

# COMPOSITES

## DESIGN, CERTIFICATION and MANUFACTURING

Some Practical Industry Perspectives

CAA-NZ Composites workshop 2-3 March 2016

# MEMKO – Skills and Capabilities

Doug McPherson (Engineering Manager – MEMKO)

Sal Carta (Consulting Engineer and Project Manager)

Combined project experience, Design, Manufacturing and Project Management, includes

- MDX - fuselage
- C130 - flaps
- Airbus A330, A340 - MLG Doors
- ESSM - Fins
- Sonic Cruiser – Canard
- B747 – LE Slats
- B777 – Rudder and Elevator
- B787 – Moveable trailing edges
- JSF – F35 – various structural parts

# MEMKO Business Streams



## Engineering

- ✓ Design, Analysis, Test and Certification
- ✓ Fleet Technical Management
- ✓ Aircraft Weight and Balance
  - ✓ Part 21.M Engineering
  - ✓ AOG Support

MEMKO is a design organisation with an accredited AS9100/ ISO 9001 Quality Management System. A holder of CASA Part21.M approval for repairs and modifications and transitioning to CASR Subpart21J Approved Design Organisation



## Technology

- ✓ Software Product
- ✓ Services



## Training

- ✓ Aviation & Aerospace
- ✓ Product Life Cycle Management (PLM)

MEMKO Pty Ltd is a service provider specialising in Aviation, Aerospace and Defence with comprehensive design engineering and technical services focused on initial & continued airworthiness support of fixed wing and rotary aircraft



## Industry Experiences

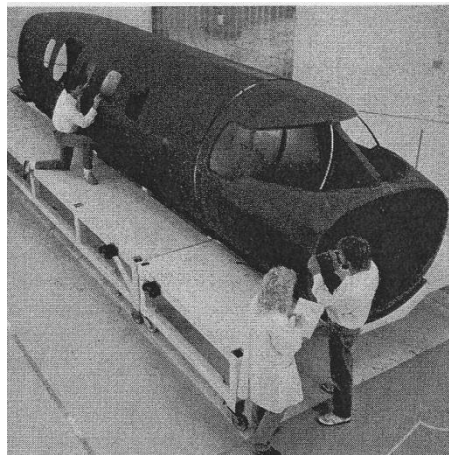
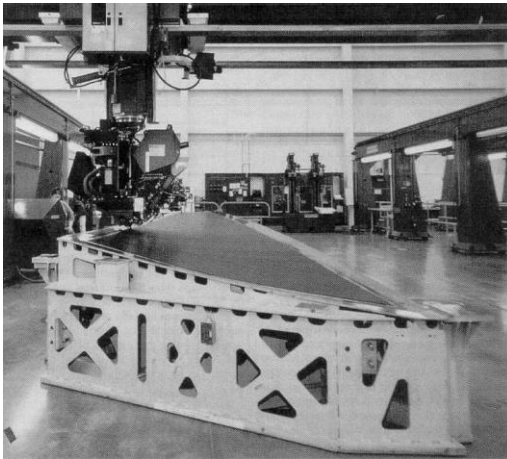
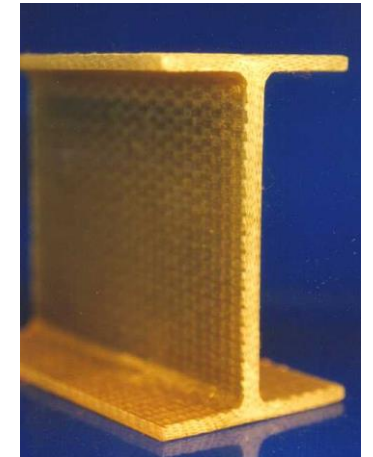
- ✓ Aerospace & Defence
- ✓ Architecture, Engineering & Construction
- ✓ Automotive & Transportation
- ✓ Consumer Goods & Packaging
- ✓ Energy, Processes & Utilities
- ✓ Financial & Business Services
- ✓ High Tech/Electronics
- ✓ Industrial Equipment
  - ✓ Life Science
  - ✓ Ship Building

