Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army											Date: February 2015	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602211A *I Aviation Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
Total Program Element	-	54.667	63.414	56.884	-	56.884	65.914	65.902	68.583	69.932	-	-
47A: *AERON & ACFT Wpns Tech*	-	47.985	55.393	48.377	-	48.377	56.159	55.468	57.886	59.024	-	-
47B: *Veh Prop & Struct Tech*	-	6.682	8.021	8.507	-	8.507	9.755	10.434	10.697	10.908	-	-

A. Mission Description and Budget Item Justification

This program element (PE) conducts air vehicle component design, fabrication and evaluation to enable Army aviation transformation. Emphasis is on developing aviation platform technologies to enhance manned and unmanned air vehicle combat and combat support operations for attack, reconnaissance, air assault, survivability, logistics and command and control missions. Project 47A researches and evaluates components and subsystems for air vehicles in the areas of aviation and aircraft weapons technology. Project 47B researches and evaluates components and subsystems for air vehicles in the areas of propulsion and structures. Focus areas include: engines & drive trains; rotors & vehicle management systems; platform design & structures; aircraft & occupant survivability; aircraft weapons & sensors; maintainability & sustainability; and unmanned & optionally manned systems. This PE supports the National Rotorcraft Technology Center (NRTC), a partnership of government, industry, and academia.

Work in this PE contributes to the Army Science and Technology (S&T) air systems portfolio and is fully coordinated with efforts in PE 0603003A (Aviation-Advanced Technology), PE 0602624A (Weapons and Munitions Technology), PE 0602303A (Missile Technology) and PE 0603710A (Night Vision Advanced Technology).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering S&T focus areas and the Army Modernization Strategy.
Work in this PE is performed by the U.S. Army Aviation and Missile Research, Development, and Engineering Center (AMRDEC), located at Redstone Arsenal, AL; Joint Base Langley Eustis, VA; NASA Ames Research Center, Moffett Field, CA; NASA Langley Research Center, Hampton, VA; and at the U.S. Army Research Laboratory (ARL), located at Adelphi, MD; Aberdeen Proving Ground, MD; Hampton, VA; and Cleveland, OH.

Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army					Date: February 2015
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*		R-1 Program Element (Number/Name) PE 0602211A / *Aviation Technology*			
B. Program Change Summary ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**
Previous President's Budget	55.586	63.433	57.290	-	57.290
Current President's Budget	54.667	63.414	56.884	-	56.884
Total Adjustments	-0.919	-0.019	-0.406	-	-0.406
• Congressional General Reductions	-	-0.019			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.919	-			
• Adjustments to Budget Years	-	-	-0.406	-	-0.406

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army			Date: February 2015
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602211A / *Aviation Technology*	Project (Number/Name) 47A / *AERON & ACFT Wpns Tech*	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
47A: *AERON & ACFT Wpns Tech*	-	47.985	55.393	48.377	-	48.377	56.159	55.468	57.886	59.024	-	-

A. Mission Description and Budget Item Justification

This project designs and evaluates technologies for Army/Department of Defense (DoD) vertical lift and unmanned air systems 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 aircraft systems.

Work in this project is fully coordinated with PE 0603003A (Aviation Advanced Technology) and work in this project related to aircraft weapons integration is also fully coordinated with PE 0602624A (Weapons and Munitions Technology), PE 0602303A (Missile Technology), and PE 0603710A (Night Vision Advanced Technology).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering S&T focus areas and the Army Modernization Strategy.

