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FEATURED FACILITY

Arnold Engineering Development Center (AEDC) 70-MW Arc Heater Facility, Arnold Air Force Base, Tennessee

TECHNICAL PAPER ABSTRACTS:

The T&E/S&T Program: Foundation Technologies for Future Test Capabilities

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Born in the minds of visionaries more than 10 years ago, the idea of applying science and technology (S&T) funding to kick-start test and evaluation (T&E) capability development formally became a reality in February 2002 for the Department of Defense (DoD), with its T&E/S&T Program. Established and seeded originally with only $6 million a year, Program Element 603941D8Z was developed to expedite the transition of technologies from the laboratory environment to the T&E community. The program aims to accomplish this goal by leveraging applicable research from the highly developed technology base in DoD service laboratories and test centers, industry and academia. The program was structured as a partnership and collaboration between the Director, Defense Research and Engineering (DDR&E) and the Director, Operational Test and Evaluation (DOT&E). The partnership has since been expanding throughout the T&E and S&T communities, and will, perhaps, be one of the most acclaimed accomplishments of this program's legacy.

High-Density High-Speed Holographic Memory for T&E of Next-Generation Embedded Instrumentation Weapon Systems

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Massively parallel "onboard" storage technologies for high-density and high-speed recording/retrieval of data from both weapons systems and test instrumentation are needed to improve the test and evaluation process of many of today's smart weapons systems. This will be accomplished by dramatically increasing the amount of available data that are necessary to perform comprehensive systems analysis. An innovative holographic memory system has been developed at the Jet Propulsion Laboratory, Pasadena, California, for high-density and high-speed data storage for stressing environments. This paper discusses the development and technical progress of a system utilizing a newly developed electro-optic beam-steering technology to achieve a design goal of greater than 250 Gbs of storage in a cubic photo-refractive crystal with up to 1 Gbs-per-second transfer rate. A compact disc-size holographic memory breadboard was recently developed and demonstrated for holographic data storage and retrieval.

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Application of Computational Fluid Dynamics in the Test and Evaluation of Aircraft/Store Compatibility

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The U.S. Air Force SEEK EAGLE Office (AFSEO), Eglin Air Force Base, Florida, has developed a capability that utilizes computational fluid dynamics (CFD) to provide high-fidelity aerodynamics in support of the store certification process.By supplementing inexpensive lower-order methods and costly, sub-scale testing, CFD has been used to reduce certification costs,increase flight test safety margins and develop more confidence in the numerical predictions that lead to the determination of flight test requirements. CFD has been used within the AFSEO to calculate aircraft/store carriage loads, predict store separation characteristics and to visualize the flow field phenomena of complex aircraft and weapon configurations.This paper discusses AFSEO CFD activities as they were applied to a specific aircraft/store certification project.

Geometric Automated Video Enhanced Location System (GAVELS)

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The U.S. Army field artillery has a need to collect data that measure flight parameters and accuracy of indirect fire munitions. The ability to measure and collect these types of data during indirect live fire operational testing is critical to providing adequate data for an evaluator to determine whether or not a military system under test is suitable and effective in an operational environment.The Army Test and Evaluation Command (ATEC) needed an instrumentation capability that would: acquire data from a munition while in flight; accurately measure the munition flight parameters; and measure the accuracy of the impact point. To satisfy the evaluator's requirements to collect these types of data,the Geometric Automated Video Enhanced Location System (GAVELS) concept was developed in 1999 by ATEC's Operational Test Command Fire Support Test Directorate. GAVELS provides an automated data acquisition and reduction capability that is not available within the current Army instrumentation inventory. Prior to GAVELS, munition performance characterization was difficult, time-consuming and manpower-intensive. The manual process of data collection contributed to critical errors in both data acquisition and data reduction. In addition, the time line between the data event and the availability of data reduction would reach several days.In order to reduce costly test time and improve accuracy in data acquisition and reduction, the raw data that are collected must be reduced as close to real time as possible.

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The Development of a New GPS Hybrid Engine for High Dynamic Test and Training Applications

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The Global Positioning System (GPS) has assumed its role as a primary source of time-space-position information (TSPI) for test and training. Today, GPS instrumentation is found on nearly all test and training platforms requiring track data. Instrumentation packages have been developed for mounting within the platform ("internal mount") and for mounting in an external instrumentation pod (an AIM-9 instrumented shell mounted on a wing station pylon), with embedded instrumentation available soon. GPS "receivers"are used to support low-to-medium dynamic applications to include tanks, helicopters and fighter aircraft. Translators,a GPS receiver variant,have been in use for some time to support high dynamic applications to include missiles and munitions. Translators,as opposed to receivers, can handle the high dynamic environment, but have operational issues that limit their application.

