



Toray Advanced Composites



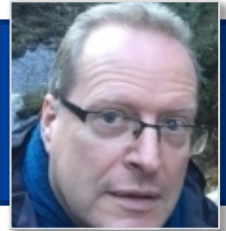
Composite Tooling – Bridging the gap between eVTOL development and series production!

2nd March 2022

Toray Advanced Composites
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CONFIDENTIAL

AmberTool[®]

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Who is TORAY?

FOUNDED
1926

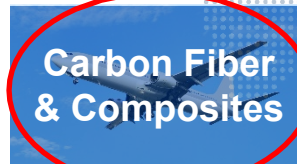
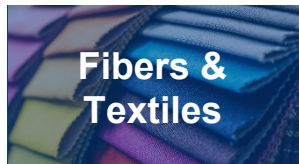
OPERATING
COUNTRIES
29

SUBSIDIARIES
& AFFILIATES
283

'21 ANNUAL
REVENUE
\$16.5B

EMPLOYEES
46,267

BUSINESS DIVISIONS



Aerospace and Industrial applications in synergy

Aerostructures



Space & Communications



High-Performance Industrial



Commercial Aviation



Business Jets & General Aviation



Defense



Radomes



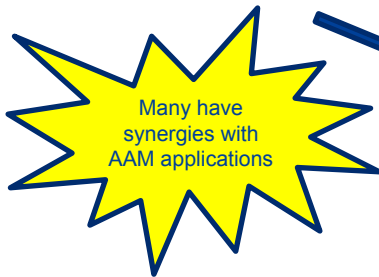
Satellites / Launch



Automotive / Industrial



Consumer



Toray business snapshot – Thermoset materials

