COMPOSITES DEFINING THE FUTURE OF AEROSPACE

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Today the use of composite materials are revolutionizing many products (sporting equipment, boats, cars and airplanes) by enabling new design concepts and applications and breakthrough performance. This trend is driving challenges for design, materials and process and manufacturing engineers. The aerospace industry has been at the forefront of implementation of composites and can be used to highlight some of the current challenges to designing and manufacturing with composite materials.

Our experience with the composites has grown over time from thin and lightly loaded secondary structure using single phase simple resin formulas coupled with standard modulus fibers to highly loaded structure with wide variation in dimensions constructed with multi-phase resins and intermediate modulus high strength fibers. Our material specifications, test methods, analysis techniques and manufacturing procedures have all increased in number but have not necessarily evolved with the material.

The design space for composite materials is moving from simple material replacements in non-critical structure to highly optimized critical structure. This expansion of the design space has put an increased demand on the designer and structural analyst to understand the performance of a composite in complex loadings and environments.

First generation composites were treated as quasi-isotropic - smeared property materials - or in aerospace industry jargon “black aluminum” while 2nd and 3rd generation composites are systems of materials. These systems require an understanding of performance across many scales starting at the polymer, fiber or fiber/polymer interface and ending with the vehicles interaction with the environment

1st generation material development was dominated by empirically generated data with little regard to the potential end use. Computer speed and software sophistication is now enabling “the perfect laboratory” to understand the performance and limitations of new composite material systems subjected to more complex environments. These tools coupled with our laboratory capabilities will allow us to move beyond empirical based development methodologies of the past to a paradigm where material development and optimization might be done inside the design cycle.

Realization of the benefits of this new paradigm poses significant challenges to the composites community and will define the future of our aerospace products.