Advancements in G-Hardened Telemetry Instrumentation for the Test and Evaluation of Projectiles

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Technological advancements in microelectronics and wireless communications have allowed the U.S. Army Research Laboratory (ARL) to miniaturize, g-harden and package inertial sensor suites and telemetry components into customized onboard telemetry instrumentation systems that offer improved capability to test and evaluate a variety of projectiles. As an example, this paper describes the development and flight demonstration of a first-of-its-kind diagnostic instrumentation fuze specifically designed for mortar test and evaluation. These instrumentation systems can allow the projectile's motion to be measured during launch and flight, verify airframe flight stability and performance, validate aerodynamics, provide onboard diagnostics and be used as a truth measurement for inertial guidance packages. These systems offer materiel developers a non-intrusive method to rapidly "redesign and retest" developmental hardware, which allows substantial time savings in reaching technology readiness levels; reduces hardware waste and range time, thus allowing for increased efficiency by lowering test and evaluation costs; and provides critical in-bore and in-flight measurements not available with other ground-based range hardware to increase data collection amount.

Readiness and Range Preservation Initiative

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This paper is drawn from a speech given by Raymond F. DuBois, Jr., Deputy Under Secretary of Defense for Installations and Environment,at the Annual ITEA International Symposium, September 10, 2002, in Las Vegas, Nevada.

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Joint Interoperability Test Command's E-Business/E-Commerce Test Facility Modernization & Technology Transformation

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The Joint Interoperability Test Command's (JITC's) Electronic Business/Electronic Commerce Test Facility Modernization and Technology Transformation is a result of the technology revolution that is radically changing the way business and government operate. This revolution has significantly impacted how they communicate, how they conduct business and how they manage their daily lives. The proliferation of Internet marketing and purchasing is obvious. Governments, corporations, mid-size and even small businesses are marketing their merchandise over the Internet. E-Business/e-Commerce has rapidly become a multibillion-dollar market ready to be exploited even further. However, business applications are being introduced over the Internet without proper testing. JITC is actively working to solve this problem.

Storage and Mining of Test and Evaluation Video Data

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There are major challenges in designing and implementing a realistic information system for storage and mining of video data associated with test and evaluation (T&E) applications. This paper provides a description of the information technology challenges peculiar to a video-centric T&E system; a high-level description of a state-of-the-art storage and mining system for video T&E applications composed of both commercial off-the-shelf and custom (yet open interface) software elements (currently being implemented by a Sarnoff Corporation research team); a partial overview of previous work in mining video data; and an analysis of what challenges remain for creating future video-oriented T&E systems.

Disciplined Engineering: The Reality of Advanced Systems Development

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This paper is drawn from a speech given by Lt Gen Stewart E. Cranston, USAF (Ret.), of Veridian Corporation, on February 19, 2003, at the Aircraft-Stores Compatibility XIII Symposium (see "Association News"), hosted by the ITEA Emerald Coast Chapter in Destin, Florida.

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Adaptive, Scenario-Based, Object-Oriented Test Frameworks for Testing Embedded Systems

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This paper presents a process to develop adaptive, object-oriented, scenario-based test frameworks for testing embedded systems. Embedded systems often require rigorous testing due to the mission-critical nature of their applications, and they are often developed as a family of products. The process uses techniques such as design-for-change, design patterns, scenarios, ripple-effect analysis and regression testing. This paper provides an example to illustrate this process by applying it to test a mobile telephone system. The framework constructed can facilitate generation of numerous test cases quickly with minimal effort, and it can also accommodate changes suggested by another party without changing the overall structure of the framework.

PRESIDENT'S CORNER

While serving as ITEA's international president for the past nine months, I have been fortunate to participate in a number of chapter workshops, luncheons and presentations. While each of these activities was significant in its own right, I have enjoyed a perspective that few members see on how these events collectively support the Association's core values. I have been especially impressed by how well the chapters support the next generation of test and evaluation professionals through their local scholarship programs and their success in providing an environment for the exchange of technical information for the test, evaluation and related communities.

