aeropolis.it

AIDAA ASSOCIAZIONE ITALIANA DI AERONAUTICA E ASTRONAUTICA

EUROAVIA NAPOLI "Umberto Nobile"

BEST NAPLES

SEMINARI INTERDISCIPLINARI DI CULTURA AERONAUTICA

Napoli
12 maggio 2018

Aula Scipione Bobbio
Scuola Politecnica e delle Scienze di Base
Napoli Fuorigrotta P.le Tecchio

Sviluppo ed applicazioni di Materiali Compositi nell'industria aerospaziale

AUTOMAZIONE NEI PROCESSI DI PRODUZIONE CON FOCUS SUL PROCESSO AFP

Leonardo Lecce

ACCREDIA — RINA Member of CISQ Federation EN 9100 Certified Quality System

25 years NOVOTECH SRL AEROSPACE ADVANCED TECHNOLOGY

Partner of CLEANSKY

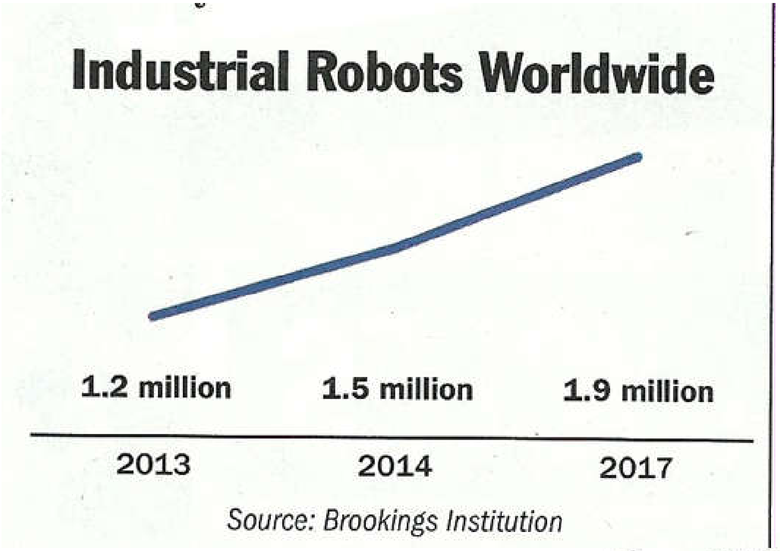
CONTENTUTO

1. *INTRODUZIONE*
2. *PANORAMICA TECNOLOGIE AUTOMATIZZATE*
3. *ESPERIENZE DI SVILUPPO DI TECNOLOGIE AUTOMATIZZATE in NOVOTECH*
4. *TEMATICHE DI SVILUPPO E RICERCA*
5. *CONCLUSIONI*

Partner of CLEANSKY

1. INTRODUZIONE

AUTOMAZIONE…….QUALI INCOGNITE ?!



markets. Take Boeing's Black Diamond project. "The heart of this project is about automation," Allen says. "In both our defense and commercial businesses, when we automate we can radically change the cost proposition for building out our products."

tion think tank. Oxford University researchers Carl Frey and Michael Osborn studied 702 occupational groupings in 2013 and found "47% of U.S. workers have a high probability of seeing their jobs automated over the next 20 years."

Partner of CLEANSKY

Comparison between manufacturing of autos and aircrafts

Current aerospace composite part manufacture

Composites Clean Room

Current automobiles manufacture

TECNICA TRADIZIONALE : HAND-LAY-UP (HLU)

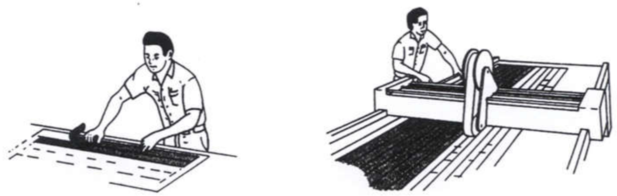
Advantages of the hand-lay-up method

1. Has been the workhorse for composites since the beginning –proven process.
2. Very flexible- Can handle part with complex configuration
3. Does not involve high capital investment in acquiring expensive machines
4. Can handle custom made parts well

Disadvantages of the hand-lay-up method

1. Rate of material deposition is slow.
2. Requires large amount of manual labor
3. Variability depending on the operator
4. Can not handle large parts
   1. Limit of out life of the prepregs
   2. Logistic issues
5. Introduces large amount of waste.
6. Lack of integration between manufacturing and design
7. Difficulty in making parts with no free edge (tubes)

Hand-lay-up.



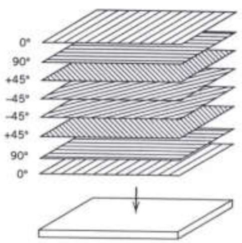
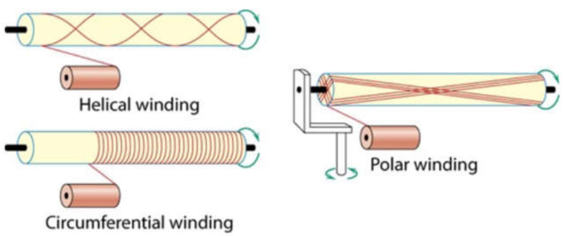


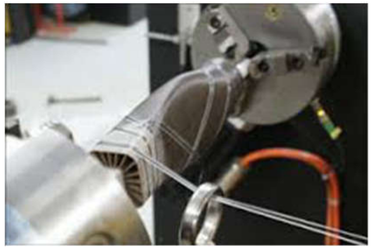
Figure 1.9 Stacking sequence of a (0/90/ ± 45)s quasi-isotropic layup.

Overview on Automated Manufacturing Technologies

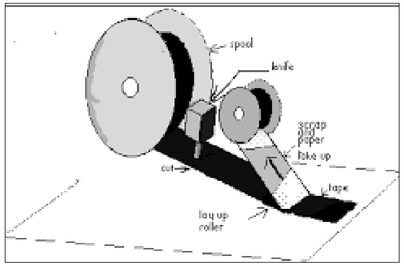
FILAMENT WINDING (FW)

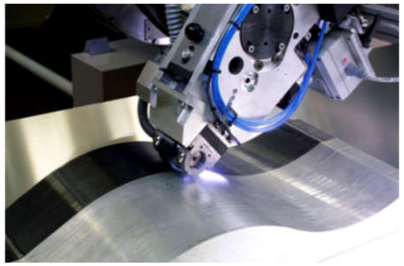
- Ex: pressure tanks
- Continuous filaments wound onto mandrel

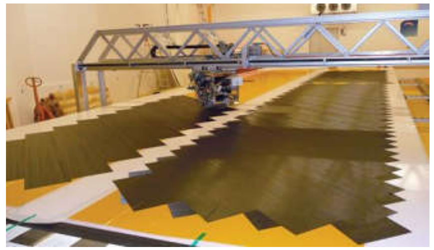




AUTOMATED TAPE LAYING (ATL)







CONTINUOUS COMPRESSION MOULDING (CCM)

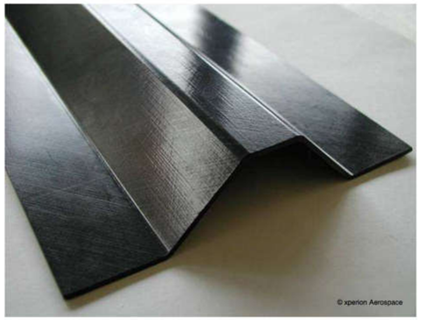
POLTRUSION, PCM, ARTM, ETC

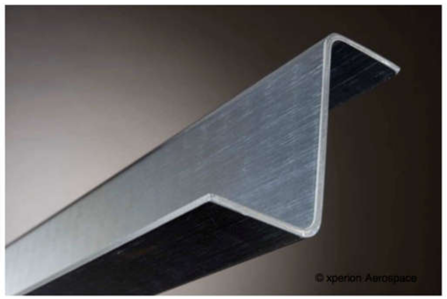
PANORAMICA TECNOLOGIE AUTOMATIZZATE

CCM: CONTINUOS COMPRESSION MOULDING
(FINO A 80 m/h di profilati rettiliniei)

