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FEATURE

The life of a composite: Turning materials data into materials knowledge

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Composite materials have experienced a boom in popularity over the last 40 years, thanks in large part to their weight saving advantages. Modern passenger aircraft, for example, may contain up to 50% composite materials, up from only 6% in the 1980s, and this trend seems set to continue. Compared to conventional materials, such as the aluminium alloys used in aerospace, composites can offer outstanding mechanical properties at lower density. However, engineering with composites can also be both expensive and time consuming, with development and qualification costs for new materials in the tens of millions, and time from conception to implementation measured in years. Engineering organizations continue to optimize composite performance, achieving further weight reductions, but also look to do so at lower cost, and with faster time to market.

The composite lifecycle

In order to achieve this optimization, it is important to consider the entire composite lifecycle. For the purpose of this article we have split the typical composite lifecycle into seven stages (Fig. 1). This lifecycle might be entirely contained within a single organization (for example, a large aerospace company), or may reflect multiple organizations (e.g. material producers, manufacturers, and external qualification experts). In either case, at every stage of this lifecycle engineers and designers must answer questions – does this new material have promise? What applications would best suit the mechanical properties of this composite? How will the geometry of my part affect the properties of the material? How reliable are the values I've calculated from my test data? The answers to these questions have enormous value, and the more accurately they can be answered, the more efficiency can be achieved from the development process. Answering these questions requires the right data. The answers themselves represent materials knowledge – the sum of accurate data, information about the context of the data, and the expertise to use this information effectively.

Developing materials knowledge for an organization is not simply a case of efficiently storing data and information at each

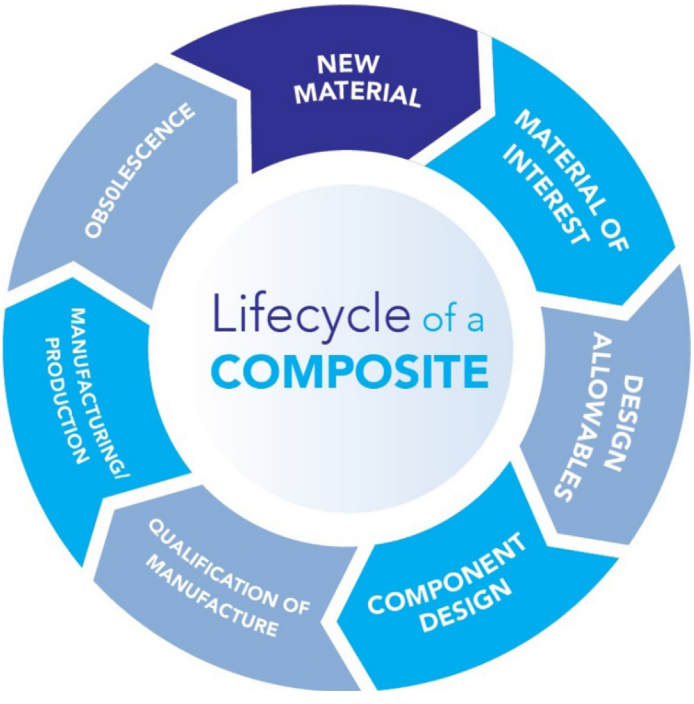

FIGURE 1
Typical lifecycle of a composite.