Work in this project is performed by the Aviation Development Directorate of the U.S. Army Aviation and Missile Research, Development, and Engineering Center (AMRDEC), (located at the NASA Ames Research Center, Moffett Field, CA, NASA Langley Research Center, Hampton, VA; and Joint Base Langley Eustis, VA).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: National Rotorcraft Technology Center (NRTC)	3.014	5.055	4.704
Description: NRTC focuses government, U.S. rotorcraft industry, and academia resources on the development of pre-competitive, high-priority, military technology to maintain U.S. preeminence in rotorcraft capabilities.			
FY 2014 Accomplishments: Developed modeling tools to determine lubricated/loss-of-lube gear performance; developed measurable criteria for repairable gear tooth damage and standardized repair methods; and executed extensive correlation efforts for time-accurate, analytic coupling methods for model-scale rotors in hover and full scale rotors in forward flight.			
FY 2015 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47A / *AERON & ACFT Wpns Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Develop industry accepted criteria and repair methods for lightly damaged gear tooth repair, enhance understanding of surface finish effect on gear noise; improve fatigue life and stress corrosion cracking mitigation for magnesium castings; and explore laser scanning technology to improve the fidelity and speed of housings and dynamic components inspection techniques. ***FY 2016 Plans:*** Will conduct industry-collaborative research in rapid certification of complex aviation systems; extreme reliability; structural integrity; aeromechanics modeling, design, and analysis of complex systems; advanced vehicle management systems and controls; component design and analysis tools; and design of transmission and drives component technology for reduced rotorcraft procurement and sustainment cost.			
Title: Rotors & Vehicle Management Technologies	8.704	8.774	9.431
Description: Design and investigate advanced airfoil and rotor blade technologies, including active control elements, to support goals of increased hover and cruise efficiency. Design and evaluate advanced flight control and vehicle management component technologies to support goals of increased maneuverability, reliability, and reduced weight and cost. ***FY 2014 Accomplishments:*** Conducted test stand preparation for a sub-scale rotor experiment to refine current modeling and simulation tools for rotor structural loads; conducted sub-scale experimental studies in drag reduction using active and passive techniques where combined rotor and fuselage flows are complex; analyzed rotorcraft configurations for improved performance, including both aerodynamics and structural dynamics; developed new software that includes the ability to model high fidelity simulations of helicopter missile launch; conducted analysis and simulation to evaluate autonomous multi-ship teaming (e.g., twin lift); developed and validated flight simulation models of compound high-speed configurations for handling qualities requirements; and initiated development of flight control architectures for advanced configurations with many control surfaces and widely changing dynamic responses over the flight envelope. ***FY 2015 Plans:*** Conduct studies on the highly complex, non-linear, downwash/outwash flow field beneath a sub-scale rotor in hover to refine current physical understanding and non-intrusive diagnostics techniques; improve the accuracy and efficiency of computational software that models full-vehicle rotorcraft aerodynamics on high-performance parallel computers; analyze performance, aerodynamics and structural dynamics for advanced rotorcraft configurations; update Aeronautical Design Standards (ADS-33) to integrate lessons learned from degraded visual environment mitigation and slung load handling qualities measurements into new requirements; develop and simulate methods of controlling dual lift configurations; and analyze and simulate flight control concepts for advanced rotorcraft configurations. ***FY 2016 Plans:*** Will develop and test high-fidelity computational models of complete rotorcraft for the aerodynamics and dynamics in both straight and level and maneuver flight. Will complete last phase of downwash / outwash flow field beneath a sub-scale rotor in hover			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47A / *AERON & ACFT Wpns Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
parametric study to refine current physical understanding of the complex, non-linear, coupled, downwash / outwash interactional flow field and enable refinement of modeling and simulation tools using measured downwash / outwash data. Will develop innovative diagnostic techniques to measure and improve understanding of interactional aerodynamic phenomena. Will integrate rotors and vehicle management system technologies to reduce rotor loads, reduce hub and airframe drag and improve vehicle performance. Will conduct flight experiments of dual-lift flight control. Will integrate flight control and handling qualities analysis into Army preliminary design tools NASA Design and Analysis of Rotorcraft (NDARC) for advanced rotorcraft configurations. Will initiate piloted handling qualities experiments toward new / revised ADS-33 quantitative and qualitative criteria to address advanced rotorcraft concepts and missions supporting FVL.			
Title: Aircraft and Occupant Survivability Technologies	9.774	9.306	4.494
Description: Investigate advanced technologies to reduce susceptibility and vulnerability of aircraft to damage from threats or accidents, as well as technologies to defeat small arms, rocket and missile threats. ***FY 2014 Accomplishments:*** Conducted coupon testing of developed electro-optical (EO)/infrared (IR) materials for signature control and environmental durability; began design of advanced systems/subsystems and configurations that provide threat protection against conventional ballistic threats and non-conventional weapons to include directed energy, active crash protection for full spectrum crashworthiness, and crashworthy ballistic tolerant fuel containment systems independent of fuel type. ***FY 2015 Plans:*** Complete performance and material analyses of lightweight composite transparent armor system and validate analyses through laboratory test; complete chemical analysis of JP-8 and alternative fuel blends; complete fabrication of test specimens for crashworthy ballistic fuel containment systems, and validate analyses through laboratory tests; leverage flight test in part and full mission simulators to validate performance models of active crash protection system algorithms; complete the development of EO/IR materials, and conduct sub-scale testing of developed EO/IR materials for signature control and environmental durability; investigate preliminary near real-time survivability route planning algorithms; investigate Adaptive IR engine suppressor capability designed to optimize IR signature reduction and aircraft lift and range performance. ***FY 2016 Plans:*** Will develop and evaluate composite armor integrated into primary load bearing structure systems to improve conventional threat protection while reducing overall system weight. Will evaluate passive and active energy attenuating devices integrated into primary structure to improve crashworthiness while reducing overall system weight. Will conduct ballistic and crash experiments on lightweight composite armor components and energy attenuating devices to verify performance. Will begin development of next generation ballistic, crash, and directed energy weapon protection and fuel containment technologies			
Title: Engine and Drives Technologies	4.942	5.083	3.600