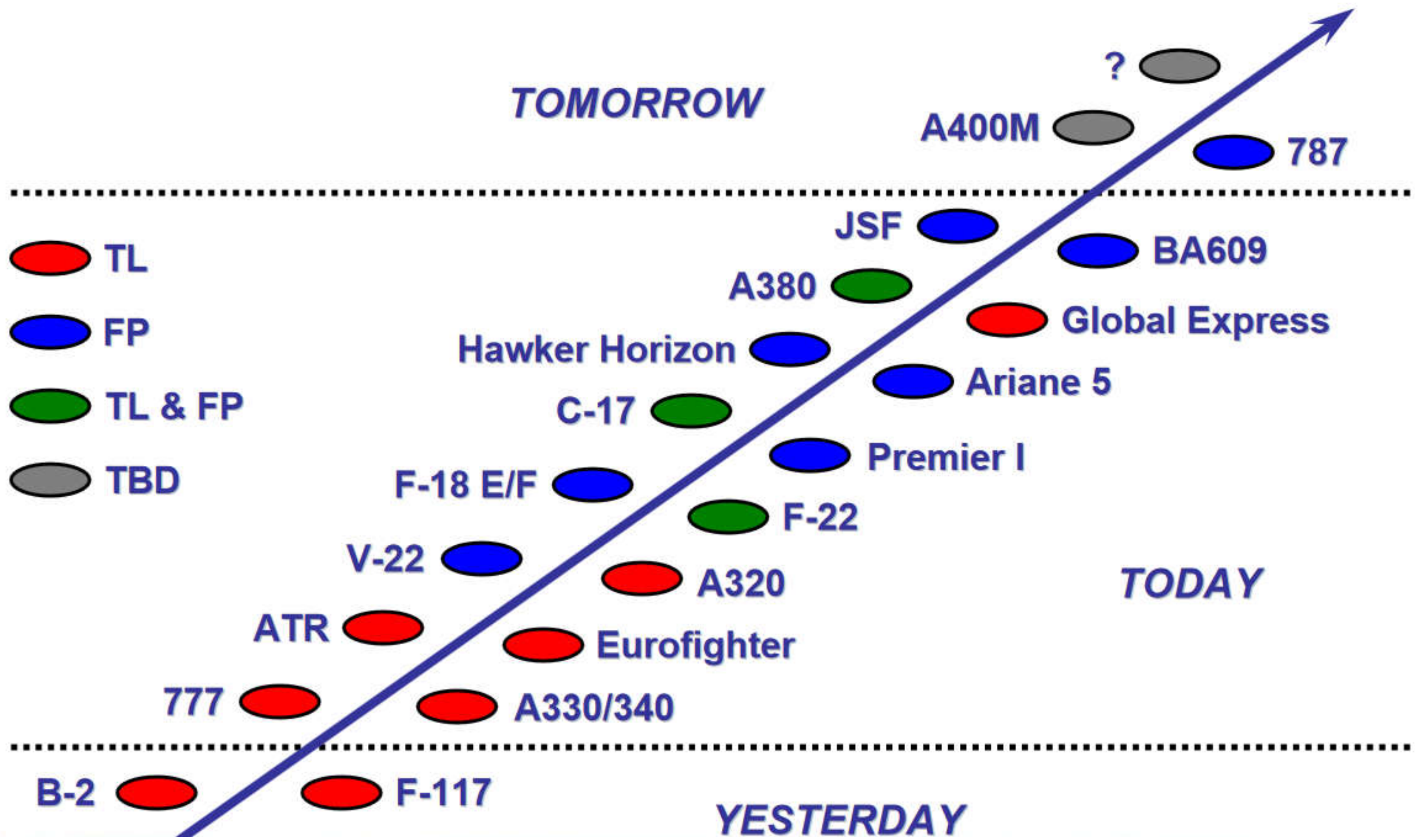
Continuous Compression Moulding Machines

CCM Part hat shape





Aerospace Programs Using Automated Composites Processing Systems

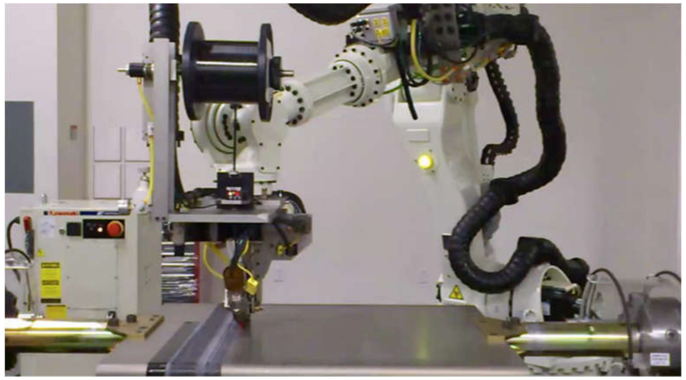


PANORAMICA TECNOLOGIE AUTOMATIZZATE
Tipologie diverse di AFP

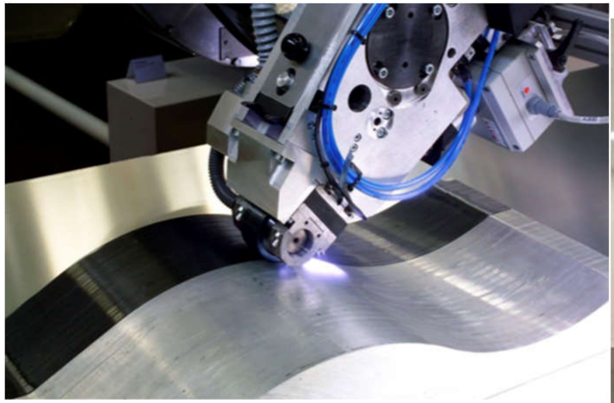
MAG IAS machine

MTorres machines

Automated Fiber Placement (AFP) machine at Concordia University



Ingersoll machines

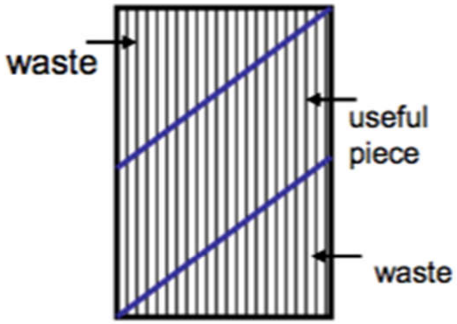


Fraunhofer machine

CORIOLIS machine

Advantages of automated fiber placement (AFP)process

1. Fast speed of material deposition (> 10 lb/hr) (as compared to HLU- 2.5 lb/hr)
1. Does not depend on the operator
2. Less labor intensive
3. Less waste of materials (lower buy/fly ratio)
4. Repeatability of results
5. Seamless transition between manufacturing and design
6. Can handle large structures
7. Can produce unique structures
8. Steerable fibers



Challenges for automated fiber placement (AFP)process

1. High capital cost
2. New technology
3. Thermoset composites still need second operation (autoclave or oven)
4. Laps and gaps issues
5. Distortion in thermoplastic composite processing