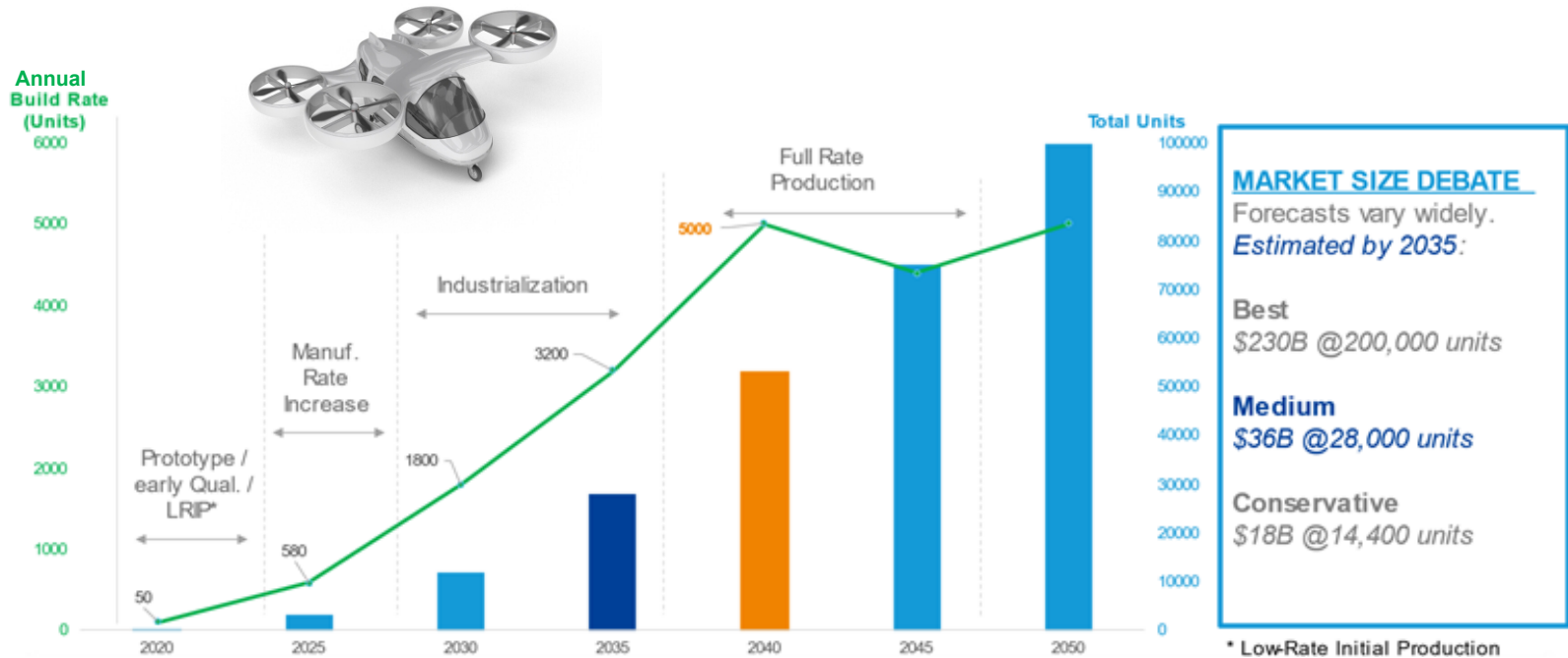
Advanced Composites

- λ Largest supplier of **ultra pure / low dielectric prepregs** for commercial aerospace SATCOM, military and shipboard **radome** structures
- λ Key supplier of **epoxy prepregs** to the **general aviation, launch vehicles, helicopter programs and UAV industries**
- λ The leading supplier of **high modulus advanced composites** for satellite structures
- λ Provider of chopped fiber **compression molded parts** with internal tool design and part fabrication capabilities
- λ Supplier to **high end industrial applications** including F1, niche automotive, sport footwear and recreational
- λ **Key provider of composite tooling prepregs under Toray AmberTool® brand**

AmberTool®



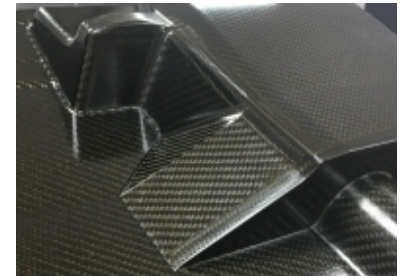
Focusing on AAM market for tooling



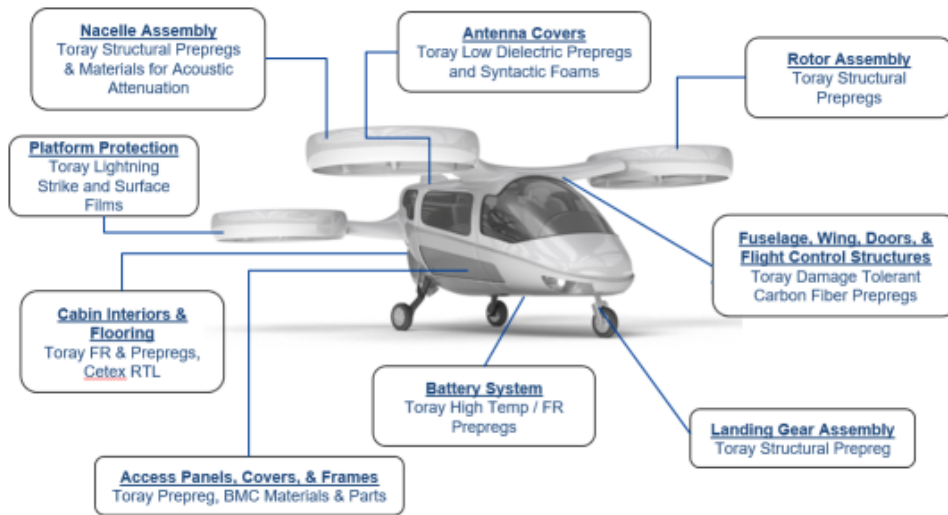
Courtesy SMG

What is AmberTool[®]?

