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

February 2002

BUDGET ACTIVITY
3 - Advanced technology development

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

	COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
	Total Program Element (PE) Cost	167679	225960	234978	218157	181468	105234	110314
221	COMBAT VEH SURVIVABLTY	27270	31879	49401	44327	27166	16136	17972
440	ADV CBT VEHICLE TECH	89017	22954	2774	10066	10896	54601	55094
441	COMBAT VEHICLE MOBILTY	7167	14603	39210	18184	14181	13910	16402
497	COMBAT VEHICLE ELECTRO	2916	5567	6334	5955	68	13267	13342
506	METAL MATRIX COMPOSITES	7692	2481	0	0	0	0	0
515	ROBOTIC GROUND SYSTEMS	1694	9219	8873	22514	14939	5092	5191
533	TECHNOLOGY TRANSFER CENTER	4807	0	0	0	0	0	0
539	MOBILE PARTS HOSPITAL	7692	5559	0	0	0	0	0
53B	FUEL CELL AUX POWER UNITS FOR LINE HAUL TRUCKS	2884	0	0	0	0	0	0
53C	NATIONAL AUTOMOTIVE CENTER - UNIV INNOVATIVE RSCH	2884	0	0	0	0	0	0
53D	NATIONAL AUTOMOTIVE CENTER - ADV TECH	3845	4169	0	0	0	0	0
53E	IMPACT TRUCK PROGRAM	4807	3474	0	0	0	0	0
53F	NAC STANDARD EXCHANGE OF PRODUCT MODEL DATA	2884	2481	0	0	0	0	0
53G	FUTURE COMBAT SYSTEMS (FCS)	0	110587	125147	116112	113194	0	0
540	IMPROVED HMMWV RESEARCH	0	2084	0	0	0	0	0
C66	DC66	2120	4703	3239	999	1024	2228	2313
CA2	TACOM HYBRID VEHICLE DEMO: LITHIUM ION TECH	0	1000	0	0	0	0	0
CA3	CORROSION PREVENTION AND CONTROL PROGRAM	0	1400	0	0	0	0	0
CA4	VEHICLE BODY ARMOR SUPPORT SYSTEM	0	3300	0	0	0	0	0
CA5	FUEL CATALYST RESEARCH EVALUATION	0	500	0	0	0	0	0

A. Mission Description and Budget Item Justification: The goal of this Program Element (PE) is to mature and demonstrate new and improved combat vehicle and automotive technologies to enable transformation of the Army to the Objective Force. Future Combat Systems (FCS), the Army's top priority S&T program, is the primary emphasis of work funded in this PE to support Army Transformation. A large portion of the funds in this PE supports the collaborative Army/Defense Advanced Research Projects Agency (DARPA) FCS program. A Memorandum of Agreement (MOA) between the Army and DARPA (signed February 2000) delineates the approach, funding and responsibilities for the FCS program. The Army vision demands a force that is deployable, agile, versatile, lethal, survivable and sustainable across the spectrum of operations. This PE supports the following enabling technology areas: survivability, mobility and intra-vehicular digital electronics. It also integrates diverse vehicle technologies developed by the Army, other DoD agencies and industry. These technologies are demonstrated in coordination with Army warfighter organizations through vehicle component and system level technology demonstrations. In addition, three Advanced Technology Demonstrations (ATDs) are funded: Future Scout and Cavalry System (FSCS), Crew Integration & Automation Testbed (CAT), and Robotic Follower. The FSCS ATD is a joint US/UK effort incorporating the state-of-the-art sensor, armor, and survivability technologies that could transfer to the FCS. The CAT ATD demonstrates multi-mission capable crew stations, required for the versatility of the Objective Force. The Robotic Follower ATD will demonstrate an unmanned ground system capability for FCS that will increase survivability and reduce logistics. 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 program 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, and fully coordinated with, PE 0602601A (Combat Vehicle and Automotive Technology). Furthermore, the project is coordinated with the Marine Corps office 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 cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan and Project Reliance. The program element contains no duplication with any effort within the Military Departments. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

