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Stimulated Simulation Methods for Accelerated Fatigue Characterizations

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Reifsnider and Case (2002) have recently discussed a methodology for combining the effects of multiple physical phenomena (like fatigue and creep) to estimate long-term performance metrics (like remaining strength and life) in the presence of changes in material states and stress states. This methodology was originally conceived to enable the application of composites to high-performance aircraft, including the F-16 in the 1980's, with the help of several industrial partners. The most common operative form of that methodology is a simulation code (called MRLife) which combines data from physical measurables with rate equations and kinetic models of material state changes to simulate, in real time, the performance of composite materials and systems. Halverson has taken the methodology one step further and has shown that one can improve the predictions of performance for a specific component by using at least one of the physical measurables to "stimulate" the simulation in real time, to make a greatly improved prediction of future performance for that specific component. That "stimulated simulation" is the subject of the present paper. In particular, the authors will discuss the use of stimulated simulation to accelerate the characterization of the fatigue response of heterogeneous materials such as specialized composites (including functional composites used in fuel cells). Examples of the accelerating effects of stimulation will be presented. The integration of statistical considerations in the method will also be discussed.

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