- λ A low temperature curing (60°C) curing epoxy pre-preg system capable of producing medium to high temperature cure tooling
- λ Consists of multiple layers of carbon reinforcement in a quasi-isotropic laminate. Fabric weights 205-990 gsm
- λ Tools allow the efficient delivery of precision components as the Cte of the tool matches the part, minimizing thermal distortion during process
- λ F1 analogy = production of AmberTool[®] from design to part within 48hrs



AmberTool[®] enabling in emerging AAM Markets

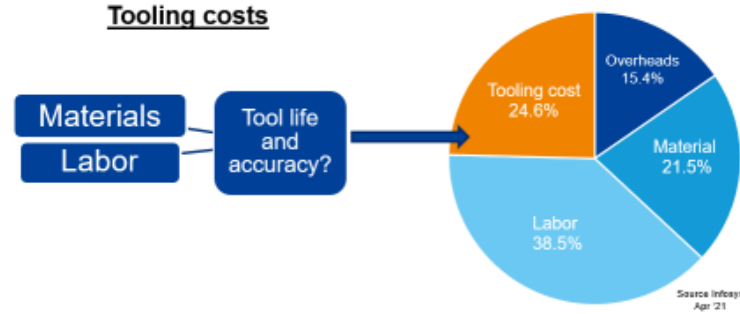


- Very complex geometry!
- Limited production prototypes
- Thermoset to thermoplastic crossover

Toray AmberTool® - “bridging the gap”



Typical project costs



Development

- Complexity of parts
- No. of iterations
- Number of units/sets
- Project lifecycle

Composite tooling

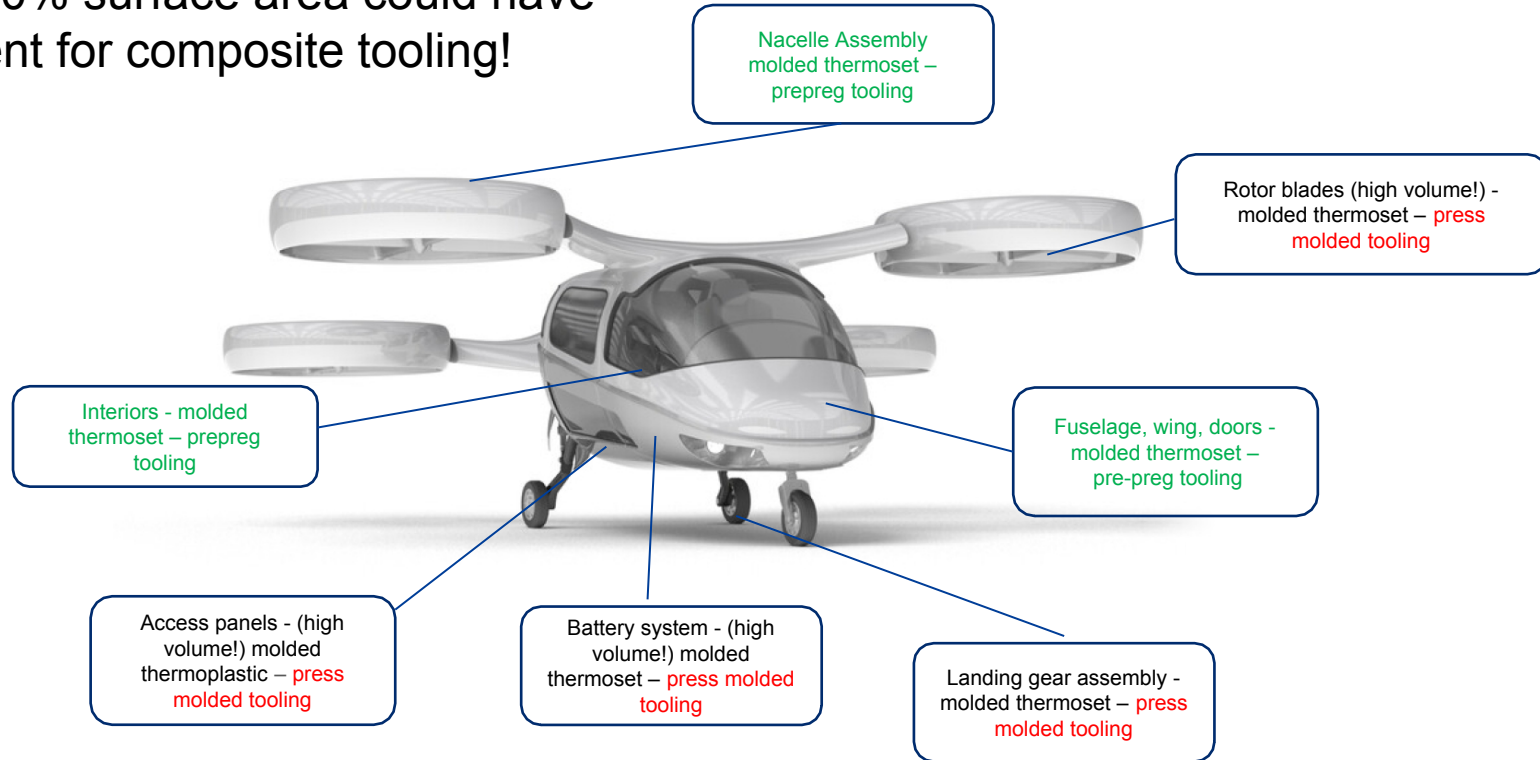
- Master pattern realization
- Quick modification
- Fast iteration cycles
- Thermoset/plastic applications