Over the past year, the chapters on their own have awarded more than $70,000 in scholarship funds to deserving students, schools and universities without a single dime of matching funds from ITEA's annual budget. This is a remarkable accomplishment in its own right, but it is even more impressive when considering the fact that almost 100 percent of these funds return to the community through awards to students, schools and universities within the chapter's geographical region. I have presented scholarship checks on behalf of the Roadrunner Chapter to students from universities in Las Cruces, New Mexico, and El Paso, Texas. I have observed the Antelope Valley Chapter present thousands of dollars in awards to Antelope Valley schools in support of their science programs, to include the support of a robotics team that is working to compete at the national level. I was present at the George Washington Chapter's scholarship breakfast, where four universities in the region were given substantial checks to supplement their scholarship programs. I watched the Tidewater Chapter present a local teaching institution with funds collected from the golf outing held in conjunction with its workshop.

These are just a few examples of the scholarship award programs that are underway in the various ITEA chapters; many chapter scholarship programs receive little visibility except at the local level. However, my experience tells me that each ITEA member present at these events, whether at the local or national level, shares vicariously in the thrill of the students' accomplishments when their names are called and they come forward to receive an award. Our members feel a sense of pride when a teacher speaks glowingly of how ITEA is providing critical funds to set up a science laboratory the school could not otherwise afford. They applaud with gusto when the head of a university science department states that, because of ITEA's help, some deserving student will now have enough funds to continue his or her degree program in a hard skill area relative to the test and evaluation profession.

To put a twist on a well-used advertising slogan, scholarships are our most important product. How important? Part of the answer lies in two speeches that were recently given to members of the George Washington Chapter. The message from Dr. John H. Hopps, Jr., Deputy Director, Defense Research and Engineering and Deputy Under Secretary of Defense (Laboratories and Basic Sciences), convincingly pointed out that the United States has lost ground in its intellectual resources in science, engineering and technology.

Gary L. Bridgewater

Dr. Hopps' message was that the rest of the world has equal access to science and technology information, the intellectual capacity to use it, and the capability to produce their own products based on these areas. Dr. Hopps made a strong case for reshaping U.S. educational investments and that the best place to start is to create interest in science, engineering and technology at the high school level or earlier. He stated his belief that we should approach this task in a number of ways, but motivating students with real-world, hands-on experiences is the key.

A second presentation by Dr. Shirley Malcom, head of the Human Resources Program Directorate, American Association for the Advancement of the President's Council of Advisors on Science and Technology, presented a similar theme for minority students.

The challenge to ITEA from both presenters is clear. The more we as an association can actively involve students in the science-related field of test and evaluation, the more we will be able to influence those students to pursue careers in this critical field. However, we must go beyond our scholarship program. I challenge each ITEA chapter and member to look for ways to work with students in their local area to increase their interest and participation in science, engineering and technology. Use test and evaluation as the conduit: spend time helping schools and students see real-world applications of science, engineering and technology; and provide them with the experiences that will "turn them on" to this critical career field. That is how we will build the next generation of test and evaluation professionals.

A final note regarding technology—I am pleased to announce that the next issue of *The ITEA Journal of Test and Evaluation* will present a new offering titled "Tech Notes." The ITEA Technology Committee has agreed to provide a new article in each issue that will showcase an interesting technology or technology approach that supports test and evaluation.

Gary Bridgewater

Research, Development, Test and Evaluation

The Honorable Dr. Ronald M. Sega
Director of Defense Research and Engineering (DDR&E)

Through the research and engineering activities, the Department of Defense (DoD) continually strives to enhance the warfighting capability of the armed forces through insertion of advanced technology. This was clearly shown in the operations in Iraq. Advanced technology routinely allowed the military to find, fix, track, target, engage and assess under various conditions and with a precision heretofore unknown in the annals of warfare. This technical capability was developed through the stable investments made over a number of years in DoD's Science and Technology (S&T) program. The harvest of the long-term investment in S&T enables superior operational capability.

Dr. Ronald M. Sega

However, DoD cannot rest on its past achievements. Today, technology development is moving ahead at a rapid pace. In many cases,new developments are conceived, prototyped, tested and deployed on timelines measured in days, rather than in weeks, months—and even years—experienced in the past. This trend will continue with military systems moving more quickly from the drawing board to deployment.

While investments in defense S&T remain strong, they are dwarfed in scale by the combined research investments of the commercial, academic and non-DoD federal sectors. DoD must incorporate this research and the associated products of these communities, while also recognizing that a potential adversary may also have access to much of the same body of knowledge and products. The implication of this trend is that investments in defense technology must be focused on providing the capabilities to give U.S. forces the edge in combat.

