Assembly Line in Toulouse

Static Test Facilities

FAL Building
A380 – PAX and Freighter Version

560t
555 seats
8000 nm
EIS 2006

590t
150 t
5620 nm
EIS 2008
Material Distribution in Airbus Aircraft

- Composite/Glare A380
- Miscellaneous
- Steel
- Titanium
- Aluminium

A320
A340
A380

%
A380-800 Materials Distribution

Structure Material Breakdown
(Engine, Landing gear not included)

- 61% Aluminium Alloys
- 22% Organic Materials (CFRP, GFRP, QFRP)
- 10% Titanium & Steels Alloys
- 3% GLARE
- 2% Surface Protections
- 2% Miscellaneous
The flight test program proves the capacity of the A380 now already

Simultaneously: simulation of the life cycle in Dresden
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A380 Innovative Metal Technology (Examples)

- New Al-alloys
- Al-Li Floor Beams
- Electron Beam Welding
- More Ti & New Ti-alloys
- Integral Structures (LBW)
- Wing Centre Spar, Die Forgings
Laser Beam Welding

LBW machine – stringer to skin welding

LBW Fuselage structure:
- Weight reduction (approx. 10%)
- Manufacturing cost reduction (approx. 20%)
- Improved corrosion resistance
Laser Beam Welding

LBW – with support from heaven …
Laser Beam Welding

A318:
1 laser beam welded panel in section 17

A380:
8 laser beam welded panel
- 3 panels in section 13
- 5 panels in section 18

A340 HGW:
14 laser beam welded panel
- 4 panels in section 13
- 6 panels in section 14
- 4 panels in section 14b
New Aluminium Alloys on A380-800 Fuselage

A380-800

C22  C29  C38  C46  C53  C62  C74  C89  C95

Glare  7475  2024 HDT  6013
Materials for A380 Freighter Fuselage

- C11
- C15
- C18
- C21
- 2024
- 2024 HDT
- Glare
- 6013
- Al-Li
- 2024
- C22
- C28
- C38
- C46
- C53
- C62
- C74
- C89
- C95
- UDCD
- MDCD
- RH
- LH
- P22
- P39
- P6
- P53
- P9
- P10
# Status ALCAN alloys

**Overview - Fuselage**

<table>
<thead>
<tr>
<th>Aircraft Part</th>
<th>Design drivers</th>
<th>Ref Alloy</th>
<th>Alcan Proposals</th>
<th>Th range (mm/in)</th>
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</thead>
<tbody>
<tr>
<td><strong>Fuselage</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper shell panels</td>
<td>Compression &amp; DT (+formability)</td>
<td>2024 Cl T3</td>
<td>2024 HF Cl T3, 2098-T8, 2056 Cl T3</td>
<td>0.8 – 12mm</td>
</tr>
<tr>
<td>Lower shell panels</td>
<td>Tension &amp; DT</td>
<td>2024 Cl T3</td>
<td>6156 (HDT) Cl T6 / bare T78</td>
<td>1.6 – 8mm</td>
</tr>
<tr>
<td>Stiffeners</td>
<td>Tension / compression</td>
<td>7175-T73</td>
<td>7349-T6/T76 – 6056-T6/T78</td>
<td></td>
</tr>
<tr>
<td>Upper panel CWB</td>
<td>Tension / Compression</td>
<td>7010-T6</td>
<td>7449-T651</td>
<td>6 – 20mm</td>
</tr>
<tr>
<td>Lower panel CWB</td>
<td>Tension and DT</td>
<td>2024-T3</td>
<td>2027-T351</td>
<td>12 – 55mm</td>
</tr>
<tr>
<td>Main frames</td>
<td>All kind / complex</td>
<td>7010&amp;50-T74 7x75-T73</td>
<td>7040-T7451, 2050-T851</td>
<td>&lt;= 216 mm</td>
</tr>
<tr>
<td>Seat tracks</td>
<td>Tension</td>
<td>7175-T73/T79</td>
<td>7349-T6/T76</td>
<td></td>
</tr>
</tbody>
</table>
Example: A380 Deck Crossbeams

Composite and innovative Al-alloy material for optimum crossbeam material choice

CFRP floor beams

Al-Li floor beams
New Aluminium Alloys on A380 Wing

Upper Skins/Stringers:
- 7055 HF T7951 Plate
- 7010/7050 T7651 Plate
- 7449 T79511 Extrusions

Ribs:
- 7010/7050 T7651 Plate
- 7449 T7651 Plate

Spars:
- 7085 T7651
- 7040 T7651 Plate/Die Forgings

Lower Skins/Stringers:
- 2024 HDT T351 Plate
- 2027 T3511 Extrusions
Aluminium Forgings

