

# Materials for Aeronautical Structures

## Reason and Rules for Material Change

by  
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# ALENIA AERMACCHI PRESENTATION



Finmeccanica is Italy's leading industrial group in the high technology sector and ranks among the top ten global players in aerospace, defence and security. The Finmeccanica Group focuses on three strategic sectors - *Helicopters, Defence Electronics and Security and Aeronautics* - in which it generates 75% of its revenues and 73% of its orders and employs 74% of its staff. Finmeccanica is Europe's leading defence systems company and is well positioned at international level, and has a strong presence in the space sector, where it has the leadership in the satellite services market. Furthermore, the group has substantial expertise and a well-established position on the global transport and power generation markets.

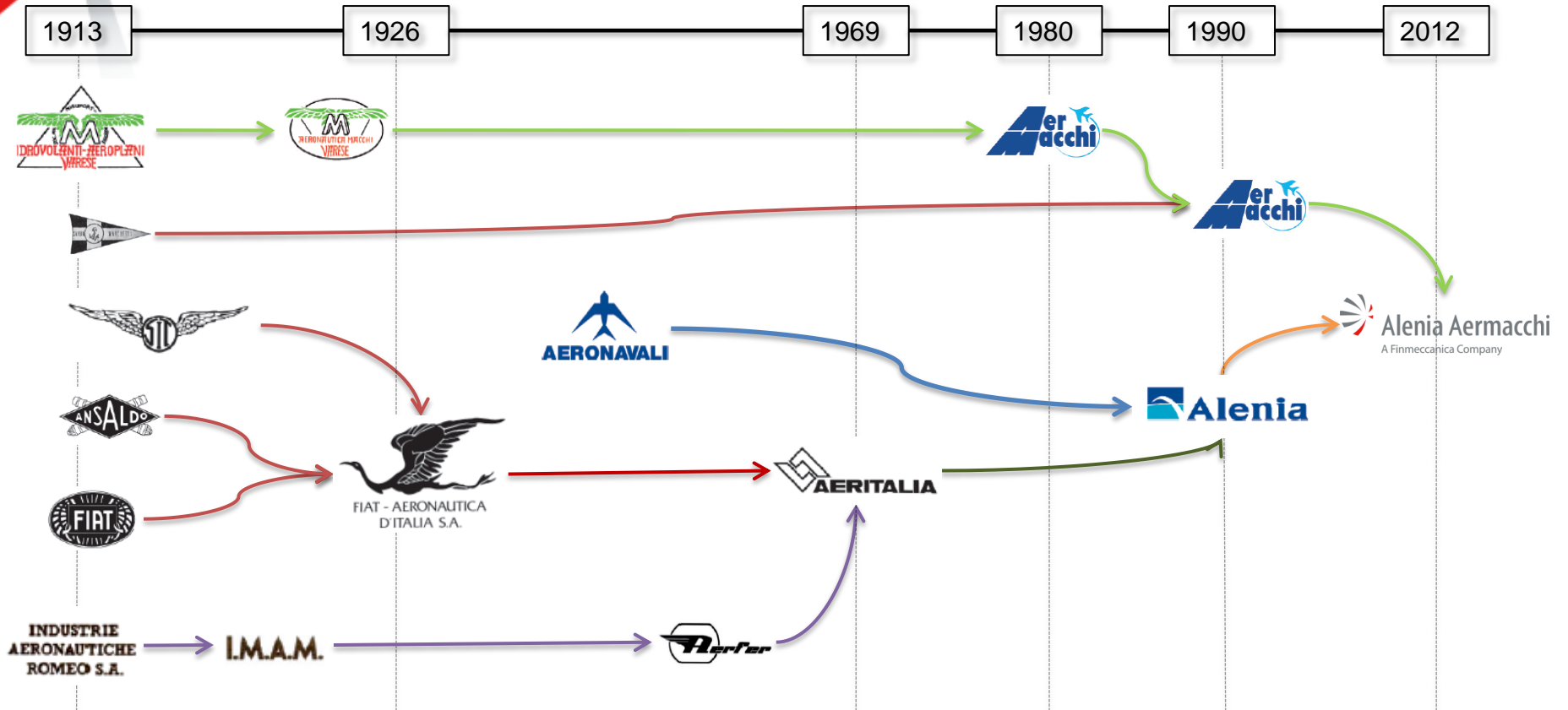
Sector	2012 Revenues (EUR million)	2012 Orders (EUR million)
Helicopters	4.243	4.013
Defence and Security Electronics	5.754	5.136
Aeronautics	2.974	3.169
Space	1.053	866
Defence Systems	1.256	1.005
Energy	715	834
Trasportation	1.719	2.290
<b>Finmeccanica*</b>	<b>17.218</b>	<b>16.703</b>

