

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)						February 2006	
BUDGET ACTIVITY 2 - Applied Research			PE NUMBER AND TITLE 0602211A - AVIATION TECHNOLOGY				
COST (In Thousands)	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
Total Program Element (PE) Cost	47536	39424	32804	33747	34126	34423	34681
47A AERON & ACFT WPNS TECH	36398	29807	28472	29540	29876	30136	30362
47B VEH PROP & STRUCT TECH	3904	3999	4332	4207	4250	4287	4319
47C ROTORCRAFT COMPONENT TECHNOLOGIES (CA)	7234	5618	0	0	0	0	0
<p><u>A. Mission Description and Budget Item Justification:</u> The Aviation Applied Research Technology program element (PE) conducts research and expands scientific knowledge 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 teaming in 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. These technologies are assessed for their ability to support the long-term sustainability and reduced logistics required of Future Force airframes. Unmanned technologies are directed toward compatibility with the FireScout, the Organic Air Vehicle (OAV), and the Micro Air Vehicle (MAV). 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). Upgrade activities of Department of Defense (DoD) systems such as the AH-64 Apache, UH-60 Black Hawk, CH-47 Chinook; the U.S. Navy SH-60 Seahawk; and U.S. Marine Corps V-22 Osprey, AH-1 Cobra and CH-53 Super Stallion are included in this PE. This PE does not duplicate any efforts within the Military Departments and supports Project Reliance for which the Army is the lead service for the maturation of rotorcraft science and technology. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Technology Area Plan (DTAP). Work in this PE is performed by the Aviation and Missile Research, Development and Engineering Center, Redstone Arsenal, AL and the Army Research Laboratory, Adelphi, MD, with facilities located at Fort Eustis, VA; Ames Research Center, Moffett Field, CA; Glenn Research Center, Cleveland, OH; and Langley Research Center, Hampton, VA.</p>							

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BUDGET ACTIVITY

PE NUMBER AND TITLE

2 - Applied Research

0602211A - AVIATION TECHNOLOGY

	FY 2005	FY 2006	FY 2007
<u>B. Program Change Summary</u>			
Previous President's Budget (FY 2006)	47780	34295	32370
Current BES/President's Budget (FY 2007)	47536	39424	32804
Total Adjustments	-244	5129	434
Congressional Program Reductions		-174	
Congressional Rescissions		-397	
Congressional Increases		5700	
Reprogrammings	-244		
SBIR/STTR Transfer			
Adjustments to Budget Years			434

Four FY06 Congressional adds totaling \$5700 were added to this PE.

FY06 Congressional adds with no R-2A (appropriated amount is shown):

(\$1200) Aircraft Structural Condition Monitoring (ASCM) for Diagnostics and Prognostics

(\$2500) Center for Rotorcraft Innovation

(\$1000) Composite Small Main Rotor Blades

(\$1000) Mono Tiltrotor Scaled Demonstrator

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COST (In Thousands)	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
47A AERON & ACFT WPNS TECH	36398	29807	28472	29540	29876	30136	30362
<p>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 involve technology applicable to all aviation platforms, with a focus on unmanned aerial vehicle (UAV) systems, manned and unmanned teaming, and opportunities for application on manned systems. These system technologies will provide enhanced rotor efficiencies, improved survivability, increased structure and airframe capability, improved engine performance, improved sustainability, improved mission avionics performance, and reduced cost of unmanned and manned aerial vehicles. This project supports the National Rotorcraft Technology Center (NRTC), a partnership of government, industry and academia. The propulsion component technologies investigated in this project will provide improved specific fuel consumption, horsepower to weight ratios, and operation and support (O&S) cost savings for manned and unmanned Future Force systems. These engine component technologies address engine needs for future UAVs with up to a 50% endurance and 30% payload increase over currently available turbine engines. These component technologies will also enable engine demonstrations for manned systems, providing a 33% increase in payload and a 50% reduction in fuel consumption for the CH-47 Chinook; and an 80% payload increase and a 20% combat range increase for future rotorcraft. 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 survivable re-route decision aiding systems. Advanced active controls, aerodynamics, handling qualities, and smart materials (materials that respond to specific stimuli) technologies will 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. This project leverages work accomplished in collaboration with the National Aeronautics and Space Administration (NASA) and is being adjusted to compensate for severe reductions in rotorcraft activities in NASA's Aeronautics program. Technologies researched within this project will transition to advanced technology development programs with application to future, as well as current, Army / DoD rotorcraft systems. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Technology Area Plan (DTAP). Work in this project is performed by the Aeroflight Dynamics Directorate of the Aviation and Missile Research, Development and Engineering Center (AMRDEC), located at the NASA Ames Research Center, Moffett Field, CA, the NASA Langley Research Center, Hampton, VA, and the Aviation Applied Technology Directorate, Fort Eustis, VA.</p>							
Accomplishments/Planned Program				<u>FY 2005</u>	<u>FY 2006</u>	<u>FY 2007</u>	
National Rotorcraft Technology Center (NRTC) - In FY05, design and develop, then test component technologies that enable rotorcraft performance improvement, limited authority flight control, damage tolerance, and rotorcraft transmission advances. In FY06, design, develop and test components in the areas of damage tolerance of materials, rotorcraft integrated analysis and design, advanced transmission technologies, health monitoring technology, rotor load prediction analysis, and gear noise reduction technologies. In FY07, will design and develop, then test component technologies that enhance manned and unmanned rotorcraft capabilities using active rotor controls, intelligent flight controls, smart composite structures, advanced manufacturing technologies, and advanced subsystem technologies.				6704	7190	7501	

