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TECHNICAL PAPER ABSTRACTS:

New Capabilities of the Army's Maintenance Manpower Modeling Tool

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This paper discusses the recent updates to the Improved Performance Research Integration Tool (IMPRINT) that significantly improve its ability to predict the maintenance manpower needed to support the Army's Unit of Action. IMPRINT has been developed by the U.S Army Research Laboratory (ARL) Human Research and Engineering Directorate (HRED) to support the Army's need to consider the soldier's capabilities during the early phases of the weapon system acquisition process. The purpose of IMPRINT modeling is to consider the soldier's performance as one element of the total system readiness equation. IMPRINT has been available since the mid-1990s, but the newest version includes significant advances.

White Sands Missile Range Video Tracker Development

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White Sands Missile Range has developed a video tracker using a consumer-grade personal computer and frame grabber. The video tracker receives NTSC video at a 60-Hz field rate and delivers tracking data with a 32-ms delay. Thirty video trackers have been fielded with great success, tracking highly dynamic rockets and airplanes from launch with an azimuth slew rate of up to 60 degrees/second. Simple contrast tracking is employed for both initial launch and steady-state tracking. Smart region of interest determination is used to facilitate servo control issues. The video tracker was developed by government personnel and is not proprietary. It has been fielded and successfully collects optical tracking data on a daily basis in a wide variety of tracking scenarios.

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Hypersonic Wind Tunnel Nozzle Design Procedure for Viscous Reacting Flow

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This paper presents a new procedure to design the contour of an axi-symmetric hypersonic wind tunnel nozzle. The method may be generally categorized as Navier-Stokes-based design by analysis. In the newly developed design procedure, the contour is first designed with an existing method-of-characteristics code and modified with an additive boundary-layer correction. Next, the characteristics contour is optimized using a finite-rate Navier-Stokes solver to compute the objective function, where the design parameters are selected input variables to the characteristics code. The optimized characteristics contour is then further corrected with a correction distribution represented by cubic splines using a suitably small number of nodes along the nozzle. The corrections at the nodes are the next set of design parameters. A formal least-squares optimization procedure is used to select the values of the design parameters that minimize the flow non-uniformity at the nozzle exit.

The U.S. Army Electronic Proving Ground (EPG) Develops Ground Truth Monitor System

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In the course of developmental testing, the need arises to provide a real-time verification of signals presented to a system under test (SUT). To test modern communications intelligence systems, the test officer must present a dense radio frequency environment containing a wide variety of signals. In order to present a realistic environment, the emitters must be geographically spread out relative to the SUT. To present this environment, the U.S. Army Electronic Proving Ground (EPG) developed a series of emitter vans, each of which presents a time order event list of radio emissions. The timing of radio emissions is accurately triggered using a Global Positioning System-based clock, and to enhance the test officer's confidence that the correct emissions are indeed occurring at the intended times, the EPG developed the Ground Truth Monitor (GTM). The GTM performs sampling of the radio frequency (RF) environment in the vicinity of the SUT to verify that each of the intended RF emissions is reaching the SUT at the intended RF power level and time. The GTM was installed and has successfully supported recent major test objectives at the Red Tower location at EPG's Antenna Test Facility.

A High-Speed Digital Alternative to Analog Data Recorders

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The DSAS 2010 high-speed data recorder was designed by B&B Technologies, Inc., to address the high-speed, high-channel-count data acquisition needs of the Defense Threat Reduction Agency (DTRA). In the interest of national security, the Department of Defense pooled its resources, expertise and capabilities to create DTRA with the charter to improve, enhance and bolster U.S. national security. DTRA ensures that the United States remains capable of deterring, reducing and countering the present and future threats from weapons of mass destruction. One of the agency's principal focuses is to evaluate the lethality of conventional biological, chemical and other advanced weapons against a broad spectrum of target types in real-world scenarios.

