Praxis-Seminar Luftfahrt,
Hochschule für Angewandte Wissenschaften Hamburg, DGLR, VDI
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Airbus A380: Vertical Tailplane

Jens Hinrichsen
Airbus Deutschland
Director A380 Vertical Tail Plane

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Introduction

- **A380 realizes the most ambitious program since commercial aviation started business during the 1920's.**
- **A380 is in-line with market evolution, completing the Airbus product range at the upper end.**
- **Selection of advanced and new technologies follows an evolutionary approach, backed by experience gained during**
- **30 years of Airbus corporate history.**
- **The A380 program delivers a significant contribution to wealth of the European Community and the US in terms of direct and indirect employment, tax revenues income and industrial competitiveness for the future:**
  - **200.000 employments world-wide, of which**
    - **145.000 jobs are created in the EU**
    - **60.000 jobs are created in the US**

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A380 completes the Airbus Family

Complete fleet solutions from 100 seats to 500/600 seats

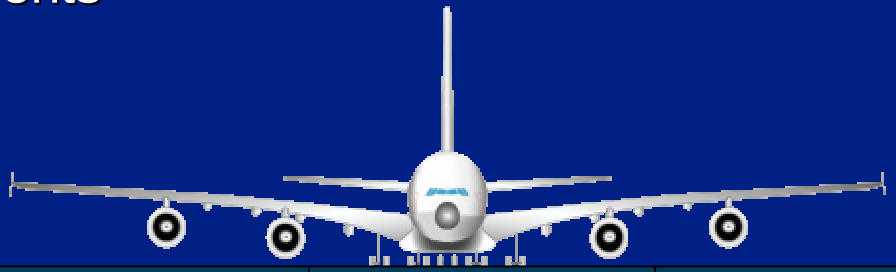
- Expansion of our offer in the freighter business from 40 to 150 tons

Contents

A380 Key Characteristics

Designed for:

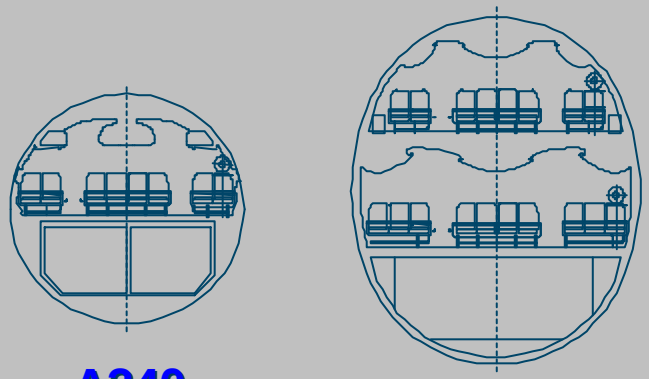
- ***Cruise**:* at Ma 0.85 up to 45,000 ft
- ***Range**:* 7900 - 8750 nm
- ***Take-off and Landing**:* equal or better than the 747
- ***Noise**:* 18 to 20 dB less than FAR 36 requirements (St.3 rules) meeting QC2/QC1 LHR (A380-800)
- ***Vortex**:* no larger separation at approach than the 747
- Meeting infrastructure requirements



	A380-800	A380-800R	A380-900
Capacity	555 pax	555 pax	656 pax
Range	7900 nm	8750 nm	7900 nm

From A340 to A380: A Big Step in Design Weights

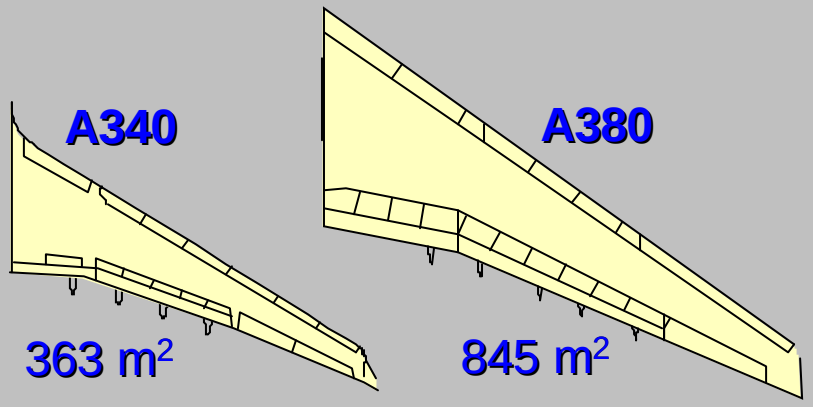
Non-circular cross section
Three decks



A340 A380

Larger dimensions of wing and tailplanes

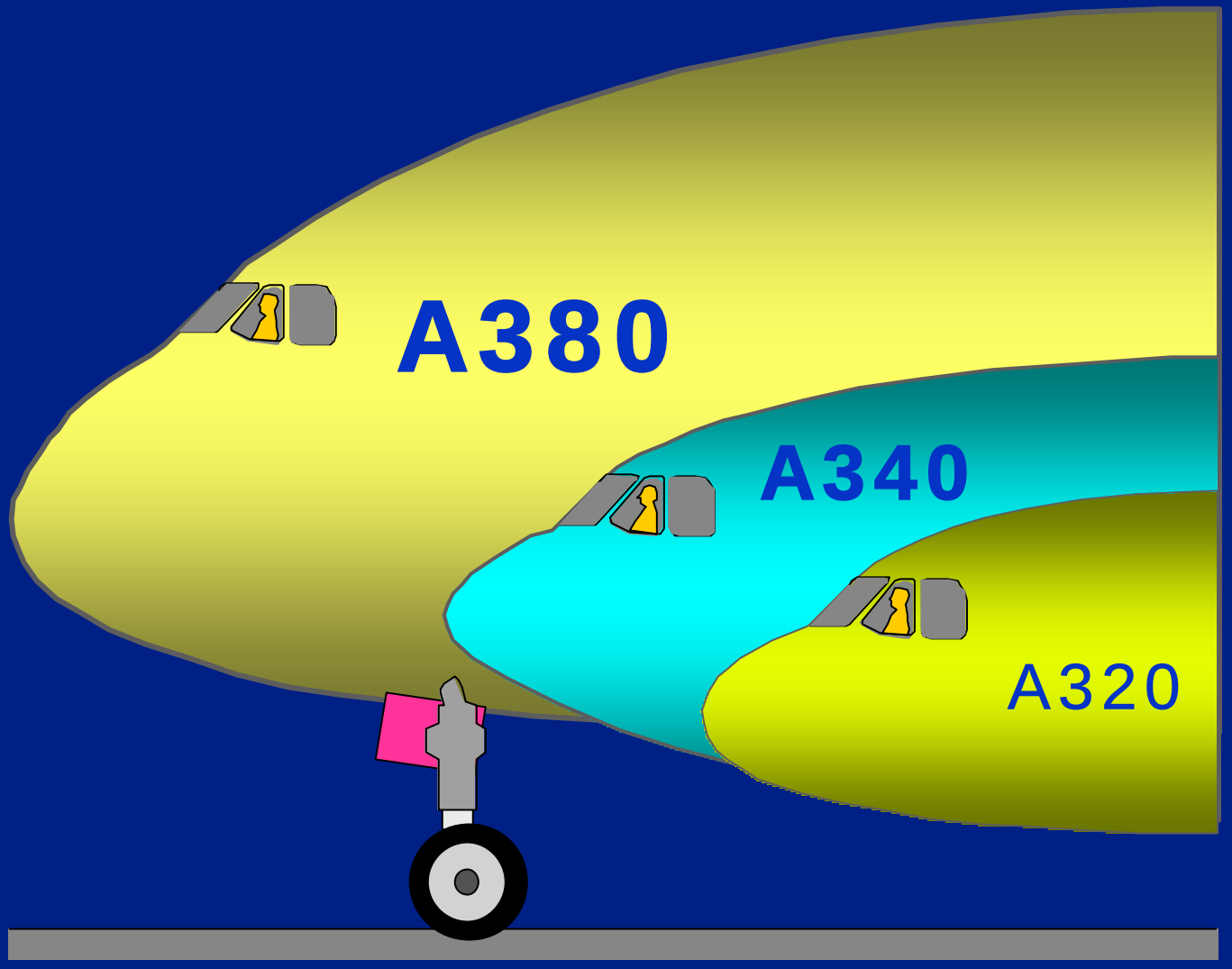
(A380 Horizontal Tail Plane = A310 wing)



Highest design weights

	A340-300	+ %	A380-800
Max. take-off weight	275 t	*+ 104 %*	560 t
Max. zero fuel weight	180 t	*+ 100 %*	361 t
Max. landing weight	190 t	*+ 103 %*	386 t
Operator's weight empty	130 t	*+ 114 %*	278 t

The A380: A big Step in Size



Setting New Standards on all 3 Decks

1st Class Privacy

Under Floor Galley

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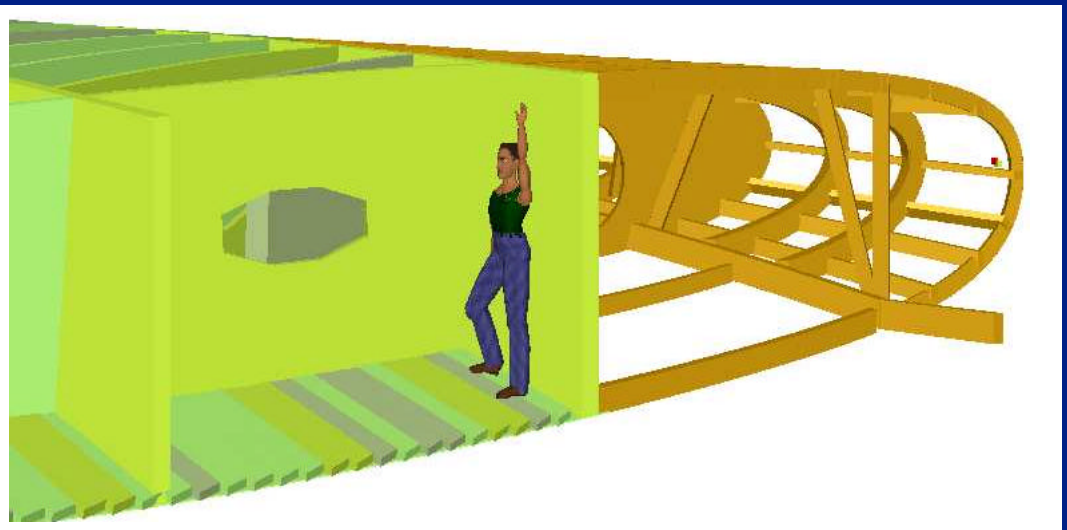
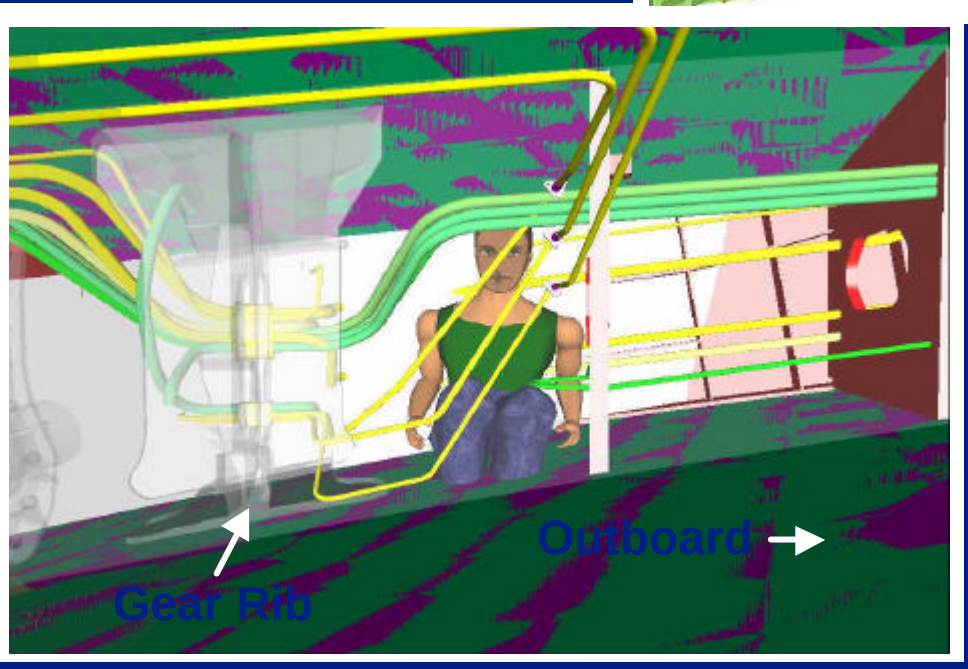
A380: A big Step in Size

