

Presentation ISOJET

- HIGH PERFORMANCE COMPOSITES

LIQUID INJECTION WAY Examples

Presentation

- ISOJET equipments
- Composites market
- Overview technology
- Examples
- conclusions

ISOJET EQUIPEMENTS

- ISOJET has developped solutions for all liquid resin moulding applications
- RTM (flow and pressure controlled, pressure controlled), infusion , VAP, LRI ,VARTM....
- Large experience in AEROSPACE applications and Automotive

ISOJET ÉQUIPEMENTS

Z.A. - 2, Chemin du Génie - Allée Marc Seguin - 69200 Vénissieux FRANCE
Tél. (33) 04 78 67 14 14 - Fax (33) 04 78 67 13 13 - www.isojet.com

Les hommes, les fonctions

Gérant : Hervé Pons-Habit
Responsable technique : Pascal Julien
Agents commerciaux : Christophe Poncelet (France)
Johannes Werder (Allemagne, Suisse, Autriche et Grande-Bretagne)

Principales Références

Wiel, Siemens Automotive,
Lambert, Thomson, Airbus Dassault,
CEA, Eurocopter Uthmaniyah, Muehlebach

AUTOMOTIVE and ELECTRONIC APPLICATIONS

- **Matériels :**
Unités monocomposants ou bicomposants (basse pression)
- **Application :**
Collage, encapsulation, injection RIM...
- **Résines :**
Polyuréthanes, époxydes silicones
- **Equipments :**
Monocomponents units or bicomponent units (low pressure)
- **Applications :**
Adhesive dispense, potting, RIM injection...
- **Resins :**
Polyurethanes, epoxydes, silicone



AEROSPACE APPLICATIONS

- **Matériels :**
Unités d'injection RTM. Automatiques et semi automatiques
Systèmes de transfert de résine
Presses chauffantes pneumatiques
Systèmes d'acquisition de données
Ateliers complets clef en main
- **Résine :** époxydes
- **Equipments :**
RTM injection units full automated or partially automated
Resin transfer system
Pneumatic Heated presses
Data acquisition systems
Full plant turn key
- **Resin :** epoxydes



In Few words

Founded 1979
12 persons
2.6 million € TO
65% abroad

Representative agent
SAIMEX Italy
JAPAN is KBK company
GERMANY/SWITZERLAND/
AUSTRIA is WERDER SYSTEM
CHINA is SINO COMPOSITES



What is our EXPERIENCE

- Injection machines for RTM and INFUSION technology
- Full automated processes
- Presses and data recording

Composites

- More and more developed
- Aerospace (military and civil planes)
- Automotive
- And generally transportation



WHY COMPOSITES

- New materials = new performances
- Weight reduction (density medium 1,7 for composites and 2,8 for aluminium)
- Reduction of costs
- Assembly technology

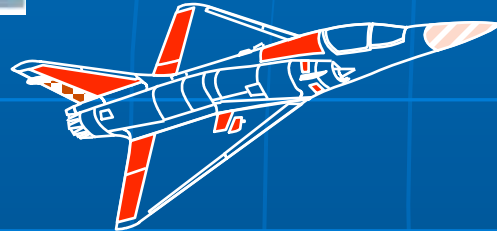
ALL PUSHES THE LIMITS

Composites in military planes DASSAULT

1975
EH Mirage F1



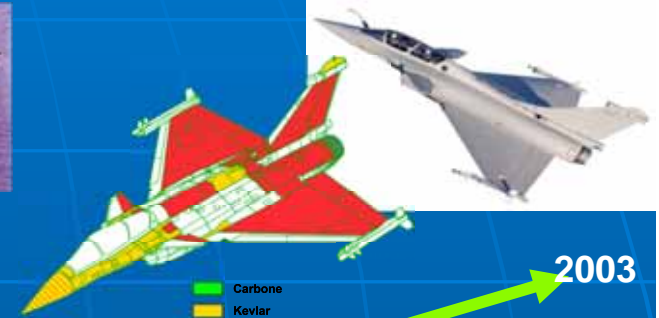
1978
Prototype Mirage 2000



1979
Super Mirage 4000



Depuis 85
Rafale proto & série



2003
2003: F7X



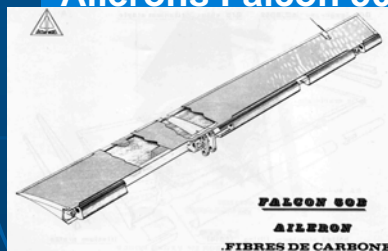
1984
Structures secondaires
Falcon 900



1998
Empennage
Falcon Composite



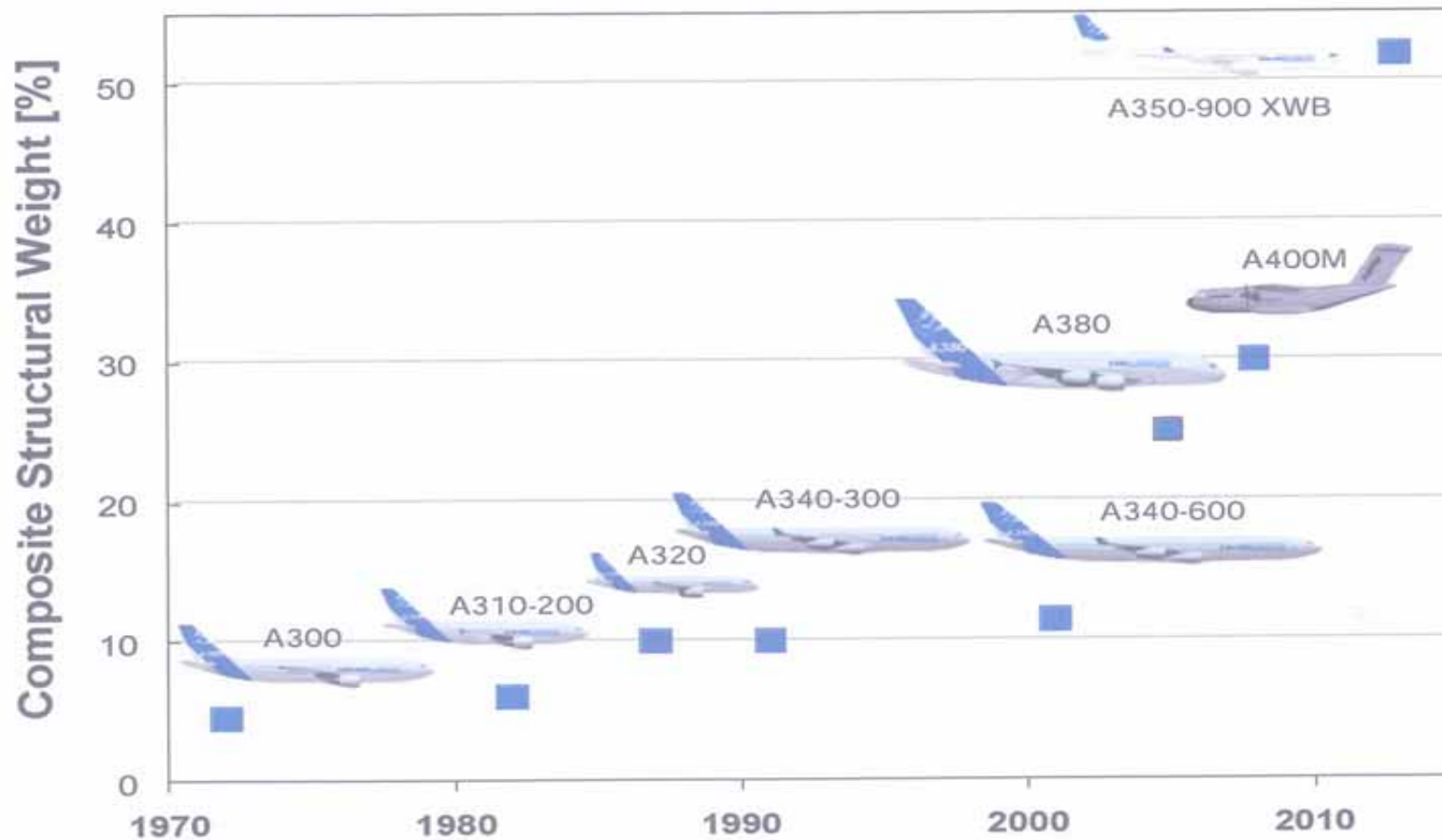
1979
Ailerons Falcon 50



1978- 1985
V10F



Evolution composites in civil aircrafts AIRBUS



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COMPOSITE MANUFACTURING

Composites High Performance
Mainly carbon fibers or aramide fibers

PREPEGS
Applications
Main application
High growth

Combinations
Ex GLARE
Few developments

Liquid injection
In dry fabrics
Only few %(10?)
total
Production
High growth

What is liquid injection moulding

- Injecting resin into dry fabrics
- Injection needs special moulds
- Injection with flow and pressure
- Injection assisted by vacuum



RTM (RESIN TRANSFER MOULDING)

(injection in closed moulds with pressure)

VAR /VAP (VACUUM ASSISTED RESIN/PROCESS) or (VACUUM ASSISTED RTM) VARTM

(injection in closed mould or under membranes with vacuum help)

INFUSION of resin (covered partially by VARTM or VAR, diffusion of resin stripes in fabrics...)

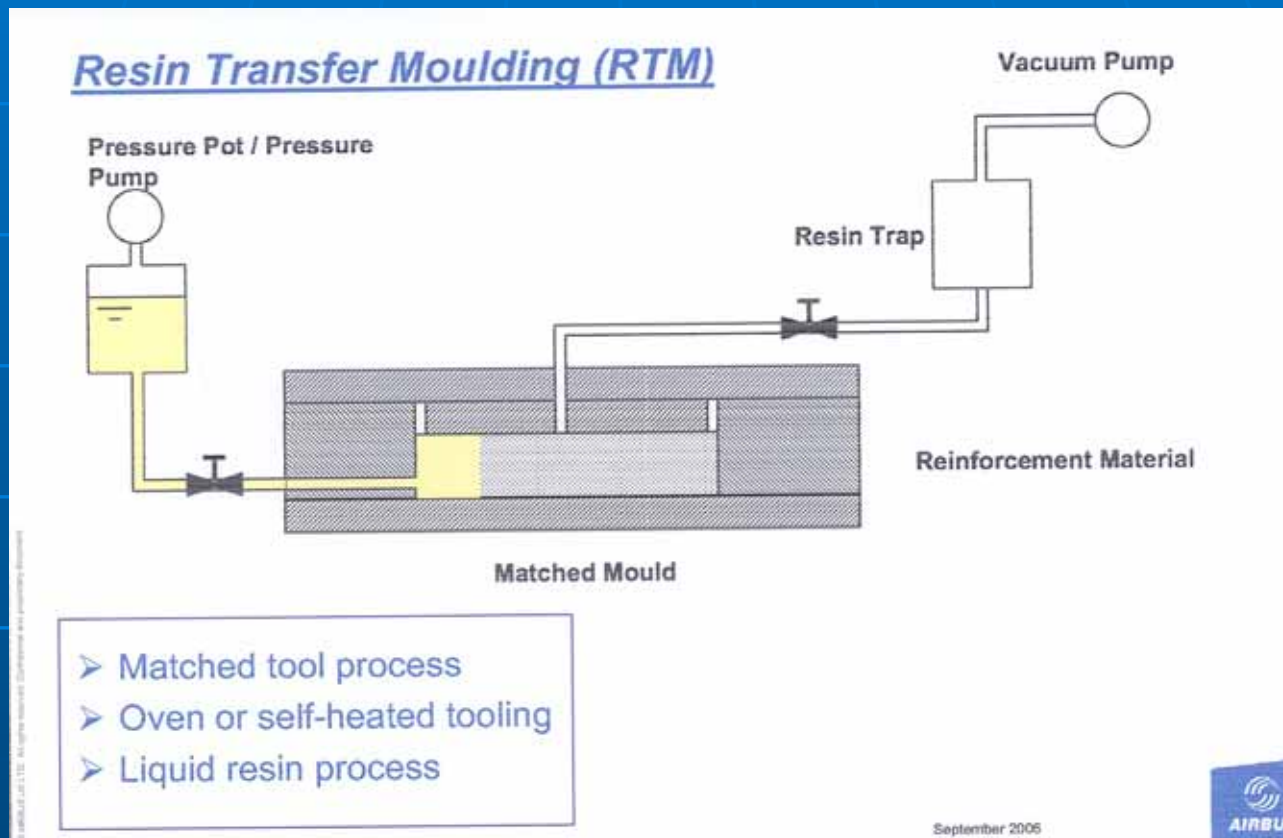
1 RTM TECHNOLOGY

- INJECTION WITH FLOW and PRESSURE CONTROL
- INJECTION WITH PRESSURE CONTROL
- Injection High volumes from 1 to 500 kg
- Injection of RTM6 or other resins (CYTEC, HUNTSMANN.....)
- Injection 2 components resins in RTM technology
- Moulds are High cost

