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Exhibit R-2, PB 2010 Army RDT&E Budget Item Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 2 - Applied Research					R-1 ITEM NOMENCLATURE PE 0602211A AVIATION TECHNOLOGY					
COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
Total Program Element	42.547	46.898	41.332						Continuing	Continuing
47A: AERON & ACFT WPNS TECH	34.531	37.636	37.053						Continuing	Continuing
47B: VEH PROP & STRUCT TECH	4.149	4.239	4.279						Continuing	Continuing
47C: ROTORCRAFT COMPONENT TECHNOLOGIES (CA)	3.867	5.023	.000						Continuing	Continuing
<u>A. Mission Description and Budget Item Justification</u> This aviation technology program element (PE) conducts applied research applicable to rotary wing vehicle (RWV) technologies to move towards air vehicle objectives. Emphasis is on developing rotary wing platform technologies to enhance manned and unmanned RWV combat and combat support operations for attack, reconnaissance, air assault, survivability, logistics and command and control missions. The PE supports research and development components and subsystems for air vehicles in the areas of aviation and aircraft weapons technology (project 47A) and vehicle propulsion and structures technology (project 47B). 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). 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 (AMRDEC), located at Redstone Arsenal, AL; Fort Eustis, VA; Moffett Field, CA; and Hampton, VA, and at the Army Research Laboratory (ARL), located at Adelphi, MD; Hampton, VA; and Cleveland, OH.										

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2040 - Research, Development, Test & Evaluation, Army/BA 2 - Applied Research		PE 0602211A AVIATION TECHNOLOGY		
B. Program Change Summary (\$ in Millions)				
	FY 2008	FY 2009	FY 2010	FY 2011
Previous President's Budget	43.280	42.013	41.598	
Current BES/President's Budget	42.547	46.898	41.332	
Total Adjustments	-.733	4.885	-.266	
Congressional Program Reductions	.000	-.155		
Congressional Rescissions	.000	.000		
Total Congressional Increases	.000	5.040		
Total Reprogrammings	-.236	.000		
SBIR/STTR Transfer	-.497	.000		
Change Summary Explanation				
FY09 funding increase is due to congressional adds.				

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APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 2 - Applied Research				R-1 ITEM NOMENCLATURE PE 0602211A AVIATION TECHNOLOGY					PROJECT NUMBER 47A	
COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
47A: AERON & ACFT WPNS TECH	34.531	37.636	37.053						Continuing	Continuing

A. Mission Description and Budget Item Justification

The objective of this project is to develop 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 and crew survivability; and improve combat sustainability. 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. 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.

Work in this project is related to and fully coordinated with PE 0603710A (Night Vision Advanced Technology); PE 0602624A (Weapons and Munitions Technology); and PE 0602303A (Missile Technology).

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.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Aircrew Survivability Technologies: Investigate passive technologies to reduce susceptibility and vulnerability of aircraft to damage from threats or accidents and active technologies to defeat or provide alert to the crew concerning small arms, rocket and missile threats. In FY08, completed development of Cognitive Decision Aiding-Threat Lethality Predictor (CDA-TLP) specific cockpit controls, displays and aural cues as part of the Survivability Planner Associate Re-router (SPAR) software suite. Developed criteria 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. Developed conventional ballistic threat and advanced crew protection concept preliminary designs. In FY09, develop updated structural design guidelines based on emerging criteria. Develop and test innovative techniques for reducing detection of propeller and rotor driven aircraft by threat	6.918	7.068	7.536	