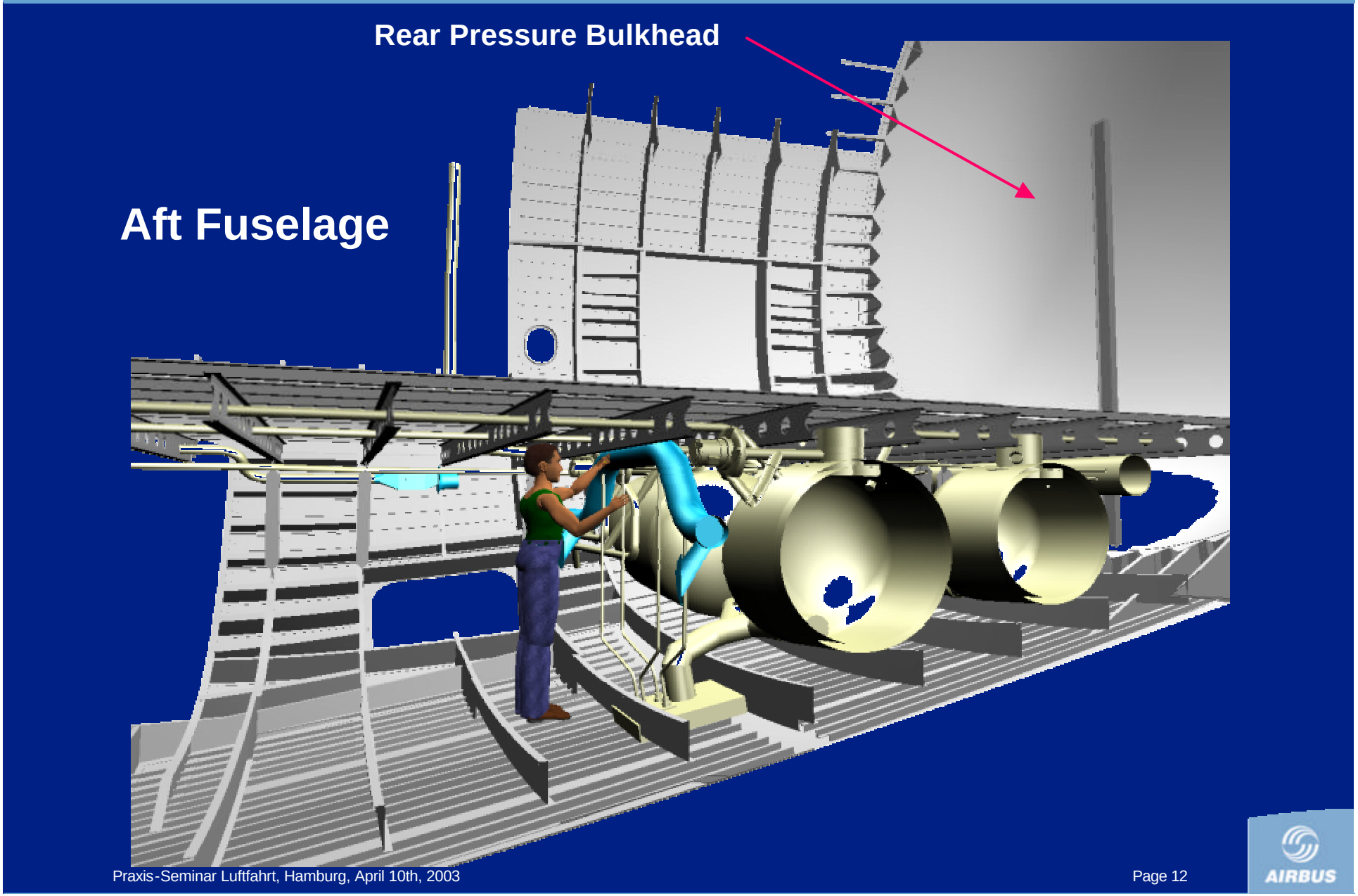
Wing Root Size



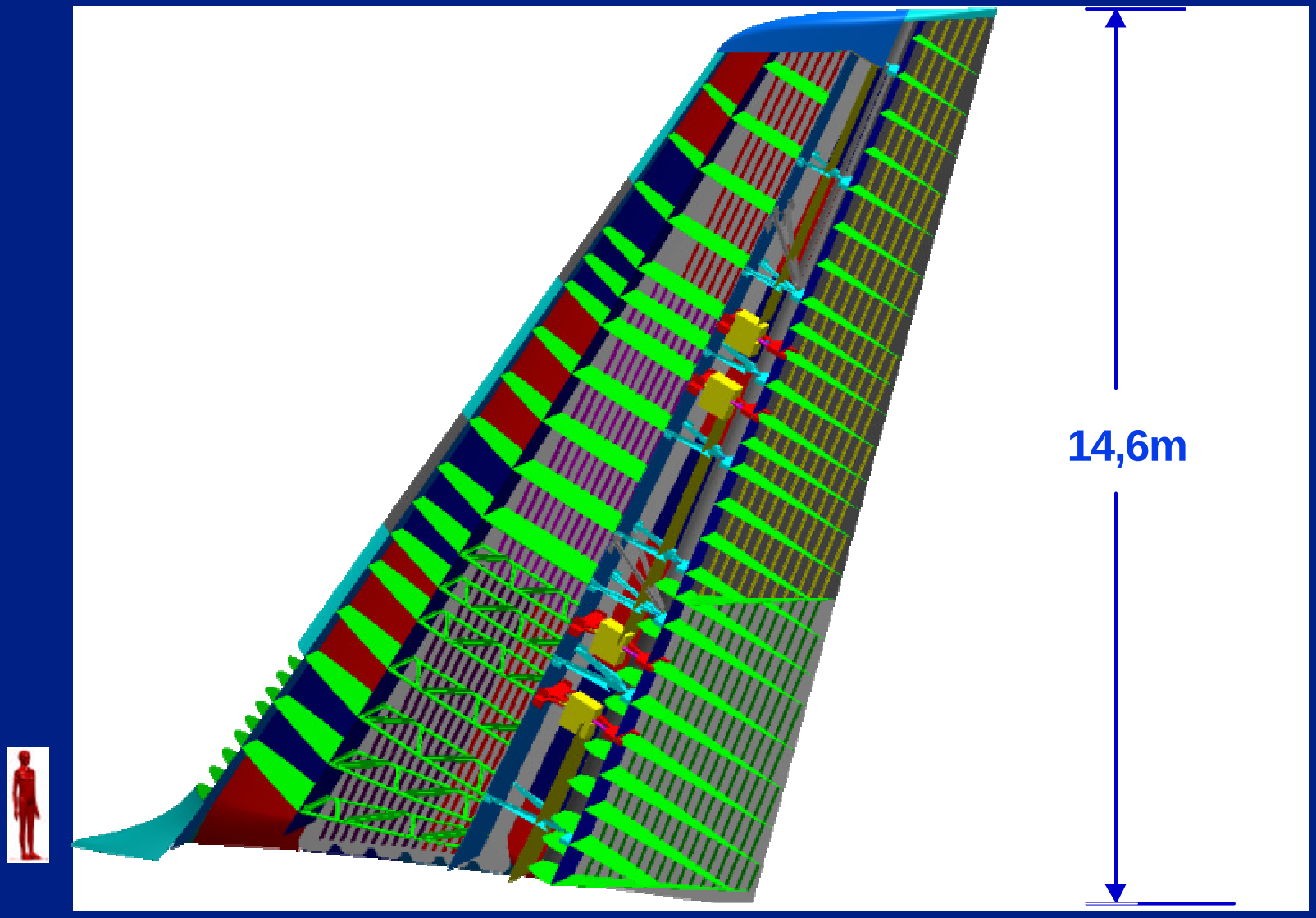


Accessibility Assessment for Wing Trailing Edge

A380: A big Step in Size



A380 Vertical Tail



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Top Level Technology Requirements

- **Requirements driven by Airline Interests:**
  - **Robust structure: Damage tolerant and easy to inspect & repair**
  - **Good corrosion prevention**
  - **Long inspection intervals**
  - **Simple inspection methods**
  - **Low spare part prices**
- **Requirements driven by Manufacturer Interests:**
  - **Weight savings (a/c performance and reduction of emissions)**
  - **Manufacturing cost savings (recurring and non-recurring costs)**
  - **Proven service readiness**
  - **Proven maturity of manufacturing processes**
  - **Built-in potentials of new technologies for further improvements**

