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Leveraging University Creativity

by

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USAWC CIVILIAN RESEARCH PROJECT

Leveraging University Creativity

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Abstract

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The purpose of this study is to provide an analysis of how the Army is leveraging the University Affiliated Research Center (UARC), the Institute for Creative Technologies (ICT). ICT is a strategic resource that conducts basic, applied, and advanced research in virtual human technologies with a training centric focus. This research examines the Army's funding and return on investment. Research analyses suggest that UARC investment is a relatively untapped resource and that the Army should review additional consideration for investment and mentorship. UARCs can provide research stability amongst budgetary uncertainty and provide acquisition agility. Analysis also uncovers potential issues that may influence the Army's ability for future innovation and discovery. Key questions addressed: What are the benefits of the Army investment in ICT and how can the Army maximize the effectiveness of this resource?

Leveraging University Creativity

Institutes of Higher Education have long provided an intellectual and synergistic foundation for our future. They develop and supply leaders for both our nation's businesses and military and, less publicized yet vitally important, they provide research and development (R&D) contributions which promote discovery and establish the groundwork for innovative breakthrough. Today, more than 200 universities are conducting R&D efforts across a broad range of sciences in support of the Department of Defense (DoD).[1] Intricate parts of this research partnership are the University Affiliated Research Centers (UARC) who represent one model of DoD collaboration with higher education. It is from this R&D perspective that this research hopes to provide insight into how the U.S. Army is leveraging one particular UARC, the University of Southern California's Institute for Creative Technologies (ICT), to help bring virtual human technology to the forefront of the scientific and training landscapes.

Five central themes are apparent when researching the DoD and the Army's involvement with universities: an abundance of evidence suggests R&D funding is not commensurate with the importance we place on R&D for our future; virtual human technologies are only at the frontier of what is possible; cultivating and harnessing creativity requires long term vision and creative leadership; advances in training technologies are not keeping pace with traditional weapon platform programs; and lastly, our strategy to improve training tools is on the right track, but the pace of discovery and integration may not allow concurrent synchronization with the profoundly rapid change in technological advances.

Historical Perspective

Although this research largely addresses the DoD's interaction with Higher Education today, our Government has long sought academia's advice and expertise. The formal involvement on a large scale began 150 years ago. The Morrill Act of 1862, signed by President Abraham Lincoln, established the nation's land-grant universities and endowed them, in part, with a research mission.[2] Growth in higher education institutions and their support of Government-based research can in many respects be attributed to the Morrill Act. During World War II Federally Funded Research Development Centers (FFRDCs), formerly called Federal Contract Research Centers, grew out of the need to obtain objective assessments of military problems or programs of increasing technical complexity. FFRDCs are federally constituted research and development (R&D) organizations that meet special, long-term needs that cannot be met by existing government or contractor resources. They operate in the public interest, free from organizational conflicts of interest, and can therefore assist the DoD in ways that industry and for-profit contractors cannot.[3] UARCs established in 1996 share similar characteristics and missions of FFRDCs. Common traits include: non-profit public-interest status, research and development in defined domains, freedom from conflict of interest, and long-term strategic relationships between the contractor entity and the sponsoring government agency.

Distinctions include: UARCs must have a university affiliation, have education as part of their mission, and tend to have more flexibility to compete for work than DoD FFRDCs. FFRDCs may be operated by non-university organizations, including private industry; FFRDCs are subject to staff level ceilings and units may not compete for work

outside the FFRDC, while UARCs may compete for science and technology work. FFRDCs can also use military construction funding (MILCON) while, UARCs cannot. With only two exceptions, FFRDCs are sponsored by federal governing agencies, vice UARCs who are sponsored primarily by Service components such as the Army or Navy.[4] Although FFDRCS and UARCs are not without critics, they gained an advocate in 2011 when the Under Secretary of Defense for Acquisition, Technology, and Logistics, Ashton B. Carter, characterized "FFRDCs as immensely valuable capabilities that the Department should use all means legally available to preserve and strengthen".[5]

Research and Development (R&D)

The significance of discoveries attributed to DoD basic research is difficult to measure in terms of overall value, regardless of definition. However, one needs only consider a few examples to know its contribution to our global society. Technological advancements in computers, internet, lasers, semiconductors, weather satellites, microwave electronics and global positioning technologies all, in part, have origins that can be attributed to DoD basic research.[6] To research the possible and advanced existing technologies, DoD and the Army typically partner with industry and academia to provide innovative solutions required to sustain a continuous flow of new and time-sensitive products into the hands of our warriors. These partnerships are pivotal to maintain global technological advantage while increasing our economic growth through this investment.[7]

