NAVY MANTECH manufacturing technology program

iMAST

Institute for Manufacturing and Sustainment Technologies

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DIRECTOR'S CORNER

Thanks for reading our humble publication. We work hard to bring timely, relevant iMAST projects and events information to you as good examples of our capabilities. I'd like to jump right in on three subjects of relevance to us, and you: (1) iMAST/ARL's role; (2) the effect of sequestration; and (3) savings accountability. First, in my frequent talks to groups during my visits to the shipyards, depots, and major defense contractor facilities, I have to deal with preconceived ideas about who we are and what limitations that implies. As the saying here goes: We are Penn State! ARL resides on a large collegiate campus. Our 1,200 engineers, scientists and support staff receive their paychecks every month from the University. However, behind that administrative infrastructure is a DoD laboratory called a UARC (University Affiliated Research Center)—complete with an Office of the Secretary of Defense charter that identifies us as a "Trusted Agent". That facilitates our role with a

Timothy D. Bair

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Transitioning Technology to the Warfighters

by David Smalley, Office of Naval Research

[The key to success with respect to any Navy Manufacturing Technology (ManTech) project is transition. The focus of the Navy ManTech program is getting worthy technology into the hands of the operational force—be it front line, direct or indirect support activities. The following article recently published by the Office of Naval Research bears repeating.]

ARLINGTON, Va.—A new report issued by the Government Accountability Office (GAO) puts a spotlight on the Office of Naval Research (ONR) for effective ways to get new technologies out of the lab and into the hands of the warfighter.

The report, "Defense Technology Development," released this month after a year-long study, looks at programs across the Department of Defense (DoD) that transition research into actual use, or acquisition, by Sailors, Marines, Airmen and Soldiers.

ONR is the Department of the Navy's science and technology (S&T) provider, charged with discovering, developing and transitioning innovative S&T to meet warfighter needs. The command's Future Naval Capabilities (FNC) program—responsible for developing QuikClot blood-clotting agents, single-coat ship tank coatings to reduce corrosion damage, and much more—is cited in the report for finding efficient, cost-effective ways to make research functional.

"Establishing clear and consistent commitments and communication channels among stakeholders is fundamental to managing transition projects and achieving transition," the report says. "We found the Future Naval Capabilities program provides a good example of senior leadership positively affecting project management activities."

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Dr. Tom Killian, Director of Transition at the Office of Naval Research, recently visited ARL Penn State as part of capabilities assessment. He is shown here being briefed by Dr. Kevin Koudela on composite activities while Dr. Tom Donnellan, Associate Director for ARL's Materials and Manufacturing Office looks on.

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DIRECTOR'S CORNER

sole source contract capable of moving funds via MIPR, or direct funding via a task order under our NAVSEA contract. The confusion usually centers on two issues: (1) the nature of a UARC—as essentially a DoD lab; and (2) misunderstanding our "university" identification. The latter usually takes the form of assumptions that our primary mission is education and engineering research—that it is a "spare time" activity funded via grants, with no defined deliverables. While we are a not-for-profit contractor, solving DoD's problems with advanced or mature technology applied in innovative ways, we function as a DoD asset, maintaining and certifying our freedom from conflict of interest by not competing with industry.

As a DoD (UARC) laboratory we get no baseline budget to support an on-going presence. ARL must preserve its role as a DoD brain trust—one task order at a time! Consequently, sequestration is having a progressively corrosive effect on us as well. The need to cut costs across the enterprise, life, and acquisition cycles has not declined. Quite the opposite is true. From my chair, I've noticed a couple of trends that are probably familiar to you as well. The budget has declined, but the cost of an average project has increased. ManTech took cuts in FY-13 and will do so again during FY-14. Project costs are inflating at the same time. Eight years ago an average project was around $300K. Today, they're easily pushing $5-600K. Making the two trends work means iMAST is spending more time managing cost and looking for ways to reduce overhead—just like you. We are continuing to pursue acquisition cost saving projects with the OEMs (who are also working hard to cut costs). Finding projects that help cut the life cycle cost of our operational systems seems to be doubly rewarding, as the benefit is frequently increased capacity to sustain the operational fleet.