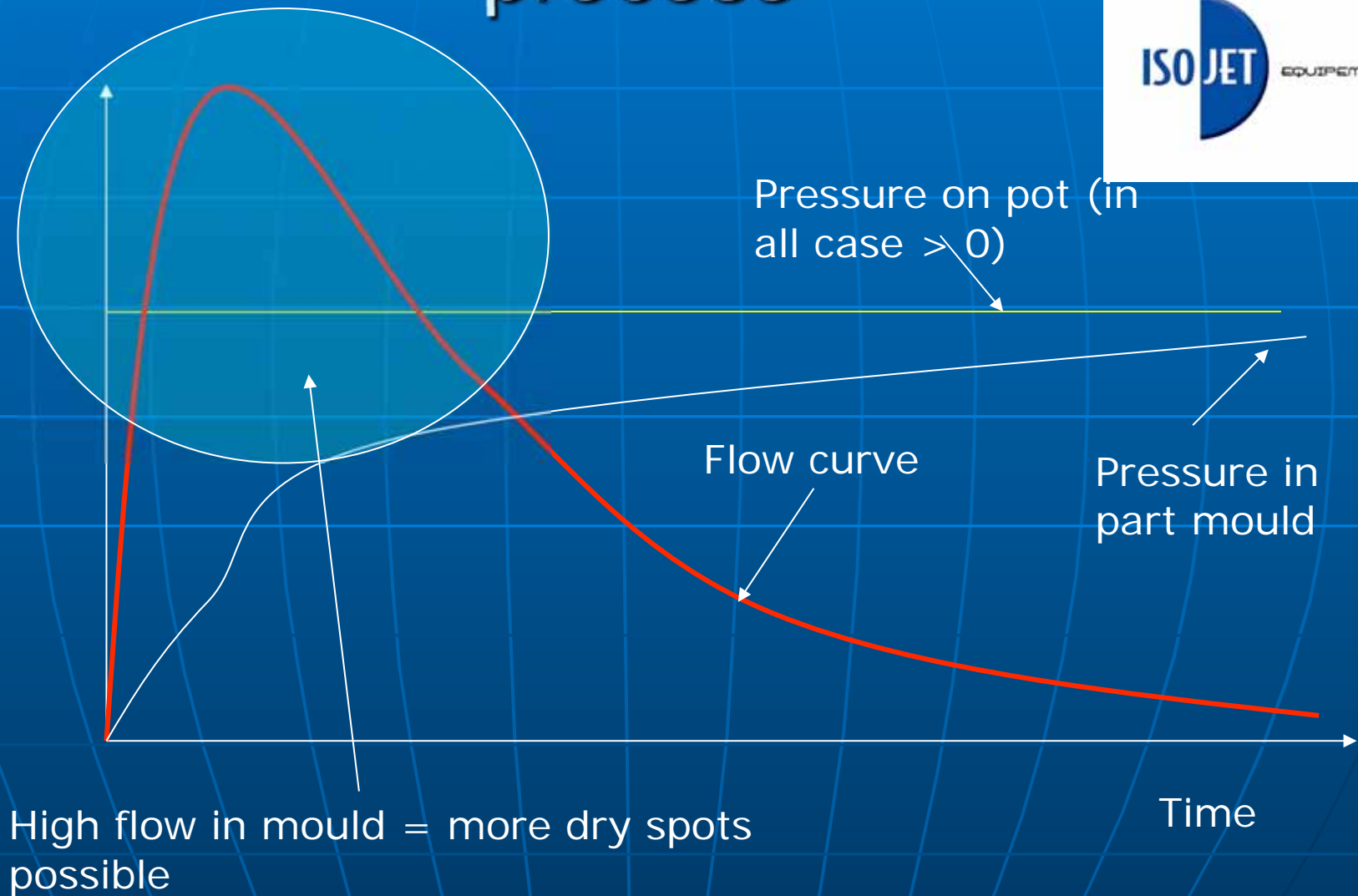
WHY RTM Process

- FLOW AND/OR PRESSURE CONTROL APPROACH
 - Control of the injected flow and/or pressure
 - Positive pressure (up to 30 bars)
 - Possible interfaces with simulation softwares (RTMFLOT, PAM, POLYWORKS)
 - High pressure possible (up to 30 bars or more).

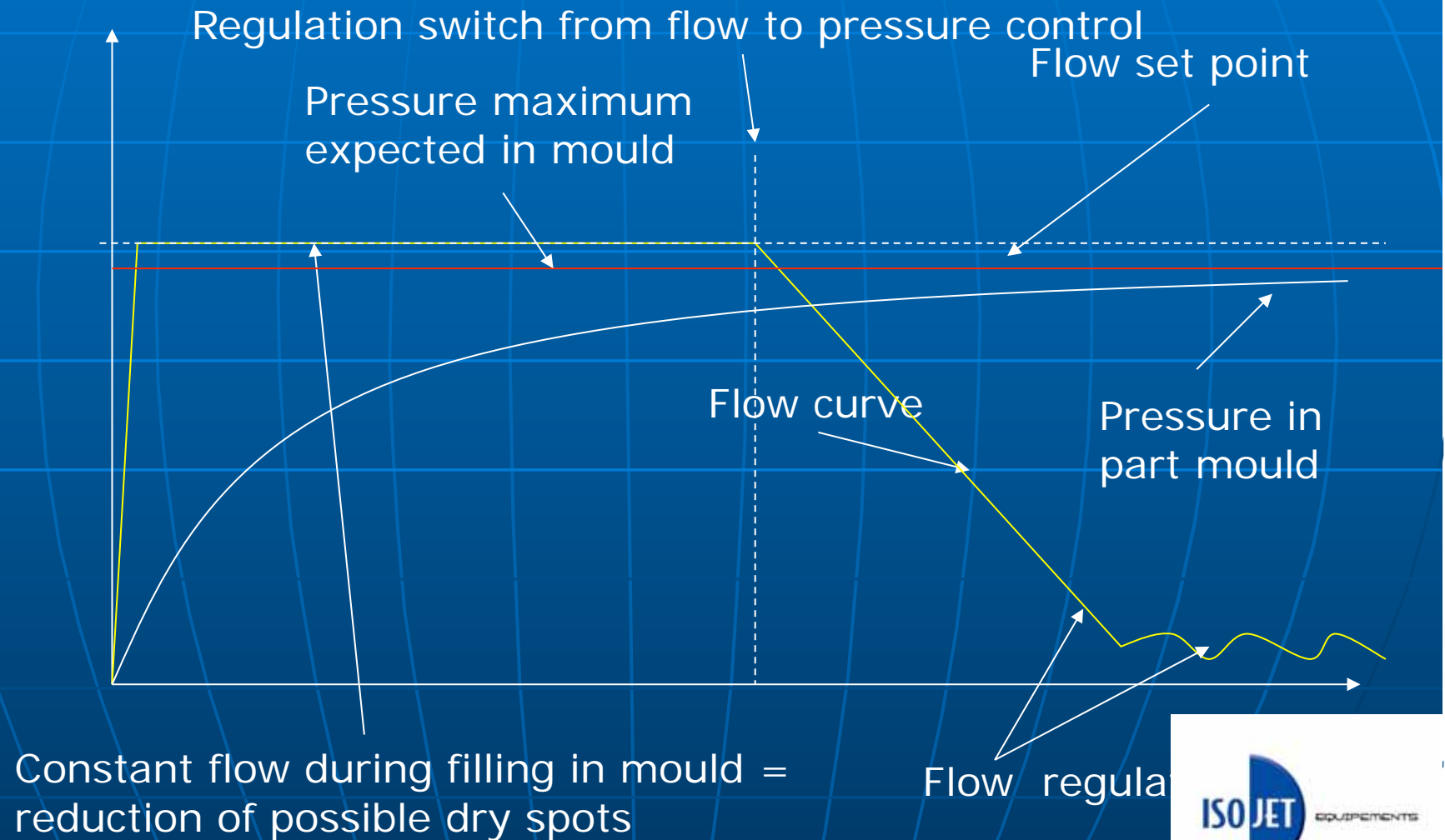
RTM principle schema



Injection in pressure control process



Injection in FLOW and Pressure control process

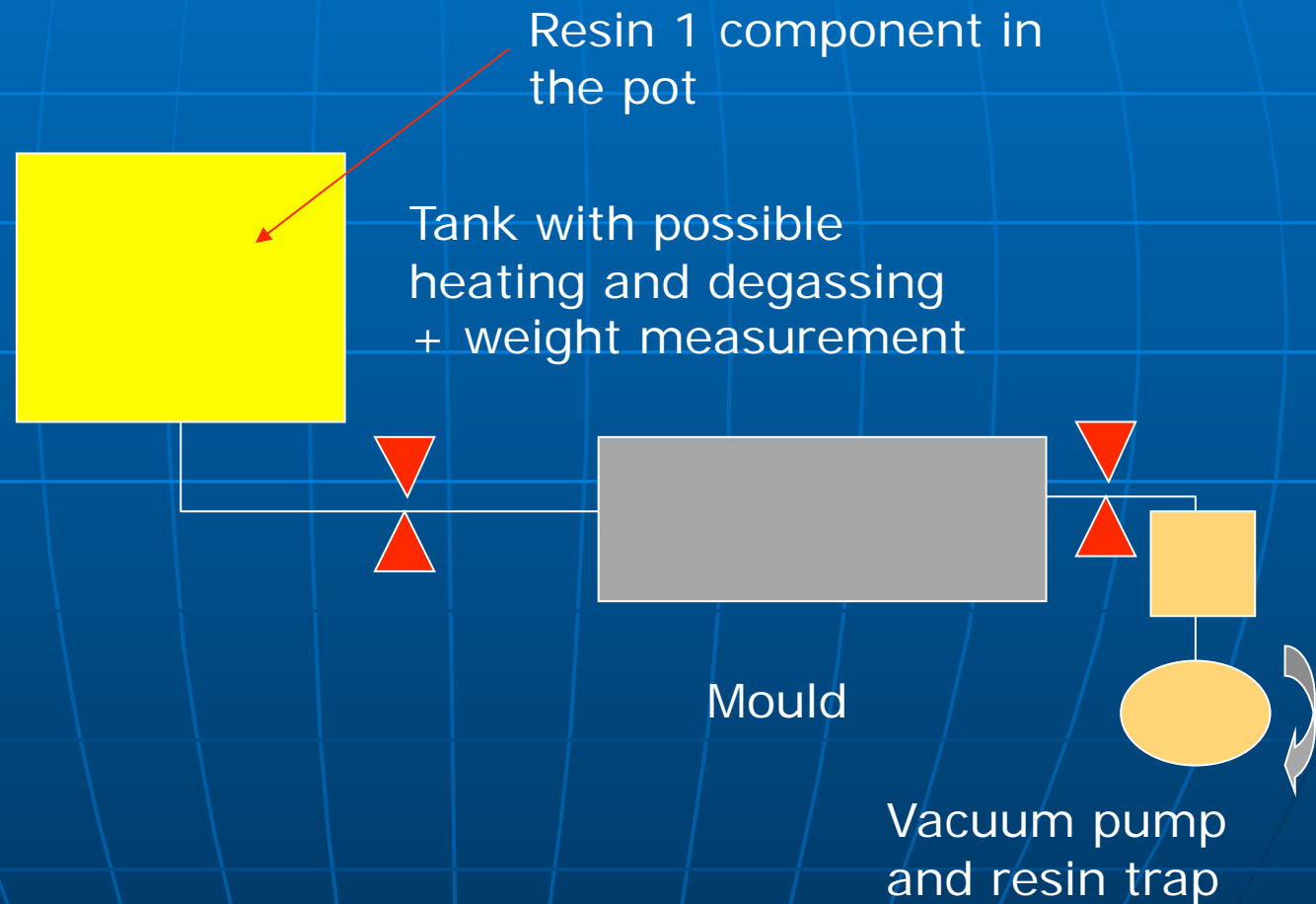


Machines principles

Pressure pot

Pressure max 10 bars

Vacuum 1 mbars



Pressure pot machine

Injection POT

- from 1 to 75 Liters injection volume
- Vacuum up to 2 mbars
- pressure up to 10 bars
- Heating/stirring
- PC logging
- Full automation

