ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE
3 - Advanced technology development	**0603005A - Combat Vehicle and Automotive Advanced Technology**

	COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
	Total Program Element (PE) Cost	200974	245629	112492	92447	94339	98743	112004
221	COMBAT VEH SURVIVABLTY	17662	45126	37525	24166	28890	38406	50930
441	COMBAT VEHICLE MOBILTY	33194	43599	44659	50019	46789	41345	41738
497	COMBAT VEHICLE ELECTRO	9288	13027	7459	7598	7718	7890	8067
515	ROBOTIC GROUND SYSTEMS	16855	9424	10182	10316	10942	11102	11269
533	Ground Vehicle Demonstrations	45186	76097					
53D	NAC Demonstration Initiatives (CA)	53831	38952					
53G	FUTURE COMBAT SYSTEMS (FCS)	20951	14101	11992				
C66	DC66	4007	5303	675	348			

A. Mission Description and Budget Item Justification: The Army vision demands a force that is deployable, agile, versatile, lethal, survivable, and sustainable across the spectrum of operations. The goal of this program element (PE) is to mature and demonstrate leap-ahead combat vehicle automotive technologies to enable transformation to the Future Force and, where possible, to exploit opportunities to enhance Current Force vehicle-related capabilities. This PE supports maturation and demonstration of enabling component technologies in the areas of survivability (project 221), mobility (project 441), combat vehicle electronics (project 497), and robotic ground systems (project 515). These advanced technologies are demonstrated in coordination with Army Acquisition Project Managers and warfighter organizations. Project 221 matures and demonstrates survivability technologies including advanced armors, Active Protection Systems (APS), and safety devices. Project 441 matures and demonstrates power/energy component and hybrid electric vehicle (HEV) technologies, which provides power for propulsion, control systems, communications, life support systems, electric weapons, and protection systems, which are key enablers for enhancing Current Force and Future Force capabilities. Project 441 includes evaluating the maturity of HEVs for military applications and on demonstrating the associated performance benefits and burdens by evaluating against relevant tactical mission duty cycles and environments. The Pulse Power technology effort focuses on the development of those key high power electronic devices essential in the development of viable advanced electric weapons (lasers, high power microwaves, and electromagnetic guns) and advanced electric-based protection systems (Electromagnetic (EM) Armor). Project 497 focuses on maturing technologies that enable Soldiers and robotic systems to fight side-by-side. The Robotics Collaboration effort that concludes in FY08 pursues technologies for human-robot interaction in Soldier-robot teams such as: intelligent agents, adaptive automation, augmented reality for increased local situational awareness, and user-friendly displays to reduce the Soldier's burden in the control of manned and unmanned ground and air systems. Project 515 focuses on the development, integration, and engineering evaluation of control architecture, autonomous navigation technologies, as well as Unmanned Ground Vehicle (UGV) platform mobility trade studies. Army Science and Technology continues to play an important role for the Future Force vehicles by providing critical technology solutions and spiral opportunities. Project 53G matures UGV technologies. The Robotic Vehicle Technologies and Autonomous Platform Demonstrator efforts will focus on the design and development, and fabrication of UGV control architecture, hardware and software, and UGV platform mobility technologies. Projects 533 and 53D fund congressional special interest items. Project C66 supports classified activities. Properly accessed individuals can obtain further information from the ASA(ALT) Special Programs Office. Work in this program element is related to, and fully coordinated with, PE 0602601A (Combat Vehicle and Automotive Technology), 0602618A (Ballistics Technology, Robotics Technology), 0602105A (Materials), and 0602705A (Battery/Ind Power Technology). Work in this PE is coordinated with the US Marine Corps, the Naval Surface Warfare Center, the Naval Research Laboratory, Air Force Armaments Command, and other ground vehicle developers

within the Departments of Energy, Commerce, and Transportation as well as DARPA. 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 Tank Automotive Research, Development, and Engineering Center (TARDEC), Warren, MI.

B. Program Change Summary	FY 2007	FY 2008	FY 2009
Previous President's Budget (FY 2008/2009)	204383	131436	108554
Current BES/President's Budget (FY 2009)	200974	245629	112492
Total Adjustments	-3409	114193	3938
Congressional Program Reductions		-1587	
Congressional Rescissions			
Congressional Increases		115780	
Reprogrammings	1959		
SBIR/STTR Transfer	-5368		
Adjustments to Budget Years			3938

Forty-eight FY08 congressional adds totaling $115780 were added to this PE.