The success of iMAST is predicated on two commodities: implementation and savings. In purely ManTech project terms (i.e. acquisition cost reduction), successfully implemented projects result most of the time in a decreased contractually-determined cost per hull or aircraft. RepTech projects aren't so easy to audit, and almost never result in saving. Cost avoidance is the term to describe "savings" that aren't available to reallocate because it may only represent a cost that doesn't happen—meaning the industrially-funded project is no longer required, but the maintenance personnel and facility is now available to move on to another critical task. Sometimes the net effect of a successful RepTech project is improved availability of the weapon system or ship. One great example is all the work being done by iMAST project teams, as well as many others, to extend the overhaul cycle for Virginia Class Submarines. Another example is the laser metrology work we've successfully implemented across the NAVSEA shipyards—which is the subject of our feature article. Thanks again for reading. I hope you enjoy this offering.

Tim Bair

PROFILE

Paul Swanson, an Associate Research Engineer at ARL Penn State, has acquired significant experience during his 30-plus year career. His project engineering work in the Fluid Dynamics and Turbomachinery Department led to his appointment as group head of the Computer Aided Design and Manufacturing Group. During this period, he led a team that incorporated the first CAD/CAM system at ARL Penn State and manufactured numerous prototype propulsors for test programs in the Garfield Thomas Water Tunnel. Several of these prototypes were successfully transitioned to full-scale in the U.S. Navy fleet. Mr. Swanson is currently a member of the Product and Process Design Department. His work is focused primarily on Shipyard Manufacturing, Automation and Inspection.

★ MATERIALS PROCESSING TECHNOLOGIES
★ MECHANICAL DRIVE TRANSMISSION TECHNOLOGIES
★ LASER PROCESSING TECHNOLOGIES
★ COMPLEX SYSTEMS MONITORING TECHNOLOGIES
★ COMPOSITES MATERIALS TECHNOLOGIES
★ NAVY/MARINE CORPS REPAIR TECHNOLOGIES
★ MANUFACTURING SYSTEMS TECHNOLOGIES

Focus on Manufacturing Systems (Metrology)

Laser Metrology in the Organic Shipyards

by Paul Swanson & Sean Krieger


FARO

Part of the Institute for Manufacturing and Sustainment Technologies (iMAST) mission, as an Office of Naval Research Navy Manufacturing Technology Center of Excellence (Navy ManTech), is the introduction of new manufacturing tools into mainstream public shipyards and depots. Consequently, we occasionally use new and emerging technologies as potential solutions for various challenges that are frustrating progress. We can't always anticipate how the solution(s) will be received, or what degree of success will be realized, but that is the nature of our efforts. What follows is a success story that began in 2006 as a simple attempt to evaluate laser metrology tools and their potential application within recurring ship maintenance inspections issues at one shipyard. This project was called Shipyard Submarine Alignment & Inspection Improvement. Within three years this evaluation had expanded into a full implementation effort incorporating all four U.S. organic naval shipyards. The project resulted in the purchase of more than sixteen (16) laser trackers along with several arms and scanners which ultimately were used in an expanding list of applications. The Navy ManTech Program, via iMAST, had a grand slam hit on its hands!

When the project team started work, the technology was only being applied to shipbuilding by General Dynamics Electric Boat (GDEB) and Huntington Ingalls Shipbuilding (formerly Newport News). No laser trackers had previously been purchased for the [primary] purpose of maintenance and repair. The challenge of proving the benefit of laser metrology tools, in the context of specific alignment tasks, resulted in buy-in by the shipyard community, via testing and evaluation on actual Navy components, that laser technologies could improve inspection accuracy over older techniques. Once ARL was convinced it was on the right track (no pun intended), the project team conducted several demonstrations at Portsmouth, Puget Sound, Pearl Harbor and Norfolk Naval Shipyard(s)—thus bringing together laser metrology vendors with shipyard artisans and engineers.