# Composite Technologies & Developments

Labour Cost Savings – decrease manual processes and setup times



Material Cost Savings – Liquid moulding. Ply cut nesting. CMH-17 materials



# Quickstep

**Australia's Largest Independent Carbon Composites Company – Aerospace & Auto**

Leading research and development in:

- manufacturing automation with composites materials and resin systems
- out of autoclave manufacturing solutions

Headquarters and factory located at Bankstown Airport, NSW, Australia

Subsidiaries in Germany and USA

Employs 170 people worldwide

MEMKO - engineering technology solution provider to Quickstep



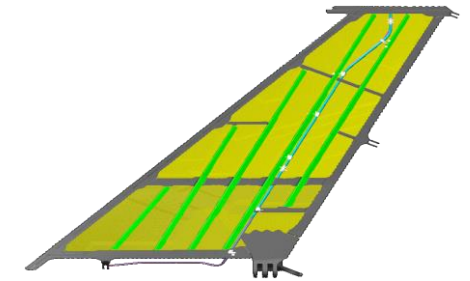
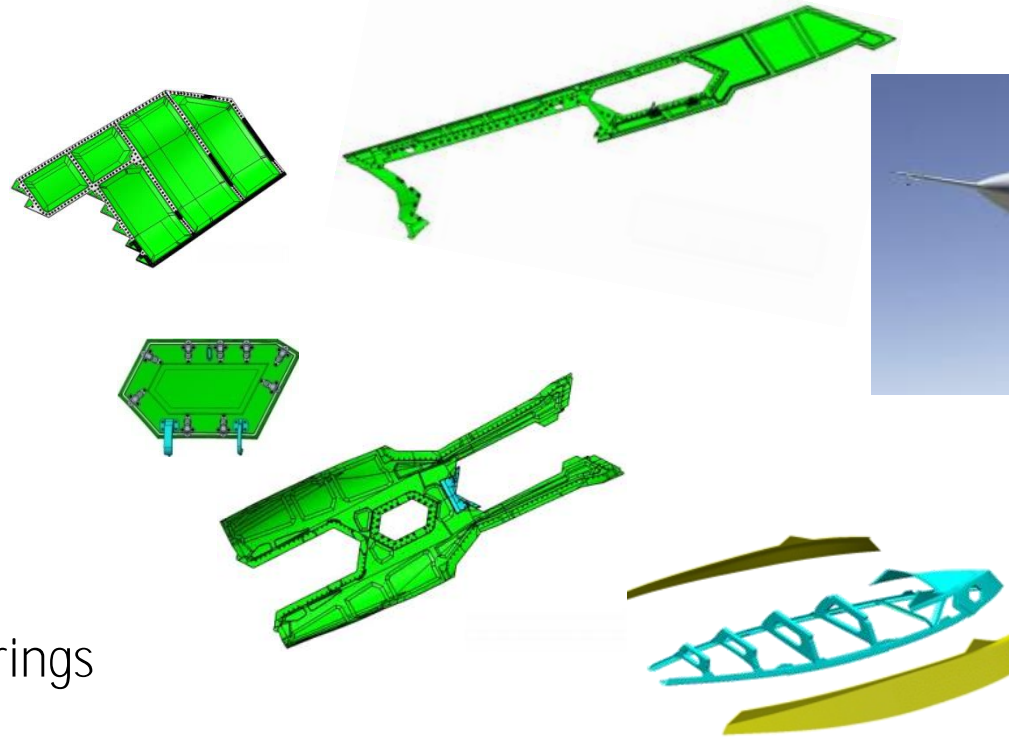
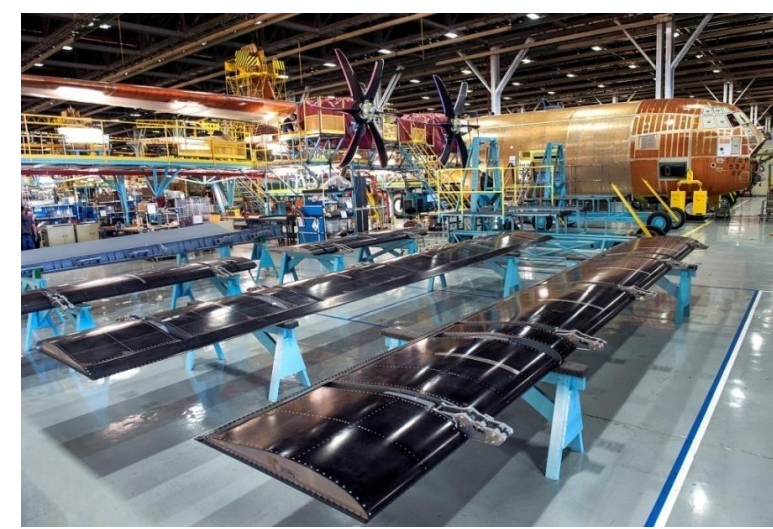
THALES



