ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2005

BUDGET ACTIVITY
2 - Applied Research

PE NUMBER AND TITLE
0602308A - Advanced Concepts and Simulation

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
Total Program Element (PE) Cost		30153	22721	16013	16858	17104	17481	17827	18182
C90	ADVANCED DISTRIBUTED SIMULATION	10068	9843	10586	10921	11035	11289	11513	11742
D01	PHOTONICS RESEARCH	4870	3356	0	0	0	0	0	0
D02	MODELING & SIMULATION FOR TRAINING AND DESIGN	4989	4633	5427	5937	6069	6192	6314	6440
D14	ADVANCED MODELING AND SIMULATION INITIATIVES (CA)	7791	4889	0	0	0	0	0	0
HB4	IMMERSIVE ENVIRONMENT APPLIED RSCH INITIATIVE (CA)	2435	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This program element conducts applied research in modeling and simulation technologies for application to training and evaluation of the Future Combat Systems (FCS), the Future Force (FF), and where feasible, the Current Force. It establishes standards, architecture, and interfaces essential to realizing the Army vision of creating a verified, validated, and accredited synthetic "electronic battlefield" environment as an acquisition and training evaluation tool. The creation of this electronic battlefield environment requires advanced distributed simulation technologies, such as networking of models, complex data interchange, and collaborative training. The application of this electronic battlefield environment to support training requires applied research in modeling, simulation, and training technologies, such as immersive training, leadership development, and concept exploration. This environment will help the Army to investigate and refine new warfighting concepts, including the generation of tactics, doctrine, training techniques, soldier support systems, and system upgrades. Project C90 focuses on advancing technologies required for real time interactive linking within and among constructive, virtual, and live simulation and training by maturing technologies for advanced distributed interactive simulation. Project D02 provides applied research in immersive training at the Institute for Creative Technologies (ICT) at the University of Southern California, Los Angeles, California, to leverage the entertainment and game industries in advancing the Army's modeling and simulation technology and applications. This program will ensure the transition of the research results of the ICT into the Army technology base and future Army training products. Projects D01, D14, and HB4 fund Congressional special interest items. This program is fully coordinated with other Army applied research programs, the Defense Advanced Research Projects Agency (DARPA), and the Defense Modeling and Simulation Office. Results from this applied research will feed PE 0603015A (Next Generation Training & Simulation Systems). 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 PE is performed by the Research Development and Engineering Command (RDECOM), Orlando, FL.

B. Program Change Summary	FY 2005	FY 2006	FY 2007
Previous President's Budget (FY 2005)	15041	16144	16662
Current Budget (FY 2006/2007 PB)	22721	16013	16858
Total Adjustments	7680	-131	196
Net of Program/Database Changes			
Congressional Program Reductions	-338		
Congressional Rescissions			
Congressional Increases	8600		
Reprogrammings			
SBIR/STTR Transfer	-582		
Adjustments to Budget Years		-131	196

Change Summary Explanation:

Two FY05 Congressional adds totaling $8600 were added to this PE.

FY05 Congressional Adds with no R-2A:
($4891) Joint Unmanned Systems Test and Research (JOUSTER), Project D14: The purpose of this one year Congressional add is to establish and operate the Unmanned Systems Controlled Experimental, Test and Research Facility at the Virginia Polytechnic Institute to support the cost effective and timely evaluation and development of military autonomous vehicle systems. No additional funding is required to complete this project.

($3357) University Photonics Research, D01: The purpose of this one year Congressional add is to manufacture, assemble and characterize optical components and laser output for a unique fiber laser combiner. No additional funding is required to complete this project.

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - Applied Research	**0602308A - Advanced Concepts and Simulation**	**C90**

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
C90	ADVANCED DISTRIBUTED SIMULATION	10068	9843	10586	10921	11035	11289	11513	11742

A. Mission Description and Budget Item Justification: This project develops enabling technologies for advancing distributed interactive simulation in synthetic environments such as networking of models, complex data interchange, and collaborative training. It will enhance the use of modeling and simulation as an acquisition and training evaluation tool by providing that ability to create a virtual representation of a lethal combined arms environment with the warfighter-in-the-loop that constructive (event driven) simulation cannot provide. Such environments permit the evaluation of new system concepts, tactics and doctrine, and test requirements with a warfighter-in-the-loop throughout the acquisition life cycle at a reduced cost and in less time. This project develops technologies to support embedded simulation, intelligent forces representation, rapid and cost-effective generation of synthetic environments, simulation interface and linkage technologies, and complex data modeling. 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 Research Development and Engineering Command (RDECOM), Orlando, FL.