Location of 7085 die forgings on the A380 wing

Inner Front Spar 1

Inner Centre Spar 1

Inner Rear Spar

Gear rib/Sidestay attached
Aluminium Forgings

A380 Inner centre spar 1
A380 Titanium Structural Applications

- Nacelle parts
- Pylon parts
- Thrust fittings
- Trailing edge - Pintle fittings - Flap track 3 bracket
- Trunion between inner flap and wing
- Slat track can SPF/welding
- Landing gear - several parts
- Flap track Roller track

• Typical titanium alloy and its characteristics
• Ti-6%Aluminum-4%Vanadium
• Density .160 Lb/inch
• Typical strength Yield Strength 145,000lbs/inch
• Temperature range –160F to 750F
A380 Titanium Applications

Engine pylon

Upper & Lower Spars
- TiAl6V4 plate

Current Ribs
- TiAl6V4 αβ sheet

Front Pylon Engine Attachment
- TiAl6V4 forging

Half Main Ribs
- TiAl6V4 precision casting

Side Panels
- TiAl6V4 plate

Rear & Front Links
- TiAl6V4β plate

Rear Pylon Wing Attachment
- TiAl6V4β plate / forging

Current Ribs
- TiAl6V4 αβ sheet

Front Pylon Wing Attachment
- TiAl6V4β forging

Rear Pylon Engine Attachment
- TiAl6V4αβ forging
A380 Titanium Applications

Wing landing gear
- Sidestay
- Torque links (arms)
- Bogie Beam

Body landing gear
- Top & front panels
- Ti 10-2-3 plates & forgings
- Lower & upper Torque links (arms)
A380 New Composite Applications (Examples)

GLARE®

CFRP Floor Beams for Upper Deck

CFRP Wing Ribs

CFRP Center Wing Box

CFRP flap tracks

New materials & processes: High modulus fiber, RFI, AFP

CFRP Section 19

CFRP Section 19.1
Fibre Metal Laminates: Example GLARE®

GLARE® lay-up

GLARE® Micrograph

Composite material (GFRP)

Aluminum material

500 µm

Number of fatigue cycles

ALUMINUM 2024-T3
$\ell = 2 \text{ mm (0.078 inch)}$

GLARE 3 - 3/2

ARALL 2 - 3/2

GLARE 2 - 3/2

Half crack length

0 1x10^5 2x10^5 3x10^5 4x10^5 5x10^5

0 10 20 30 40
GLARE® - Fuselage Panel

Airbus - Nordenham
A380 Centre Wing Box - CFRP

Airbus - Nantes
A380 Rear Pressure Bulkhead - CFRP

Airbus - Stade
A380 Wing Rib - CFRP
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A350 Hybrid Airframe Decision

Major structural components material breakdown

Empennage (VTP & HTP) predominantly CFRP

Outer Wing Box: Predominantly CFRP

Rear unpressurized fuselage predominantly CFRP

Centre Wing Box predominantly CFRP

Fuselage:
- Shells: AlLi
- Stringers: 7349 / AlLi
- Typical Frames: AlLi / 2024 / 7075
- Keel Beam: CFRP

Pylon: predominantly Titanium
Friction Stir Welding

Developed at TWI, UK
Patented 1991

FSW process:
Frictional heating and plastic deformation provided by a rotating and profiled tool (shoulder and pin), which is plunged into and traversed along the joint line between two surfaces causes the material to soften and flow. High forging forces help to consolidate the joint.
Friction Stir Welding

**Main BENEFITS**

**Reduced Weight**
- No fasteners, No sealant, No doublers, No Crack-stoppers
- Larger panels (less splices)
- Higher mechanical properties (no stress concentration)

**Improved Corrosion Behaviour**
- Absence of holes & rivets
- No overlap joint and No crevice

**Improved Aerodynamics**
- No external rivet heads
- No overlap – smooth outside

**Reduced Manufacturing Cycles**
- Reduced material consumption
- Faster than riveting
- Simpler assembly
- Easy to automate
Friction Stir Welding

Future application fuselage

Longitudinal welds

today

Stringer

BONDED

SEALING

BONDED

DOUBLER

future

FSW

LBW / EXT
Perspectives - New Aluminium Developments

• New 2XXX / 7XXX alloys for 15 to 30 % increase of strength

• AlMgSc alloys for improved corrosion behaviour

• New Al-Li alloys offering lower density, weldability and high damage tolerance

• Extruded panels

• Advanced Fibre-Metal Hybrids

• Premium castings
Beyond 2020 ;-)

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