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Rotor Technology [Includes the Low Cost Active Rotor (LCAR) program and the Lightweight Active Rotor Concept (LARC) program] - In FY05, integrated selected candidate lightweight rotor and hub concepts for application of on-blade control and began integrated concept subsystem tests. In FY06, start fabrication of Mach-scale model rotor blades and complete model subsystem tests. In FY07, will complete model blades for the LARC rotor and begin evaluation of on-blade primary flight control.	3783	4147	4224	
Manned / Unmanned Rotorcraft Enhanced Survivability - In FY05, constructed a database of threat sensors, multi-spectral signatures, and clutter and jammer effects and demonstrated real-time threat lethality predictor, with and without jamming, in 3-dimensional terrain environment. In FY06, integrate intelligent decision aid agent to provide cueing for 'what to do' given threat array and integrate intelligent decision aid agent, along with cooperative/collaborative behaviors, to provide cueing for the manned / unmanned team to respond as a team, and not just as individual platforms. In FY07, will demonstrate the Survivability Planner Associate Re-Router (SPAR) system software on manned and unmanned mission management simulators and will integrate SPAR into existing manned and unmanned air vehicle mission management simulation systems and demonstrated.	3795	4032	4108	
Structures and Airframe - In FY05, validated and disseminated improved loads determination tools that are 25% more accurate; conducted bench tests on smart re-configurable airframe and rotors structures; continued efforts to standardize (Joint Service) test methods for durability and damage tolerance certification / qualification of composite structures; demonstrated field and depot level advanced composite airframe inspection and repairs; and evaluated conceptual re-configurable panels, blades and self-healing structures. In FY06, generate and evaluate structures that incorporate ballistic protection and survivability features and evaluate and mature concepts that are self-sensing and self-healing (smart parts). In FY07, will validate Mode III and Mixed-Mode (II & III) fracture mechanics failure modes and test methods to support Durability and Damage Tolerance (D&DT) certification methodology for composite structures and will generate technologies to reduce structural integrity uncertainty for lower load factors on airframes/rotors.	2335	2315	2404	
Small Heavy Fuel Engine (SHFE) - In FY05, completed rig-test of 700 horsepower compressor for improved performance; completed fabrication and evaluated advanced foil bearing components for weight and cost reduction; and continued fabrication of 700 horsepower class ceramic turbine hardware for improved performance and reduced weight. In FY06, complete design of advanced ceramic matrix composite power turbine for improved performance with reduced weight; mature advanced foil bearing via rig-test to validate weight and cost reduction; and complete fabrication and conduct rig-test of 700 horsepower class ceramic turbine to validate improved performance and reduced weight. In FY07, will complete fabrication and conduct test of advanced ceramic matrix composite power turbine blades to validate improved performance and reduced weight and will complete design of advanced technology combustors for reduced engine weight and cost.	1431	977	1391	
Network Operations and System Integration [Includes the Precision Automated Landing Adaptive Control Experiment (PALACE), Handling Qualities & Flight Controls (HQ&FC) Intelligent Control Concepts, and Advanced Rotary Wing Concepts]. PALACE - In FY05, completed full mission simulation of UAV autonomous landing with computer vision-based guidance and flight-evaluated autonomous site selection, descent, and landing in a cluttered environment, without GPS, on a Yamaha RMAX rotorcraft UAV. HQ&FC Intelligent Control Concepts - In FY06, low-altitude 3D navigation through obstacle field using laser radar and stereo cameras and apply advanced control law analysis tools using the RASCAL in-flight simulator for the UH-60M upgrade program. In FY07, will validate closed-loop individual blade control (IBC) with full-scale wind tunnel test; will complete UH-60 Black Hawk flight test with external load stabilization devices allowing increased speed envelope for aerodynamically active sling loads; and will complete piloted simulation and human factors evaluation of multi-UAV operator interface and control techniques. Advanced Rotary Wing Concepts - In FY05, completed characterization of rotary wing UAV platform vibration environment and data link latency issues in order to address stabilization and other system performance characteristics to achieve precision engagements. In FY06, initiated integration of advanced targeting and stabilization technologies to provide a precision attack capability for rotary wing UAVs. In FY07, will conduct flight test	5895	6319	6555	

