coexpair™
Composites Expertise for Aircraft

Molds & Equipment

Software & Services

In Partnership with

Radius Engineering, Inc.

Table of Content

COEXPAIR SERVICES AND PRODUCTS

Coexpair - Composites Expertise for Aircraft – leads the market of RTM & SQRTM equipment and technologies in partnership with Radius Engineering, USA. Coexpair combines equipment development and fabrication with engineering of composite parts. Our shop is the right location for equipment demonstration, training and first part production (no serial production).

Gathering a high level of aeronautics background and focusing our expertise on Out of Autoclave Net Shape Process (RTM, SQRTM, IPM), we offer a unique solution for the development of advanced composites for engine & airframe components. We transfer technologies to our customers so they enter smoothly and quicker in serial production.

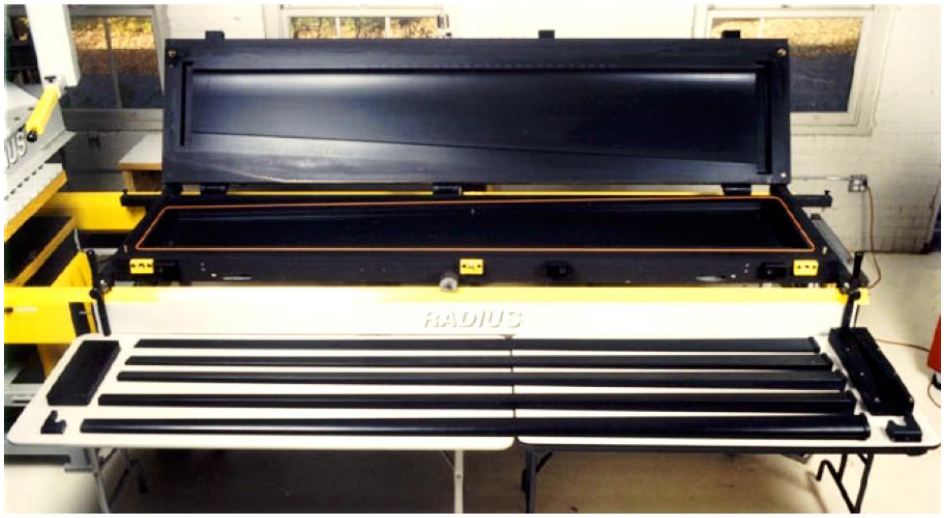
- **Engineering** Services - Design, Analysis, M&P
- **Process** Set-up to First Part Qualification
- **Mold** Design & Fabrication
- **Equipment** Injection Systems, presses,
- **Trainings** : 3 days introduction to RTM or SQRTM

RTM & SQRTM MOLDS

Design *(130+ Mold designed at Coexpair)*

The ambition of RTM mold design phase is to define molds that can produce a large number of parts, with a minimal production cycles and a low scrap rate. More than 30 years ago, Radius Engineering defined the design principles and criteria that make its molds as the reference on the market. The main advantages of the RTM molds we propose are described here after:

- Full impregnation is reached with only one inlet & outlet. This right level of impregnation is directly obtained without making a lot of injections (cost and time savings in comparison with other mold suppliers)
- High dimensional tolerance with a standard minimum of +/- 0.15mm on part thickness to ensure the right fiber volume fraction (vf) everywhere in the part. Better tolerance is possible as needed ;
- State-of-the-art accessories to ensure high production rates (i.e. injection ports, provision for thermocouple, pressure and vacuum sensors, seals, de-molding features, hoisting point, thermal isolation)
- De-molding operation and related accessories optimized to avoid any damage to the tool or to the molded part
- Easy cleaning with no sharp radius, no resin trapped area, specific injection ports and polished surfaces
- Low scrap rate achievable when used in combination with Radius systems (injection and presses). Scrap rates of less than 1% is state of the art
- Project management by experienced team to design quality, give visibility to the customer (schedule, milestones, risk assessment) and the right follow-up of design and production. Delivery of high quality mold on schedule is our mission




EN9100 qualified design process


Part design for fabrication


Resin flow optimization


Thermal simulation


Moulding and demoulding simulation

Regarding **SQRTM, the mold design is more complex** than for RTM. For RTM, only about 60% of the composite material is present in the tool before injection (the fiber). But for SQRTM, more than 100% of the material of the part is present into the tool before closure (pre-preg material features a little bit of resin in excess). The tool closure kinematics and usage of a floating bed pneumatic press has to be fully understood in the tool design.

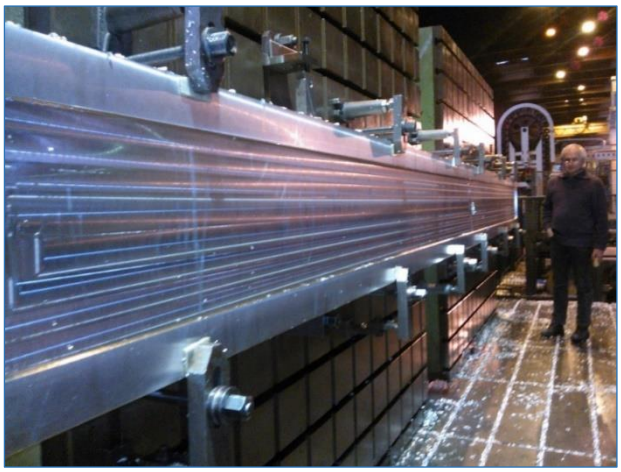
One other key point is the resin runner sizing to allow filling of the mold on time. Also the sizing of the resin gates that will be used to pressurize the part is relevant. Kinematics, runners, gates and other parameters are always specific to a part geometry and size. These parameters cannot be easily extrapolated from one design to another.

Material

The molds we propose are manufactured out of steel or of a specific aluminum alloy selected for its mechanical performances up to 180°C (350°F) and for its capacity to sustain heating and cooling cycle without deformation. The selection of aluminum and the pre-machining operations we perform are the basis of the quality of large aluminum tools.

Qualified Machine shops (6)

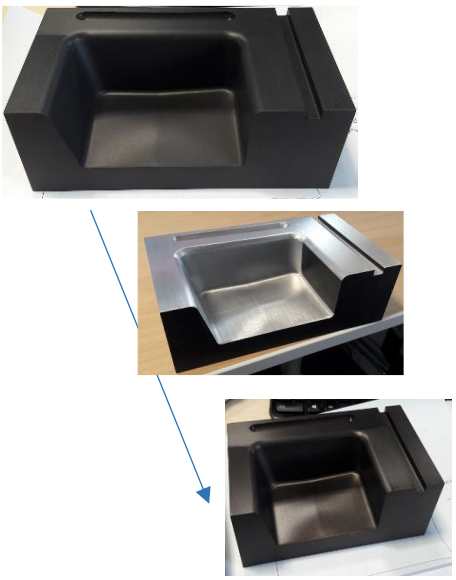
The accurate machining is performed in partner shops we have selected and qualified to take part to the production of our molds. Working with partners ensure a good understanding of requirements between designers and operators, what is mandatory to produce unique parts like mold elements. This allows us also to provide quality assurance and for example three different measuring methods are used during the mold production stages.

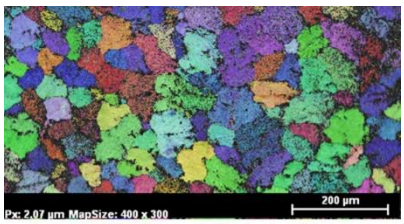


Finishing & Surface Treatment

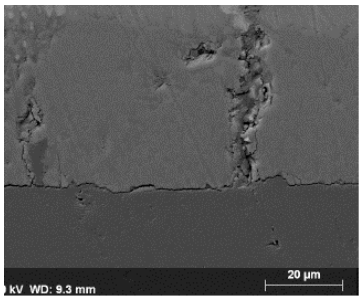
Our mold elements are carefully adjusted so each element fits in its location for the whole life of the tool. This operation requires skilled operators who measure, compare and manually adjust the elements. Once all the mold elements fits perfectly together they are hand polished before surface treatment is applied. In case of Aluminum, hard anodizing gives to the mold element a scratch resistance equivalent to steel.

