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

February 2003

BUDGET ACTIVITY
3 - Advanced technology development

PE NUMBER AND TITLE
0603005A - Combat Vehicle and Automotive Advanced Technology

	COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
	Total Program Element (PE) Cost	220196	264795	210856	205245	158907	163390	188081	192493
221	COMBAT VEH SURVIVABLTY	30883	41284	45713	26806	19563	20406	23114	23942
440	ADV CBT VEHICLE TECH	22279	20945	0	16586	0	48976	60400	56335
441	COMBAT VEHICLE MOBILTY	14182	41683	35933	31630	55476	58318	78843	85037
497	COMBAT VEHICLE ELECTRO	5405	5966	6749	5868	9977	9722	13287	13592
502	HAECO II	0	1191	0	0	0	0	0	0
506	METAL MATRIX COMPOSITES	3744	1431	0	0	0	0	0	0
515	ROBOTIC GROUND SYSTEMS	8921	8456	7428	12248	22709	23702	10116	11214
539	MOBILE PARTS HOSPITAL	5372	7149	0	0	0	0	0	0
53B	FUEL CELL AUX POWER UNITS FOR LINE HAUL TRUCKS	0	2859	0	0	0	0	0	0
53D	NATIONAL AUTOMOTIVE CENTER - ADV TECH	1619	2574	0	0	0	0	0	0
53E	IMPACT TRUCK PROGRAM	3358	3336	0	0	0	0	0	0
53F	NAC STANDARD EXCHANGE OF PRODUCT MODEL DATA	2398	2382	0	0	0	0	0	0
53G	FUTURE COMBAT SYSTEMS (FCS)	109620	114351	114051	111102	48998	0	0	0
540	IMPROVED HMMWV RESEARCH	2015	0	0	0	0	0	0	0
C66	DC66	4453	3087	982	1005	2184	2266	2321	2373
CA2	TACOM HYBRID VEHICLE DEMO: LITHIUM ION TECH	958	0	0	0	0	0	0	0
CA3	CORROSION PREVENTION AND CONTROL PROGRAM	1343	2430	0	0	0	0	0	0
CA4	VEHICLE BODY ARMOR SUPPORT SYSTEM	3166	2430	0	0	0	0	0	0
CA5	FUEL CATALYST RESEARCH EVALUATION	480	953	0	0	0	0	0	0
CA6	INTEGRATED PROGRAM MANAGEMENT FRAMEWORK	0	953	0	0	0	0	0	0
CA7	RAPID PROTOTYPING	0	1335	0	0	0	0	0	0

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 is to mature and demonstrate leap-ahead combat vehicle automotive technologies to realize the Army's vision and enable transformation to the Objective Force. The Future Combat Systems (FCS), the Army's top priority Science and Technology program, is the primary effort funded in this PE; therefore in FY02-FY05, a significant portion of the funds supports the collaborative Army/Defense Advanced Research Projects Agency (DARPA) FCS program. The FCS Memorandumof Agreement (MOA) between the Army and DARPA, signed in February 2000, delineates the technical approach, cost-shared funding profile and responsibilities associated with this partnership. In addition to FCS, this PE supports maturation and demonstration of enabling technologies in the areas of survivability (Project 221), mobility (Project 441) and intra-vehicular digital electronics (Project 497). It also funds efforts to integrate and evaluate diverse vehicle technologies developed by the Army, other DoD agencies and industry. These advanced technologies are demonstrated in coordination with Army warfighter organizations through vehicle component and system level technology demonstrations. Three Advanced Technology Demonstrations (ATDs) are funded. The Future Scout and Cavalry System (FSCS) ATD, a joint US/UK effort completed in FY02, incorporated state-of-the-art sensor, armor, mobility and survivability technologies that are available to the FCS program. The CAT ATD demonstrates multi-mission capable crew stations required for the versatility of the Objective Force. The Robotic Follower ATD (Project 515) will mature and demonstrate an unmanned ground system capability for the FCS and the Objective Force Warrior. The intent is to reduce the soldier's equipment burden, increase survivability and reduce the logistics burden. Hybrid electric and electric vehicle technologies are key enablers for achieving Future Combat Systems (FCS) and Objective Force capabilities. FCS vehicles will be designed with hybrid electric architectures, providing power for propulsion, communications and control systems, life support systems, and electric weapons and protection systems. In the mid-term, pulse power for electrothermal chemical (ETC) guns and electromagnetic (EM) armor will be matured and demonstrated. In the longer term, vehicle energy and power levels will be increased to accommodate advanced electric weapons (e.g., lasers, high power microwave and electric guns) and advanced electric-based protection systems. This program will demonstrate critical power, propulsion and electric systems, including energy storage, power distribution and pulse forming networks (PFNs). This PE is managed by the U.S. Army Tank-Automotive Research, Development and Engineering Center (TARDEC), a subordinate organization of the Tank-Automotive and Armaments Command (TACOM), located in Warren, MI. This PE adheres to Tri-Service Reliance Agreements on advanced materials, fuels and lubricants, and ground vehicles with oversight and coordination provided by the Joint Directors of Laboratories. Work in this program element is related to, fully coordinated with PE 0602601A (Combat Vehicle and Automotive Technology) and 0602618 (Ballistics Technology). The PE is coordinated with the Marine Corps through the Naval Surface Warfare Center, the Naval Research Laboratory, Air Force Armaments Command, and other ground vehicle developers within the Departments of Energy, Commerce, Transportation and DARPA. The work cited is consistent with the Army Science and Technology Master Plan, the Army Modernization Plan and Project Reliance. The program element contains no duplication with any effort within the Military Departments. No Defense Emergency Response Funds were provided to the program. This program supports the Objective Force transition path outlined in the Transformation Campaign Plan.