B. Program Change Summary	FY 2001	FY 2002	FY 2003
Previous President's Budget (FY2002 PB)	166571	193858	300150
Appropriated Value	168114	227858	0
Adjustments to Appropriated Value	0	0	0
a. Congressional General Reductions	0	-1898	0
b. SBIR / STTR	-2287	0	0
c. Omnibus or Other Above Threshold Reductions	0	0	0
d. Above Threshold Reprogramming		0	0
e. Below Threshold Reprogramming	3394	0	0
f. Rescissions	-1542	0	0
Adjustments to Budget Years Since FY2002 PB	0	0	-65172
Current Budget Submit (FY 2003 PB)	167679	225960	234978

Change Summary Explanation:

Significant Changes:

FY02 (+$32102) - Increase due to Congressional Adds as noted below.
FY03 (-$65172) - Decrease Project 53G due to FCS acceleration (i.e., Milestone B in FY03 vs. FY06); funds redirected to accelerate high priority FCS Army enabling technologies.

FY02 - Congressional adds were made for: Aluminum Reinforced Metal Matrix Composites for Track Shoes, Project 506 ($2500); Combat Vehicle Research - Weight Reduction, Project 440 ($6000); Electrochromatic Glass for Combat Vehicles, Project 53D ($1700); Fuel Catalyst Research Evaluation, Project C51 ($500); Mobile Parts Hospital Technology Program, Project 539 ($5600); Movement Tracking System (MTS) for Family of Heavy Tactical Vehicles, Project 53D ($2500); National Automotive Center Standardized Exchange of Product Data (N-STEP), Project 53F ($2500); Up-armored HMMWV, Project 540 ($2100); TACOM Hybrid Vehicle Demonstration: Lithium Ion Technology, Project CA2 ($1000); Improved Materials & Powertrain Architecture for 21st Century Truck (IMPACT), Project 53E ($3500); Composite Body Parts, Project 440, ($1400); Corrosion Prevention and Control Program,Project CA3 ($1400);

Vehicle Body Armor Support System, Project CA4 ($3300)

Projects With No R-2A:
Project 506 (FY02 Funding = $2481) Aluminum Reinforced Metal Matrix Composites for Track Shoes - Supports and completes verification of the performance of the XT172 Single Pin Metal Track through a 3,500 mile durability test in Yuma Proving Grounds (YPG) and explores the potential of adapting metal matrix composites technology to the other automotive components. No additional funds required to complete this effort. COMPLETE 4Q02

Project 539 (FY02 Funding = $5559) Mobile Parts Hospital Technology Program - Supports and completes testing of a computerized module testing of a containerized module for the mobile Parts Hospital (MPH), due for delivery 1 APR 02; implementation of an agile manufacturing cell at Focus: HOPE; adding parts to the MPH database; testing sample parts on Army vehicles; and MPH demonstrations at various sites. No additional funds required to complete this effort. COMPLETE 4Q02

Project 53D (FY02 Funding = $4169) National Automotive Center - Formulates and matures (and completes) advanced modeling and simulation strategies for the Army's vehicle fleet; models and experimentally validate advanced propulsion and mobility simulations for future fleet of vehicles. COMPLETE 4QFY02

Project 53D (FY02 Funding = $1700) Electrochromatic Glass for Combat Vehicles - Demonstrates and completes evaluation of electrochromatic glass in Combat Vehicle applications. No additional funds required to complete this effort. COMPLETE 4Q02

Project 53D (FY02 = $2500) Movement Tracking System (MTS) for family of Heavy Tactical Vehicles - Demonstrates and completes adaptation, installation and testing of commercially available situational awareness/logistics technology (currently used in the automotive industry and commercial log-haul trucking). No additional funds required to complete this effort. COMPLETE 4Q02

Project 53E (FY02 Funding = $3474) Improved Materials and Power Train Architecture for 21st Century Truck (IMPACT) - Develops and completes the transfer and optimization of weight reduction and fuel technologies, developed and integrated into a commercial Model F150 into a demonstrator platform using a heavier commercial truck platform (Model F350). No additional funds required to complete this effort. COMPLETE 4Q02

Project 53F (FY02 Funding = $2481) National Automotive Center Standardized Exchange of Product Data (N-STEP) - Develops and completes development of Standardized Exchange of Product Data (STEP) protocols for manufacturing and demonstrating STEP as a cost savings saving tool for manufacturing. No additional funds required to complete this effort. COMPLETE 4Q02

Project 540 (FY02 Funding = $2084) Up-Armored HMMWV - Improves (and completes) the protection level of the HMMWV by developing, fabricating, and testing lightweight ceramic/composite materials for ballistic protection. No additional funds required to complete this effort. COMPLETE 4Q02