Maintenance and Repair





Analyse EBSD – Microscopie électronique à balayage



Our services includes maintenance and repair of our aluminum high-rate molds This includes edge notch repairs, surface damage repairs and full surface restoration. Advanced surface analysis for quality assurance.

Packaging – Turnkey

Our molds are carefully packaged to avoid any damage during transportation or unpacking at customer premises. The delivery includes the user manual with maintenance recommendation and all accessories needed to operate to tool immediately (seals, o-ring, screws, injection blocks, fittings, etc).

WORKSTATIONS – PRESSES

SERIES OVERVIEW

The advantages of our Press come from 30 years of composite processing experience and equipment knowledge:

- Accurate Control of Heating and Pressure Parameters
- Reliability with Extremely Low Rate of Rejects Parts
- Fully Operational in Industrial Production Environment
- Compact Equipment
- Very Low Maintenance Cost. No Oil in Composite Shop
- Worldwide High Quality Support
- Accurate control of vacuum (0-27 mbar)
- Water Cooling systems on request
- No foundation needed, whatever the size.

7 Coexpair workstations are operating in 3 shifts at Spirit Aerosystems at exceptional availability rate and minimal maintenance cost.

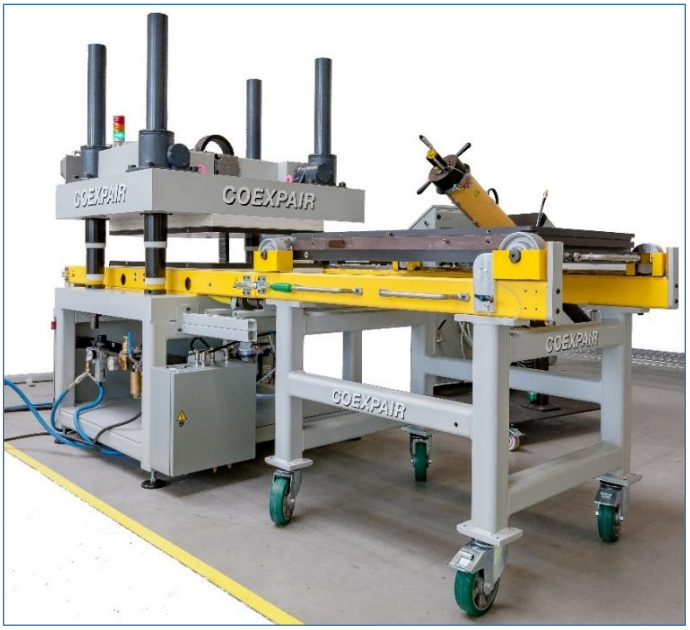
BASIC PRESS 70 or 110 Tons

- Typically used for flat panel or small part production
- The clamping area is 1000mm x 650mm. Available Clamping force from 70 to 110 metric tons
- Threaded rod construction to quickly adjust the daylight between platens from 25mm to 400mm
- Insulation to reduce heat transfer into the bolsters
- 28 kW heating capacity. Maximum temperature is 200°C (390°F). Capacity sized to heat a 150mm thick aluminum tool @ 3°C/min
- Heating platens are flat and parallel to < 0,15mm. The maximum bolster deflection is <0,15mm (10 bars)
- Rotary vane vacuum pump with trap, valves and a 0-26 mbar (20 torr) vacuum transducer
- Tool loading / unloading station that includes an external 1,25m rail system
- Siemens S7-1515 PLC with Profinet communication to data acquisition computer
- Siemens 12” color touchscreen with trending
- 12 Tool thermocouple inputs (Type J)
- 15 step, ramp/soak heating profile
- Controller with recipe storage and recall from PC hard drive

- SCADA Software Package with **integrated control and data acquisition for Injection Systems**
- Electric Utility: 400 VAC, 3 phases, 50 Hz, 50 Amps
- Pneumatic Utility: 15 bar, clean, dry air
- The clamping station lies on 4 adjustable feets. Its installation could be done on any standard industrial floor (no need of construction work).

ELECTRIC DAY-LIGHT ADJUSTMENT

- Typically used for flat panel or small part production, the electric daylight adjustment is perfectly adequate for production with variable tool thicknesses.



PRESS 195 Tons with WATER COOLING System

- Typically used for production where compacity and short cycle time is needed
- 72 kW heating capacity. Maximum temperature is 220°C (428 °F).
- The clamping area is 1,5m x 0,65m.
- Manual Tool loading / unloading station that includes an external 1,75m rail system
- Included : recipes, Tool TC monitoring, Floware™ and data collection.
- Automation available : Master™ synchronized injection and Maestro™ SCADA system
- Rotary vane vacuum pump with trap, valves and a 0-26 mbar (20 torr) vacuum transducer
- Siemens 12” color touchscreen with trending
- 16 Tool thermocouple inputs (Type J)

PRESS 240 Tons with AUTOMATED TROLLEY

- Typically used for production in highly automated workshops.
- Welded upper steel bolster construction.
- 128 kW heating capacity. Maximum temperature is 200°C (390 °F).
- The clamping area is 2,4m x 1m.
- Automatic Tool loading / unloading station that includes an external 2,5m rail system.
- Included: recipes, Tool TC monitoring, Floware™ and data collection.
- Automation available : Master™ synchronized injection and Maestro™ SCADA system
- Rotary vane vacuum pump with trap, valves and a 0-26 mbar (20 torr) vacuum transducer
- Siemens 12” color touchscreen with trending
- 12 Tool thermocouple inputs (Type J)

PRESS 270 Tons with ELECTRIC DAY-LIGHT ADJUSTMENT

- Typically used for production with variable tool thicknesses
- Welded upper steel bolster construction
- The clamping area is 1,8m x 1,3m. The maximum bolster deflection is less than 0,125mm (11 bars)
- Electric bolster actuation using (6) electric screw jacks. Daylight from 25mm to 600mm
- Capacity to heat a 1800mm x 1320mm x 300mm aluminum tool @ 1,75°C/min
- Heating platens are flat and parallel to less than 0,125mm
- Available clamping force of 270 metric tons
- 5 metric tons wheeled tool loading / unloading cart with pneumatic docking to the press
- Siemens or Telemecanique PLC and controls with 7,4” color touchscreen
- PC with control and data acquisition software
- 10 Inputs for thermocouples type J

PRESS 384 tons, LENGTH: 4.8 meters

- Welded upper steel bolster construction.
- 224 kW heating capacity. Maximum temperature is 200°C (390 °F).
- The clamping area is 4,8m x 0,8m.
- Automatic Tool loading / unloading station that includes an external 2,5m rail system.
- Included: recipes, Tool TC monitoring, Floware™ and data collection.
- Automation available : Master™ synchronized injection and Maestro™ SCADA system
- Siemens 12” color touchscreen with trending
- 10 Tool thermocouple inputs (Type J)
- PC with control and data acquisition software

