

# ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2005

BUDGET ACTIVITY  
2 - Applied Research

PE NUMBER AND TITLE  
0602716A - HUMAN FACTORS ENGINEERING  
TECHNOLOGY

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	23884	20656	17482	18160	18469	18607	18767	19101
H70 HUMAN FACT ENG SYS DEV	18527	16629	17482	18160	18469	18607	18767	19101
J20 OMNI DIRECTIONAL TREADMILL UPGRADE	5357	0	0	0	0	0	0	0
J21 HUMAN FACTORS APPLIED RESEARCH CA	0	4027	0	0	0	0	0	0

**A. Mission Description and Budget Item Justification:** This program investigates and evaluates aspects of human factors engineering that may limit or improve capabilities of individuals and teams of Soldiers operating in complex, dynamic environments to enable maximizing the effectiveness of Soldiers and their equipment for mission success. Key research areas include sensing, perceptual and cognitive processes, ergonomics, and biomechanics, and the tools and methodologies required to manage interaction within these areas and within the Soldiers' combat environment. Research is focused on decision-making; human robotic interaction; crew station design; improving soldier performance under stressful conditions such as time pressure, information overload, information uncertainty, fatigue, on-the-move, and geographic dispersion; and enhancing human performance modeling tools. Specialized laboratory studies and field evaluations are conducted to collect performance data on the capabilities and limitations of Soldiers, with particular emphasis on Soldier and equipment interaction. Application of advancements and tools yields reduced workload, fewer errors, enhanced soldier protection, user acceptance, and allows the soldier to extract the maximum performance from the equipment. Work in this PE is related to, and fully coordinated with, efforts in PE 0602601 (Combat Vehicle and Automotive Advanced Technology), PE 0602786 (Warfighter Technology), PE 0602120 (Sensors and Electronic Survivability), PE 0602784 (Military Engineering Technology), PE 0602783 (Computer and Software Technology), PE 0602308 (Advanced Concepts and Simulation), PE 0603005 (Combat Vehicle and Automotive Technology), PE 0603710 (Night Vision Advanced Technology), PE 0603015 (Next Generation Training and Simulation) and PE 0603007 (Manpower, Personnel and Training Advanced Technology). 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 Army Research Laboratory (ARL).

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<u><b>B. Program Change Summary</b></u>	FY 2005	FY 2006	FY 2007
Previous President's Budget (FY 2005)	16899	18181	18707
Current Budget (FY 2006/2007 PB)	20656	17482	18160
Total Adjustments	3757	-699	-547
Net of Program/Database Changes			
Congressional Program Reductions	-302		
Congressional Rescissions			
Congressional Increases	4200		
Reprogrammings			
SBIR/STTR Transfer	-141		
Adjustments to Budget Years		-699	-547

## Change Summary Explanation:

One FY05 Congressional add totaling \$4200 was added to this PE.

FY05 Congressional Add with no R-2A:

(\$4028) Manpower and Personnel Integration (MANPRINT), Project J21: The purpose of this one year Congressional add is to fund research in manpower and personnel integration. No additional funds are required to complete this project.