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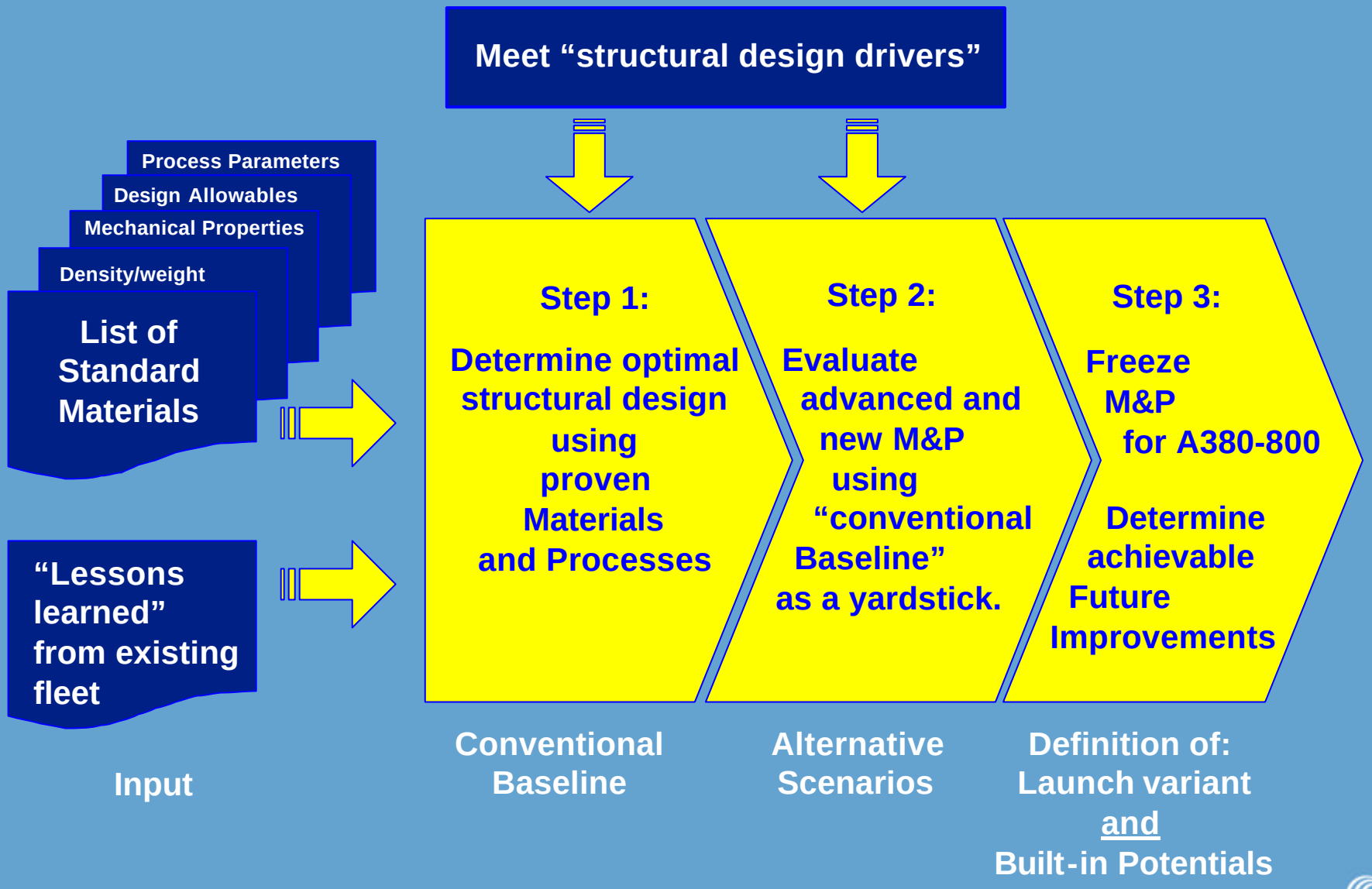
The A380 M&P Selection Process: Steps



The A380 M&P Selection Process: Partnership

Thickness, sizes, etc

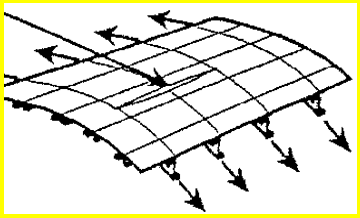
Density/weight, prices

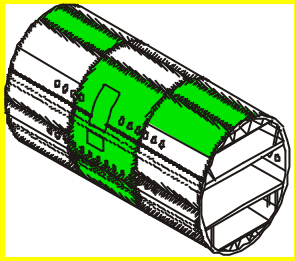
Input from Material Suppliers

Material Suppliers

Continuous Dialog, e.g. Integrated Project Team (IPT) with ALCOA

Research	**Airframe Manufacturer**	**Airlines**
M&P Research - **material properties** - **material performance** - **process parameters** - **etc** **Testing of coupons & small sub-assemblies**	**Design & Processes** - design principles, - costing, weights, - process verification, - requirements, evaluation **Testing of aircraft components**	**Maintainability:** Agreement on concepts for - inspections, - repairs **Lessons Learned** **Acceptance of new Technologies** (Customers have to give their "green light")





Requirements:

Design drivers, design principles, complexity of geometries, tolerances, surface protection, etc

In-service experience, inspection methods/equipment, repairs, accessibility, etc

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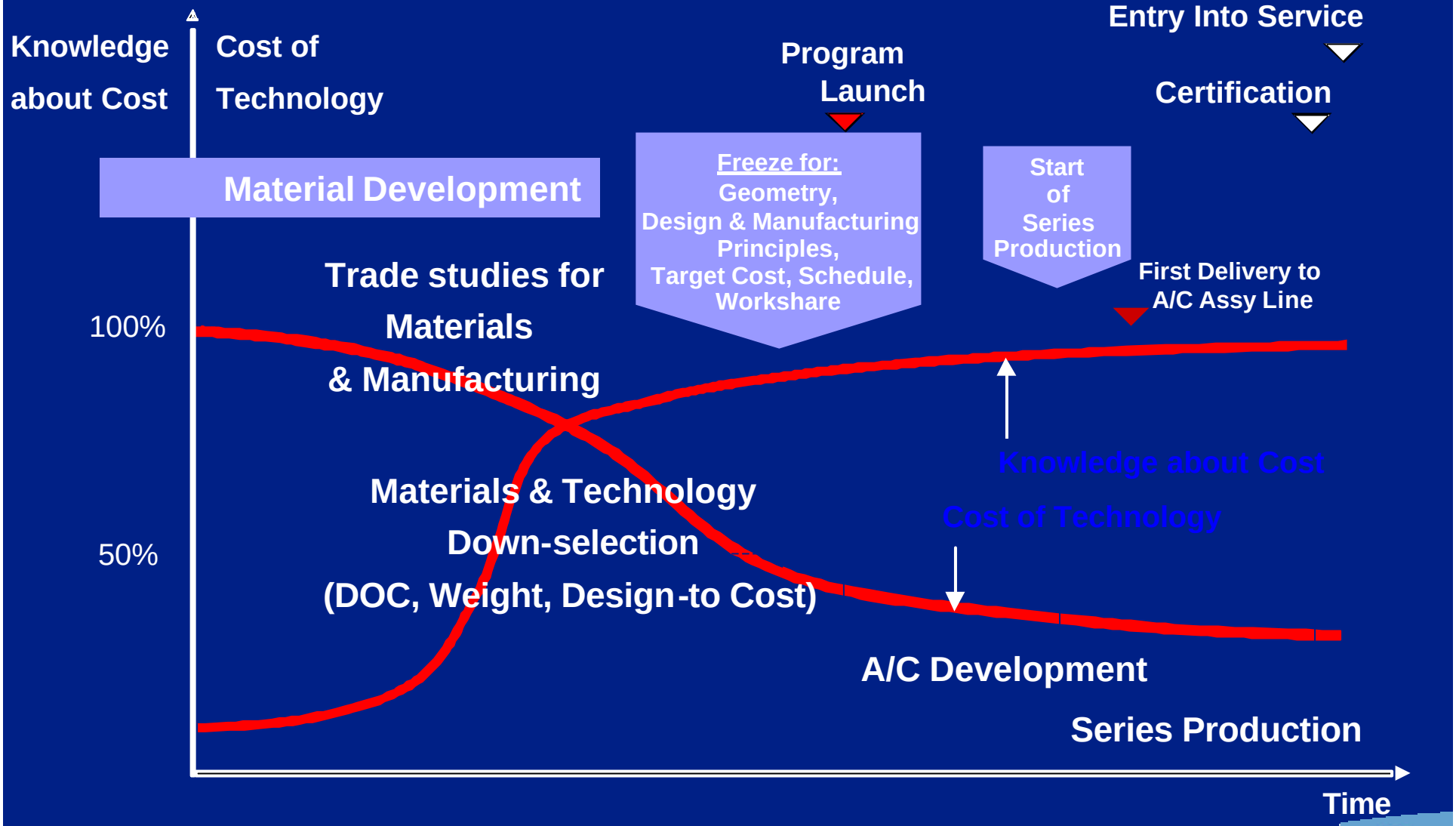
The A380 M&P Selection Process: Schedule



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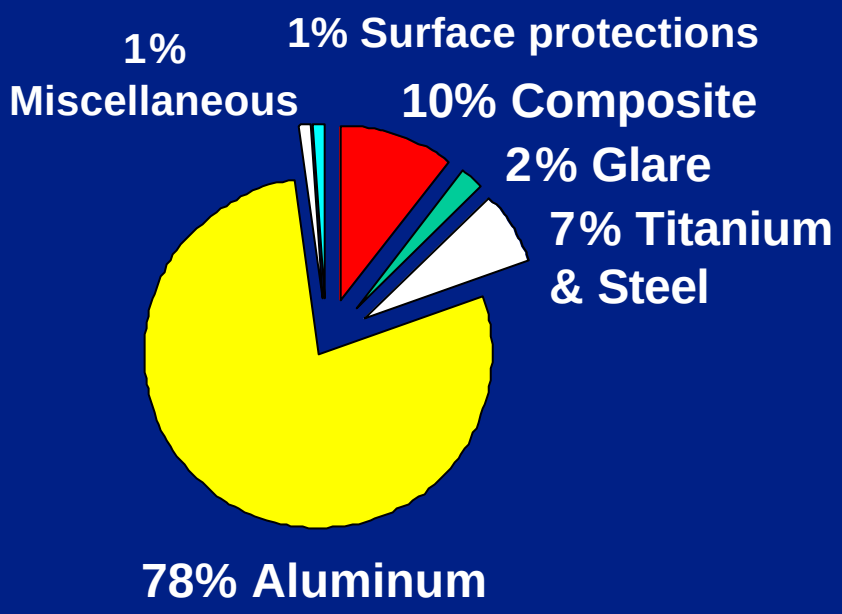
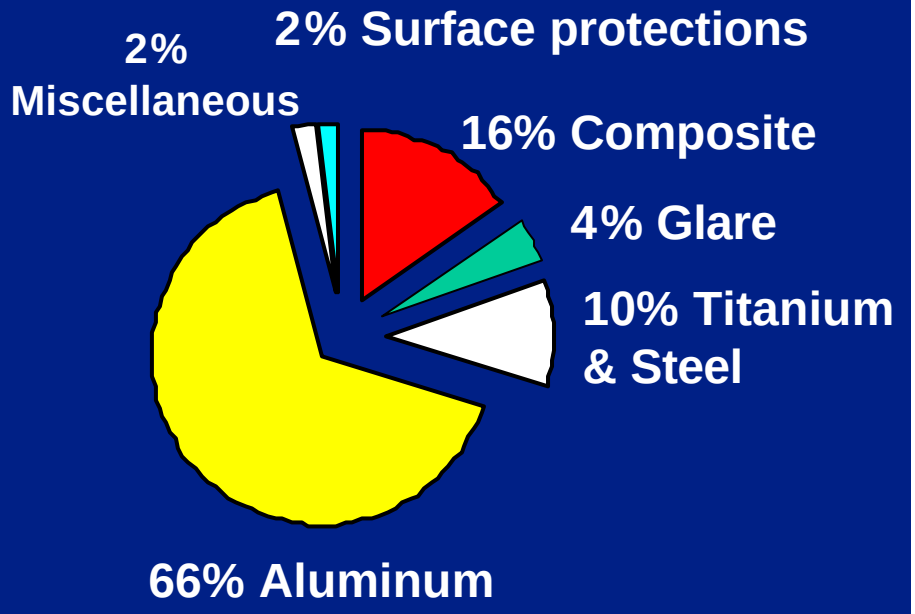
A380 Material Distribution (Weight break-down)