PRESS 630 Tons with ELECTRIC DAY-LIGHT ADJUSTMENT

- Illustrating the modularity of our press concept, the 630 Tons press is an assembly of a 270 Tons press module and a 360 Tons module
- Welded upper steel bolster construction
- The clamping area is 4,2m x 1,3m. The maximum bolster deflection is less than 0,125mm (11 bars)
- Electric bolster actuation using (14) electric screw jacks. Daylight from 25mm to 600mm
- Capacity to heat a 4200mm x 1320mm x 300mm aluminum tool @ 1,75°C/min
- Heating platens are flat and parallel to less than 0,125mm
- Available clamping force of 630 metric tons
- 5 metric tons wheeled tool loading / unloading cart with pneumatic docking to the press
- Siemens PLC and controls with 7,4” color touchscreen
- PC with control and data acquisition software
- 10 Inputs for thermocouples type J
- Electric Utility: 400 VAC, 3 phase, 50 Hz, 330 Amps
- Pneumatic Utility: 6 bar, clean, dry air

LARGE PRESSES 1400 Tons, 8 x 1.8 meters

- Press construction is scalable to large sizes
- Reliability & low maintenance costs
- Proven efficiency for serial production of RTM / SQRTM aerospace components

V-SHAPE LARGE PRESS 1500 tons, 12 x 1 meters

WING OF TOMORROW SPAR - AIRBUS

High Performance 12 m RTM Workstation

- Lateral loading
- 12m long equipment workstation with aluminum mold

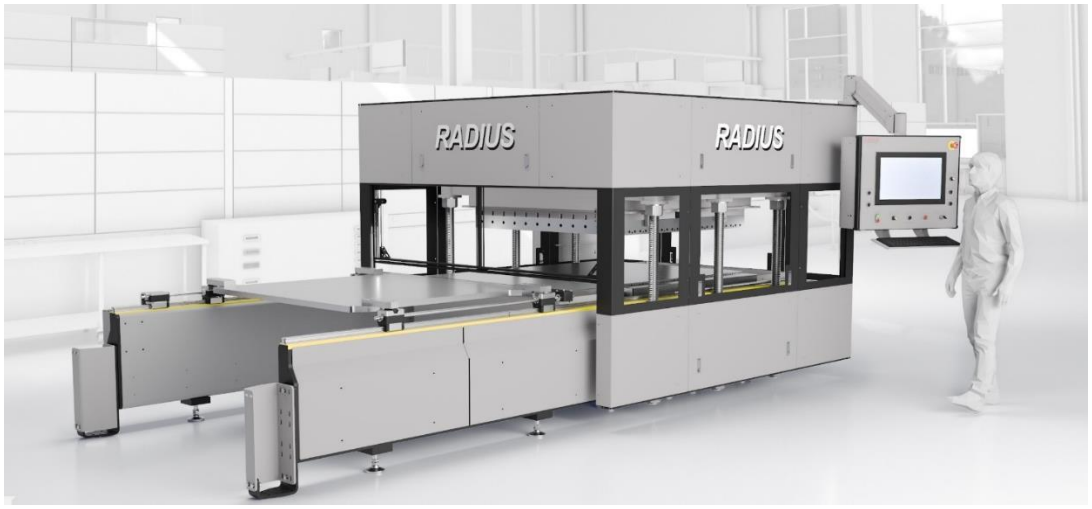
WORLD LARGEST PRESS FOR RTM AEROSTRUCTURES
4000 tons, 9 x 4 meters; 1000 Amps

Original MOLD concept for COMPLEX SKIN PANEL

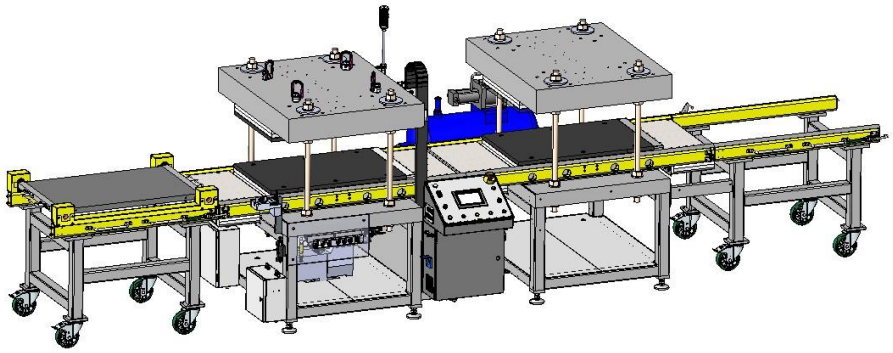
THERMOPLASTIC PRESSES

- Thermoplastic Press for consolidation
- Single station or dual station

Radius Engineering Solution



Coexpair Mutli-stage Concept



RTM INJECTION SYSTEMS

SERIES OVERVIEW

Our Resin Transfer Molding (RTM) Injection Systems are the industry's premier injection systems, engineered with over 25 years of RTM processing expertise. Each system is designed to inject both single and multi-component resins while simultaneously providing precise PID processing control throughout.

Every injection system is built around our unique dual polyseal piston design that enables the low vacuum and high pressure processing required in RTM manufacturing. Standard models offered in either Electric or Pneumatic versions are available in capacities of 2100, 5000, or 10000 cc's. All injection systems can be customized to the specific application at hand. Additionally, we offer an innovative range of optional features such as resin degassing, end cap and line heating, and auxiliary sensor monitoring.

RTM Injection Systems provide the very best in injection process control worldwide

- **Precision Design** – utilizes positive displacement piston for precise pressure and flow control. Every system is designed to achieves less than 0,13 mbar (0,1 Torr) vacuum sealing and 27,5 Bar (400 psi) pressure sealing at operating temperatures up to 180°C (350°F)

Controls Interface

- **Processing controls** – are provided by means of an industrial programmable logic controller (PLC) for the PID control of all injection system processes

- **Real Time Data** – user-friendly displays of all injection processes are provided through the 7.5-inches Color Touch Screen controls interface. Complete system data acquisition is provided by Floware™ software running on an external PC

Graphical Data Display

- **Injection Software Tools** – our toolkit streamlines the manufacturing process with features such as recipe creation for automated system settings, an automated vacuum leak rate calculator, a vacuum degassing timer, and a resin cure monitor

SYSTEM FEATURES

Positive-Displacement Design

ELECTRIC SERIES

- Offered in standard volume capacities of 2100, 5000, and 10000 cc
- Pressure and Flow Control – The system injects resin at a specified flow rate until the pressure approaches the set-point and then gradually reduces the flow rate as the mold is filled
- Heated Resin Cylinder for operations up to a maximum of 180°C (350°F)
- Positive-Displacement piston driven by a precision DC stepper motor
- Aluminum piston with dual polyseal design ensures vacuum and pressure integrity
- Inputs provided for (8) RTM Tool J-Type thermocouples
- PLC Control of all injection processes
- Complete Data Acquisition via the DELL™ PC running Floware™ software (provided). Floware™ enables complete control of the injector from the external PC, as well as offering User Management & Recipe controls
- Simple piston access for quick and easy cleaning and maintenance

In-Cylinder Degasser

PNEUMATIC SERIES

- Lower priced version with the same specifications as listed in the "Electric Series" with the exception of resin flow control
- Positive-Displacement piston is driven by a pneumatic actuator
- Economy versions also available (offered without PLC control or DAQ)

OPTIONAL FEATURES (Electric and Pneumatic)

- In-Cylinder Degassing
- Heated Cylinder End-Plugs (SQRTM)
- High Temperature Processing

GENERAL SPECIFICATIONS

Capacities:	2100 / 5000 / 10000 cc's
Model Versions:	Electric / Pneumatic
Pressure Rating:	Electric - 27.5 Bar (400 psi) Pneumatic – 17,0 Bar (250 psi)
Vacuum Rating:	< 0,13 mbar (0,1 Torr) Absolute Pressure
Flow Rate Rating:	Up to 750 cc/min
Max. Temperature:	180°C (350 °F)
Power Requirements:	380V - 3 Phases - 50 Hz (Amperage varies)
Typical Dimensions:	140 cm (L) x 83 cm (W) x 111 cm (H)
Typical Weight:	360 kg (800 lbs)

2,100cc PNEUMATIC RTM INJECTION SYSTEM

The 2,100cc RTM pneumatic injector is a pressure controlled system, designed to inject single component or premixed multi-component resin systems.