\* Total figures consider revenues from other activities and elisions









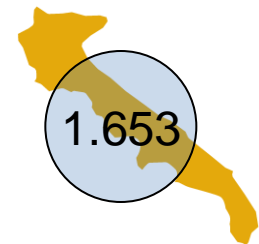
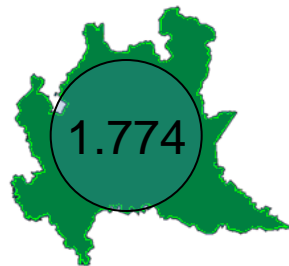
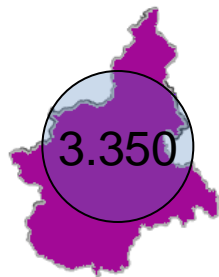
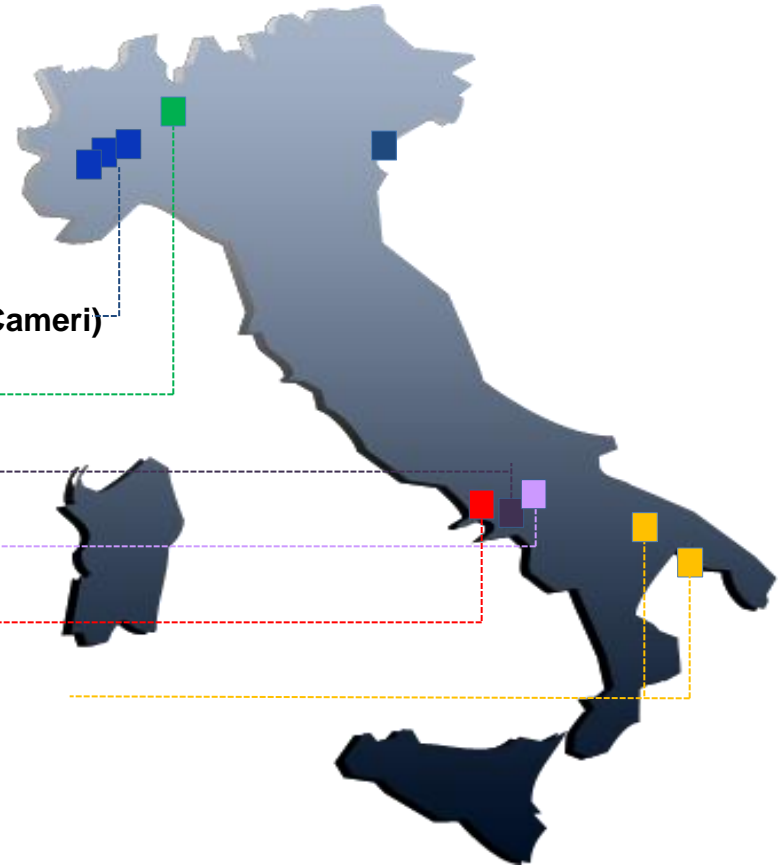


# Evolution of the Italian aviation industry



9 production sites structured in  
“Integrated Production Centres”.

-  **Military Operations Centre\Defence Aircrafts (Torino, Caselle, Cameri)**
-  **Training Systems (Venegono Superiore)**
-  **Civilian Operations Centre (Pomigliano d’Arco)**
-  **Metal Aerostructures (Nola)**
-  **Airlifters (Napoli)**
-  **Composites\DG Boeing (Foggia and Monteiasi Grottaglie)**



**Total headcount: 11.159 persons**

# Lines of business



## Combat aircraft

### Eurofighter Typhoon

Supersonic single/two-seat fighter, twin engined multirole fighter

**Partners:** Alenia Aermacchi (21%), Cassidian (46%), BAE Systems (33%)

**Alenia Aermacchi Responsibilities:**

- Design and manufacture of Left Wing, Rear Fuselage, Wing Pylons, Navigation Systems, Armament System, Utilities Control System.
- Final Assembly and Acceptance Flights for ITAF aircraft.



### ORDERS

UK/Italy/Germany/Spain	472
Austria	15
Saudi Arabia	72
Oman	12

**Potential export sales: 250**  
**Tranche 1 deliveries: 148**  
**Tranche 2 deliveries: 207**  
(through Jan. 2013)

### F-35 Joint Strike Fighter Lightning II

Supersonic single seat, single-engined, ground attack aircraft

**Alenia Aermacchi Responsibilities:** National program leader for

- Strategic second source for production and complete wings
- Final assembly and flight test for Italy and other European countries
- European maintenance, repair, overhaul and upgrading facility (MRO&U)  
(For all F-35 operating in Europe)



**Development phase: 2002-2016**

**Production phase: 2009-2033**

# Trainers

The company is a world leader in the design, production and support of military training aircraft and offers the largest range of products that meet the requirements of all training phases from primary to jet-powered basic, advanced and lead-in fighter trainers. These include the M-346, the only all-new European LIFT, the MB-339 flown by the Italian Air Force “Frecce Tricolori” aerobatic team, the M-345 basic-advanced trainer and the screener/basic SF-260 family.