Buy



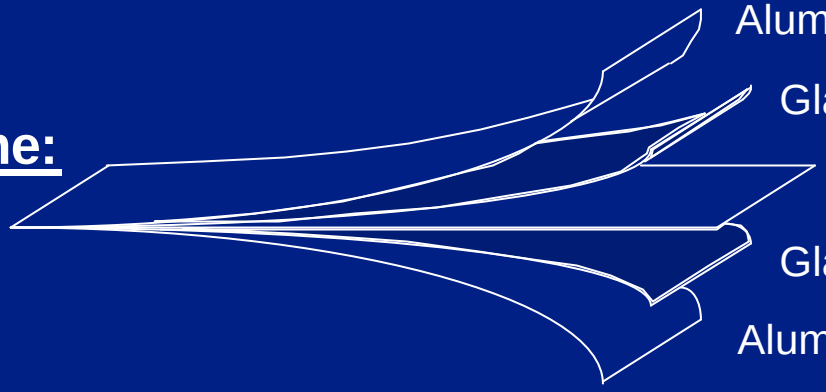
Fly



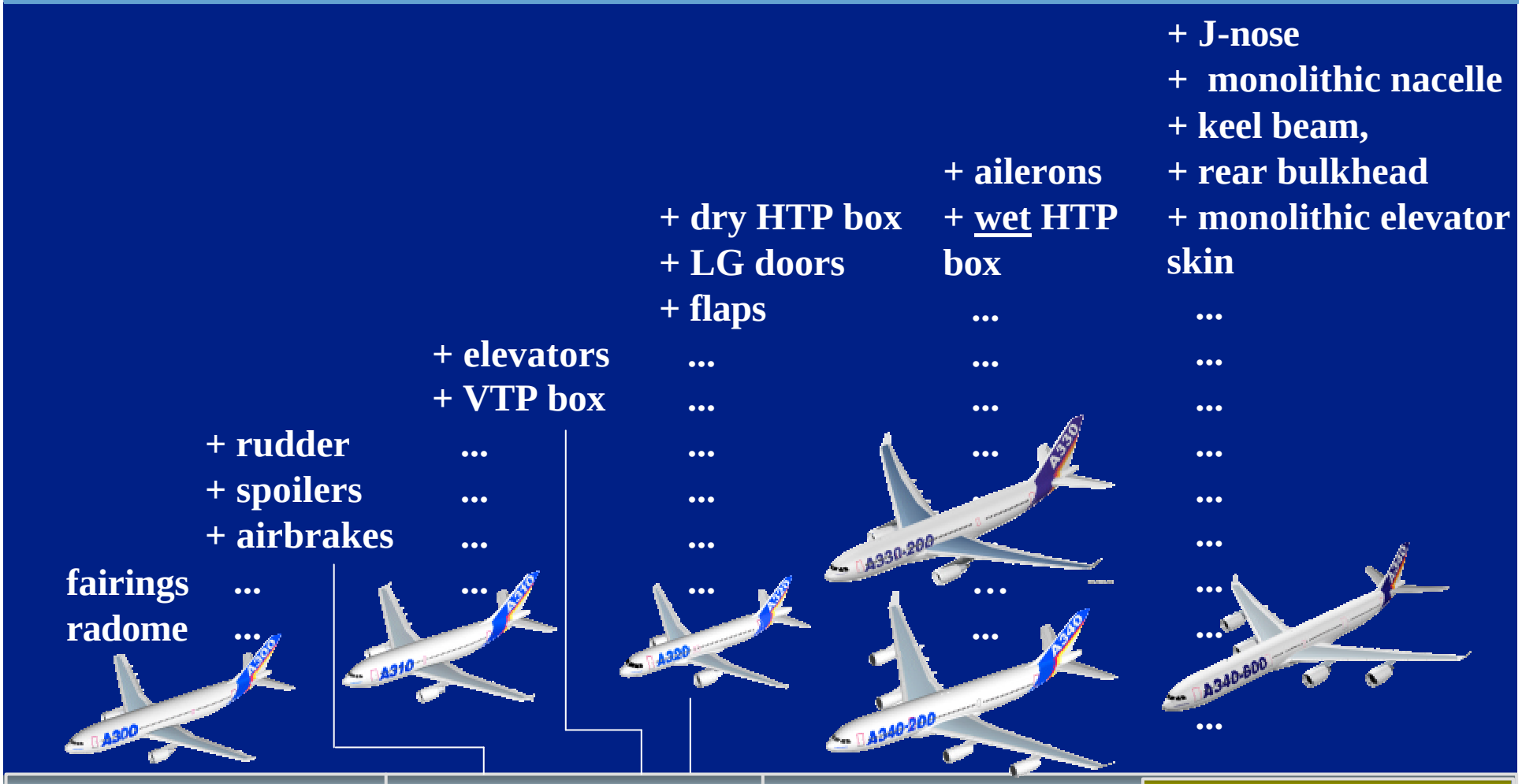
What Glare is

- **GLARE is a member of the family of Fiber Metal Laminates (FML).**

Lay-up Scheme:



Evolution of Composite Technology at Airbus



Examples for Major Composite Structures: A340-600

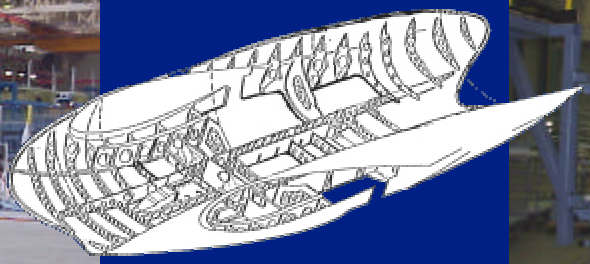
Wing J-Nose, Fokker Special Products, NL