- Pneumatic pressure actuates piston to inject resin at a 1.8:1 ratio
  - Maximum output pressure is 17 Bar (250 psi)
- Heated resin cylinder and injection line sleeve (max temperature 180 °C (350 °F))
  - Maximum temperature of 180 °C (350 °F)
- Aluminum piston with two polyseals for vacuum and pressure integrity
  - Seal design for vacuum sealing to < 0.25 mbar (<0.2 Torr)

Data Acquisition System Option

- PLC based control of all injection processes
- 7.5” color touch screen for system control and monitoring of all injection parameters
- Local graphical trending of all injection process parameters
- Inputs provided for monitoring / trending (4) user provided tool temperature sensors
- Includes tool pressure transducer input and sensor
- Alarm display and history logging
- Serial communications via TCP/IP with Modbus™ RTU or Profinet protocol
- Record Injection data, alarms and operator notes to the computer hard drive
- Operator can create, store and recall injection recipes
- Simplified part cure timing based on tool temperature sensors
- Floware software and PC for data logging of all injection system parameters and inputs including: pressures, flow rate, vacuum level, temperatures, events, alarms and operator notes

2,100cc ELECTRIC RTM INJECTION SYSTEM

The 2,100cc RTM electric injector is a flow and pressure controlled system, designed to inject single component or premixed multi-component resin systems.

- Injects resin at a specified flow rate until the pressure approaches the pressure set point and begins to gradually slow the flow rate
  - Maximum resin pressure 27.5 bar (400 psi)
  - Maximum resin flow rate 500 cc/minute
- Heated resin cylinder and injection line sleeve
  - Maximum temperature 180 °C (350 °F)
- Positive-displacement piston driven by a precision DC stepper motor system
  - Maximum resin injection volume of 2,100 cc's
  - Fully retracts to 2,600 cc's to provide additional volume for in-cylinder degassing
- Aluminum piston with two polyseals for vacuum and pressure integrity
- Seal design for vacuum sealing to less than 0.25 mbar (0.2 Torr)
- 7.5" color touch screen for system control and monitoring of all injection parameters
- PLC based control of all injection processes
- Local graphical trending of all injection process parameters
- Inputs provided for monitoring and trending of (8) user provided tool temperature T/C's
- Includes tool pressure transducer input and sensor
- Alarm display and history logging
- Serial communications via TCP/IP with Modbus™ RTU or Profinet protocol
- Record Injection data, alarms and operator notes to the computer hard drive

5,000cc ELECTRIC RTM INJECTION SYSTEM

The 5,000cc RTM electric injector is a flow and pressure controlled system, designed to inject single component or premixed multi-component resin systems.

- Injects resin at a specified flow rate until the pressure approaches the pressure set point and begins to gradually slow the flow rate
  - Maximum resin pressure 27,5 bar (400 psi)
  - Maximum resin flow rate 750 cc/minute
- Heated resin cylinder and injection line sleeve
  - Maximum temperature 180 °C (350 °F)
- Positive-displacement piston driven by a precision DC stepper motor system
  - Maximum resin injection volume of 5,000 cc's
  - Fully retracts to 6,000 cc's to provide additional volume for in-cylinder degassing
- Aluminum piston with two polyseals for vacuum and pressure integrity
- Seal design for vacuum sealing to less than 0.25 mbar (0.2 Torr)
- 7.5" color touch screen for system control and monitoring of all injection parameters
- PLC based control of all injection processes
- Local graphical trending of all injection process parameters
- Inputs provided for monitoring and trending of (8) user provided tool temperature T/C's
- Includes tool pressure transducer input and sensor
- Alarm display and history logging
- Serial communications via TCP/IP with Profinet protocol
- Record Injection data, alarms and operator notes to the computer hard drive
- Operator can create, store and recall injection recipes
- Simplified part cure timing based on tool temperatures T/C's
- Floware software and PC for data logging of all injection system parameters and inputs including: pressures, flow rate, vacuum level, temperatures, events, alarms and operator notes

10,000cc ELECTRIC RTM INJECTION SYSTEM

The 10,000cc RTM electric injector is a flow and pressure controlled system, designed to inject single component or premixed multi-component resin systems.

- Injects resin at a specified flow rate until the pressure approaches the pressure set point and begins to gradually slow the flow rate
  - Maximum resin pressure 11 bar (160 psi)
  - Maximum resin flow rate 1000 cc/minute
- Heated resin cylinder and injection line sleeve
  - Maximum temperature 180 °C (350 °F)
- Positive-displacement piston driven by a precision DC stepper motor system
  - Maximum resin injection volume of 10,000 cc's
  - Fully retracts to 12,000 cc's to provide additional volume for in-cylinder degassing
- Aluminum piston with two polyseals for vacuum and pressure integrity
- Seal design for vacuum sealing to less than 0.25 mbar (0.2 Torr)
- 7.5" color touch screen for system control and monitoring of all injection parameters
- PLC based control of all injection processes
- Local graphical trending of all injection process parameters
- Inputs provided for monitoring and trending of (8) user provided tool temperature T/C's
- Includes tool pressure transducer input and sensor
- Alarm display and history logging
- Serial communications via TCP/IP with Profinet protocol
- Record Injection data, alarms and operator notes to the computer hard drive
- Operator can create, store and recall injection recipes
- Simplified part cure timing based on tool temperatures T/C's
- Floware software and PC for data logging of all injection system parameters and inputs including; pressures, flow rate, vacuum level, temperatures, events, alarms and operator notes

10,000cc ELECTRIC RTM INJECTION SYSTEM – NEW 30 bars

The 10,000cc RTM electric injector is a flow and pressure controlled system, designed to inject single component or premixed multi-component resin systems.

- Injects resin at a specified flow rate until the pressure approaches the pressure set point and begins to gradually slow the flow rate
  - Maximum resin pressure 30 bar (435 psi)
  - Maximum resin flow rate 1000 cc/minute
- Heated resin cylinder and injection line sleeve
  - Maximum temperature 180 °C (350 °F)
- Positive-displacement piston driven by a precision DC stepper motor system
  - Maximum resin injection volume of 10,000 cc's
  - Fully retracts to 12,000 cc's to provide additional volume for in-cylinder degassing
- Aluminum piston with two polyseals for vacuum and pressure integrity
- Seal design for vacuum sealing to less than 0.25 mbar (0.2 Torr)
- 7.5" color touch screen for system control and monitoring of all injection parameters
- PLC based control of all injection processes
- Local graphical trending of all injection process parameters
- Inputs provided for monitoring and trending of (8) user provided tool temperature T/C's
- Includes tool pressure transducer input and sensor
- Alarm display and history logging
- Serial communications via TCP/IP with Profinet protocol
- Record Injection data, alarms and operator notes to the computer hard drive
- Operator can create, store and recall injection recipes
- Simplified part cure timing based on tool temperatures T/C's
- Floware software and PC for data logging of all injection system parameters and inputs including; pressures, flow rate, vacuum level, temperatures, events, alarms and operator notes

15,000cc ELECTRIC RTM INJECTION SYSTEM

The 15,000cc RTM electric injector is a flow and pressure controlled system, designed to inject single component or premixed multi-component resin systems.

