ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE
2 - Applied Research	**0602211A - AVIATION TECHNOLOGY**

	COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
	Total Program Element (PE) Cost	39383	43280	42013	41598	41194	41977	40295
47A	AERON & ACFT WPNS TECH	27568	35157	37761	37297	36869	37556	35775
47B	VEH PROP & STRUCT TECH	4261	4147	4252	4301	4325	4421	4520
47C	ROTORCRAFT COMPONENT TECHNOLOGIES (CA)	7554	3976					

A. Mission Description and Budget Item Justification: The Aviation Technology program element (PE) conducts applied research applicable to both manned and unmanned rotary wing vehicle (RWV) technologies in support of the Future Force and, where feasible, exploits opportunities to enhance Current Force capabilities. Emphasis is on developing rotary wing platform technologies to support manned and unmanned rotary wing vehicle combat and combat support operations for attack, reconnaissance, air assault, survivability, and command and control missions. Technologies that enable autonomous flight, higher aerodynamic loads, lower detectability, and increased maneuverability are emphasized. Increased effort is being placed on technologies to increase both manned and unmanned aircraft survivability, crashworthiness, and crew protection. Prognostics and diagnostics technologies are being developed and evaluated to support Condition Based Maintenance (CBM) efforts desired to reduce Operating and Support (O&S) costs of Current and Future Force airframes. This PE advances integrated unmanned operations through autonomous collaboration and refinement of unmanned technologies. This PE also supports the National Rotorcraft Technology Center (NRTC), a partnership of government, industry, and academia. Project 47C funds congressional special interest items. Efforts under this PE transition to projects supported by PE 0603003A (Aviation - Advanced Technology). Department of Defense (DoD) systems such as the AH-64 Apache, UH-60 Black Hawk, CH-47 Chinook, Armed Reconnaissance Helicopter, Light Utility Helicopter, the U.S. Navy SH-60 Seahawk, and U.S. Marine Corps V-22 Osprey, AH-1 Cobra, and CH-53 Super Stallion benefit and are supported directly or indirectly by this PE. This PE does not duplicate any efforts within the Military Departments. The Army is the executive agent for the maturation of rotorcraft science and technology on behalf of all Service needs. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy and the Army Science and Technology Master Plan. Work in this PE is performed by the Aviation and Missile Research, Development, and Engineering Center, with facilities located at Redstone Arsenal, AL; Fort Eustis, VA; Moffett Field, CA; and Hampton, VA, and at the Army Research Laboratory, with facilities located at Adelphi, MD; Hampton, VA; and Cleveland, OH.

B. Program Change Summary	FY 2007	FY 2008	FY 2009
Previous President's Budget (FY 2008/2009)	40156	42567	42051
Current BES/President's Budget (FY 2009)	39383	43280	42013
Total Adjustments	-773	713	-38
Congressional Program Reductions		-3287	
Congressional Rescissions			
Congressional Increases		4000	
Reprogrammings	-297		
SBIR/STTR Transfer	-476		
Adjustments to Budget Years			-38

Two FY08 congressional adds totaling $4000 were added to this PE.

($1600) Composite Small Main Rotor Blades
($2400) Aircraft Structural Condition Monitoring (ASCM) for Diagnostics and Prognostics

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - Applied Research	**0602211A - AVIATION TECHNOLOGY**	**47A**

COST (In Thousands)		FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
47A	AERON & ACFT WPNS TECH	27568	35157	37761	37297	36869	37556	35775