Engine Cowling, Airbus Espana

Vertical Tail, Airbus Deutschland

Horizontal Tail, Airbus Espana

Keel Beam, Airbus France

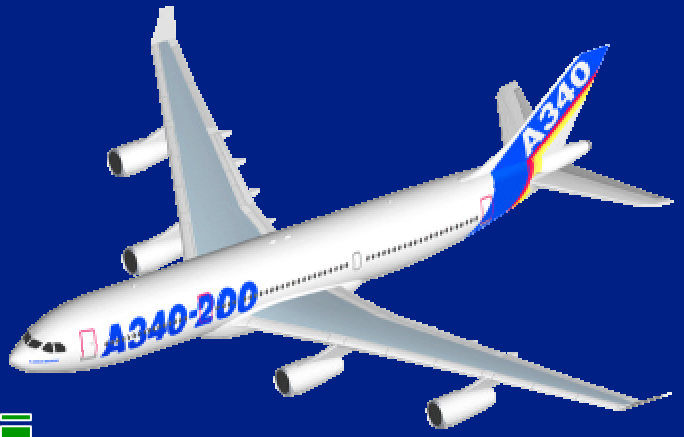


Belly Fairing, Airbus France

Rear Pressure Bulkhead, Airbus Deutschland

“Lessons learned”: Take benefit from earlier products

1. CFRP Rear Pressure Bulkhead



2. Most advanced Alloys for Wing Box and Fuselage Panels

3. Thermoplastic Wing J-nose

4. Monolithic Engine Nacelles

1. HTP with Fuel Trim Tank

2. Advanced Composite Structure for HTP and VTP

Welded Panels for Fuselage

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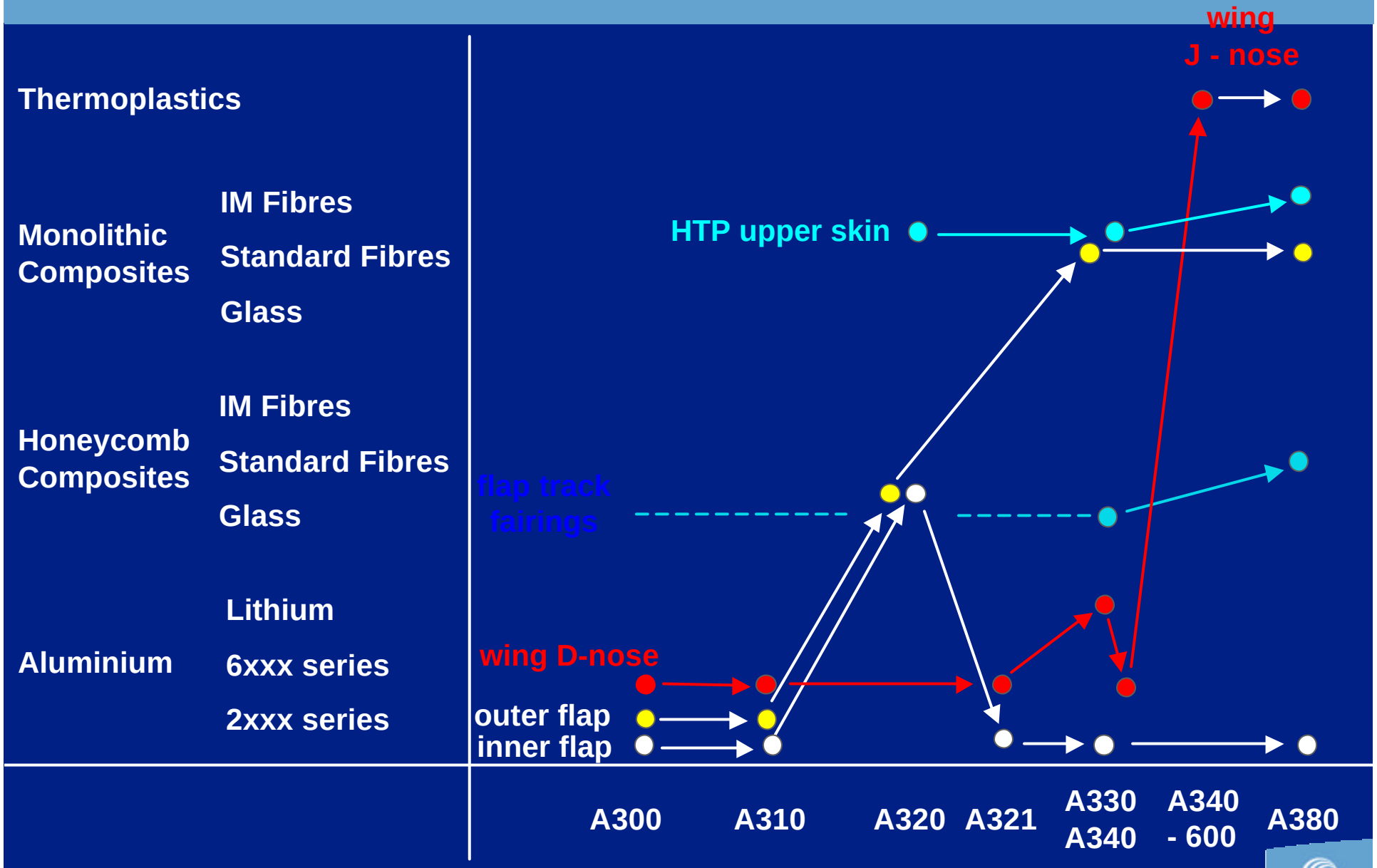
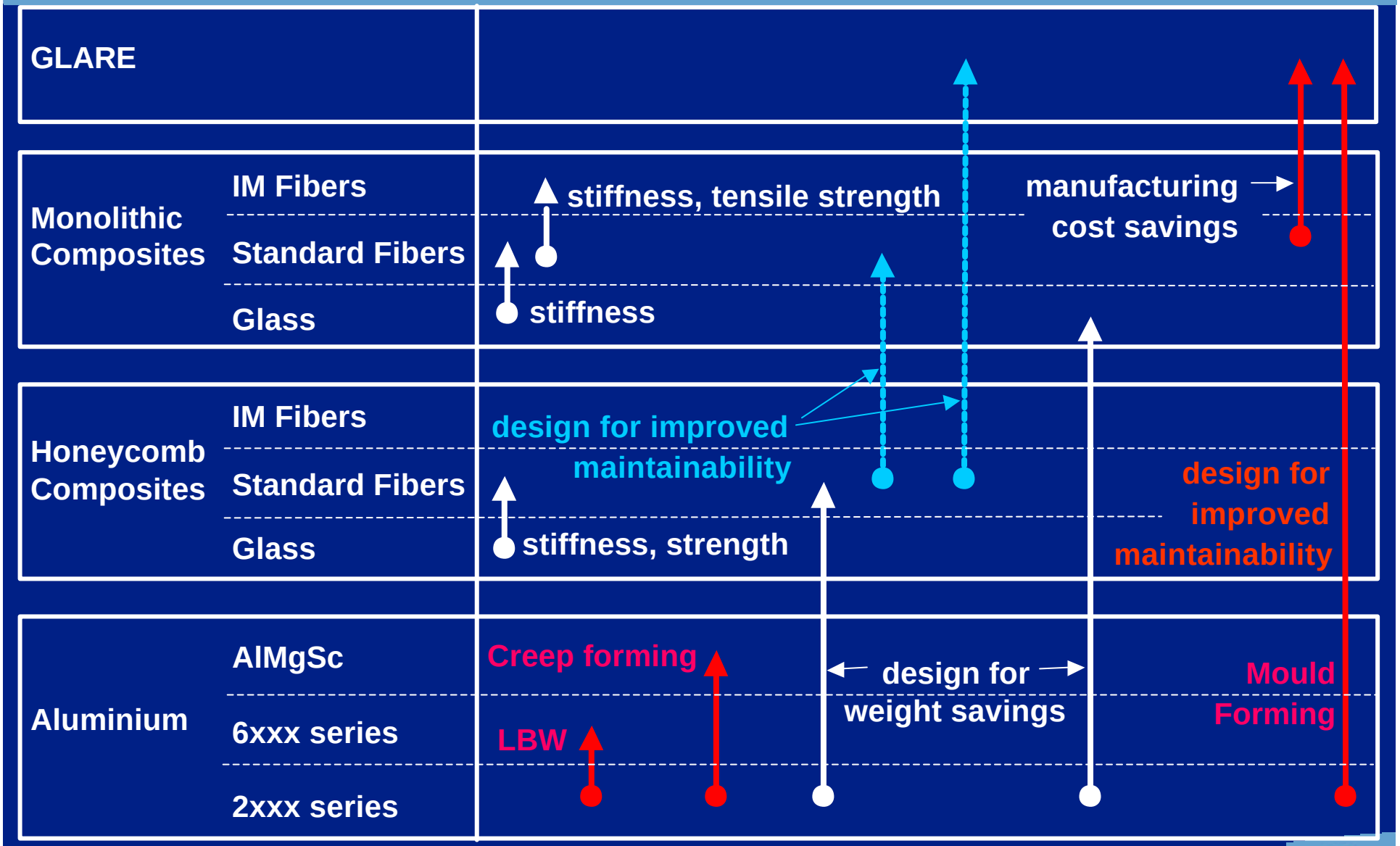
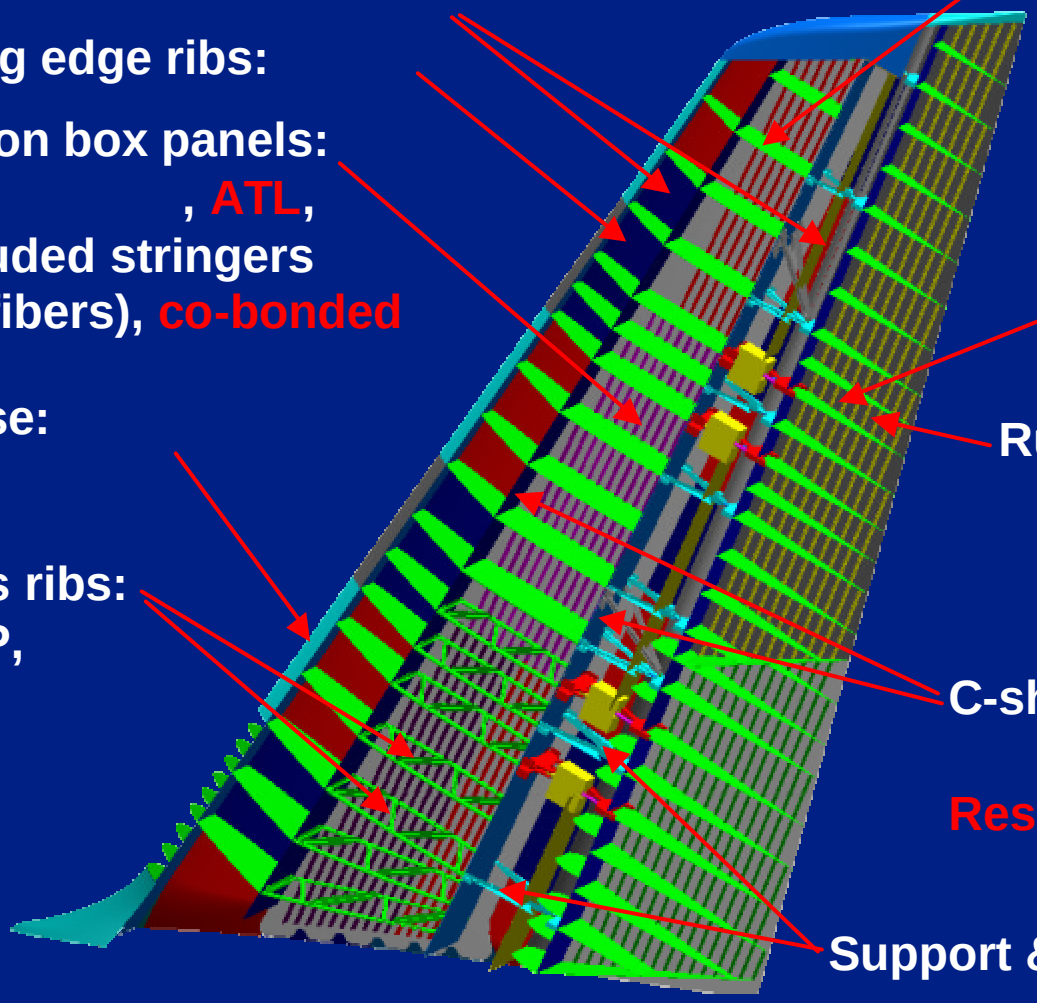
Evolution is not always continuous



Trends for Materials and Manufacturing Processes



M&P for the Vertical Tail Plane



Leading edge & trailing edge panels:
CFRP fabrics &

Leading edge ribs:

Torsion box panels:
, ATL,
pultruded stringers
(HT- fibers), co-bonded

D-nose:

Truss ribs:
CFRP,

C-ribs:

Resin infusion (VAP)

Rudder skins:
, ATL

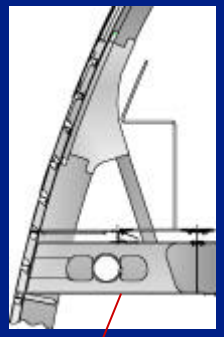
Rudder panel stringers:
, co-bonded

C-shape front & rear spars:

Resin Infusion (VAP)

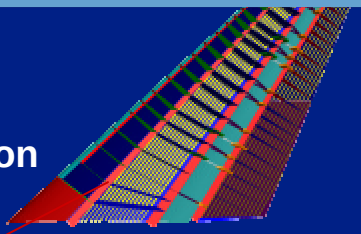
Support & actuator fittings: RTM

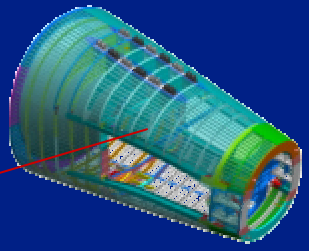
Major monolithic CFRP & Thermoplastics Applications

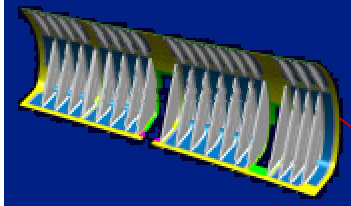


Floor Beams
for upper Deck:
CFRP, continuous Process

Vertical Tail Plane:
IM Fiber, ATL for Torsion
Box and Rudders

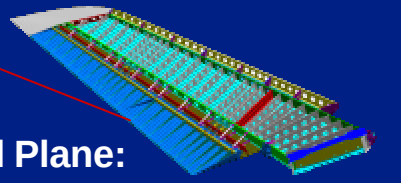






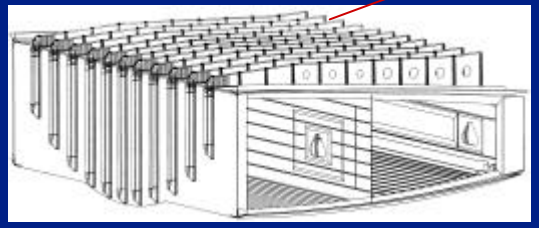
CFRP Outer Flaps:
CFRP, ATL

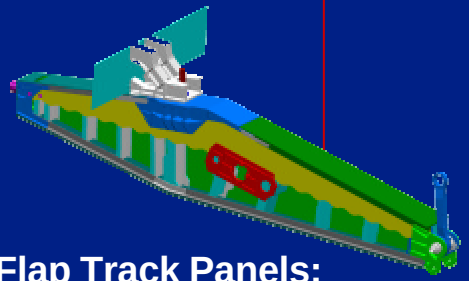
Un-pressurized Fuselage:
solid laminated CFRP, AFP

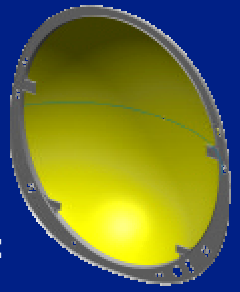


Wing: Glass
Thermoplastic
J-nose

Horizontal Tail Plane:
IM Fiber, ATL for Torsion
Box and Elevators







Center Wing Box:
HT & IM Fiber, ATL

Flap Track Panels:
CFRP

Rear Pressure Bulkhead:
CFRP, RFI with NCF

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Advanced Composite Materials