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Workshop Paper Series—"The 'E' in T&E":

Francis Scott Key Chapter Workshop Paper Series

By Reta Morgan Reynolds

The test and evaluation (T&E) community must define new processes to support system-of-systems evaluations and analyses in a capabilities-based environment. New challenges for T&E are emerging, such as combining data from experimentation, analysis, testing and training; system-of-systems evaluation/analysis based on data from distributed testing; and interoperability evaluation/analysis based on joint experimentation, testing and training. The Francis Scott Key (FSK) Chapter of ITEA, in partnership with The Johns Hopkins University Applied Physics Laboratory, hosted a workshop from October 5-7, 2004, in Baltimore, Maryland, which addressed the challenges faced by the T&E community, as well as other issues critical to the "E" in T&E.

Rapid Evaluation to Support an Army at War: Applying Lessons from Today to Preparation for Tomorrow

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During a recent workshop sponsored by ITEA, a team of analysts tackled the issue of Army preparation for war, and the acquisition, test and evaluation processes that must be conducted both during peacetime and wartime. The analysts proposed a set of actions and recommendations to address these challenges, and their recommendations cover organizing for rapid acquisition, establishing a rapid evaluation process and assembling a "Current to Future Force Test Bed" to enable the acquisition community to be more responsive to combat commanders' rapid equipping needs.

Over the past two years, we have witnessed revolutionary alteration to the ways we do business within the T&E community. The launching of the Defense Test Resource Management Center (DTRMC) and Office of the Secretary of Defense (OSD) test and training range initiatives should be viewed as new opportunities for the T&E community to enhance its operating procedures. Dialog between members of both government and industry needs to be encouraged. In this vein, ITEA must continually strive to stay focused on member service by providing forums and opportunities to facilitate the sharing of information. It is our goal to provide you with information that will afford a clearer understanding of what the Department of Defense (DoD) leadership wants the T&E community to achieve.

Your response to our previous calls for dialog has been most impressive. As a result, your Association recently hosted "An Open Forum on Test and Training Investments." This well-attended, day-and-a-half event featured senior OSD, Joint Forces Command (JFCOM), National Aeronautics and Space Administration (NASA) and industry test and training leaders. All presented their views on the triumphs and challenges facing the T&E community.

The concluding two-hour Round Table discussion, facilitated by ITEA Board Member Dr. John A. Wiles, was the highlight of the gathering. This rambunctious, fast-paced discussion was most impressive. I want to share with you my notes on the input from the group. In no particular order, here are some of the participants' comments:

■ If you are a tester or trainer and don't think JOINT, you haven't gotten the message.

■ DoD 5000.2 has had three changes in four years, and at least one more change is coming.

■ We must develop persistent test and training range capability.

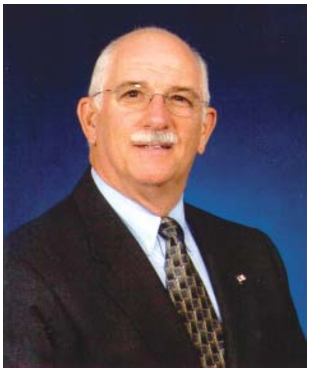
■ T&E in a joint environment is now a requirement.

■ Joint T&E (JT&E Program) methodology must be a standardized methodology with standardized policies, processes and tools.

■ Our challenge is to overcome the (Service/test and training) cultural differences that prevent joint range solutions.

■ The JNTC will include accrediting test and training exercise environments (scenarios), and certifying sites, systems and capabilities.

■ The DTRMC mandate from Congress is to provide a strategic plan every two years and certify to Congress the adequacy of T&E infrastructure investment and operating budgets.


Robert T. Fuller

■ The DTRMC will review and oversee DoD test facility and resource budgets and expenditures, as well as (some) outside DoD.

■ The differences between the DoD Test and Training Enabling Architecture (TENA) and High-Level Architecture (HLA) must be resolved to provide one standard software architecture and interface.

■ The JNTC will network for live, virtual and constructive sites to provide realistic accredited joint training.