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demonstrations of precision attack capability from test bed UAV under airborne control from a manned aircraft.			
Unmanned Collaborative Operations [Includes Part 1 of the Unmanned Autonomous Collaborative Operations (UACO) program (Part 2 of UACO is under 63003/313) and Digital Situational Awareness Testbed]. UACO - In FY05, developed three competitive preliminary designs for control of vehicle, mission equipment, and flight management architectures of multiple UAVs; initiated maturation of autonomy and collaboration technologies; and worked with other Government agencies to interface behaviors into a synthetic environment for future independent assessment and evaluating/collection of metrics. In FY06, conduct simulation demonstrations at contractor and government facilities, and flight test the best of the three designs for autonomous collaborative UAV behaviors using multiple small UAVs. Digital Situational Awareness Testbed - In FY05, completed piloted simulation and human factors evaluation of control of multiple UAVs from a manned cockpit. In FY06, evaluated candidate controls/displays for control of multiple UAVs with varying mission requirements. In FY07, will develop guidelines for control of multiple UAVs from a single station (either airborne or ground).	12455	4827	2289
Total	36398	29807	28472

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COST (In Thousands)	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
47B VEH PROP & STRUCT TECH	3904	3999	4332	4207	4250	4287	4319
<p>A. Mission Description and Budget Item Justification: The Vehicle Propulsion and Structure Technology project investigates engine, drive train and airframe 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. The 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 inability to design for acceptable reliability and durability with current tools, 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. The 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. The structures research is focused on the effects of aerodynamic loads, aeroelastic interactions, integrated composites, structural integrity, low cost manufacturing and crashworthiness that will provide improved rotor and airframe structure subsystems. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Technology Area Plan (DTAP). 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.</p>							
<u>Accomplishments/Planned Program</u>					<u>FY 2005</u>	<u>FY 2006</u>	<u>FY 2007</u>
Rotor & Structure Technology [Includes the Survivable, Affordable, Repairable Airframe Program (SARAP), and the Lightweight Active Rotor Concept program] - In FY05, validated reliability-based design methods, durability and damage tolerance analysis methods, lightweight crashworthy concepts, and advanced Non-Destructive Evaluation (NDE) methods in support of SARAP and completed wind-tunnel demonstration of a new lightweight and stable heavy lift tiltrotor concept. In FY06, conduct wind-tunnel tests on a Quad-Tiltrotor model; conduct hover experiments on an advanced active-twist rotor system using the AH-64 Apache as baseline; and evaluate reliability, durability and damage tolerance for tailored and multi-functional composite structures. In FY07, will conduct wind-tunnel test in cooperation with Bell Helicopter to evaluate new heavy lift tiltrotor hub design and will develop multi-functional structural concepts and design tools to reduce ballistic vulnerability for airframes applicable to heavy lift rotorcraft.					1946	1581	994
Propulsion & Drive Train Technology [Includes the Rotorcraft Drive System for the 21st Century (RDS21) program and the Small Heavy Fuel Engine (SHFE) program]. RDS21 - In FY05, conducted experiments and computer simulations of active stall control technologies to extend stable engine operation and investigated autonomous propulsion system technology for future Unmanned Aerial Vehicle (UAV) propulsion control and operation. In FY06, demonstrate and validate active stall control technology. In FY07, will define 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. SHFE - In FY05, performed laboratory endurance tests of face gears to evaluate strength and					1958	2418	3338

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durability. In FY06, evaluate environmental and thermal barrier coatings for silicon nitride turbine nozzles; complete full-scale rig testing and analysis of the lubrication and thermal behavior of high-speed rotorcraft helical gears to allow operation for 30 minutes after loss-of-lubrication supply; and perform rotor-dynamic tests of an oil-free foil air bearing technology that will reduce engine maintenance costs by 50% and weight by 15%. In FY07, will evaluate heavy-fuel concepts for potential fuel cell applications; will complete performance and endurance tests of innovative non-contacting air-to-air seal technology for military helicopter and UAV class engines; and will demonstrate and test a low conductivity thermal barrier coating system.			
Total	3904	3999	4332