A. Mission Description and Budget Item Justification: The Aeronautical and Aircraft Weapons Technology project develops Rotary Wing Vehicle (RWV) technologies for manned and unmanned Army / Department of Defense (DoD) rotorcraft to increase strategic and tactical mobility / deployability; improve combat effectiveness; increase aircraft survivability; and improve combat sustainability. This project supports the Future Force by providing technology to improve capabilities in Force Application and Focused Logistics. Areas of research address desired characteristics applicable to all aviation platforms, such as enhanced rotor efficiencies, improved survivability, increased structure and airframe capability, improved engine performance, improved sustainability, improved mission avionics performance, and reduced cost. This project supports the National Rotorcraft Technology Center (NRTC), a partnership of government, industry, and academia. The propulsion technologies investigated in this project provide improved specific fuel consumption, horsepower to weight ratios, and operation and support (O&S) cost savings for manned and unmanned systems. These engine component technologies address engine needs for future aircraft with up to a 50 percent endurance and 30 percent payload increase projected over currently available turbine engines. Aircraft survivability component technologies include adaptive Infrared (IR) signature suppression of engine and airframe thermal sources, visual signature control, acoustic signature attenuation, in-cockpit threat situational awareness, and survivability re-route decision aiding systems. Advanced active controls, aerodynamics, handling qualities, and smart material (materials that respond to specific stimuli) technologies provide rotors and flight controls capable of increased payload, range, agility, maneuverability, and survivability. Manned / unmanned system interfaces, autonomous collaborative flight controls, flight simulation, weapons and sensor integration, pilot-vehicle interface technologies, and advanced mission equipment packages are being pursued that provide full spectrum engagement, precision, and selectable lethality, suitable for the target and engagement scenarios. The operations and sustainment technologies provide advanced prognostic / diagnostic algorithms necessary to implement Condition Based Maintenance (CBM). This project leverages work accomplished in collaboration with the National Aeronautics and Space Administration (NASA). Technologies within this project transition to advanced technology development programs with application to future, as well as current, Army / DoD rotorcraft systems. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed by the Aeroflightdynamics Directorate of the Aviation and Missile Research, Development, and Engineering Center (AMRDEC), (located at the NASA Ames Research Center, Moffett Field, CA; and the NASA Langley Research Center, Hampton, VA); and the Aviation Applied Technology Directorate, Fort Eustis, VA. Work in this PE is related to and fully coordinated with program elements 0603710A (Night Vision Advanced Technology); 0603624A (Weapons and Munitions Technology); and 0602203A (Missile Technology).

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
National Rotorcraft Technology Center (NRTC): In FY07, incorporated and evaluated fluid damper and magnetic-particle damper models in comprehensive analyses. Designed and tested wireless proximity sensors. Conducted passive layered isolator flight test demonstration. Performed simulation test of ad-hoc networking of rotorcraft teams. Developed advanced sensors and networks for a practical condition based maintenance implementation. Designed improved crashworthy armored seats. Developed metal matrix composite design for airframe applications. Designed drive train torque measurement system. In FY08, perform wind tunnel tests of rotor designs with improved static/dynamic stall characteristics. Test oscillatory jets on rotor airfoils to assess effect on aerodynamic improvements. Perform qualification test on improved drive system gears. Test improved crashworthy armored seats. Test metal matrix composite design for airframe applications to assess structural suitability as a substitute for a titanium structure. Investigate and evaluate a drive train torque measurement system to aid in assessing loads on the system. In FY09, will perform bird strike and head impact	7464	8262	8616