Key to advancing strategic goals in R&D is growing the DoD's scientific and technological communities' partnerships and long-term commitments to investment in R&D that provide the initial foundation some describe as the "seed corn"[8] for further advances and discoveries. A plethora of R&D articles and reports over the past 30 years provide an array of theories and concerns with respect to funding, maximizing R&D effectiveness and its impact on U.S. global leadership. The 2006 book titled, *Rising Above the Gathering Storm - Energizing and Employing America for a Brighter Future,*[9] and a report from the RAND Corporation in 2012, *Improving Army Basic Research*,[10] provide a good consensus perspective on this subject. Both provide analyses of the importance of R&D as well as associated problematic issues that influence the constraints upon current and future innovation. Their common perspective underlines the importance of R&D, supporting governance with a long-term vision and associated resources to grow innovation. "The Army must have a high-quality, inquisitive, agile basic research program with a long-term time horizon, because of geopolitical futures and the needs of the future Army are uncertain".[11] Overall, DoDs basic research is too near-term in its focus and lacks mechanisms within organizations to stimulate staff to undertake high-risk but potentially transformational research in areas relevant to the Army.[12] The Defense Science Board reports for 2010 and 2012[13] emphasize many of the same concerns to sustain and strengthen the nation's traditional commitment to long-term basic research that produces new ideas which fuel the economy, provide security and enhance the quality of life. With few exceptions, long-term visions with commitment to R&D funding are the primary arguments that must be addressed to promote future technological advancements and to sustain U.S. global

leadership. Overall and compared to Gross Domestic Product (GDP), U.S. R&D spending leads all nations; however, the United States may be falling behind, possibly losing the advantage in technology development and the educational foundation that provides a steady flow of physical sciences, engineering, mathematics and information sciences research professionals.[14]

"*In an era of accelerating innovation, it is likely that many of the new concepts required to drive the Army's transformation a reality will only be realized through the discovery and application of breakthrough research and development (R&D)*".

RAND Report on Improving Basic Research, 2012[15]

R&D advances realized through industry are well publicized and demonstrate, due in part to continual war over the past decade; however, these successes primarily are in direct support of weapon platforms. What appears to be lagging behind is the funding and rapid growth in soldier-training-centric technologies. Innovation in two wars over the past decade is the proximate catalyst for the funding focus on weapon systems; however, this focus may be a shortsighted approach and one that presents risks to future developments. Notwithstanding the critical need for R&D, funding during wartime engagements has been relatively flat over the past five years in comparison to many DoD programs. Because of budgetary projections and national economic challenges and subsequent prioritization, this pattern may not change for the foreseeable future. Reductions in funding across the Army are inevitable; however, we must safeguard what has brought us the technologies we currently enjoy and rely upon, as well as those

future innovations we will need to maintain our shrinking technological edge over potential adversaries.

R&D Funding

R&D investment develops new products and services that drive growth, create jobs and improve the national welfare. For decades, the U.S. government and private sector have spent more than any other nation on R&D. But that advantage may be eroding as other nations increase public and private R&D investments at faster rates, causing the global U.S. share of this critical investment to decline. Over the first decade of the twenty-first century, total public and private U.S. R&D expenditures grew at just 5 percent per year, reaching $400 billion annually in 2009. Meanwhile, R&D spending has generally surged across Asia, with China and South Korea maintaining double-digit growth rates. China became the second highest spender on R&D worldwide with $154 billion in 2009 surpassing Japan. For that same period, the European Union averaged 5.8 percent R&D spending growth, reaching $300 billion.[16] In 2009, the U.S. R&D to GDP ratio reached a record high of 2.9 percent, a number last achieved in 1964. Nevertheless, eight nations had a higher ratio (table 1.1).[17] To compound the concern over R&D spending, one must only look at our modest increase in Federal R&D obligations, which show less than 1 percent growth from 2005-2011 (table 2.1). The total annual budget for R&D is just over 3 percent of the total budget. The DoD's budget comprises just over 51 percent of the total R&D budget.

Table 1.1; 2010 Top Spenders on R&D as a Percentage of GDP

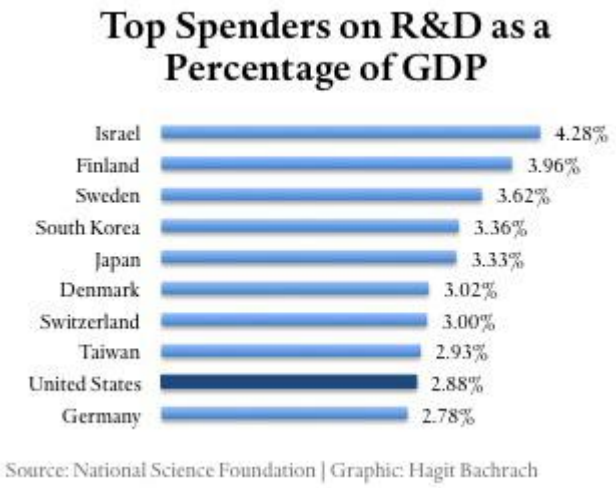


Table 2.1, Federal obligations for research and development, by character of work.