The M-346, conceived to train the pilots of the latest combat aircraft, can cover all advanced and pre-operational training phases. This allows the M-346 to reduce the training hours flown on more expensive operational types.

## It is also equipped with:

- Fully digital instrumentation: two Head-Up Displays (HUD), six Multi-Function Displays (MFD)
- Main mission controls integrated in throttles and stick (HOTAS)
- Software of on-board simulation of operational scenarios
- Provision for in-flight refueling
- Nine external hard points capable of 3,000 kg overall



**ORDERS**

**Italy (6)  
Singapore (12)  
Israel (30)**

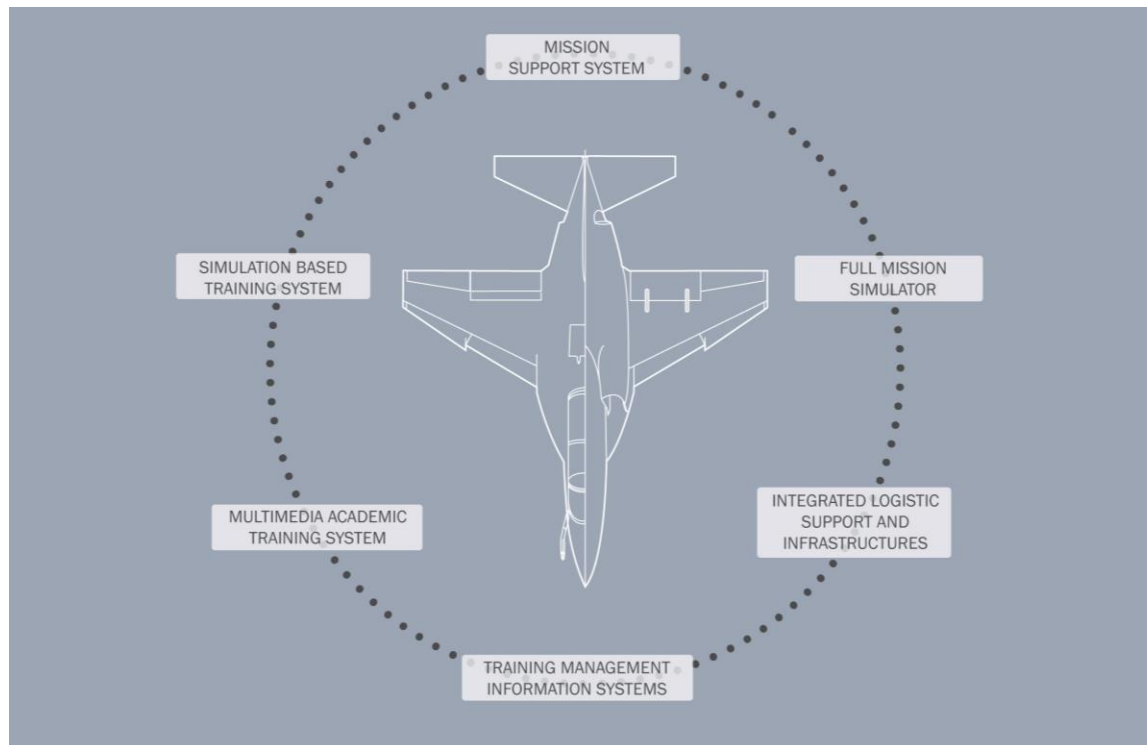
**Deliveries:**  
**Italy (2)  
Singapore (3)  
(Jan. 2013)**

# Integrated Training Systems (ITS)

Alenia Aermacchi has the capability to design and deliver complete Integrated Training Systems optimized for the different phases of the training syllabus, including suitable aircraft, Ground Based Training System (GBTS) and related Integrated Logistic Support (ILS).

The Company offers the broadest range of aircraft types for all training phases from Screening (SF-260) through Basic (M-345) and up to Advanced/LIFT (M-346).

The Ground Based Training System includes the Academic Training System, Simulation Based Training, Flight Training Device and Full Mission Simulator. Mission Support and Training Management Information systems are also available to complement the ITS.



## Airlifters

### **C-27J Spartan - the only true tactical airlifter on the market**

**Extraordinarily strong, robust in hostile environments, reliable and maneuverable. Ordered by the United States in 2007, under the Joint Cargo Aircraft program.**

#### **Deliveries:**

**Italian Air Force (12/12)**  
**Greek Air Force (8/8)**  
**Bulgarian Air Force (3/3)**  
**Lithuanian Air Force (3/3)**  
**Romanian Air Force (5/7)**  
**US Army and Air Force (15/38)**  
**Moroccan Air Force (4/4)**  
**Mexican Air Force (4/4)**  
**Australian Air Force (0/10)**  
**African Customer *restricted* (0/2)**



## Special Versions

### ATR 42 MP Surveyor

Based on the ATR 42 turboprop platform, the aircraft is equipped with radar and optical sensors. Developed for surface vessel search and identification, coastal water surveillance and protection, search and rescue (SAR), monitoring and identification of marine pollution. Specific kits allow for easy reconfiguration to carry passengers, troops, paratroopers or cargo, for medical and humanitarian evacuation.

