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DESIGN, OPTIMIZATION, AND AUTOMATED FABRICATION OF NON-CONVENTIONAL COMPOSITE LAMINATES

Zafer Gürdal

McNAIR Center for Aerospace Innovation and Research
Professor and Ronald E. McNair Endowed Chair Holder
Department of Mechanical Engineering
University of South Carolina,
Columbia, SC 29208
gurdal@cec.sc.edu

Developments in automated composite production technologies enable rapid penetration of composite materials into many different products. In addition to providing a fabrication process that reduces the production cycle time, automated processes are natural solution to address problems associated with variability in quality resulting from the manual processes. However, the real advantage of such processes for designers is the possibility to build non-conventional layups with innovative features that will allow better exploitation of tailoring potential of composite laminates.

The presentation will start with a brief introduction to the McNAIR Center which is established to address the needs of aerospace community in education, research, outreach, and economic development regionally in South East United States, and grow to become a nationally and internationally recognized institution. Mission and activities of the McNAIR Center and associated research Labs and Centers will be brief described.

After providing a brief introduction to non-conventional laminates, the talk will demonstrate their advantages through analysis and test results. A new multi-step design methodology that allows design optimization of large scale composite parts with large number of discrete orientation angles will be introduced. The new methodology makes use of lamination parameters, which provide a simple way of representing the stiffness properties of a multi-layered laminate with only a few variables. The first stage of the design utilizes a novel optimization scheme based on cellular automata paradigm for continuous design variables using optimality criteria. After obtaining optimal distribution of lamination parameters a guide-based Genetic Algorithm approach is applied in the second step to generate the fully blended solution with discrete stacking sequence. In the last step fiber-paths are generated using fluid flow analogy.