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B. Accomplishments/Planned Program (\$ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011	
systems. Develop analytical tools (executable software) required to evaluate material behaviors during both ballistic and high energy impact events. In FY10, will complete conventional ballistic protection and advanced crew protection efforts initiated in FY08 and will transition knowledge gained to ballistic protection and advanced crew protection technology maturation in PE0603003A. Will develop remote optical parametric oscillators (OPOs) to tune laser wavelengths to desired threat bands for effective Infrared (IR) jamming of man-portable missiles.					
Network Operations and System Integration and Intelligent and Active Control (Cont.): In FY10, will develop handling qualities criteria for legacy upgrades and future rotorcraft; will develop the Rotorcraft Air Crew Systems Concepts Airborne Laboratory (RASCAL), a JUH-60A Black Hawk helicopter, into a variable-stability in-flight simulator; and will flight demonstrate increased-agility, obstacle field navigation and landing algorithms. Will also investigate geo-location improvements and lightweight sensors incorporating advanced image stabilization techniques to provide hemispherical situational awareness for improved pilotage.	.000	.000	8.683		
Rotor Technology: Evaluate performance enhancements gained from advanced rotor technologies, including on-blade controls. In FY08, evaluated, via wind tunnel tests, on-blade control rotor system to include performance enhancement and noise reduction. In FY09, acquire validation test data for highly instrumented full-scale conventional UH-60 rotor, and validate advanced modeling and simulation methods for active rotor controls using previously acquired test data. In FY10, will evaluate rotor aeromechanics issues for high speed configurations using high fidelity analyses. Will validate methods for UH-60 and active rotor tests. Will prepare Active Elevon Rotor (AER) and test stand.	3.200	3.234	3.390		
Network Operations and System Integration and Intelligent and Active Control: Perform feasibility, operations and concept studies and Analysis of Alternatives to identify promising candidate technologies that can be evaluated as options for improved or new platform capabilities. In FY08, investigated flight control stability margin requirements for upgraded/new airframe configurations and integrated aerodynamics and structural dynamics into control systems optimization. In FY09, expand handling quality requirements and flight control systems for legacy upgrades, multi-role and future rotorcraft. Digital Situational Awareness Testbed: In FY08, developed and evaluated supervisory control interface for multiple heterogeneous Unmanned Aerial Systems (UAS). In FY09, investigate supervisory control techniques for control of multiple UAS. Advanced Rotary Wing Concepts: In FY08, conducted flight test experiments of precision attack capability from test bed UAS operating in support of manned aviation and ground troops in an urban environment. In FY09, conduct flight test experiments using various sensors and weapons systems to gauge precision expected from rotary wing UAS in varying flight modes, i.e., high and low hover, firing on the move, and moving targets.	7.424	7.173	.000		

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
Small Business Innovative Research/Small Business Technology Transfer Programs		.000	.385	.000	
Rotorcraft Airframe Technology: Develop new rotorcraft structure technologies to improve structural performance while reducing fabrication, operating, and support costs. In FY08, developed structural integrity management by fusing loads monitoring and damage detection capabilities to improve safety and survivability. Investigated ballistic properties and effectiveness of reduced-weight multifunctional structural armor. In FY09, conduct laboratory testing to validate strain-allowable integrity approach, emerging platform concepts and modeling fidelity.		1.230	.984	.000	
Advanced Engines: Design and develop advanced 3000 horsepower turboshaft engine component technology to support goals of reduced fuel consumption, engine size, weight, and cost, and improved reliability, maintainability and survivability. In FY08, completed design of an advanced compressor for improved performance and reduced weight of utility/attack rotorcraft sized engines and completed advanced combustor design, fabrication and evaluation for improved engine performance and structural life for future utility/attack rotorcraft sized engines. In FY09, complete design of an advanced gas generator turbine that improves engine performance and durability for future cargo sized rotorcraft engines. Complete fabrication of an advanced compressor for improved performance and reduced weight for utility/attack rotorcraft sized engines. Conduct an advanced combustor rig-test to validate improved performance and structural life for utility/attack rotorcraft sized engines. In FY10, will complete the design of an advanced compressor, will complete fabrication of a gas generator turbine and will complete the advanced compressor laboratory rig test.		1.931	2.015	2.006	
National Rotorcraft Technology Center (NRTC): The goal of the NRTC is to focus government, US rotorcraft industry and academia resources on pre-competitive, high priority, military focused technology development to maintain preeminence in rotorcraft capabilities. In FY08, performed wind tunnel tests of rotor designs with improved static/dynamic stall characteristics. Tested oscillatory jets on rotor airfoils to assess aerodynamic improvements. Performed qualification test on improved drive system gears. Tested improved crashworthy armored seats. Tested metal matrix composite design for airframe applications to assess structural suitability as a substitute for a titanium structure. Investigated and evaluated a drive train torque measurement system to aid in load assessment. In FY09, perform bird strike and head impact simulations to improve rotorcraft crashworthiness and survivability. Conduct certification testing and probabilistic analysis to evaluate damage tolerance modeling methodologies. Test advanced drive system designs for noise and wear characteristics. Evaluate active crash protection system for application to rotary wing unmanned aerial systems. In FY10, will conduct whirl tower testing of reconfigurable rotor system. Will demonstrate composite production techniques for a 25% reduction in component weight and a 40% reduction in recurring manufacturing costs		8.269	8.456	7.882	