**Deliveries:**

- Italian Treasury Police (4/4)
- Italian Coast Guard (3/3)
- Nigerian Air Force (2/2)
- Libyan General Security (1/1)



### ATR 72 MP

Based on the stretched ATR variant. The aircraft is capable of performing similar duties of the ATR 42 MP but at longer ranges and with greater payload. Thanks to its self-protection and ESM systems, it can also perform ELINT missions and operate in hostile areas. The advanced communications system simplifies information relay, making the ATR 72 MP an effective “force multiplier”.

**Orders:** Italian Ministry of Defence (4)



## Regional aircraft

### ATR – 42 and 72

Alenia Aermacchi designed and builds the complete fuselage and empennage.  
2009 saw the first flight of the new - 600 variant, which offers improved performance and an even quieter and more comfortable cabin.

	ATR 42	ATR 72	Total
<b>Orders:</b>	437	817	1,254
<b>Deliveries:</b>	422	611	1,033

(through Dec. 2012)



### Sukhoi Superjet 100

Developed and manufactured by Sukhoi Civil Aircraft Corp. (SCAC) in partnership with Alenia Aermacchi, this is the most important commercial aeronautical programme between Europe and the Russian Federation.

The 95-seat baseline has been already certificated by Russian Certification Authority IAC AR and by EASA.

A 115-120 seat variant is being studied.

In 2011 the SSJ100 VIP version has been launched.

**Orders:** 179  
**Deliveries:** 13  
(through Jan. 2013)



## Unmanned aircraft (UAS/UAV)

### **Sky-X** - Technology demonstrator for system development and automated mission management

- First UAS in Europe in the over one ton class to fly successfully
- Performance comparable to a subsonic fighter
- Automated join-up and formation flight in May-June 2008
- **First flight: May 2005**



### **Sky-Y** - Technology demonstrator for a civil and military surveillance UAV

- Conceived for medium altitude and long endurance operations (MALE)
- All-composite structure
- All-electric systems
- Automotive-derived diesel engine with 14 hour maximum endurance
- Datalink and advanced sensor package
- **First flight: June 2007**



### **Neuron** - The largest European aerospace research project

The program covers the design, development, production and flight test of a UAV with low radar and infrared signature, capable of autonomous flight and armament launch.

Alenia Aermacchi is specifically responsible for:

- Electrical generation and distribution system
- Air data system
- Bomb bay doors and mechanisms and “smart” bomb bay
- Alenia Aermacchi is the first partner after Dassault (France). Other participants are SAAB, EADS-CASA, HAI and RUAG.

**First flight: September 2012**



## Upgrades and updating

**G222/C-27A** - The G222 medium twin turboprop airlifter flew in 1970 and over 100 were built. Alenia will continue to support some 30 G222 for the next 10-15 years.



**Tornado** - Alenia Aermacchi developed and carried out the mid-life update (MLU) programme for the ITAF Tornado multirole combat aircraft. A partner of EADS and BAE SYSTEMS in Tornado since programme launch, Alenia Aermacchi originally assembled 99 aircraft for Italy and later converted a number to ECR (Electronic Combat Reconnaissance) configuration.



**AMX** - The ITAF ACOL programme to improve the logistic and operational capabilities of 52 AMX attack and reconnaissance aircraft is nearing completion. Alenia Aermacchi is the prime contractor with a 72% share the other 28% is held by Embraer of Brazil.



## Aerostructures

### Boeing:

**787 Dreamliner** – Alenia is a Boeing “Strategic partner”, with a 14% share of the airframe. It makes the horizontal stabilizer and fuselage sections 44 and 46.

**First flight: 2009 / First delivery: 2011**

**Alenia Aermacchi deliveries to Boeing: 124 fuselage shipsets – 107 Horizontal Stab. shipsets**  
**Boeing deliveries to Airlines :49 a/c (through Jan. 2013)**

**767** – Alenia builds fin, rudder, elevators, spoilers, flaps, ailerons, slats, wing tips, radome

**Deliveries: 1,053 shipsets (through Jan. 2013)**

**777** – Alenia supplies outboard flaps and radome

**Deliveries: 1,050 shipsets (through Jan. 2013)**



### Airbus:

**A380** – Alenia designed and builds about 4% of the fuselage.

**Deliveries: 135 shipsets (through Jan. 2013)**

**A321** – Alenia builds fuselage section 14/A

**Deliveries: 813 shipsets (through Jan. 2013)**

**ATR 42-72** – Alenia Aermacchi designed and builds the entire fuselage and empennages of the most widespread regional aircraft. **Deliveries: 1,033 (through Jan. 2013)**



### Bombardier Cseries:

Alenia Aermacchi will design, develop, industrialize and build significant structural components of the new Bombardier Cseries regional jet in two versions: CS100 / 130 seat and CS300 / 150 seat.