Production

- Commitment to design
- Modular design allows project lifecycle changes
- Flexibility within delivery timeline
- Parallel tooling sets
- Economies of low mass!

AAM tooling requirements

Estimated 80% surface area could have a requirement for composite tooling!



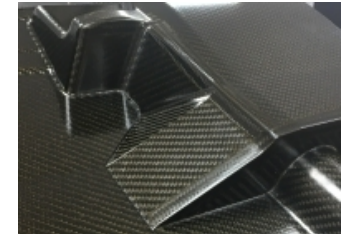
Toray AmberTool® thermoset tooling range

Our product range enables ideal processing conditions in AAM production

Toray AmberTool®	Resin	Tg (onset)**	Min cure temp	Typical cure
HX56	Epoxy	185°C (365°F)	40°C (104°F)	6 hours at 55°C (131°F)
HX50	Epoxy	190°C (374°F)	40°C (104°F)	6 hours at 55°C (131°F)
HX42	Epoxy	211°C (412°F)	50°C (122°F)	8 hours at 60°C (140°F)
HX40	Epoxy	203°C (397°F)	50°C (122°F)	12 hours at 65°C (149°F)
TC40	BMI	213°C (415°F)	182°C (360°F)	6 hours at 182°C (360°F)



Low temp. cure
50-60°C facilitated



'TORAY' AmberTool® tooling products already enable -

- λ Fast routes to producing small to medium production runs
 - Short lead times – raw material availability and process times
- λ Economical production of precision parts
 - Matched CTe delivers fine tolerances
- λ Energy efficient production
 - Low mass tooling supports production economies i.e. heat capacity and improved ergonomics



Conclusion

- λ Toray Advanced Composites are a leading supplier in AAM applications
- λ We work hard to enable our materials in emerging markets, partnering with leading composite manufacturers in successful and efficient prototype to production solutions
- λ Our experience with AmberTool® in related applications across OEM's and a sub-contractors base means are in a unique position to leverage our materials in this pro-active market.
- λ **Toray Advanced Composites and AmberTool® are “bridging the gap” between development and production cycles in AAM markets.**



Thank you!



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