■ The CTEIP vision provides for development of multi-service T&E infrastructure needs. If a business case can be made, industry will use DoD ranges, but proprietary considerations, access, availability and adaptability are all important.

■ Future joint test and training must not increase personnel or operations tempo.

■ One day we will strip test and training and just talk "ranges" factors.

■ To create a truly joint infrastructure for test and training, there must be a partnership with a common approach to instrumentation investment.

■ Embedded instrumentation, not unlike that in our automotive industry, is needed at the platform level.

■ The government and industry approaches to making training system investments are very different.

Many participants were encouraged by ITEA's sponsorship of this productive forum. We received numerous requests to repeat this event, and we are working with the ITEA Events Committee to explore holding this type of meeting again next year. Chapters who prefer not to host workshops may want to poll their members and look at their own needs to see if the Open Forum venue would afford an exciting, informative and comparatively rapid way to highlight hot topics of interest to their members and immediate community. It can also do wonders for your scholarship fund.

The NASA Engineering & Safety Center— Improving Test and Evaluation Inside the National Aeronautics and Space Administration

Roy D. Bridges, Jr.

NASA Langley Research Center, Hampton, Virginia

Following the tragic loss of the Space Shuttle *Columbia* and her crew on February 1, 2003, the National Aeronautics and Space Administration (NASA) began the long process of trying to understand the cause of the accident and what needed to be done to make future flights safer. Early in the investigation, the Columbia Accident Investigation Board identified a concern in that the Space Shuttle Program's safety organization lacked the funding, critical skills, expertise and other resources required to adequately provide the program with a second look at its most challenging technical problems.

NASA Administrator Sean O'Keefe proactively responded to this criticism. O'Keefe asked me to move from serving as director of the Kennedy Space Center in Florida to serving as director of the Langley Research Center in Hampton, Virginia. He gave me about a half-day to unpack and then asked me to stand up a new entity that we decided to call the NASA Engineering and Safety Center (NESC) at Langley. I asked one of NASA's very best engineering leaders, Ralph Roe, to join me at Langley as my special assistant. Over the next two months we created and "stood up" the NESC. Roe was appointed as the first NESC director. The NESC conducts quite a lot of independent test and evaluation in accomplishing its mission, and the following will provide some insight into this new organization.

Roy D. Bridges, Jr.

The NESC was chartered to bring together the best technical talent within NASA, augmented through partnerships with industry, academia and other government agencies, to provide independent test, evaluation and analysis of NASA's most critical technical problems. Like most technical organizations in the country, NASA's top technical critical skills are a limited resource. Because the same critical skills are required to execute NASA's programs, the process of making them available to provide a second technical check on other programs represented a significant challenge. The NESC had to approach the challenge of limited technical critical skills from the broadest possible perspective, because the problem could not be solved with the resources available within any one particular NASA program or even within one of NASA's 10 centers. The solution was to bring together the top technical skills from across the entire agency and, in fact, the entire country. This agency-wide perspective is the key principle in another NASA initiative called One NASA.

Creating this nationwide network of technical experts was a significant challenge. The NESC began by selecting the recognized NASA technical experts in 12 classical engineering disciplines. The disciplines were methodically selected to ensure that the breadth of technical expertise covered by these disciplines would be able to adequately cover the technical issues historically experienced in previous NASA programs. The next step was to charge the new discipline leaders with creating a nationwide network of technical experts in their respective engineering disciplines.

Developing this network of experts is a continuous process. It started with the immediate technical communities located at the discipline leader's respective center; continued to include experts at all of NASA's 10 centers; and then expanded to include experts in industry, academia and other government agencies. After a year-long effort, the network of experts includes approximately 500 engineers and scientists, representing hundreds of years of technical experience across all of NASA's programs. The teams are considered to be matrix support to the NESC, meaning that they stay within their current organization, but when they are needed to tackle a problem, the NESC will fund their work. This ensures independence, but it also allows the engineers to continue to work at their respective centers. The teams meet regularly, via teleconference, to discuss the top issues in their respective disciplines. They have become proactive "think tanks," attempting to uncover issues before they become problems for any one program. Applying these top critical skills where and when they are needed most, from an agency-level perspective, is the key to making the NESC successful and NASA's programs safer.