**First flight: beginning 2013**

**Orders: 138 (66 CS100 / 72 CS300) + 124 options (through Dec. 2012)**



### Dassault:

**Falcon 2000 EX new version** - T5 fuselage section, baggage compartment door

**Deliveries : 533 shipsets (through Jan. 2013)**

# Integrated and Tailored LifeCycle Support Solutions

A wide array of support solutions to meet Customers' operational needs

Proactive organization committed to providing tailored solutions

“Through Life Support” to maximize readiness and optimize lifecycle costs



- Customized recommendations and Initial Provisioning
- Ground support equipment (GSE)
- Technical publications
- Type rating training
- Simulators and training aids
- Field service representatives



- Integrated lifecycle support solutions
- Prompt availability of spares (on-site stocks, pool access)
- Turn-Key solutions to maximize operational readiness of aircraft



- Reprovisioning and maintaining of stock levels
- Remote technical assistance
- Airframe repairs and components overhaul
- Line support
- Technical publications revision service
- Recurrent training activities



- State-of-the-art flight training devices and advanced simulation systems to meet the latest qualification standards and any operational training requirement

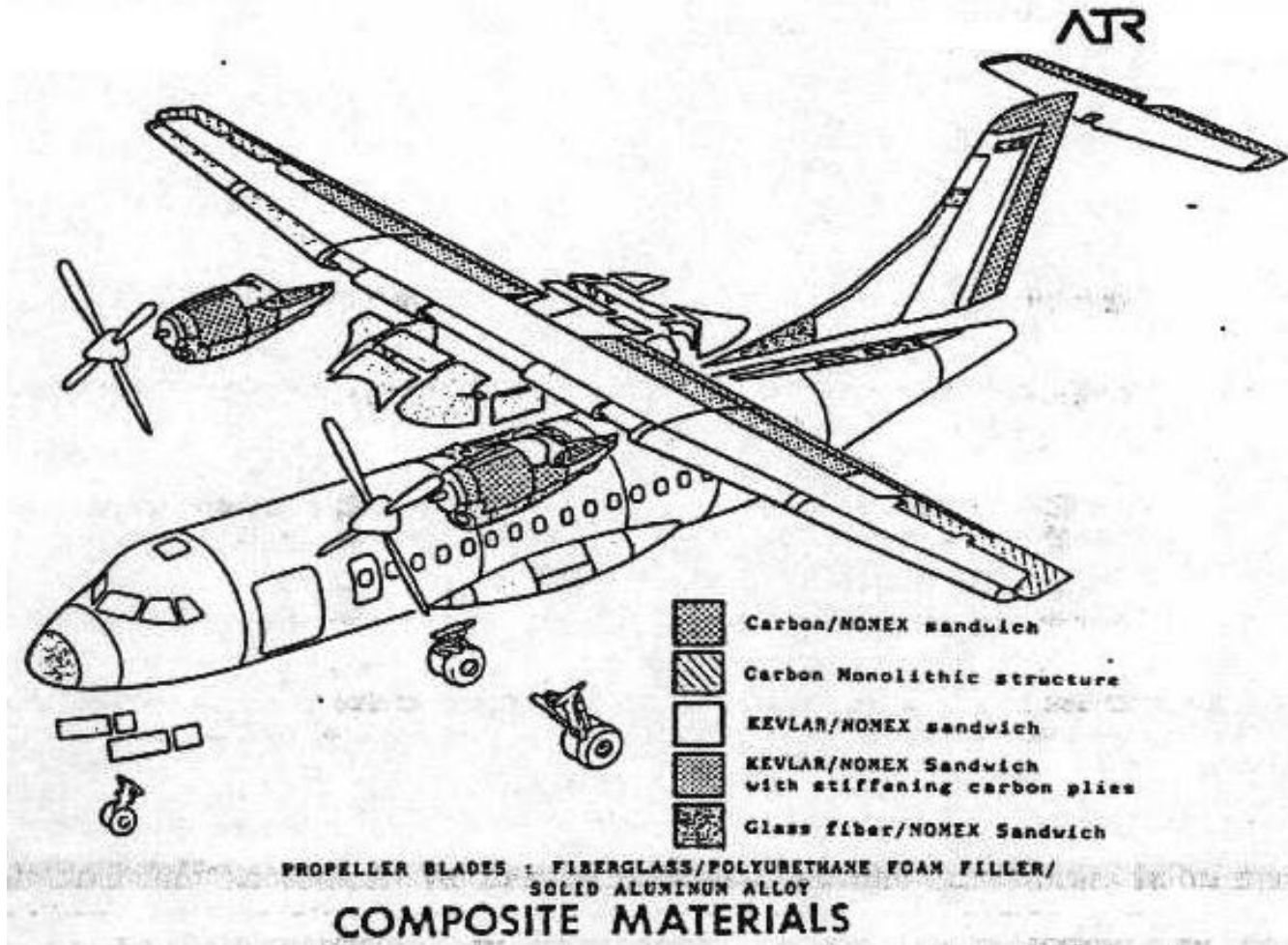
# Materials for aircraft structures

## -Metallic

- Aluminum Alloys
- Titanium Alloys
- Steels

## -Composites

- Polymer based
  - thermoset or thermoplastic matrix
  - carbon, glass, aramidic reinforcement
- Metal matrix



# Material Requirements for Aircraft Structures Certification

## Repeatability and Reliability

Different batches of material must show properties which don't change above a controlled level of variability.

Design properties are evaluated taking in account the statistical variability (due to raw material properties and process factors variability) as well as all the other factors which can affect them (e.g. temperature, service damage, etc.)

# Material Requirements for Aircraft Structures- contn'd

Typical Documents Controlling the Material  
Properties

Material Specification

Process Specification

Design Allowables

# Aircraft Structures Certification Material Requirements – contn'd

## Material Specification

Document aimed to control all the material properties critical for the application, specifying the procedure to guarantee them, including the quality control documentation and test procedure.

It typically includes the procedure for material qualification (mandatory). All the qualified materials are listed in a document (Qualified Product List - QPL) which is a specification attachment.

## Aircraft Structures Certification Material Requirements – contn'd

### Process Specification

Document aimed to standardize the process, in order to guarantee the properties of the produced parts. All the process parameters values during the process are specified. Also the characteristics of the process facilities are described, as well as the quality control requirements.

Process specification requires qualified processors and plants.

# Aircraft Structures Certification Material Requirements – contn'd

## Design Allowables

Design Allowables are the material properties used in the design of the structural parts. They must take in account: variability of the properties batch to batch, variability of the process parameters, environmental effects on the mechanical properties, damage and fatigue effects.

Raw materials for aeronautical structural applications can be generally critical for availability of qualified sources more than for basic availability.

Examples:

Aluminum

Titanium

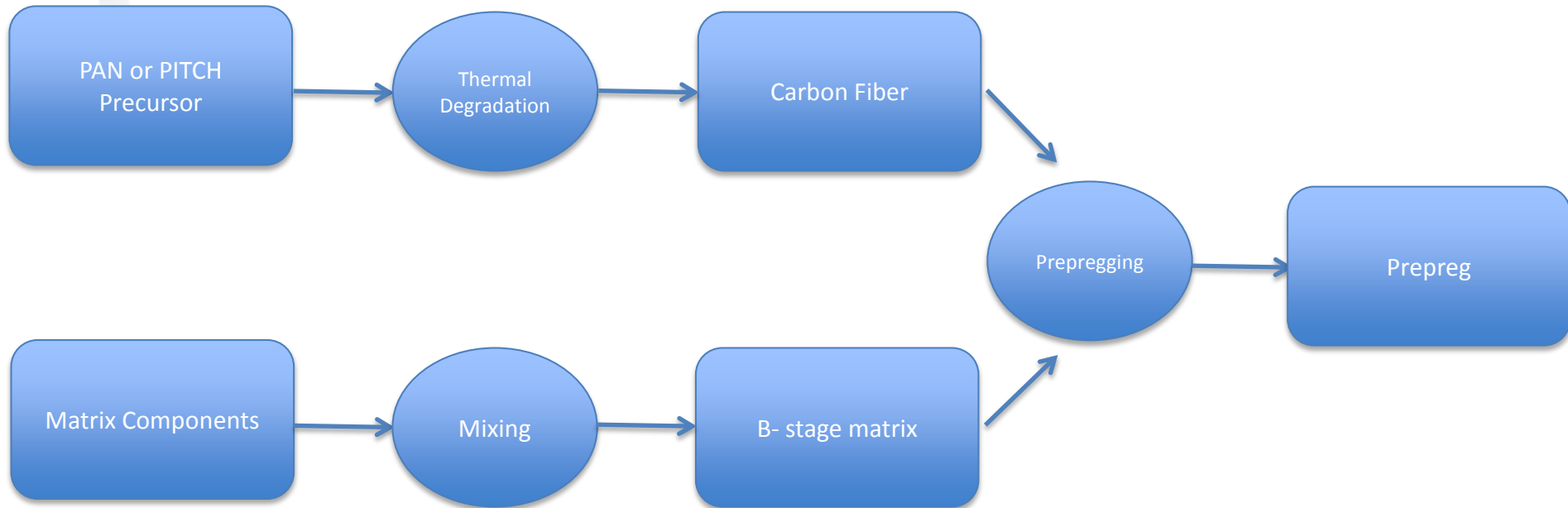
Composites

## Aluminum and Titanium

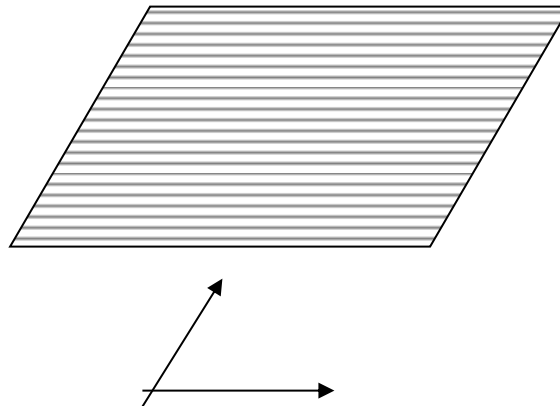
Few qualified producers (two or three) of intermediate parts (extruded, sheets, plates, forgings) suitable for aeronautical applications.

Composites (epoxy matrix and carbon fiber reinforcement)