($800) Enhanced Directed Armor RPG Vehicle Protection System
($800) Ground Vehicle Fastening and Joining Research
($800) Vehicle Information Manager Display for Drivers (VMID)
($900) Liquid Desiccant-Based Atmospheric Water Generation without Reverse Osmosis
($1000) Battlefield Requirements Management Support System
($1000) No Idle System (NIS)
($1000) Hydraulic Hybrid Vehicles (HHV) for the Tactical Wheeled Fleet
($1000) Improved HMMWV Tactical Shelter Project
($1000) Vehicle Armor Structure Development and Testing for Future Combat Systems and Joint Light Tactical Vehicle
($1600) Advance Lithium Iron Phosphate Battery System for Army Combat Hybrid HMMW V and Other Army Vehicle Platforms
($1600) Advanced Lightweight Composite Armor
($1600) Center for Tribology and Coatings
($1600) Full Spectrum Close-in Layered Shield (FCLAS) for thin skinned vehicles (Transfer from line 55)
($1600) Ground Forces Readiness Enabler for Advanced Tactical Vehicles (GREAT-V)
($1600) High Performance Aluminum Structures and Components
($1600) Networked Reliability and Safety Early Evaluation System (NRSEES)
($1600) On-Board Vehicle Power Management
($1600) Secure On-the-Move Information Analysis and Control for Advanced Combat Vehicles
($1600) Tactical Rocket Propelled Grenade Airbag Protection System (TRAPS) Enhancement
($1600) Advanced Thermal and Oil Management System
($1600) Fuel Cell Cost Reduction Research

($1600) Next Gen Non-Tactical Vehicle Propulsion
($1600) Special Operations Vehicle - Lightweight, Armored, Hybrid, Power Generating,Tactical Vehicle
($2000) Diesel Hybrid-Electric Utility Vehicles
($2000) Diminishing Manufacturing Sources and Material Shortages (DMSMS) Case Resolution Program
($2000) LEAN Digital Product Development
($2000) Light Weight Structural Composite Armor for Blast and Ballistic Protection
($2000) Rotary Multi-Fuel Auxiliary Power Unit (APU) for the Abrams M1A1 Tank
($2400) Field Deployable Fleet Hydrogen Fueling
($2400) Military and Interstate Commercial Truck Component Weight Reduction Program
($2400) Novel Onboard Hydrogen Storage System Development
($2400) Tactical Wheeled Vehicle Composite Component Weight Reduction Program
($2560) Vehicle Maintenance and Prognostics System
($2600) High Strength, Powder Metal Gears for Vehicle Transmissions
($3000) Armor Ready Composite Cab Transition
($3000) Crosshairs Hostile Fire Indicating System
($3040) Active Protection Systems Initiative for the Joint Light Tactical Vehicle
($3200) Advanced Composites Development for Light Weight, Low Cost Transportation Systems Using 3+ Extruder
($3200) Advanced Thermal Management System
($3200) Next Generation Manufacturing Technologies for Defense Supply Chain
($3200) 3-D Advanced Battery Technology
($3200) Defect-Free Commercially Viable SVC Semiconductor Using Superlattice Technology
($3200) High Speed Diesel Combustion
($4000) Tactical Wheeled Vehicle Structures for Improved Survivability and Performance
($4000) Antiballistic Windshield Armor (AWA)
($4080) Center for Military Vehicle Technologies
($8000) Hybrid Engine Development Program for Tactical Wheeled Vehicle Fleet
($12000) Unmanned Ground Vehicle Initiative

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February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
3 - Advanced technology development	**0603005A - Combat Vehicle and Automotive Advanced Technology**	**221**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
221 COMBAT VEH SURVIVABLTY	17662	45126	37525	24166	28890	38406	50930