- **Combination of Intermediate Modulus Fibers and Resins**

Applications	Fibers		Resins		Prepregs
	Type	Product	Type	Product	Prepreger
IM Tapes under qualification	T800S	Toray	M21	HEXCEL	HEXCEL
	IMS	Tenax-Toho	977.2	Cytec-fiberite	Cytec-fiberite

NCF (Non-Crimped-Fibers)

Saertex Wagener Material: HTA Preforms (+45°/-45°)

Hexel Resin: RTM6

Contents

Design-to-Cost: M&P for Fuselage Panels

Skins	Stringers	Forming	Heat treatment re-solution	Skin/stringer assembly	Impact on Manufacturing
AL 2024	**Al 2024**	Roll/stretch	Yes	Upper fuselage: Bonding, lower: riveting	**Reference**
Al 2524	**Al 7xxx**	Roll/stretch	Depending on severity of double curvature	Upper fuselage: bonding; lower: riveting	Savings due to forming in as-delivered temper
Al 6xxx	**Al 6xxx**	Roll/stretch	Yes	Welding in 3D-contour	Lower assembly costs through welding
AlMgSc	**AlMgSc**	**Creep forming of stiffened panel**	**No**	In-plane welding	**In-plane welding, No heat treatment Resolution, no waste From clamp length**
GLARE	**Al 2024 or Al 7xxx or GLARE**	Skins:lay-up in mould incl. doublers Stringers: Roll	For Al stringers	Bonding	**Savings through significant waste reduction and mould forming**

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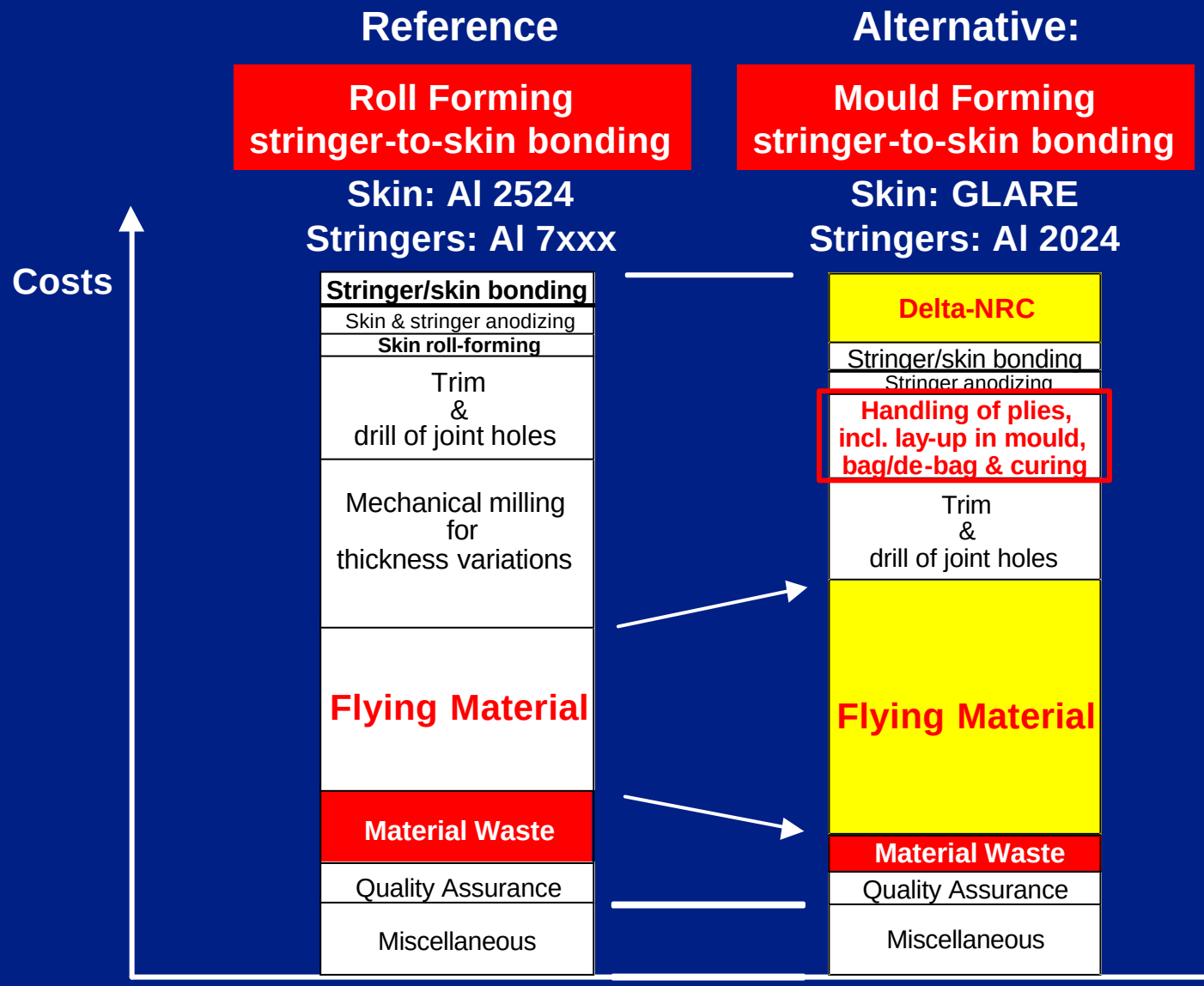
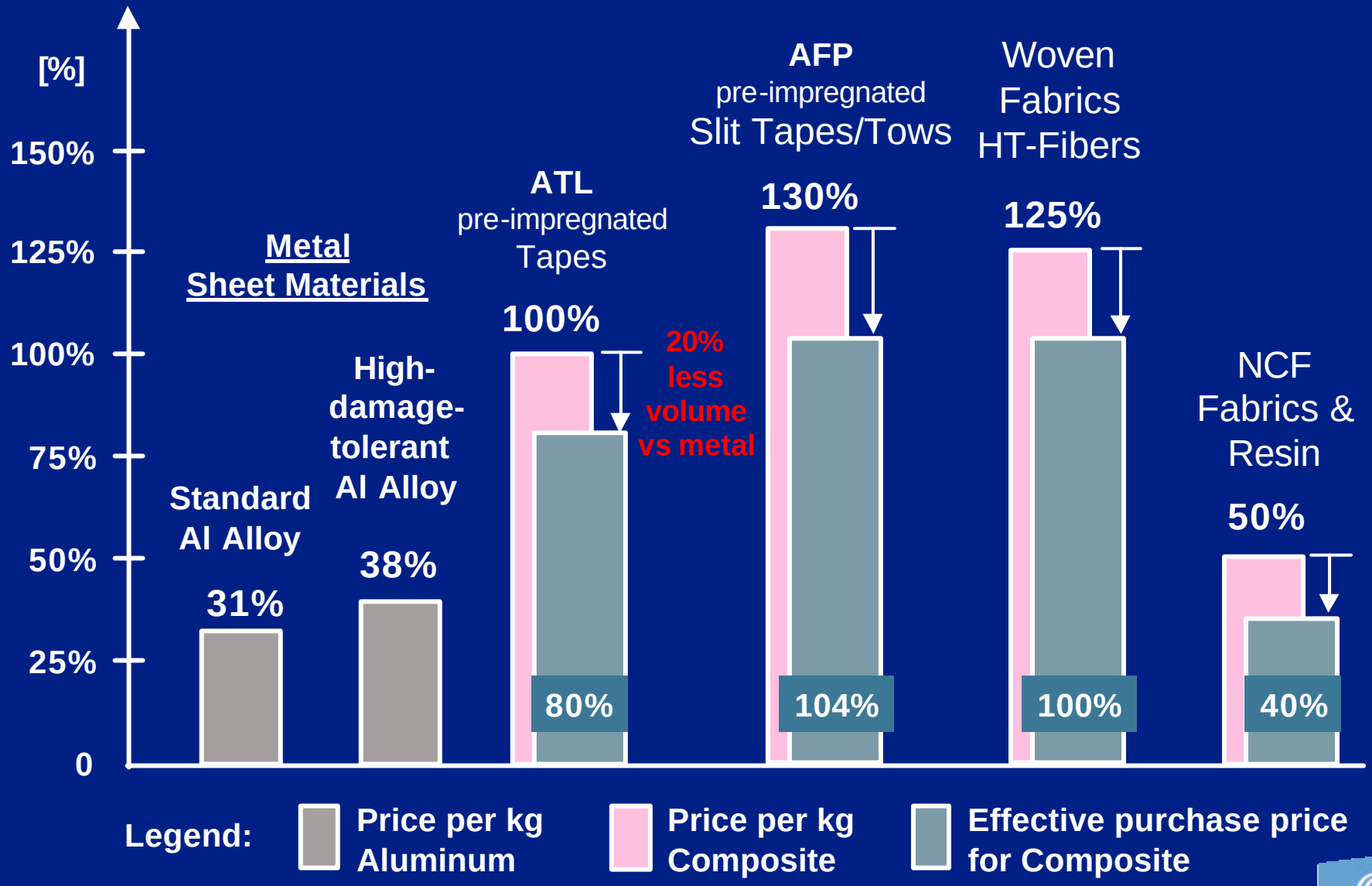
Design-to-Cost: Upper Fuselage Panels (single curved)