Initial project work was focused on four submarine alignment and inspection applications; shafts, torpedo tubes, sails, and dive planes. It was understood that many more applications would ultimately follow. During one of the early demonstrations at Portsmouth the project team brought together Faro Technologies and shipyard accuracy control personnel from the four shipyards. The local Faro sales representative had never stepped onto a submarine prior to the demonstration, yet he conducted a complex submarine combat systems alignment in four (4) hours. This effort typically requires three days (48 labor hours) using old technology standards. During this demonstration the laser tracker was compared to the designated optical telescope and piano wire approach—a standard designated shipyard protocol. Performance testing was significantly faster and more accurately, with minimal set-up and fixturing time an added bonus. This was truly a "Eureka" moment within the ManTech project effort. The subsequent integration of laser trackers and laser scanning devices within the shipyard communities cascaded toward additional applications.

iMAST conducts a laser tracker evaluation at Portsmouth Naval Shipyard with witnesses from all four shipyards and NSWC-Philadelphia in 2007.

Continued from Page 3

Laser Trackers are used to measure Aircraft Carrier Catapult Rails.

Currently, laser technologies are being implemented to conduct submarine and aircraft carrier alignments and inspections. Many of the shipyard alignment and inspection capabilities that have recently been implemented were not previously possible until the advent of these laser metrology tools. Momentum has grown significantly since the first successful implementation that took place during 2007. A good example would be at the Naval Aviation Warfare Center at Lakehurst (New Jersey) where a modified CVN Catapult Launch inspection procedure was initiated this year which allows laser trackers to replace the existing rolling fixture methodology for inspecting and aligning aircraft catapult rail systems.

So where are we now headed? Laser tracker technology has continued to improve and expand in terms of potential use by the Navy's supporting naval shipyards and depots (and DoD in general). There are many portable laser metrology technologies and services in the market today, but the key ones are laser trackers incorporating arms and scan arms, handheld scanners, and 3D laser scanners. Below is a short synopsis of tools and applications that may be a part of your future.

LASER TRACKERS

Laser trackers are instruments that accurately measure large objects by determining the positions of optical targets held against those objects. The accuracy of laser trackers is on the order of 0.001 inches over a distance of several feet. And the market quality is improving. Almost annually the laser tracker manufacturers deliver a new model with better quality and range than the last. Figure 1 anecdotally shows the measuring range and accuracy of laser trackers compared to other comparable metrology technologies. Shipyard examples of laser tracker applications include aligning sails and torpedo tubes.

To gather measurements, the artisan first sets up a laser tracker on a tripod with an unobstructed view of the object to be measured. He then removes a target from the base of the laser tracker and carries it to the object to be measured, moving smoothly to allow the laser tracker to follow the movement of the target. Next he places the target against the object and triggers measurements to be taken at selected points. Measurements can be imported into different types of software to analyze the points or to calculate deviation from nominal position. There are three primary competitors in the laser tracker market: the API Radian, the Leica Absolute, and the Faro Technologies Vantage, all shown in Figure 2.

Laser trackers have been used successfully to perform alignments for torpedo and missile tubes, Special Hull Treatment (SHT) tile sensors, wide aperture arrays, aircraft carrier catapult, throttle cable linkages and radar array alignments to name just a few.