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
Live, Virtual, Constructive Simulations: In FY04, prototyped an environmental data model to represent urban terrain structures in high resolution environments enabling realistic dismounted soldier training, mission rehearsal, and analysis capability in future virtual environments; and analyzed magnetic fluid Inertial Measurement Unit (IMU) sensor for use in obtaining enhanced position/navigation information of soldiers and vehicles during operations and training in urban environments. In FY05, enhance modeling of unconventional threats in complex virtual urban environments; develop breadboard instrumentation using IMU sensor to improve performance of tactical engagement simulation systems for test and training; and increase constructive simulation realism by developing single-processor Graphics Processing Unit (GPU) software architecture and coprocessor algorithms to overcome current constructive simulation computational bottlenecks. In FY06, will establish a standard toolset for high-resolution urban environment development and increase interoperability of multi-service virtual simulations networked with live systems in training environments; will miniaturize prototype instrumentation system with IMU sensor to demonstrate full position/navigation and tracking capabilities at the Military Operations in Urban Terrain (MOUT) test site; and will develop multiple GPU cluster architecture using algorithms from GPU coprocessor research. In FY07, will extend research of alternative data sources from Corps of Engineers to rapidly develop urban environments for training, mission planning and rehearsal to reduce the dependence on training specific databases; will reduce size, weight, and power consumption of the IMU sensor and software GPS receiver to permit embedment into small arms weapons and the Joint Tactical Radio System; and will prototype Army Constructive Training Federation using multiple GPU architecture.	2609	3750	3894	3867

Accomplishments/Planned Program (continued)	FY 2004	FY 2005	FY 2006	FY 2007
Modeling and Simulation Training Technologies. In FY04, matured concepts for field deployable patient simulators to provide clinically accurate training in realistic combat environments; prototyped a virtual reality based dismounted embedded training system; investigated augmented reality technologies that merge simulated entities with virtual graphics to provide the soldier an enhanced real world representation; developed wireless command and control concepts for medical simulation suites; and integrated robotic sensor suites and intelligent survivability behaviors on platforms and demonstrated control capability. In FY05, enhance patient simulator by incorporating realistic skin, physiologically accurate injuries, sensors, and miniaturization technologies; develop a prototype dismounted soldier training system to demonstrate augmented reality in a full-immersive combined arms training environment; and develop models to facilitate the assessment of the effectiveness of mixed teams. In FY06, will integrate a patient simulator into a distributed simulation infrastructure at a live training center to demonstrate the seamless transfer of patient data and the modeling of geographically dispersed levels of care; will evaluate a field capable dismounted embedded training system integrated with a FCS surrogate to demonstrate deployable collective training and distributed action review (AAR) technologies; will mature deployable human wearable augmented reality training technologies; and will develop tools to evaluate mixed human-intelligent agent team performance. In FY07, will increase the effectiveness of distributed medical simulation supported training by integrating advances in wound simulation and physiological modeling; will investigate the usability of flexible display technologies and the application of nano-sensors embedded in the Soldiers' clothing and weapon systems; and will develop intelligent and adaptive behaviors to represent autonomous systems to enhance t	4730	3521	3771	3778

Accomplishments/Planned Program (continued)	FY 2004	FY 2005	FY 2006	FY 2007
Collaborative and Immersive Environment Technologies. In FY04, began maturing tools to develop training environments and scenarios in an Internet-based asymmetric warfare virtual training technology (AWVTT) environment; performed user evaluations with the Illinois Army National Guard; and prototyped test-beds for distributed component simulations to support the training missions of the Future Force (FF) to include Future Combat Systems (FCS) and dismounted warrior systems. In FY05, continue to develop new behaviors in the One Semi-Automated Forces (OneSAF) Objective System (OOS) baseline and begin developing the linkages between the AWVTT and the OOS; perform user evaluations with combat units; and expand our understanding of the student learner model to identify aspects of learning scenarios that will facilitate the enhancement of virtual learning environments. In FY06, will complete development of the tools required for a trainer to develop new types of asymmetric warfare training scenarios; and will use the student learner model to evaluate the effectiveness of the single-user training module for immersive training. In FY07, will research and prototype a distributed fully immersive asymmetric warfare virtual training environment for the FF and FCS; and will conduct experiments to validate the metrics, tools, and methods of the single-user framework and extend the single-user framework to accommodate multi-user small team collaborative requirements.	2729	2572	2921	3276
Totals	10068	9843	10586	10921