INDUSTRY NEEDS REGARDING AFP

Industry	Aerospace	Industry
Materials	Thermoset Binder Yarn Thermoplastics 50 to 100 €/kg	Dry fiber Thermoplastics Thermoset 5 to 15€/kg
Typical parts	Fuselage + Door Tail cone Fairings	Chassis Body structure Spars
Dimensions **Parts/Year**	1 – 25 m 100 - > 2.000	0.1 – 2.5 m 1.000 - > 200.000
Features	Double curved High quality Complex contour Sandwich	Complex 3D Variable thickness Local reinforcements

Flexible machine
Precision

⇨

Highly automated
High productivity
Low material costs

NOVOTECH SRL AEROSPACE ADVANCED TECHNOLOGY 25 years

PANORAMICA TECNOLOGIE AUTOMATIZZATE
Diffusione macchine AFP-ATL

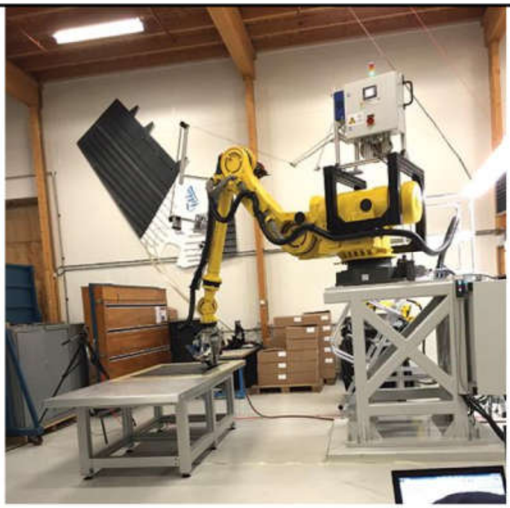
Partner of CLEANSKY

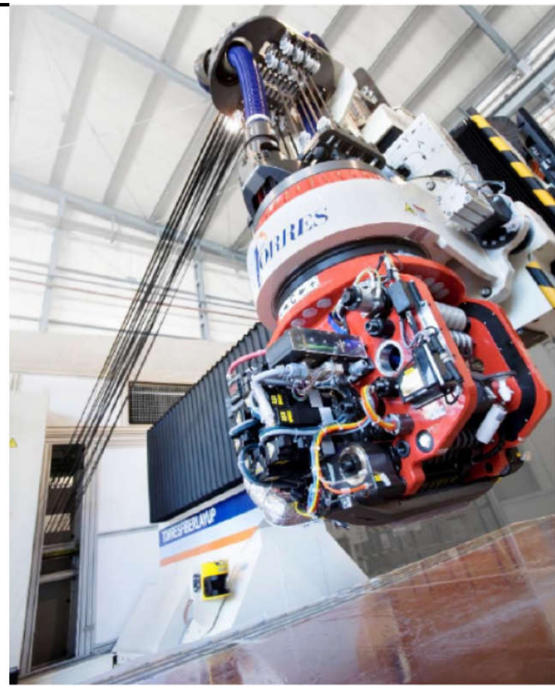
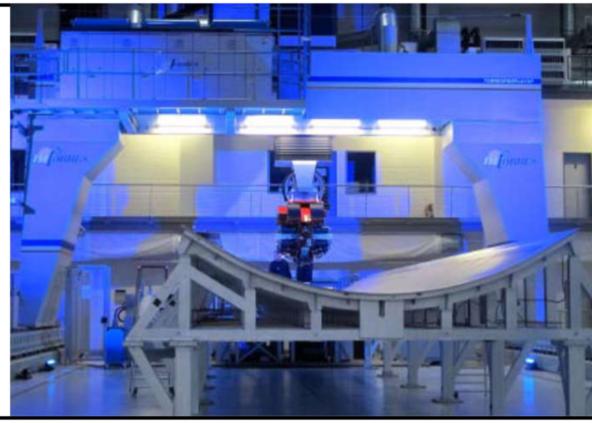
GRUPPI INDUSTRIALI

1. Boeing
2. Spirit
3. Airbus
4. Bell Helicopter TexTron
5. Bombardier (Coriolis)
6. ATK
7. COMAC
8. SUPERJET
9. FINMECCANICA - AA (Grottaglie-Foggia)
10. FINMECCANICA –AW (Brindisi)

UNIVERSITA' E CENTRI DI RICERCA

1. Sheffield university (UK)
2. Manchester Institute of Technology (UK)
3. Bristol University (UK)
4. Fraunhofer Institute (Germany)
5. NLR (Netherlands)
6. Univ. of Missouri (USA)
7. Union College (USA)
8. Australia
9. Japan
10. Concordia University (Canada)
11. National Research Council Canada (Canada)
12. TUM Munich (Germany)
13. COMPODITATOUR (France)

Supplier	Programma	Struttura	Figura
Daher-Socata (FR)	A350 XWB	Main Landing Gear Door	
Fokker (NL)	A380	wing leading-edge	
GKN (UK)	A350 XWB	Rear spar and trailing edge	

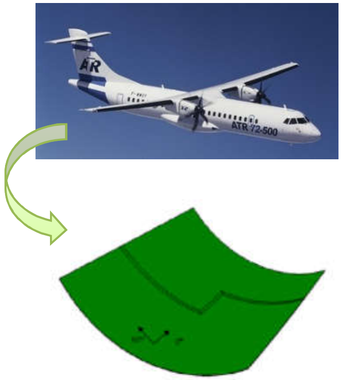
TECHNOLOGIE ZENTRUM NORDENHAM (GE)	A350 XWB	Wing Frames	
PREMIUM AEROTEC (GE)	A350 XWB		

Pls, see Video Novotech-AFP Process.m4v

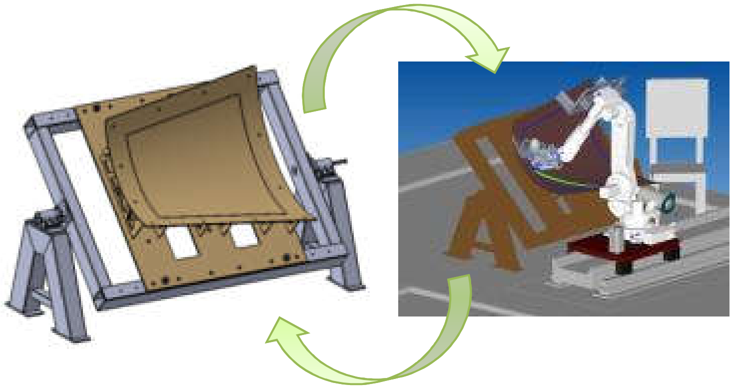
Design & Manufacturing of Composite Layups by AFP Process - LAMITECH Project

DEVELOPMENT OF A REGIONAL A/C TAIL CONE PORTION (1/4)

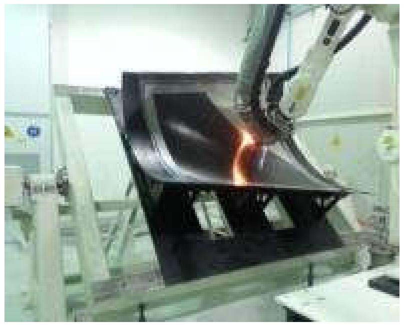
DOUBLE CURVATURE COMPOSITE PANEL WITH RAMP



CONCEPT, DESIGN AND FEASIBILITY STUDY

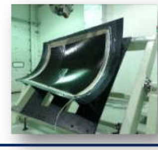


MANUFACTURING

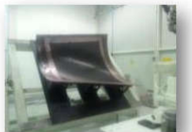


Double Curvature panel (r_{min}=850, r_{max}=1150 mm) with a ramp - Thermoset Prepreg (977-2-35-12KHTS from Cytec)