- Injects resin at a specified flow rate until the pressure approaches the pressure set point and begins to gradually slow the flow rate
  - Maximum resin pressure 11 bar (160 psi)
  - Maximum resin flow rate 1000 cc/minute
- Heated resin cylinder and injection line sleeve
  - Maximum temperature 180 °C (350 °F)
- Positive-displacement piston driven by a precision DC stepper motor system
  - Maximum resin injection volume of 15,000 cc's
  - Fully retracts to 15,500 cc's to provide additional volume for in-cylinder degassing
- Aluminum piston with two polyseals for vacuum and pressure integrity
- Seal design for vacuum sealing to less than 0.25 mbar (0.2 Torr)
- 7.5" color touch screen for system control and monitoring of all injection parameters
- PLC based control of all injection processes
- Local graphical trending of all injection process parameters
- Inputs provided for monitoring and trending of (8) user provided tool temperature T/C's
- Includes tool pressure transducer input and sensor
- Alarm display and history logging
- Serial communications via TCP/IP with Profinet protocol
- Record Injection data, alarms and operator notes to the computer hard drive
- Operator can create, store and recall injection recipes
- Simplified part cure timing based on tool temperatures T/C's
- Floware software and PC for data logging of all injection system parameters and inputs including; pressures, flow rate, vacuum level, temperatures, events, alarms and operator notes

25,000cc PNEUMATIC RTM INJECTION STATION

A 25,000cc pneumatic actuated injection station comprised of (2) two individual 12,500cc resin cylinders. The specifications of this station are provided below:

- (2) Two 12,500cc resin cylinder assemblies
  - Combined volume capacity of 25,000cc's
- Pneumatic pressure actuates the resin cylinder piston to inject at a 1:1 ratio
  - Maximum resin output pressure is 10 bar (150 psi)
- Injects resin at a semi-controlled flow rate until the resin pressure approaches the pressure set point and begins to gradually slow:
  - Typical flow rate control range from 400cc/min to 2000cc/min per cylinder.
  - Typical flow rate control range from 800cc/min to 4000cc/min for the system.
- Heated resin cylinder and injection line sleeve
  - Max temperature 180°C (350 °F)
- Dual polyseal piston design for vacuum and pressure integrity
  - Vacuum sealing to < 0.25 mbar (<0.2 Torr)
- 7.5" color touch screen for system control and monitoring of all injection parameters
- Inputs provided for monitoring and trending of (4) user provided tool temperature T/C's
- Local graphical trending of all injection process parameters
- Alarm display and history logging
- Serial communications via TCP/IP with Profinet protocol
- Record injection data, alarms and operator notes to the computer hard drive
- Software for data logging of all injection system parameters and inputs including; pressures, flow rate, vacuum level, temperatures, events, alarms and operator notes
- All documentation provided in the English language

25,000cc ELECTRIC RTM INJECTION STATION

A 25,000cc electrically actuated injection station comprised of (2) two individual 12,500cc resin cylinders. The specifications of this station are provided below:

- (2) Two 12,500cc resin cylinder assemblies
  - Combined volume capacity of 25,000cc's
- Injects resin at a specified flow rate until the resin pressure approaches the pressure set point and begins to gradually slow
  - Maximum resin pressure 11 bar (160 psi)
  - Maximum resin flow rate 1000 (cc/min) for each cylinder
- Heated resin cylinder and injection line sleeve
  - Max temperature 180°C (350 °F)
- Dual polyseal piston design for vacuum and pressure integrity
  - Vacuum sealing to < 0.25 mbar (<0.2 Torr)
- 7.5" color touch screen for system control and monitoring of all injection parameters
- Inputs provided for monitoring and trending of (4) user provided tool temperature T/C's
- Local graphical trending of all injection process parameters
- Alarm display and history logging
- Serial communications via TCP/IP with Profinet protocol
- Record injection data, alarms and operator notes to the computer hard drive
- Software for data logging of all injection system parameters and inputs including; pressures, flow rate, vacuum level, temperatures, events, alarms and operator notes
- All documentation provided in the English language

45,000cc ELECTRIC RTM INJECTION STATION

A 45,000cc electrically actuated injection station comprised of (3) three individual 15,000cc resin cylinders. The specifications of this station are provided below:

- (3) Three 15,000cc resin cylinder assemblies
  - Combined volume capacity of 45,000cc's
- Injects resin at a specified flow rate until the resin pressure approaches the pressure set point and begins to gradually slow
  - Maximum resin pressure 11 bar (160 psi)
  - Maximum resin flow rate 1000 (cc/min) for each cylinder
- Heated resin cylinder and injection line sleeve
  - Max temperature 180°C (350 °F)
- Dual polyseal piston design for vacuum and pressure integrity
  - Vacuum sealing to < 0.25 mbar (<0.2 Torr)

- 7.5" color touch screen for system control and monitoring of all injection parameters
- Inputs provided for monitoring and trending of (8) user provided tool temperature T/C's
- Local graphical trending of all injection process parameters
- Alarm display and history logging
- Serial communications via TCP/IP with Profinet protocol
- Record injection data, alarms and operator notes to the computer hard drive
- Software for data logging of all injection system parameters and inputs including; pressures, flow rate, vacuum level, temperatures, events,alarms and operator notes
- All documentation provided in the English language

LARGE SYSTEMS – In Production use & leasing available

ADVANCED SYSTEMS 285°C & 2K

5,000cc ELECTRIC RTM HIGH TEMPERATURE INJECTION SYSTEM

The 5,000cc High temperature RTM electric injector is a flow and pressure controlled system, designed to inject single component or premixed multi-component resin systems.

- Injects resin at a specified flow rate until the pressure approaches the pressure set point and begins to gradually slow the flow rate
  - Maximum resin pressure 27 bar
  - Maximum resin flow rate 500 cc/minute
- Heated resin cylinder and injection line sleeve
  - Maximum temperature **285 °C** (550 °F)
- Positive-displacement piston driven by a precision DC stepper motor system
  - Maximum resin injection volume of 5,000 cc's
  - Fully retracts to 6,000 cc's to provide additional volume for in-cylinder degassing

2-COMPONENTS INJECTION SYSTEM

Coexpair injection system have a very accurate flow control which allows to build 2K-resin injection systems.

IN-CYLINDER DEGASSING MIXER ASSEMBLING

FOR INJECTION SYSTEM

The in-cylinder degassing assembly allows for degassing, agitation, and heating of resin at temperatures up to 180 °C (350°F) directly inside of the resin cylinder.

- In-cylinder degassing attachment with integral mixing motor and resin thermocouple
- In-cylinder degasser and resin cylinder vacuum sealing rated to less than 0.25 mbar (0.2 Torr)
- Integration of a vacuum transducer inside of the injector control cabinet for monitoring of vacuum levels from 26 – 0.01 mbar (20 – 0.01 Torr)
- Corrosion resistant, dual-stage, rotary vane vacuum pump provided, capable of achieving <0.01 mbar (0.01 Torr) absolute pressure.
- Vacuum intake trap and vacuum line header
- Includes vacuum level data acquisition, real-time trending at injector and PC with 1-hour history, degassing timer software, tool leak rate calculator software

SQRTM - HEATED END PLUG FOR INJECTION

The heated end plug is designed to provide PID controlled heat to the resin as it exits the injection system.