Project CA2 (FY02 Funding = $1000) TACOM Hybrid Vehicle Demonstration: Lithium Ion Technology - Completes development and evaluation of Li-Ion

batteries to provide higher energy density and improved power output vs. current lead acid batteries. No additional funds required to complete this effort. COMPLETE 4Q02

Project CA3 (FY02 Funding = $1400) Corrosion Prevention and Control - Completes the evaluation of specific corrosion prevention and control techniques for Army vehicles. No additional funds required to complete this effort. COMPLETE 4Q02

Project CA4 (FY02 Funding = $3300) Vehicle Body Armor Support System - Develops, demonstrates an effort that protects crew in a tactical wheeled vehicle against small arms fire. No additional funds are required to complete this project. C

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

February 2002

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

COST (In Thousands)		FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
221	COMBAT VEH SURVIVABLTY	27270	31879	49401	44327	27166	16136	17972

A. Mission Description and Budget Item Justification: This project demonstrates the advanced vehicle protection technologies needed for a force that is survivable across the full spectrum of operations. As combat systems become smaller and lighter to provide the necessary strategic deployability and tactical mobility, providing adequate protection without reliance on heavy armor is one of the greatest technological and operational challenges. The solution involves developing and integrating an optimal suite of protection approaches such as armor, active protection systems (APS), signature reduction, jammers, and decoys. This project matures, integrates, and demonstrates the advanced component APS technologies that will provide protection against threat munitions (e.g., guided and unguided anti-armor munitions) for FCS and Objective Force. Products will be made available to FCS contractors for incorporation into their systems designs. Initial APS efforts demonstrate the technologies needed for a system that is effective against Chemical Energy (CE) munitions (e.g., anti-tank guided missiles with Shape Charge warheads). The ultimate goal is a Full Spectrum Active Protection (FSAP) system that will provide hemispherical survivability against CE, large caliber tube launched Kinetic Energy (KE), and top attack threats. Survivability technologies, integrated and demonstrated in the laboratory and in the field under this project, include those technologies transitioned from the following program elements: 0601102A, 0602270A. Major contractors include: United Defense Limited Partnership, San Jose, CA; Sanders, a Lockheed Martin Company, Nashua, NH; TRW, Redondo Beach, CA; Hughes Danbury, Danbury, CN; General Dynamics Land Systems, Warren, MI; Chang Industries, Salt Lake City, UT & Laverne, CA; New Mexico Tech, Socorro , NM; IST, Goleta, CA, Aerojet, Azusa, CA. This program supports the Objective Force transition path of the TCP.

FY 2001 Accomplishments:

- 15147 - Conducted APS development and testing of advanced technologies under contract with UDLP; completed APS component integration.
- 1011 - Matured APS radar design and investigated advanced tracking radar technologies for FCS.
  - Procured test munitions for system testing.
- 1462 Provided program management for APS technology maturation and advanced survivability technologies integration and other government agency/user/test support.
- 4825 - Identified design changes which will provide the extended range sensor capability to detect and track KE threats for FSAP system.
- 4825 - Evaluated emerging signature management technologies utilizing survivability optimization modeling to reduce combat vehicle detection probabilities; conducted an initial test evaluation of emerging signature management technologies to quantify performance.

Total 27270

FY 2002 Planned Program

•	12352	- Conduct full scale range testing to demonstrate defeat of Anti-Tank- Guided Missiles, Rocket Propelled Grenades and smart munitions with the survivability system integrated on a surrogate platform.
		- Prepare and deliver final report and video summarizing all testing and accomplishments of the program; develop design guides for vehicle Program Manager (PM) use.
•	388	- Perform distributed interactive simulation for combat fidelity testing and user evaluation.
•	1564	- Provide program management for APS development and advanced survivability technologies integration and other government agency/user/test support.
•	897	- Conduct field testing to evaluate performance of integrated survivability system.
•	5512	- Test and demonstrate tracking radar sensor technology for FSAP KE detection and tracking.
		- Conduct range tests of FSAP KE countermeasure warheads against multiple horizontal and overhead threats.
		- Locate and obtain threats for coordinated test and evaluations.
		- Integrate countermeasure and sensor subsystem models for FSAP performance simulations.
•	5000	- Conduct full scale breadboard testing to quantify field performance and validate signature modeling predictions.
		- Develop virtual models of vehicle integration concepts to predict signature management performance.
		- Mature advanced signature management to prepare for FY 2004-2005 full scale performance testing.
•	6166	- Design and develop control algorithms and platform stabilization hardware for APS on-the-move demonstration.
		- Fabricate hardware for stabilization units and develop search radar.
		- Conduct preliminary testing of stabilization hardware configuration.