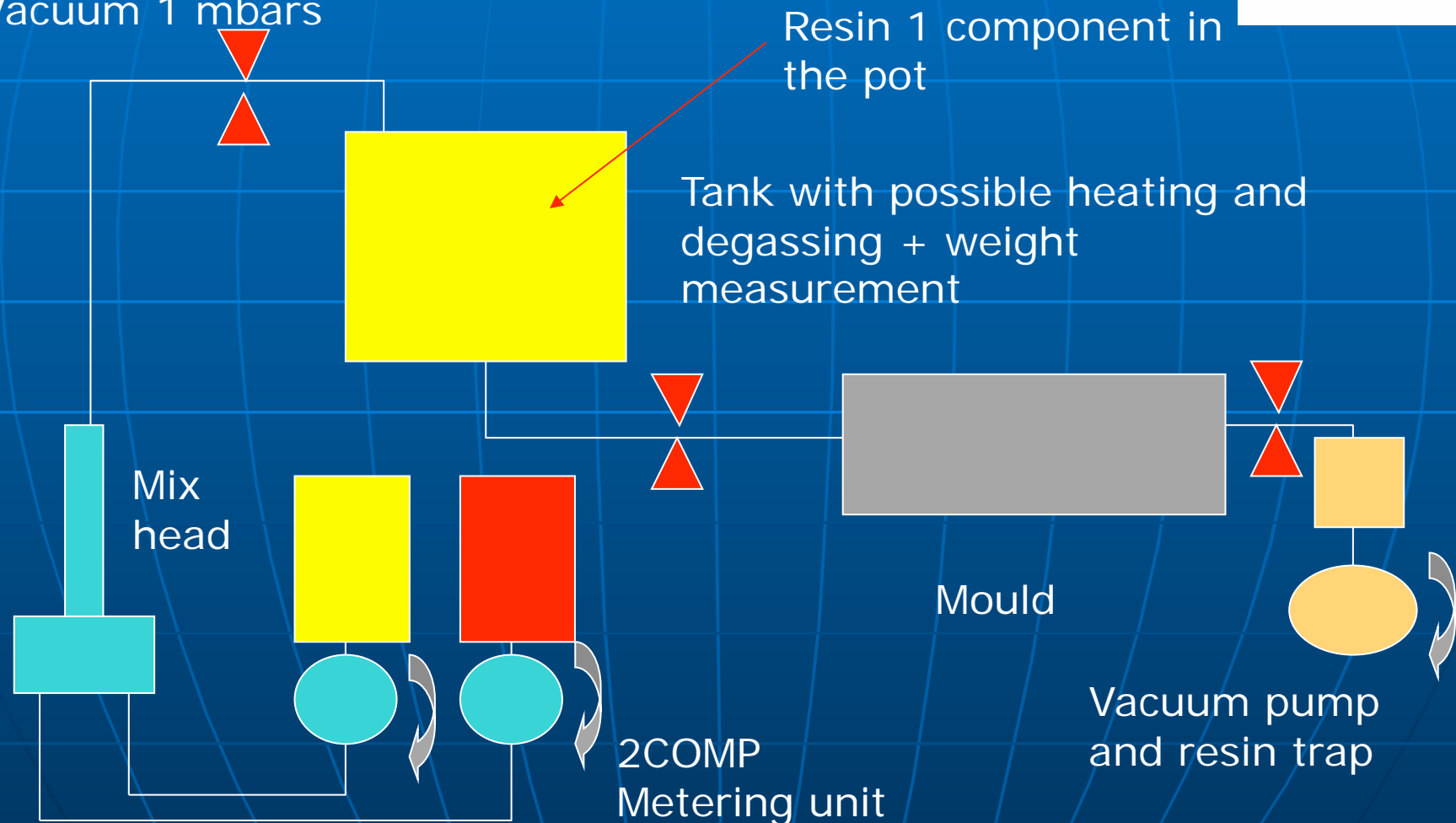


Injecting 2 component resin with an injection pot



Pressure max 10 bars

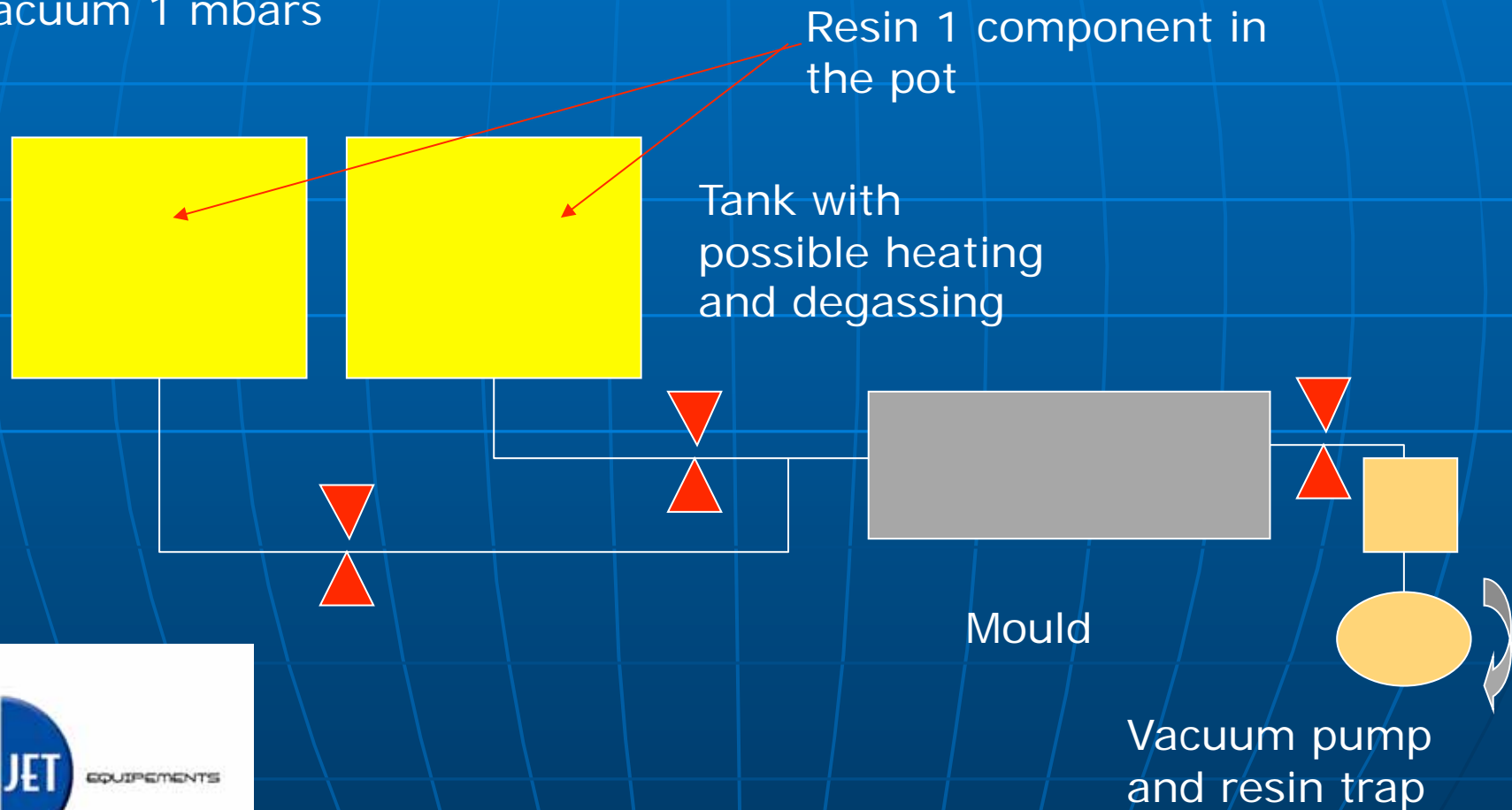
Vacuum 1 mbars



High volume injection

Pressure max 10 bars

Vacuum 1 mbars



Double RTM Tank

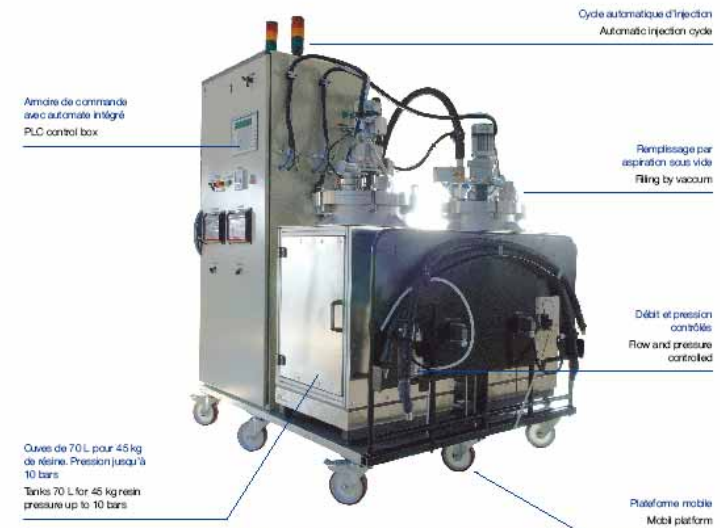
- Double 50 liters capacity tanks
- RTM or Infusion process
- Full automated
- AIRBUS nantes (8 machines)
- 2003/2006



EQUIPEMENT POUR L'APPLICATION DES RESINES DE SYNTHSE
EQUIPMENT FOR DISPENSE OF THERMOSETTING RESINS

UNITÉ INJECTION / INFUSION RTM AIRBUS

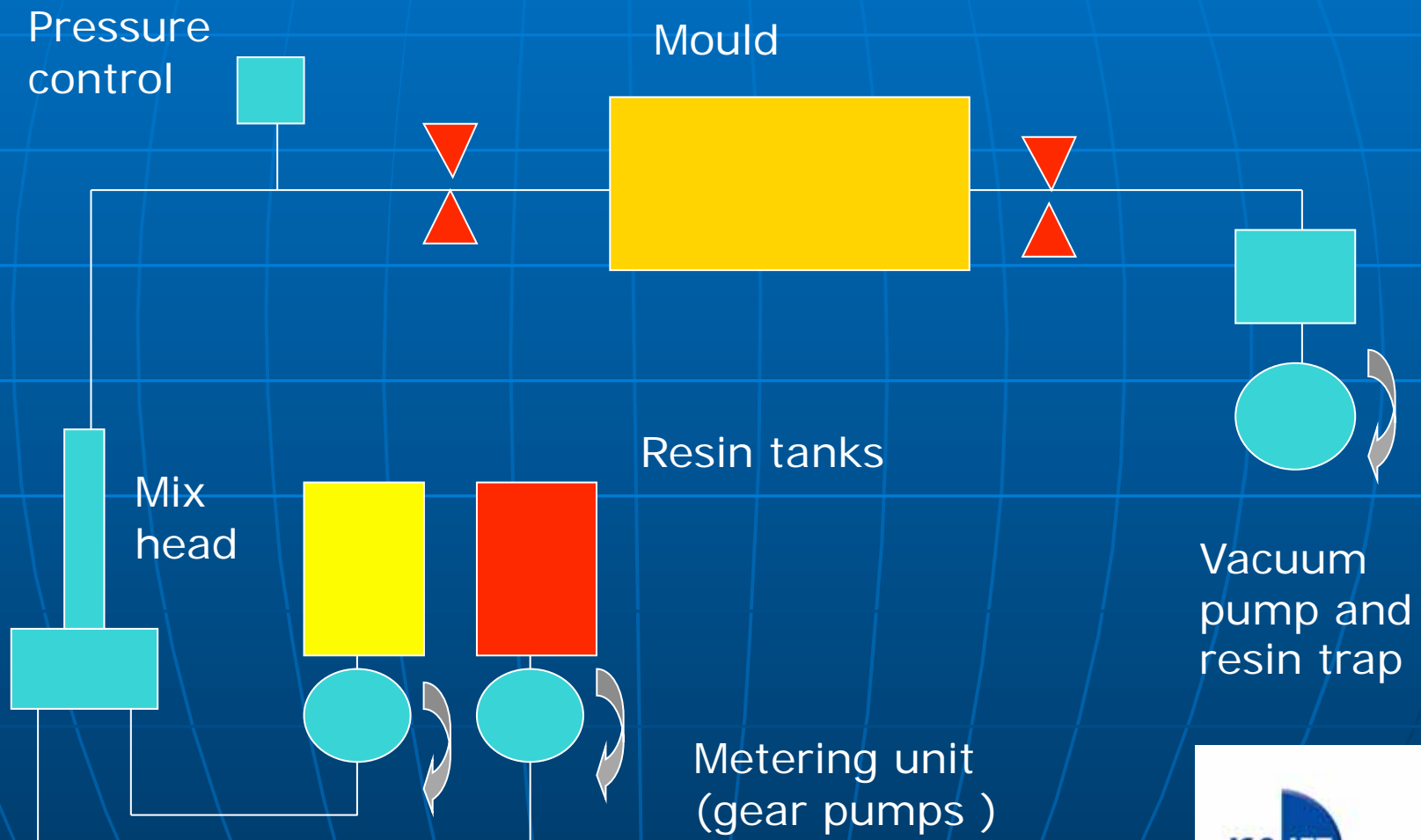
Unité d'injection de résine monocomposante. Injection RTM ou Infusion. Machine automatique pilotée par automate et/ou PC. Capacité 1 ou 2 fois 45 kg de résine. Vide maxi = 1 mbar. Pression maxi = 10 bars.
Resin monocomponent injection unit. RTM or Infusion process. Automatic unit managed by PLC with/without PC. Capacity of 1 or 2 times 45 kg of resin. Max vacuum = 1 mbar. Max pressure = 10 bars.



Cette présentation du matériel peut être adaptée à la demande du client.
This presentation of the equipment can be adapted to customer specification.

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Direct injection RTM resin 2 components



RTM full automated 2 components resins

- Automotive production
- PLC
- Flow meter for continuous control
- Full heated machine 120°C



EQUIPEMENT POUR L'APPLICATION DES RESINES DE SYNTHÈSE
EQUIPMENT FOR DISPENSE OF THERMOSETTING RESINS

INJECTION RTM RÉSINES BICOMPOSANT 2K RTM INJECTION SYSTEM

Injection RTM à basse pression max 15 bars.

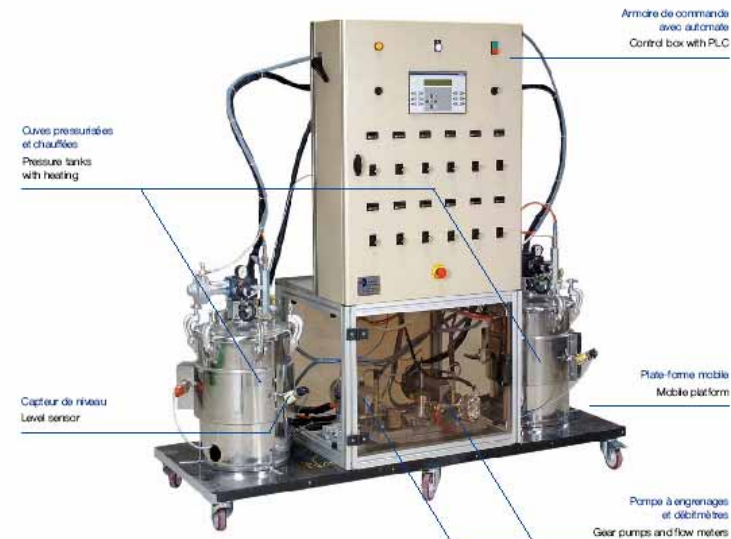
Distribution continue ou séquentielle du produit mélangé et chauffé

Gestion électronique du rapport de pression. Connection possible à un PC.

RTM injection max 15 bars.

Continuous or sequential dispense of mixed and heated materials.

