The NCEMT Looks Back on 15 Years of Excellence

In **1988**, the National Center for Excellence in Metalworking Technology (NCEMT) was established as one of the Centers of Excellence sponsored by the U.S. Navy Manufacturing Technology (MANTECH) Program. Early in its history, the NCEMT established its reputation as one of the nation's premier resources for developing and disseminating forward-thinking, advanced metalworking technologies. Since 1988, the NCEMT has been meeting defense needs affordably. As the primary problem-solver for Navy MANTECH metalworking problems, the NCEMT has been combining leading-edge capabilities, world-class expertise, and a genuine commitment to excellence. This timeline looks back on 15 years of significant milestones for the NCEMT Program.

1989

- The NCEMT begins to position itself as one of the MANTECH Centers of Excellence to carry out technology transfer activities in Navy metalworking applications through industry technology assessments and databases, seminars and training, and research and development. Initial technology areas include net-shape forming, surface treatment, advanced materials, joining, nontraditional cutting, and automation.
- The NCEMT begins work on its first technical project initiatives for the Navy. They include *Atlas of Formability*, Hot Isostatic Pressing, Industry Needs Survey Metalworking Curriculum, Plasma Spray, Powder Compaction, Weld Filler Alloy, and Workability Test System.
- The NCEMT refines a finite element modeling system for simulation of powder consolidation processes for net-shape forming.
- The NCEMT starts up a CAD and solid modeling system to become the core of a Computer-Integrated Manufacturing System.
- The NCEMT develops finite element code modifications for graphical prediction of defects during metalworking process simulations.

1990

- The NCEMT officially opens its 24,000-square-foot System Integration Facility (SIF) in April, which houses the Machining Technology Laboratory, Welding Laboratory, and Automation and Process Demonstration Laboratories. The SIF is created as a beta test and demonstration site for Navy programs and manufacturers seeking to develop new systems and equipment.
- The NCEMT responds to problems with the production of MS 3314 (1,000 lb. Class) suspension lugs by performing an analysis of the component's design and examining the materials and manufacturing processes required to produce it. The NCEMT successfully develops two alternative designs and identifies an extrusion-forging process that provides a more uniform grain structure and no material weakness. With minimal alterations, the new design and process can also be applied to the 2,000 lb. class suspension lugs.
- The NCEMT installs the Robotic Adaptive Welding System (RAWS) in its SIF to develop automated welding technology for use in Navy weapon systems production and commercial applications. The NCEMT is also slated to develop/refine automated systems for cutting, inspection, and cleaning for use in Navy installations and in the metalworking industry. RAWS was developed by the Westinghouse Science and Technology Center.

1991

- The NCEMT develops a systematic problem-solving methodology named **Rational Product & Process Design®** (**R•P²D®**) that manufacturing organizations can use to drastically reduce or eliminate the need for prototyping or trial-and-error effort on the shop floor.
- The NCEMT's advances with its *Atlas of Formability*—an engineering knowledge base of generated experimental data on metalforming characteristics for 120+ materials of interest to the U.S. Navy, Department of Defense (DoD) and industrial base for advanced weapons systems and commercial applications—result in published comprehensive flow stress curves and workability limits at various strain rates and temperatures for XD Composite, Monel K-500, Cast Aluminum Alloys 6061/6063, and Inconel 625/600.
- The DoD chooses the NCEMT to establish the nation's first Computer-Aided Acquisition and Logistics Support (CALS) Shared Resource Center (CSRC) to establish the electronic means to handle the massive volumes of data associated with the design, manufacture, procurement, maintenance, and disposal of military systems.
- The NCEMT develops the materials composition, processing parameters, and part design for the Navy for Phalanx Close-In Weapon System penetrators.

1992

- The work of the NCEMT is published for the first time in prominent industry magazines such as *Advanced Materials & Processes*, *Metallurgical Transactions*, *Modern Casting*, and *Welding Journal*.
- The NCEMT develops a safer, more economical technique for the Navy to remove sections of submarine hulls for repair or decommissioning. The NCEMT's computer-controlled abrasive saw-cutting system eliminates the fire hazard and reduces the time required to prepare and cut open a hull section from more than 400 hours to less than 48, significantly reducing costs to the Navy.
- The NCEMT works with the Oregon Graduate Institute to demonstrate how the Electroslag Surfacing (ESS) process can replace the shrink-fit collars currently used to protect propeller drive shafts. ESS is projected to save the Navy as much as $1M per propeller shaft over a vessel's 30-year life span through its low installation cost and long-term performance.
- The Naval Surface Warfare Center, Dahlgren, VA, conducts ballistic tests on several advanced penetrators developed at the NCEMT. One of the penetrator alloys displayed vastly improved retention characteristics and leads the way to a more effective Phalanx system.