Federal obligations for research and development, by character of work

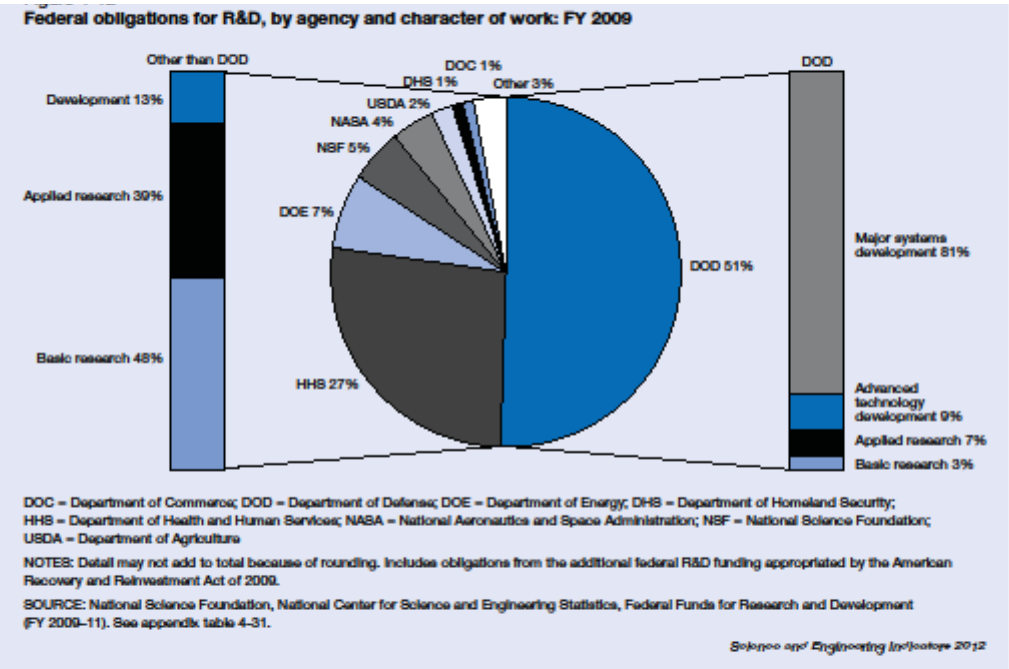
FY	Development	Basic Research	Applied Research	Total R&D
2005	27,140,335	26,597,910	65,109,619	118,847,864
2006	26,584,592	26,951,058	68,194,299	121,729,949
2007	26,865,786	27,227,779	27,227,779	127,262,861
2008	27,153,966	26,739,712	73,211,988	127,105,666
2009	32,877,860	30,830,948	69,640,161	133,348,969
2010	32,051,646	33,198,420	71,175,961	136,426,026
2011	30,083,418	30,288,947	67,414,273	127,786,638

SOURCE: National Science Foundation/National Center for Science and Engineering Statistics, Survey of Federal Funds for Research and Development.

Because of past and current funding trends, it is difficult to argue that R&D is funded proportionally to the importance placed upon its mission. However, an opportunity may exist to reshape our future by exploiting existing DoD R&D funding by reemphasizing commitment to long-term basic research that stems innovation. As table 3.1 depicts 2009 Federal Obligations for R&D, the DoD's funding is focused upon major systems. This funding focus is in large part due out of necessity because of war. However, now that

significant troop drawdowns from Afghanistan are within reach, realignment of DoD's R&D funding from a major systems focus to a gradual shift to basic, applied and advanced development research emphases may be prudent to effectively invest in long-term discovery research. The DoD's 51 percent of federal R&D funding is distributed as follows: 81 percent is for major weapons systems, 9 percent is allotted to advanced development, 7 percent for applied, and only 3 percent is allocated to basic research. An incremental shift to reverse this trend warrants investigation and could prove to have substantial effects upon future technological advances and discovery within current budgetary constraints.

Table 3.1: Federal Obligations for R&D, by agency and character of work, FY 2009



University Affiliated Research Centers (UARCs)

In R&D innovations a relatively underutilized research resource is the Army's relationship with higher education institutions called University Affiliated Research Centers. UARCs are strategic DoD research centers whose purpose is to ensure the development of essential engineering and technology capabilities of particular importance. They are designed to provide concerted focus and critical mass in research areas that meet Army and DoD future needs and anticipated combat requirements.[18] UARCs are university-led collaborations between universities, industry and Army laboratories that conduct basic research, applied research and advanced technology development. They are considered to be at the forefront of science and innovation in a specific research area. The emphasis for each UARC is to conduct research where breakthroughs are likely to enable revolutionary capabilities for our warfighters.[19] Currently, there are 12 UARCs: 5 Navy, 3 Army, 2 National Security Agency, 1 Missile Defense Agency and 1 National Aeronautics and Space Administration. The Army's UARCs are the Institute for Collaborative Biotechnologies, University of California-Santa Barbara; the Institute for Soldier Nanotechnology, Massachusetts Institute of Technology; and the Institute for Creative Technologies, University of Southern California.[20]