Total 31879

FY 2003 Planned Program

- 9329 - Design and fabricate optimal extended range tracking radar sensor based on FY 2002 tests of APS.
  - Complete FSAP integrated system design and fabricate into a full scale operational FSAP System.
- 5000 - Acquire threat munitions for range tests.
  - Conduct laboratory FSAP system simulations to predict system performance.
  - Add FSAP capability to Commander's Decision Aid.
- 4924 - Mature signature management technology for virtual component designs and performance predictions.
  - Fabricate and integrate advanced hardware to prepare for full scale vehicle testing in FY 2004.
  - Mature detailed virtual vehicle and prototypes in preparation for FY 2004 virtual hardware evaluations with user organizations.
- 9148 - Mature on-the-move simulation and algorithms.
- 8000 - Integrate and test search radar for on-the-move full scale range testing of on-the-move vehicle APS against threat munitions.
  - Provide program management for APS development and other government agency/user/test support.
- 9000 Conduct full scale range testing of tracking sensor and perform redesign based on range test results.
  Fabricate and mature threat tracking radar.
  Fabricate high acceleration, clean exhaust countermeasure rocket motor and range test.
  Design and fabricate rotational countermeasure rocket guidance sensor.
- 4000 Design and fabricate course correction into countermeasure rocket and range test.
  Construct engineering level model of full spectrum active protection system.

Total 49401

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

February 2002

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

COST (In Thousands)		FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
440	ADV CBT VEHICLE TECH	89017	22954	2774	10066	10896	54601	55094

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 integrates advanced sensors, survivability, mobility and communications technologies into a robust vehicle platform. Congress zeroed the Army's FY 2001 request for the FSCS ATD without prejudice. In September 2000, the Congress approved reprogramming of FY 2000 funds in the amount of $65.894M for the FSCS Program. Two consortia, SIKA and Lancer, perform the work under firm fixed price contracts awarded by the United Kingdom. Each will deliver to the government robust integrated demonstrator assets, through which they will demonstrate the technical maturity and the ability to successfully integrate technologies. The demonstrators will undergo technical testing with a limited operational evaluation to assist the Training and Doctrine Command in developing warfighting tactics, techniques, and procedures. The FSCS ATD program completes in FY02. Technologies developed under this program and the lessons learned about integrating FSCS technologies on a C-130 transportable platform will be made available to the FCS LSI to reduce risk and, perhaps, accelerate FCS development. This program supports the Objective Force transition path of the TCP.

FY 2001 Accomplishments:

- 7197 - Provided Army's share of funds in support of Army/DARPA FCS concept development for four contractor teams ($7752 in PE 0602601A, Project HH7, also supports this effort).
  - Developed metrics for evaluation of FCS performance; designed and demonstrated force-level simulation capability for FCS.
  - Conducted technical and operational experimentation in support of system design concepts ; demonstrated use of and completed architecture for Integrated Data Environment (IDE).
  - Conducted technology and operation trade-assessments to determine optimum design for each systems concept.
- 28272 - Provided Army's share of funds in support of Army/DARPA FCS enabling technologies as follows:
  - Netfires: produce system prototypes.

FY 2001 Accomplishments: (Continued)

- Autonomous Navigation (Preceptor): Award Section 845 agreement; produce robotic surrogates for testing in FY 2002.

- Unmanned Ground Vehicle Program: Award ten (10) Section 845 agreements to investigate/study concepts for unmanned ground vehicles.

- Laser Radar (LADAR) Through Canopy (Jigsaw): Award Section 845 agreement to develop technical approaches for producing a LADAR that can see through canopies.

• 3963 - Completed Congressional special interest program designing two advanced structural concepts; one pure monocoque and one hybrid spaceframe/stiffened skin/monocoque incorporating derivatives of CAV composites technology, aerospace aluminum-lithium alloys and friction-stir welding; structural and ballistic component tests confirmed structural and ballistic efficiencies.