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B. Accomplishments/Planned Program (\$ in Millions)			FY 2008	FY 2009	FY 2010
compared to a conventional metallic structure. Will correlate nonlinear aeroelasticity analysis results with wind tunnel and flight test data to improve understanding and predictive capability for rotor stall flutter.					
System Concepts Studies: Provide high fidelity methodology for analysis and design of future air vehicles, leading to the ability to develop improved performance and design specifications earlier in the acquisition process. In FY08, initiated design of an analysis environment which integrates higher-fidelity models for aeromechanics and flight controls into the design synthesis of rotorcraft configurations. Focused 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 (HQ) assessments. Examined a Variable Speed Tilt Rotor (within the analysis environment) and used results to refine the overall design of the analysis environment. In FY09, expand the design of the models to enable analysis of hover, cruise, transition and maneuver flight conditions. Begin assessment and validation of configuration design process. Initiate the capability to analyze a Slowed Rotor Compound Helicopter. Investigate interfaces to allow inclusion of other new and emerging technical capabilities and rotorcraft configurations. In FY10, will extend the CFD flight conditions for transition and maneuver flight. Continue the validation of modeling capabilities and the ability to pass/generate data within the integrated analysis environment. For example, will automate the methodology for transforming a 3-D Computer Aided Design (CAD) drawing into a grid which can be analyzed with CFD tools.			1.113	2.949	2.390
Durability and Sustainment Technologies: Develop prognostic and system health assessment technologies to enable transition to a Condition Based Maintenance supportability structure. In FY08, initiated development of new prognostic algorithms for aircraft systems. Developed and evaluated predictive models for engine line replaceable parts and automated trim tab adjustment actuators based on the fusion of data-driven and model-based approaches. Performed rig-testing of ceramic components to characterize failure modes. Embedded sensors in structural components and assessed feedback to form basis of damage detection algorithms. Evaluated sensor and load monitoring feedback methods for structural diagnostics/prognostics and reduction of uncertainty in probabilistic methods for life management. In FY09, perform rig-testing of engine prognostic algorithms, begin bench testing of automatic trim tab actuators, initiate development of prognostic algorithms for structural components and assess structural corrosion and damage detection algorithms. Continue to evaluate sensor and load monitoring feedback methods for structural diagnostics/prognostics and reduction of uncertainty in probabilistic methods for life management. In FY10, will perform bench testing to demonstrate the accuracy and robustness of developed prognostic and diagnostic technologies. Will bench test the physics			4.446	5.372	5.166

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010
of failure models for electronics, as well as, validate prognostic reasoner to predict failures. Will integrate a corrosion monitoring system into the Health and Usage Monitoring System and demonstrate on an airframe structural component.				
Total		34.531	37.636	37.053
C. Other Program Funding Summary (\$ in Millions) N/A				
D. Acquisition Strategy N/A				
E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.				

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
47B: VEH PROP & STRUCT TECH	4.149	4.239	4.279						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project investigates engine, drive train, and airframe enabling technologies such as multifunctional materials, fluid mechanics and high temperature, high strength, low cost shaft materials.

Work in this project is related to and fully coordinated with PE0603003A (Aviation Advanced Technology).

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.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Rotor and Structure Technology: Devise 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. In FY08, improved analytical tools of rotor/body and wake flow predictions, investigated aeromechanics design tools to enable the evaluation of new small-scale unmanned air vehicles and micro-scale flapping-wing air vehicles. In FY09, evaluate new multi-functional structural concepts based on biological systems that are key enablers for future microsystems development. In FY10, will conduct wind-tunnel test on a conceptual active rotor system to improve performance.	.771	.842	.886	
Propulsion and Drive Train Technology: Investigate 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 FY08, assessed and quantified the baseline performance of a model-based diagnostic methodology to accurately detect, determine trends isolate engine faults and validated the mechanical properties of advanced gear materials to assess their feasibility for use in rotorcraft transmissions.	3.378	3.397	3.393	

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B. Accomplishments/Planned Program (\$ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
In FY09, assess the durability of advanced environmental barrier coatings to improve the design of hot section engine components and validate variable speed transmissions sub-scale components to enable improvements in rotorcraft maneuverability and noise reduction. In FY10, will assess the feasibility of fabricating sub-elements of hollow and solid turbine blades from monolithic ceramic/composite hybrid materials to reduce engine weight and will investigate the design of a sand injection facility to enable the development of improved inlet particle separators.					
Total		4.149	4.239	4.279	
C. Other Program Funding Summary (\$ in Millions) N/A					
D. Acquisition Strategy N/A					
E. Performance Metrics Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.					

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COST (\$ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
47C: ROTORCRAFT COMPONENT TECHNOLOGIES (CA)	3.867	5.023	.000						Continuing	Continuing
<u>A. Mission Description and Budget Item Justification</u> Congressional Interest Item funding provided for Rotorcraft Component Technologies.										
<u>B. Accomplishments/Planned Program (\$ in Millions)</u>							FY 2008	FY 2009	FY 2010	FY 2011
SBIR/STTR							.000	.140	.000	
Composite Small Main Rotor Blades							1.546	1.550	.000	
Aircraft Structural Condition Monitoring (ASCM) for Diagnostics and Prognostics							2.321	1.550	.000	
Intensive Quenching for Advanced Weapons Systems							.000	.930	.000	
Helicopter Reliability and Failure Analysis Center							.000	.853	.000	
Total							3.867	5.023	.000	
<u>C. Other Program Funding Summary (\$ in Millions)</u> N/A										
<u>D. Acquisition Strategy</u> N/A										
<u>E. Performance Metrics</u> Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.										

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