The UARC's relevance is highlighted in comments by senior government leaders. In October 2012, Sen. Mike Johanns (R-Neb.) applauded the announcement of a U.S. Strategic Command (USSTRATCOM) sponsored UARC to be established at the

University of Nebraska. DoD is investing $17 million in an initial contract that creates a key partnership with academia in defense-related research.[21]

> "*A strong and innovative military that continues to evolve is vitally important to our national security. The establishment of this center will advance cutting edge defense research in our state, which will help to continue the University of Nebraska's tradition of research excellence as well as conduct important work critical for STRATCOM, Nebraska and the nation".*
>
> *Sen. Mike Johanns (R-Neb.)*[22]

Army UARCs Synopsis

The Institute for Collaborative Biotechnologies (ICB) is led by the University of California, Santa Barbara (UCSB), in partnership with the Massachusetts Institute of Technology (MIT) and the California Institute of Technology (Caltech).

"Overall emphasis is on the study of the fundamental mechanisms underlying the high performance and efficiency of biological systems and the translation of these results to engineering systems of benefit to the Soldier. Specific research is within five key areas, (1) Biomolecular Sensors, (2) Bio-Inspired Materials, Lightweight Portable Energy, and Flexible Energy-Dispersive Composites, (3) Biodiscovery Tools, (4) Bio-Inspired Network Science, and (5) Cognitive Neuroscience".[23]

The Institute for Soldier Nanotechnology (ISN), Massachusetts Institute of Technology, centered at MIT, engages in fundamental, multidisciplinary nanoscience

research relevant to the Soldier. "The five ISN strategic research areas are: (1) Lightweight Multifunctional Nanostructured Materials and Hybrid Assemblies, (2) Soldier Medicine: Prevention, Diagnostics and Far-Forward Care, (3) Multiple Blast and Ballistic Threats: Materials Damage, Human Injury Mechanisms and Lightweight Protective Systems, (4) Hazardous Substances Sensing, Recognition and Protection, and (5) Nanosystems Integration for Protected Communications, Diagnostic Sensing and Operational Flexibility in Complex Environments".[24]

"The University of Southern California's Institute for Creative Technologies (ICT) conducts basic research and development to create engaging and effective immersive systems that shape the future of Army training and analysis using virtual, constructive, and live simulations. Focusing on research into Counter Insurgency (COIN), sustainment operations, tactical intelligence, leadership, decision-making and a wide-range of therapeutic applications, the ICT seeks to redefine the range of skills that Warfighters can obtain from future, dynamic simulation systems. The ultimate goal of the combined research and prototype developmental efforts of the ICT and its partners is to harness the power of artificial intelligence, emerging visuals, immersive simulation technologies and storytelling to provide America's Army a worldwide technological advantage on the battlefield against terrorism. ICT conducts basic research, applied research and advanced technological prototype development focused on (1) Virtual Humans; (2) Social Simulations; (3) Emerging Visualizations, Sounds, Graphics; (4) Mixed Reality (MR); and (5) Learning Sciences to advance Army training and analytical capabilities."[25]

The Research, Development, Test & Evaluation (RDT&E) budget is sub-divided into 7 separate activities: basic research, applied research, advanced technology development, demonstration and validation, engineering manufacturing development, management support and operational systems development, designated as 6.1 through 6.7. UARCs comprise only of 6.1, 6.2 and 6.3 research areas:[26]

> *Basic Research (6.1) is the systematic study directed toward attaining greater knowledge observable facts without specific applications toward processes or products in mind. It is farsighted, high-payoff research that provides the basis for technological progress.*
>
> *Applied Research (6.2) translates promising basic research into solutions for broadly defined military needs and includes studies, investigations, and non-system-specific technology efforts. The key characteristic is that applied research is directed toward general military needs with a view toward developing and evaluating the feasibility and practicality of the proposed solutions and determining their parameters.*
>
> *Advanced Technology Development (6.3) includes development of subsystems and components and efforts to integrate subsystems and components into system prototypes for field experiments and/or tests in a simulated environment.. Projects typically have a direct relevance to identified military needs. The results of these efforts are proof of technological feasibility and assessment of*

subsystem and component operability and producibility rather than the development of hardware for service use.

The overarching authority for UARCs is the Assistant Secretary of Defense for Research and Engineering (ASD(R&E)), Office of the Secretary of Defense with direct Army UARC oversight from RDECOM, ARL, and Simulation and Technology Training center (STTC). The UARC Plan is the primary governing document issued by then Director of Defense Research and Engineering in 2010, which outlines the UARC's long-term strategic relationship with DoD: [27]

(1) Responsiveness to evolving sponsors requirements.