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BUDGET ACTIVITY 2 - Applied Research			PE NUMBER AND TITLE 0602716A - HUMAN FACTORS ENGINEERING TECHNOLOGY				PROJECT H70			
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
H70	HUMAN FACT ENG SYS DEV		18527	16629	17482	18160	18469	18607	18767	19101
<p><b><u>A. Mission Description and Budget Item Justification:</u></b>The goal of this project is to maximize the effectiveness of soldiers in concert with their equipment, in order to survive and prevail on the Future Force battlefield. Major efforts in this project include research to identify sources of stress, potential stress moderators, intervention methods, adaptive learning, and supporting information technology to reduce uncertainty and improve decision quality for leaders and teams engaged in Command and Control (C2) planning and execution; enhancement of human performance modeling tools to optimize soldier machine interactions for Future Force Warrior (FFW) and Future Combat System (FCS) and the collection of empirical data on human perception (vision and hearing) to support the development and validation of human and system performance models; investigations on the effects on soldier performance from integration of advanced concepts in crew stations designs; the identification, assessment, and mitigation of the effects of vehicle motion on soldier performance; investigations to determine interface design solutions for Unit of Action (UA) Maneuver Team information systems that enhance situational understanding and decision cycle performance; identification and quantification of human performance measures and methods to address future warrior performance issues; and improvement of human robotic interaction (HRI) in a full mission context. The barriers to achieving the goal include incomplete soldier performance data and models of the new missions, organizations, and new and complex technologies transforming the Army. Specialized laboratory studies and field evaluations are conducted to collect performance data on the capabilities and limitations of soldiers, with particular attention on soldier and equipment interaction. The resulting data are the basis for weapon systems and equipment design standards, guidelines, handbooks and soldier training and manpower requirements to improve equipment operation and maintenance. Application of advancements yields reduced workload, fewer errors, enhanced Soldier protection, user acceptance, and allows the Soldier to extract the maximum performance from the equipment. Work in this project is conducted in cooperation with Tank and Automotive Research, Development and Engineering Center (TARDEC); Natick Soldier Center (NSC); Communications -Electronics Research, Development and Engineering Center (CERDEC); Simulation and Training Technology Center (SSTC); Engineer Research and Development Center (ERDC); Army Research Institute (ARI); and Army Materiel Systems Analysis Activity (AMSAA). 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 is performed by the Army Research Laboratory (ARL).</p>										

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<u>Accomplishments/Planned Program</u>		FY 2004	FY 2005	FY 2006	FY 2007
<p>- Identify sources of stress, potential stress moderators, intervention methods, adaptive learning, and supporting information technology to reduce uncertainty and improve decision quality for leaders and teams engaged in Command and Control (C2) planning and execution. In FY04, identified organizational, cultural, and cognitive factors to enhance decision making in the network-centric future force; assessed the functionality and usability of tactical visualization tools for commander decision making in time constrained environments; and generated models to examine the effect of missing or partial information as a predictor of decision quality. In FY05, determine and transition critical performance requirements for prototype information displays; and determine metrics to assess the training effectiveness of interactive simulation technology. In FY06, will refine decision aids to optimize visualization and information sharing requirements in the UA; and will investigate the usability and effectiveness of interactive technology for immersive training scenarios. In FY07, will validate a suite of tools to improve C2 capabilities in uncertain and urban environments; and will conduct cognitive task analysis of multi player training modules.</p>		3452	3444	3720	4201

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## H70

Accomplishments/Planned Program (continued)	FY 2004	FY 2005	FY 2006	FY 2007

4	FY 2005
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FY 2006

FY 2007

- Enhance human performance modeling tools to optimize soldier machine interactions for FFW and FCS. Collect empirical data on human perception (vision and hearing) to support the development and validation of human and system performance models. In FY04, verified and distributed Improved Performance Research Integration Tool (IMPRINT) version 7; applied the hearing hazard model to firing weapons in urban enclosures and tunnels to specify hearing protection requirements; collected acuity measurement under various luminance levels (ranging from a quarter-moon to dark, overcast day, with the chart illuminant having the spectral distribution of starlight) and transitioned data to CERDEC to support visual acuity modeling. In FY05, link vehicle dynamics, biodynamics, and anthropometric modeling capabilities to extend soldier centered design tools; develop architectures for modeling human performance of system of systems (SoS) through linked IMPRINT models and the Modeling Architecture for Technology and Research Experimentation (MATREX); validate activity-based target acquisition model comparing surveillance techniques used by military and civilian law enforcement. In FY06, will incorporate ability to model human performance in joint operations with IMPRINT 8 (Pro); will develop a model for visual performance prediction for monocular, binocular, and biocular helmet mounted displays (HMDs). In FY07, will identify and apply analysis metrics aimed at distinguishing performance of teams embedded within SoS and joint operations; will create and distribute a protected web-based repository of human performance models used in Manpower and Personnel Integration (MANPRINT) analyses; and develop a model of minimum tolerance values of optical disparities for monocular and binocular HMDs under static and dynamic conditions and transition to Army Aeromedical Research Laboratory and special operations community.