1993

- NCEMT casting engineers and computer science professionals develop a casting simulation software model using fluid dynamics modeling techniques conceptualized at Los Alamos National Laboratories and enhanced at the University of Pittsburgh. It is named R•P•D/CAST® to reflect the time it saves by avoiding the traditional iterative trial-and-error approach in developing optimal casting designs. It is used to design and analyze a wide range of castings in industry and government, including the U.S. Navy MANTECH Program. Trademark achieves registration in June of this year.
- The NCEMT establishes working relationship with the Air Force, Navy, Advanced Research Projects Agency, and private industry to develop the manufacturing technology to fabricate commercial quantities of high-temperature superconducting wire and tape. In collaboration with the Naval Research Laboratory, the NCEMT pursues application of these materials on magnets for use on Navy power systems.

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PEPS is a registered trademark of Vanguard Research, Inc. (VRI).

1994

- Based on the NCEMT's work, the U.S. Army schedules first firing test to focus on acquisition of thermal data and model verification. The NCEMT completes modeling studies on, and the design for, inserting partial refractory metal alloy liners in the U.S. Army Bushmaster.
- The NCEMT enhances the producibility of titanium matrix composite engine components for the U.S. Air Force ManTech program for use in the hollow fan blade for the Pratt & Whitney 4000 series engine and fan frame strut for the GE 90 Engine.
- The NCEMT supports the DoD and industry with a variety of educational enterprise projects.
- Using offline CAD/CAM programming and advanced machining methods, the NCEMT helped technicians at the Naval Aviation Depot – Cherry Point, Naval Engine Airfoil Center (NEAC) to improve remanufacturing throughput and provided a series of workshops to NAVAIR personnel.
- Working with the University of Pittsburgh at Johnstown, the NCEMT establishes a Master's program in Manufacturing Systems Engineering to educate qualified engineers in techniques of world-class manufacturing.
- R•P²D achieves registration in October of this year.

1995

- The NCEMT goes online at www.ncemt.ctc.com to provide updates on upcoming NCEMT events, technical presentations, technology demonstrations, overviews of the NCEMT technical thrust areas and accomplishments, and recent NCEMT publications.
- The NCEMT inaugurates its demonstration facility for the Semi-Solid Metalworking (SSM) process, which is capable of producing parts with higher mechanical properties, close to those of forgings, yet at high production rates as in die casting. The SSM process can produce a variety of naval and military components at lower cost.
- The NCEMT collaborates with NAVAIR and McDonnell Douglas to study Superplastic Forming (SPF) to provide materials property data for concurrent product and process design, establish manufacturing procedures through process simulations, and fabricate full-scale prototypes for technology demonstrations and implementation.
- The NCEMT, in conjunction with GE Aircraft Engine, PCC Airfoils, and Howmet Corporation, develops computer simulation methodology to determine optimum heat-treatment cycle for superalloy turbine airfoils that will reduce the cost of heat-treating turbine blades for Navy and Air Force engines by 65%.

1996

- The NCEMT's developments in optimized welding technologies leads the NAVSEA technical community to certify the use of undermatched weldments for the HY-100 pressure hull of the New Attack Submarine (NSSN). Implementation of this technology, which identifies when undermatched welds can be used without compromising structural integrity, will provide superior weld performance and save an estimated $7M per NSSN.
- The NCEMT uses Integrated Product and Process Design (IPPD) and combines its process design capability with McDonnell Douglas Aerospace's product design expertise to fabricate a superplastically formed (SPF) T-45A trainer aircraft nose cone prototype. The team identifies the best SPF conditions for the manufacture of the nose cone and cuts production costs by 50%.
- The NCEMT develops comprehensive Casting Process Design system, which is being applied to optimize the casting of components as diverse as Navy submarine propellers, valves for aircraft launch systems, projectiles for the Air Force, and a trail end attachment for the Army.