A. Mission Description and Budget Item Justification: This project matures and demonstrates combat vehicle survivability technologies essential for the Future Force and provides technical solutions for enhancing the survivability capabilities of the Current Force. Focus is on advanced armors, Active Protection Systems (APS), safety devices, and integration of these onto the Future Force combat and tactical wheeled vehicles and where practical, Current Force vehicles. As combat vehicle systems become smaller and lighter and tactical vehicles are more often exposed to combat conditions, one of the greatest technological and operational challenges is providing adequate crew protection without reliance on heavy passive armor. These challenges are being addressed by major efforts in integrated survivability suites comprised of APS coupled with advanced ballistic protection including smart and ceramic armors integrated with advanced composite and laminate structures, and advanced transparent armor formulations. The APS against Kinetic Energy (KE) threats effort conducts essential trade studies, technical evaluations, and demonstrations of APS components/sub-systems including countermeasure warheads and interceptors, detectors, and trackers, and fire control hardware and software required to identify, classify, and defeat KE threats as defined for the 2017 threats to Future Force combat vehicles. Technologies and performance data are transitioned for use in Future Force manned ground vehicles and potential spin-offs to Current Force combat vehicles. This effort is integrated and coordinated with efforts from program elements (PEs) 0602624A (Weapons and Munitions Technology), 0603004A (Weapons and Munitions Advanced Technology), and 060313A (Missile and Rocket Advanced Technology). TWV Survivability focuses on maturing and demonstrating viable integrated survivability suites that can be tailored to meet current and future threats when applied to light, medium, or heavy tactical wheeled vehicles. This effort provides essential underpinning data to support the joint effort between the Army and Marines for the Joint Light Tactical Vehicles (JLTV). Lightweight, integrated armor technologies, using components from PEs 0602601A (Combat Vehicle and Automotive Technology), 0602618A (Ballistics Technology), and 0602105A (Materials Technology), are integrated and demonstrated through ballistic testing to validate performance versus weight against various armor protection requirements. APS and signature management treatments are also integrated and evaluated to determine effectiveness and ability to counter threats in conjunction with armor treatments. Modeling tools that characterize hardware performance of the survivability enhancements are matured and validated and linked to combat and tactical vehicle virtual prototyping tools, enabling more rapid and cost effective adaptations and evaluations of effectiveness in the future. The Vision Protection effort ending in FY09 matures and demonstrates treatments to optical systems that provide protection from frequency-agile laser weapons and is coordinated and collaborative between work conducted at Army Research Laboratory's PE 0602120A (S3I Technology), PE 0602705A (Elec and Electronic Dev), Natick Soldier Center PE 0602786A (Clothing and Equipment Tech), and the Communications-Electronics Research, Development, and Engineering Center's PE 0602712A (Camouflage and Counter-Recon Tech). These technologies are appropriate for transition to Future Force vehicles for spiral integration or to Current Force vehicles such as the Abrams, Bradley, and Stryker. Work in this PE is related to and closely coordinated with work conducted in PE 0602601A (Combat Vehicle and Automotive Technology) and in collaboration with the Army Research Laboratory's PE 0602618A (Ballistics Technologies) as well as with the US Marine Corps and Office of Naval Research. 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, as well as the Army's TWV Fleet Modernization Strategy. Work in this project is performed by the Tank Automotive Research, Development, and Engineering Center (TARDEC), Warren, MI; Army Research Laboratory (ARL), Aberdeen Proving Ground, MD; US Army Armaments Research, Development, and Engineering Center (ARDEC), Picatinny, NJ; and the US Army Aviation and Missile Research, Development, and Engineering Center (AMRDEC).

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
APS against KE: In FY07, collaborated and conducted integration of AMRDEC's preliminary design of KE APS interceptors and	8658	17240	9869

ARDEC's blast warhead and fuze package for defeat of KE threats; conducted KE APS systems engineering support with development of Systems Engineering Plan (SEP), Test and Evaluation Master Plan (TEMP), systems architecture, initial system and component specifications, and interfaces. In FY08, provide design support to integrate matured components into Future Force combat vehicle architecture and hardware for the KE AP system; collaborate and integrate ARDEC's warhead and fuse package with interceptor being developed at AMRDEC; update the SEP, TEMP, systems architecture, system and component specifications and interfaces; coordinate, manage, and conduct KE APS component testing of warhead, fuze, and interceptor. In FY09, will complete component and system design specifications and finalize all system interfaces; will complete coordinatation and integration support of ARDEC's warhead and fuse package and AMRDEC's interceptor; will build and test warheads in support of KE APS final demonstration; will coordinate transition of components for integration into current and future force combat vehicles; will collaborate and coordinate with ARDEC and AMRDEC to conduct FY10 KE APS interceptor/system testing, demonstration, and analysis.			
TWV Survivability: In FY07, used modeling and simulation tools to conduct trade studies and analyses to identify viable candidate integrated survivability suites for one or more TWVs; matured selected safety equipment and short range threat APS components (non-KE threats) and validated ballistic performance, structural capability, and durability of components; assessed manufacturability and affordability of candidate solutions; selected "best mix" survivability suite for initial demonstration; provided results of assessments and data from performance tests to PM Future Tactical Systems. In FY08, finalize component maturation and fabricate demonstration vehicle(s) while continuing integrated suite design activities and conducting studies to determine the impact of various survivability suites on vehicle weight, volume, and power system. In FY09, will conduct extensive experiments and tests on an expanded set of integrated survivability suites on demonstration vehicle(s) to verify and validate the level of protection achieved, the durability of the systems and the impact of the added weight, volume, and power on vehicle performance; and will complete analysis tool to simulate the effects of mine blast impacts on vehicle and crew. The level of testing for this program will be increased to address emerging threats.	5405	11928	10976
Vision Protection: In FY07, integrated and evaluated nonlinear optical materials that protect the sensors from laser-induced damage; began construction of a breadboard targeting system using these concepts; and began design of laser-protected navigation camera system and optical fire control for future force combat vehicles. In FY08, complete construction of breadboard targeting system and conduct tests of the fire control camera breadboard for optical and laser protection performance and fabricate protection system for navigation camera. In FY09, will complete and validate performance of agile laser protection in future force combat vehicle-type navigation camera and optical fire control breadboards.	1971	5556	3817
Armor/Mine Protection: In FY07, investigated lighter weight/more efficient/novel protection technologies in the areas of opaque armor, transparent armor, and close-in Rocket Propelled Grenade (RPG) protection, and mine protection for Tactical Wheeled and Combat Vehicles; pursued near-term armor design options to provide increased protection against small arms, surface laid and buried mines, and Explosively Formed Penetrator (EFP) threats, close-in RPGs; provided design guidance for increasing Light Tactical Vehicle (LTV) mine protection; and developed initial vehicle-level mine response modeling and simulation (M&S) capability to support vehicle trade studies. In FY08, mature near-term opaque/transparent/RPG armor designs and develop design guidance for future Medium Tactical and Combat Vehicles mine protection; demonstrate initial mine kit designs; develop and demonstrate candidate spin-out armor/transparent armor/RPG protection; and further develop vehicle-level mine response M&S to include vehicle kinematics response. In FY09, will accelerate maturation and demonstration of combat and tactical wheeled vehicle armor recipes and improved mine kit designs against objective threats while reducing armor weights; will further develop vehicle-level mine response M&S tools to include crew/occupant response to support system level analysis.	1628	9469	12863
Small Business Innovative Research/Small Business Technology Transfer Programs.		933	