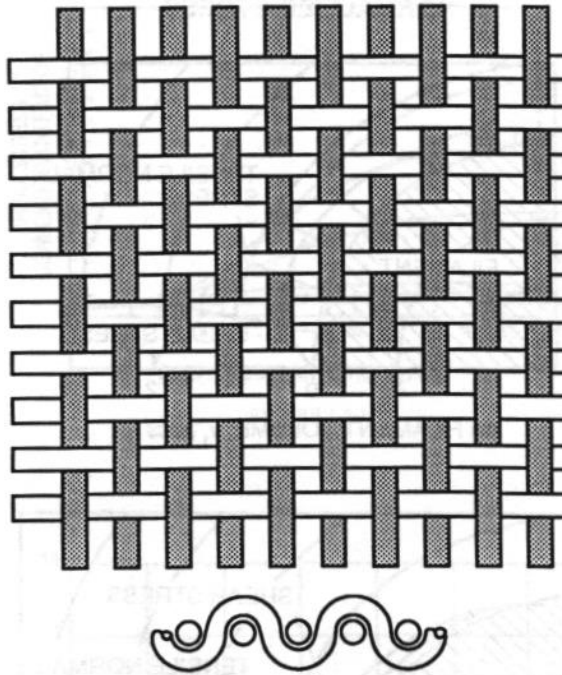
Most of the aeronautical structures are based on prepregs



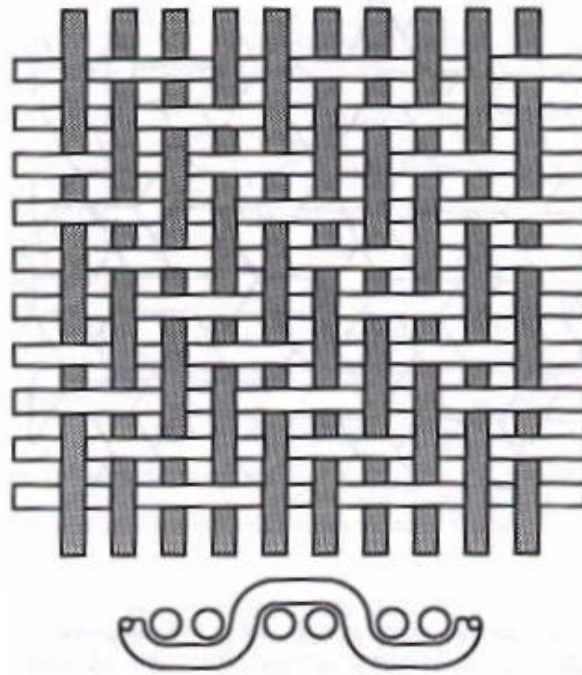
Prepreg tape: parallel fibers impregnated in a not cured polymeric matrix



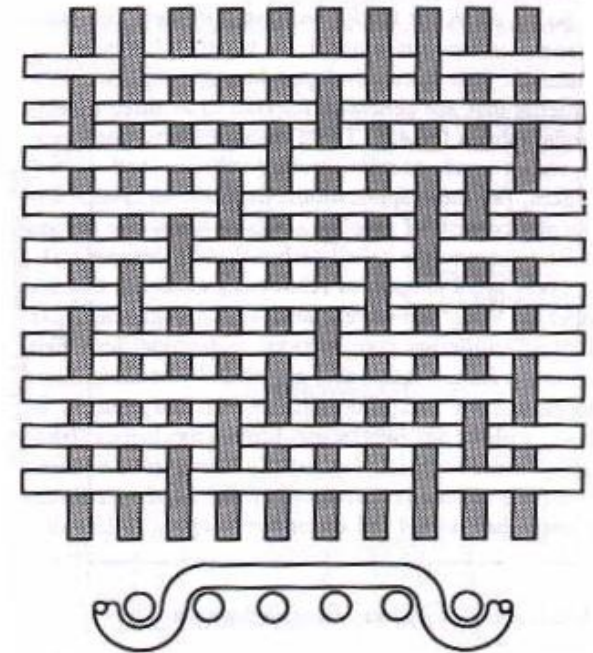
## Fabric Prepregs - Woven Fiber Yarns impregnated in a not cured polymeric matrix