Even with a ready pool of experts available, the NESC must judiciously manage where and when the experts should be engaged. In order to know where to apply its resources, the NESC will gain insight into NASA's programs through multiple paths. The NESC has engineers who participate along with NASA's most critical programs, and they become the eyes and ears of the organization, always vigilant in detecting potential technical issues. They serve a chief engineer function by asking the right questions and digging for underlying concerns. The NESC also has formed a strong systems engineering corps that is developing tools and techniques for performing trending within and across NASA's many programs. The goal of trending is to look for indicators of potential problems that could be addressed before they become an issue for any one program.

By continually communicating the capability of this new matrix technical resource, the NESC has become a natural option for NASA leadership and program management, as well as for the safety and mission assurance and engineering communities, to turn to and engage in solving their most difficult technical problems. An example of how this works goes back to the root cause of the *Columbia* accident. A piece of sprayed-on-foam insulation (SOFI) from the external tank of the Space Shuttle struck the reinforced carbon wing leading edge of the Orbiter, damaging it enough to degrade its thermal and structural integrity during reentry. The SOFI was liberated from the tank due to the expansion of undetected voids in the foam during ascent. SOFI is a closed-cell foam and, by its nature, is mostly air.

Currently, there is no nondestructive evaluation (NDE) technique available for SOFI, and the presence of unacceptable voids is controlled by visual inspection during application and representative strength testing following application. In response to the accident investigation findings, the Shuttle Program engaged all of the resources that were available to it in order to begin developing potential NDE techniques for SOFI *(see Figure 1)*. With the NESC established, and its network of technical experts in place, the program team was augmented with world-class NDE experts from NASA's Research Centers, industry and the Department of Defense. The team is making good progress in developing the application of three NDE techniques for SOFI: backscatter X-ray, terahertz imaging and micro-focus X-ray.

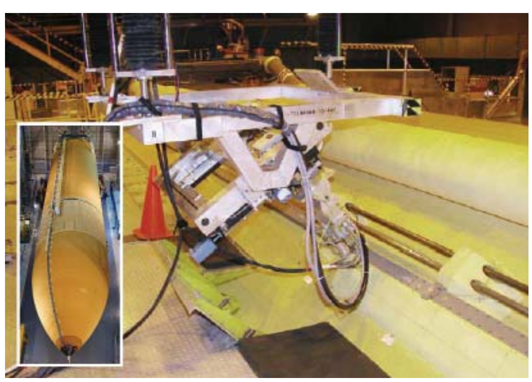


Figure 1. ET Protuberance Air Load (PAL) ramp nondestructive evaluation

Another example of applying these agency-wide critical skills to difficult problems involves the Space Shuttle main engines (SSMEs), which burn liquid hydrogen (LH_2) and liquid oxygen (LO_2) to develop over a half-million pounds of thrust. In 2002, inspections revealed cracks in the gimbal joint flowliners that direct the LH_2 into the low-pressure fuel turbo pump of the SSME *(see Figure 2)*. Each gimbal joint has a mated pair of 12-inch-diameter, thin-walled flowliners (upstream and downstream) to facilitate flow through the movable joint. The cracks were located at the slots in the flowliner, which facilitate cleaning during manufacturing and allow release of trapped propellant. Flight-critical issues included loss of flowliner structural integrity and metallic foreign object debris ingestion by the SSME. All detectable cracks were repaired through welding, and all slot edges were polished to remove defects that could start new cracks. Subsequent ground tests conducted in the SSME test stand at the Stennis Space Center resulted in measured strains in two different flowliner test articles that were considerably higher than

Figure 2. SSMEs and LH_2 feedline with flowliners (inset)

expected. Predictions of fatigue life using the test data cast doubt on the long-term validity of the post-repair flight rationale.