Total	17662	45126	37525

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
3 - Advanced technology development	**0603005A - Combat Vehicle and Automotive Advanced Technology**	**441**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
441 COMBAT VEHICLE MOBILTY	33194	43599	44659	50019	46789	41345	41738

A. Mission Description and Budget Item Justification: This project matures and demonstrates advanced mobility and electric component and subsystem technologies for next generation ground combat and tactical vehicles and provides demonstrations of increased vehicle performance and capability. It enables lightweight, agile, deployable, fuel efficient, and survivable ground vehicles needed for the Future Force and enhancements to the Current Force. It demonstrates critical propulsion, power, and electrical components and subsystems (advanced engines, lightweight track, energy storage devices, power distribution systems, and Pulse Forming Networks (PFNs)) needed to employ both conventional and alternative propulsions systems for combat and tactical vehicles. Power/energy component and Hybrid Electric Vehicle (HEV) technologies, which can provide power for propulsion, control systems, communications, life support systems, electric weapons, and protection systems, are key enablers for enhancing capabilities. In the near term a major focus is on evaluating and demonstrating the maturity of HEVs for military applications and on demonstrating the HEV performance benefits and burdens against relevant duty cycles and environments in a Power and Energy Systems Integration Laboratory (P&E SIL) and at instrumented test tracks. Over the longer term, the efforts focus on advancing component energy density and system efficiency while increasing platform capability. The P&E SIL is a reconfigurable hardware-in-the-loop experimentation facility that replicates vehicle power and performance characteristics in a simulated system representing military HEVs (including power distribution and storage systems, traction motors, active suspension, high-density capacitors and pulse power components, and high-temperature silicon (Si)/silicon carbide (SiC) electronics). The HEV Propulsion effort matures components and sub-systems and demonstrates them in the P&E SIL, which is reconfigurable but currently configured for Future Force combat class vehicles. The effort also supports development of mission duty cycle profiles critical to evaluations of ground vehicle HEV technologies. The HEV Experimentation and Assessment effort analyzes differences between the demands of commercial, civilian operating environments, and the military operating environments, determines the impact of these differences on the performance of various HEV designs and architectures, evaluates and demonstrates the maturity of HEVs for military applications, and develops modeling and simulation tools that may be used to predict drive cycle fuel economy and performance characteristics (primarily fuel economy but also acceleration, speed, reliability, maintainability, tractive power, and ability to maintain speed on grade) for tactical platforms. The Advanced HEV Components effort seeks significant increases in next generation combat and tactical vehicle mobility, efficiency, and mission capability without increasing vehicle weight or volume through the maturation and demonstration of advanced traction wheel motors, active suspension, high temperature electronic components, regenerative brakes, thermal management, lightweight track, and segmented band track. New designs and packaging concepts are matured and validated in component testing to verify improved performance, reliability, durability. The Pulse Power effort matures component technologies and demonstrates compact components and subsystems that enable revolutionary survivability and lethality applications. The goal is to make significant advances in the maturity of high power density, capacitor-based PFNs that enable advanced weapons including High Energy Laser and Electro-Magnetic gun systems. The Advanced Lightweight Track effort matures and demonstrates new segmented band track and hybrid steel track technologies that are robust, lightweight, exhibit low vibration and acoustic emissions, reduce crew maintenance, and are field supportable. The JP-8 Reformation for Fuel Cells effort matures reformer and desulphurization technologies, which converts battlefield fuels to the hydrogen required for fuel cell operation, where more efficient reformation is needed for practical use on future military vehicle power applications. The Fuel Efficiency ground vehicle Demonstrator (FED) focuses on demonstrating the viability of achieving significant decreases in fuel consumption without sacrificing the performance or capability in a tactical vehicle by integrating potentially high-payoff fuel efficient technologies and advanced lightweight materials in new and innovative designs. The Propulsion-Prime Power effort focuses on providing propulsion and power technologies for current and future tactical wheeled vehicles. 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 Tank Automotive Research, Development, and Engineering Center (TARDEC), Warren, MI, in conjunction with Army Research Laboratory (ARL), Adelphi, MD.