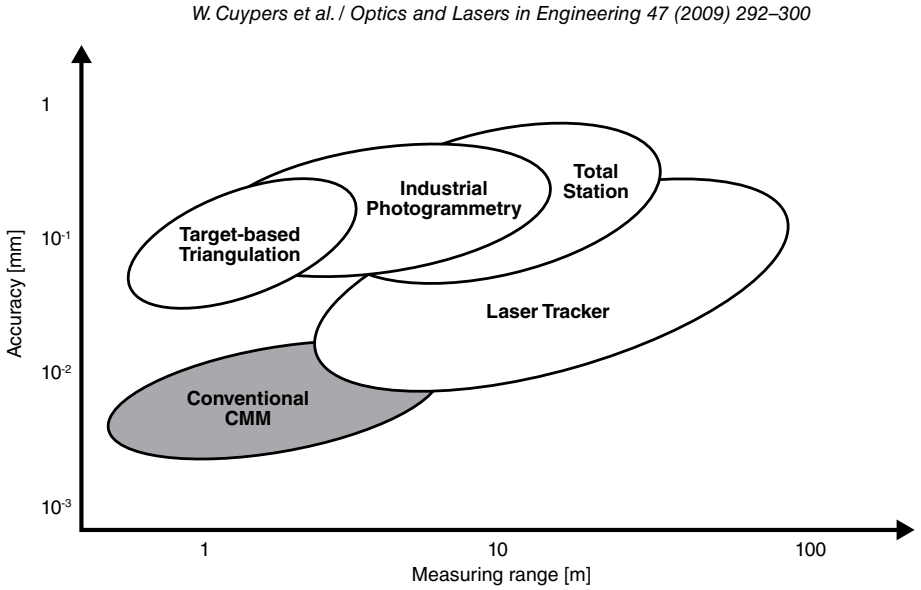

Figure 1. Measuring range accuracy of portable CMMs versus traditional CMMs

Figure 2. The leading laser trackers on the market today. (left to right) the API Radian, the Leica Absolute, and the Faro Technologies Vantage

Figure 3. The leading portable laser scan arms on the market today. (left to right) the Faro Technologies Edge, the Hexagon Romer, and the Nikon MCAx

Figure 4. The Creaform MaxScan (left) requires targets and the Leica system (center) monitors and reports position via laser tracker. The scan data (right) is the result of these handheld tools.

PORTABLE ARMS AND SCAN ARMS

Portable arms with or without laser scanners are popular for gathering inspection data by securing the arm at its base and then moving the articulating arm to the point(s) of interest for inspection. These arms usually operate in two modes. The first is the touch probe for gathering individual points (one at a time). The other mode is laser scanning using triangulation. The triangulation 3D laser scanners are also active scanners that use laser light to probe the environment. Depending on how far away the laser strikes a surface, the laser dot appears at different places in the camera's field of view. This technique is called triangulation because the laser dot, the camera and the laser emitter form a triangle. Three vendors offer the leading portable laser arm scanners on the market: the Faro Technologies Edge, the Hexagon Romer, and the Nikon MCAx, as shown in Figure 3.

Shipyard applications are mostly in-shop inspections of prismatic and contoured parts, but many times the arms are taken aboard ship for "as is" measurements on the ship. An example of an in-shop application would be Geometric Dimensioning & Tolerances measurements for submarine shaft cylindricity and taper. Other applications include: ball valves, foundry work, tooling, first article inspection of castings, and even propellers.

HANDHELD PORTABLE 3D SCANNERS

Hand-held laser scanners create a 3D point cloud using the triangulation mechanism described above: a laser dot, or line, is projected onto an object from a hand-held device and a sensor (typically a charge-coupled or position-sensing device) which measures the distance to the selected surface. Data is then collected in relation to an internal coordinate system. Consequently, to collect data when the scanner is in motion, the position of the scanner must be determined. The position can be determined by the scanner using reference features on the scanned surface (typically adhesive reflective tabs, but natural features have been also used in research work).

Another form of handheld portable scanning requires the handheld scanner to be tracked using a laser tracker while data is collected on the part surface. This technique, shown in Figure 4, takes the form of a laser tracker (to provide the sensor position) with integrated camera (to determine the orientation of the scanner) or a photogrammetric solution using three or more cameras that exploit the complete six degrees of freedom the scanner provides. These techniques tend to use infrared light emitting attached to the scanner which are seen by the camera(s).