Responding to a request from the Space Shuttle Program Orbiter Project Office, the NESC independently determined that the most likely root cause of the cracks was high cycle fatigue due to flow-induced vibration. Crack initiation and growth were accelerated by the stress concentrations due to the slot geometry and surface defects from the manufacturing process. The NESC concluded that the repair actions previously taken in 2002 rendered the Orbiters safe to fly but required post-flight inspections of the flowliners. The most difficult challenge to overcome in the NESC assessment was the high degree of uncertainty in the loads acting on the flowliner due to the lack of similitude between the ground test article and the flight hardware.

To analyze the flowliner issues, NESC developed fatigue-loading spectra for nominal flight conditions and refined three-dimensional (3D) fracture mechanics analysis methods, which couple crack growth kinetics directly to the structural dynamics. The NESC also developed a high-fidelity (non-traditional) inspection method for *in-situ* examination of the flowliner slots *(see Figure 3)*. The NESC qualified this edge replication inspection method, which can detect fatigue cracks down to 0.005-inch, characterize flowliner slot surface finishes and produce a near-net-shape mold of the flowliner slot. The results of these efforts were used to develop rationale for the flowliner flight certification. Applying these top critical skills to this problem potentially avoided a lengthy engine test program that could have cost the Space Shuttle Program millions of dollars.

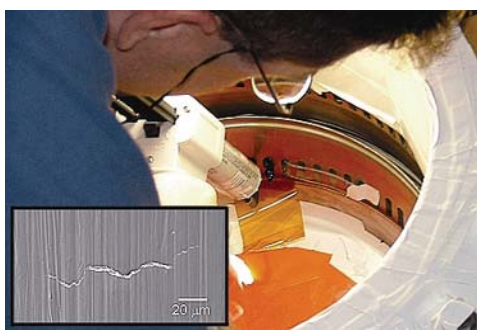


Figure 3. Flowliner slot inspection technique

By pooling the top critical skills in the agency, partnering with experts from across the country in industry, academia and other government agencies, and by judiciously applying these critical skills to our most difficult problems, NASA and the NESC are significantly improving the safety of this nation's space programs. Space exploration is a high-risk endeavor, with tremendous benefits and rewards for humankind. Our space explorers deserve for our best and brightest experts to be engaged in ensuring their safety in this endeavor, and organizations such as the NESC are making sure this obligation is fulfilled. ❑

Roy D. Bridges, Jr., *is director of NASA's Langley Research Center, Hampton, Virginia. As the senior management official of the laboratory employing approximately 2,400 civil service personnel, Bridges is responsible for the center's aeronautical and space research programs, as well as facilities, personnel and administration. He is also an advisor to the NASA administrator on agency programs. Bridges previously served as director of NASA's John F. Kennedy Space Center (KSC) for more than six years, where he was responsible for managing facilities and activities related to the processing and launch of the Space Shuttle, processing and integration of Shuttle payloads and those aboard expendable launch vehicles (ELVs), as well as final tests and preparation of elements delivered to the International Space Station via Shuttle. He was also responsible for managing the acquisition and launch of all NASA ELV missions. A retired U.S. Air Force major general, Bridges has held many key space-related positions. Prior to his last Air Force assignment at Wright-Patterson Air Force Base, Ohio, he was the commander, Air Force Flight Test Center, Edwards Air Force Base, California. He also was the Commander, Eastern Space and Missile Center, Patrick Air Force Base, Florida, and commander, 412th Test Wing, Edwards Air Force Base. As a NASA astronaut, he piloted the Space Shuttle* Challenger *on mission STS-51F in July 1985. Bridges is a distinguished graduate of the U.S. Air Force Academy, Colorado Springs, Colorado, where he earned a bachelor's degree in engineering science. He received a master of science degree in astronautics from Purdue University, Indiana. In May 2001, he received an honorary doctorate of engineering degree from Purdue.*

Acknowledgment

The author wishes to acknowledge Ralph Roe, director, NASA Engineering and Safety Center (NESC), Langley Research Center, Hampton, Virginia, for his invaluable assistance in preparing this guest editorial.