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ENGINEERING PROJECT H70

## 2 - Applied Research

## 0602716A - HUMAN FACTORS ENGINEERING TECHNOLOGY

## H70

Accomplishments/Planned Program (continued)	FY 2004	FY 2005	FY 2006	FY 2007

FY 2005

FY 2006

FY 2007

2184

2155

2260

2350

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ENGINEERING PROJECT  
H70

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Investigate and determine interface design solutions for UA Maneuver Team information systems that enhance situational understanding and decision cycle performance. Identify, mature, and quantify human performance measures and methods to address future warrior performance issues. In FY04, modeled communication and messaging processing of operators with various information display options; completed six FCS vehicle variant models and a dismounted model to identify tasks with high potential for cognitive overload, the sensory channel loadings for these tasks, as well as their associated critical information requirements; investigated highest risk tasks in field evaluations; an investigation on the impact of increased information on Future Force workload identified an increase in shooting errors with helmet mounted displays (HMD) as compared to both auditory and wrist mounted conditions (PDAs); characterized the ability of UA soldiers to obtain situational understanding based on sensor design and density; evaluated relationships among cognitive performance and stress response variables and analyzed differences between various encapsulation configurations. In FY05, refine the models matured in FY04 using newly gathered field data; conduct further experiments for model validation for integration into force-on-force models; provide interface design solutions to FFW; conduct decision cycle time model validation studies. In FY06, will refine the models, run final experiments using displays that provide information across the soldiers' sensory modalities, and publish display design guidelines for FCS based upon the experiment and model results. In FY07, will mature physics-based models of human locomotion to research soldier load and range of motion of future systems; and will evaluate soldier physical and cognitive performance using prototype FFW Soldier systems.

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4673

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## Accomplishments/Planned Program (continued)

- Improve human robotic interaction (HRI) in a full mission context. In FY04, determined common operational definitions of Soldier-robot interaction in concert with tri-service, university and industry programs to advance a common understanding of issues and metrics; conducted task and workflow analysis of soldier robotic interactions for FFW- FCS missions with multitasking; and investigated specialized Operator Control Unit (OCU) technologies to improve Soldier robotic team performance focusing on 3-D stereo interfaces, multimodal interfaces, and non-intrusive workload measures for adaptive systems. In FY05, model cognitive workload and performance in multi-task conditions at the system of system level; examine workload, levels of autonomy, shared situation awareness, and soldier performance for scalable OCU concepts; determine requirements for mixed asset control and workload management for mounted and dismounted missions; and investigate Soldier-robot team performance and workload using realistic simulation environments. In FY06, will examine effects of situational uncertainty, user expectancies, task interruption, knowledge representation, and adaptive automaton on HRI using realistic simulations of FCS and FFW missions; will Investigate OCU concepts during field experimentations and transition results to the TARDEC; and will investigate HRI implications of mixed asset teaming concepts in realistic simulation or field experiments. In FY07, will address Soldier-robotics team performance using models and metrics with the goal of identifying optimal systems for particular operational contexts and understanding the implications of each; and will utilize metrics and diagnostics to determine optimal span of control and adaptive automation for mounted and dismounted Future Force missions using aerial and ground unmanned systems.

- Human System Interaction Modeling: This one year Congressional add augmented human performance modeling tools via the release of the IMproved Performance Research Integration Tool (IMPRINT) version 7. No additional funding required to complete this project.

	FY 2004	FY 2005	FY 2006	FY 2007
	4018	3896	4079	3846
	2327	0	0	0
Totals	18527	16629	17482	18160