(2) Comprehensive knowledge of sponsors requirements, and problems.

(3) Broad access to information, including proprietary data.

(4) Broad corporate knowledge.

(5) Independence and objectivity.

(6) Quick response capability.

(7) Current operational experience.

(8) Freedom from real and/or perceived conflicts of interest.

U.S. Army Training Strategy

The Army Training Strategy, dated 3 October 2012,[28] The Army Equipment Modernization Strategy, dated 4 March 2013[29] and numerous U.S. Army Training and Doctrine Command (TRADOC) regulations describe a critical need to develop, enhance and leverage virtual human, immersive and resilience type training to maximize training

effectiveness and to capitalize on technological advances that enable better resource management.

Army Doctrine Publication 7-0 states that the “Army cannot afford to train in live environments only,”[30] therefore Commanders must fully utilize the integrated training environment by mixing live, virtual, constructive and gaming enablers as appropriate to enhance training, improve realism and save resources where practicable. They must understand the value of training technologies and use them to exploit and gain a tactical and technical proficiency advantage that will translate into live events. The Army Learning Concept 2015 highlights the need to take advantage of opportunities presented by dynamic virtual environments; it speaks of access to applications, the blending of physical and virtual collaborative environments and learning outcomes. Key actions necessary to achieve ALC 2015 goals are to “dramatically reduce or eliminate instructor-led slide presentation lectures and begin using a blended learning approach that incorporates virtual and constructive simulations, gaming technology, or other technology-delivered instruction.”[31] While virtual training environments do not replace all live training, they do offer advantages. They provide training events that are highly compressed in time, simulate environments that cannot be replicated in live training, can be tailored to the learners’ level of knowledge, can ramp up complexity and stress on demand, allow multiple repetitions to increase mastery and have advantages of accessibility and adaptability.

University of Southern California, Institute for Creative Technologies (ICT)

The U. S. Army is leveraging the research skills of ICT to help bring virtual human technology to the forefront of the scientific and training landscapes. ICT is the only training-centric focused Army UARC with the mission to build a partnership between the Army, academia and the entertainment industry to create synthetic experiences so compelling that participants react as if they are real. The result is new and engages immersive technologies for learning, training and operational environments[32]. Major research areas include: Immersion, Scenario Generation, Content Creation, Graphics, Artificial Intelligence, Sound, Knowledge Integration, Creative Technologies, Evaluation and Learning Sciences. Each of these competencies focus on varying degrees of basic, applied and advanced research. ICT research projects fit into the Concept and Technology Development within the Pre-Systems Acquisition and Pre-Materiel Development Decision phase of the Acquisition Management System.

Cost and return on investment

The Army's Science & Technology (S&T) R&D funding for ICT in 2013 is ~$14M (table 4.1).[33] This is ~37 percent of the total Army UARC budget and comprises less than 1 percent of the total S&T basic through advanced development (6.1-6.3) research budget.