For further information

Visit the NASA Engineering and Safety Center website, ***www.nesc.nasa.gov***, for further information.

Material for TechNotes is solicited each issue by the ITEA Technology Committee, chaired by G. Derrick Hinton, Staff Member, DTRMC, Office of the Secretary of Defense. (itea@itea.org, Attn: G. Derrick Hinton, Chairman)

Innovative Technology in Media Asset Management

By Tom Stone

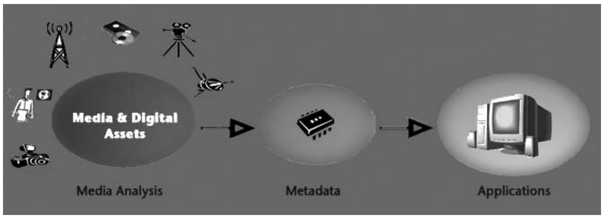
Anyone who has tried to find a telephone number sent in an e-mail message quite a long time ago knows it would appear hopelessly buried among thousands of saved e-mail messages. To circumvent the digital abyss, some opt for organizing e-mails by topic, date, source or other ways. The problem is that sorting e-mails by topic preempts finding anything by source. So, many people resort to just not sorting the data at all.

This is one tiny example of digital content search issues facing private business and government alike. Entire enterprises now face the same problem: how to manage digital content easily and affordably. Electronic data capture, distribution and server technologies are rapidly expanding the availability of up-to-the-minute information. Even if an enterprise is not managing digital media now, there is a good chance that it will be in the future as more information is encoded into digital media consisting of images, voice, voice-generated text, layered image composites, video and embedded hyperlinks.

With the help of the Google desktop or similar search engine, finding a telephone number in an old e-mail message takes seconds, as the engine searches an entire computer, including e-mail messages. But, that is just one needle in the haystack of a future full of search-engine-based media and digital asset management efficiencies to come. In the future, all data will be indexed, categorized, pre-processed and searchable, and digital media will represent every aspect of an enterprise from start to finish.

Because a majority of digital media content is not inherently searchable in nature (for example, a digital image is simply thousands of pixel values that say nothing about the picture itself), the value of digital media content takes on exciting dimensions when related searchable content attributes are added in the form of metadata. Metadata is data that describe or define the attributes of information and are typically embedded into the information itself. For example, metadata for a digital image might contain the date, time, location, subject, context, photographer and camera. The metadata attributes would be similar, but different, for a video clip or a voice recording.

Searchable metadata can be used to relate the content of different media and across time. For example, a company public relations announcement could be correlated with the company's minute-to-minute stock value, synchronized in time with a corresponding video clip from a popular afternoon business cable television show that mentioned the company to measure the resulting stock price bump or slump.



Uncovering unknown relationships between disparate media data can lead to powerful information and knowledge gains in areas as diverse as education, health care, human activities, law enforcement, defense intelligence and many other fields.

This technology is now at hand. In today's terrorism-heightened atmosphere, media management technology could aid airport security. For example, future terrorists could be those most critical of U.S. policies today. One way to identify these persons might be to correlate the probabilistic names derived daily from facial recognition technology operating on foreign news clips where the speaker uses antagonistic terms toward U.S. policies with a similar list of names derived from facial recognition technology at key points of entry into the country. Thus, authorities could be immediately alerted to the presence of someone with a documented anti-U.S. position upon entering the country.

The potential of data recording systems that include metadata creation and search capabilities will lead to the integration of network data recording with embedded media content analysis. Innovative technology to accomplish these goals is under development and being *delivered* today.

The remaining challenges are to continuously develop the machine understanding capabilities of media data, including all aspects of search, retrieval, visualization and summarization in both immediate and archival content. The objectives are to improve the dynamic extraction, summarization, visualization and presentation of digital media, automatically producing collages and auto-documentaries that summarize the numerous possible relationships between many disparate data types. ❑

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