Developing composite solutions to meet the eVTOL market needs of today and tomorrow

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The eVTOL Show

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Progress beyond

Solvay's key markets for Materials

Large commercial transport

Fan engines, business jets and military

Rotorcraft and AAM

Space and Launch

F1, Premium and efficient road vehicles

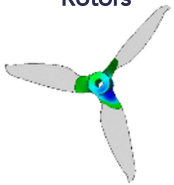
Over 40 years of experience supplying high performance composite materials into the aerospace industry

Solvay's material portfolio aligned to AAM/UAM market needs

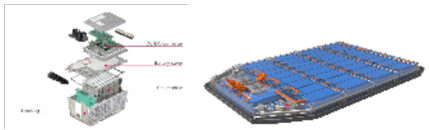
APPLICATION

Airframe

Rotors

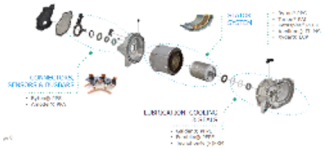


Battery Enclosures



Interiors

E-motors



MATERIAL SOLUTIONS

Liquid Molding

Thermoplastic Prepregs

Thermoset Prepregs

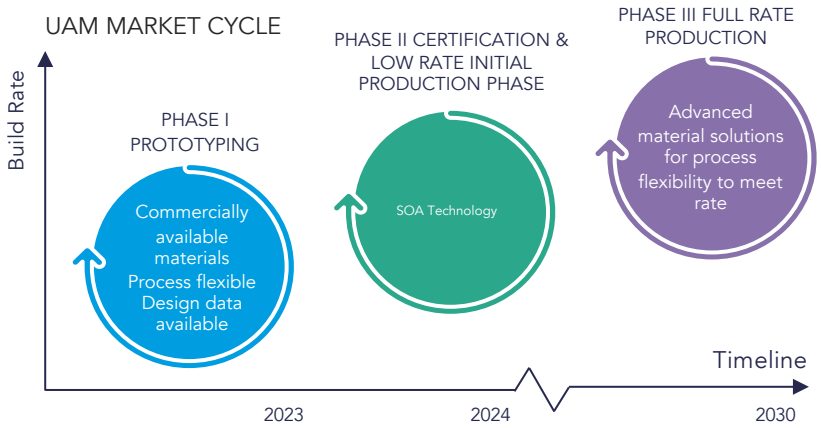
Surface Preparation, Paste and Film Adhesives

LSP Protection

Specialty Polymers

The most diverse advanced material portfolio to meet the UAM market needs

The path to certification and rate



MATERIAL OPTIONS WITH FUTURE RATE IN MIND

- Key focus on technology evolution to understand future needs of the market
- Solvay's offers materials with embedded rate capability to cover multiple phases within the market cycle

Injection Moulding
Thermoplastic

Stamp forming
Thermoplastic

Photo courtesy of ATC Manufacturing

Press Cure + DDF (Double Diaphragm Forming)
Thermoset

PROTOTYPING

- Reactive supply
- Design data
- Meet key design drivers
- Flexible processing to accommodate full supply chain