Follow-on Navy ManTech projects have emerged since the initial discovery and implementation of laser metrology systems for the shipyards. ARL Penn State has teamed with Portsmouth, Puget Sound, and Pearl Harbor Naval Shipyards to identify a methodology for repairing the tile damage that is occurring on the Virginia-Class Submarines. This project is aimed at establishing faster methods for repairing the numerous voids that exist by using a portable hand-held scanner to capture the ship's tile geometry. This data is then used to manufacture replacement tiles on a CNC Router. This approach allows for acquisition of first-time geometrically accurate replacement tile cuts for damaged or missing tiles. During this project effort, iMAST worked closely with shipyard artisans to identify, and then provide, the tools necessary to accomplish this work. The reverse engineering part of the project required iMAST professionals to evaluate numerous laser scanners before down-selecting the best product for the task. The project team identified the Creaform MaxScan as best-suited for this task. iMAST performed the reverse engineering procedure in an ARL Penn State laboratory, followed by an effort at a ship at Portsmouth Naval Shipyard. iMAST was able to create the necessary tiles by segmenting the large scanned area using the MaxScan system. Ultimately, these parts can be machined directly on the large multi-axis CNC routers acquired by shipyards specifically for this effort.

3D FAR-FIELD LASER SCANNERS

The latest project we are undertaking is to evaluate and develop a methodology for performing Ship Checks using a 3-D Far-Field Laser Scanner. Puget Sound Naval Shipyard has acquired a Faro Focus (Figure 5, next page) to perform the data capture for this task. As with most laser scanning projects, there is a

FEATURE ARTICLE

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second variable to the process: the translation software—which is equally critical to shipyard implementation. Our task is to evaluate several of the leading software products, listed in Table 1, to identify the best fit for the Ship Checks task. The visit to the 2013 Coordinate Metrology Systems Conference to see the latest in Coordinate Measuring Technology during the last week of July helped kickoff the "state of the technology" determination.

CONCLUSION

The range of products identified in this article (laser trackers, portable arms and scan arms, handheld portable 3D scanners, and 3D far-field laser scanners) give the U.S. Navy the capability to perform accuracy control for a broad range of applications. Since 2006, the leadership provided by iMAST, on behalf of the Office of Naval Research Manufacturing Technology Program, has initiated evaluations and demonstrations which have brought technology experts and shipyard artisans together in order to validate new laser technologies over the traditional measurement techniques currently employed. The artisans at the organic Navy shipyards can now perform alignments and inspections using these quantitative tools that provide them the necessary data to make important decisions regarding the repair and maintenance of U.S. naval vessels. The numerous alignments and inspections now incorporated in the repair and sustainment effort were not possible until these new laser technologies were introduced. iMAST will continue to identify new technologies that provide the naval community with tools that not only save time and money, but also back up their findings as ships are repaired during critical shipyard availabilities.

Figure 5. The leading 3D laser scanners on the market today: (left to right) the Faro Technologies Focus and the Surphaser HSX

VENDOR	PACKAGE	MODULES
3D Systems	Geomagic	Studio, Verify, Control
Hexagon Metrology New River Kinematics Metrologic	PC-DMIS Spatial Analyzer Metrolog X4	Planner, Portable, ReShaper
InnovMetric	Polyworks V12	IMAlign, IMEdit, IMInspect
Autodesk	AutoCAD 2014	ReCAP, Revit, Navisworks
Kubit	PointSense	Basic, Pro, Plant, Building
Faro Technologies	CAM2	Measure10, SmartInspect, Scene
VERISURF	VerisurfX	CAD, Measure, Build, Reverse, Validate Connect
McNeel & Assoc.	Rhino 5	Mesh Tools, Render Tools
VirtualGrid	VRMesh	Studio, Survey, Reverse, Design

Table 1. Some of the software leaders

A Reminder...

Mark your calendars for the annual Defense Manufacturing Conference.

Stop by the iMAST exhibit booth.

AAV repair and refurbishment line at MCLB Albany.