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47A / *AERON & ACFT Wpns Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Description: Design and evaluate advanced turboshaft engine component technologies to support goals of reduced fuel consumption, engine size, weight, and cost, as well as improved reliability and maintainability. Design and evaluate advanced drive system component technologies to support multi-speed transmissions, lighter weight gearboxes, and reduced costs, while improving reliability and maintainability. ***FY 2014 Accomplishments:*** Completed component testing of advanced combustor designs for reduced size, weight, and cost; initiated fabrication of an advanced power turbine for improved performance and operational capability; investigated clutch and gear systems to permit multi-speed transmissions required for high speed rotor and prop/rotor operation. ***FY 2015 Plans:*** Complete investigation of advanced variable speed power turbine for improved performance and operational capability; complete alternate engine concepts design and analysis effort; perform conceptual design analysis of advanced integrated engine/flight controls with integrated health management for reduced weight/cost and improved reliability/fault detection; design/fabricate clutchless concepts for multi-speed gearbox component testing; develop integral shaft/bearing races to reduce weight in large gearboxes and investigate new high-strength, corrosion resistant materials for drive system applications. ***FY 2016 Plans:*** Will perform the conceptual design and determine the benefits of advanced integrated engine controls technologies such as distributed controls and more electric controls for improved aviation system engine performance, weight, and maintainability; initiate design of a smart adaptable efficient filtration system for improved engine performance and durability; and will investigate drive train technologies with multi-speed (ability to vary shaft speed between 50 and 100%) in support of Next Generation Rotorcraft Transmission and Future Vertical Lift objectives.			
Title: Platform Design & Structures Technologies	5.287	7.493	7.331
Description: Enables new rotorcraft configurations by evaluating critical advanced aviation technologies using design and analysis methods with greater modeling fidelity with an ultimate goal of reducing the timelines associated with overall design of new aircraft. Introduces high fidelity methodology for improved performance and design predictions earlier in the development and acquisition process. Use physics of failure modeling and coupled discipline analysis to drastically improve component and system reliability. Work is coordinated with Aviation Component Failure Modeling efforts in PE 0602211, Project 47B at Army Research Laboratory (ARL). ***FY 2014 Accomplishments:***			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47A / *AERON & ACFT Wpns Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Expanded the vehicle design analysis and modeling environment to improve analytic efficiency, including enhanced component weights methodology, incorporation of vehicle cost methodologies, and linkage of design tools to specialized higher fidelity analytic codes. ***FY 2015 Plans:*** Continue enhancement and refinement of vehicle costing methodologies and analytical efficiencies and accuracy; apply modeling and simulation tools to design and perform analysis of the Family of Systems (FoS) for Future Vertical Lift (FVL) to support "Zero Maintenance" helicopter concepts; investigate and develop physics of failure modeling to improve reliability of system components, and to enable damage tolerant component design; investigate methods to monitor component loads and integrate with aircraft controls to stay within component failure limits; and investigate modeling and simulation methods to reduce the time required to design and develop new aircraft. ***FY 2016 Plans:*** Will continue enhancement of the Integrated Design Environment for conceptual design of advanced rotary wing concepts with the addition of methodologies for airfoil design, signatures, operational impact of downwash/outwash, stability & control, and design optimization and sensitivity analysis. Will apply modeling and simulation tools to support design of FVL/novel concepts and analysis of their operational feasibility. Will enhance probabilistic structural integrity and useful life analytical techniques through improved damage initiation and propagation models; develop and perform building block investigation of high-strain capable, multifunctional structures that offer improvements in structural efficiency and enable ultra-reliable, operationally durable designs.			
Title: Unmanned and Optionally Manned Technologies	5.221	6.489	6.603
Description: Design and develop collaboration and cooperation algorithms to support goal of intelligent teaming for manned-unmanned operations. Design and develop advanced unmanned aerial system (UAS) components to support goal of improved small UAS performance. When applicable, technologies in this area are leveraged to support mitigation of degraded visual environments. ***FY 2014 Accomplishments:*** Completed evaluation of brown-out symbology software (BOSS) in actual brown-out conditions at Yuma Proving Ground for approach-to-landing, hover and take-off flight regimes; and evaluated simulation of BOSS symbology for forward tactical flight regimes; evaluated the use of high priority "plays", or pre-defined UAS operational functions, based on pilot feedback from Manned/Unmanned-Teaming (MUM-T) simulation studies. ***FY 2015 Plans:*** Develop optimal human-machine visual, aural, and tactile interfaces for manned-unmanned teaming that supports efficient mission execution and safe flight operations with high situation awareness for pilots and unmanned aerial system operators. Building upon previous sensor and symbology efforts, design and develop methods to optimally blend forward-looking synthetic and enhanced vision sensor information with cueing symbology that aids the helicopter pilot or operator in control of the helicopter			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47A / *AERON & ACFT Wpns Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
in degraded visual environments; and investigate advanced technologies to increase task and mission effectiveness of unmanned aerial systems when partnered with ground and airborne soldiers, including autonomous behaviors, perception, autonomy architectures, and human aiding. ***FY 2016 Plans:*** Develop, integrate, and test advanced Unmanned Aircraft System (UAS) behaviors and technologies that significantly increase the autonomy, the mission effectiveness, and the ease of use of UAS systems. These advanced behaviors and technologies will be enabling capabilities to support simultaneous control of multiple UASs, advanced Manned Unmanned Teaming operations with smart UASs, and employment of UAS systems under canopy and in dense urban environments. Will optimally blend plan-view and forward-looking synthetic and enhanced vision sensor information with symbology, aural, and haptic cueing that aids the helicopter pilot or operator in control of the helicopter in complex environments. Will include close proximity flight in a simulation environment and develop technology for a simulation experiment. Will develop data fusion technologies of both on and off board sensors in a simulation environment.			
Title: Aircraft Weapon & Sensor Technologies ***Description:*** Design and develop innovative approaches for integrating advanced weapons and sensors on aircraft platforms, including smart dispensers, data transfer, and post-launch weapon communication. ***FY 2014 Accomplishments:*** Researched and determined applicability of advanced sensor technologies for improved situational awareness; researched lightweight remote control weapons turrets to eliminate the need for dual door gunners, and advanced weapons system management algorithms for reconnaissance, attack, and utility aircraft. ***FY 2015 Plans:*** Investigate integrated targeting/intelligence, surveillance, and reconnaissance (ISR) sensors and alternative targeting sensors; assess emerging lethal and non-lethal deterrent weapons capabilities for development and aircraft integration; and prepare the lightweight remote control system for follow on testing. ***FY 2016 Plans:*** Will develop sensor integration architecture and networking standards to enable the capability to quickly and easily integrate sensor systems onto Army aircraft, and to enable more seamless sensor and imaging data fusion. Will conduct lab based sensor networking and experimentation to verify the enhanced sensor integration and fusion capabilities. Will conduct a Common Gun study to determine the requirements and feasibility of a common gun system on FVL, Apache, and other Army aircraft systems, operating across a range of missions. Will continue to support AMRDEC Missile PE 0603313A, and CERDEC NVESD, 0603710	1.596	1.613	1.604