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
Hybrid Electric Vehicle Propulsion and P&E SIL: In FY07, purchased/built, integrated, and evaluated enhanced hybrid electric propulsion components (batteries, switches, controllers, compact engine/generator, thermal management, and power distribution systems) in SIL; began validation of vehicle emulation model; added instrumentation to enable evaluation of Electromagnetic Interference (EMI) on the FY06/FY07 built future force prototype combat vehicle chassis; and continued to develop and incorporate future force combat vehicle duty cycles for use in SIL. In FY08, complete integration of advanced traction drive into the prototype combat vehicle chassis; optimize architecture for best thermal management; continue reducing EMI through filtering, shielding, and grounding; and continue to update power and energy mission profiles. In FY09, will upgrade electronic architecture and thermal management system on the prototype combat vehicle chassis to continue evaluation the hybrid electric system in a space constrained vehicle environment; and will utilize user-developed scenarios to establish baseline performance of prototype combat vehicle chassis and integrated hybrid electric propulsion system.	8607	7892	7760
Hybrid Electric Vehicle Demonstration and Assessment: In FY07, developed a set of representative duty cycles for light tactical vehicles for a variety of missions and determined an appropriate test operating procedure to enable direct comparison of HEV performance in tactical missions; provided input to vehicle performance assessments in cooperation with the Future Tactical Truck System military utility assessment; used Modeling and Simulation (M&S) to explore the variation in performance across various TWV missions/scenarios and various vehicle weights. In FY08, continue analysis and testing of HEVs, with focus on M&S excursions to expand lessons learned from military utility assessment and conduct additional experiments and performance tests. The demos also help refine HEV designs and/or applications to TWVs. In FY09, will continue analysis and testing of HEVs and focus on M&S excursions with actual demonstrations to validate models and expand lessons learned to quantify fuel economy and performance of Hybrid Demonstrator Vehicles; conduct additional experiments on HEVs designed with various architectures.	2485	4832	4790
Advanced Hybrid Electric Vehicle Components: In FY07, matured and demonstrated inverter, battery, traction motor, and DC-DC converter component technologies; conducted product evaluations/tests; continued evaluations and laboratory tests of Li-ion and other types of high performance batteries; evaluated advanced thermal management technologies for maintaining coolant temperatures of 110 C° during system demonstrations using innovative cooling techniques (i.e. spray cooling and hybrid cooling loop); and demonstrated component performance in high power density DC-DC converters and in-vehicle applications. In FY08, demonstrate advanced HEV-based modular drive train systems consisting of power sources and energy storage devices under different architectures in the propulsion lab, with focus on developing effective thermal management system architectures and power management control strategies that can be applied to next generation tactical vehicles; and mature and demonstrate system architecture designs for improving reliability, safety, and power consumption strategies. In FY09, will conduct laboratory assessment of several advanced high energy/power density battery systems to gauge their suitability for final Non-primary Power System (NPS) hardware; and will demonstrate advanced power generation technologies to meet NPS requirements (Silent Watch increase duration from 5 to 12 hours and power from 2 to 8 kW).	8794	6232	4896
Pulse Power: In FY07, demonstrated reduced size for critical pulse power components while maintaining the critical electrical performance needed for the dual mode PFN, the Solid State Laser (SSL) PFN and Electro-magnetic (EM) Gun switch; evaluated performance of improved High Energy Density (HED) capacitors in Advanced EM Armor application/vehicle demonstration; integrated and demonstrated transitional switch with improved pulse width for EM Gun at scaled power levels, and completed the design/development of the laboratory version of the a PFN/Battery Box for SSL. In FY08, complete development of vehicle-ready version of the 100kW power supply for the SSL to include development, integration, and test of high power-density batteries with the	4912	6613	5478