- PID temperature control to 180°C (350°F)
- Temperature controlled by injection system PLC
- Temperature recorded by injection system DAQ

ON-SITE TRAINING & SUPPORT

This consists of three days of on-site support by Coexpair for equipment startup and operator training. Two RTM simple parts can be typically fabricated during the visit to demonstrate equipment operation and RTM processing. The schedule is generally as follows:

- Day 1 – Equipment set-up, operation overview, RTM injection preparation
- Day 2 – RTM Injection #1 performed by Coexpair and assisted by customer
- Day 3 – RTM Injection #2 performed by customer and assisted by Coexpair

CUSTOM SYSTEM

RTM Degassing and Transfer Carts

- High Vacuum Level Degas (<0.1 mbar)
- 'PID" Temperature Controlled Resin Heating
- Dual Stage Rotary Vane Pump
- Availae in 3.5 Liter and 10 Liter Capacities

3.5 Liter – Resin Degassing

Radius RTM Pail Injectors

- Inject pre-degassed resin directly from shipping pail
- "PID" Pressure Control and Platen Heating
- Gerotor pump for high volume & high pressure capability

20 Liter – Pail Injection System

Custom Injection Equipment

- We can offer completely customizable resin injection solutions based on project requirements
- Examples of Radius Developments Include:
  - Custom 1900 Liter Injection System
  - 25 Liter Resin Degas & Transfer Cart

Custom 1900 Liter Injection System

Degassing Station

- We can offer degassing stations with very high vacuum level
- Injection systems could be filled directly from the degassing station

2 buckets degassing station

COMPARISON SHEET

Radius Injection Systems provide superior operating and safety features compared to alternatives

	Features	Radius RTM / SQRTM Injection Systems	Competitors' RTM Injectors	Pressure Pot Systems	Meter Mix Systems	Description
Technical Specifications	Injection pressures up to 27 Bar	O	-	X	O	• High tolerance precision honed components and unique dual polyseal design provides pressure (27 Bar) and vacuum (<0.1 Torr) sealing that is ***critical*** to the SQRTM/RTM processes and unmatched by competitors • Radius is the ***only*** production proven SQRTM injection system available on the market.
	Precise flow rate control (5cc/min up to 1500cc/min)	O	X	X	X	
	Flow rate resolution (1cc/min)	O	X	X	X	
	Standard temperature range (180 C)	O	O	-	-	
	High temperature option (280 C)	O	X	X	X	
	Vacuum Sealing (<0.1 mbar)	O	X	X	N/A	
	SQRTM processing capability	O	X	X	X	
	High viscosity resin processing	O	-	X	O	
Safety	Low Exothermic Risk	O	-	X	O	• Radius' control system constantly monitors process values for exotherm identification and mitigation
	Low Burst Risk (Potential Energy Storage)	O	O	X	O	
	Automated Process Monitoring	O	X	-	-	
	Direct In-cylinder Pressure Monitoring	O	-	O	N/A	

Radius Injection Systems offer full integration with Radius work cells and offer extensive design features

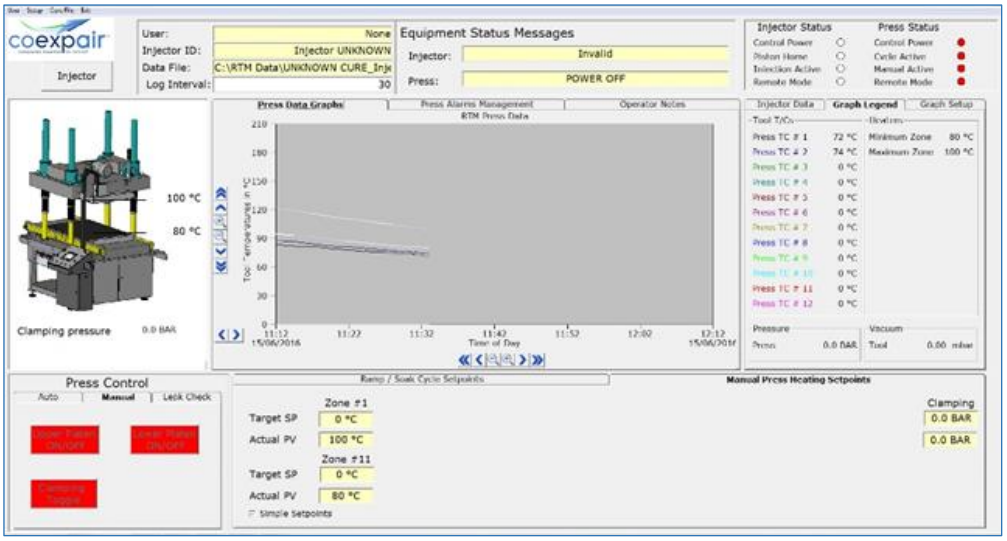
	Features	Radius RTM / SQRTM Injection Systems	Competitors' RTM Injectors	Pressure Pot Systems	Meter Mix Systems	Description
Work cell Integration	Single PC control of entire workcell operation	O	X	X	X	• Only Radius can offer fully integrated production proven SQRTM work cells. • Single source data acquisition and equipment control
	Full integration with RTM press software	O	-	X	X	
	Complete workcell data-acquisition	O	X	X	X	
	Similar controls components for easy maintenance	O	X	X	X	
Design Features	In-cylinder degassing option	O	X	-	N/A	• Radius injectors are fully customizable with auxiliary process options. • Unique Radius injector seal design allows for quick cleaning and injector turn around. • Eliminates the need for large volumes of solvent for cleaning • Mechanical design is optimized to provide the lowest possible level of maintenance. • Radius offers full 1 year warranty on all equipment
	Auxiliary heating control option	O	-	X	-	
	Auxiliary sensors for Tool temperature & vacuum	O	-	X	-	
	Touchscreen controls interface	O	-	X	X	
	Compact size, easy to move	O	-	O	-	
	Fast cleaning time (< 15 minutes)	O	-	O	-	
	Easy seal replacement / cleaning	O	-	N/A	N/A	
	No large quantities of solvent for cleaning	O	O	X	X	
	Low maintenance mechanical design	O	-	O	-	

4.0 AUTOMATION SOFTWARE

Coexpair develops its own Software suite which allows to adapt to each customer requirements

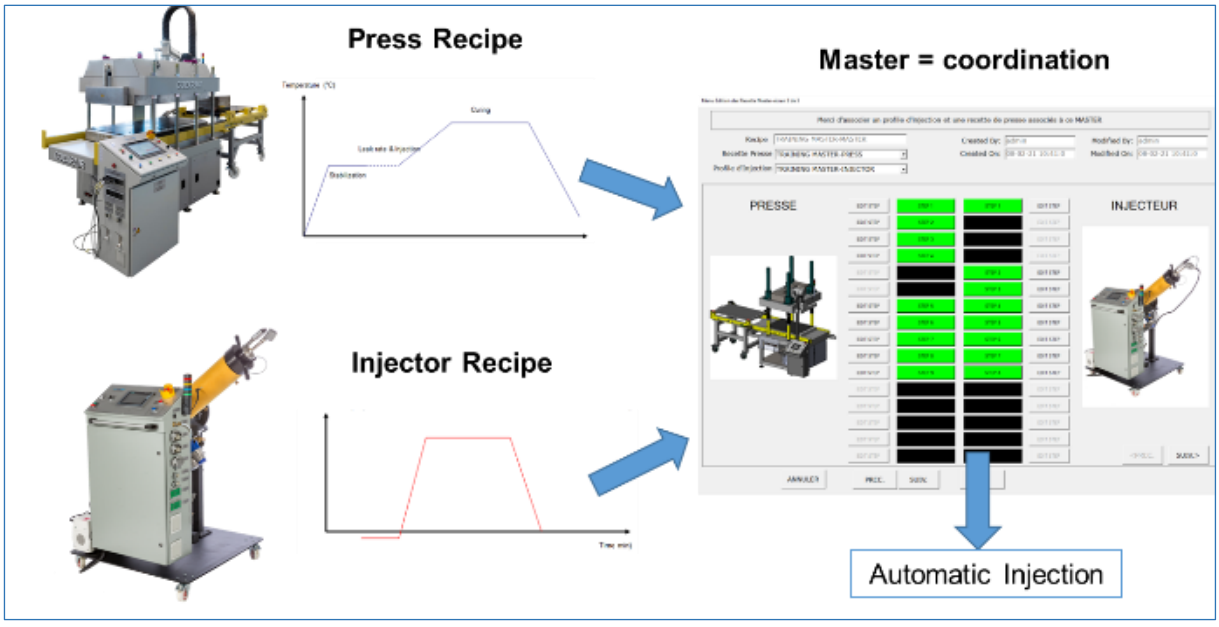
Floware™: Machine HMI with local Data & recipes

