ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)

February 2003

BUDGET ACTIVITY
2 - Applied Research

PE NUMBER AND TITLE
0602211A - AVIATION TECHNOLOGY

	COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
	Total Program Element (PE) Cost	41295	39693	39459	41886	43272	41166	45463	39425
47A	AERON & ACFT WPNS TECH	37813	35999	35689	38111	39209	37035	41294	35148
47B	VEH PROP & STRUCT TECH	3482	3694	3770	3775	4063	4131	4169	4277

A. Mission Description and Budget Item Justification: The Aviation Applied Research Technology program element (PE) conducts research and expands scientific knowledge in the area of manned and unmanned rotary wing vehicle (RWV) technologies in support of the Objective Force and Joint Vision 2020. Based on the Army transformation, this PE is focused to investigate technologies applicable to unmanned systems and selected opportunities for manned systems. Unmanned RWVs bring unprecedented agility, maneuverability, and lethality to the Objective Force, while providing reduced signature and logistics. Emphasis is on developing rotary wing platform technologies to support unmanned combat, reconnaissance, and communications relay capabilities. Technologies that enable autonomous flight, higher aerodynamic loads, lower detectability and increased maneuverability will be emphasized. These technologies also will be assessed for their ability to support the long-term sustainability and reduced logistics required of Objective Force airframes. This PE supports Phase I and II of the Unmanned Combat Armed Rotorcraft (UCAR) and unmanned technologies for the A-160 Hummingbird, the Organic Air Vehicle (OAV), the Micro Air Vehicle (MAV) and the Unmanned Cargo Lifter. This PE also supports the National Rotorcraft Technology Center (NRTC), a partnership of government, industry and academia, and adds a major focus to develop organic air vehicles designs and other unmanned rotorcraft technologies. Efforts under this PE transition to projects supported by PE 0603003A (Aviation - Advanced Technology). Upgrade activities of DoD systems such as the RAH-66 Comanche, AH-64 Apache, UH-60 Black Hawk, Navy SH-60 Seahawk and USMC AH-1 Cobra are included in this PE. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance, for which the Army is the lead service for the maturation of rotorcraft science and technology. The program element does not duplicate with any effort within the Military Departments. 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 Ames Research Center, Moffett Field, CA; Glenn Research Center, Cleveland, OH; and Langley Research Center, Hampton, VA. This PE supports the Objective Force transition path of the Transformation Campaign Plan.

No Defense Emergency Response Funds have been provided to this program.

B. Program Change Summary	FY 2002	FY 2003	FY 2004	FY 2005
Previous President's Budget (FY 2003)	43859	43692	34857	34792
Current Budget (FY 2004/2005 PB)	41295	39693	39459	41886
Total Adjustments	-2564	-3999	4602	7094
Congressional program reductions				
Congressional rescissions		-3262		
Congressional increases				
Reprogrammings	-1952	-227		
SBIR/STTR Transfer	-612	-510		
Adjustments to Budget Years			4602	7094

Change Summary Explanation: Funding - FY 2004/2005: Funds realigned to this PE from PE 0603003A Aviation Advanced Technology to conduct applied research for increasing levels of autonomy for vertical takeoff and landing (VTOL) unmanned aerial vehicles (UA V).

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)

February 2003

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

COST (In Thousands)		FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
47A	AERON & ACFT WPNS TECH	37813	35999	35689	38111	39209	37035	41294	35148