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47A / *AERON & ACFT Wpns Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
for the design and development of an organically launched sensor system that will be deployed from Army aircraft with a wide range of sensing capabilities.			
Title: Maintainability & Sustainability Technologies ***Description:*** Develop prognostic and system health assessment technologies to enable an enhanced Condition Based Maintenance supportability structure and posture for application towards an ultra-reliable, low maintenance design approach that significantly reduces unscheduled maintenance, inspections and operations and sustainment costs. ***FY 2014 Accomplishments:*** Developed technologies to enable lighter weight designs through loads monitoring of critical components; developed multi-use sensors to monitor cracking and delamination in composites as well as crack growth algorithms; developed wireless sensors for on-component processing of part health and usage history; investigated probabilistic failure initiation and progression analysis methods to estimate remaining component life, including improved analysis techniques for metallic and composite rotating and non-rotating structures; investigated methodologies to allow for probability of failure predictions based on vehicle current state and anticipated mission, and developed improved load and usage spectrum characterization techniques; and investigated durable structural concepts including application of high-strain capability designs through advanced design, analysis and/or material solutions, while also considering repairability. ***FY 2015 Plans:*** Develop embedded multifunctional sensors with built-in processing and communications; develop health assessment systems to support adaptive controls; develop technologies for component self assessment, usage tracking and embedded history; and investigate technologies to provide health monitoring to support and optimize design efficiencies. ***FY 2016 Plans:*** Will investigate use of wireless communication technologies to reduce wiring weight associated with prognostics and diagnostics; will integrate health assessment technologies into Joint Common Architecture (JCA)/avionics/cockpit; will develop fly-by-wire (FBW) with CBM monitoring capability; will develop miniaturized wireless sensors with on-component processing, history and parts tracking; will develop improved fleet management capability with autonomous logistics for parts/production control; will investigate technologies for in-flight data transmission to ground.	3.548	3.580	2.104
Title: Survivability For Degraded Visual Environment Operations ***Description:*** Research advanced sensor and cockpit display technologies to provide ability to maintain terrain and obstacle situational awareness during aircraft induced (brown-out & white-out) and environmentally induced (rain, snow, smog, fog, smoke, low light, etc.) degraded visual environment. Work in this area is being done in coordination with efforts at U.S. Army Communications-Electronics Research, Development, and Engineering Center (CERDEC), PE 603710A, Night Vision Advanced Technology.	5.899	8.000	8.506