B. Program Change Summary	FY 2002	FY 2003	FY 2004	FY 2005
Previous President's Budget (FY 2003)	225960	234978	218157	181468
Current Budget (FY 2004/2005 PB)	220196	264795	210856	205245
Total Adjustments	-5764	29817	-7301	23777
Congressional program reductions		-9018		
Congressional rescissions		-5126		
Congressional increases		57900		
Reprogrammings	324	-6721		
SBIR/STTR Transfer	-6088	-7218		
Adjustments to Budget Years			-7301	23777

Change Summary Explanation:

Significant Changes:
FY05 - Funds increases in FCS engine, Pulse Power, Robotics, and Advanced Mobile Integrated Power.

FY03 ($57900) Congressional Adds:
Truck Research, Project TBD ($1000)
Composite Body Parts – CAV Technology Transition, Project 440 ($2100)
Digital Human and Virtual Reality for Future Combat System, Project 440 ($3500)
Hybrid Electric Drive, Project 441 ($1500)
Aluminum Reinforced MMC's for Track Shoes on Ground Based Vehicles, Project 506 ($1500)
Advanced Thermal Management System, Project 440 ($1000)
Geisel, Project 502 ($1250)
Integrated Program Management Framework, Project CA6 ($1000)
Ultra-high Performance Hybrid Structures and Armors, Project CA4 ($2550)
Electrochromatic glass for combat vehicles, Project 53D ($1700)
Future Scout and Cavalry Vehicle Demonstration, Project 440

($8500)
Objective Force Cost Module, Project 440 ($3600)
Fuels catalyst research and evaluation, Project CA5 ($1000)
Rotary, Multi-fuel, Auxiliary Power Unit Development Program, Project 53B ($3000)
IMPACT, Project 53B ($3500)
NAC Standardized Exchange of Product Data, Project 53F ($2500)
Mobile parts hospital, Project 539 ($7500)
Rapid prototyping, Project CA7 ($1400)
Hybrid electric vehicles, Project 441 ($5250)
Pacific Rim Corrosion Project, Project CA3 ($2550)
Tracked Hybrid Electric Vehicle, Project 441 ($1000)
Turbo Fuel Cell Engine, Project 440 ($1000)

Projects with FY2003 Congressional Adds and no R-2A not listed/defined due to space limitations.

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

February 2003

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

COST (In Thousands)		FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
221	COMBAT VEH SURVIVABLTY	30883	41284	45713	26806	19563	20406	23114	23942

A. Mission Description and Budget Item Justification: This project matures and demonstrates vehicle survivability technologies essential for FCS and the Objective Force, including: active protection (AP), advanced lightweight armor and signature management. As combat vehicle systems become smaller and lighter to provide the necessary strategic deployability and tactical mobility, one of the greatest technological and operational challenges is providing adequate protection without reliance on heavy passive armor. This challenge will be met using a layered approach, substituting long-range situational awareness, multi-spectral signature reduction, AP systems and advanced lightweight armor for conventional armor. Initial AP efforts demonstrate technologies needed for a system that is effective against Chemical Energy (CE) anti-tank guided missiles (ATGMs), rocket propelled grenades (RPGs) and tank fired high explosive anti-tank (HEAT) munitions. The goal of the AP against CE effort is to demonstrate hard kill, physical interruption with a countermeasure (CM) warhead, and soft kill electronic warfare (EW) spoofers and jammers while the vehicle is on-the-move (OTM). Defeat of Kinetic Energy (KE) threats offers a substantial challenge due to size and speed of the threat. The goal of the AP against KE effort is to defeat KE with a multi-purpose hard kill CM warhead. The project uses component technologies from PEs 0602601A, 0602120A, 0602618A and 0602624A. The goal of the ballistic protection effort is to provide a suite of lightweight armor component technologies for all manned FCS ground vehicle variants. Armor technologies include electromagnetic, smart and ceramic armors integrated with advanced composite and laminate structures. Lightweight, integrated armor technologies, including components from PE 0602601A, 0602618A and 0602105A, will be demonstrated by ballistic testing of quarter vehicle sections to validate performance versus weight as required for frontal and side armor protection. The signature management effort will improve existing multi-spectral signature modeling tools, characterize hardware performance, and provide inputs to FCS virtual prototyping. The technical goal is to demonstrate an 80% signature reduction in a validated virtual combat vehicle concept. Multi-spectral combat vehicle signature models will be validated using hardware samples with measured signature characteristics and will be used to assess FCS platform designs. Protection for sensors from laser attack is addressed. This program supports the Objective Force transition path of the Transformation Campaign Plan. No Defense Emergency Response Funds were provided to the program/project.