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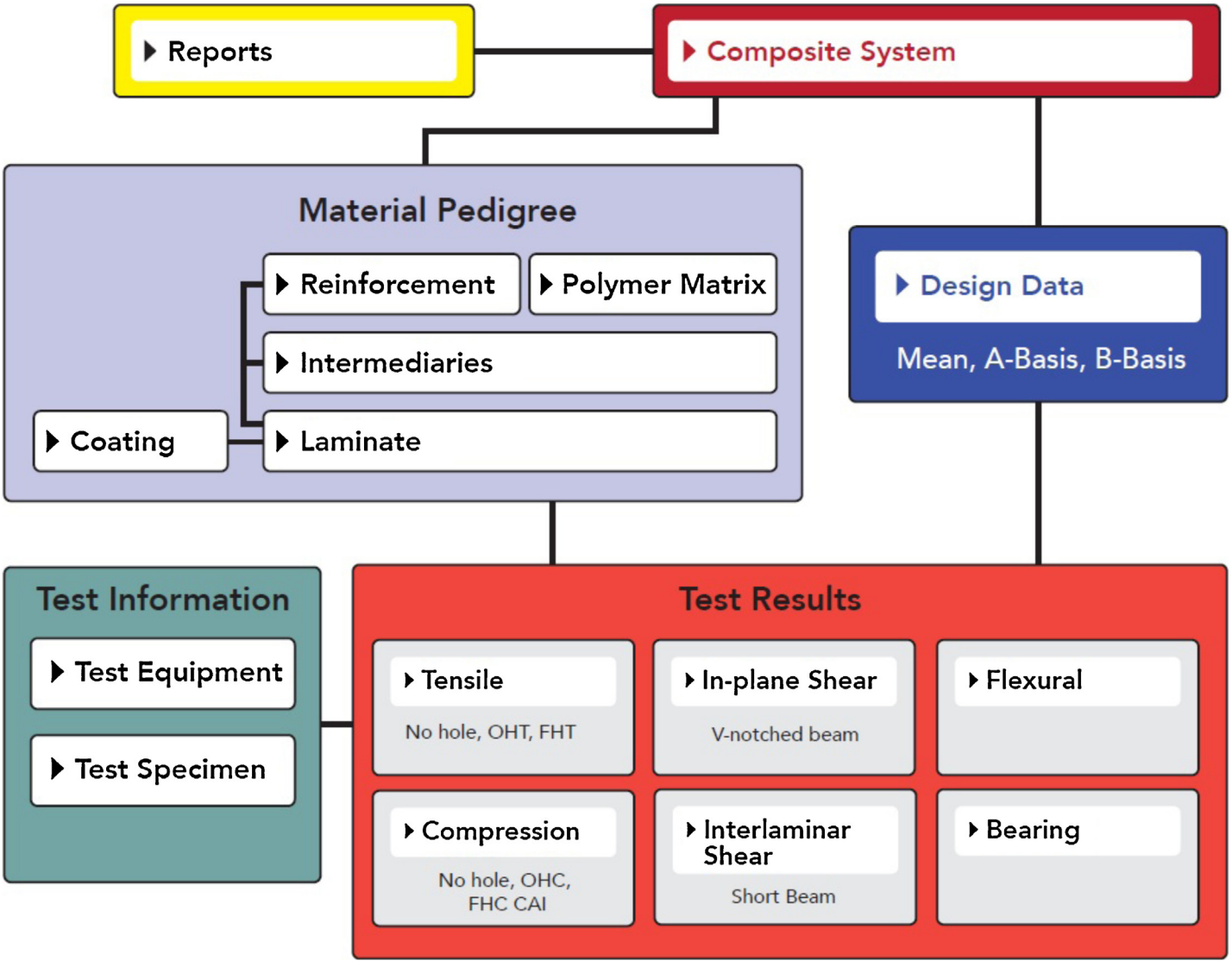

FIGURE 2
A standard schema for managing composites data.

discrete stage of the lifecycle. Information must flow to all points in the process. Clearly, information from earlier stages will be important later – in order to qualify a part for manufacture, an exhaustive history of testing may be required, allowing traceability and providing confidence in the consistency and accuracy of the part's performance. However the flow of information should not be considered to be one-way. Information gathered in later stages may well inform decisions earlier in the lifecycle – for example, material simulations might be refined following results gathered from real-world testing of in-service materials.

Capturing data for re-use in this way is a key theme in presentations given by Dr Steve Arnold, Chief of the Mechanics and Life Prediction Branch at the NASA Glenn Research Center.[1] He highlights the importance of ensuring that all historical test and simulation data is systematically saved and made accessible, increasing the likelihood of extracting value from this data in future projects. Dr Arnold is chair of the Material Data Management Consortium (MDMC), a collaborative project focused on developing systems for managing mission-critical materials data in the aerospace, defense, and energy sectors. Members include Airbus Helicopters, Boeing, Honeywell Aerospace, NASA, and Rolls-Royce.

Creating a solution

The MDMC is focused on the idea that supporting the flow of materials information through the development process requires software systems to control and centralize this data, and then make it available throughout the product lifecycle. Nowhere is this more relevant than when working with composites. The greater the ability to integrate and standardize the data, the more effectively it can be used to bring about enterprise wide improvements. With all lifecycle composite data managed in one place, it is possible to intelligently link this data, using raw data to develop and enhance information and knowledge, which can itself be captured for later re-use.

In addition, capturing all data in one location greatly reduces the chance of data loss, and thus the likelihood of unnecessary duplication of testing or analysis. Boeing's Joe Sharp, who heads

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