MCLB Albany Visit

iMAST visited the Marine Corps Logistics Base Albany (GA) recently to see if it could render support to the tremendous maintenance and repair effort that takes place within the resident Marine Corps Logistics Command's Maintenance Center. The center provides the bulk of rebuild and repair of ground combat and combat service support vehicles as well as support equipment for the bulk of east coast Marine Corps forces. Ten years of continuous combat has challenged the Maintenance Center's efforts in supporting Marine Corps warfighters. iMAST looks forward to increasing it support of the center through the resources of its ManTech and RepTech program.

Modern Day Marine Expo

The annual Modern Day Marine (MDM) Expo did not kick-off without the continued presence of iMAST. The MDM Expo provides an important opportunity for iMAST to showcase to the Marine Corps Systems Command iMAST's contributions to the Navy-Marine Corps team. Quantico is the heart of the Marine Corps' research, development and acquisition effort. The Marine Corps' requirements, procurement, and professional school activities take place among the various tenet commands at Quantico—to include the Marine Corps Systems Command as well as the Marine Corps Warfighting Laboratory. iMAST's Navy ManTech program has contributed to Marine Corps operational readiness enhancements within its sphere of repair, refurbishment, logistics, and modernization through spares program effort.

Cover Story

Continued from Page 1

Since its inception in 2002, the FNC program is designed to develop and transition cutting-edge technology products to acquisition officers within a three- to five-year timeframe. The GAO reports that across all military services and departments, the FNCs have the highest historical transition rate, at 86 percent.

"Getting the most effective, useful technologies to our Sailors and Marines is critical," said Chief of Naval Research Rear Admiral Matthew Klunder. "Without the right processes in place, even the best ideas might not make it through to the fleet."

The road from research idea to tangible capability can be long and complex, involving multiple demands from different players. The FNC program goal is to ensure warfighter needs are addressed in an expeditious and fully vetted manner.

The report acknowledges that this isn't always easy, and commends the best practices by research programs across DoD—including the creation of Integrated Product Teams (IPTs) that get early commitment and regular input from the warfighting, acquisition and scientific communities, among others.

"In the case of the Navy," the report states, "IPTs identify capability gaps, provide input on which S&T projects may address those gaps, assess project progress, make sure transition strategies remain valid, and confirm funding is aligned to support transition."

ONR uses multiple assessment and tracking tools to measure transition efforts and outcomes.

"Multiple, ongoing reviews help us document success—and to understand the reasons when a technology fails to transition," said Dr. Thomas Killion, who heads ONR's Directorate of Transition. "That helps us improve our processes and increase the likelihood of successful transition in future technology development programs."

The report notes that "by maintaining this level of tracking, the Navy is better aware of the benefits and obstacles associated with a substantial portion of their S&T portfolio, which may better inform decisions made by Navy leadership."

ONR's rapid-turnaround program, TechSolutions, which takes requests from Sailors and Marines for quick solutions to capability problems in the field, also receives favorable mention in the GAO report, as does the cost-cutting Manufacturing Technology, or ManTech, program.

Since its inception in 1946, ONR research efforts have supported the development of the laser; GPS; transistors; fiber optics; radar; cell phones and more.

To learn more about Navy Future Capabilities programs and processes, go to ONR's website to download a copy of the

To learn more about Navy Future Naval Capabilities programs and processes, go to ONR's website to download a copy of the 2013 FNC Guidebook. http://www.onr.navy.mil/Science-Technology/Directorates/Transition/Manufacturing-ManTech.aspx

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"Shipbuilding is a priority not only in the Navy budget but also with the Department of Defense and Congress."
—Sean J. Stackley, Assistant Secretary of the Navy for Research, Development and Acquisition

CALENDAR of EVENTS

2013

14–17 Oct	Logistics Officers Association Conference	CANCELLED	** Dallas, TX
21–23 Oct	AUSA Expo		Washington, D.C.
18–20 Nov	DoD Maintenance Conference	CANCELLED	** Long Beach, CA
2–4 Dec	Defense Manufacturing Conference		** Orlando, FL

2014

14–16 Jan	Surface Navy Association Symposium	** Crystal City, VA
7–9 Apr	Navy League Sea-Air-Space Expo	** National Harbor, MD

** Visit iMAST booth