• 49585 - Reduced technical and schedule risk for FCS program by increasing the competition for ideas by the Army/DARPA FCS contractors, increased funds for critical Army enabling technologies, and bolstered modeling and simulation to support the Army/DARPA FCS program as follows:

- Augment Army/DARPA FCS contractor teams.

- Performed government modeling and simulation to support FCS program.

- Demonstrated additional, competing Netfires concept.

- Completed Congressional special interest program to demonstrate turbo fuel cell engine

- Conducted government C4ISR architecture study and analysis.

- Initiated the Joint Virtual Battlespace (JVB) program, and executed the following*: - (1) Developed the Modeling & Simulation (M&S) framework and Federation of Models (FOM) architecture to support integration of Simulation & Modeling for Acquisition, Requirements and Training (SMART) tools for Future Combat System (FCS) and Objective Force (OF), - (2) Integrated functional capabilities including force behavior models, robotics, route planning, mobility, communications, etc., to support operational concept assessments; and - (3) Initiated Objective Force Survivability Study in support of TRADOC/TRAC for the analysis of key Objective Force operational concepts and organizational design issues.- *Note: JVB was initiated in FY01 with PE 0603005A funds but, beginning in FY02, funding for JVB is included in PE 0603238A.

Total 89017

FY 2002 Planned Program

- 15554 - Complete software development and assemble hardware into FSCS ATD demonstrator vehicles.
  - Conduct and complete combined US/UK user test of FSCS ATD demonstrator vehicles.
  - Conduct and complete combined US/UK evaluation and analysis of FSCS ATD demonstrator vehicles and prepare final report.
- 1400 - This one year Congressional add (Composite Body Parts) supports and completes the adaption and evaluation of HMMWVs with composite construction. No additional funds are required to complete this initative.
- 6000 - This one year Congressional add (component Vehicle Research - Weight Reduction) 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 initative.
  - Perform prototype and field exposure tests of multiple wheeled vehicle "composite-sheet-metal" components and assemblies.

Total 22954

FY 2003 Planned Program

- 2774 - 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.

Total 2774

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February 2002

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

COST (In Thousands)		FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
441	COMBAT VEHICLE MOBILTY	7167	14603	39210	18184	14181	13910	16402

A. Mission Description and Budget Item Justification: This project matures and tests vehicle mobility technologies that that will provide lighter, agile, deployable, and more fuel efficient ground combat vehicles needed for FCS and the Army Transformation to the Objective Force. The principal elements of these mobility demonstrations are: higher power density engines, hybrid-electric drive, active and semi-active suspensions, and lightweight track. The Army matures high power density engines because commercial engines lack the necessary power density to meet power, space and weight constraints of FCS, and alternate power generation technologies (e.g., fuel cells) are not expected to be sufficiently mature for initial FCS fielding in this decade. Main programs funded by this project are Combat Hybrid Power Systems (CHPS) and FCS Engine. Hybrid-Electric drive offers unique capabilities, such as improved performance, silent operation and vehicle design flexibility; however, it presents new challenges, especially in power electronics thermal management. Army efforts in hybrid electric drive leverage two prior joint Army/DARPA programs, CHPS and the Electric Drive Vehicle Demonstration Program. CHPS successfully transitioned to the Army in FY 2000 with the objective of designing, maturing and testing a robust ground vehicle electrical power architecture in a Systems Integration Laboratory (SIL) that will support the FCS program. FCS Engine develops prime power for combat vehicles with a goal to double the power density (horsepower per cubic foot) of a comparable, state-of-the-art, commercial engine. Other efforts funded in this project focus on developing components to meet unique military requirements for mobility, including: need for a stable ride at high speeds (above 20 miles per hour) over cross country terrain for weapon targeting on the move; need to provide crew comfort and endurance for maneuver-dominant warfare, the need for compact and light vehicle systems to reduce vulnerability of detection, acquisition and attack by enemy weapons, enhanced deployability and reduced logistics burden (e.g., fuel); the need to protect vehicle subsystems under armor (e.g., complicates design of air intake and exhaust systems). Government partners include: Army Research Laboratory (ARL), Aberdeen Proving Ground, MD; Waterways Experiment Station, Vicksburg, MS; Army Research Laboratory, Adelphi, MD. Major contractors include: General Dynamics Land Systems Muskegon Operations, Muskegon, MI; Pentastar, Huntsville, AL; SAIC, San Diego, CA; United Defense Limited Partnership, San Jose, CA; Michigan Technological University, Houghton, MI; General Electric, Schenectady, NY; and Cadillac Gage Textron, New Orleans, LA; Northrop Grumman, Los Angeles, CA. This program supports the Objective Force transition path of the TCP.