Technology and transformation

DoD identified three broad, cross-cutting initiatives that address the development of its critical transformational technologies. The three areas are: the National Aerospace Initiative (NAI), Energy and Power Technologies, and Surveillance and Knowledge Systems.

The first of the joint transformational technology initiatives is the NAI, which consists of research and development in hypersonic flight technology, affordable and responsive space launch, and enhanced on-orbit space technologies.

Hypersonic technology could be truly transformative, as it could provide increased capability through speed in several mission areas. For example, hypersonic technology could provide the opportunity to conduct tactical strikes from strategic distances in a short amount of time. Technology has progressed to the point where demonstrations of a Mach number per year, reaching Mach 12 by 2012, are within reach.

In addition, a technology roadmap, developed cooperatively by DoD and the National Aeronautics and Space Administration (NASA), provides long-term potential for affordable access to space.

The second transformational technology thrust is Energy and Power Technologies. This involves a coordinated investment by three military services and the Defense Advanced Research Projects Agency (DARPA) to generate, store and use power in systems ranging from microsystems to future-generation electric ships. This initiative is investing in technology that could develop batteries with more than five times the energy density; fuel cells that are reliable and safe to use on the battlefield; and capacitors that will decrease size needed to store electricity on ships by a factor of 5 to 10. This effort could also potentially impact military logistics operations by providing efficient energy and electrical power to forces and systems.

The third cross-cutting initiative is Surveillance and Knowledge Systems. This initiative will seek to develop low-cost sensors with various capabilities (such as optical, infrared, acoustic, magnetic, biological, chemical and so forth), connect these information sources to tactical networks, route the data from tactical to strategic level and, finally, initiate the development of knowledge-based technologies that can assist the decision-maker. The initiative should continue to make the vision of network-centric warfare a reality.

Keeping the edge

Testing is an essential component of the systems engineering processes. Too often, DoD has viewed testing as a disconnected single event or milestone through which systems must pass. Testing should be a process that begins on day one and continues throughout the design life of any system. This is especially true when one considers the new evolutionary acquisition model. This model embraces the concept of spiral development and encourages rapid technology insertion. In this model, testing is critical to producing and improving overall systems by integrating knowledge about the impact (benefits and limitations) of each technology insertion into the development cycle.

Testability should be designed into the system from day one. Engineers and testers should work together early on to ensure that key components are easily instrumented or readily provide necessary test data. In some cases, this is simply a matter of approaching the development with testing in mind. In other cases, creative methods may be required. Progress should be aided by the fact that, as information technology becomes more available and pervasive in systems, the ability to collect, export and analyze test data will dramatically improve.

Nowhere is this need more urgent than in software design. Recent experience has shown that software development and integration is a significant challenge in major defense acquisition programs. Many major systems have experienced cost growth due primarily to software engineering and development issues. Software is absolutely essential for the effective operation of today's military hardware at all levels (battleships to bullets), and these systems are increasingly being integrated through networking. The ability to quickly test, debug, integrate and maintain software is increasingly important. Because of the complexity of software, the department has directed development of a course in software engineering as part of the Level III certification of the new acquisition career field track for S&T managers. Fully one-third of the specialized course required for Level III certification is in software engineering.

Partnerships

Establishing a partnership between the science, technology, engineering, development, test and user communities is essential for both current and future developments. All of these communities must work together to ensure that they plan now for the transformation of the test ranges and infrastructure. In this regard, the office of the Director of Defense Research and Engineering (DDR&E) is working closely with the Director of Operational Test and Evaluation (DOT&E), to establish a partnership and to develop roadmaps for the future. Both offices must ensure that they clearly identify gaps and opportunities and have adequate capacity to act. Additionally, they must tap into other departments and agencies to ensure that they harmonize their requirements.

A recent example is the use of NASA facilities to provide key capability to DoD projects, such as the HyFly hypersonic missile research program. In 2002, the full-size device from this Navy/DARPA program was tested at the NASA Langley Research Center, Norfolk, Virginia. Additionally, the Department of Energy has facilities and capabilities that are increasingly important as DoD develops and fields weapons using highly energetic materials.

Walking the talk

Testing is a thread that weaves through all phases of acquisition. From laboratory bench tests through Advanced Technology Demonstrations (ATDs), testing is a critical activity within DoD research and engineering programs. DoD has recently begun an initiative in research and development of advanced instrumentation that should support a range of research, development, test and evaluation (RDT&E) activities.