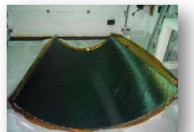
Double Curvature panel (r_{min}=850, r_{max}=1150 mm) with a ramp layered on Copper foil - Thermoset Prepreg (977-2-35-12KHTS from Cytec)



Double Curvature panel (r_{min}=850, r_{max}=1150 mm) with a ramp - Dry Fiber material (Prism TX1100 IMS-65 from Cytec)



Double Curvature panel (r_{min}=850, r_{max}=1150 mm) with a ramp - Thermoplastic Prepreg (APC2-34-AS4 from Cytec)

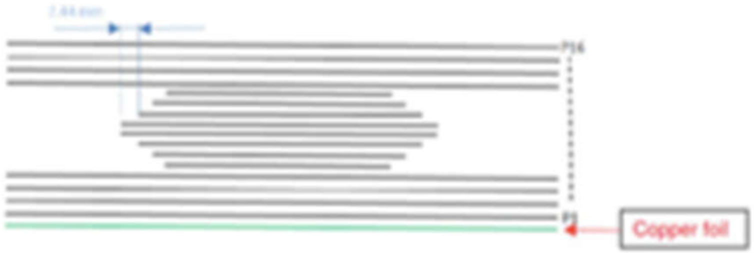


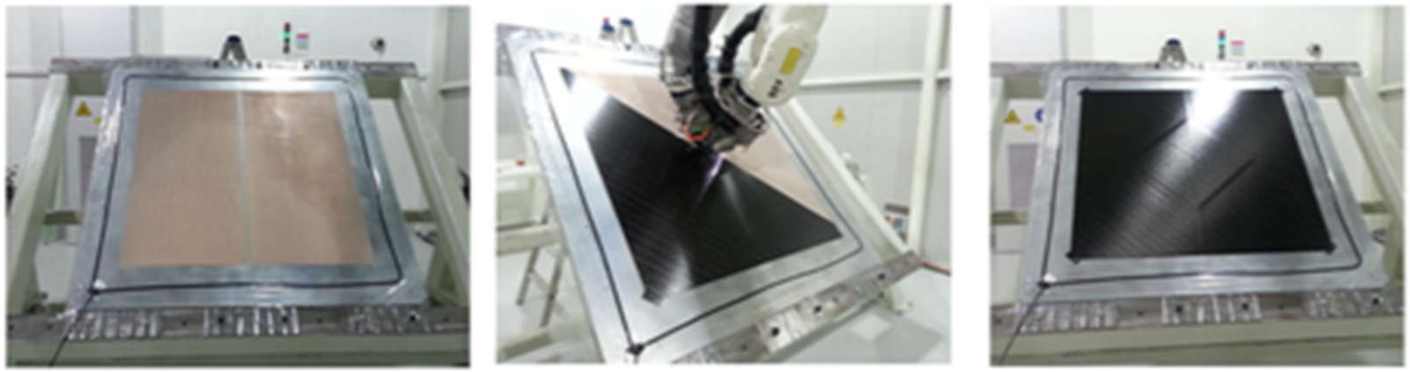
The 2nd International Symposium on *Automated Composites Manufacturing*
April 23-24, 2015 Montreal, Canada

NOVOTECH
ADVANCED AEROSPACE TECHNOLOGY

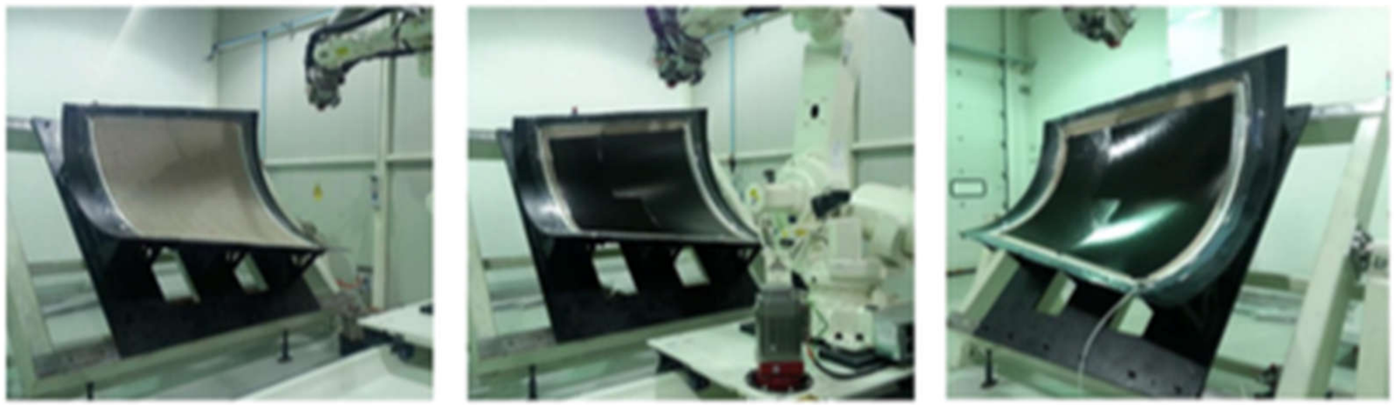
Alenia Aermacchi
A Finmeccanica Company

Manufacturing of test trials with Lightning strike protection





Test Trial #1

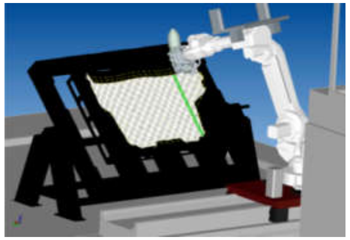


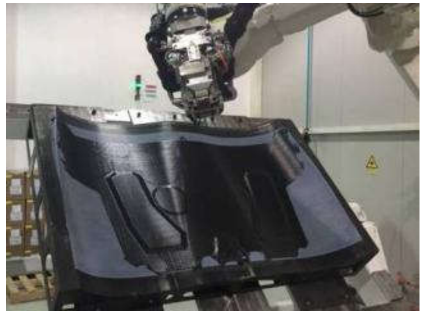
Test Trial #2

R&I Projects AFPM based: SPIA

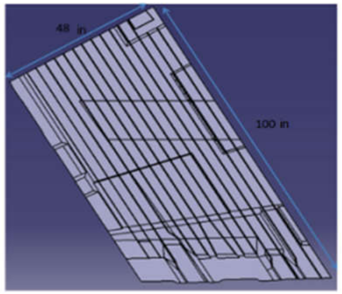
DEVELOPMENT OF COMPLEX COMPOSITE DEMONSTRATORS

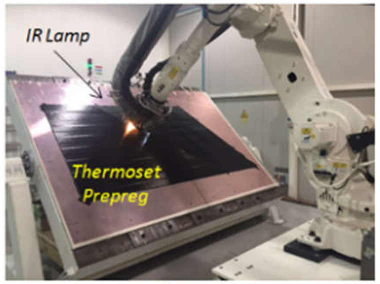
M-346 FUSELAGE PORTION (scale 1:1)

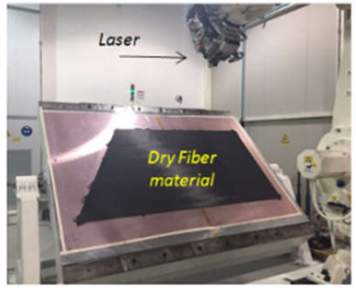




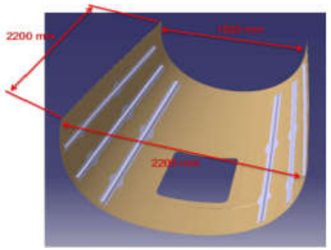
NGTP VERTICAL FIN PORTION (2.5mtx1.5mt)