PFN/Battery Box, continue to improve EM Gun Switch with SiC based devices; increase HED capacitor's life by 25 percent; and increase energy density of HED capacitors to 2.0 J/cc. In FY09, will develop active cooling for the HEL pulse power supply, allowing greater operational time and increased power/weight efficiency by 40 percent; and will develop high voltage-reversal capacitors with extended durability and increased capacity.			
HIPER: In FY07, redesigned turbo-machinery system, including controls, on a high power density 440 kW capable test engine and conducted engineering tests to obtain performance and durability data.	2013		
Advanced Lightweight Track: In FY07, fabricated prototypes of new segmented band track and a lightweight hybrid steel track incorporating new bushing elastomers; and evaluated and analyzed effectiveness of reinforcement and joint structural performance for anti-personnel mine blast survivability, heat transfer, and sprocket/track interfaces. In FY08, integrate and evaluate performance of the new segmented band track and hybrid steel track on demonstrator vehicles under field conditions with focus on durability and mobility. In FY09, a set of Hybrid Lightweight Track will be fabricated and vehicle tested for durability, mobility, and survivability capabilities to demonstrate a sufficient technology maturity for transition to Future Force manned ground vehicles.	3911	3849	2000
JP-8 Reformation for Alternative Power Sources: In FY07, assessed selected reformation and desulphurization technology approaches and began initial system integration efforts for future laboratory hardware performance demonstration. In FY08, integrate JP-8 reformer to transportable system and interface with fuel cell; and optimize key components to make the system transportable.	2472	3739	
Fuel Efficiency ground vehicle Demonstrator (FED): In FY08, use modeling and simulation that exploits advanced materials and construction techniques to design a tactical wheeled vehicle significantly lighter and more fuel efficient than the HMMWV with comparable or improved mobility and survivability; identify potentially high pay-off lightweight/fuel efficient designs and components (such as electric/hybrid electric propulsion systems, high energy density-high efficiency engines, advanced power units, fuel cells, advanced batteries, lightweight armors, electric motors, lightweight/durable suspensions, and energy efficient tires); select best design and begin physical fabrication/integration effort. In FY09, will complete demonstrator fabrication/integration and conduct comparative performance evaluations, using M1114 Up-armored HMMWV as baseline; will analyze test results and identify opportunities to implement technologies developed, integrated, and evaluated in current and future force vehicles.		9282	9976
Propulsion-Prime Power: In FY09, will test and evaluate for Tactical Wheeled Vehicles compact advanced high power density components developed by the Advanced Hybrid Electric Vehicle (HEV) Components effort; will modify, optimize, and evaluate performance of commercially available tactical vehicle engines to enable them to operate using standard JP-8 fuel without damaging components that would lead to engine failure; will mature, demonstrate, and refine Magneto-Rheological Suspension on Stryker MGS to improve vehicle stability; will complete and verify system level models of the suspension and propulsion systems; will develop and refine intelligent power management components and control strategies on system/test platform; and will evaluate intelligent power and thermal management concepts.			9759
Small Business Innovative Research/Small Business Technology Transfer Programs.		1160	
Total	33194	43599	44659

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February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
3 - Advanced technology development	**0603005A - Combat Vehicle and Automotive Advanced Technology**	**497**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
497 COMBAT VEHICLE ELECTRO	9288	13027	7459	7598	7718	7890	8067

A. Mission Description and Budget Item Justification: This project matures, integrates, and demonstrates vehicle electronics hardware (displays, sensors, communications systems, and vehicle command/control/driving mechanisms) and software that result in increased crew efficiencies, performance, and/or reduced crew size for Future Force vehicles and, where practical, for insertion into Current Force vehicles. The project advances open system architectures for ground combat vehicles that allow more efficient crew stations to be adapted for a variety of Future Force ground platforms. Technical challenges include: increased levels of automation for both manned and unmanned systems, advanced user interfaces that support improved/increased span of control for robotic operations, and collaborative vehicle operations, workload management, reliability of driving aids and commander's decision aids, and embedded simulation for battlefield visualization and fully integrated virtual test/evaluation. The Robotics Collaboration effort matures and demonstrates common scaleable user interface software that can reside on multi-screen mounted crewstations, single screen operator control units, or small Soldier portable devices. A major objective is to construct a common scaleable interface that has potential to reduce platform-unique training requirements by providing intuitive interfaces with a common look, feel, and function across a range of devices for the control of unmanned ground and air systems. The interface is designed to allow graceful degradation of the display system, reconfiguring controls and displays in the event of hardware failure and to provide associated functionality to the Soldier upon the discovery of available services. Robotics Collaboration also matures and refines mounted crew and dismounted Soldier task models, combines these in an Intelligent Systems Behavior Simulator (ISBS), and conducts focused experiments that will define key metrics and drive development of embedded intelligent agents that have potential to lessen Soldier workload and reduce and/or automate mounted and dismounted system control tasks. This work is performed in conjunction with Robotics Collaboration effort described in project 515. Force protection measures of the future require the mounted Soldier to operate for extended periods of time under armor with hatches closed. When operating in this mode, the Soldier's local situational awareness and ability to maneuver the vehicle currently are degraded. A portion of this project focuses on Intelligent Secure Mobility (ISM), work that seeks to improve mobility and survivability by collecting and analyzing data from vehicle sensors to provide mounted Soldiers and crew with enhanced local area awareness inside the vehicle. Unmanned assets organic to the platoon expand the local sensing sphere to increase standoff distances and response times. Real-time embedded models predict vehicle system behavior to support safe mobility and weapon operations. The effort supports definition and refinement of requirements based on employment of human factor methodologies and through human-in-the-loop static and ride-motion simulation. The Robotics Collaboration and ISM work is performed in close cooperation with the Army Soldier Battle Lab. 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 Tank Automotive Research, Development, and Engineering Center (TARDEC), Warren, MI, in conjunction with Army Research Laboratory - Human Resources Engineering Directorate (ARL-HRED), Aberdeen, MD.

