MULTISCALE DESIGNER:

A DESIGN FRAMEWORK SUPPORTED BY MINIMAL TESTING

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ABSTRACT

Development of accurate computational models for composite materials presents a challenge for industry practitioners. The input parameters of a multiscale model for a composite material are the properties of the constituent materials, e.g. carbon fiber and epoxy. It is often not possible to fully characterize a complex constituent material like carbon fiber by performing experiments on the constituent in isolation, and even if possible, manufacturing processes may result in different in situ properties. A stochastic, multiscale-multiphysics software package, known as Multiscale Designer, addresses these difficulties. Multiscale Designer aims to provide predictive and computationally efficient multiscale material models that require a minimum number of experimental tests to specify the material parameters. The approach to determining the parameters is based on rigorous inverse calibration, and within Multiscale Designer, this inverse calibration is automated and highly accessible to practicing engineers. In particular, the stochastic approaches provide crucial insight into the reliability of the inverse solution, and can inform the analyst when the lack of a particular experimental observation negatively impacts the solution. The salient features of Multiscale Designer are: (i) arbitrary numbers of spatial scales, (ii) a unique model reduction scheme that reduces the computational cost of complex n-scale material systems, (iii) stochastic reverse engineering procedures that reliably identify material properties at multiple spatial scales, (iv) multiple temporal scales with application

to fatigue, and (v) seamless integration in major commercial finite element codes. The talk will include a brief overview of the involved multiscale theories and of applications within both the aerospace and automotive industries.