FY04 Technical Program Summary

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Vehicle Technology Directorate -
Langley Site
US Army Research Laboratory
at
NASA Langley Research Center
Hampton, VA 23681-0001

The ARL Vehicle Technology Directorate at the Langley Research Center conducts research in two business areas:

Structural Mechanics and
Loads & Dynamics

Program areas funded under these technical competencies include basic (6.1) and applied (6.2) research in Aviation Technology and Ground Vehicle Technology. The following "Table of Contents" outlines the organization of the work packages and individual research projects within this document.

Aviation Loads & Dynamics Research - 6.1 - 61102 / AH66 / VS1015

VS1015.AL05	Aeroelastic Modeling of Advanced Rotor Configurations
VS1015.AL06	High Performance Piezoelectric Actuator Development
VS1015.AL07	Lightweight Multifunctional Structural Components Development
VS1015.AL08	Fuselage Dynamics and Tail Buffet
VS1015.AR01	Structural and Material Characteristics of Biological Morphologies
VS1015.DC01	Crashworthiness of Composite Frames and Floor Sections
VS1015.DR14	Modeling of Thin Membrane Structures

Ground Vehicle Loads & Dynamics Research - 6.1 - 61102 / AH42 / VS1016

VS1016.DC02	Nonlinear Mechanics of Elastomeric and Composite Structures

Aviation Structural Mechanics Technology - 6.2 - 62211 / A47B / VS2011

VS2011.CA02	SARAP Crash Safety Research Program
VS2011.CD01	Damage Initation and Growth Studies in Tailored Laminates
VS2011.IC02	Skin/Stiffener Debonding Analysis Methods
VS2011.IC03	Exploratory Research on Adaptive Sensors for Composite Rotorcraft
VS2011.IC04	Failure of Rigid Foams
VS2011.IF04	Z-pin Reinforcement Analysis
VS2011.IF08	Fatigue Life Methodology of Metallic Rotorcraft Dynamic Components
VS2011.IF11	Impact Damage Resistance & Tolerance of Thin Skin Composite Sandwich Structure
VS2011.IF12	Reliability-Based Design Methods
VS2011.IN01	Composite Thermal Nondestructive Evaluation
VS2011.IN07	SARAP NDE/Reparability Program

Ground Vehicle Structural Mechanics Technology - 6.2 - 62105 / AH84 / VS2012

VS2012.CA01	Research on Ground Combat Vehicles
VS2012.CA02	Buckling - Vibration Interaction
VS2012.CA03	Analysis of Structural Joints for Ground Vehicles
VS2012.CA04	Inflatable Structures
VS2012.CD01	Selective Reinforcement of Aluminum Structures
VS2012.CD02	Multi-Functional Structures
VS2012.IN07	NDE of Composite Structures Using Laser Ultrasonics
VS2012.IN12	NDE of Electrical Wire Insulation Using Ultrasonics

Aviation Loads & Dynamics Technology - 6.2 - 62211 / A47B / VS2015

VS2015.AA02	High-Speed Aeroelastic Research Models
VS2015.AE03	High-Voltage Electrical Systems
VS2015.AL04	Experimental Investigation of Active Twist Rotor Concepts for Vibratory Load Reductio
VS2015.AL05	Analysis and Design of Active Twist Rotor Blades
VS2015.DC08	Innovative Composite Fuselage Design for Improved Crashworthiness
VS2015.DC09	Soft Soil - Water Impact
VS2015.DC11	Crash Simulation of an ATR42 Aircraft
VS2015.DT01	Applications of Structural Tailoring Concepts

Ground Vehicle Loads & Dynamics Technology - 6.2 - 62105 / AH84 / VS2016

Date Last Modified: 11-JAN-04

BUSINESS SUBAREA:	6.1		LOADS & DYNAMICS	
PE/PRJ/WP#/WP:	61102	AH66	VS1015	Aviation Loads & Dynamics Research
DIRECTORATE/DIVISION	Vehicle Technology Directorate		Loads & Dynamics	
POC/PHONE:	Dr. Mark W. Nixon		(757) 864-1231	

THRUST:

Develop and enhance advanced methodologies for high speed rotorcraft concentrating on low vibration and increased aeroelastic stability margins, and conduct basic research experiments to validate these methods.

Develop and validate advanced analytical models for multi-body kinematics and dynamics with emphasis on improvements in modeling crashworthy structures.