# Quickstep

Major aviation composite manufacturing projects

- F-35 Lightning II JSF – Structural components
- C-130J ‘Super Hercules’ - Flaps
- Through Northrop Grumman and BAeSystems & Marand Precision Engineering:
  - BMI and epoxy resins
  - Doors & panels
  - Lower side skins
  - Maintenance access panels
  - Fuel tank cover
  - Lower skins
  - Vertical Tail Composite & Fairings



# SOME OF THE QUESTIONS AND CHALLENGES WE HAVE BEEN ASKED TO HELP WITH

# PRACTICALITIES FOR DESIGN and CERTIFICATION

- Concurrent Engineering – The composite design will be inefficient if composite manufacture is not involved – produceability is paramount
- Understand the certification basis and engage with the regulator at the beginning
- Understand the design drivers – cost, weight, durability, shapes, strategic etc
- Qualification of new materials and processes is very expensive and not for the faint hearted or those without a sympathetic bank manager
- Aircraft design and certification is by nature and necessity very, very conservative
- **Don't let Human factors, OH&S and environmental considerations become an afterthought**
- Composite design requires effective pre-learning and design management. It is not the same as metal design.



# PRACTICALITIES FOR DESIGN and CERTIFICATION

- CMH-17 - enables proven materials and processes to decrease the certifications costs
- New technology processes require extensive statistical test program and certification via full **“building block approach”**
- Composite Technologies emanating from industries such as maritime and automotive require full certification and qualification in aviation industry.
- The scale of composite technology/construction affordability:
  1. High performance defence aircraft
  2. Lower operating cost RPT airliners and business jets
  3. Higher performance airwork aircraft
  4. General Aviation Aircraft
  5. Light Sports Aircraft (LSA)
  6. Recreational and amateur built aviation

# PRACTICALITIES FOR MANUFACTURING AND PRODUCTIONISATION

Design:

- Is it late?
- Is it incomplete?

The delivery schedule will not change!

Do we start manufacturing at risk?

- How can we do this?
- What authorisation do we need and who from?

What CAD data do you need to define the design of a composite part for manufacturing?

How do you read design data and how do you extract manufacturing information from it?

How do I define the scope of work to make this part?

What are the overall skills and capabilities required to make the part?

How do I estimate my labour costs – number of hours to make and number of people?

What type of tooling do I need to make the part – GD&T, layup, in or out of autoclave, trim, inspect, assembly, how much?

What facilities do I require, size, environment control, accreditation?

# PRACTICALITIES FOR MANUFACTURING AND PRODUCTIONISATION

How do you leverage from research results to generate manufacturing information?

What is a pre-production verification cycle?

What is a material specification?

What is a process specification?

Do I need to be a qualified supplier and to what standard?

What are test coupons?

- Why do I need them?
- How do I make them?
- How do I test them?

How do I make the part?

- What is the build / manufacturing standard?
- What is a manufacturing instruction (work order / traveller), how do I prepare one and what information does it need in it?
- What tools and fixtures do I need for details and assemblies?
- What is the most appropriate tooling management plan?

# PRACTICALITIES FOR MANUFACTURING AND PRODUCTIONISATION

Inspection of composite parts?

- Where and how do I capture QA verification activities?
- Inspect for form, fit and function and?
- NDT – which method and why?

Effective data control and management method?

- What type of data do I need to control?
- In what format is the data available?
- What is configuration control, why do I need it and how do I achieve it?

What is the most effective factory floor layout?

- How do I perform a value stream analysis?

What is the most appropriate freight and shipping solution?

What are the continued airworthiness requirements?