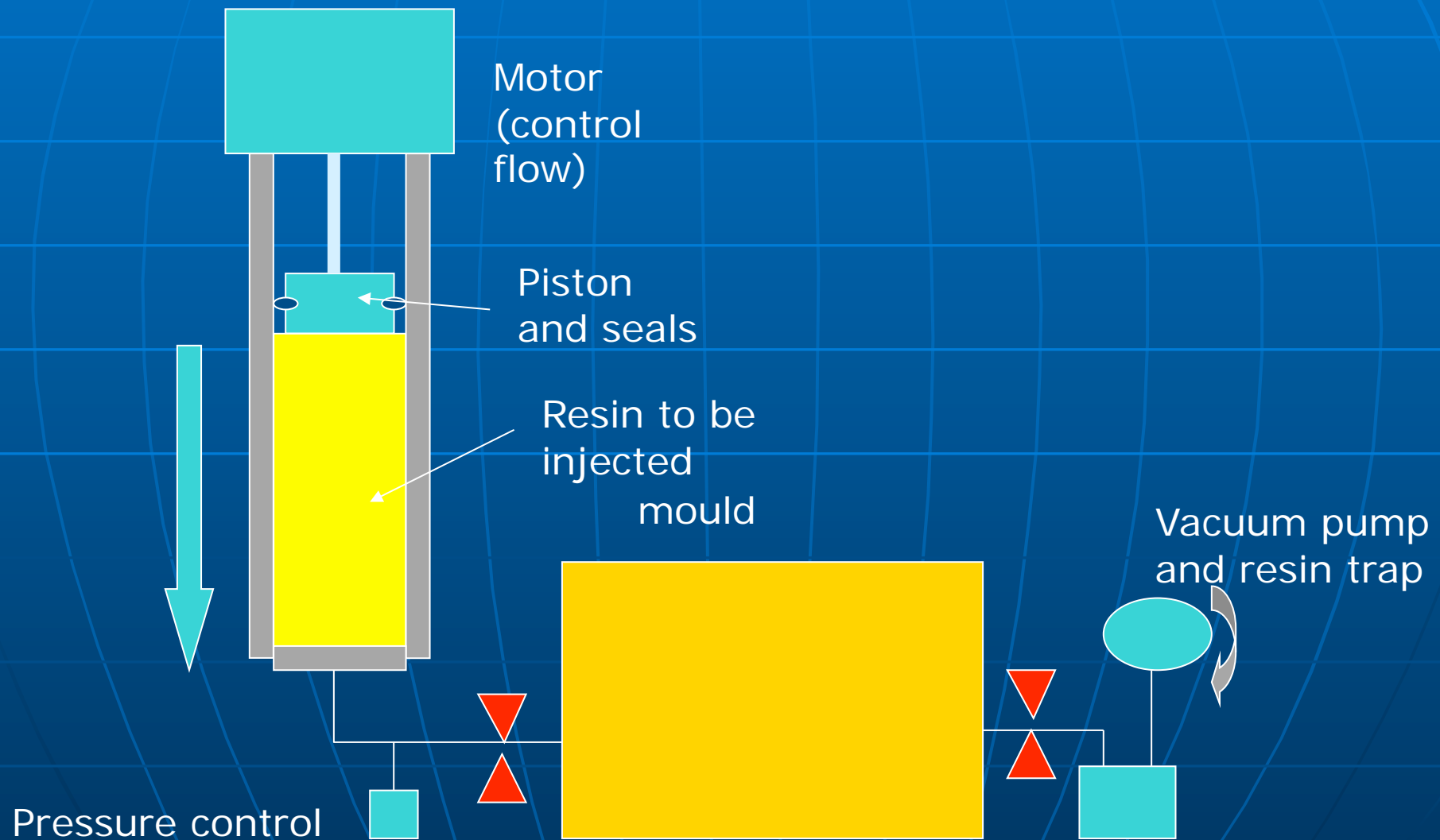
Electronic management of mixing ratio. Possible connection to a computer.



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Injection Piston (flow and pressure controlled)



Flow and pressure controlled technology with injection pistons



Soft for flow control
developped by AIRBUS
CIMPA exclusive license for
isojet

This technology developped since
1999 based on piston system with
flow and pressure controlled
application

Capacity up to 30 l pistons

Flow from 10 to 2000 CC/min

Pressure up to 30 bars

Software for data acquisition

Injection piston new generation

This technology developed since 1999 based on piston system with flow and pressure controlled application

Capacity up to 30 l pistons

Flow from 10 to 2000 CC/min

Pressure up to 30 bars

Software for data acquisition

ISO JET EQUIPEMENTS

EQUIPEMENT POUR L'APPLICATION DES RESINES DE SYNTHÈSE
EQUIPMENT FOR DISPENSE OF THERMOSETTING RESINS

**PISTON INJECTEUR / INJECTION PISTON
FLOW AND PRESSURE CONTROLLED**

Unité d'injection par piston. Débit et pression contrôlés. Pression de 0 à 25/30 bars.
Débit de 0 à 1000 cc/min. Température de 0 à 170°C (option 300°C). Capacité de 0,5 à 30 litres.
Injection piston unit, flow and pressure controlled. Pressure 0 to 25/30 bars.
Flow 0 to 1000 cc/min. Temperature up to 170°C (or 300°C optional). Piston volume 0.5 to 30 litres.

Logiciel Supervision + acquisition de données et stockage cycles
Software for supervision + data acquisition and cycle storage

Contrôle par microprocesseur
Microprocessor controlled

PC de contrôle de l'application
PC controlled

Pistons injecteurs
0,5 à 30 litres
0 à 25 bars
Piston injection
0.5 to 30 litres
0 to 25 bars

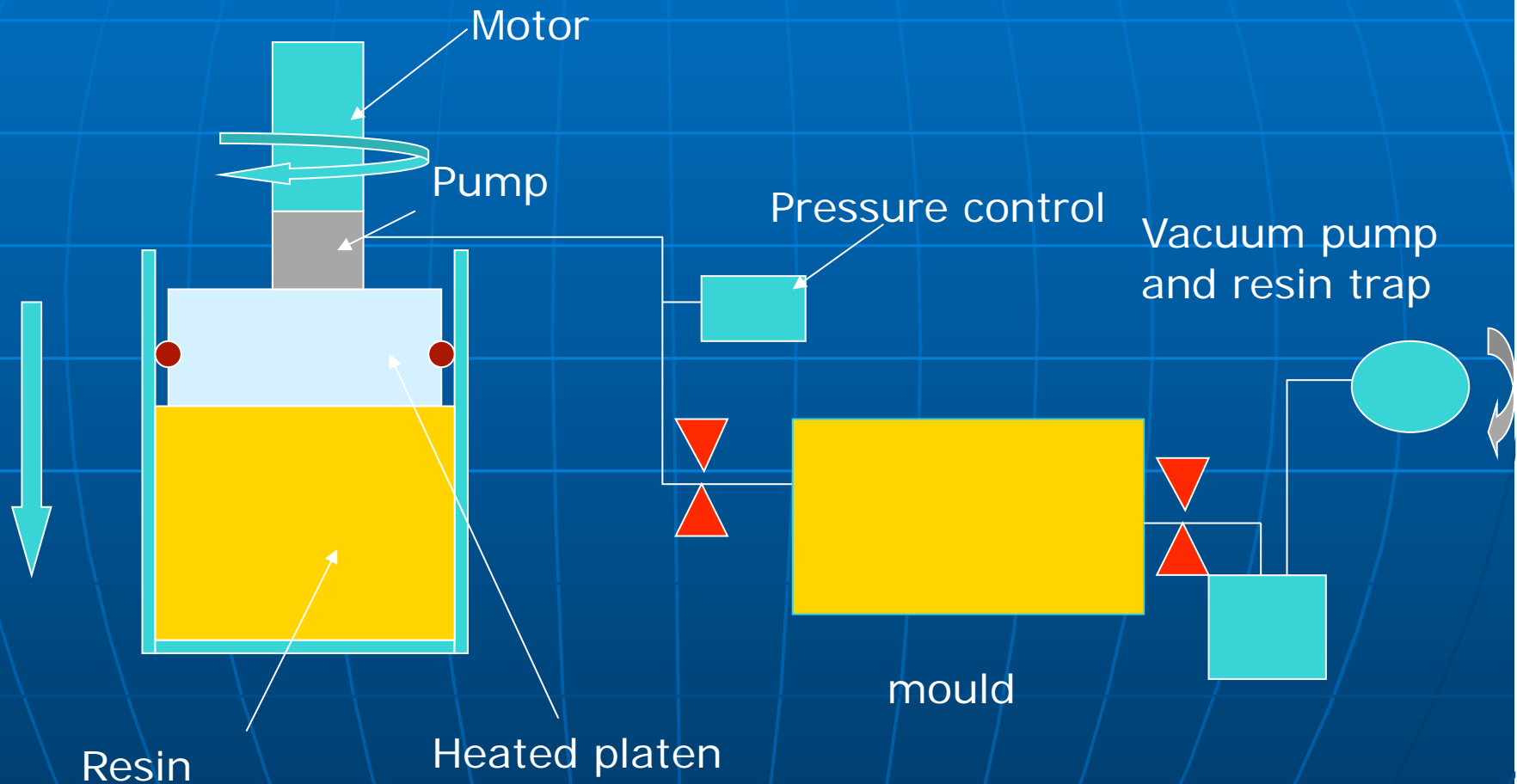
Platforme mobile
Mobile platform

Acquisition externe
0 température 2 pressions
Colonnes externes
0 température 2 pressions

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RTM flow /pressure controlled direct pumping



Continuous injection application flow and pressure controlled



EQUIPEMENT POUR L'APPLICATION DES RESINES DE SYNTHÈSE
EQUIPMENT FOR DISPENSE OF THERMOSETTING RESINS

INJECTION RTM DÉBIT/PRESSION CONTRÔLÉS RTM INJECTION GEAR PUMP

Pompe d'injection résine mono composant. Débit et pression contrôlée. Débit de 10 à 500 cc / min.
Pression jusqu'à 25 bars. Température jusqu'à 175°C.

Injection pump resin mono component. Flow and pressure controlled. Flow from 10 to 500 cc / min.
Pressure up to 25 bars. Temperature up to 175°C.



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www.isojet.com ■ E-mail : hphiblot@wanadoo.fr / contact@isojet.com

Software for flow control
developped by AIRBUS
CIMPA exclusive license for
isojet

**High Quality transfer
pump (including sever
duty applications)**



RTM Parts in A380



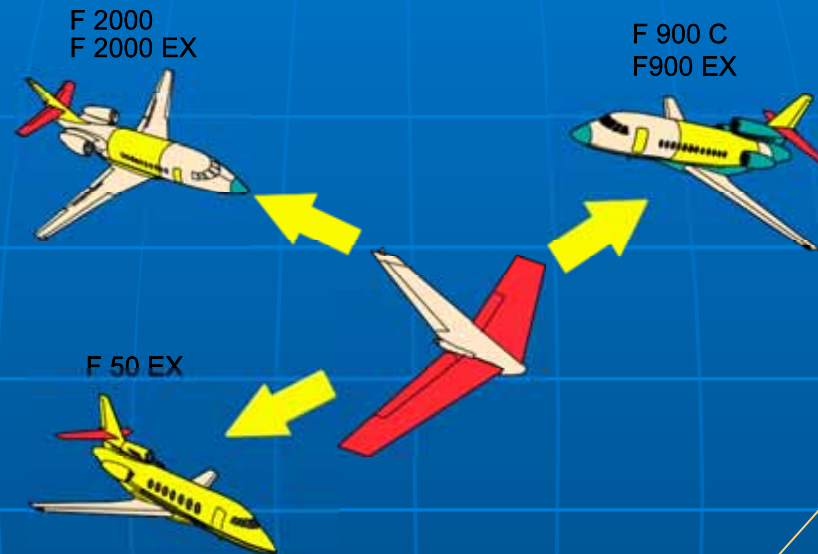
A380 Applications

- Rudder Hinge Fittings (RTM)
- Elevator Hinge Fittings (RTM)
- Corner Fittings (RTM)
- Lower Rib Flanges (RTM)
- Junction Angles (RTM)

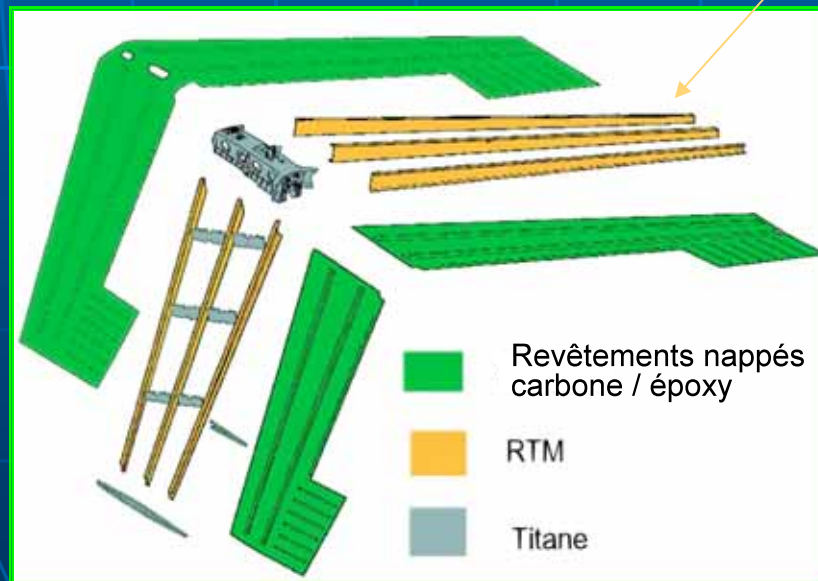
Airbus A 380 central wing box (S21)