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
Active Protection against CE – In FY 02, tested active protection hard kill and EW jamming against live ATGMs and RPGs; demonstrated ability to defeat RPGs, ATGMs and tank-fired HEAT rounds; demonstrated defeat of two ATGMs fired nearly simultaneously, using hard kill on one and soft kill on the other. These demonstrations were accomplished with a static vehicle. In FY 03, design and integrate radar and CM launcher stabilization required for operation of the AP system OTM; demonstrate hard kill ATGM defeat from a moving test vehicle; develop and test an extended range tracking radar sensor; develop a more capable CM warhead and begin design of cueing sensor radar for hemispherical detection of threat munitions. In FY04, integrate and test explosive warhead, low cost threat warning sensor, and search radar against tank-fired HEAT, ATGMs, RPGs, and Fallers/Flyers; integrate complete hemispherical CE AP system onto test vehicle for end-to-end OTM testing in an operational environment; and mature OTM algorithms for AP motion compensation. In FY05, mature OTM algorithms for EW; test Multi-Function EW Countermeasure; test OTM full hemispherical, integrated AP/EW system.	20321	32041	27213	7189
Active Protection against KE (Full Spectrum Active Protection) - In FY 02, conducted over 100 CM warhead/threat interaction tests to identify a single warhead design that has the potential to defeat all threat classes; identified three different countermeasure configurations: blast, blast/fragment, and multiple explosively formed penetrator warhead configurations with potential to be effective against KE and all threat classes. In FY 03, test and validate CM interceptor and warhead fusing technologies; perform CM warhead fly off tests against KE, CE and ATGM threats and improve model fidelity. In FY04, demonstrate FSAP close-in layered shield against near field RPG, DPICM, and man portable ATGM threats. Complete FSAP radar design, fabricate and demonstrate e-scan radar, select and demonstrate final interceptor with proximity fuse and countermeasure against the full spectrum of threats, and complete the final FSAP system design. Mature, miniaturize and ruggedize selected technologies for system integration. In FY05, complete FSAP system design, fabricate, integrate, and demonstrate the system in a dynamic environment against all threat classes.	5562	5500	5000	11672
Ballistic Protection for Block II - In FY04, complete EM armor component development, build vehicle quarter section ballistic targets and range test these fully integrated 3rd generation armor/structure designs against FCS Block II threats and demonstrate: armor/structural capability at FCS weights; integration of critical components; and armor/structural reliability. In FY05, conduct ballistic range tests to optimize and validate the best achievable integrated armor packages for lightweight test platforms.	0	0	8500	3000

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
Signature Management - In FY02, developed improved virtual modeling tools and fabricated full-scale test hardware to validate virtual modeling results, completed verification, validation and accreditation on Thermal Predictive Model version 7.0; VVA proceeding with other models. In FY03, deliver proof of principle virtual prototyping signature field test capability to LSI and contractors and perform breadboard testing to quantify field performance and commence FCS signature modeling predictions. In FY04, deliver enhanced modeling capability including exhaust plume signature effects and integration with synthetic imagery, optimize field performance of hardware for FY05 validation tests. In FY05, perform full-scale validation tests and deliver to LSI full capability signature management virtual models, and provide robust signature modeling capability to Joint Virtual Battlespace.	5000	3743	5000	4945
Totals	30883	41284	45713	26806

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

February 2003

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
3 - Advanced technology development	**0603005A - Combat Vehicle and Automotive Advanced Technology**	**440**

COST (In Thousands)		FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
440	ADV CBT VEHICLE TECH	22279	20945	0	16586	0	48976	60400	56335

A. Mission Description and Budget Item Justification: This project demonstrates the operational potential, technical feasibility and maturity of advanced combat vehicle technologies through integrated demonstrations of subsystems, systems, and system of systems. In FY 2002 Army funds for the collaborative Army/DARPA FCS effort were transferred from this project to Project 53G to provide better visibility (see project 53G for a description of the FCS program). Work performed under this project (440) demonstrates innovative concepts, combat vehicle configurations, enabling technologies and integration techniques. All demonstrations include User and developer teaming in field and/or laboratory environments. Computer simulations and hardware demonstrations (subscale and full-scale) are conducted to accomplish a more rapid and seamless transition of advanced technologies into systems applications. The FSCS ATD, completed in FY02, integrated advanced sensors, survivability, mobility and communications technologies into robust vehicle platforms. The integrated prototype assets delivered to the government demonstrated the technical maturity and the ability to successfully integrate technologies. The demonstrators underwent technical testing with a limited operational evaluation to assist the Training and Doctrine Command in developing warfighting tactics, techniques, and procedures. Technologies developed under this program and the lessons learned about integrating FSCS technologies on a C-130 transportable platform were made available to the FCS LSI to reduce risk and accelerate FCS development. The Future Tactical Truck System (FTTS) effort is a program to build medium support and utility vehicle demonstrators and evaluate them in a field environment. The program evaluates future tactical vehicle technologies including high power density engines, hybrid electric propulsion, electric traction motors, advanced power distribution & control, advanced battery storage, independent & variable height suspension, semi-active/selectable damping suspension, advanced digital driver displays & controls, and vehicle structure & cab designed for survivability and mine protection. New methods and techniques for material handling will be demonstrated. The demonstrations will be supported by virtual prototyping through the use of 3D CAD models and analysis. No Defense Emergency Response Funds were provided to the project. This system supports the Objective Force transition path of the Transformation Campaign Plan.