Table 4.1, ICT FY12 and FY13 Funding

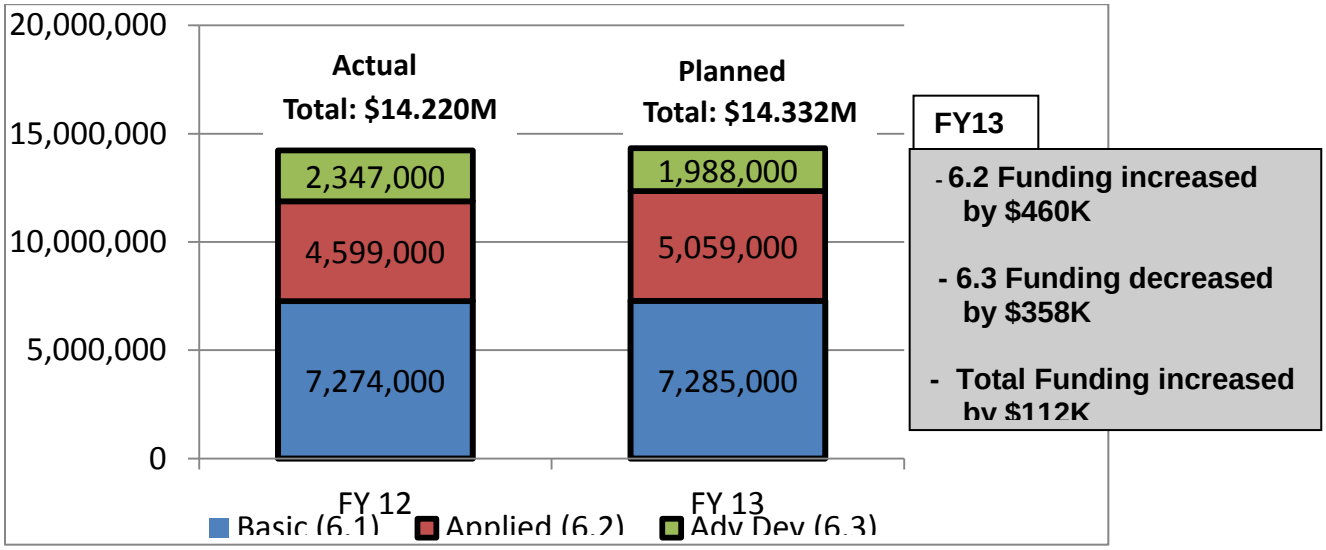


Table 4.2 below provides the funding allocation for all UARCs in 2010[34]. As illustrated, the Navy has the preponderance of the UARC funding ~87 percent primarily for John Hopkins University. Of note, the Navy, prior to formal UARC establishment, has had a long term relationship with academia, in particular Johns Hopkins University, for the past 60 years, which likely contributes to the funding disparity.

Table 4.2, University Affiliated Research Center (UARC) 2010 Funding

Army	
- University of California at Santa Barbara: Institute for Collaborative Biotechnologies	**$11.9**
- University of Southern California: Institute for Creative Technologies	**$31.3***
- Georgia Institute of Technology: Georgia Tech Research Institute	**$13.2**
- Massachusetts Institute of Technology for Soldier Nanotechnologies	**$12.0**
- University of Texas at Austin: Advanced Technology	**$6.1**
MDA	
- Utah State University: Space Dynamics Missile Defense Agency	**$30.5**
Navy	
- Johns Hopkins University: Applied Physics	**$684.3**
- Pennsylvania State University: Applied Research	**$97.7**
- University of Washington: Applied Physics	**$14.0**
- University of Hawaii at Manoa	**$2.5**
Nation Security	**$2.5**
- University of Maryland, College Park:	**$18.7**
Advanced Study of Language Agency (NSA)	
- Stevens Institute of Technology:	**$7.2**

Note: *ICT received two year awards on 2010; annual funding is actually ~$14M

Return on investment for the Army

A closer look into ICT gives evidence to the possibilities of UARCs and benefits associated with their research aligned with the DoD and the Army's training strategies. What is unique and has been lacking in existing Army simulation training type venues is ICT's current capability to develop and enhance realistic virtual human graphic technologies with the integration of creative immersive storylines that replicate and

induce cognitive processes and emotions similar to being in an operational environment. Matching creativity with technology is a critical aspect of ICT's value to the Army. And although ICT's progress and potential in virtual human technology is extremely appealing, it is not intended to replace a Soldier individual or classroom training; however, it can be used as a tremendous supplement to reinforce traditional learning methods. Benefits include reduced training time, reduced manpower, and the ability to teach and reinforce training that ultimately reduces instructor-led training duration. ICT's work in developing virtual human immersive scenarios that aid in the treatment of PTSD is also of significant importance.

> "One-and-a-half million Americans have served in Iraq and Afghanistan. Not one of them came home unchanged. No one comes back unchanged".
>
> *COL (Dr.) Tom Burke, DOD Director of Mental Health Policy*[35]

Due to advances in virtual human technologies and ICT's relationship with the entertainment industry, the Army is now in a better position to leverage virtual human technologies to advance training and the treatment for warriors returning from multiple battlefields and/or heavily stress-induced environments.

The return on investment for the Army is substantial, including:

- Dedicated training-centric focused research on virtual human technologies
- Army's affiliation with a top 10 research university in the Nation[36]

- A long term investment in research that covers basic through advanced development
- Human capital that is uninhibited by “intuition borne of experience”.[37]
- Additional research capability and the potential for flow-down research for the Army.
- Training products influenced by ICT research

As depicted in table 3.1, R&D funding is primarily slanted toward major systems (81 percent); therefore, having a dedicated training-centric focused research center is extremely important and something that should be capitalized on to the fullest extent. Because virtual human technologies are only at the frontier of the possible, the possibilities, from Accessions Command to TRADOC to warfighters on the ground, have significant promise. ICT is structured to support basic and applied research and has a unique capability to support technology advancement for near-term solutions for the field. This capability, unmatched by the traditional acquisition process, is critically important in today’s Army because emerging tactical needs often necessitate short timelines to push new technologies quickly to the field. The intangible benefit to the Army is the affiliation with a top tier research university. In 2012, University of Southern California was ranked among the top 10 research universities across the United States.[38] Although the ARL has an excellent reputation, the diverse faculty and infrastructure of a major university is difficult to compete with. The intuition of experience does not always translate into innovation; in fact, it may have a limiting effect.[39]

Determining the significance of discovery that can be attributed to ICT research is difficult to measure in terms of overall value, primarily because of the level of research conducted: basic, applied and advanced. "*This domain of research is a continuum of discovery, knowledge, invention, innovation, technology development, and technology demonstration with feedback cycles*".[40] It is often not a simple sequential process whereby an idea is started in basic research, migrates to applied research and then transitions to technology demonstration. However, characteristics of a good research center can provide insights to the value or potential benefit of ICT. Their professional recognition, speed and agility of research, research influence or output and external partnership or affiliation offer a good sight picture of their research stature.