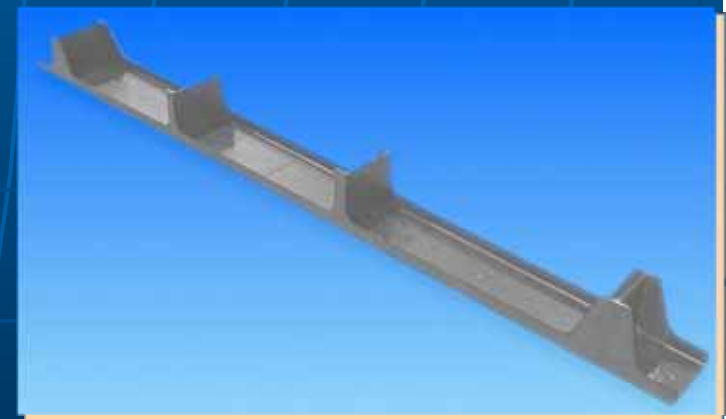
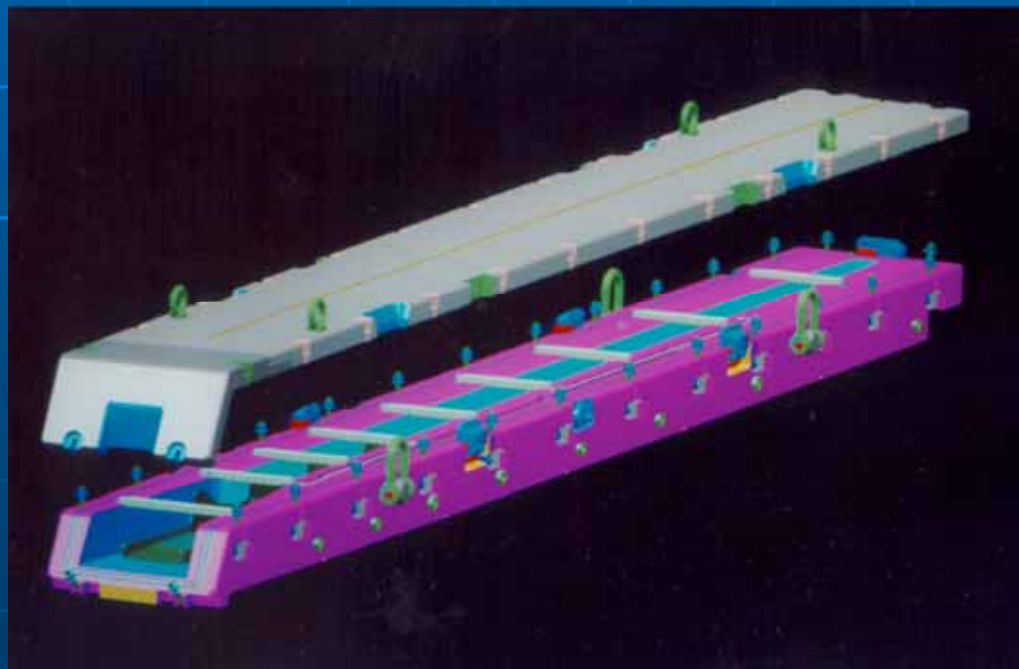
Example in DASSAULT Plane



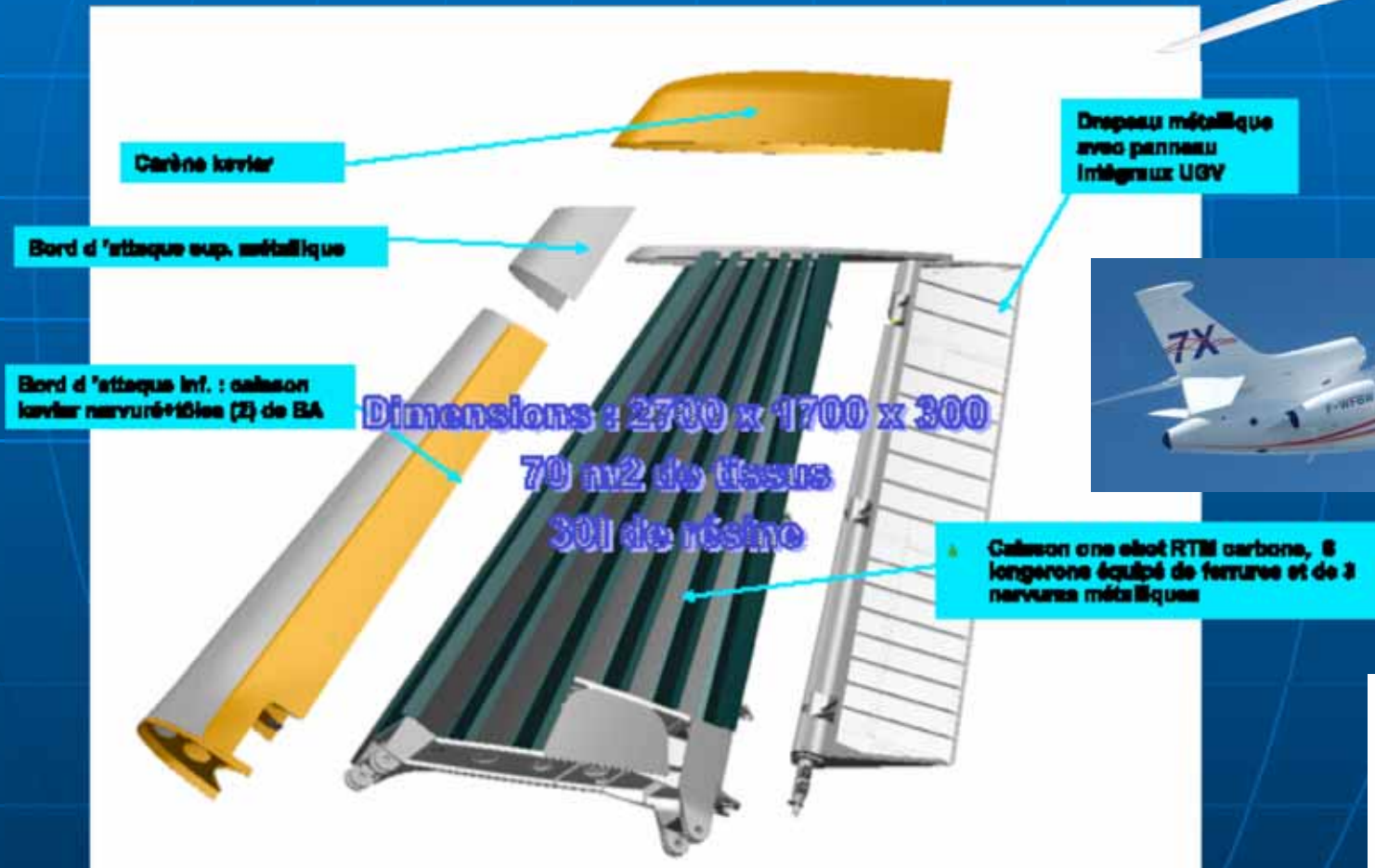
RTM part



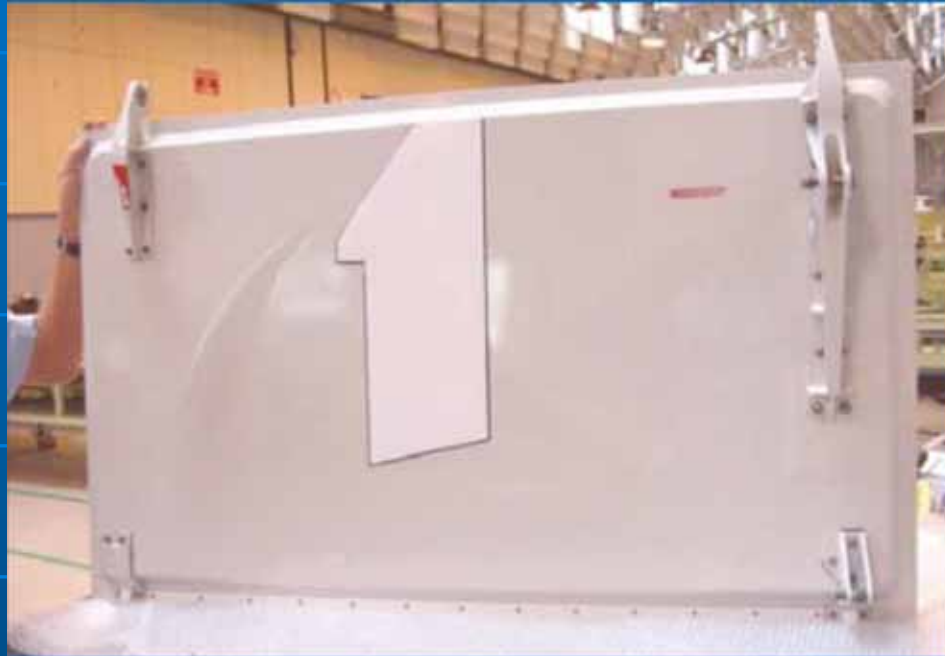
RTM parts produced for FALCON



Vertical Stabilizer F7X falcon



Landing gear trap (falcon)

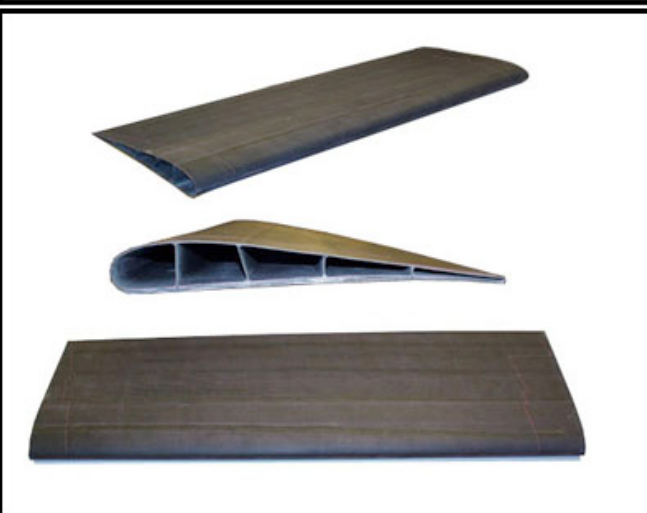
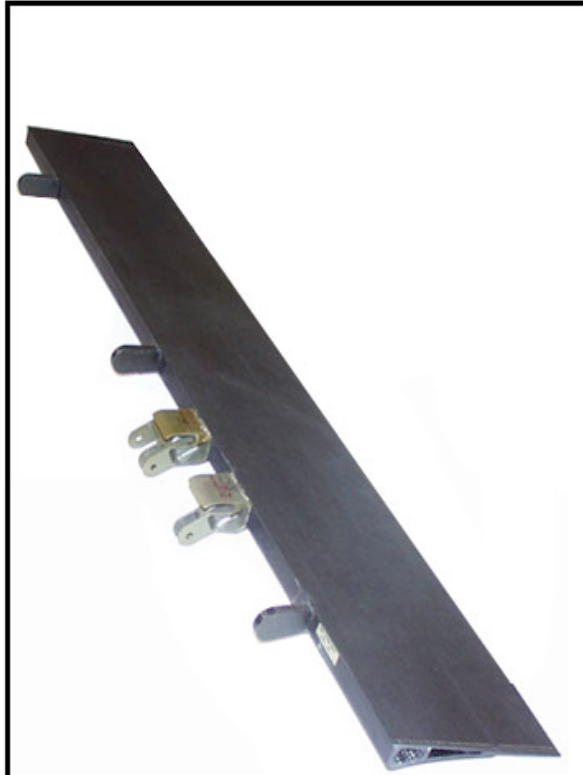


PARTS REALISED MORE AND MORE COMPLEX and SOPHISTICATED



Developments of wing
parts





Raytheon premier

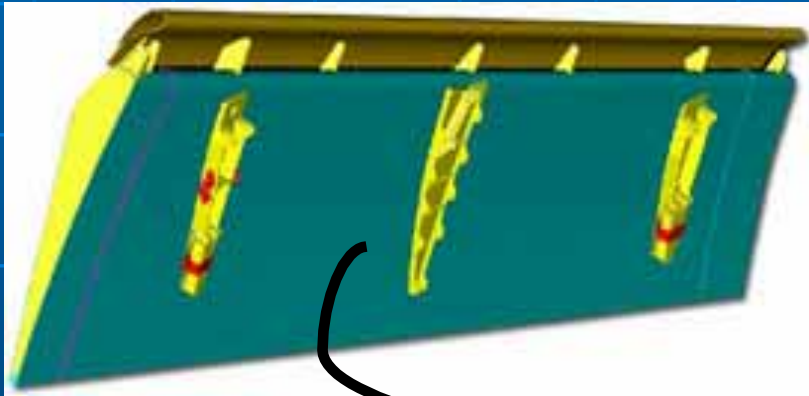
13 different parts

**Highlights include
co-cured titanium or
titanium/carbon lugs
for the spoilers**

**Integrated co-cured
counter-weights in
the ailerons.**

**1 Piece RTM inboard
and outboard flaps.**

FLAP CRJ Bombardier



High structural parts



Landing Gear parts for 787 aircraft
(AIRCELLE LE HAVRE SAFRAN GROUP)