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
Future Scout and Cavalry System (FSCS) ATD - In FY02, this effort completed FSCS Advanced Technology Demonstration (ATD) Program which demonstrated the feasibility and operational potential of a lightweight scout vehicle platform in various areas including survivability, target acquisition, mobility, deployability, and lethality, by integrating scout specific technologies with complementary advanced vehicle technologies. More specifically, this program addressed issues including survivability strategies, sensor capabilities, and mobility enhancements. Technology risk reduction and subsystem maturation activities initiated during the FSCS ATD were available for transition into the Future Combat System (FCS) Program.	15167	0	0	0
Water Recovery from Vehicle Exhaust for FCS - In FY03, initiate development and demonstration of a system to recover water from vehicle exhaust gases for logistics burden reduction for FCS using technology being developed in PE 0602601 Project AH91.	0	1930	0	0
Future Tactical Truck System (FTTS) – In FY05, build multiple medium support and utility vehicle demonstrators/prototypes; test vehicles in a field environment to evaluate performance and military utility. This effort will be supported by virtual prototyping through the use of 3D models and analysis. This project uses technology developed in PE 0602601 Project AH77.	0	0	0	16586
Future Scout and Cavalry Vehicle Demonstration - In FY03, this one-year Congressional Add continues risk reduction and subsystem maturation activities initiated during the FSCS Advanced Technology Demonstration (ATD) Program. These activities are at an integrated system and subsystem level, focusing on transition to the Future Combat Systems (FCS) Program. No additional funds are required to complete this project.	0	8208	0	0
Composite Body Parts – In FY02, this one year Congressional Add supports and completes the adaption and evaluation of HMMWVs with composite construction. No additional funds are required to complete this project.	1345	0	0	0
Combat Vehicle Research in Weight Reduction – In FY02 this one-year Congressional Add supports and completes development and evaluation of low-cost composites using intelligent Vacuum Assisted Resin Transfer Molding (VARTM) process control and low cost tooling technology for thin gage sheet metal panel replacement for trucks and other tactical vehicles. No additional funds are required to complete this project.	5767	0	0	0
Digital Human & Virtual Reality for FCS – In FY03, this one-year Congressional Add developments digital human modeling/simulation tools and applications that currently do not exist and are needed to analyze & evaluate the human interface for digital models of vehicle systems. No additional funds are required to complete this project.	0	3378	0	0

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
Composite Body Parts CAV Technology Transition - In FY03, this one-year Congressional Add: expands manufacturing trials to all variations of HMMWV doors, the 5 ton truck hood, HMMWV hood front corners, and 2 1/2 ton and 5 ton truck doors; conducts 12-month field evaluations of more than 500 composite body parts; and provides small, initial population of 2 1/2 ton hoods for immediate field use to solve logistics No-Source Problem. No additional funds are required to complete this project.	0	2027	0	0
Turbo Fuel Cell Engine - In FY03, this one-year Congressional Add develops materials, manufacturing processes, and tube interconnections for solid oxide fuel cell tubes, which are the core of a turbo-charged fuel cell vehicle engine. No additional funds are required to complete this project.	0	964	0	0
Objective Force Cost Module - In FY03, this one-year Congressional Add develops a collaborative information and budget software tool for application to the management of programs being developed for the Objective Force. No additional funds are required to complete this project.	0	3474	0	0
Advanced Thermal Management System - In FY03, this one-year Congressional Add funds development of advanced pumping technologies for parasitic reduction combined with advanced cooling technology for thermal control. No additional funds are required to complete this project.	0	964	0	0
Totals	22279	20945	0	16586

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

February 2003

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

COST (In Thousands)		FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
441	COMBAT VEHICLE MOBILTY	14182	41683	35933	31630	55476	58318	78843	85037