A. Mission Description and Budget Item Justification: The Aeronautical and Aircraft Weapons Technology project investigates RWV technologies for unmanned and manned Army / DoD rotorcraft to increase strategic and tactical mobility / deployability; improve combat effectiveness; increase aircraft survivability; and improve combat sustainability. This project supports the Objective Force and Joint Vision 2020 by providing technology to improve capabilities in Dominant Maneuver, Precision Engagement and Focused Logistics. Areas of research are focused on technology application to UAV systems, manned/unmanned teaming, and selected opportunities for manned systems. These system technologies will provide enhanced rotor efficiencies, improved survivability, increased structure and airframe capability, improved engine performance, improved sustainability, and reduced cost of unmanned and manned aerial vehicles. This project will begin research for the Unmanned Combat Armed Rotorcraft (UCAR), a lethal, survivable Vertical Takeoff and Landing (VTOL) UAV capable of autonomous operations. UCAR is a joint program with the Defense Advanced Research Projects Agency (DARPA) and is planned to transition to Program Executive Officer Aviation at the completion of its 6.3 funded phases. UCAR will be capable of performing mobile strike operations; reconnaissance; target acquisition and identification; suppression of enemy air defense (SEAD), and teamed with the RAH-66 Comanche, will bring unprecedented lethality to the Army's Objective Force. This project supports the National Rotorcraft Technology Center (NRTC), a partnership of government, industry and academia, and adds a major focus to develop organic air vehicles designs and other unmanned rotorcraft technologies. 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 objective force systems. These engine component technologies address engine needs for future UAVs, such as the UCAR and A-160 Hummingbird, with up to a 50% endurance increase and 30% payload increase over current available turbine engines. These component technologies also will enable engine demonstrations for manned systems, providing a 33% payload improvement and 28% range increase for the RAH-66 Comanche; a 33% increase in payload and a 50% reduction in fuel consumption for CH-47 Chinook; and an 80% payload increase and a 20% combat range increase for the Army's Future Utility Rotorcraft. Advanced active controls, aerodynamics, handling qualities, acoustic signature attenuation and smart materials (materials that respond to specific stimuli) technologies will provide rotors and flight controls with increased payload, range, maneuverability, agility and survivability. Unmanned/manned system interface, autonomous collaborative flight control, flight simulation, weapons and sensor integration, and pilot-vehicle interface technologies are focused on research of advanced mission equipment packages that will provide full spectrum engagement, precision and selectable lethality, suitable for the target and engagement scenario. This project also supports work done by NASA and work done under the auspices of the NRTC. 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 Aviation Applied Technology Directorate located at Fort Eustis, VA. Technologies researched within this project will transition to advanced development technology demonstration programs with application to future, as well as current, Army / DoD rotorcraft systems. This project supports the Objective Force transition path of the Transformation Campaign Plan.

No Defense Emergency Response Funds have been provided to this project.

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
Unmanned Combat Armed Rotorcraft (UCAR)- In FY02 executed Memorandum of Agreement with DARPA to initiate the UCAR program. Completed Source Selection and began program with Phase I Concept Development and System Trades to conduct requirements analyses, design trade studies, and risk reduction. Industry teams conducted design trades that considered alternative vehicle/mission equipment configurations and system of systems architecture. Teams documented/evaluated UCAR configuration and architecture design alternatives with respect to system performance, mission effectiveness, life cycle cost, and risk. Teams prepared Risk Management and Mitigation Plan and conducted Systems Requirements Review. In FY03, complete Phase I and initiate Phase II Preliminary Design with one or more industry teams. Industry teams will conduct Preliminary Design of UCAR System to include vehicle systems/subsystems, survivability features, weapons/sensors integration, and system of systems architecture. The manned-unmanned teaming approach will be implemented as part of this design. Advanced Technology Development for the UCAR is funded in FY04 and beyond in PE 0603003A Aviation Advanced Technology.	6000	10000	0	0

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
National Rotorcraft Technology Center (NRTC) - In FY02, conducted component maturation / test / validation and transition of technology to NRTC government / industry partners. Conducted focused research on unmanned rotorcraft applications, rotorcraft aerodynamics, and rotorcraft performance improvement. In rotorcraft flight controls, matured carefree maneuvering technology and limited authority flight control technology. In rotorcraft structures, matured damage tolerance and structural joining technologies. Performed NRTC advanced technology maturation efforts in improved bevel gear design concepts, advanced transmission technology, Health and Usage Monitoring (HUM) smart transducer data bus maturation, composite durability and damage tolerance, and integrated helicopter design technology. In FY03, conduct component research in the areas of rotorcraft aerodynamics, rotorcraft performance improvement, limited authority flight control technology, damage tolerance, crashworthiness and advanced structures, and advanced low-cost composite manufacturing. Perform NRTC applied research efforts in improved bevel gear design concepts, HUM smart transducer data bus research, composite durability and damage tolerance, and integrated helicopter design technology. In FY04, conduct component research in the areas of rotorcraft performance improvement, limited authority flight control technology, damage tolerance, crashworthiness and advanced structures, advanced low-cost composite manufacturing, structural joining technologies, and rotorcraft transmission technologies. Perform NRTC applied research efforts in improved bevel gear design concepts, HUM smart transducer data bus research, composite durability and damage tolerance, and integrated helicopter design technology. In FY05, conduct component research in rotorcraft performance improvement, limited authority flight control technology, damage tolerance, and rotorcraft transmission technologies.	6651	6519	6984	7192