FY 2001 Accomplishments:

- 2706 - Installed compressible fluid strut suspension system on a wheeled vehicle to test for increased mobility and speed over cross country terrain.
  - Determined differential torque steer dynamic model from physical test and establish control requirements.
  - Completed design of advanced high efficiency mechanical transmission enabling reduced vehicular fuel consumption and increased transmission power density.
  - Modified combat vehicle band track for mine resistance.
- 2840 - Projected system level and component level power requirements for FCS within hybrid electric architecture.
  - Built and tested pulse forming networks for electro-thermal-chemical gun and electromagnetic armor for FCS.
  - Conducted repetitive ETC gun simulator.
- 1621 - Tested advanced components (e.g., flywheel, high temperature/fast response converters and advanced high energy density batteries) for performance assessment in CHPS Systems Integration Laboratory (SIL).

Total 7167

FY 2002 Planned Program

- 4732 - Test advanced components of CHPS hardware on a mobility test bed to demonstrate robustness and fuel efficiency for combat vehicles.
  - Incorporate new system level and component level vehicle power requirements based on results of CHPS SIL testing and FCS contractor concept designs.
  - Incorporate and evaluate advanced componentry design and integrate into SIL-based vehicular architecture reflecting potential FCS configuration.
  - Complete and issue initial version of hybrid electric design guide and virtual prototyping modeling tool.
- 9871 - Establish demonstration program of at least two competing high power density diesel engines to meet FCS power, size, and weight constraints with a goal of twice the horsepower at 1/2 the weight and volume.

Total 14603

FY 2003 Planned Program

- 6210 - Demonstrate state-of-the-art combat vehicle high power, control methodology, and hybrid-electric architecture that will be available for FCS.

  - Configure CHPS SIL with FCS contractor hybrid electric breadboard systems and test.
  - Develop and modify hybrid electric architecture to accommodate directed energy weapons.
  - Fabricate an advanced component level design for future testing in a vehicular architecture reflecting an FCS-like configuration.
  - FCS system level prototype componentry incorporation into architecture and prep for CHPS SIL reconfiguration.
- 7000 - Continue development of high power and high temperature components for hybrid electric propulsion for FCS.
- 11000 - Demonstrate performance benefits of hybrid electric propulsion with both real and simulated combat vehicles; identify and implement solutions to vehicle integration issues to assure availability of a compact propulsion system for FCS mobility platforms.
- 15000 - Demonstrate at least two competing high power density engines to meet FCS power, size, and weight constraints with a goal of twice the horsepower per cubic foot of total propulsion installation volume.

Total 39210

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

February 2002

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

COST (In Thousands)		FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
497	COMBAT VEHICLE ELECTRO	2916	5567	6334	5955	68	13267	13342

A. Mission Description and Budget Item Justification: This project provides key enabling technologies for transforming the Army to the rapidly deployable Objective Force. Work conducted matures intra-vehicle electronics hardware and software technologies that will yield increased crew efficiencies/performance or reduced crew size; demonstrates these technologies; and advances open system architectures for ground vehicle weapon systems. Current efforts leverage semi-autonomous robotics technologies (e.g., automated driving) for application to manned systems. A FY 2004 vehicle demonstration is planned to prove the ability of a UGV to perform crew functions associated with fighting, performing reconnaissance and carrying troops for a two-man crew vehicle. Goals include a 30% reduction in software cost, a 10 times increase in architecture throughput, and full mission rehearsal via embedded simulation that will be relevant to the FCS. Major contract efforts will include: DCS Corp, Alexandria, VA; Oasis, Troy, MI; and RST, Westminster, MD. This program supports the Objective Force transition path of the TCP.

FY 2001 Accomplishments:

- 2916 - Conducted field experiments of indirect vision technology, an enabling technology to reduce size and increase survivability in combat vehicles.

  - Conducted vehicle test bed data reduction and analysis; identified lessons learned for application to reduced volume crew stations to meet FCS deployability requirements.

  - Designed advanced architecture for reduced volume crew stations, incorporating semiautonomous driving and embedded simulation system.

  - Demonstrated conceptual FCS multi-mission crew stations for User at Mounted Maneuver Test Facility (Fort Knox, KY).