A. Mission Description and Budget Item Justification: This project matures and applies advanced mobility and electric technologies to next generation vehicles and will demonstrate increased vehicle performance and capability. It enables light, agile, deployable, fuel efficient and survivable ground combat vehicles needed for FCS and the Objective Force. The main efforts funded by this project are Hybrid Electric Vehicle (HEV) Propulsion Technologies, FCS Engine, Advanced HEV Technologies, and Pulse Power. HEV develops and matures components, sub-systems and systems for hybrid-electric vehicles including power distribution and storage systems, in-hub wheel motors, active suspension, high-density capacitors and pulse power components, and high-temperature silicon/silicon carbide electronics. Demonstrations of these items will be conducted in the Combat Hybrid Propulsion System (CHPS) Systems Integration Laboratory (SIL) that simulates combat vehicles weighing less than 20 tons. Hybrid Electric Vehicles offer: improved automotive performance, significant reduction in fuel consumption (20-50% savings over today's combat vehicles), silent watch and silent mobility, and vehicle design flexibility. The SIL will demonstrate electrical power and energy sources, significantly enhanced control methodologies and electrical architectures (enabled by high-speed switching) to provide on-board power management. The HEV effort is enhanced significantly with infusion of FY03 funds to ensure that this critical technology will be mature enough to use in FCS block I vehicles. The goal of the FCS Engine effort is to mature and demonstrate prime power (engines) for hybrid combat vehicles with a goal to double the power density (horsepower per cubic foot (hp/cu.ft.)) of a comparable, state-of-the-art, commercial engine. The Army develops and matures high power density engines because commercial engines lack robustness and power density required for Army vehicles. In FY02 and FY03, both internal combustion diesel engines and turbines are being pursued as FCS candidates. The goal of the effort is to demonstrate a prototype engine system with power density of no lees than 6 hp/cu.ft. in FY05. The Advanced HEV Technologies will seek further increases in vehicle mobility, efficiency and mission capability without increasing vehicle weight and volume. This project will apply advanced technologies (in-hub wheel motors, active suspension, high temperature electronic components, regenerative brakes, thermal management, lightweight track and band track) to next generation vehicles and identify changes in vehicle performance. Army efforts in hybrid electric drive leverage two prior joint Army/DARPA programs, CHPS and the Electric Drive Vehicle Demonstration Program, and component technologies from PE 0602601A and PE 0602618A. The Pulse Power effort will build on work performed under the CHPS HEV initiative. Compact, high power density Pulse Forming Networks (PFNs) will enable more lethal electric weapons and more effective protection systems. The goal is to accelerate development of high power density, capacitor-based PFNs for electro-magnetic armor and weapons for FCS Block II and beyond. No Defense Emergency Response Funds were provided to this project. This program supports the Objective Force transition path of the Transformation Campaign Plan.

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
HEV FCS Propulsion – In FY02, operated basic hybrid electric power management system in the Combat Hybrid Power System (CHPS) SIL at 300 and 600 volt levels, emulating the full range of vehicle operating conditions, completed and installed 300kW lithium ion battery, fabricated electromagnetic (EM) armor simulator; and completed 200kW/cu.m multi-functional PFN and demonstrated 100kJ/pulse power discharge into simulated electrothermal chemical (ETC) load. In FY03, there is a major focus on acceleration of hybrid electric/hybrid technologies to support FCS block I. Downsize components to fit the FCS-class ground vehicles (<20 tons) using a volume goal of 80 cubic feet for the power pack; configure SIL for FCS component testing; demonstrate power levels, control techniques and unique hybrid electric power architecture at the 750 volt level. Demonstrate pulse power at 200 kJ for both EM armor and ETC gun, and test traction motors; develop electric suspension to increase speed over cross country terrain by 70%; document findings/results and transition mature components and subsystems to FCS LSI for Block I. In FY04, implement strategy for upgrading hybrid electric technologies for potential FCS insertion; advance power densities of compact FCS components to objective (goal) power levels (200 kW per cu.m).	4742	16923	2943	0
FCS Engine - In FY02, contracted for a competitive engine demonstration program with three different engine companies to implement designs to double commercial off-the-shelf engine power density in the same space and weight limitations imposed by FCS prime power needs. In FY03, demonstrate the power density potential of the three competing engines through preliminary hardware testing in the laboratory and down select to one engine. In FY04, the engine will undergo performance improvement, mechanical durability development and 50 hour NATO durability demonstration. It will also be optimized for hybrid electric application and reconfiguration design begun for specific FCS vehicle application. In FY05 the reconfigured design will be built and matured for 400 hour NATO demonstration.	9440	16314	10000	9963
Advanced HEV Technologies - In FY04, demonstrate improved electric in-hub motor with reduced weight and volume characteristics; develop SiC motor inverter for 10 kW level for improved power density; test improved Li-Ion batteries at 750 volts to improve efficiency and reduce volume; develop and demonstrate Si/SiC 50 kW DC-DC converter for higher frequency and reduced volume; develop all SiC 10 kW DC-DC converter and scale to 50 kW; and adapt lab capabilities to emulate full electric hybrid system for FCS Block II. In FY05, demonstrate 50 kW SiC motor inverter; develop Li-Ion batteries for 1000 volts; and demonstrate improved hub motor and active electric suspension in FCS Block II surrogate.	0	0	18086	17194