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
Robotics Collaboration: In FY07, refined and modeled additional crew control tasks, display information, and intelligent agents; integrated display designs and intelligent agents into target hardware; conducted experiments in which Soldiers evaluated the mounted and dismounted scaleable interface; and measured the impact of controlling unmanned (and manned) systems on Soldier task work load during performance of militarily significant combat scenarios. In FY08, refine task timelines and models in the Intelligent Systems Behavior Simulator (ISBS) environment based on Soldier evaluations and experimental data; conduct final design and integration of scaleable interface software and intelligent agents into mounted and dismounted system hardware and perform final capstone Soldier operational	9288	12682	7459

field experiments in militarily significant combat scenarios in urban environments, capturing all relevant performance data. In FY09, will perform ISM human-in-the-loop simulation experiments to identify best design approaches for augmented reality interface and automation capabilities required for vehicle navigation and local awareness; begin development of augmented reality and automation technology; begin development of predictive models for safe mobility and weapon operations.			
Small Business Innovative Research/Small Business Technology Transfer Programs.		345	
Total	9288	13027	7459

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February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
3 - Advanced technology development	**0603005A - Combat Vehicle and Automotive Advanced Technology**	**515**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
515 ROBOTIC GROUND SYSTEMS	16855	9424	10182	10316	10942	11102	11269

A. Mission Description and Budget Item Justification: This project matures and demonstrates unmanned ground vehicle technologies for the Future Force and explores feasibility for enhancements to the Current Force. The main focus is on integrating and demonstrating in relevant environments sensor technologies, perception hardware and software, and robotic control technologies that enable Unmanned Ground Vehicle (UGV) systems to maneuver on- and off-road at militarily significant speeds with minimal human intervention, thereby enabling the Soldier to perform other mission tasks. Challenges addressed include: obstacle avoidance, overcoming perception limitations, intelligent situational behaviors, command and control by Soldier operators, frequency of human intervention, operations in adverse weather, and robots protecting themselves and their surroundings from intruders. Mature technologies are incorporated in UGV technology demonstrators so that performance can be evaluated for tactical maneuver and sustainment applications. The Near Autonomous Unmanned Systems effort matures a set of automated tactical behaviors and self-security systems that allow unmanned vehicles to perform intelligent tactical maneuvers in a semi-autonomous mode and enable self-protection through the identification and deterrence of human threats. This effort also develops UGV control architecture and demonstrates the viability of autonomous vehicle operations in a relevant environment. These technologies are integrated with sensor hardware onto a demonstration platform. Potential missions/functions include perimeter security, medical re-supply, and evacuation; scout/reconnaissance; and remote weapons delivery. This effort integrates a brass-board Autonomous Mobility Perception Suite onto a large scale UGV platform to provide autonomous maneuver capabilities. The work also develops and integrates the mission execution, computer operating environment, and vehicle management system hardware and software necessary for unmanned vehicle control. The Robotics Collaboration effort develops, matures, and demonstrates models that optimize the way Soldier-robot teams perform operations. Models are validated through both man-in-the-loop simulation and field experiments in which Soldier-robot teams perform military relevant scenarios. It develops 3D models and algorithms using colorized ranging with Laser Radar (LADAR) and visual sensors for safe operations of unmanned systems around humans. In addition, this effort focuses on developing and demonstrating UGV behaviors, including force protection and tactical/reactive/self-security, which provides the ability to consistently operate safely in a semi-autonomous mode in urban environments in the presence of Soldiers, pedestrians, and other vehicles. It also matures technologies that contribute to improved/enhanced navigation. Work done in this project is complementary to the Robotics Collaboration effort described in project 497. The Robotic Vehicle Control Architecture Technologies (RVCAT) effort develops a UGV end-to-end control architecture to reduce future UGV technology integration risk and demonstrate the viability of autonomous UGV operations in a relevant environment. The effort integrates a prototype Autonomous Navigation System (ANS) onto a large scale UGV platform to provide autonomous maneuver capabilities as well as develops and integrates the mission execution, computer operating environment, and vehicle management system hardware and software necessary for unmanned vehicle control. RVCAT performs a series of engineering evaluations and Soldier operational exercises to measure system performance and effectiveness from both the technical and operational point of view. The approach builds upon, complements, and does not duplicate previous and ongoing investments conducted under the Joint Robotics Program Office and the Defense Advanced Research Projects Agency, in program element (PE) 0602601A, project H91 (Tank and Automotive Technology) and by the Army Research Laboratory (ARL) PE 0602618A (Robotics 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 Tank Automotive Research, Development, and Engineering Center (TARDEC), Warren, MI, in collaboration with the Army Research Laboratory (ARL), Adelphi and Aberdeen Proving Ground, MD.