1997

- Joint effort with the NSWC, Carderock Division; Newport News Shipbuilding; and the NCEMT leads to the certification of a cost-effective, undermatched welding system for the Seawolf and NSSN pressure hulls. The team used numerical modeling tools to optimize welding parameters in submarine fabrication.
- Major Navy suppliers estimate that the NCEMT's *Atlas of Formability* data on more than 120 materials contributed to the reduction of their forging development costs by 60%.
- In collaboration with leading investment casting foundries PCC Airfoils and Howmet, the NCEMT develops methodology to optimize the solution heat-treatment of single crystal turbine airfoils that is implemented into the production of Navy turbine engines for the F/A-18 Hornet and F-14 Tomcat fighters and expanded and applied to commercial engines.
- The NCEMT develops welding technology to ensure structural integrity when welding HSLA-65 steel with 70-ksi-series consumables, which provides reduced weight ship structures and results in significant savings in both acquisition and life-cycle costs. As a result, Newport News Shipbuilding estimates a 2,400-ton weight savings and potential life-cycle savings of $24M with use of HSLA-65 in the CVN-77.

1998

- Significant advances made by the NCEMT in the area of SSM are adapted to reduce the cost of manufacturing the 25-mm M919 Sabot for the U.S. Army. Previous conventional methods of manufacturing a finished sabot for an ammunition round require many time-consuming, costly machining steps.
- Under a Rapid Response initiative, the NCEMT establishes the feasibility of rolling neodymium (Nd) metal into ridged tapes. Working with the NSWC-CD, ingots of the brittle, rare-earth metal were processed into high-tolerance ridged tape, which enables NSWC-CD to confirm the effectiveness of a redesigned cryocooler—increasing its cooling capacity by 50%. The new technology is slated to cool the superconducting magnet in a mine-sweeping system under development for an air-cushioned landing craft.
- The U.S. Army Acquisition Pollution Prevention Support Office and Corpus Christi Army Depot consider the NCEMT's capabilities to access applicability of pulsed optical energy decoating as an alternative process for decoating Navy helicopter rotor blades. The NCEMT's demonstration shows a capability to reduce waste disposal and labor costs in the removal of aircraft coatings without damaging substrate integrity or causing adverse metallurgical effects.

1999

- NCEMT engineers develop powder compaction simulation software called PCS Elite®—a computer-based process modeling and simulation software package for die compaction. PCS Elite® allows P/M process designers to determine optimum tool design and pressing parameters. The predictive capabilities of the model have been confirmed through the use of quantitative metallography and a fully instrumented mechanical compaction press. Broad-based implementation of PCS® software within the P/M industry is being promoted through the Metal Powder Industries Federation and the Center for Powder Metallurgy Technology. PCS trademark achieves registration in May and PCS Elite trademark achieves registration in July of this year.
- The NCEMT helps the Army Construction Engineering Research Laboratory to develop a prototype mobile Plasma Energy Pyrolysis System (PEPS®) for DoD activities that produce a variety of problematic waste streams that must be safely and effectively disposed of.

NCEMT

2000

- The Office of Naval Research awards a competitively bid $150M contract for an additional five years of operation of the NCEMT to *CTC*.
- The NCEMT develops friction stir welding parameters for the AAAV armor weldment that greatly surpass ballistic shock test specifications that were never before passed by conventional welds. Not only did the plate pass the 673-fps impact specific minimum in a July demonstration at Aberdeen Proving Grounds, but exceeded it with impact velocities of 845 and 875 fps, impressing witnesses from the AAAV Government Program Office, General Dynamics Land Systems, and the U.S. Army.
- The NCEMT designs, fabricates, and tests a modified geometry baseline barrel and a Ta-10W-lined barrel, which completed a Schedule A endurance test at 500 shots per minute—marking the first time this has been achieved for any medium-caliber barrel with high-impetus ammunition.
- The NCEMT optimizes the casting of a new wear-resistant composite for the brake linings for anti-slack devices and hydraulic winch components that once had to be replaced on the Navy's Underway replenishment ships after only 85 hours of service—that now last for five years. This reduces the operating cost from $250 per hour to just $18.
- The NCEMT begins independent design, manufacture, and testing of reliable, cost-effective preproduction prototype Carriage, Stream, Tow, and Recovery System (CSTRS) for Organic Airborne Mine Counter Measure systems.