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
Pulse Power - In FY04, develop: high energy density pulse forming Network (PFN) at 6.6 kJ/ft3; hybrid Si/SiC DC-DC converter for pulse power PFN application; and sealed vacuum discharge switches for pulse power. In FY05, incorporate SiC switches into PFN for greater energy density and develop high frequency SiC DC-DC converter for pulse forming network. This is a collaborative TARDEC/ARL effort.	0	0	4904	4473
Hybrid Electric Drive - The objective of this one-year Congressional Add is to support the systems engineering study that makes an assessment of hybrid electric drive systems on military and commercial trucks to identify the technologies and configurations within the design space that will support both a military and commercial requirement. No additional funds are required to complete this project.	0	1635	0	0
Hybrid Electric Vehicles - The objective of this one-year Congressional Add is to build light and medium HEV demonstration platforms that will be evaluated in the field by the warfighter to determine the impact the advanced technologies will have on the warfighters' ability to reduce the logistics footprint while meeting mission requirements. No additional funds are required to complete this project.	0	5721	0	0
Tracked Hybrid Electric Vehicle - The objective of this one-year Congressional Add is to demonstrate the system integration and synergistic effects of Command & Control electronics integrated into a hybrid electric vehicle having on-board power generation and storage. No additional funds are required to complete this project.	0	1090	0	0
Totals	14182	41683	35933	31630

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

February 2003

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

COST (In Thousands)		FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
497	COMBAT VEHICLE ELECTRO	5405	5966	6749	5868	9977	9722	13287	13592

A. Mission Description and Budget Item Justification: This project matures and demonstrates intra-vehicle electronics hardware and software, producing a multifunctional crew station that will result in increased crew efficiencies/performance and/or reduced crew size. In addition, the project advances open system architectures for ground combat vehicles that will allow the vehicle crew station to be adapted for a variety of FCS and Objective Force ground platforms. The primary effort is the CAT ATD, which focuses on automation of crew functions and integration of advanced electronic architecture compatible with automotive and system platform requirements. Products include simplified/user friendly, responsive controls for unmanned ground and air systems, up to 30% reduction in software and modified commercial power architecture. In FY03 and FY06, vehicle demonstrations are planned to prove out configurations of multi-role crew stations that will enable a two-man crew to perform functions associated with fighting the battle, reconnaissance, logistics and sustainment, as well as unmanned asset control in a test-bed with reconfigurable crew stations. Goals include a 30% reduction in software cost, a ten-fold increase in architecture throughput, and full mission rehearsal via embedded simulation that will be relevant to the FCS. For the period FY05-FY09, activities will focus on advanced multifunctional ground vehicle crew station concepts and technologies for FCS Block II and III. This will include an integrated Section Level Associate with a Vehicle Commander's Associate, improved and increased span of control for mixed initiative robotic operations, collaborative vehicle operations for workload management, and continued maturity of auto driving aids and embedded simulation for battlefield visualization and fully integrated virtual test and evaluation.
No Defense Emergency Response Funds were provided to the project. This program supports the Objective Force transition path of the Transformation Campaign Plan.

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
Crew Integration and Automation Testbed ATD: In FY02, defined semi-autonomous driver's aid and adapted cognitive decision aid; matured route planning for mobile testbed evaluation; and designed and integrated a Systems Integration Laboratory which led to the implementation of a crew station and electronic architecture for FCS technology evaluated by FCS system integrator. In FY03, conduct an unmanned combat demonstration in a virtual experiment with an advanced crew station; complete cognitive decision aid and soldier in-the-loop test crew station and embedded simulation. In FY04: integrate and conduct field testing of advanced crew station, electronics architecture and embedded simulation component technologies; add operator's intent inferencing and system automation to the commander's associate; demonstrate SMI and decision aids for UAV control; augment combat vehicle driver's aid to utilize pedestrian/dismounted soldier identification; and mature a distributed digital indirect vision system for closed hatch vehicle driving operations. In FY05: mature technology to mix live and virtual imagery, enabling on-the-move embedded simulation and mission rehearsal; implement and test ground vehicle autopilot capability; mature a distributed workload management system across manned/unmanned assets that support the FCS network centric concept; and procure/fabricate advanced hardware needed to test the full range of ATD exit criteria in the following year.	5405	5966	6749	5868
Totals	5405	5966	6749	5868

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

February 2003

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

COST (In Thousands)		FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
515	ROBOTIC GROUND SYSTEMS	8921	8456	7428	12248	22709	23702	10116	11214

