

## New Design Tools to Expand Use of Composite Materials (con't.)

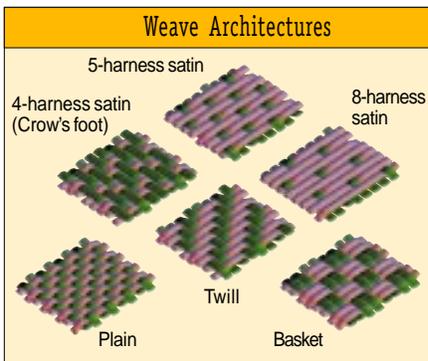
[continued from page 3...](#)

Dr. Mackin employs a thermoelastic infrared (IR) imaging method to measure full-field surface stresses in damaged composites caused by weather-related, accidental injury, or battle-damage type incidents. Dr. Sottos has investigated the micro-mechanics of interface damage such as that typically found in the layered material of an aircraft's wing skin. The infrared imaging method provides a precise quantitative measure of the current stress state, the evolution of damage during loading, and the resulting stress redistribution. Recent application of the IR method on polymer composites enabled a quantitative measure of impact damage and provided a new method for accurately predicting the remaining fatigue lifetimes of the damaged composites.

### OPTIMIZED FIBER-MATRIX DESIGN PATTERNS

Dr. John Whitcomb of Texas A&M University has developed a three-dimensional simulation model for evaluating textile composites. Results indicate that the very complex process of damage initiation and growth can be predicted. The model traces damage evolution in textile composites subjected to thermal and mechanical loads and evaluates the relative influence of different fiber architectures such as woven, knitted, and braided patterns. The computational model evaluates several factors including fiber material properties, degree of waviness (texture), and the phase of undulation in adjacent fibers. Use of this new model will allow material designers to develop strategies for avoiding premature failures.

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### Research Highlights

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[Cover Story - continued from page 2...](#)

Boeing Phantom Works. On many projects it has cut controller design effort by at least 50 percent. Besides the JDAM and MMTD, several other programs use the AUTOGAIN system including the Tomahawk cruise missile, the BQM-74 (Navy target drone), and the 4<sup>th</sup> Generation Escape System program.

Under AFOSR basic research support, Dr. Wise augmented these design tools in an important way. He developed new control system robustness analysis algorithms that have proved instrumental in analyzing a flight control system's dependency on knowing uncertain aerodynamic parameters. This analysis problem was of critical importance on the 4<sup>th</sup> Generation Escape System program where the mass properties

and aerodynamic characteristics significantly vary between the 95 percent male pilot and 5 percent female pilot population. Wise's algorithms were used to accurately determine that the ejection's seat flight control system would perform over this wide range of parameters, culminating in the first ever supersonic ejection seat flight test at Holloman AFB, N.M.

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