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
Near Autonomous Unmanned Systems: In FY07, integrated a brass-board Autonomous Mobility Perception Suite and control architecture	12946	4714	2492

components onto a large scale UGV platform, designed control architecture for command and control of UGVs by Soldier operators, designed and developed the mission execution and vehicle management hardware and software for UGV control, integrated and assessed tactical behavior algorithms designed to enable maneuver- and formation-based missions; integrated human detection and tracking components associated with self-security suite into testbed and evaluated performance through engineering testing; conducted engineering field evaluations and experiments to assess maturity and assist in development of tactics, techniques, and procedures; and continued to mature tactical behavior algorithms and self protection technologies using data collected from field experiments. In FY08, develop and begin integration and evaluation of tactical behavior algorithms required for scout missions and mature entire suite of tactical behaviors and vehicle self-security system. In FY09, will conduct capstone Soldier-in-the-loop field experiments in a militarily relevant environment using a militarily significant scenario.			
Robotics Collaboration: In FY07, conducted experiments to evaluate Soldier-robot teaming models in the performance of militarily significant combat scenarios employing unmanned systems; conducted engineering evaluations to collect data and refine initial safe operation models, and supported the control architecture design development for the Robotic Vehicle Control Architecture program. In FY08, integrate Soldier-robot teaming and safe-operations algorithms into hardware and perform capstone Soldier-field demonstration in urban environments to obtain performance data and support the Robotic Vehicle Control Architecture technologies program technical efforts. In FY09, will develop and evaluate baseline behaviors that enable UGVs to navigate around people and other vehicles in a realistic military testing environment.	3909	4447	3327
Robotic Vehicle Control Architecture Technology: In FY09, will integrate a prototype Autonomous Navigation System (ANS) onto the UGV platform; will conduct a series of engineering evaluations on the UGV platform to test and measure system capabilities given the prototype ANS and upgraded control architecture hardware and software; and will finalize platform system development and update with latest Software and interfaces.			4363
Small Business Innovative Research/Small Business Technology Transfer Programs.		263	
Total	16855	9424	10182

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
3 - Advanced technology development	**0603005A - Combat Vehicle and Automotive Advanced Technology**	**53G**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
53G FUTURE COMBAT SYSTEMS (FCS)	20951	14101	11992				

A. Mission Description and Budget Item Justification: This project funds FCS technologies. When mature, technologies such as armor, active protection system components, power and energy components, and unmanned systems, developed under this project are transitioned into the FCS acquisition program to enable objective capabilities. Current efforts are to demonstrate an Autonomous Platform Demonstrator (APD). The APD effort will develop a large scale, greater than 9 tons, hybrid electric Unmanned Ground Vehicle (UGV). This large sized UGV will integrate, and demonstrate advanced mobility technologies such as: hybrid electric drive systems, suspension systems, and lightweight chassis technologies. This effort supports and collaborates with the Robotic Vehicle Control Architecture program (Project 515) and is critical to effectively evaluate large scale high speed UGVs in a mobile tactical network. 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.

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
In FY07, Affordable Adaptive Conformal Electronically Scanned Array Radar (AACER) fabricated optimized integrated airborne system antenna array and perform ground performance demonstrations; the Air Assault Expeditionary Force experiment performed operational assessment of warfighting utility of FCS enabling technologies and concepts, in an operational environment, via experimentation with surrogates and mature demonstrator hardware/software. Mobile Network MMO (Multi-Input/Multi-Outut) validated MNM concept with perform 10-node demonstration tests on improved MIMO hardware/software demonstrator; UPI conducted full-up demonstration of enhanced capability sensors on two UGCV platforms; initiated a redesign and build of the Crusher vehicles to address UGV requirements.	20951		
In FY08, complete design for Crusher/UGV vehicles subsystems including software and mission payloads and conduct subsystem design performance tests followed by integrated testing; Integrate and test armor and active protection components; mature and integrate combat vehicle power and energy components.		13707	
In FY09, will finalize control architecture designs for the control of UGVs by Soldier operators; will finalize designs and finish development of the mission execution, computer operating environment, vehicle management, sensor management and fusion hardware and software for UGV control and integrate components onto the vehicle platform in preparation for engineering evaluations.			11992
Small Business Innovative Research/Small Business Technology Transfer Programs.		394	
Total	20951	14101	11992