Notwithstanding ICT's relatively new entry into the research establishment (1999), their professional recognition and credentials are reputable. From 2008 to 2012, ICT's ~135 researchers have contributed to 520 peer-reviewed conference papers which are published in 249 journal publications and cited in over 80 books.[41] This recognition and exposure provide evidence to their leadership in fields of graphics research, virtual humans, multi-modal sensing, natural language processing and cognitively real agents and medical virtual reality exposure therapy.

This type of professional recognition places ICT in a category of what is typically characterized as a good research center.[42] ICT's are leaders in their field of research and are structured in a manner that enables them to exploit and capitalize on opportunities from an array of research initiatives that provide agility, using discoveries

from a broad spectrum of customers. This research agility and broad discovery opportunity is unique to Army research and runs counter to how Army labs operate today. The UARC plan, in addition to providing strategic links and guidelines, gives UARCs a unique feature that allows flexibility to expand research outside the affiliated sponsor (Army) initiatives without compromising their primary mission to support the sponsor. This flexibility enables UARCs to expand their research portfolio and expertise across DoD and the private sector, while providing specific research to the Army. This approach differs from how traditional ARLs operate today where research is focused on a single customer or Service and operates within a relatively closed environment of comparable Army R&D researchers. A compelling argument for allowing UARCs this independence is a strategic shift. As resources begin to tighten, organizations must collaborate and expand their relationships within and outside the DoD to maximize capabilities and efficiencies. This approach creates a broader corporate knowledge base that translates into innovation and creativity, in part because of the flow down discovery potential to sponsors' research that otherwise may not have been gained if restricted to a closed research environment or single research project.

Determining research value or success, in particular to basic and applied research, can be difficult to measure; however, one indicator is the amount of influence research has on actual prototypes or end products that make it to the market or Service. To date, ICT's research has permeated over 27 products throughout DoD,[43] with a total trained to date of ~90,000 DoD personnel at over 100 sites.[44] Army-specific products include:

- Emergent Leader Immersive Training Environment (ELITE) (Classroom Version)
- UrbanSim, Dismounted Interactive Counter, IED Trainer (DICE-T)
- Intelligence, Surveillance, & Reconnaissance Trainer (ISR-T)
- Jumpmaster Personnel Inspection Rehearsal Tool (JMPI-RT).

Unlike commercial products where sales are the primarily indicator of success, this research could not determine fully ICTs research success or failures. This is not uncommon with respect to basic and applied research, however professional recognition, feedback from SMEs, PM and annual review boards in part do substantial ICT's potential and value to the Force.

Research Focus

ICT research is broadly guided by warfighter outcomes provided by TRADOC in an effort to leverage research in a direction that will address future operational and strategic areas of interest. This effort is extremely important, yet difficult to manage because of the nature of basic research. Too much research influence or direction can deter from legitimate discoveries; however, if managed effectively, it can foster significant positive outcomes. RDECOM's ARL, Simulation and Technology Training center (STTC) provides overall project oversight and direction for ICT. To ensure appropriate strategic and operational focus, TRADOC provides the vision and guidance for strategic training initiatives. To maintain strategic alignment and review project viability, ICT's current research and potential projects are presented by the project manager to a collaboration of stakeholders highlighted by the Assistant Secretary of the

Army for Acquisition, Logistics, and Technology (ASA(ALT)) and TRADOC, primarily through annual review boards, the Technical Advisory Board and Executive Steering Board.

Although this research lacks empirical evidence, feedback from stakeholders suggests a need for formality and rigor in the project review process and a greater need for Army mentorship. ICT is a strategic resource that conducts independent research on behalf of the government. This is a non-profit organization established to provide critical research for DoD. They are not a defense contractor, and therefore should be integrated into the Army team at all levels. Currently, the program manager acts as a conduit to S&T senior officials. However, due to competing initiatives, lessor funded projects can unintentionally be left in the shadows of more visible programs due to the hierarchy of the organization structure. Because of UARC's mission, integration of ICT into the Army team at all levels warrants consideration. The value of mentorship to increase strategic focus and obtain a better understanding of the art of the possible from a research perspective should not be underestimated. A key aspect of R&D is to provide leaders with what is possible in respect to research, which can shape long term strategic research initiatives. Without a clear mechanism to encourage direct communication due to unintended bureaucratic processes and structural hierarchy this exchange is greatly diminished. To promote a teaming relationship with ICT, S&T should consider solidifying a process with stakeholders to integrate coordination and dialog with ICT with the intent to progress into natural, uninhibited mentorship between the Army and ICT. Creating a mechanism that will enhance Army mentorship with

UARCs and streamline oversight layers to promote teaming, program advocacy and dialog with senior leadership will aid in future research discoveries.