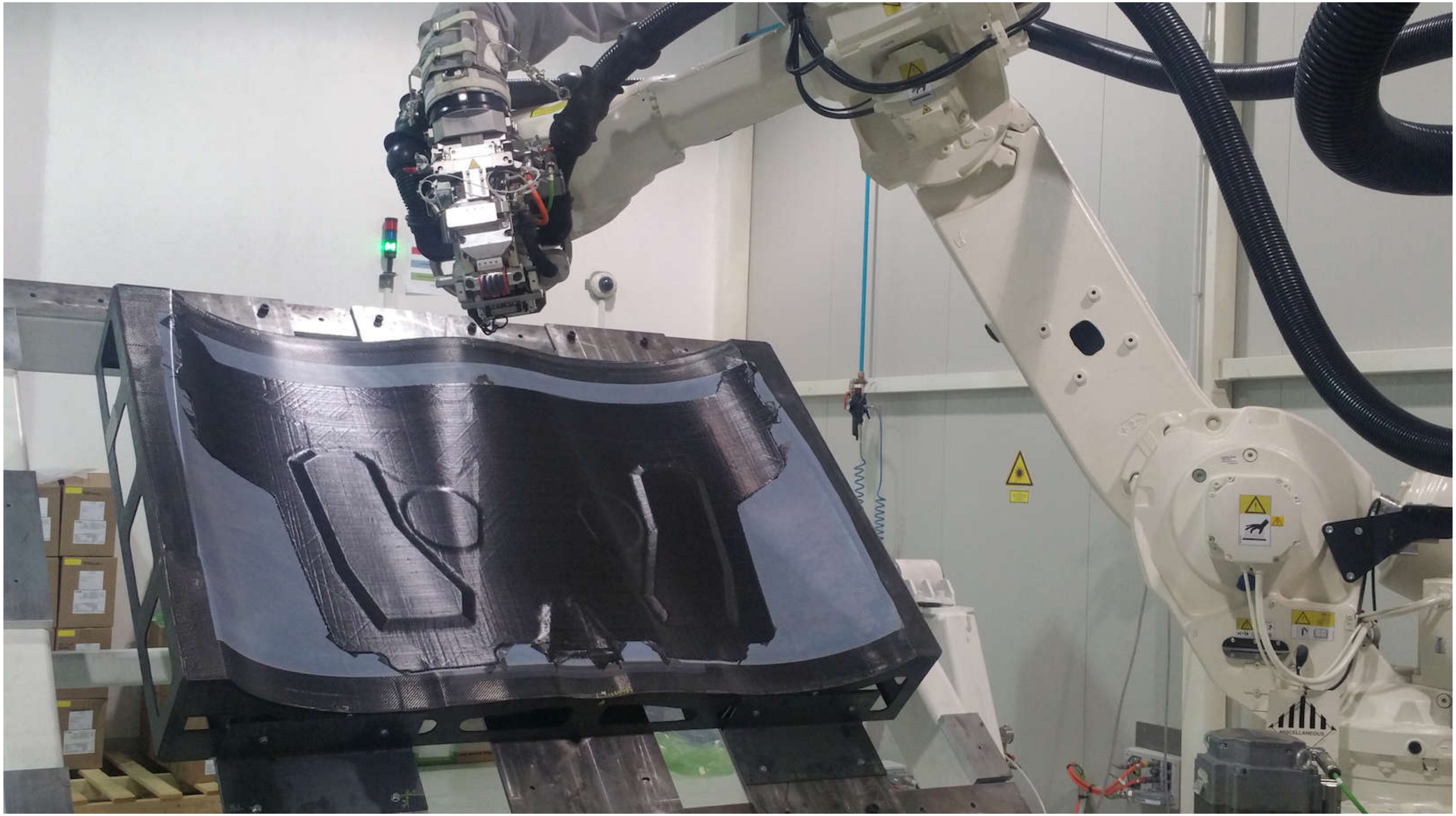






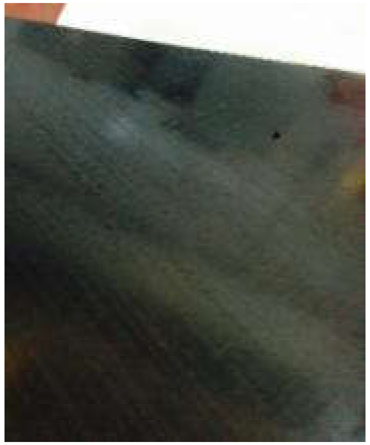
A/C TAIL CONE PORTION (1/2 & 1/4) including stringers laydown by AFP process

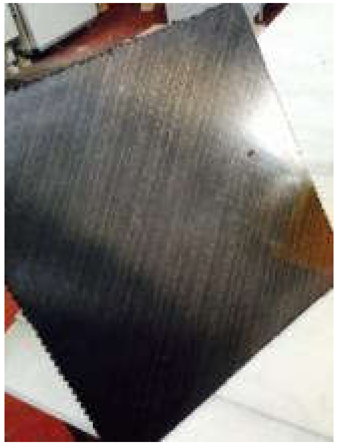




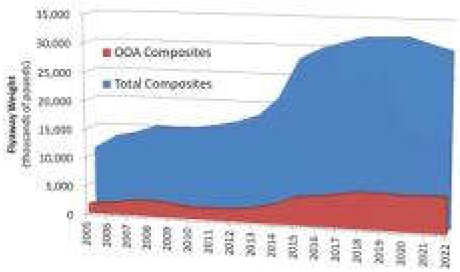
Partners:

Out of Autoclave Panels (CYCOM 5320-1) using AFPM





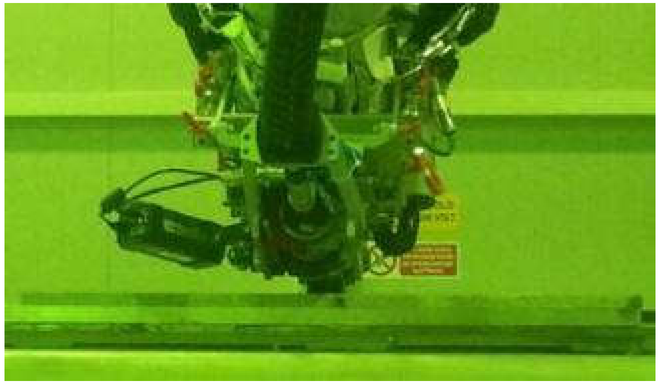
ESTIMATED 2013-2022 MARKET FOR TOTAL AEROSPACE COMPOSITE STRUCTURES VS. OOA COMPOSITES.