- Computer for Data Collection (pressure, vacuum, temperature) – SQL database or CSV file
- HMI and Floware™ to create/call recipes.
- Easy Interface with different level of access (Admin, operator)
- 12 to 24 TC inputs (for tool temperature control)

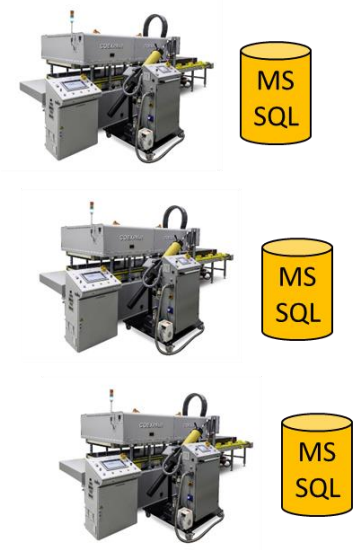


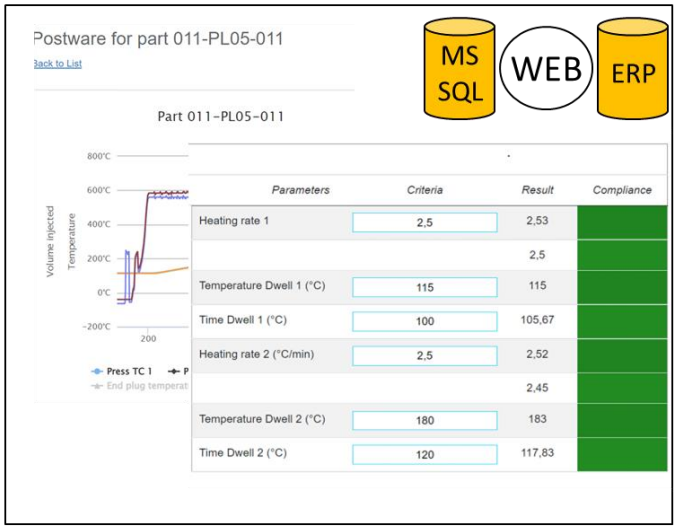
MASTER™: Multi-Equipment Synchronisation

- Thanks to this software, the press and injector steps can be synchronized to be able to perform an **automatic injection**.
- Automatic closing of outlet valve based on resin detection also available.
- Ergonomic and efficient solution
- Interfaces to other brand of equipment is possible.

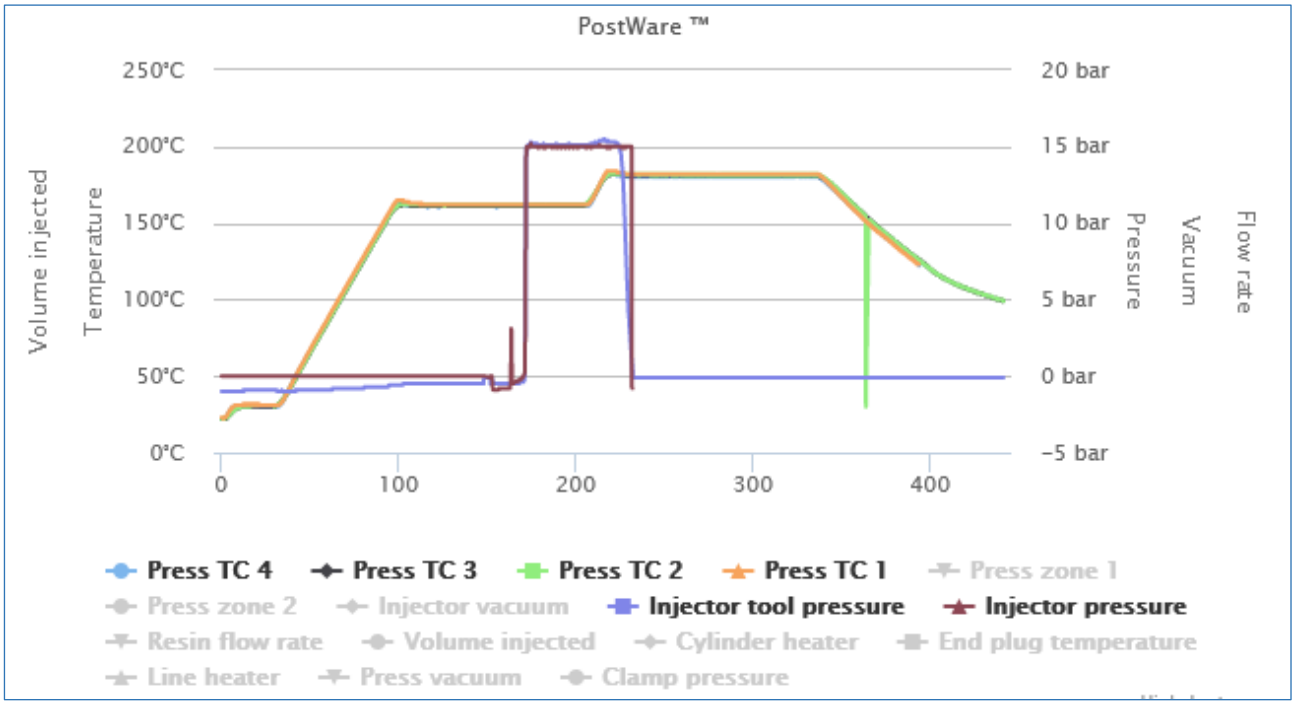


MAESTRO™: Live Central Data Processing – 4.0





- Maestro™ is a **SCADA system** that aim to centralize all production data to generate extra value from them.
- Maestro™ runs on Microsoft Server; Web interface.
- LIVE synchronization from/to production equipment.
- Centralization of all production data allows to analyze multi-workstation data such as all operated injections with a mold across presses.
- QA validation, automatic reporting, KPI and communication to ERP

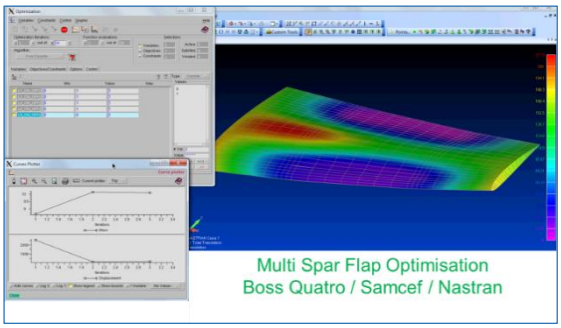


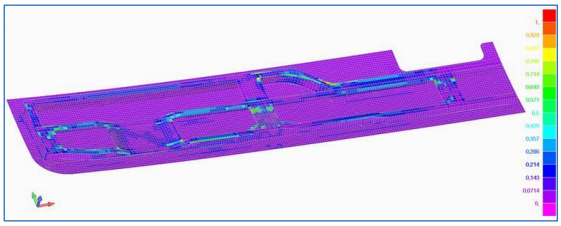
ENGINEERING

Net-shape composites are an opportunity to improve performances: lower weight, lower cost, shorter manufacturing cycle. We support you by engineering for optimal performance, starting from functional requirements through to design for manufacturing (DFM).

ANALYSIS

Our Skilled Engineers are experienced with Samcef and Nastran FEA (static, stability, dynamic, thermal). They are distinguished by their hands-on experience of manufacturing (SQ)RTM parts themselves. Their engineering approach is built on understanding the key process elements that impact mechanical performance. Allowables generation including test campaign definition is also part of their job.