Section fuselage TANGO 2003



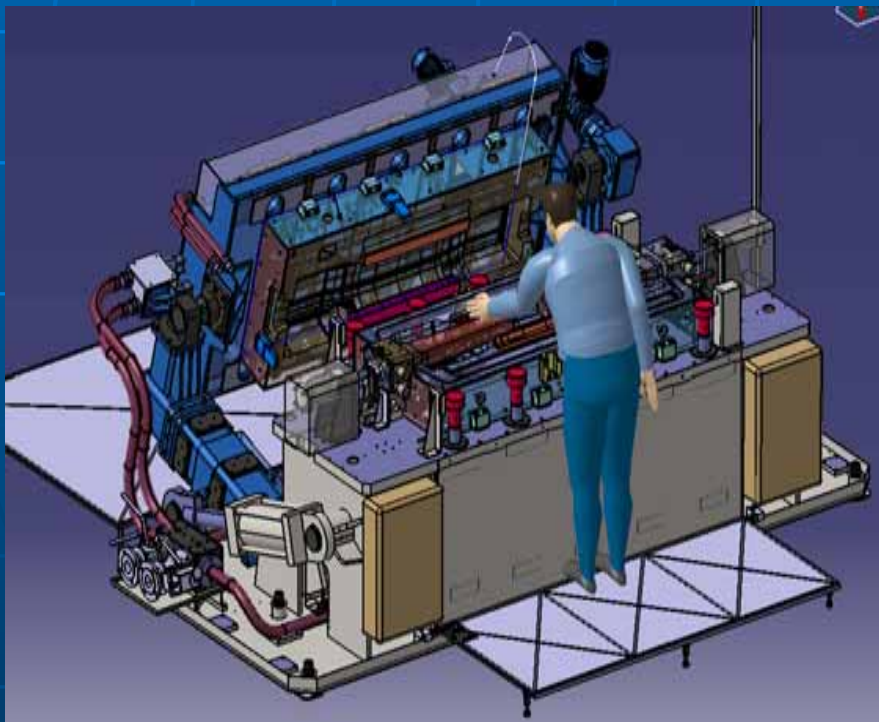
MOULDING A KEY POINT



- Falcon 7X moulding vertical stabilizer

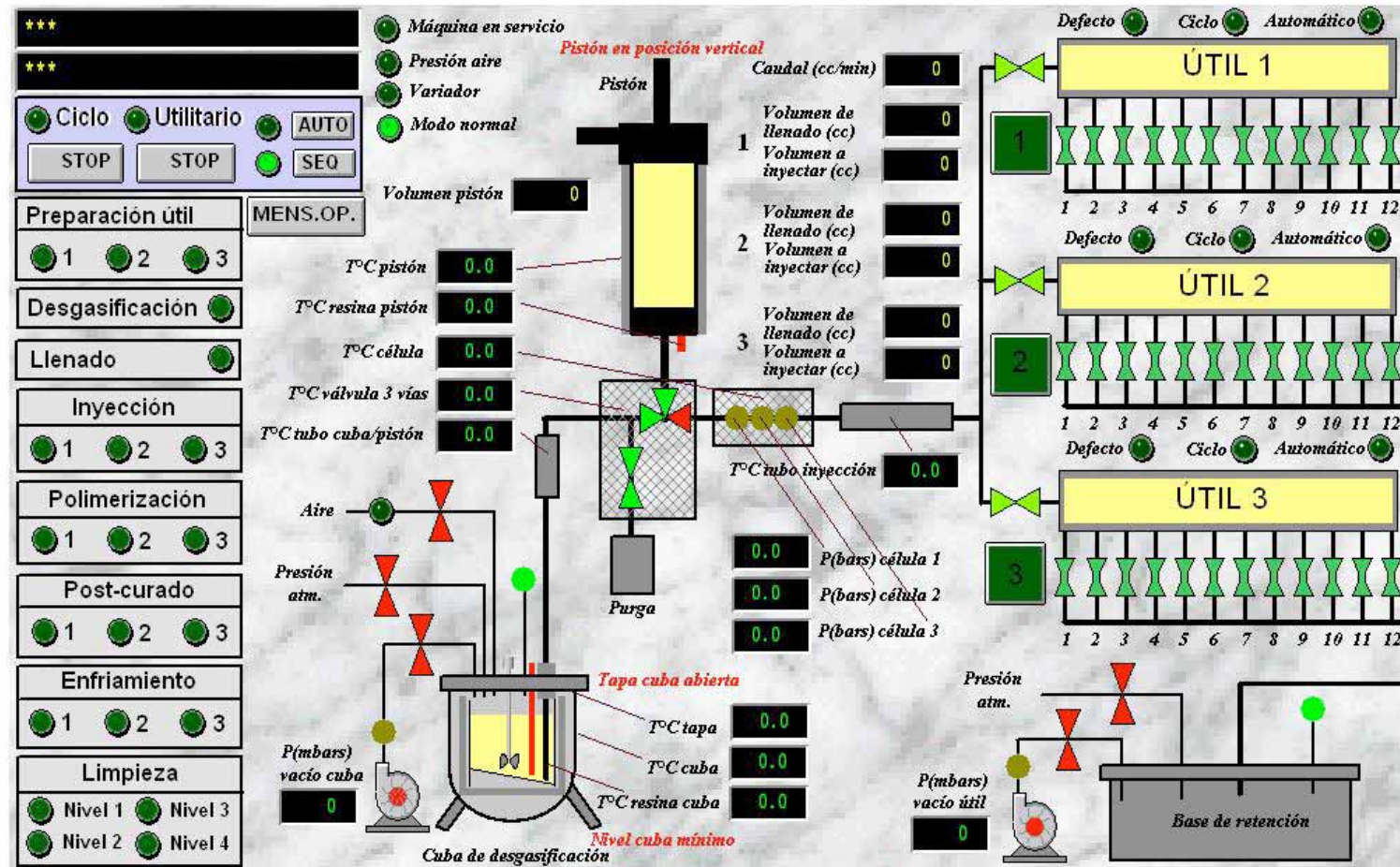
Industrialization major target

- Partner ship with key industrialization specialists



RTM PLANT developped by TECHNIMODUL ENGINEERING (France)

General management of production site



2 RESIN INFUSION

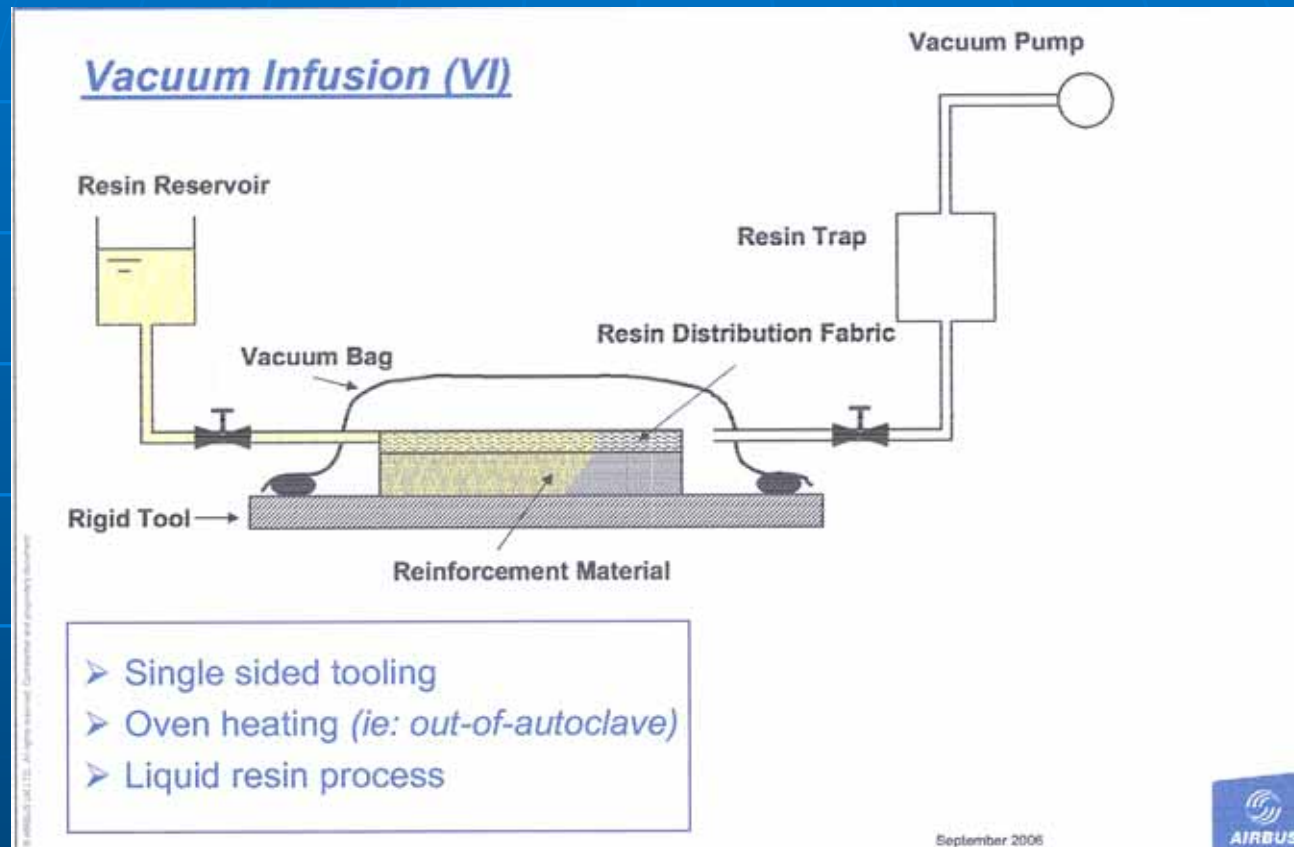
- Injection under vacuum (low pressure process)
- High quantity resin injection
- Simplified mould



WHY infusion ?

- Very low pressure injection
- Cost of mould
- Adapted to large size parts
- Less sophistication in machinery and process

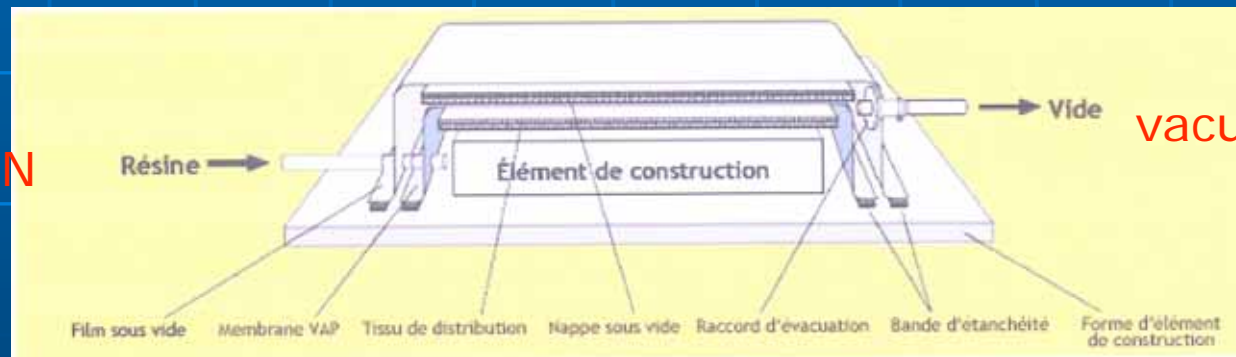
Principle Vacuum infusion



A different approach VAP process (patented eads military)