Within DDR&E, the Advanced Systems and Concepts office has three programs that apply this concept of integrated testing to more mature technologies. The first is the most familiar: Advanced Concept Technology Demonstrations (ACTDs). These programs demonstrate technology in relevant environments and test concepts of operations. Embedded in their way of doing business is the testing and qualification of both technical capability and doctrine. This process demonstrates advanced technologies in the intended environment and proves to the user that the system works as intended. ACTDs have fielded systems

such as Predator, which is providing enhanced capability to the warfighter today.

While each ACTD does not complete the exhaustive range of operational testing expected of a major acquisition program, ACTD managers complete those test elements that make sense in the context of the individual demonstration. Successful element demonstrations support a compelling case for transition to acquisition and for acceleration to procurement. Overall, DoD continues to improve the integration of developmental tests, demonstrations and operational tests in its RDT&E activities.

Another program is the Foreign Comparative Test (FCT), which takes technologies and systems produced offshore and tests them against standards applied to counterpart U.S. technology. FCT uses rigorous test criteria, both operational and developmental, to run these side-by-side comparisons. One success was the AT-4 (Close Support) Swedish Anti-Tank missile, which was initially accepted by U.S. Special Operations Command for employment from constricted spaces. This weapon system gained wide acceptance during operations in Iraq and Afghanistan, especially in urban settings. AT-4CS will likely augment the Army's Light Anti-Tank Weapon (LAW).

Finally, the department just kicked off the Defense Acquisition Challenge Program (DACP), which is focused on improving the capability of currently deployed programs of record. DACP allows nontraditional defense technology providers to introduce new components, systems and subsystems that might not have otherwise been considered for military procurement. These components will then be tested on the actual systems in cooperation with the system program manager. If successful, DACP will support the integration and transition of the new technology. Based on the initial response to a Broad Agency Announcement (BAA), the department is optimistic about the potential impact of this program. More than 200 responses were submitted with regard to the BAA.

Conclusion

Technology is increasingly important to the warfighter. As the pace of change increases, partnerships between engineers and testers, industry and government, departments and agencies will become increasingly more important. Working together in an integrated fashion across RDT&E will be crucial for success on tomorrow's battlefield.

The Honorable Dr. Ronald M. Sega, Director of Defense Research and Engineering (DDR&E), is the chief technical advisor to the Secretary of Defense and the Under Secretary of Defense for Acquisition, Technology and Logistics (USD-AT&L) for Department of Defense scientific and technical matters, basic and applied research and advanced technology development. Dr. Sega also has management oversight for the Defense Advanced Research Projects Agency (DARPA). Prior to his confirmation as the DDR&E, Dr. Sega had an extensive career in academia, research and government service. He received his doctorate in electrical engineering from the University of Colorado and began his academic career as a faculty member in the Department of Physics at the U.S. Air Force Academy, Colorado Springs, Colorado. His research activities in electromagnetic physics led to his appointment as an assistant professor, Department of Electrical and Computer Engineering, University of Colorado at Colorado Springs in 1982. In addition to teaching and research activities, he also served as the technical director, Laser and Aerospace Mechanics Directorate, F. J. Seiler Research Laboratory, and at the University of Houston as assistant director, Flight Programs, and program manager for the Wake Shield Facility. In 1996, he became the dean, College of Engineering and Applied Science, University of Colorado at Colorado Springs.

Dr. Sega has authored or co-authored more than 100 technical publications and was promoted to professor in 1990. He is also a Fellow of the Institute of Electrical and Electronic Engineers and the Institute for the Advancement of Engineering. In 1990, Dr. Sega joined the National Aeronautics and Space Administration (NASA), becoming an astronaut in July 1991. He served as a mission specialist on two Space Shuttle flights, STS-60 in 1994, the first joint U.S. Russian Space Shuttle Mission and the first flight of the Wake Shield Facility, and STS-76 in 1996, the third docking mission to the Russian space station, Mir where he was the payload commander. He was also the co-principal investigator for the Wake Shield Facility and the director of operations for NASA activities at the Gagarin Cosmonaut Training Center in 1994-95.

Dr. Sega has also been active in the Air Force Reserves. A command pilot in the Air Force with more than 4,000 hours, he has served as an instructor pilot and in various operational assignments for the Air Force. From 1984 to 2001, he held several positions in the Air Force Reserves supporting planning and operations for Air Force Space Command. He was promoted to the rank of major general in the Air Force Reserves in July 2001 and currently serves as reserve assistant to the Chairman of the Joint Chiefs of Staff.