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February 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - Applied Research	**0602308A - Advanced Concepts and Simulation**	**D02**

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
D02	MODELING & SIMULATION FOR TRAINING AND DESIGN	4989	4633	5427	5937	6069	6192	6314	6440

A. Mission Description and Budget Item Justification: This project enables the transfer and maturation of simulation and training research results to the Army from PE 0601104, Project J08 (Institute for Creative Technologies). Goal of this research are to make training applications widely available and enhance the Army's ability to train any time and any place by researching modeling, simulation, and training technologies, such as immersive training, leadership development, and concept exploration; by creating a true synthesis of creativity and technology by leveraging the capabilities of industry and the R&D community; and by conducting research in virtual humans to enable them to embody natural language, speech recognition in noisy environments, gesture, gaze, and conversational speech. Achieving this goal requires research in techniques and methods for integrating different sensory cues into virtual environments to enhance training and leader development; investigating the application of emerging photo-realistic rendering algorithms and 3-dimensional signal processing techniques to advanced experience learning applications; and enhancing the efficiency of 3-dimensional sound techniques in virtual environments that vary from medium sized immersive environment rooms with high-end graphics and computing systems to low-cost, game console applications using commercial off the shelf speakers. 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 Research Development and Engineering Command (RDECOM), Orlando, FL.

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
Immersive Technology Environments. In FY04, created solutions and matured research for the shortfalls in human to virtual human interactions. In FY05, investigate verbal communications techniques for virtual human interactions with soldiers; and examine the concept of an integrated learning environment framework and identify interdependences to increase the realism of immersive environments used for training. In FY06, will investigate nonverbal communications techniques for virtual human interactions with soldiers; and will integrate the representations of selectable ethnicity and situational impact of emotions into the human to virtual human interaction. In FY07, will integrate enhanced virtual humans into leader training exercises and advanced technology demonstrations in collaboration with TRADOC; and will mature virtual human research utilizing feedback from evaluations to support self-guided and self-directed training.	2267	2171	2538	2682

Accomplishments/Planned Program (continued)	FY 2004	FY 2005	FY 2006	FY 2007
Immersive Technology Techniques. In FY04, demonstrated photo-realistic rendering of human faces and integrated this into immersive environments; integrated audio and sensing cues algorithms and techniques into the immersive environments to investigate emotional responses for increased realism during training; and demonstrated laser-scanned environment in immersive virtual reality system. In FY05, begin developing single-user learning environment integrating advanced computer generated coaching and mentoring tools (artificial intelligence) into an immersive simulation environment; begin to develop the tool sets that will allow training developers to rapidly create relevant immersive learning scenarios; mature and demonstrate next generation global illumination algorithms and facilitate their adoption into military training applications. In FY06, will complete development of single-user learning environment; will begin usability and effectiveness testing of single-user prototype; will create computer-based opposing forces in a simulation that learns to improve its behavior from observations of others and by analyzing its own mistakes; will develop new programming technology that allows a system to be self-documenting by explaining its reasoning and how it works in easily understood English; and will integrate captured photo-real human characters into a real-time simulation. In FY07, begin developing multi-user learning environment integrating advanced computer generated coaching and mentoring tools (artificial intelligence) into an immersive simulation environment; will investigate concepts and begin to develop the tool sets that will allow training developers to rapidly create relevant immersive learning scenarios; will advance and incorporate explainable artificial intelligence technology in computer coaches that provide advice and corrections to learners as they use training systems; and will provide improvements to rapid simulation development tools.	2722	2462	2889	3255
Totals	4989	4633	5427	5937