- No resin exhaust ,
volume need to be
calibrated

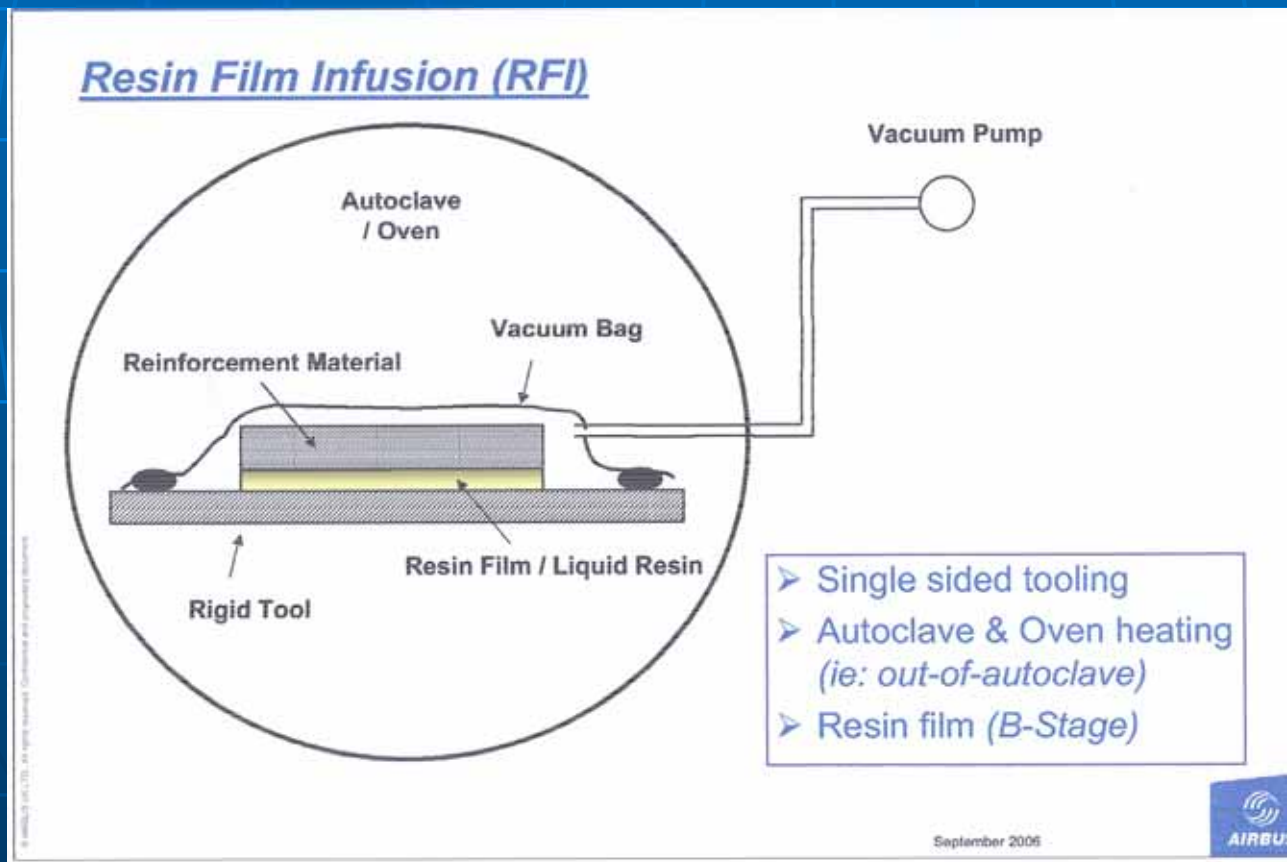
Resin IN



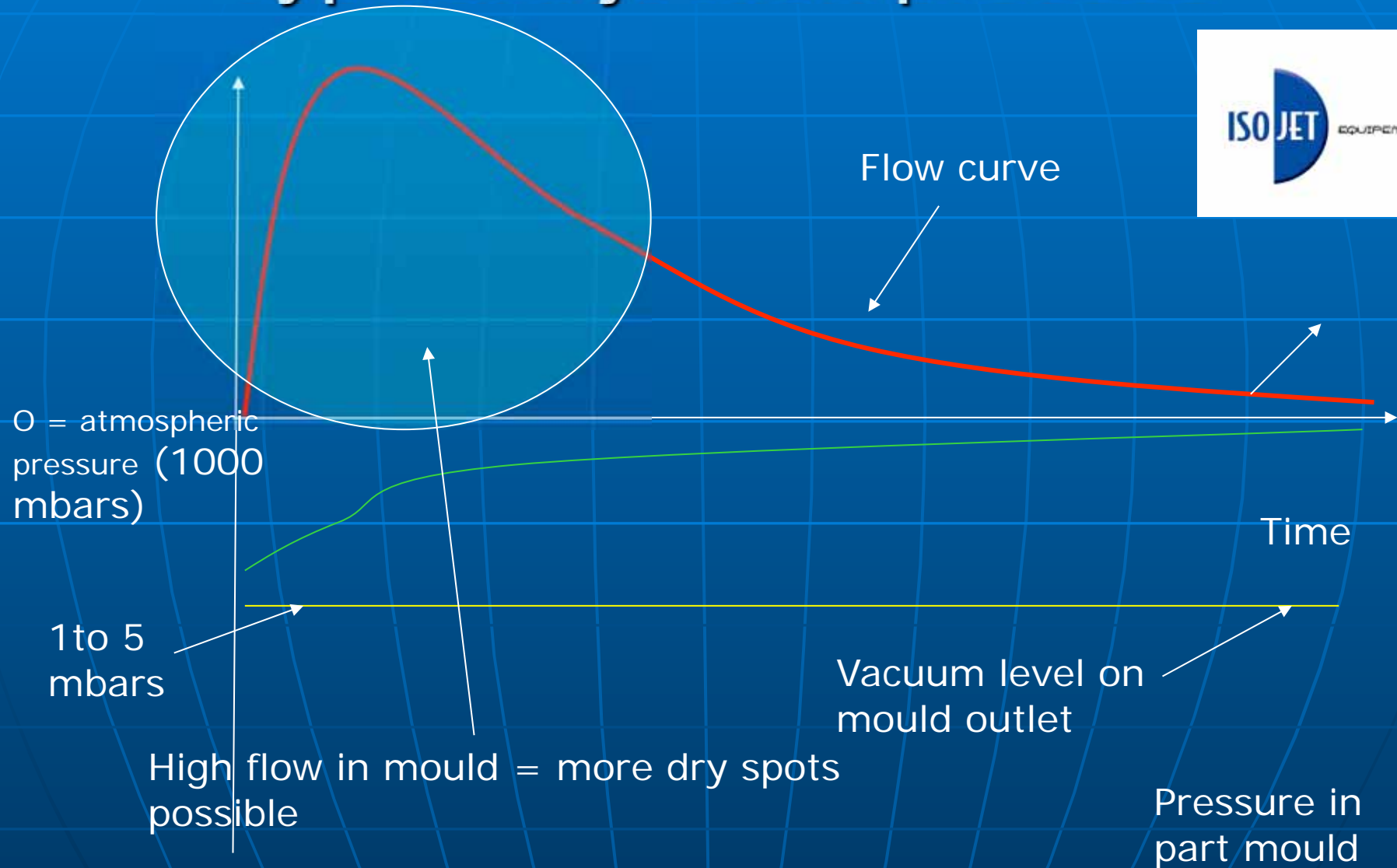
vacuum

Resin Infusion

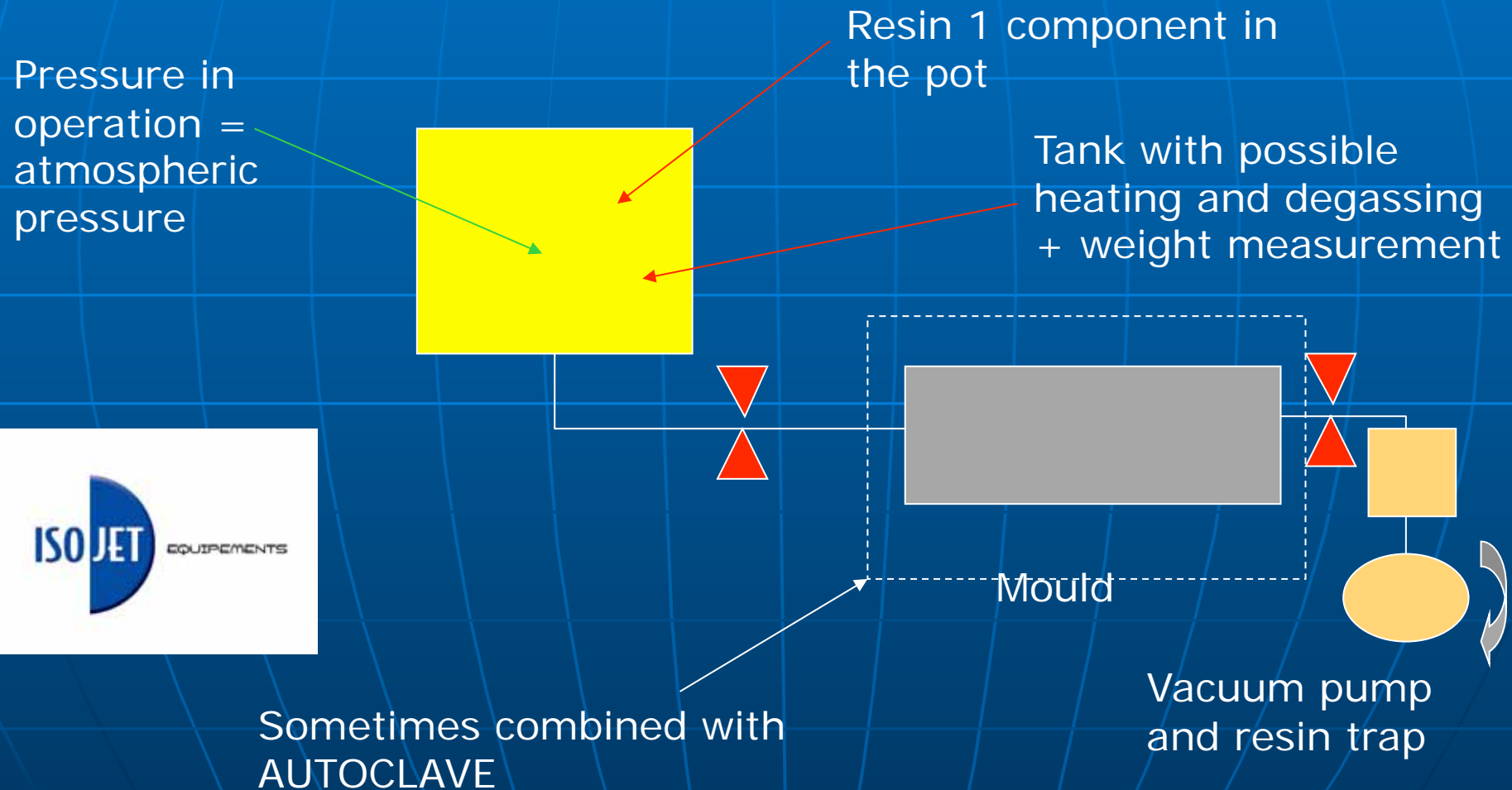
- In this approach films of resin positionned in the mould



Typical injection process



Principle infusion process



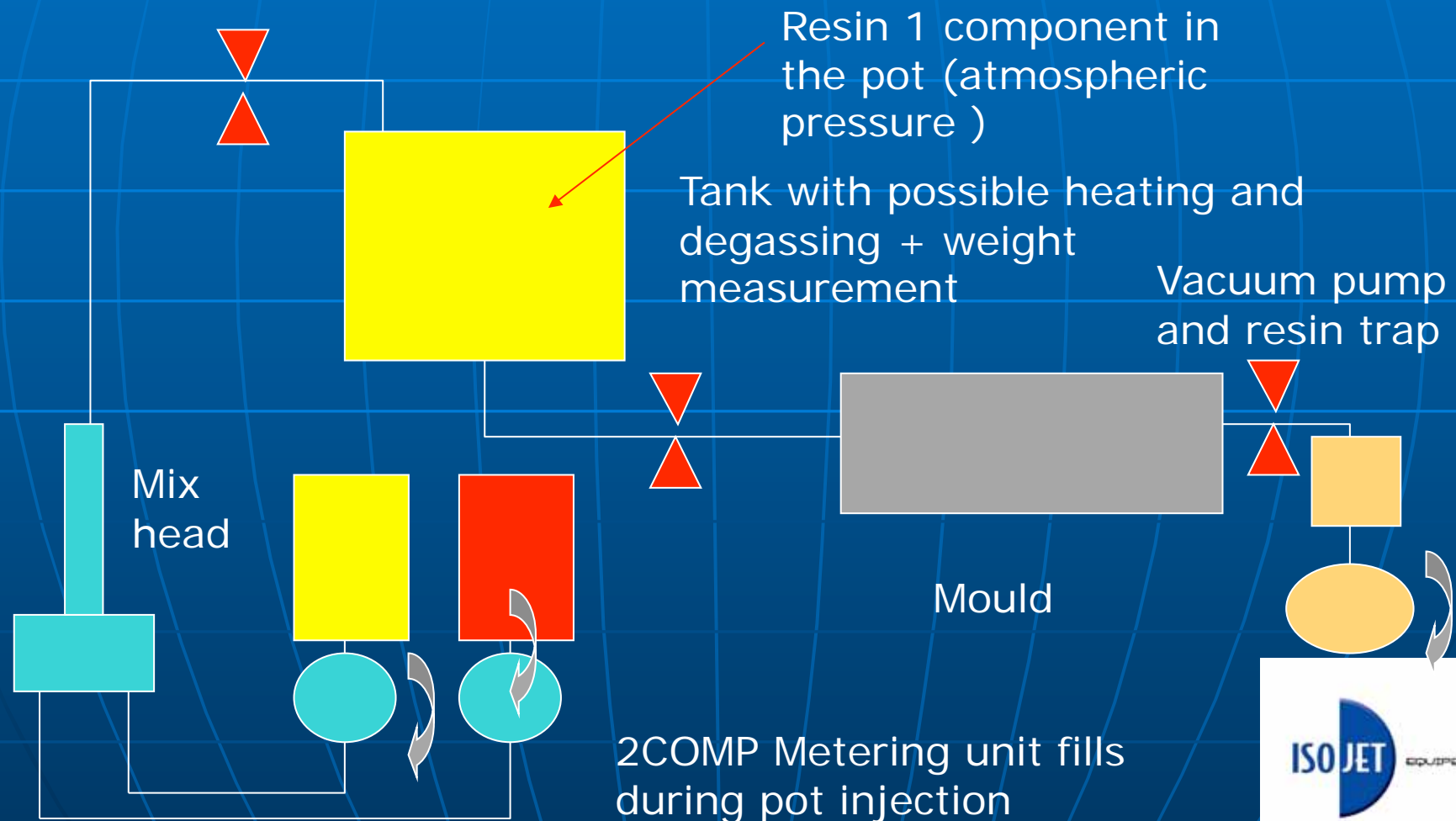
INFUSION pot machine (versatile INFUSION/RTM)

Injection POT

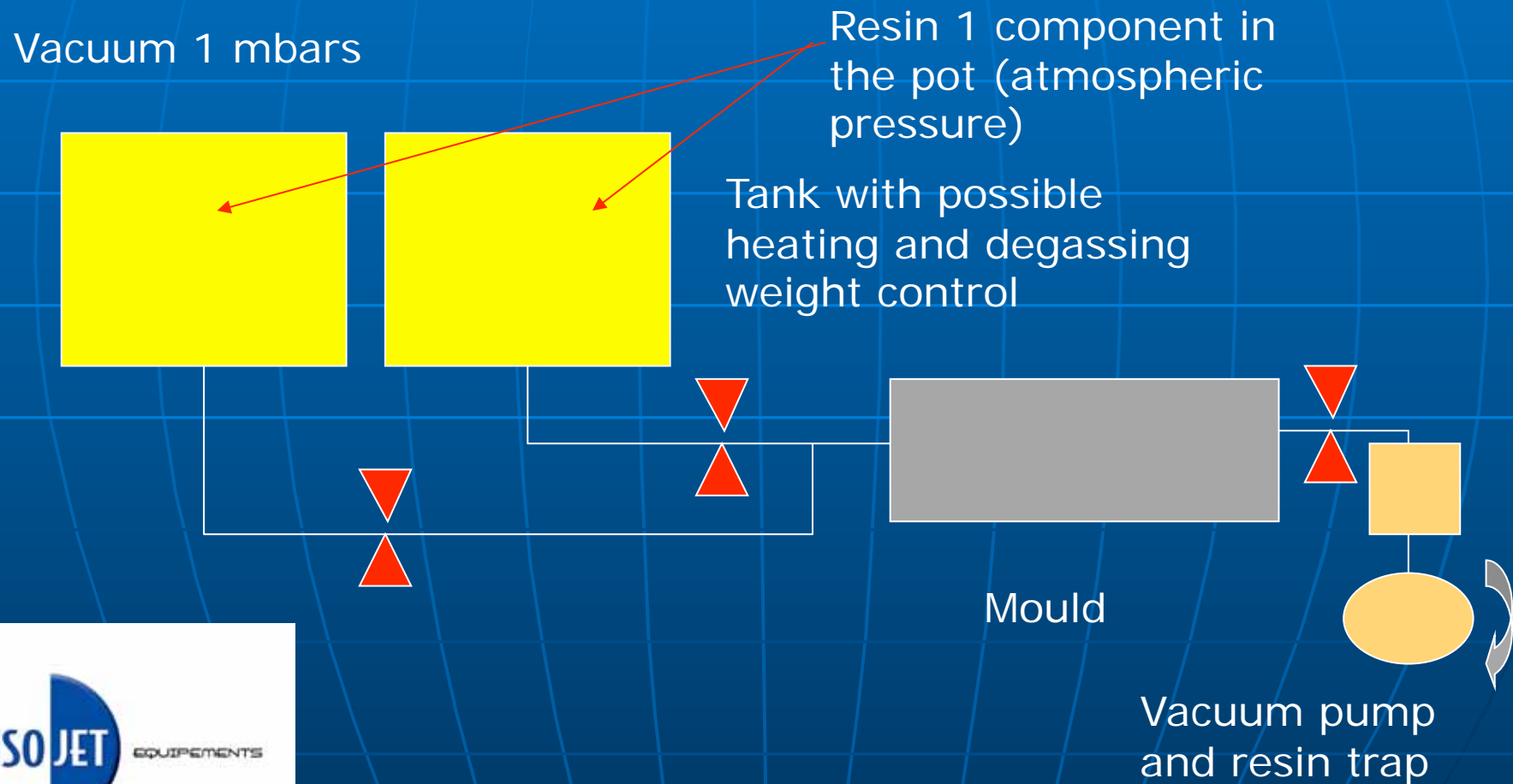
- from 1 to 75 Liters injection volume
- Vacuum up to 2 mbars
- pressure up to 10 bars
- Heating/stirring
- PC logging
- Full automation