Source CFC (Jan 2014)

TP In-Situ Consolidation using AFPM

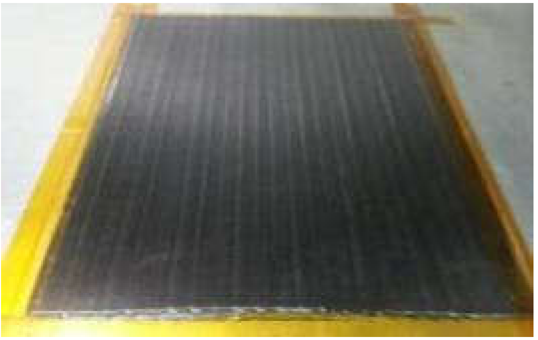
- *Layup performed by NVT*
- *Materials provided by AAAEM*
- *NDI and Mechanical Tests will be performed by Cytec*

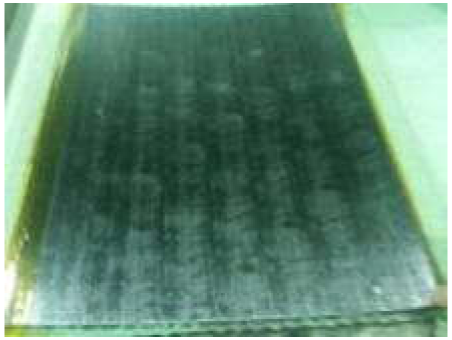


Alenia Aermacchi
A Finmeccanica Company

CYTEC

Partners:



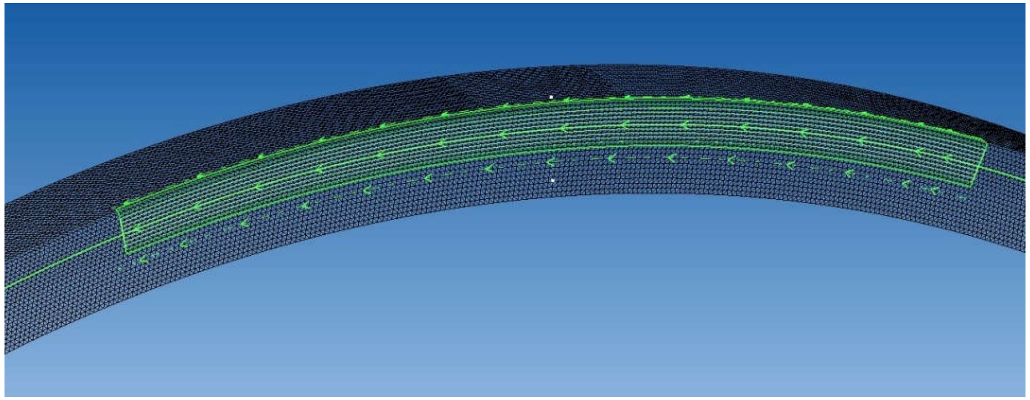


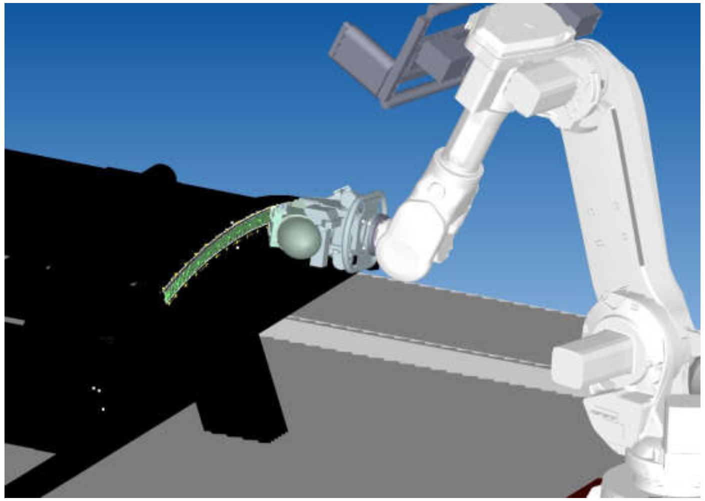
(a)
Layup at T≈250° C

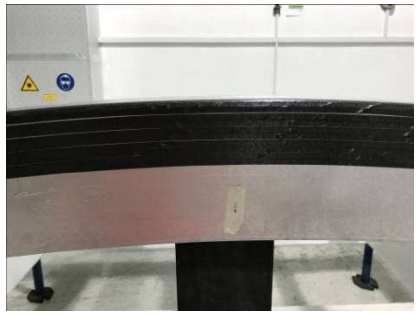
(b)
Layup at T ≈ 400° C

(c)
Layup at T ≈ 400° C on a thermal insulation plate

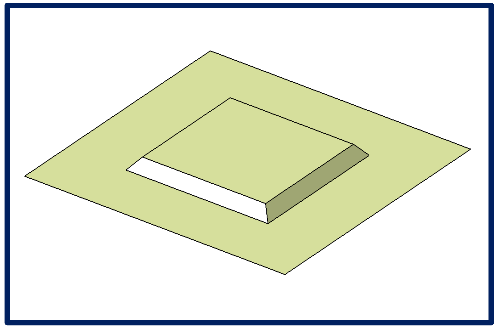
Comparison between CADFiber simulation (left) and experimental laydown (right) of a 0° ply