Effective Material Costs at 20% Weight Saving



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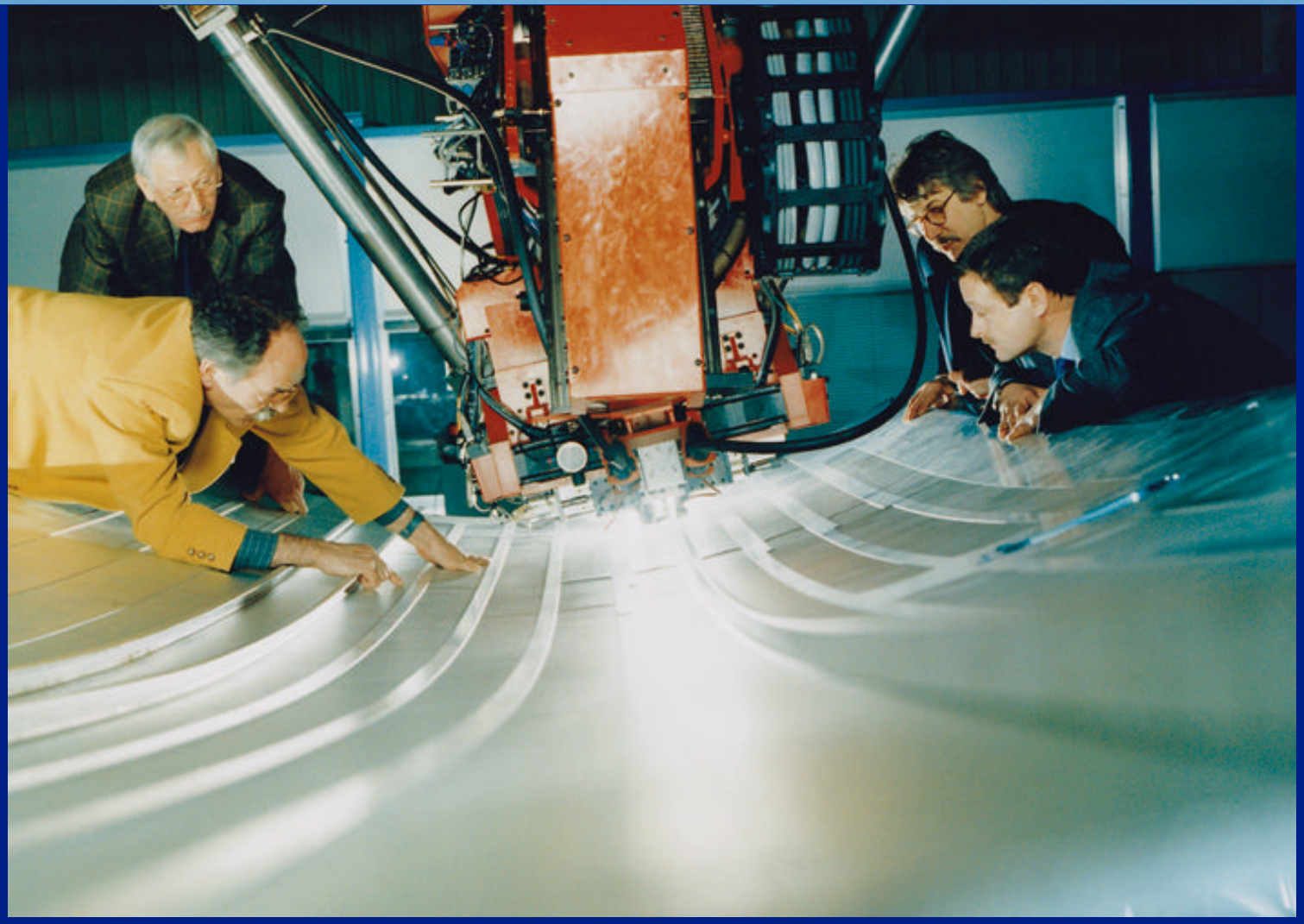
Demonstrators



Laser-Beam Welding for long and double-curved Panels

Demonstrator Programs

Mega-Liner Fuselage Demonstrator

Demonstrators

Lower Wing Shell: Resin Infusion Technology

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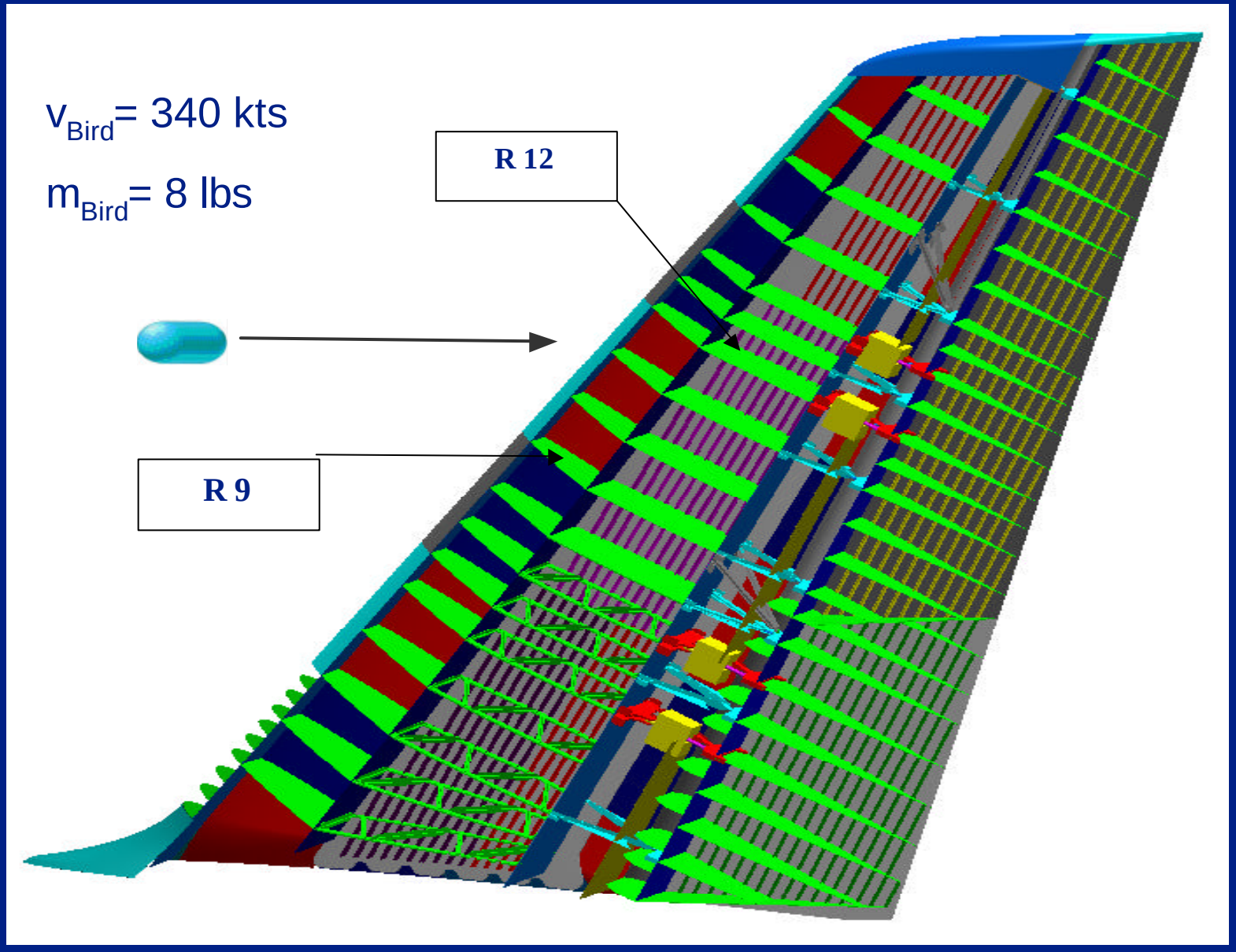
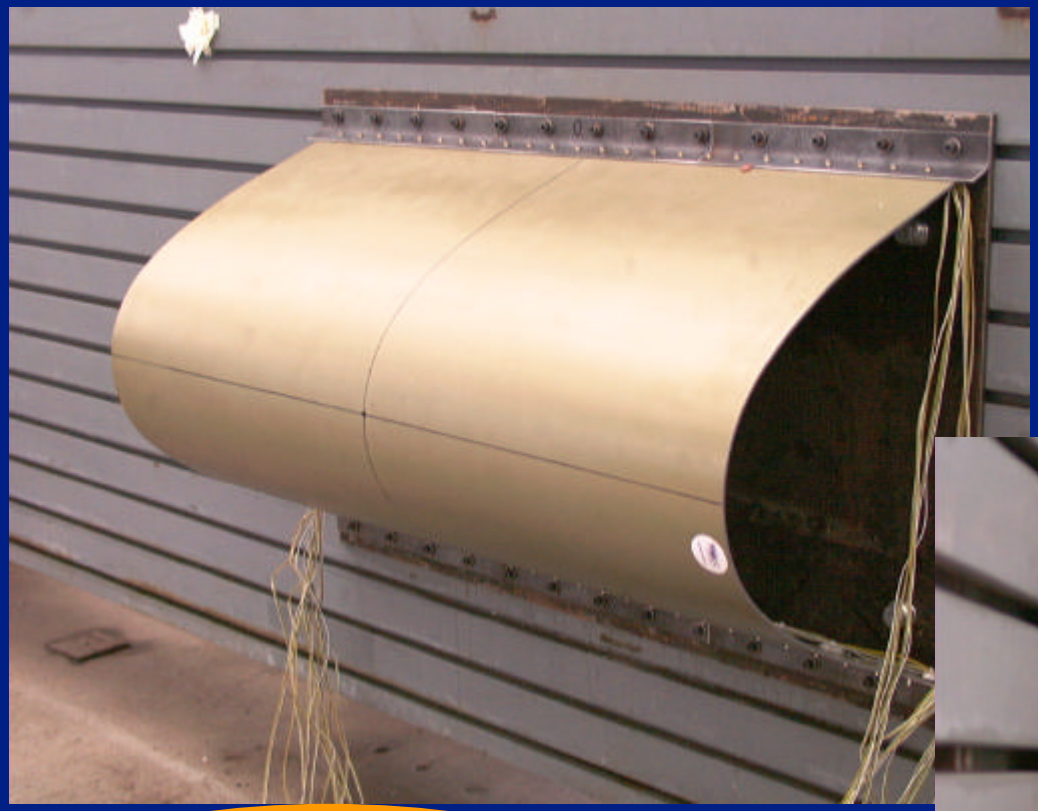
Demonstrators, Bird Strike Tests