Total 2916

FY 2002 Planned Program

•	1250	- Define semi-autonomous driving interface for integration into mobile reduced crew testbed.
•	900	- Adapt cognitive decision aids for ground systems for integration into mobile reduced crew testbed.
•	700	- Mature route planning software for integration into mobile reduced crew testbed.
•	1822	- Design and integrate Systems Integration Laboratory (SIL) to enable early evaluation of advanced crew station, electronics architecture and embedded simulation technologies by FCS contractors in FY03.
•	895	- Implement testbed architecture in SIL.
Total	5567	

FY 2003 Planned Program

•	1492	- Complete SIL and conduct early evaluation of advanced crew station, electronics architecture and embedded simulation technologies for FCS.
•	2087	- Complete cognitive decision aids and route planning software development for future integration into mobile reduced crew testbed.
•	2068	- Develop mobile test bed to allow soldier testing of advanced crew station, electronics architecture and embedded simulation technologies and for evaluation by FCS contractors.
•	687	- Develop technology to mix live and virtual imagery, enabling on-the-move embedded simulation and training.
Total	6334	

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

February 2002

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

COST (In Thousands)		FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
515	ROBOTIC GROUND SYSTEMS	1694	9219	8873	22514	14939	5092	5191

A. Mission Description and Budget Item Justification: This project provides near-term unmanned ground system technologies to support the FCS program and the Objective Force. The project funds technological maturation and demonstration of unmanned follower vehicle technologies required for multiple tactical and logistics applications. Efforts demonstrate technologies required for unmanned ground vehicle (UGV) systems to move autonomously over terrain at militarily significant speeds, mature the technologies for transition to FCS, and conduct system-of-systems field experimentation to allow warfighters and FCS contractor(s) to evaluate these technologies. The main effort funded in this project is the Robotic Follower ATD. In addition the project funds development of advanced technologies needed to improve flexibility and utility of UGVs, decrease the frequency of human intervention/direct control, and implement a robotic leader initiative for potential future applications (e.g. scout/reconnaissance missions.) Technologies proven in robotic demonstrations are expected to be transferable to other unmanned platforms as well as manned platforms to reduce operator workload. 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 Army's approach builds upon previous and ongoing investments, such as the Demo III program, conducted under the Joint Robotics Program Office. The work is primarily conducted by U.S. Army Research Laboratory (ARL), Aberdeen Proving Grounds, MD Major contractors include: GDLS, Sterling Heights, MI; DCS Corp, Alexandria, VA; and GDRS, Westminister, MD. This program supports the Objective Force transition path of the TCP.

FY 2001 Accomplishments:

• 1694 - Completed analysis of leader/follower robotics technologies and supporting operational concepts for initial unmanned system capabilities for FCS.

- Identified standard architecture for intelligent control of baseline unmanned system demonstrators.
- Identified existing and required modeling and simulation capabilities and requirements to support robotics technology development and testing.

Total 1694

FY 2002 Planned Program

•	529	- Model sensors, representative terrain and ARL autonomous mobility algorithms.
•	500	- Complete development of intelligent control architecture.
•	950	- Implement Demo III autonomous mobility algorithms as baseline.
•	900	- Design unmanned follower control interface for manned lead vehicle.
•	1421	- Perform system integration for field demonstration to prove Technology Readiness Level (TRL) 5.
•	419	- Model robotic follower capability for logistics and Net Fires.
•	1400	- Implement robust follower asset TRL 6 experiments.
•	2200	- Evaluate algorithms for line-of-sight (LOS), high speed, on-road convoying for logistics convoy to demonstrate TRL 6.
•	900	- Assess algorithms for low speed, all terrain, robotic mule with advanced autonomous perception for low-speed, off-road mounted or dismounted following to demonstrate TRL 6.
Total	9219	

FY 2003 Planned Program

•	500	- Conduct chassis evaluation and select demonstration system with mobility characteristics that are relevant to FCS.
•	1250	- Perform field demonstration for FCS contractors to prove TRL 5.
•	2823	- Complete autonomous mobility design, purchase and integrate sensors.
•	900	- Implement intelligent control architecture in testbed vehicles.
•	1700	- Integrate ARL autonomous mobility algorithms.
•	500	- Demonstrate TRL 6 using modeling and simulation in conjunction with FCS contractor platforms.
•	1200	- Mature autonomous mobility software for transition to FCS contractors.
Total	8873	