simulations for rotorcraft crashworthiness and survivability. Will conduct certification testing and probabilistic analysis to evaluate damage tolerance methodologies. Will test advanced drive system designs for noise and wear characteristics. Will evaluate active crash protection system for application to rotary wing unmanned aerial systems.			
Rotor Technology: In FY07, wind tunnel tested active/passive integration techniques for enhancement of on-blade controls, both for blade section concepts as well as two model rotor designs. Validated an analytical model of the system. In FY08, evaluate, via wind tunnel tests, on-blade control for model rotor system to include performance enhancement and primary control.	4203	3269	
Aircrew Survivability Technologies: In FY07, developed cognitive decision aiding (CDA) planners that enable a manned/unmanned team to respond to pop-up threats as a team, and not just as individual platforms. Integrated and evaluated the performance of the CDA planners with the Threat Lethality Predictor (TLP) algorithms. In FY08, develop CDA-TLP specific cockpit controls, displays, and aural cues. Refine performance and mission effectiveness goals using simulation. Initiate development of crash criteria (that establishes required G-loads that structures such as engines and transmissions must withstand before breaking-away during a crash and threatening the integrity of crew-occupied areas) for "full-envelope crashworthiness" based on rotorcraft size class and mission type. Develop conventional ballistic threat and advanced crew protection concepts followed by preliminary designs for selected concepts. In FY09, will develop updated design guidelines based on emerging criteria. Will complete preliminary design of a quiet propeller for Class 2/3 UAS such as Shadow 200. Will develop and test innovative techniques for reducing detection of propeller and rotor driven aircraft by threat systems. Will develop analytical tools (executable software) required to evaluate both material behaviors during ballistic and high energy impact events.	4015	7041	7173
Rotorcraft Airframe Technology: In FY07, refined multifunctional structure technology, reducing parasitic weight by adding capabilities to primary structure (e.g., integrated armor). Modified technologies to improve structural efficiency and lower design load uncertainty on airframe/rotor structures. Developed criteria using a strain-allowable approach for repair and continued use of ballistically damaged, life-limited, dynamic structures. In FY08, develop integrity management by fusing loads monitoring and damage detection capabilities to improve safety and survivability. Evaluate ballistic properties and effectiveness of reduced-weight multifunctional structural armor. In FY09, will conduct laboratory testing to evaluate strain-allowable integrity approach; and will develop and evaluate emerging platform concepts and validate modeling fidelity.	2392	1251	4280
Advanced Engines: In FY07, completed fabrication and conducted test of advanced ceramic matrix composite power turbine blades to validate improved performance, reduce weight, and increase durability. In FY08, complete design of advanced compressor for improved engine performance and reduced weight; and complete advanced combustor design, fabrication, and evaluation. In FY09, will complete design of advanced inlet particle separator that improves engine performance and durability. Will complete fabrication of advanced compressor for improved engine performance and reduced weight. Will complete advanced combustor rig-test to validate improved engine performance and structural adequacy.	1360	1965	2046
Network Operations and System Integration and Intelligent and Active Control: In FY07, applied control optimization analysis tools to UH-60M upgrade fly-by-wire control system and evaluated in the Rotorcraft Air Crew Systems Concepts Airborne Laboratory (RASCAL) in-flight simulator. Successfully demonstrated external load stabilization for aerodynamically active slung load, increasing transport speed from 60 to 110 knots. In FY08, investigate stability margin requirements for upgraded/new configuration and integrate aerodynamics and structural dynamics into control systems optimization. In FY09, will expand handling quality requirements and flight control systems for legacy upgrades, multi-role, and heavy-lift rotorcraft and extend autonomous obstacle field navigation with increased agility. Digital Situational Awareness Testbed: In FY07, developed guidelines for control of multiple UAS from a single station (either airborne or ground). In FY08, develop and evaluate supervisory control interface for multiple heterogeneous UAS. In FY09, will conduct	8134	7338	7510

tests of supervisory control techniques for control of multiple UAS. Advanced Rotary Wing Concepts: In FY07, began integration of advanced targeting and stabilization technologies to provide a precision attack capability for rotary wing UAS. In FY08, conduct flight test demonstrations of precision attack capability from test bed UAS operating in support of manned aviation and ground troops in a MOUT environment. In FY09, will conduct flight test demonstrations using different sensors and weapons systems to gauge precision to be expected from rotary wing UAS in varying flight modes, i.e., high and low hover, firing on the move, and moving targets.			
System Concepts Studies: In FY08, initiate design of an analysis environment which integrates higher-fidelity models for aeromechanics and flight controls into the process for design synthesis of rotorcraft configurations. Focus activities on creating significantly improved interfaces between the design synthesis process and other technical disciplines such as Computational Fluid Dynamics (CFD), Computational Structural Dynamics (CSD), and handling qualities assessments. Examine a Variable Speed Tilt Rotor within the analysis environment and use results to refine the overall design of the analysis environment. In FY09, will expand the design of the analysis environment to include the capability to analyze a Slowed Rotor Compound Helicopter. Will investigate interfaces to allow inclusion of other new and emerging technical capabilities and rotorcraft configurations.		1133	2995
Durability and Sustainment Techs: In FY08, initiate development of prognostic algorithms for dynamic rotor head components. Develop predictive models for hydraulics and actuators used for aircraft flight controls (based on Failure Modes, Effects, and Criticality Analysis and manufacturer's analysis of failed components). Evaluate the predictive models based on the fusion of the data-driven and model-based approaches, with bench testing of components to verify the models. Determine placement of corrosion sensors for use in development of corrosion assessment algorithms. Perform rig-testing of ceramic components to characterize the failure modes. Embed sensors in structural components and assess feedback to form basis of damage detection algorithms. Evaluate sensor and loads monitoring feedback methods for structural diagnostics/prognostics and reduction of uncertainty in probabilistic methods for life management. In FY09, will perform rig-testing of dynamic rotor head components, begin bench testing of flight control algorithms on hydraulic actuators, initiate development of prognostic algorithms for ceramic components, develop and begin validation of the corrosion damage algorithms, and assess structural damage detection algorithms. Will evaluate sensor and loads monitoring feedback methods for structural diagnostics/prognostics, and reduction of uncertainty in probabilistic methods for life management.		4512	5141
Small Business Innovative Research/Small Business Technology Transfer Programs		386	
Total	27568	35157	37761