CERTIFICATION

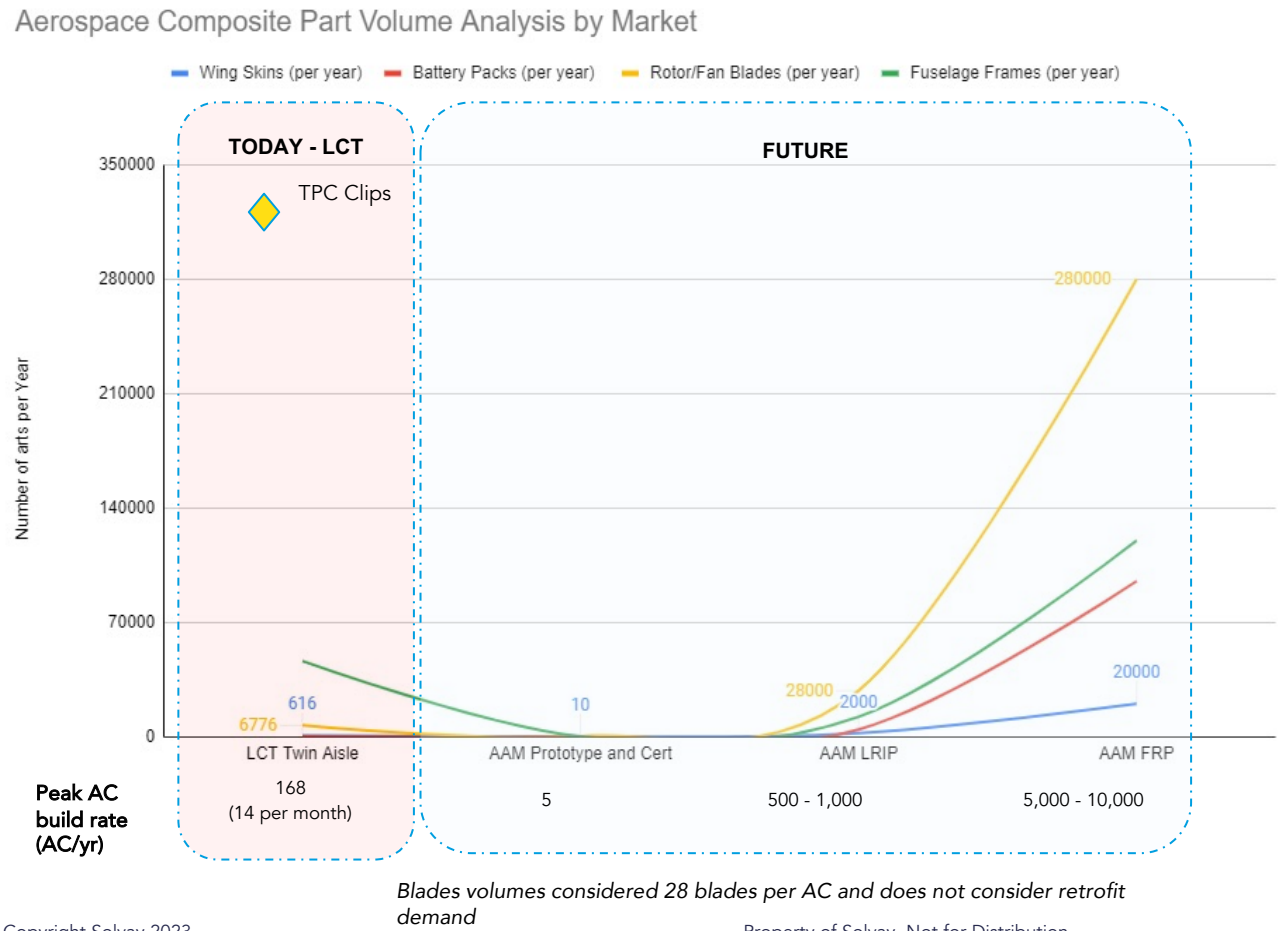
- Reactive and established supply chain
- Design data
- Materials selection tailored to critical design drivers
- Aerospace pedigree
- Core materials NCAMP qualified
- Automation ready
- Aerospace Tier 1 familiarisation
- Complete portfolio solution

AUTOMATED DEPOSITION TECHNOLOGY

- From prepreg UD (AFP/ATL) to fabric (P&P/Press), auxiliary materials, liquid molding, TPC, injection, etc

Solvay is preparing for the future market demands

Potential Part Count for AAM vs. Today's State of the Art

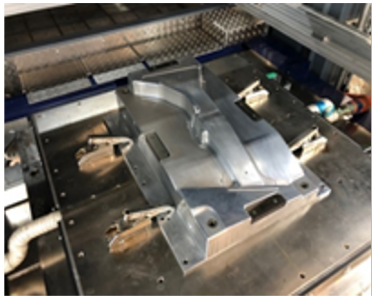


Blades volumes considered 28 blades per AC and does not consider retrofit demand

- AAM could reach part volumes that the aerospace composite industry has not seen before (with exception of some small parts)
- Step change in composite processing times is required
- Blades, battery enclosures and fuselage frames represent examples of high volume components
- Components have different structural and geometrical needs, meaning - a common composite solution may not apply
- Common part count challenge across Next Gen Single Aisle projection