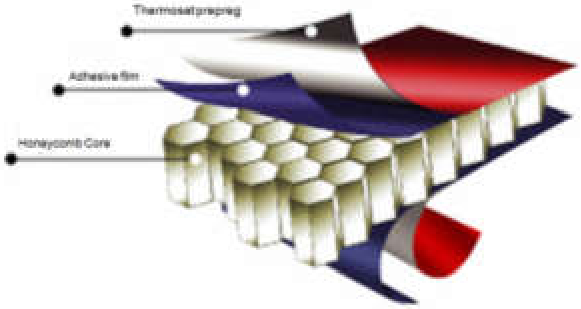




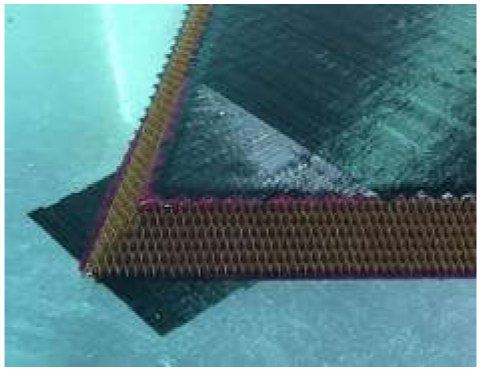


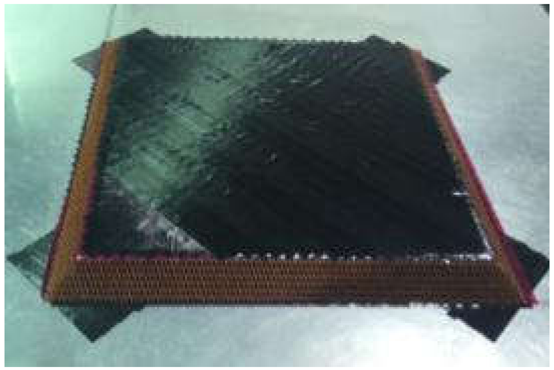
Sandwich Panels using AFPM



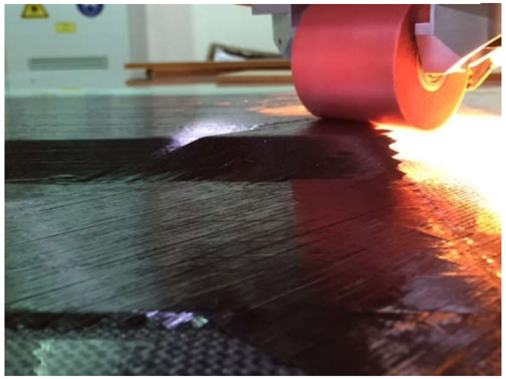


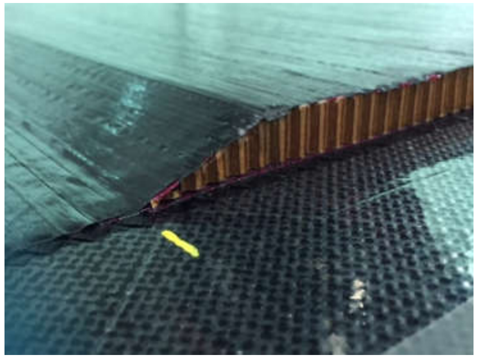
Test trial

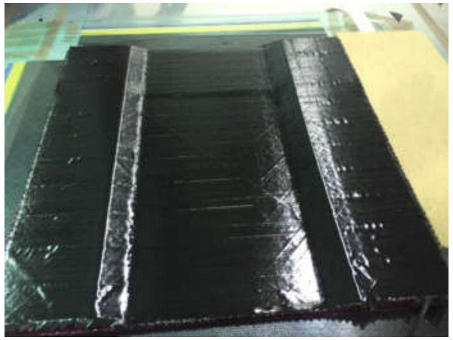


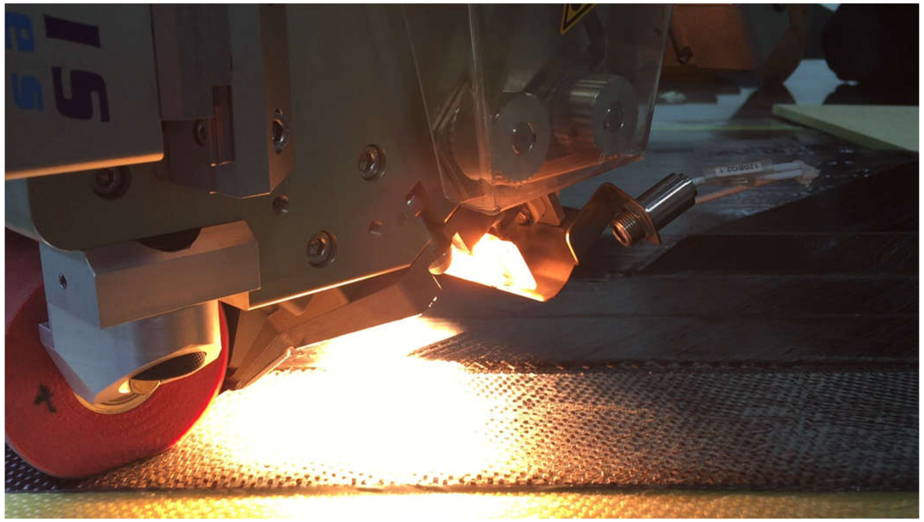


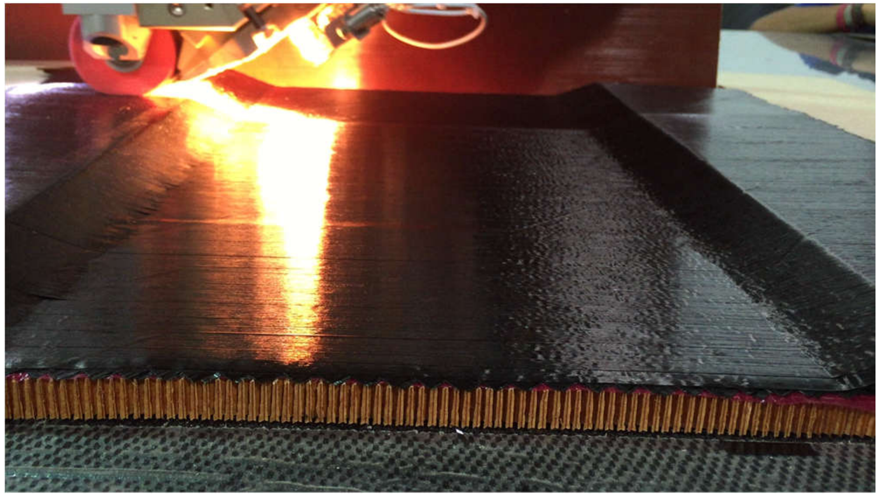
-45°	Thermoset 977-2 (Cytec)
45°	
90°	
0°	
Adhesive	3M™ Scotch-Weld™ Structural AF 163-2
Component	Honeycomb
Adhesive	3M™ Scotch-Weld™ Structural AF 163-2
0°	Thermoset 977-2 (Cytec)
90°	
45°	
-45°	









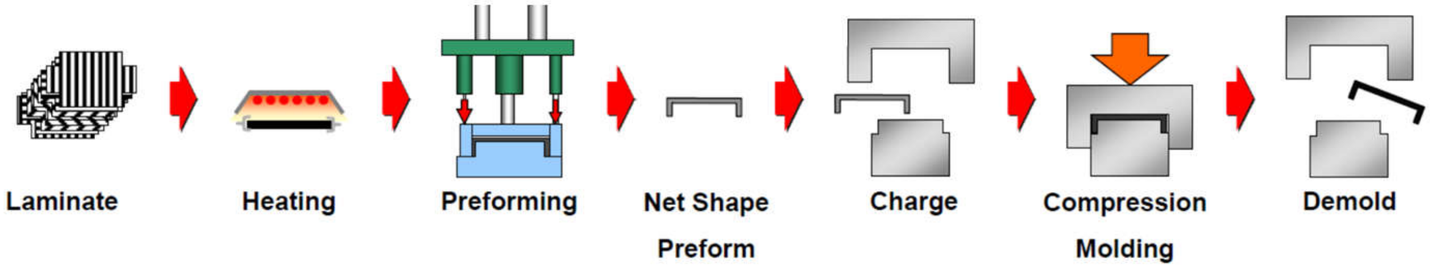


Pls, see Video Omega1.m4v

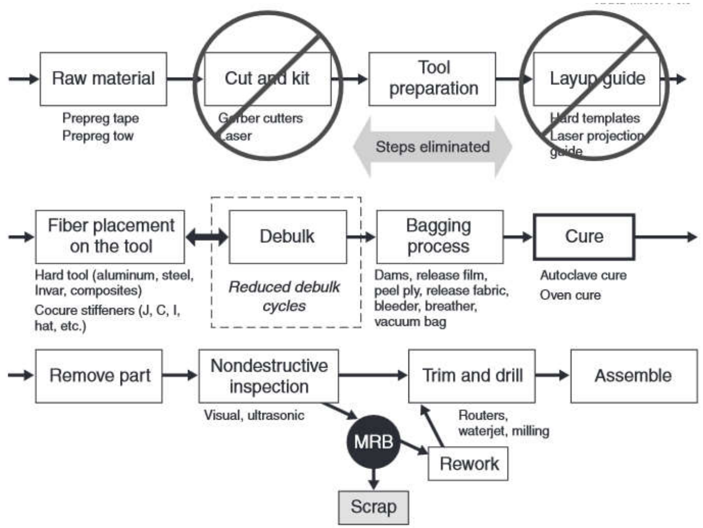
Pls, see Video Omega2.m4v

Rapid Preforming process using AFPM

- *Preforming of Prepreg for PCM or Dry Fiber material for Infusion process*
- *High Surface Quality*
- *OOA process (Hot Press or Oven depending on the part)*



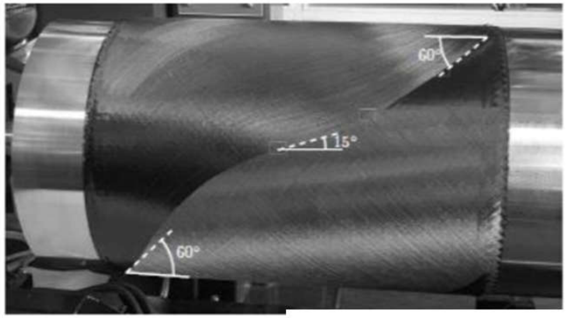
Automated Fiber Placement steps compared to Hand Layup