The absence of written guidance for ICT project review processes suggests that additional structure and rigor (forcing mechanisms) prior to review boards may be beneficial to minimize ”research drift”, strengthen alignment and provide strategic initiative awareness. ASA(ALT)’s and TRADOC’s roles cannot be over emphasized -- both are critical to ensure that S&T initiatives are synchronized with Army strategic and operational training objectives.

To better align S&T R&D initiatives with strategic training goals, research suggest shifting TRADOC’s formal involvement earlier into ICT’s proposal review process[45] (e.g. during PM guidance to ICT phase of the proposal review process). This change will enhance ICT’s strategic training situational awareness and ensure the PM and TRADOC project one voice. A key responsibility of a research center is to provide technical advice to Army senior leadership.[46] Therefore, integrating TRADOC earlier into the process will create a venue to increase dialog between ICT, PM and TRADOC.

Corporate Governance

Corporate Governance for Army UARCs resides under the Army’s RDECOM, ARL, with direct program management provided by the Simulation and Training Technology Center located in Orlando, Florida. Coordination and oversight are also provided by the ASA(ALT) and TRADOC. This oversight structure is not unusual within

the Army; however, because of the nature of basic, applied, and advanced research and the creative organization atmosphere, oversight indulgence should be restrained. Several reports, the Government Accountability Office's, *Measuring Performance Strengths and Limitations of Research indicators,* dated March 1997[47] and the RAND Corporation's, *Improving Army Basic Research*, dated 2012[48] warn of too many bureaucratic processes and parameters that create a failure avoidance climate which deters from the discovery of breakthrough technologies. In short, too much oversight and its tangential restrictions may well pollute and stagnate the pool of innovative thinking needed to meet today's and tomorrow's challenges.

"*Unnecessary and unproductive bureaucratic burden on basic researchers funded by DOD in effect equates to reduction of the DOD basic research budget. Reducing that burden is perhaps the most important thing that might be done to improve the current DOD basic research program*"

Defense Science Board Task Force on Basic Research, January 2012[49].

Observations/Recommendations

Funding

In the absence of increased R&D funding, S&T should consider realignment of existing research funding allocation to create opportunity in Army basic research. Specifically, a gradual shift from major systems research focus (81 percent of DoD R&D budget) to a basic, applied, and advanced development research-centric priority should be considered. Funding drives all aspects of discovery, and while the likelihood of an

increase in overall funding is dismal, reallocating exiting funds can present an opportunity to energize the seeds of innovation.

Return on investment

Capitalizing on UARC research to the fullest extent is a viable option to bring forward future innovations for the Army. UARCs provide substantial benefits with minimal investment. The Army S&T invests less than 1 percent of the total S&T R&D budget in support of UARC research. In an environment of continual funding constraints and challenges facing recruiting and maintaining quality research staff, this analysis gives significant credence to the benefits of a UARC partnership.

Mentorship and Collaboration

UARCs (ICT) are a strategic resource with a mission of conducting critical independent research designed to provide concerted focus on a particular research area deemed important by the sponsor (Army). They are designated by the DoD and operate as non-profit organizations (i.e. they are not contractors). Because of their special status, increased collaboration as a member of the Army team at the strategic and operational levels will aid in future desired discoveries. UARC's responsibility to provide leaders with an honest assessment of what is possible necessitates increased dialog and will promote and assist natural mentorship and teaming progression.

ICT's Research Capability

The University of Southern California is a top tier research university, ranked among the top 10 in the United States. ICT's relationship with the University of Southern California and the Entertainment industry brings a tremendous capability to the Army that traditional ARLs may not have. ICT's research priority is to support the Army UARC; however, funding is provided by an array of DoD customers to support their respective research initiatives. This flexibility is unique to traditional Army Research Labs which focus typically on a single customer or research area. Funding over the past five years from outside the UARC mission funding constituted ~55 percent of the ICT's total funding.[50] This figure indicates that the Army is underutilizing ICT's total capability; however, until additional Army commitment is realized, ICT must continue to strengthen their research portfolio by conducting research from a broad base of customers. This situation can be an advantage for the Army. In absence of UARC funding, the Army can benefit from other research funding through flow down research that may be applicable to Army-specific research. This ancillary benefit is positive for the Army and a good indicator of ICT's capability, research stature and potential.

Conclusion

The Army's partnerships with Institutes of Higher Education, including UARCs, are of strategic importance. The Army's UARCs provide an intellectual perspective that is in large part untethered by traditional military and industry processes. Therefore, they are able to induce innovations and creativity that otherwise may be lost with traditional

internal or industry partnerships. The research at the Institute for Creative Technologies is only one example of the potential and value to our nation. We must leverage ICT and similar resources by providing them with creative corporate governance that fosters timely discovery and enhances our training technologies while keeping pace with technological change.

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