High volume = solution injection and filling in the same time



High volume injection solution double pot



High volume infusion with Double tank

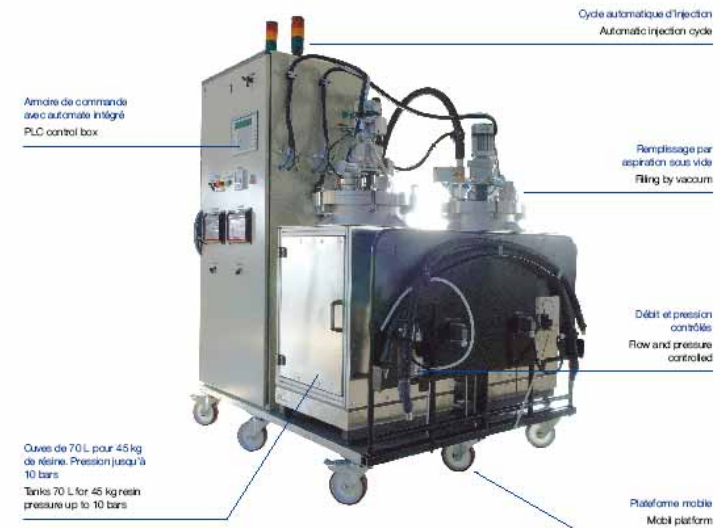
- Double 50 liters capacity tanks
- RTM or Infusion process
- Full automated
- AIRBUS nantes (8 machines)
- 2003/2006



EQUIPEMENT POUR L'APPLICATION DES RESINES DE SYNTHSE
EQUIPMENT FOR DISPENSE OF THERMOSETTING RESINS

UNITÉ INJECTION / INFUSION RTM AIRBUS

Unité d'injection de résine monocomposante. Injection RTM ou Infusion. Machine automatique pilotée par automate et/ou PC. Capacité 1 ou 2 fois 45 kg de résine. Vide maxi = 1 mbar. Pression maxi = 10 bars.
Resin monocomponent injection unit. RTM or Infusion process. Automatic unit managed by PLC with/without PC. Capacity of 1 or 2 times 45 kg of resin. Max vacuum = 1 mbar. Max pressure = 10 bars.



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Var RTM = injection with no outlet port



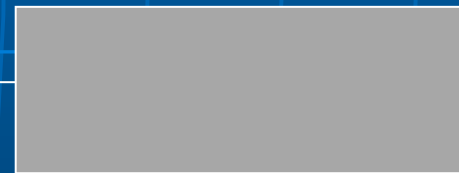
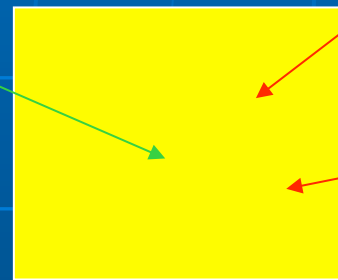
Pressure in operation = atmospheric pressure

Resin 1 component in the pot

Tank with possible heating and degassing + weight measurement

Control injection weight by weight scale or on line flow meter (need to be cleaned after injection)

Sometimes combined with AUTOCLAVE



Mould



Vacuum pump and resin trap

VAP Unit Full automated



EQUIPEMENT POUR L'APPLICATION DES RESINES DE SYNTHÈSE
EQUIPMENT FOR DISPENSE OF THERMOSETTING RESINS

UNITÉ D'INFUSION SOUS VIDE / VAR RTM INJECTION

Unité automatique d'injection de résine sous vide
technologie d'infusion de résine, VAR RTM, Injection sous assistance vide.
Vacuum assisted injection automatic unit.
VAR RTM.

Système de chargement résine
Resin filling system

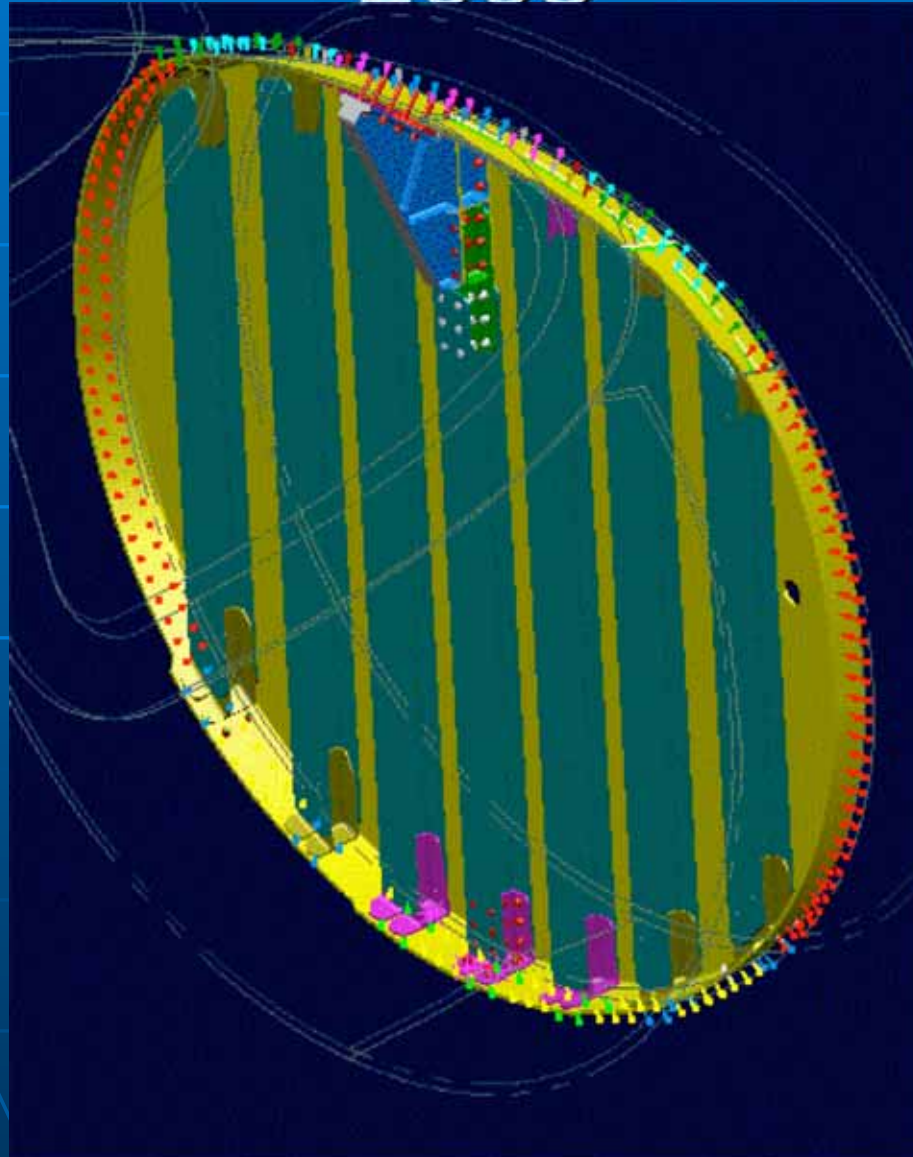
Poste de commande PC
PC controller



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Bulkhead (Fubacomp)developements 2008





- Wing Access Panels (RFI)
- Flap Track Beam Sidewalls (MVI)
- Center Wing Box (CWB)
- Fuselage
- Pressure Bulkhead (RFI)
- Vertical Tail Plane (VTP)
- C-Ribs (MVI)

High volume Infusion

- Infusion of 400 l RTM6(HEXCEL)
- One shot
- Booster demonstrator
- MAN technology
- 2004



USERS' PLATFORM Applications

New composite booster case demonstrator

At the JEC Composites Show 2004 in Paris, MAN Technologie presented a composite demonstrator of the complete forward segment of the Ariane 5 booster case, consisting of a cylinder, dome and skirt. The demonstrator was produced in cooperation with Hexcel.

In 2003, MAN Technologie AG had already presented a model of a cylinder element, manufactured as a first development step using a vacuum infusion process. This future-oriented alternative to the present steel design demonstrated that the process developed by the company in Augsburg could be applied to large-scale cylindrical structures as well, and that further innovations for Ariane 5 were feasible.

Based on this successful development, MAN Technologie AG has now manufactured a composite booster case segment demonstrator with integrated dome and skirt, using a "one-shot" vacuum infusion process. The infusion process, which is technically well known for two-dimensional parts, has been re-defined and adapted to cylindrical elements (wrapping over a mandrel)

and to closed geometries. The infusion technique is combined with dry fabrics wrapped with the designed fibre orientation with-out resin. The segment model is 3.3m in length (full-size diameter approximately 3m) and weighs about 1,200kg (while the current steel design weighs approximately 3,000kg). Wall thickness varies from 9mm (transition to dome) to 20mm (cylinder), up to 38mm at the intersegment joint zone.

Integration of dome and skirt

The new design includes a closed cylindrical structure with axial and hoop layers, and a three-dimensional curved dome and the related skirt. The polar opening (for the booster igniter with a diameter of 60cm) was designed using cross layers of continuous fibre bands placed at specific angles.



Demonstrator of a CFRP booster case segment for Ariane 5 - CFRP structure in dry fabric / resin infusion process technique.

After the combined cross lay-up of cylinder and dome, the skirt was integrated in a second step that involves applying an additional tool from the dome side to attach the already applied fibres and serve as mandrel for the skirt. Then, the axial and hoop layers for cylinder and skirt are wrapped together, according to the strength and stiffness analysis. In this way, all elements are integrated into a single preform. The completed preform is infused with resin under vacuum in one step and subsequently cured in an industrial furnace at ambient pressure.



Demonstrator of a CFRP Booster Case Segment for ARIANE 5 - Model at the MAN stand at JEC Composites Show, Paris 2004.



Demonstrator of a CFRP booster case segment for Ariane 5 - Fibre lay-up of cross layers for cylinder and dome.

VAP injection/infusion

- Full automated machine
- Large volume injection (up to 100 kg for RTM6)
- Data recording

NEWS WORLDWIDE - PROCESS

EADS Military Aircraft introduces convincing new concepts in CFRP design

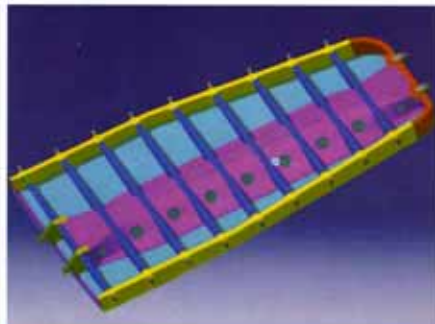
Eurofighter, Airbus A400M, A380 and A350 – never have so many new European aircraft programmes been launched in immediate succession. These programmes also represent pioneering developments in design and production. Not only is EADS Military Aircraft a major partner in all these programmes, it significantly shapes them with new design concepts.

EADS Military Aircraft's Augsburg plant, the largest external supplier to Airbus, has demonstrated its ability once again, especially within the new A380 programme.

The wing components, the inward inner fixed leading edge, and all the flap tracks have been designed as hybrid structures. This means a material mix of carbon-fibre, titanium and aluminium for highest stiffness at lowest weight.



The patented VAP process is perfectly suited to the rapid, cost-efficient production of carbon-fibre large components. VAP is already the standard used in Augsburg to produce parts for the A380 flap tracks, and will be for the A400M cargo door. The picture shows a concept study for a single-aisle aircraft bulkhead using the VAP process at the Augsburg CFRP-competence centre.



With the carbon-fibre layout of the A400M cargo door, EADS Military Aircraft is getting involved in the pressurised area of the structure for the first time. Even the transverse frames and the torsion box are being designed in CFRP produced with the VAP process. The picture shows the design of the CFRP cargo door.

The engineers are working now to simplify the flap-track design, with their sights set on further weight optimisation and faster manufacturing for series production ramp-up.

The upper shell for the Eurofighter was also developed by EADS Military Aircraft and produced in Augsburg for all eight prototypes. The airbrake for the single-seater version is currently assembled in Augsburg in a carbon-fibre/titanium mix.

The success of the carbon-fibre design is largely due to the change over to the Vacuum Assisted Process (VAP), a patented technique developed in-house. VAP eliminates the need for autoclaves, which are costly and difficult to handle.

The new technology is perfectly suited to the rapid, cost-efficient production of particularly large components. With the carbon-fibre layout of the A400M cargo door, EADS Military Aircraft is getting involved in the pressurised area of the structure for the first time. Even the transverse frames and the torsion box are being designed in CFRP produced with the VAP process.

For the A350, launched at the end of 2004, Augsburg is likewise positioning itself as a partner for pioneering design and production concepts using all materials. Negotiations are currently on with Airbus for possible workshare.

Cargo door A400 M



Wind blades



Lot of cases in
infusion up to 2000
KG injected resin



CONCLUSIONS

- High rate of developement in liquid moulding
- More and more large and sophisticated parts
- More and more sophisticated processes

Sources

- Dassault aviation presentation Sampe France Nov 2005
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