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47A / *AERON & ACFT Wpns Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
FY 2014 Accomplishments: Executed studies that include simulation, laboratory, ground test, and flight test to determine the parametric relationship between aircraft handling qualities, sensors and cueing to allow safe flight operations in degraded visual environments; defined and began implementation of improved flight controls, multi-modality sensor fusion and advanced cueing (symbology, tactile, and aural). Began execution of the first cueing experiment at USAARL that is investigating symbology, aural and tactile cueing trade-offs. ***FY 2015 Plans:*** Investigate multi-resolution fusion sensor package comprised of a 94 GHz millimeter wave radar, a laser radar (LADAR) and an infrared (IR) camera; investigate alternative fusion techniques with a different form of LADAR and an IR camera; conduct experiments focused on optimizing the forward flight modernized control laws (MCLAWS) of the UH-60 aircraft in preparation for a planned FY16 NATO capstone flight test; and explore the value of additional cueing techniques such as tactile and aural technologies in the AMRDEC simulation facility at Redstone Arsenal, Alabama. This work feeds a 6.3 Degraded Visual Environment mitigation tech demo effort beginning in FY16. ***FY 2016 Plans:*** Execute a second iteration of experimentation at US Army Aeromedical Research Laboratory (USAARL) simulation facility (Fort Rucker, AL) focusing on symbology, tactile and aural technologies trades and optimization. Continue software algorithm and material component design and development for execution of sensor fusion involving LADAR, RADAR & IR systems for two separate DVE Mitigation Program lines of effort. Execute system integration design and substantiation of two multi-modality sensor fusion packages; this includes mechanical, electrical and instrumentation packages, a "best of breed" symbology set for all modes of flight (landing, take-off, enroute), and appropriate advanced cueing tactile and aural elements that were identified in USAARL simulator experiments.			
Accomplishments/Planned Programs Subtotals	47.985	55.393	48.377