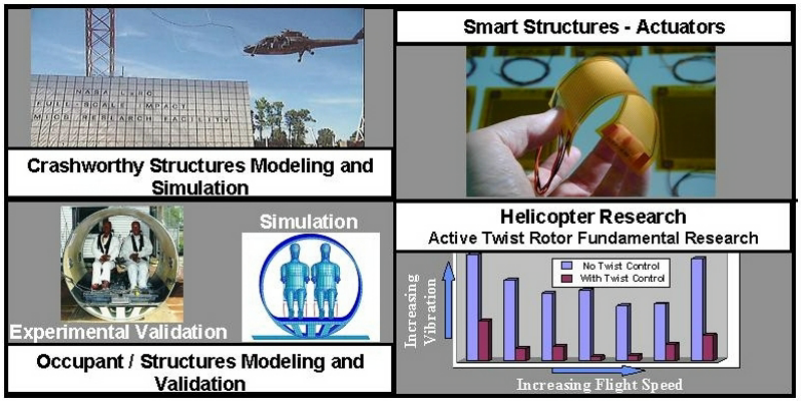
OBJECTIVES:

Develop analytical capability for the accurate prediction of rotorcraft loads and stability in steady-level flight.

Develop advanced methodology and concepts to reduce rotor vibration levels with "on-blade" active control using "smart structures" embedded in the blade.

Develop advanced lightweight hub concepts for future rotorcraft.

Improve capability of modeling composite failure mechanisms critical to a/c crashworthy designs to reduce EW/GW ratio of aircraft structures.



PROGRAM SCHEDULE:

RESEARCH STUDIES	2003	2004	2005	2006	2007
Aeroelastic Modeling of Advanced Rotor Configurations		▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
High Performance Piezoelectric Actuator Development		▪▪▪▪			
Lightweight Multifunctional Structural Components Dev	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	
Fuselage Dynamics and Tail Buffet		▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Structural and Material Characteristics of Biological Mo	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Crashworthiness of Composite Frames and Floor Sections	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Modeling of Thin Membrane Structures	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪

FY04 KEY DELIVERABLES:

- Develop flexible extensions to aeroelastic tiltrotor analysis and perform parametric study for soft-inplane hub configurations.
- Provide technical support to MFC commercial manufacturer, as required under NASA SAA.
- Further characterize single-crystal actuator devices.
- Complete fabrication of prototype PZT micro-truss actuator for membrane interface control applications
- Initiate FEA-based analyses to evaluate active control methodologies for tail buffet
- Design & initiate fab of non-active dynamically-scaled elastic fuselage section
- Develop and complete FEM of resonant flapping flight design and assess baseline structural dynamic/aeroelastic response
- Develop LS-DYNA model of braided frames for dynamic test data correlation.
- Develop other computational tools that can assisst in test analysis correlation.

This chart covers Fiscal Year 2004

Business SUBAREA:	6.1		LOADS & DYNAMICS	
PE/PRJ/WP#/WP:	61102	AH66	VS1015	Aviation Loads & Dynamics Research

Workyears	2003	2004	2005	2006	2007
ARMY	3.9	4.3	4.4	4.2	3.7
NASA	1.5	2	2.1	1.7	1.1
OTHER	.95	1	.5	.7	.3

LOADS & DYNAMICS

OBJECTIVE

The objective of the basic research program in vehicle loads & dynamics is the development of the efficient use of composite and active materials in the design and control of aviation structures to: 1) reduce rotor system vibratory loads (both fixed and rotating system) through active "on-blade" control methods and passive structural tailoring techniques and, 2) enhance rotorcraft aeroelastic and aeromechanical stability - through active control methods and passive structural tailoring techniques, and 3) enhance crew and passenger survivability in a crash environment with Energy Absorbing structures.

APPROACH

The rotorcraft dynamics (vibratory loads and stability) function represents a major thrust area of this research. It includes research in active and passive methods to reduce vibration and increase stability margins for conventional and advanced high speed rotorcraft. The "on-blade" active control research utilizes advanced comprehensive methods such as CAMRAD II and in-house developed codes to assess the vibration reduction potentials of smart structures applied to rotor blades as well as providing the tools necessary to develop appropriate-efficient control laws to implement the concepts. This research is a fundamental program supporting the Rotary Wing TDA technology effort objective in vibration reduction. It represents one of the three (3) programs in the TDA developed to demonstrate that the goals are achieved. The tiltrotor program includes utilization of and advanced development of comprehensive methods such as DYMORE and UMARC/G in the area of composite structures for tailoring the rotor systems to reduce vibration and improve aeroelastic stability. This technology contributes to satisfying the growing need for an improved commuter transport as per objectives of NASA, and is a key component of the Army heavy lift rotorcraft development that is anticipated to become part of the FCS needs.

SIGNIFICANCE

The technology benefit of this joint Army/NASA basic research in loads & dynamics will be a better understanding of the dynamic interaction of composite structures in Army vehicles, and more effective methods for their prediction. The ultimate payoff for the Army will be more accurate, more efficient, and more reliable analytical tools for designing structures to meet the dynamic requirements of the Army in the future with weight, performance, and cost as driving factors. DOD Technology Objectives supported include Demonstration of Advanced Rotor Concepts (DARC), and Rotary Wing Structures Technologies (RWST). The Armys Science and Technology Objectives includes the Advanced Rotorcraft Aeromechanics Technologies (ARCAT), Variable Geometry Advanced Rotorcraft Technology, and Low Cost Active Rotor (LCAR).