Demonstrators



Bird Strike Testing

GLARE 3 – 7/6

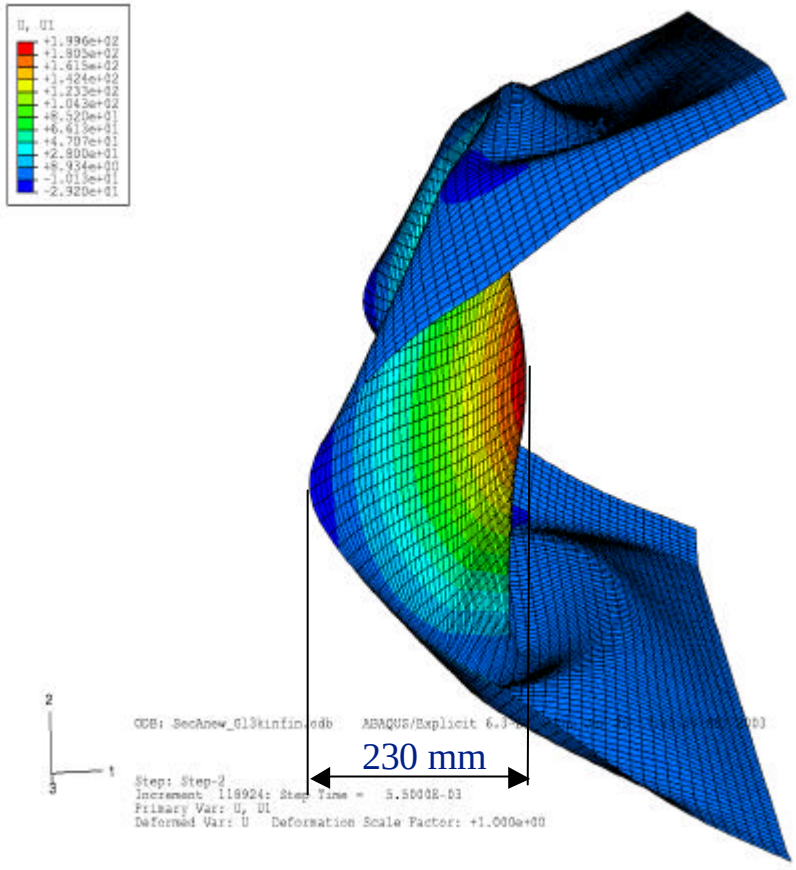
Section A

Demonstrators, Theory versus Experiment

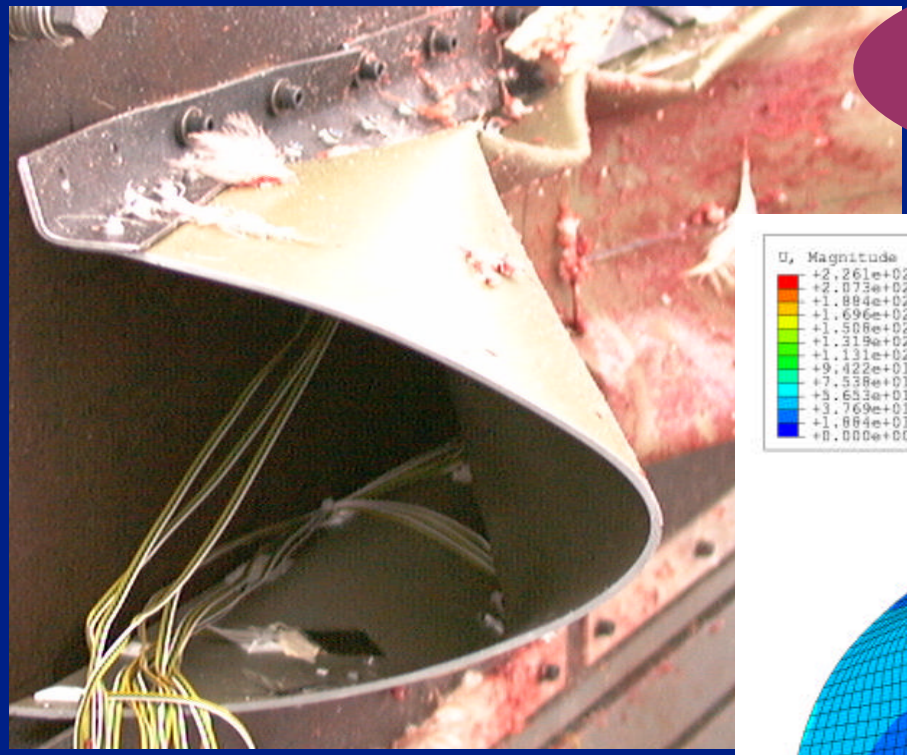
Global Deformation

GLARE 3 – 7/6

Section A

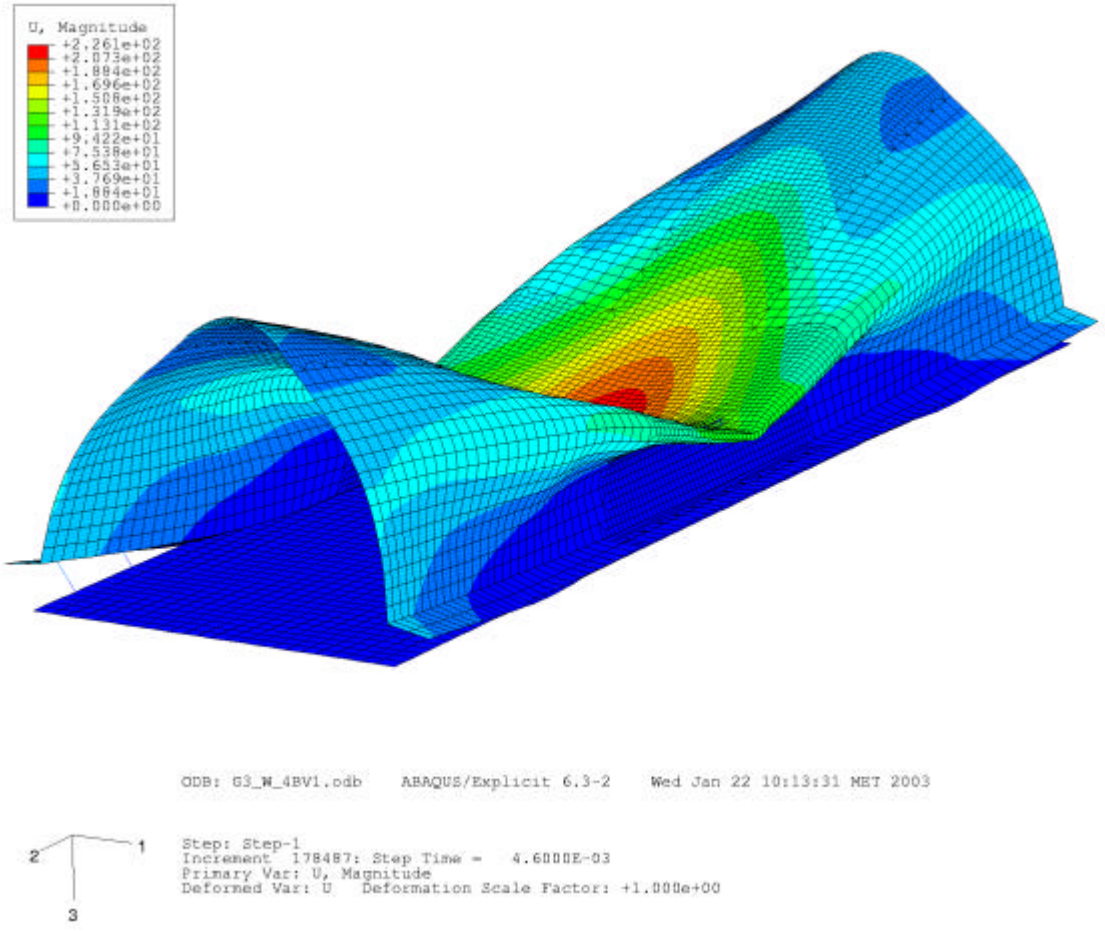


Demonstrators, Theory versus Experiment



GLARE 3 – 6/5

Section H



Demonstrators

A380 Rear Pressure Bulkhead: Resin Film Infusion (RFI) with pre-forms of non-crimped fibers (NCF)

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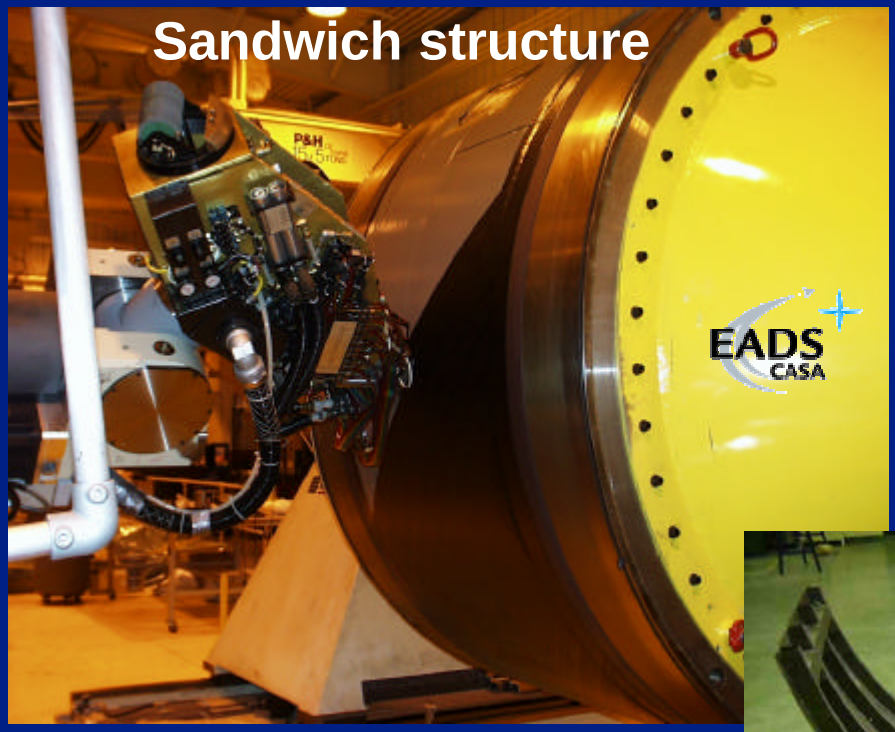
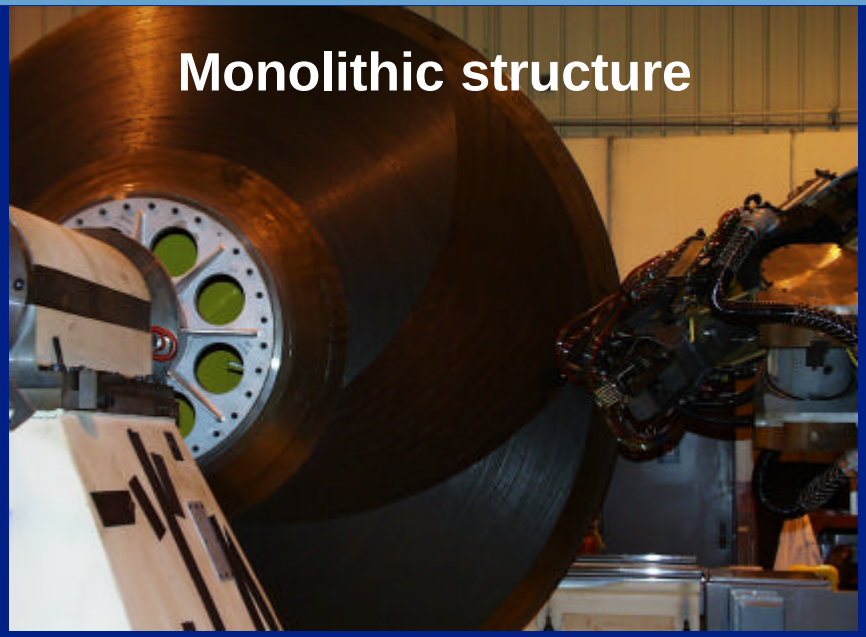
Demonstrators

Cylinders and cones:





Summary on Key Success Business Matters

- The optimum aircraft/cabin configuration was established
- A380 contributes to the solution of airport congestion.
- Structural concepts and technologies have been developed:
  - Requirements of the innovative configuration are fulfilled
  - Maturity of selected technologies was demonstrated.
- Design & technologies frozen in co-operation with major airlines
- Changes of infrastructure at airports are kept at minimum:
  - Definition of “80mx80m-box” together with major airports
  - Landing gear configuration: no higher pavement loadings as today
- A dedicated world-wide Industrial Partnership has been formed.
- The necessary Launch Customer Base was settled.
- **The Program was launched December 21st, 2000.**

Contents

Future Technology Requirement

Technologies	Requirements
GLARE	- GLARE-type for high shear loads - 180°C resin - GLARE with Al7xxx
Laser-Beam-Welding	- advanced forming process: creep forming, instead of roll forming for stringers and stretch forming for skins
Friction Steer Welding	- Not mature, - minimize impact on temper: T3 is needed for damage tolerance, but T4 at weld-line

Future Technology Requirement

Technologies	Requirements
IM Fibers **(Intermediate Modulus Fibers)**	**Improve material performance for compression after impact**
NCF Fibers and RTM6	**- Improve material performance for tension loaded structures with open holes (blunt notch design)** **- Improve material performance for compression after impact**

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Thank You for Your Attention
...Your A380 Team