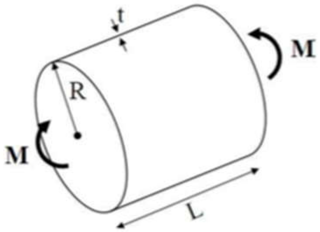


Advanced preforming process :

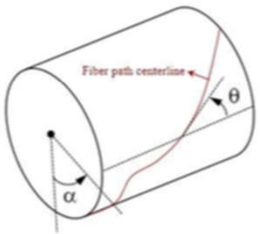
- Fast
- Consistent
- Less manual labor
- Automated

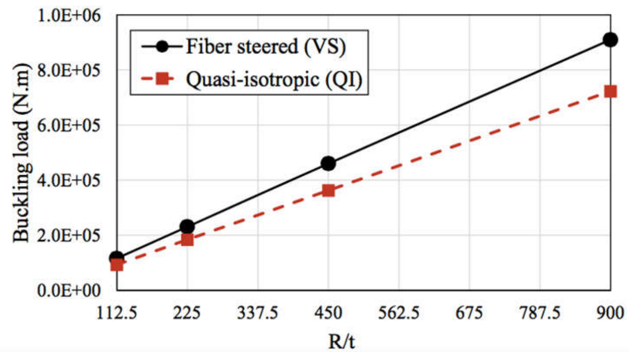
Fiber steering and buckling optimization

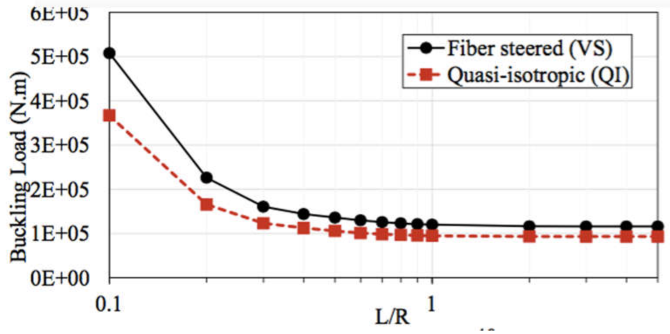




What is the optimum path (θ) to have maximum buckling load?



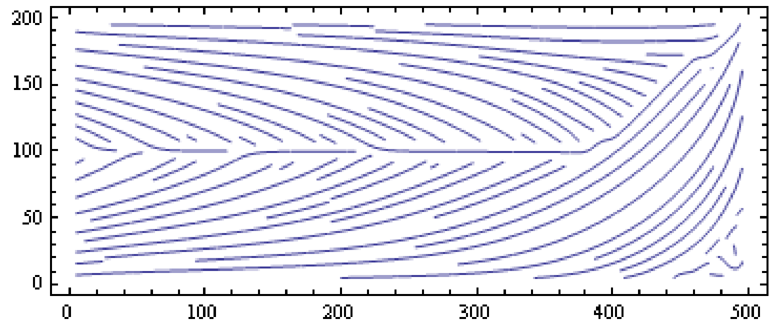


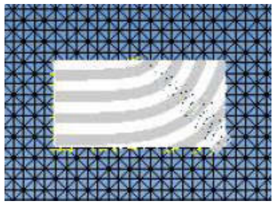


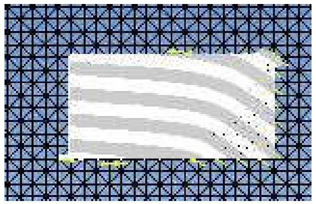
25 years NOVOTECH SRL AEROSPACE ADVANCED TECHNOLOGY

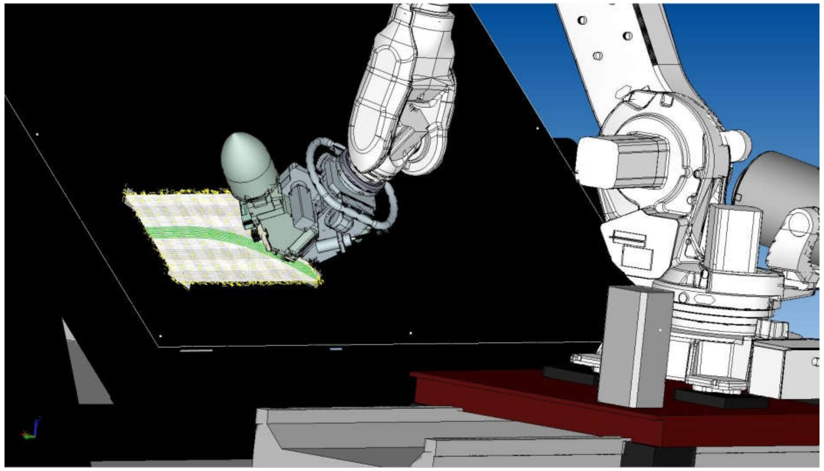
Partner of CLEANSKY

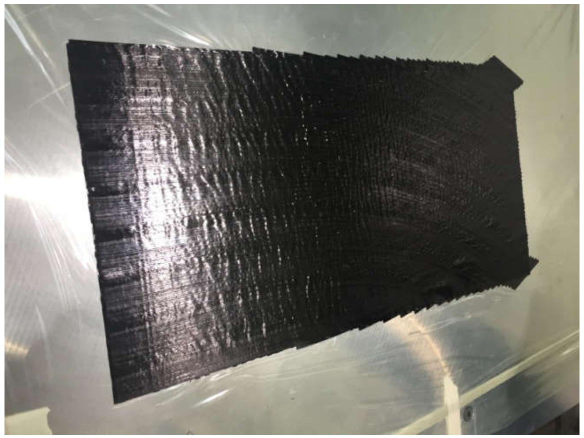
Optimized stratification strategy

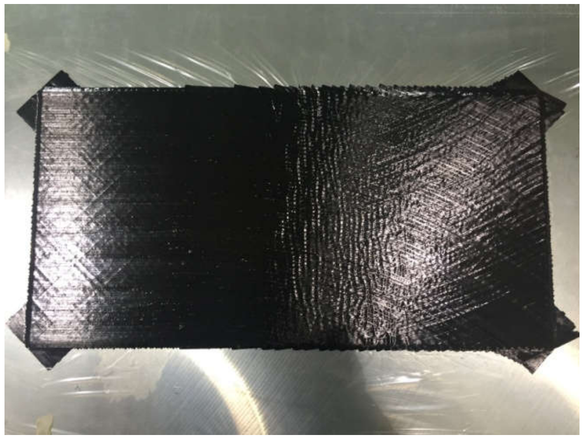


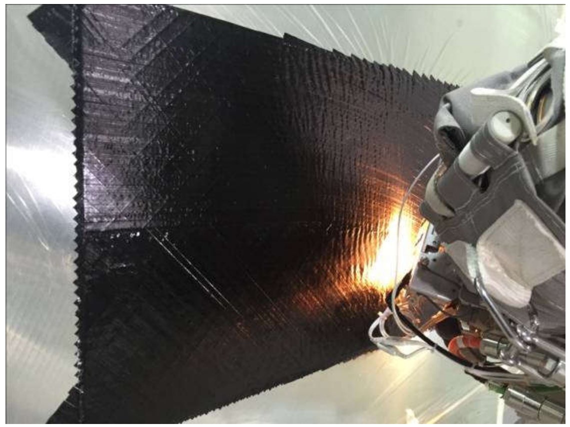












Thank you

for your attention

If You Want To Go Fast, Go Alone.
If You Want To Go Far, Go Together.