A. Mission Description and Budget Item Justification: This project matures and demonstrates unmanned ground vehicle technologies for the FCS and other Objective Force ground systems. This project demonstrates sensor technologies/perception hardware, software and robotic control technologies required to enable unmanned ground vehicle (UGV) systems to maneuver with minimal human intervention, on-and off-road, at militarily significant speeds. Mature technologies are incorporated in UGV technology demonstrators, whose performance can be evaluated for multiple tactical and logistics applications. Technical challenges addressed include: obstacle avoidance, perception limitations, intelligent situational behaviors, command and control, frequency of human intervention, and adverse weather operation. In the near term, the Robotic Follower ATD focuses on UGVs that follow other vehicles directly or follow a designated path, requiring little human intervention. The Demo III experimental UGV (XUV) and a converted Interim Armored Vehicle (robotic IAV) will serve as test vehicles. The goals for the ATD are: 5-200km separations between leader and follower, 160-750km range, obstacle detection for objects 0.3 x 1sq.m. in size, and minimum operator intervention (1 per km @20km/hr). This ATD is a cooperative effort between TARDEC and the Army Research Laboratory (ARL), using component technologies developed in PE 0602618A. The schedule has been accelerated to provide demonstration of Follower UGVs for FCS block I in FY03. The ATD is scheduled to complete in FY05. Potential applications include re-supply vehicles and soldier "mules" that may be used to reduce each dismounted soldier's carried load by 20 to 25 pounds. In the farther term, the project will advance unmanned ground vehicle technologies to enable semi-autonomous and autonomous operation and to expand the mission envelope of UGVs for FCS block II and beyond. Potential missions/functions include medical supply and evacuation, scout/reconnaissance and remote weapons delivery. This project was established by the Army in recognition of the increasing maturity of robotics technology, growing user interest in unmanned platforms, and an urgent need to make the force lighter, more agile strategically and tactically and more survivable. The approach builds upon previous and ongoing investments such as the Demo III program, conducted under the Joint Robotics Program Office, and the DARPA UGV program. Beyond completion of the Robotic Follower ATD, this project will continue to be executed in cooperation with ARL. No Defense Emergency Response Funds have been provided to this project. This program supports the Objective Force transition path of the Transformation Campaign Plan.

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
Robotic Follower Block 1: In FY02, using Stryker Infantry Carrier variant testbed added robotic control architecture and autonomous mobility algorithms to convert an Interim Armored Vehicle (IAV) from manned to unmanned vehicle; demonstrated low speed, line of sight capability to follow at 20kh and 500m separations. In FY03, obtain speeds of 65km/hr on primary roads and cross-country following speed of 20km/hr; complete software development of terrain registration geometric planning and road following; conduct war fighter experiments, testing and demonstrations of on-road, high speed, line of sight IAV follower; complete cross country, low speed follower for the dismounted soldier using XUV. In FY04, mature sensor data/map registration and trail detection technologies to obtain following speeds of 65km/hr on primary roads and 40km/hr cross-county. Integrate enhanced autonomous mobility algorithms from ARL Semi-autonomous Robotics effort for FCS. Develop robotic virtual development and test environment to enable hardware in the loop modeling and simulation. Conduct engineering evaluations and soldier operational testing of follower capability in logistic and tactical mission scenarios. Continue technology transition to FCS SDD Unmanned System developers and Objective Force Warrior teams. In FY05, develop/incorporate intelligent situational behavior to significantly increase separation times and distances and assist in prevention of communication loss or mobility kill. Develop/integrate vehicle tracking capability to enable operation within traffic.	8921	8456	7428	6979
Semi-Autonomous Robotic Mobility Demonstrations: In FY05, mature and demonstrate advanced route planning/route following algorithms, robust perception systems for obstacle avoidance, intelligent navigation and control systems, component technologies and software developed under PE 0602618; apply new component technologies to UGV demonstrators; design and conduct relevant field demonstrations of semiautonomous and autonomous UGVs to show capability to perform time consuming, dirty and dangerous missions.	0	0	0	5269
Totals	8921	8456	7428	12248

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

February 2003

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

COST (In Thousands)		FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
53G	FUTURE COMBAT SYSTEMS (FCS)	109620	114351	114051	111102	48998	0	0	0

A. Mission Description and Budget Item Justification: This project funds the Army's share of the Army/DARPA FCS program and other FCS key component technologies. FCS, the centerpiece of the Army's strategy to transform to the Objective Force, is a multi-functional family of systems that will be capable across the full spectrum of conflict and range of operations. The product of this project will be a family of systems that will meet the Army's transformation goal to have a responsive ground force that is superior in all aspects. The FCS project responds to an approved Organizational and Operational Plan and draft Operational Requirements Document developed by the U.S. Army Training and Doctrine Command (TRADOC). In September 2001 the Army decided to accelerate the FCS program to enter System Development and Demonstration (SDD) in 2003 vs. 2006. The program is on schedule to complete the Concept and Technology Demonstration (C&TD) phase in 2003 for the initial set of systems. In March 2002 DARPA issued an Other Transactions Agreement for a Lead Systems Integrator (LSI). In partnership with the Government the LSI will develop, define, refine, assess and validate a FCS concept and perform the work required to complete Milestone (MS) B, laying the foundation for a smooth transition to SDD. First Unit Equipped (FUE) for FCS with threshold capability is planned for 2008 and Initial Operational Capability, for 2010. The concept design for the first of the anticipated upgrades to achieve an objective capability will begin in 2004. DARPA is the executive agent for the FCS program in the C&TD phase. Funds in this project and those in PE 0602601/HH7 are provided to and executed by DARPA in accordance with Memoranda of Agreement (MOA). The first MOA, signed in February 2000, provided a basis for three distinct types of efforts: 1) Concept Development, Modeling and Simulation (M&S) and Surrogate Exercises; 2) Design/ Demonstration; and 3) DARPA-executed Enabling Technology efforts. The LSI executes the Design/Demonstration effort. Each Enabling Technology effort is managed as a distinct program at DARPA. Programs include: Beyond-line-of-sight (BLOS) Networked Fires Weapon (NetFires); Maneuver Command, Control and Communications; Maneuver and BLOS Surveillance and Targeting Systems; and Robotic Unmanned Ground Vehicles. Under the initial MOA (Phase I) the Army's planned share of the Army/DARPA collaborative FCS program is: $107M (FY2002), $122M (FY2003), $114M (FY2004) and $111M (FY2005). Due to the program acceleration and early transition to SDD, the intent of the original MOA has been met. Therefore, the Army and DARPA are negotiating a new MOA (Phase II) to continue the collaborative program and provide advanced technologies in support of the FCS program decisions in the FY2006 timeframe, either for technology insertion prior to FUE or future FCS upgrades. Phase II MOA primary objectives are: 1) conduct and further define Concept Development, M&S and Surrogate Exercises to assure emerging enabling technologies are on the path for inclusion in FCS; 2) continue maturation and demonstration of high payoff technologies from selected programs begun under the original MOA for insertion prior to MS C in FY2005; and 3) provide additional advanced technologies that will lead to increased capabilities in future FCS versions. The new MOA will use the FY2004 and FY2005 funding already slated for the DARPA/Army partnership. No Defense Emergency Response Funds were provided to the project. This project supports the Objective Force transition path of the Transformation Campaign Plan.

