

Name or PI: Karim Abdel-Malek
Department: Center for Computer Aided Design
College: College of Engineering

FY08 Add Request
**Digital Humans and Virtual Reality for
Future Combat Systems**

**Center for Computer Aided Design (CCAD)
THE UNIVERSITY OF IOWA**

**US Army Tank-automotive and Armaments Command (TACOM)
Department of Defense**

Objective

Continuing authorization for congressional funding to the US Army TACOM program on digital human modeling and simulation is requested for 2008.

Request

FY08 Request and Program Element Code (PEC): Add \$4M to **PE: 0603005A**; for Digital Humans and Virtual Reality for FCS.

Statement of Request: Through congressional funding and under the auspices of the US Army TACOM, the Virtual Soldier Research Program at the University of Iowa has made significant contributions to the development of new technologies in human modeling and simulation. Reduction or elimination of physical prototypes is one of the main goals in the Army's Transformation Vision. This effort has aimed to create digital humans (computer characters that can evaluate the safety, functionality, and effectiveness of weapons and vehicles), that can be deployed in the virtual world before any physical prototypes are made. This unique technology has required a unique integrated effort building upon technological advancements at the University of Iowa and in tandem with TACOM researchers. This research has been funded through this mechanism for the past two years (2004-06) and has made significant contributions to the development of a complete human modeling and simulation environment, leading to a substantial cost reduction in the costly design cycle.

Applicable Program or Activity:

This effort will yield a complete human modeling and simulation environment, where human safety and human factors issues can be simulated, early in the design cycle, thus making significant reductions in cost and time. Initially, the target users are designers at the US Army TACOM, with plans for distribution to other Army bases.

Statement of Compelling National Need

The Future Combat Systems (FCS) is a joint (across all the military services) networked (connected via advanced communications) systems of systems (one large system made up of 18 individual systems plus the network and Soldier- often referred to as 18 plus one plus one). A Soldier, linked to these platforms and sensors, has access to data that can provide a much more accurate picture of what's going on around him. The Warfighter Information Network-Tactical [WIN-T] will be the backbone of the Army's Future Combat Systems.

The goal of the FCS program 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 to support Army Transformation. A large portion of the funds support the collaborative Army/ Defense Advanced Research Projects Agency (DARPA) FCS program and provide support for the FCS analysis function of the Objective Force Task Force.

On 22 July 2004 Army officials announced plans to accelerate the delivery of selected future combat systems to the current force. All the changes increased the total cost by \$20-\$25 billion, about 25% higher than the original estimate of \$92 billion. A significant increase to the current System Development and Demonstration (SDD) phase funding of \$14.78 billion is required to accomplish the changes.

The plan expands the scope of the program's System Development and Demonstration (SDD) phase by adding four discrete "spirals" of capabilities for Current Forces. It also will fully fund the FCS network and its 18 core systems, four of which were previously deferred.

The number of brigades equipped with future combat systems technology was accelerated under the restructured plan. The first FCS unit will be fielded in fiscal 2008, with 32 brigades so equipped by fiscal 2014. Under the old plan, the first unit was set for 2012. Deployment of the first fully modernized FCS Unit of Action, with only 2,500 soldiers, slipped by two years, to 2014. The Army's experimental unit, to stand up in 2008, will test the new technology. The two extra years in the FCS schedule will give time to field all 18 planned systems by 2014, versus the 13 that would have been available by 2012.

The objective of the proposed effort is to answer some of the questions posed by the CSA. An integrated effort building upon technological advancements at Iowa and in tandem with TACOM researchers is proposed.

In specific, the proposed work is to continue the S&T phase on the concept of Digital Humans and Virtual technology that allows human-like figures to explore virtual prototype and to answer questions that could otherwise remain un-answered or would require physical prototypes. The goal of this program is to achieve significant reductions in cost and time associated with making physical prototypes of the Army's FCS hardware by involving the human evaluation aspect early in the design cycle.

Statement of the University of Iowa's unique capabilities to fulfill this need.