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army			Date: February 2015
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602211A / *Aviation Technology*	Project (Number/Name) 47B / *Veh Prop & Struct Tech*	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
47B: *Veh Prop & Struct Tech*	-	6.682	8.021	8.507	-	8.507	9.755	10.434	10.697	10.908	-	-

Note

Not applicable for this item.

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. Additional areas of research include platform, aerodynamic, transmission, and control technologies for implementation in handheld autonomous Unmanned Aerial Systems (UAS) and failure analysis and prediction models and techniques to support a "zero maintenance helicopter" concept.

Work in this project complements and is fully coordinated with PE 0603003A (Aviation Advanced Technology) and leverages basic research performed in PE 0601104/ Project H54 (Micro Autonomous Systems Technology Collaborative Technology Alliance) and PE 0601104/Project H09 (Robotics Collaborative Technology Alliance).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering S&T focus areas and the Army Modernization Strategy.

Work in this project is performed by the U.S. Army Research Laboratory (ARL) at the NASA Glenn Research Center, Cleveland, OH, the NASA Langley Research Center, Hampton, VA, and the Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Rotor and Structure Technology	2.229	2.398	2.547
Description: Devise improved tools and methodologies to more accurately design for improved component reliability and durability, resulting in platforms that are lighter in weight and less costly to acquire and maintain. Investigate rotor and structure to significantly improve rotorcraft range and speed.			
FY 2014 Accomplishments: Developed and demonstrated seat damper technology using "smart magnetic material" that will enhance the crash-worthiness of rotorcraft; evaluated the performance of an advanced, structurally-integrated, trailing edge rotor flap for its simplicity of operation and aerodynamic control authority; performed prognostic and diagnostic (P&D) inspection experiments aimed at improving structural risk assessment; developed self sensing strategies to monitor damage precursors; incorporated optimized sensing strategies into P&D systems; commissioned operation of, and began data collection on the full scale helicopter landing gear test stand facility; utilized multi-functional structural materials to augment sensing, power and energy storage, or actuation in micro air and ground vehicles; developed coupled plasma/fluid models and utilized computational models to quantitatively assess potential impacts of plasma on rotor aerodynamic performance; began experimental studies to determine the potential of nanosecond			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47B / *Veh Prop & Struct Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
pulsed plasma discharges for enhancing current and next-gen rotorcraft speed, range, and payload; developed quantitative technology payoff assessment and analysis models; and expanded models from first-order relationships to comprehensive codes to allow researchers to understand which technologies are the most critical to achieving future aviation capabilities. ***FY 2015 Plans:*** Investigate novel approaches to improve rotorcraft vehicle maintainability; investigate the feasibility of aeroelastic/aeromechanical stability enhancement of composite rotor blades through novel material concepts; develop wind-tunnel models to study advanced active-control helicopter rotor systems; develop advanced structural dynamics models of rotorcraft fuselage structures; and explore and evaluate plasma discharge based active flow control techniques for rotor dynamic stall alleviation and diffuser augmented rotor systems. ***FY 2016 Plans:*** Will design and develop smart materials that can self-sense, self-heal and self-reconfigure to facilitate damage/health assessment of aviation component structures; evaluate material/component damage sensing strategies; conduct modeling and simulation of damage detection; and investigate data fusion techniques for assessing material/component failure in aircraft.			
Title: Engine and Drive Train Technology (previously titled Propulsion and Drive Train Technology) ***Description:*** 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 system weight. ***FY 2014 Accomplishments:*** Completed evaluation of the potential for variable speed power turbines to enable efficient operation of gas turbine engines at reduced power operating conditions to enable faster rotorcraft vehicles; and completed dynamic characterization of a Pericyclic Variable Transmission (PVT). ***FY 2015 Plans:*** Evaluate the benefits of advanced technologies such as improved fuel spray, multi-fuel capability, etc., for aviation system engine performance and durability at sea level and simulated altitude conditions; and demonstrate drive train technologies with 50% increase in time-to-scuffing-failure after lubricant supply is terminated in a simulated gear environment and identify promising technologies to achieve +50% oil-out time in support of Next Generation Rotorcraft Transmission objectives. ***FY 2016 Plans:*** Will investigate coupled physics-based probabilistic design of ultra-lightweight hybrid gear; validate component modeling on extended design space for variable-speed turbine; and investigate novel micro injector technology for Unmanned Aerial System (UAS) engines using both experimentation and modeling to mature optimization tools for efficient fuel combustion to increase UAS mission capabilities.	3.863	3.113	3.198
Title: Micro/Small Scale Unmanned Aerial Systems	0.590	1.510	1.762