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COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
47B VEH PROP & STRUCT TECH	4261	4147	4252	4301	4325	4421	4520

A. Mission Description and Budget Item Justification: The Vehicle Propulsion and Structures Technology project investigates engine, drive train, and airframe enabling technologies for Department of Defense (DoD) rotorcraft in support of the Future Force, and where feasible, exploits opportunities to enhance Current Force capabilities. The intent is to significantly increase strategic and tactical mobility/deployability, increase reliability, reduce maintenance costs, and increase combat sustainability - all focused on a large reduction in the vehicle's logistics footprint for manned and unmanned rotorcraft. Problems being addressed in propulsion technology include increased fuel efficiency and reduced propulsion systems weight. Technical barriers include temperature limitations for materials, accurate modeling for flow physics, and accurate prediction of propulsion system mechanical behavior. The problem being addressed in structures technology is the inadequacy of current analytical tools to design for acceptable reliability and durability, which leads to heavier, more costly designs, and poor life cycle management. Technical barriers include inadequate structural analysis design tools, inadequate structural dynamics modeling methods for the rotating and fixed system components, inadequate modeling of rotor aeromechanical phenomena, incomplete and non-parametric loads data, and inaccurate inspection and tracking methodologies. Technical solutions are pursued through propulsion and structures research - with a focus on applications towards heavy lift technologies while supporting both manned and unmanned vehicle requirements. Propulsion research is focused on fluid mechanics, high temperature materials, and mechanical behavior for significantly improved small airflow turbine engines, transmissions, gears, bearings, and shaft components for advanced drive trains at significantly reduced weight and cost. This propulsion research supports the goals of the DoD Versatile Advanced Affordable Turbine Engine (VAATE) program. Structures research is focused on the effects of aerodynamic loads, aeroelastic interactions, integrated composites, structural integrity, low cost manufacturing, and crashworthiness that provide improved rotor and airframe structure subsystems. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed by the Army Research Laboratory (ARL) located at facilities at the NASA Glenn Research Center, Cleveland, OH, and the NASA Langley Research Center, Hampton, VA.

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
Rotor and Structure Technology: This effort devises improved tools and methodologies to more accurately design for acceptable reliability and durability, resulting in platforms that are lighter in weight and less costly to acquire and maintain. The FY07 funding was used to validate rotor wake modeling analysis using particle-based vortex tracking method and explore computational prognostic and diagnostic methods to support innovative Army reliability initiatives for the Future Force. In FY08, improve analytical tools of rotor/body and wake flow predictions, investigate aeromechanics design tools to enable the evaluation of new small-scale unmanned air vehicles and micro-scale flapping-wing air vehicles. In FY09, will evaluate new multi-functional structural concepts based on biological systems that are key enablers for future microsystems development. In FY09, will conduct wind-tunnel test on an experimental rotor system (in collaboration with Bell Helicopter and NASA).	1562	747	852
Propulsion and Drive Train Technology: This effort investigates high temperature materials, advanced models for flow physics, and improved methods for predicting propulsion system mechanical behavior to increase fuel efficiency and reduce propulsion systems weight. In FY07, defined thermal behavior and lubrication technologies of high speed, high performance gears, including loss of lubricant conditions, using modeling and a representative high-speed gear train; evaluated heavy-fuel concepts for potential fuel cell applications; completed performance and endurance tests of innovative non-contacting air-to-air seal technology for military helicopter and UAV class	2699	3400	3400

engines. Experimentally evaluated a low conductivity thermal barrier coating system for metals to improve reliability and durability of engine components. In FY08, assess and quantify the baseline performance of model-based diagnostic methodology to accurately detect, determine trends, and isolate engine faults and experimentally evaluate mechanical properties of advanced gear materials to assess their feasibility for use in rotorcraft transmissions. In FY09, will assess the durability of advanced environmental barrier coatings to improve the design of hot section engine components and will experimentally evaluate variable speed transmissions sub-scale components that will enable improvements in rotorcraft maneuverability and noise reduction.			
Total	4261	4147	4252