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
Rotor Technology –Includes Low Cost Active Rotor (LCAR) program. In FY02, evaluated active on-blade control loads modeling upgrade for application to advanced design requirements and bench-tested advanced actuator concept for swashplate-less rotor applications. Measured in-flight acoustics for rotor gust response and slung-load stability and handling qualities experiments. Performed research simulations on rotor gust / rejection and partial-authority digital flight control systems. Modified and instrumented flight research vehicle for performing gust response measurement and slung-loads stability research. Conducted soft-in-plane tilt-rotor dynamically scaled wind tunnel test or concept evaluation for manned and unmanned rotorcraft. Completed in-flight simulator envelope expansion and research control system flight development and qualification. In FY03, establish loads and affordability baselines for the swashplate-less rotor geometry and design rotor for the swashplate-less concept. In FY04, design model rotor to demonstrate 40% vibration reduction and control system weight savings. In FY05, fabricate a swashplate-less rotor model and initiate model scale testing.	10658	3911	4288	3906
Survivability - In FY02, built and validated super lightweight thermal insulation components that reduce density by 50% over current state-of-the-art COTS insulation. Conducted analytic screening of advanced aircraft camouflage designs that reduce visual signatures in both desert and vegetated environments by 50% compared to current coatings. In FY03 fabricate and ground test prototype reactive engine IR suppression system that reduces thermal signatures by 90% over currently suppressed aircraft, while eliminating engine performance penalties during non-threat operations. In FY04, conduct UAV full-spectrum threat susceptibility assessment. Define radar frequency/infra-red/electro-optic/visual/acoustic signature requirements for survivable UAV operations. In FY05, develop and demonstrate fully automatic reactive infrared suppressor control system, utilizing Common Missile Warning System (CMWS) and T-700 Digital Engine Control Unit (DECU).	3217	3743	3692	3795

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
Structures and Airframe – Includes Survivable, Affordable, Repairable Airframe Program (SARAP). In FY02, designed, modified, tested full-scale landing gear shock strut to increase AH-64 hard landing capability from 7 to 12 feet per second rate of decent. Performed detailed design of structures actuators capable of reducing airframe vibration loads at 50% less weight compared to current capability. Completed full-scale hardware testing of "smart" piezo-ceramic and elastomeric vibration isolation devices for total airframe vibration reduction. Completed full-scale hardware tests of composite design that reduced RAH-66 empennage assembly labor cost by 713 hours (52%) and weight by 6.6 pounds (6%). In FY03, conduct hardware testing to demonstrate 5% reduced airframe weight for multi-mission rotary-wing UAV with adaptive payload vibration control. Evaluate and select the design and certification standards and methods specific to rotary-wing UAVs that allow enhanced agility at reduced cost and weight. In FY04, design and fabricate smart re-configurable airframe and rotors structures for bench tests. Investigate hyper-responsive metering valves for smart, adaptive landing gears and other hydraulic systems. In FY05, validate and disseminate improved loads determination tools that are 25% more accurate. Design and fabricate smart re-configurable airframe and rotors structures for bench tests.	2366	2322	2624	2446

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
Propulsion – Includes the Integrated High Performance Turbine Engine Technology (IHPTET) program. In FY02, validated lightweight, high-strength Metal Matrix Composite (MMC) shaft for Joint Turbine Advanced Gas Generator (JTAGG) III technology demonstrator. Upgraded simulation software/hardware and performed final closed loop bench test of advanced fuel control. Designed and fabricated advanced inlet particle separator providing increased separation efficiency and reduced engine losses and Operating and Support (O&S) costs. Designed 500 horsepower class compressor for improved full and part power performance. In FY03, fabricate and rig test advanced inlet particle separator providing increased separation efficiency and reduced engine losses and O&S costs. Fabricate advanced power turbine providing increased cycle efficiency and reduced engine weight. Design and fabricate 500 horsepower class compressor for improved full and part power performance. Design 500 horsepower class, heavy-fuel turbine providing increased cycle efficiency and reduced engine weight and production cost. In FY04, conduct rig test of advanced inlet particle separator providing increased separation efficiency and reduced engine losses and O&S costs. Conduct initial rig test and aero redesign of advanced power turbine providing increased cycle efficiency and reduced engine weight. Conduct rig test of 500 horsepower class compressor for improved full and part power performance. Fabricate 500 horsepower class turbine providing increased cycle efficiency and reduced engine weight and production cost. Design a small lightweight combustor providing increased temperature capability for reduced fuel consumption, reduced costs, and improved power/weight. In FY05, conduct final rig test of advanced power turbine providing increased cycle efficiency and reduced engine weight. Conduct rig test of 500 horsepower class compressor for improved performance.	1689	1651	1379	1431