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47B / *Veh Prop & Struct Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Description: Investigated platform, aerodynamic, actuation, transmission, and control technologies for handheld autonomous Unmanned Aerial Systems (UAS); provided small units with significantly increased tactical mobility and deployability by extending soldier perception to real-time local Intelligence, Surveillance, and Reconnaissance (ISR) with handheld organic assets, and by minimizing the supporting infrastructure needed for deployment. ***FY 2014 Accomplishments:*** Developed and used various levels of model fidelity, including High-Performance Computing (HPC) modeling and simulation, experimentation, and evaluation, to advance and improve the coupled wing-actuator-control system and its components, where component-level investigation includes, but is not limited to, aspects of low speed airfoil design, airfoil turbulence sensitivity analysis, implementation-plausible (at the handheld-scale) flow control, and membrane and tendon-like actuation. ***FY 2015 Plans:*** Transition open loop control strategies employing active aerodynamic or elastic actuation to aircraft form factors for achieving gust and other disturbance rejection capability; incorporate bio-inspired sensors for enhanced state and disturbance awareness; evaluate technologies addressing the communication and processing needs of size, weight, and power constrained platforms; develop an aeromechanics analysis tool integrating fluid dynamics and structural dynamics solvers; investigate wing flexibility/ morphing for performance enhancements; and perform quantitative technology and tradeoff analyses of independent flapping wing control for maneuvering micro aerial vehicles (MAVs). This effort is coordinated with PE 0601104A/Project H54 (Micro Autonomous Systems Technology Collaborative Technology Alliance). ***FY 2016 Plans:*** Will demonstrate a span-adaptive wing which yields relatively consistent performance across its span range while responding to slowly varying conditions in a wind tunnel; and demonstrate with low degree-of-freedom surrogates, energy conservative behaviors inspired from biology.			
Title: Aviation Component Failure Modeling ***Description:*** Develop failure analysis and prediction models and techniques to support a "zero maintenance helicopter" concept. Work is coordinated with Aviation component and system reliability efforts in PE 0602211A/Project 47A at the U.S. Army Aviation and Missile Research, Development and Engineering Center. ***FY 2015 Plans:*** Develop and improve failure models to characterize and categorize specific material damage precursors relevant to aviation components; develop a probabilistic framework for predicting remaining useful life of vehicle platforms; investigate the integration	-	1.000	1.000

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47B / *Veh Prop & Struct Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
of advanced aviation component health monitoring techniques into health-usage monitoring systems (HUMS); and develop self-sensing structural material technologies that incorporate damage precursor detection philosophy. ***FY 2016 Plans:*** Will develop the Virtual Risk-informed Agile Maneuver Sustainment (VRAMS) concept, which will evaluate technologies to autonomously provide state awareness at the material level and automate stress-reduction methods; investigate a "virtual reality" concept for self-diagnostics of real-time material state and automated solutions for self-directed maneuver alternatives in real-time. This effort will enable fatigue-free and zero-maintenance aircraft components.			
Accomplishments/Planned Programs Subtotals	6.682	8.021	8.507

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A