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
FCS Design/Demonstration (Phase I): In FY02, conducted competition for LSI and awarded an Agreement in March 2002; developed and defined initial system of systems architecture; conducted analyses to determine maturity of technologies; finalized FCS organizational, operational and materiel concepts; and established an advanced collaborative environment to support M&S throughout the program. In FY03, finalize detailed design for threshold FCS; plan and conduct key tests and demonstrations of critical elements to support MS B decision; validate M&S tools developed specifically for FCS and use these to support MS B decision; and transition FCS initial systems to SDD.	28000	50000	0	0
Enabling Technologies (Phase I): In FY02-03, funds provided to DARPA for Army share of technology maturation and developments programs listed below. In addition $18.82M was provided from PE 0602601/HH7 in FY02 to meet the Army's commitment according to the MOA. More specific information on the DARPA programs and their accomplishments/plans may be found in the DARPA exhibits. NetFires: Designs, builds and demonstrates missiles launched out of a container to provide non-line-of-sight lethality for FCS. In FY02, finalized missiles design, conducted flight tests. In FY03, transition program management to Army. Maneuver Command, Control, and Communications: Evaluate novel cooperative engagement, cooperative survivability and command and control strategies to help TRADOC develop FCS-based tactics, techniques and procedures. BLOS Surveillance and Targeting Systems: Mature selected lethality, survivability, mobility and communications technologies for transition to SDD in FY03. JigSaw: Designs, builds and demonstrates a Laser Detection and Ranging (LADAR) system that will allow warfighters to "see" through dense vegetation and under a forest/jungle canopy. In FY02, finalized LADAR system design and began hardware build. In FY03, evaluate LADAR system in limited field-testing. Perceptor: Develops and demonstrates sensors and perception algorithms for autonomous navigation of unmanned ground vehicles (UGVs). In FY02, completed 4 field experiments in different terrains to evaluate UGV perception approaches. In FY03, upgrade perception prototypes and examine performance in degraded operating conditions. Unmanned Ground Vehicle: Designs, builds and demonstrates 600 kilogram and 6000 kilogram UGVs to perform a variety of functions in the FCS-equipped force. In FY02, competed and awarded system design contact. In FY03, evaluate UGVs in limited field test.	59726	61276	0	0
Enabling Technologies (Phase I): In FY02, Army share of costs beyond original MOA. Enhanced and accelerated the DARPA NetFires effort; increased scope of work for the LSI to accommodate program acceleration.	15831	0	0	0
Objective Force Task Force (OF-TF): Funds OF-TF efforts to conduct FCS analyses and to ensure that FCS can be integrated successfully into the Objective Force.	6063	3075	51	102

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
FCS Design/Demonstration (Phase II): In FY04, define, evaluate and select technologies for upgrade from threshold to objective capabilities; further develop and define FCS spiral development concept; perform trade studies, analyses and tests on technologies/systems for future upgrades. In FY05, demonstrate improved performance afforded by advanced technologies and provide detailed plan for FCS upgrades.	0	0	40000	40000
Enabling Technologies (Phase II): In FY04-05, pursue new enabling technology efforts focused on three critical areas: 1) Find the Enemy, 2) Autonomy with Intent, and 3) Affordable Combat Identification. Find the Enemy will provide capabilities to better defeat camouflage, concealment, and deception and exploit situational awareness through improved sensors, assured communications, intelligent decision aids, and data fusion. Autonomy with Intent will focus on improving unmanned systems' (UAVs and UGVs) ability to function while minimizing soldier workload and interaction. Affordable Combat Identification will increase force survivability by improving identification of battlefield entities for high OPTEMPO in complex terrains and intermingled forces. Also, some funding to complete key efforts initiated in Phase I.	0	0	74000	71000
Totals	109620	114351	114051	111102