Cycle and Takt Time - Case Study

- Material
  - Resin: CYCOM® EP2750
  - Fiber / Fabric: T650-35 3K 8HS 376 gsm
- Process
  - Double Diaphragm Forming (DDF) at Solvay Heanor, UK facilities
  - Tool Aluminum
- Part Design: B-Pillar
  - Size: 36” x 16” x 2”
  - Thickness: 0.0725” (5 plies)



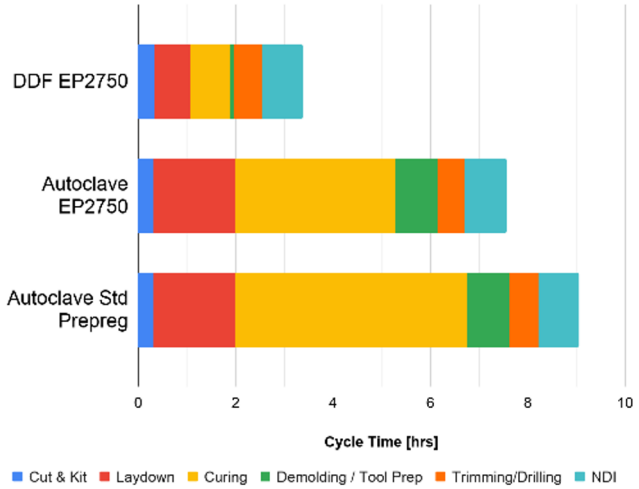
Scenario	Parts per Year	Takt Time [hrs]
Scenario 1	1,000	3.3
Scenario 2	10,000	0.3
Scenario 3	50,000	0.1

Operational Time [hrs/year] = 3,328
*16 hours / day * 260 days / year * 80%*

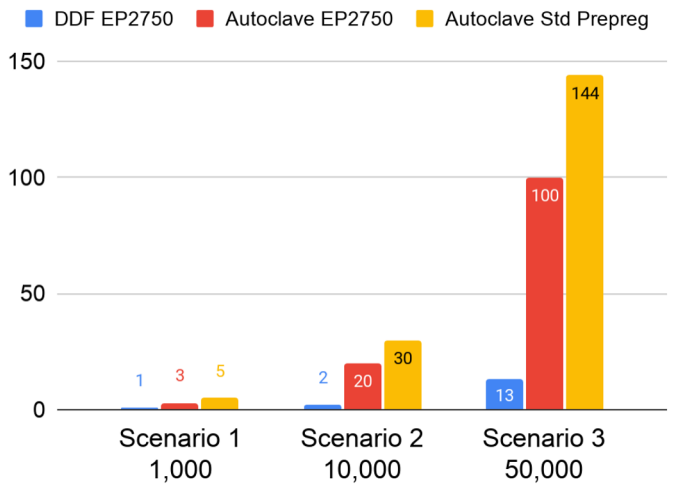
Sub 1 hour Takt times will be required if the AAM market evolves to predicted rates

Cycle and Takt Time - Case Study

Cycle and Takt Time



Number of Tools



Cycle time for autoclave part is approximately 400-500 min
DDF Press Forming reduces cycle time to less than 60 min

Number of tools impractical for 10,000+ parts for autoclave processing

Autoclave manufacturing technology is not enough to satisfy the needs of 10,000+ parts per year

Challenges of the Market - High rate production

Today's Needs - 1,000 SS/yr

Tomorrow's Needs - 10,000 SS/yr

	Low Rate Initial Production			High Rate Initial Production			
	Part Count	Required Takt Time [min]	Current Technology Achievable Takt Time [min]	Part Count	Required Takt Time [min]	Current Technology Achievable Takt Time [min]	Delta
Wing / Fuselage	1,000	300	250-500 (1 cell / tool)	10,000	30	250-500 (10 cells / tools)	
Frames / Ribs	10,000	30	250-500 (10 cells / tools)	100,000	3	250-500 (100 cells / tools)	Need 10x rate
Blades	30,000	10	250-500 (30 cells / tools)	300,000	1	250-500 (300 cells / tools)	Need 100x rate

