NASA/University JOint VEnture (JOVE)Program

FINAL TECHNICAL REPORT

Date: April 17, 2001

NAG8-1269 Grant Number	Report Period:	Sept. 1996 - Aug. 2000 (1yr extension) From To

Sam Bogan Name	bogan@charger.newhaven.edu E-Mail Address

Transverse Shear Moduli using the Torsional Reponse of Rectangular Laminates
Research Title

Institution Name: University of New Haven

Address: 300 Orange Avenue

West Haven, CT 06516

NASA/University JOint VEnture (JOVE)Program

FINAL TECHNICAL REPORT

I. **Summary of Research**
The following represents a comprehensive summary of significant accomplishments over the duration of the grant. ***(Attach additional page(s) and/or relevant documentation as necessary.)***

The first year included a study of the non-visible damage of composite overwrapped pressure vessels with B. Poe of the Materials Branch of Nasa-Langley. Early determinations showed a clear reduction in non-visible damage for thin COPVs when partially pressurized rather than unpressurized. Literature searches on Thicker-wall COPVs revealed surface damage but clearly visible. Analysis of current Analytic modeling indicated that that current COPV models lacked sufficient thickness corrections to predict impact damage. After a comprehensive study of available publishe data and numerous numerical studies based on observed data from Langley, the analytic framework for modeling the behavior was determined lacking and both Poe and Bogan suggested any short term (3yr) result for Jove would be overly ambitious and emphasis should be placed on transverse shear moduli studies.

Transverse shear moduli determination is relevant to the study of fatigue, fracture and aging effects in composite structures. Based on the techniques developed by Daniel & Tsai (JAM 6/90) Bogan and Gates determined to verify the results for K3B and 8320. A detailed analytic and experimental plan was established and carried out that included variations in layup, width, thickness, and length. As well as loading rate variations to determine effects and relaxation moduli. The additonal axail loads during the torsion testing were studied as was the placement of gages along the composite specimen. Of the proposed tasks, all of tasks 1 and 2 were completed with presentations given at Langley, SEM conferences and ASME/AIAA conferences. Sensitvity issues with the technique associated with the use of servohydraulic test systems for applying the torsional load to the composite specimen limited the torsion range for predictable and repeatable transverse shear properties. Bogan and Gates determined to diverge on research efforts with Gates continuing the experimental testing at Langley and Bogan modeling the apparent non-linear behavior at low torque & angles apparent from the tests.

Included in the NASA Jove research was outreach components to local schools and school teachers. Dr. Bogan gave numerous presentations each year 96-2000 to high school and college students on NASA research, collected and redistributed NASA teacher resource materials from Virginia Air&Space to New Haven teachers. Provided mentoring to two graduate students, one entered the Ph.D. Composite Engineering program at Georgia Institute of Technology and recently graduated.

NASA/University JOint VEnture (JOVE)Program

FINAL TECHNICAL REPORT

II. Subject Inventions

Provide a complete list of all subject inventions or patents resulting from work performed under the award or provide a statement that there were none.

No applications for patents or inventions were made.

Signature

April 17th 2001

Date

For Summaries of Research and published reports, one Micro-reproducible copy shall be sent to the NASA Center for AeroSpace Information (CASI), Attn: Acquisitions Department, 7121 Standard Drive, Hanover, Maryland 21076-1320.