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
Networked Operations and System Integration - In FY02, performed preliminary simulation/flight test validation of autonomous guidance control laws using unmanned rotorcraft. Validated the significant improvement in agility and all-weather operations using advanced control laws in the Rotorcraft Aircrew Systems Airborne Laboratory (RASCAL), a UH-60 Black Hawk test bed demonstrator. Installed test monitoring equipment on aircraft and performed flight test planning for passive external load stabilization. Conducted wind tunnel test of integrated flight/rotor control using on-blade flaps. In FY03, research autonomous control laws and operator interface for small scale UAV rotorcraft. Research control system/handling qualities criteria for Objective Force rotorcraft, to include tilt-rotor. Define display research / evaluation methodology for associated unmanned aerial vehicle aeronautical design guide. Define control law architecture, performance criteria, and simulate precision autonomous landing of UAVs. Conduct research for candidate autonomous modes of operation for UAV. In FY04, conduct requirements analysis and concept definition studies for multi-UAV control to handle multiple integrated mission operations. Evaluate control law/sensor optimization in simulation for precision autonomous landing of UAVs. Modify RMAX rotorcraft surrogate UAV for precision autonomous landing experiments. Produce UAV aeronautical design guide. In FY05, conduct preliminary design of UAV "swarm" control for vehicle/mission equipment/flight management architectures. Evaluate system performance/effectiveness/risk. Prepare specification for control law/sensor optimization for precision autonomous landing of UAVs. Research autonomous control laws and operator interface for UAV cargo rotorcraft/sling load handling qualities. Prototype a UAV operator control station that can be worn by the soldier.	7232	7853	16722	19341
Totals	37813	35999	35689	38111

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February 2003

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2 - Applied Research	**0602211A - AVIATION TECHNOLOGY**	**47B**

COST (In Thousands)		FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
47B	VEH PROP & STRUCT TECH	3482	3694	3770	3775	4063	4131	4169	4277

A. Mission Description and Budget Item Justification: The Vehicle Propulsion and Structure Technology project investigates engine, drivetrain and airframe technologies for Army / DoD rotorcraft specific to the Objective Force. 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 vehicles' logistics footprint for unmanned and manned 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 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, incomplete loads/usage data, and inaccurate inspection and tracking methodologies. Technical solutions are pursued through propulsion and structures research – with a focus on applications towards UAV technologies while supporting manned vehicle requirements. The propulsion research is focused on fluid mechanics, high temperature materials, and mechanical behavior for significantly improved small airflow turbine engines, transmissions, and gears, bearings, and shaft components for advanced drivetrains at significantly reduced weight and cost. This propulsion research supports the goals of the DoD integrated high performance turbine engine technology (IHPTET) / Joint Turbine Advanced Gas Generator (JTAGG) 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 Army Research Laboratory (ARL), located at facilities at the NASA Glenn Research Center, Cleveland, OH and the NASA Langley Research Center, Hampton, VA performs work in this project. This program supports the Objective Force transition path of the Transformation Campaign Plan.

No Defense Emergency Response Funds have been provided to this project.

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
Rotor & Structure Technology - In FY02, evaluated thermal nondestructive evaluation (NDE) experiments on bond line geometry and strength. Investigated low cost, lightweight airframe concepts for large scale, pressurized fuselages. Investigated preliminary Low Cost Active Rotor (LCAR) concepts for "Full Authority" control to eliminate need for rotor swashplates. Performed initial evaluation of Active Twist Rotor (ATR) potential for UAVs and completed assessment of 'closed-loop' ATR control actuation capability. In FY03, investigate reliability-based design methods, durability and damage tolerance analysis techniques and non-contacting NDE methods for UAV rotorcraft structures. Investigate advanced comprehensive design concepts for "Full Authority" on-blade active control rotor system. Acquire smart actuator materials for advanced ATR in support of the LCAR program. In FY04, conduct experiments and validate reliability-based design methods, durability and damage tolerance analysis methods, crashworthy concepts, and NDE methods on selected airframe and rotor hub UAV components. In FY05, conduct wind tunnel experiments on advanced “smart rotor” concept. Conduct analytical study of tiltrotor concept applicability to UAV applications. Evaluate soft-inplane hub for application to large rotorcraft design advanced tiltrotor UAV concept.	1666	1745	1859	1850
Propulsion & Drive Train Technology - In FY02, assessed and validated methods for extending the stable operating range of the centrifugal compressor stage, including microelectromechanical systems (MEMS) air injection technology. Completed baseline experiments of a unique, high speed/high temperature gas path seal rig to reduce engine secondary air flow losses leading to improved engine fuel efficiency and performance. In FY03, conduct experiments on a compact high performance two-stage engine compressor to reduce engine weight. Evaluate cooled monolithic ceramic and ceramic matrix composite turbine nozzles to achieve more fuel-efficient high temperature engine operation. In FY04, analyze the performance of a compact high performance two-stage engine compressor and cooled monolithic ceramic and ceramic matrix composite turbine nozzles. Research full 3-dimensional distributed propulsion simulation. In FY05, conduct experiments and computer simulation of active stall control technology to extend stable engine operation. Investigate autonomous propulsion system technology for future UAV propulsion control and operation.	1816	1949	1911	1925
Totals	3482	3694	3770	3775