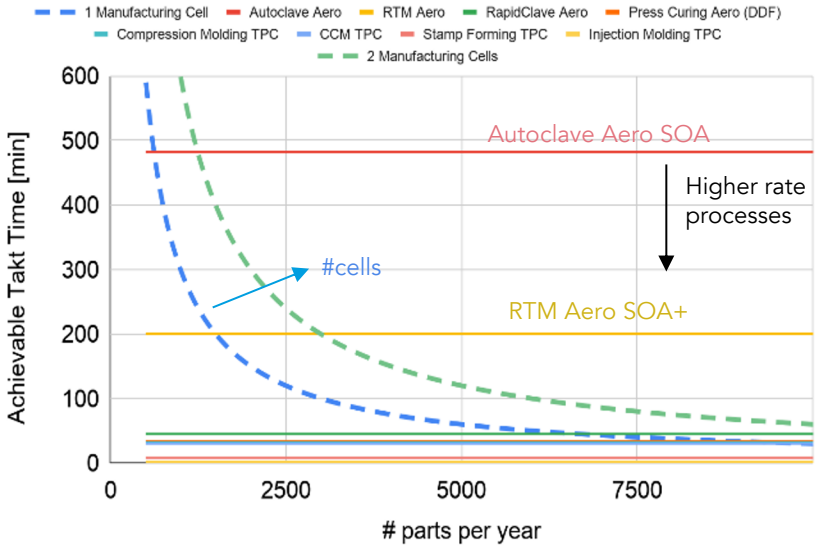
Need composite manufacturing solutions for High Rate Production

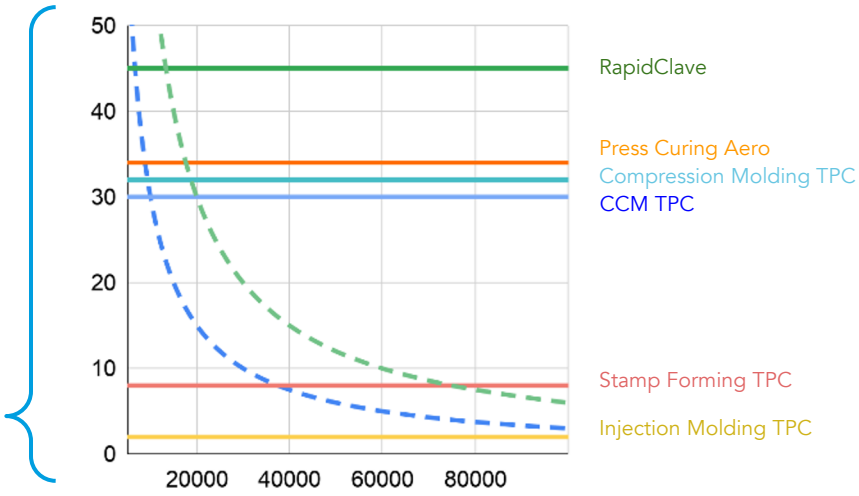
ASSUMPTIONS

*Time on cure tool considered as Takt time
**Consider single part per cure

Working days per year	260
Hours per day	24
Efficiency	0.8
Hours per year	4992
Minutes per year	299,520

Build Rate and Technology Selection for Aerospace





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Several composite manufacturing technologies are being developed and implemented but not yet available for all type of parts

Conclusion

- Low rate initial production manufacturing rates can be accomplished with today's technology
- The future projected build rates of AAM are higher than those seen in the aerospace industry before. NGSA rates are comparable - we are not alone!
- Today's composite technologies will not be enough to meet all of the challenges of tomorrow's manufacturing rate needs
- New and existing manufacturing technologies will need to fully developed to address the gap in manufacturing rates
- Solvay is actively pursuing technology development and its open to partnerships to achieve the goals

All sectors of the composite industry are needed to address the challenges of tomorrow!

Thank You

Progress beyond

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