Do I need an ERP system for overall control?

# PRACTICALITIES FOR DESIGN, CERTIFICATION, MANUFACTURING AND PRODUCTIONISATION

## The challenge

- Reduce costs
- Reduce cycle times
- Meet all requirements
  - Design functionality
  - Design certification
  - Manufacturability
  - Return on investment

# PRACTICALITIES FOR DESIGN, CERTIFICATION, MANUFACTURING AND PRODUCTIONISATION

Composites may not be the best technical solution and can be more expensive than the comparable metallic part

- Design
- Test
- Materials
- Processes
- Equipment
- Time
- Tooling
- Facilities
- QA
- Certification

Some interesting developments offer potential solutions:

- Out of autoclave cures
- Resin Spray Transfer
- Automation and high production rates

# Quickstep's Resin Spray Transfer – RST - Concept

Patented technology developed to deliver on:

- Design and manufacturing compliance.
- Reduced cycle times, quality of finish and low cost.

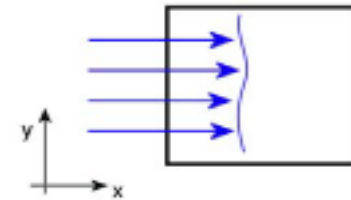
Resin is applied on the working surfaces by a spray unit incorporated into a computer controlled robotic arm.

The resin system and spray rates are selected to be compatible with the design specifications and manufacturing requirements:

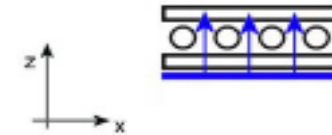
1. “Dry” Fabric or tape
2. Core, foam
3. Layup stack sequence and ply characteristics
4. Tool design
5. Overall fabrication cycle time

Resin is infused under vacuum

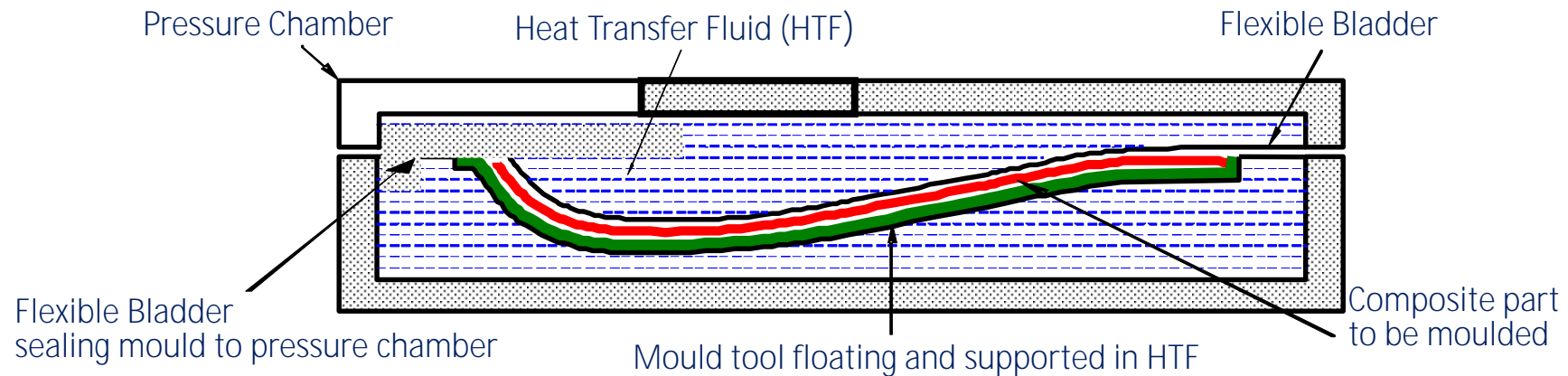
<https://www.youtube.com/watch?v=zseV4XuTgxY&feature=youtu.be>