DESIGN

Designers use Catia V5 modeler both for composite part design and for tool design. The position of the office inside the prototyping facility gives the designer a great opportunity to combine 3D models and hands-on trials.

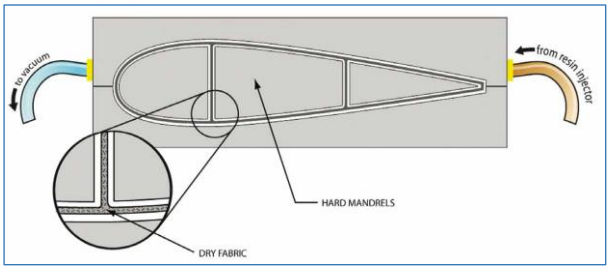
MATERIALS & PROCESSES

At the heart of our engineering services there are the selection of material and the set-up of process parameters for (SQ)RTM. Manufacturing of flat panels for coupons is a common task; tools are available in different sizes and thicknesses. More complex tools are used to validate the process and mechanical performances at higher level (sub-element level).

RTM & SQRTM PROCESSES

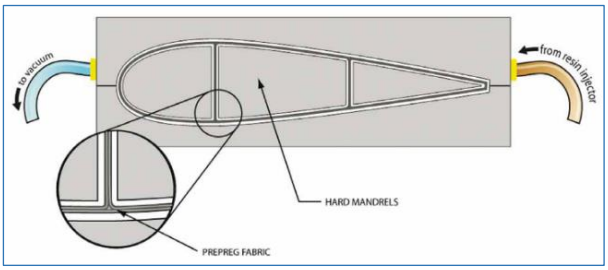
RTM (Resin Transfer Molding):

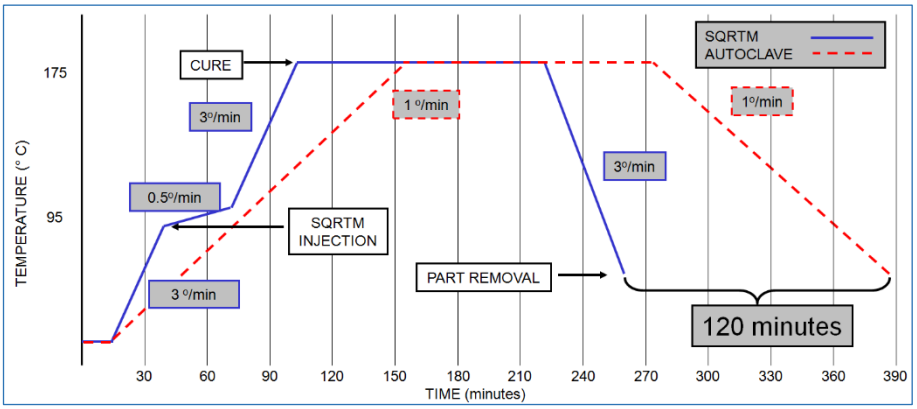
- Uses dry reinforcement to make preform
- Tooling is generally steel or Aluminum, on all surfaces
- Resin is thoroughly degassed and vacuum is drawn on tool
- Low viscosity RTM resin, < 500 cps, infuses entire preform
- Resin pressure maintained at 7 to 8 Bar during cure



SQRTM (Same Qualified Resin Transfer Molding):

- Allows use of program-specific prepreg ("same qualified"), including toughened systems such as Hexply 8552 ®, Hexply M21 ®, Cycom 977 ®, Cycom 5250-4 ® BMI, Toray 3900-2 ® (BMS 8-276)
- Fabrics or UD tapes previously laid by hand or using automatic devices (AFP, ATL)
- Tooling is Aluminum, steel or Invar
- High vacuum is drawn on tool
- As tool is heated, small quantity of prepreg resin is injected into tool to fill tool cavity around edges of part and maintaining resin hydrostatic pressure at 8 - 9 Bar during cure





FIRST PART FABRICATION

SQRTM Nose Landing Gear (NLG) door – Collaboration with Safran-SLCA

Coexpair provided:

- Project Lead
- Design
- Engineering support
- Molds
- Training

RTM Engine Lower Pressure Booster – Safran-Techspace Aero

Coexpair and Radius provided:

- Engineering support
- Molds
- First Parts Fabrication

SQRTM Pressure Floor – S.A.B.C.A.

Coexpair and Radius provided:

- Engineering support
- SQRTM Molds
- First Parts Fabrication

INTEGRATION RTM / SQRTM WORKSTATION

We propose a fully integrated solution for the production of aerospace RTM and SQRTM parts.

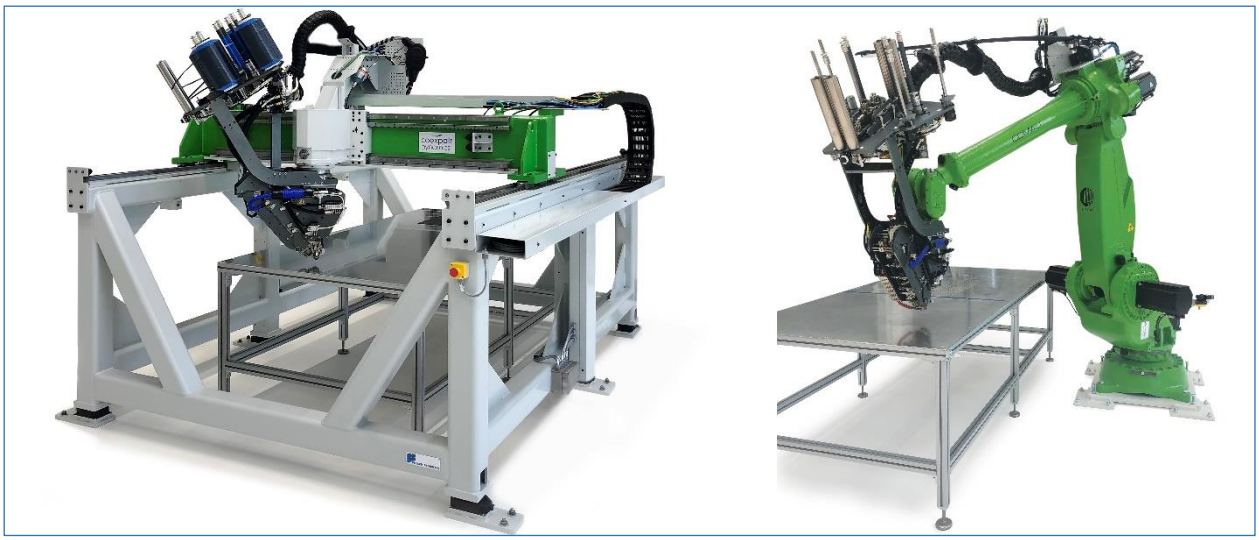
We design and manufacture all the shop core equipment: Mold, Press, Injection System

We are the architect of all needed auxiliary equipment.

INTEGRATION AFP/ATL – COEXPAIR DYNAMICS

For Automated Fiber Deposition services and equipment, you can contact Coexpair Dynamics.

Coexpair Dynamics works in collaboration with Partnership with TSS Albany (previously : Automated Dynamics). Their technology is available for thermoset prepregs, dry fibers and thermoplastic prepregs. With more than 100 machines in 17 countries, their solid experience ensures a continuous development of the AFP head over more than 25 years.



Assembled in Belgium, the automation relies on precise CNC control. Coexpair Dynamics is recognised as Solution Partner of Siemens. Both Robot or Gantry solutions have ergonomic interfaces, large HMI and are piloted through Sinumeric One.

coexpair dynamics

Contact us!

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In partnership with Radius Engineering Inc.