**Plain weave**



**Twill weave**



**Five-harness satin**

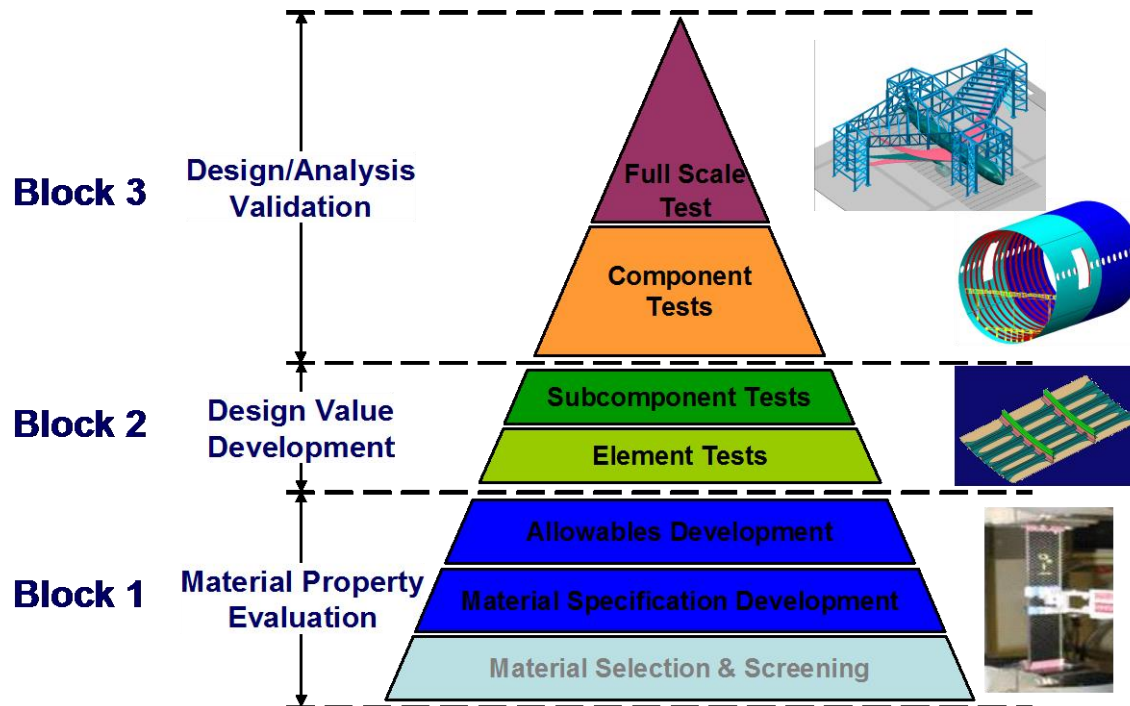
## Aircraft Structures Certification Requirements

The structural reliability of the structure must be demonstrated on the basis of:

Material Design Allowables developed for material qualified per a material specification and processed for a process specification

Design allowables developed with a scale-up approach (coupons, details, subcomponents, components)

Design allowables developed with a scale-up approach (coupons, details, subcomponents, components)



## Aircraft Structures Certification Requirements (cont'd)

Each change in the materials requires a re-certification

# Reasons for change

Potential criticality of the material source (composites):

Availability of matrix components (thermosets) or availability of matrix polymer (thermoplastics):

Basic resin, hardener, catalizer, additional resins

Availability of fiber precursors:

Availability of process thermal degradation:

Availability of qualified prepregging process

Reason for change

Potential criticality of the material source  
(metals):

Availability of qualified alloys

Availability of alloys as sheet, plates,  
extrusions, forgings

Reason for change

Potential improvement of the materials:

Best properties

- Mechanical properties

- Durability

- Functional properties (thermal/electrical conductivity, damping, etc.)

Lower cost

Best environmental affordability

Possible changes (composites)

Change in the matrix compositions  
(components, addition of nanoparticles)

Change of the matrix nature (thermoset,  
thermoplastic)

Change in the fibers

New processing methods (out of autoclave,  
etc.)

Needed solution:

European availability of qualified supplier

Fostering conditions:

Technology availability

Marketing factors

# Thanks for your attention