Reduced resin permeation required  
Through thickness only



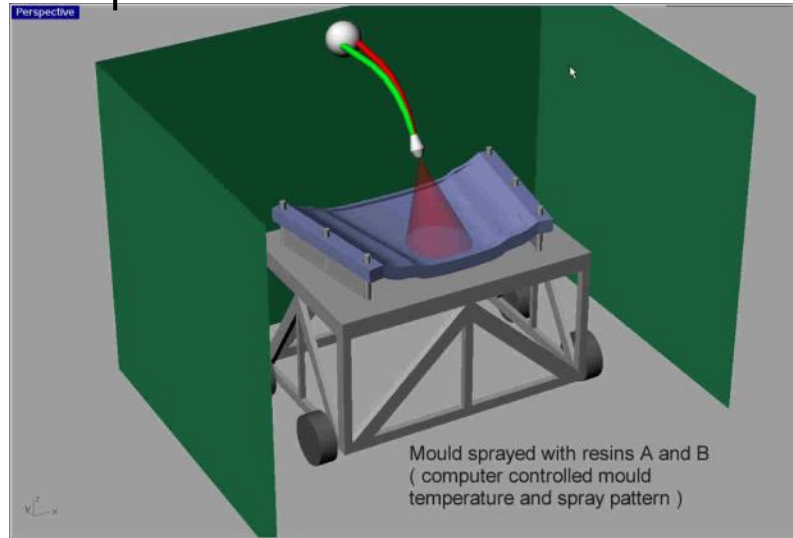
# Quickstep's Flexible bladder and Fluid Heating System



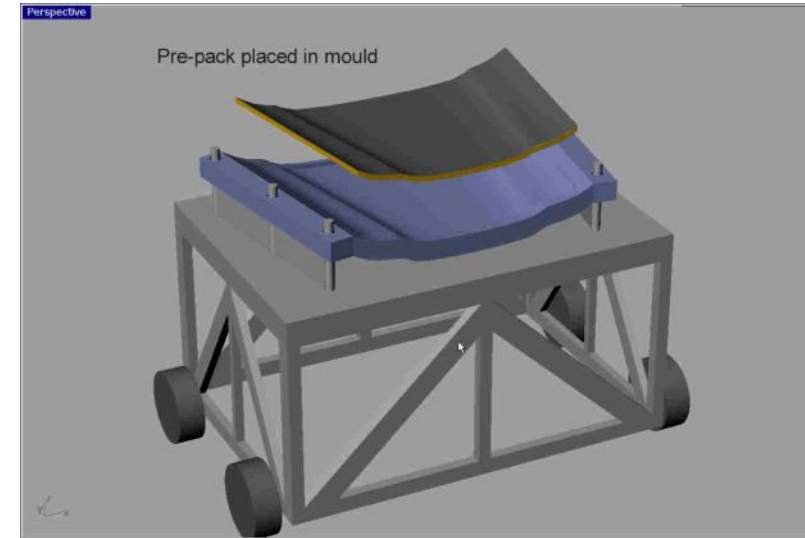
- Rapidly applying heat to the laminate, placed between a rigid or semi rigid mould. (Heating and cooling rates can be customised across the cure cycle to optimise material properties)
- Mould and laminate are separated from the circulation HTF by a flexible membrane
- Use of balanced pressure and vacuum on the laminate to cure the part
- Economical construction due to low pressure in both chambers (up to 0.8 bar)
- Faster than competition (1/2 time) cheaper investment (1/2), cheaper tooling (1/3), better technical characteristics



# RST and Flexible bladder and Fluid Heating System Production System - Concept



1. Spray



2. Add Preform



3. Cure

# RST and Flexible bladder and Fluid Heating System Production System - Benefits

Adaptable and flexible to suit various material solutions and component design configurations.

1. Potential choice of fiber and resins available to designers and manufacturers increases significantly.
2. Bespoke design for manufacturing solutions
3. Overall material costs reduced when pre-pregs are eliminated

Compatible with standard automation techniques and technologies.

1. Reduced equipment startup costs, e.g:- elimination of autoclaves
2. Reduced facility running costs, lower overall power consumption
3. Reduced touch labour hours

Developments to date, including a fully functional development cell, have demonstrated:

1. Repeatability of process and part quality
2. Significant reductions in manufacturing cycle times and potential for increased production rates

# COMPOSITES

## DESIGN, CERTIFICATION and MANUFACTURING

Some Practical Industry Perspectives

# THANK YOU

Doug McPherson (+61 427 117 205)

Sal Carta (+64 212 686 960)