The Virtual Soldier Research (VSR) program at the College of Engineering was established on October 2003 with major funding from congressional adds. Since its inception, the VSR program has moved rapidly to establish a strong nationally and internationally recognized program in human modeling and simulation. Researchers at VSR (a total of 35 researchers from a number of colleges and departments) have had a record of success in terms of attracting external funding, building strategic relationships with industry partners, hosting major conferences on UI campus, and adding significant value to scholarship in the field of human modeling and simulation. The VSR team is now considered by many around the country as the most advanced research group in the field. The UI team has leveraged several technologies to achieve the goals as first envisioned by this group.

Modeling and Simulation capabilities at CCAD have been proven across many years of implementation. Using fundamental formulations in kinematics and dynamics, mechanical systems

are modeled and simulated with high fidelity. These tools have been tested with implementations in vehicle dynamics, soldier-in-the-loop simulations, mechanism design, and robotics.

Digital humans are biomechanically accurate models of humans of various sizes that exist in virtual environments. Digital humans can be used to tell designers what they can see and reach, how comfortable they are, whether they can access controls, and other important information. This information helps design more effective tools, higher performance devices and machines, faster and for less cost. CCAD is involved in research concerning digital humans.

Virtual reality immersive environments are relatively new technologies that enable human interaction with 3-Dimensional visualization of objects and products before they are manufactured. This technology differs from the digital human approach in that real humans are placed in a virtual environment and allowed to interact with digital models as if they were real. One focus of the research being conducted at CCAD is to determine what the advantages and disadvantages are of using digital humans and/or virtual environments. The goal is to develop design methods that will reduce the number of one-of-a-kind prototypes of systems that must be built before designs are finalized. This process appears to require both virtual reality technology and digital humans.

Optimization methodologies offer opportunities to design systems and operations in best possible ways, such as minimum cost, minimum mass, maximum strength, etc. CCAD has been involved in the development of optimization methodologies and their application to real-world problems. It is a recognized world leader in the field. Optimization methodologies have been demonstrated on a variety of applications, such as damage tolerant-design of structures (survivability), design for durability, design for crash environment (safety), inverse analysis problems (system identifications), design of light weight structures, control of dynamic systems and many more. These methodologies will be used in modeling and simulation applications, design and applications of digital humans, and efficient virtual reality applications.

FY08 Request and Program Element Code (PEC): Add \$4M to PE: **0603005A**; for Digital Humans and Virtual Reality for FCS.

Funding History and Future Requirements: TACOM is currently funding advanced technology developments for human modeling and simulation tools. These tools, however, are more traditional focusing on ergonomics and do not introduce more advanced visualization and mathematically-based methods such as those at the University of Iowa and that could have a dramatic payoff. The proposed effort will focus on new and exciting methods to increase artificial intelligence in digital humans, to develop methods for studying dynamic tasks and motion prediction, as well as clothing for Nuclear, Biological, and Chemical warfare simulation of the dismounted soldier. Future requirements are strongly articulated by TACOM's needs for advanced analysis tools such as those proposed here.

Statement of National Benefits

Building on a strong research program in human modeling and simulation and a record of significant success, it is anticipated that this work will culminate in the commercialization of Santos™, the human modeling and simulation environment under development at VSR. Compared to existing technologies in this field, and by all accounts of experts, Santos™ (the culmination of research of 35 researchers for 3 years) will be a quantum leap in how products are designed. With a dual-use objective, Santos™ is expected to serve military designers in all issues dealing with human factors, particularly in the design of FCS equipment, but at the same time aid in the design and development of civilian products from automotive, construction, and appliances.

The VSR team at Iowa is a multi-disciplinary program involving several departments, 9 faculty members, 8 staff members, and about 12 graduate students. Please visit www.digital-humans.org for more information.

Technical Point of Contacts

The University of Iowa	Dr. Karim Abdel-Malek, Tel. 319-335-5676, amalek@engineering.uiowa.edu
US Army TACOM	Mr. Kyle Nebel, TARDEC POC, 586-574-8809, kyle.nebel@us.army.mil