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

February 2002

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

COST (In Thousands)		FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
53G	FUTURE COMBAT SYSTEMS (FCS)	0	110587	125147	116112	113194	0	0

A. Mission Description and Budget Item Justification: This project funds the Army's share of the cost-shared Army/Defense Advanced Research Projects Agency (DARPA) collaborative Future Combat Systems (FCS) program and other FCS key component technologies. This project (53G) was established by means of a zero sum transfer of funds from project 440, starting in FY02, to provide better visibility of this high priority program. FCS is the centerpiece of the Army's strategy to achieve the Objective Force. It is a multi-functional, system of systems that will be capable across the full spectrum of operations. DARPA is the executive agent for the FCS Program; therefore the majority of the funds in this project are provided to and executed by DARPA, in accordance with the MOA (February 2000). Under terms of the MOA, the Army committed to provide the following funding for the Army/DARPA Collaborative FCS Program: $107M (FY 2002), $122M (FY 2003), $114M (FY 2004) and $111M (FY 2005). This constitutes the Army's share of funding for both the system Design/Demonstration and the DARPA enabling technologies including: Robotic Unmanned Ground Vehicle, Maneuver Command and Control Communications, Maneuver Beyond-line-of-sight (BLOS) Networked Fires Weapon, and BLOS Surveillance and Targeting Systems. This program responds to a draft Mission Needs Statement issued by the U.S. Army Training and Doctrine Command and the Army Vision. The FCS Program completes the concept design phase in FY02. In accordance with direction from Army Leadership in November, 2001, the FCS Program has been accelerated by three years, to enter System Development and Demonstration in 2003. To meet this change in schedule, the new strategy is to recompete for the next phase of the program. In February 2002, DARPA will issue one or more Section 845 agreement(s) for a Lead System Integrator. The final product will be a system of systems that will meet the Army's transformation goals to achieve First Unit Equipped in 2008, field an Initial Operational Capability in 2010 and to have a Force that is strategically and logistically superior in all aspects. This project supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2001 Accomplishments:

- Program funded in Project 440

FY 2002 Planned Program

- 25000 - Army's share of Army/DARPA collaborative FCS core program for the FCS Design/Development efforts, in accordance with the MOA.
  - Perform FCS tradeoff and technology analyses; develop detailed cost, schedule, performance objectives;
  - Complete force level modeling and simulation efforts to support FCS concepts/Objective force employment and downselect decisions.
  - Complete evaluation of Army/DARPA FCS initial objective force concepts.
  - Select Army/DARPA FCS Lead Systems Integrator (LSI) to begin detailed design.
- 59000 - Army's share of the Army/DARPA FCS Enabling Technologies, in accordance with the MOA. The remainder of the Army's share for Enabling Technologies($20000) is funded in PE 0602601/HH7. Funding is applied to the following efforts:
  - Autonomous Navigation (Preceptor); develop detailed design of sensors and perception algorithms for autonomous vehicle designs.
  - Unmanned Ground Vehicle Program; downselect and begin detailed design of 600 Kg and 6000 Kg. unmanned ground combat vehicles.
  - Netfires; finalize missiles design and build hardware for flight test.
  - LADAR through the Canopy (Jigsaw); finalize LADAR design and begin hardware build.
- 3496 - Army Objective Force Task Force (TF); conduct analyses and program integration.
- 20091 - Perform technology integration efforts and accelerated development/ demonstration of FCS enabling technologies, for which the Army has responsibility under the MOA; matures selected lethality, survivability, mobility and communications technologies for potential transition to SDD in FY03.
- 3000 - Develop concepts and conduct Modeling and Simulation exercises in accordance with FCS MOA.

Total 110587

FY 2003 Planned Program

- 50000 - Supports Army/DARPA FCS Lead Systems Integrator detailed FCS design effort in accordance with FCS MOA.
- 72000 - Funds the Army's share of Army/DARPA FCS Enabling Technologies including:
  - Autonomous Navigation (Preceptor): Downselect to two(2) concepts and perform field tests.
  - Unmanned Ground Vehicle Program: Deliver robotic ground vehicles and perform field tests.

FY 2003 Planned Program (Continued)

- LADAR through Canopy (Jigsaw): Deliver LADAR system and perform field tests.

• 3147 - Provide Army Objective Force TF support for FCS analysis and program integration.

Total 125147