2001

- The NCEMT team is first to successfully cast a titanium slab using plasma hearth melting, which now allows U.S. combat vehicles to utilize low-cost, lightweight, high-performance titanium.
- The NCEMT is first to install the largest friction stir welding system in the United States—only one of two machines of its size in the world—that allows welding of full-sized combat vehicles for the U.S. Marine Corps AAAV and the U.S. Army combat vehicles.
- The NCEMT is first to successfully extrude aluminum alloy 2519 by developing improved fabrication technology and corrosion protection. The NCEMT orchestrated the fabrication of extrusions specific to the U.S. Marines' AAAV and established a production path with near-optimum extrusion parameters.
- The NCEMT successfully develops modeling tool for plasma arc cold hearth melting (PAM) process that is later implemented at Allvac for the manufacture of materials for F404 and F414 engine components for the Navy F/A-18 aircraft.
- The NCEMT successfully reduces cost and weight for High-Temperature Lightweight Radial Manifold used in the Concept 1 Dispenser Subsystem, part of the Surface Ship Torpedo Defense (SSTD) Soft Kill Countermeasure suite that is under development by the U.S./U.K. SSTD Joint Program Office. The aluminum manifold weight was reduced from 2.85 kg to 1.80 kg. The cost avoidance is $42.2M based on MANTECH guidelines at the obtained machining cost of $2,552 per system.

2002

- The NCEMT creates two designs for the 13–24 meter Advanced Metallic Army Bridge—the lightest, most rapidly deployable bridge ever built that can be deployed or recovered in just 10 minutes by only two soldiers. Results are met with such success that the NCEMT is asked to participate in a follow-on project to design a prototype.
- The NCEMT teams up with Timken Latrobe Steel, SPS Technologies, Electric Boat Corporation, and the NSWC-CD to develop the first-to-be-used, high-strength, marine-grade fasteners used aboard the Virginia-class submarines.
- The NCEMT identifies groundbreaking new lower-cost manufacturing methods that decrease the surface roughness of rhenium parts by 60%, which will broaden the number of machine shops able to process rhenium.
- A study conducted by the NCEMT to identify the lowest-cost process to produce the flat, double-angle cross-section turret ring for the AAAV identified roll forging as the most advantageous method.
- Half of 26 contributors to the newly published 720-page casting textbook, *Modeling for Casting and Solidification Processing*, are current/former NCEMT staff.
- The NCEMT, Lockheed Martin, EDO Corporation, and TRS Ceramics contribute to successful sea test of Lightweight Broadband Variable Depth Sonar system for NAVSEA Newport and Lockheed Martin by improving failing PMN ceramics as acoustic transducers. Previous transducers did not survive to pass a sea test before the NCEMT's new techniques that improved components.

2003

- The NCEMT receives high commendation from the Future Surface Combatant Program, named DD(X), as the NCEMT responds to a request for an evaluation of the needs and costs of existing plate forming capabilities within the DD(X) shipyards and provides an insightful recommendation of viable technologies for DD(X) plate forming requirements.
- The NCEMT, working with the U.S. Navy's PMA-264 Airborne Anti-Submarine Warfare, Assault and Special Mission Programs Office; the NSWC-CD; and battery manufacturers, improves the manufacturing process and high cost of thermal batteries used in the military to power sonobuoys, guided artillery, missiles, guidance systems, and countermeasure devices. The NCEMT's redesign greatly improved material utilization, press efficiency and cell-component quality—reducing costs, increasing production, and improving overall quality. The cost avoidance is $30M over 5 years for the sonobuoys program alone, and 7,400 more batteries can be produced per month.
- The NCEMT commercializes the process of electrodischarge machining (EDM) of rhenium for the U.S. Navy's Standard Missile 3. With MANTECH guidelines, now nearly any EDM manufacturer can produce complex shapes from rhenium because the NCEMT pioneered use of alternative methods for shaping, including electrochemical machining and abrasive waterjet cutting.
- Under the Manufacturing Technology Objective Program team, managed by the NCEMT for ARDEC and TARDEC, the NCEMT utilizes PAM to successfully process Ti-6Al-4V titanium alloy and cast the melt into rectangular slabs that could be directly rolled into armor plate—all in a single melting step, thus, reducing production costs.

New NCEMT Program Director at the Helm in Meeting U.S. Navy and DoD Directives

Daniel L. Winterscheidt

The entry of 2004 is cause both to reflect on the past and look forward to the opportunities and changes afforded by the new year. This issue of *Metalworking Technology Update* presents a timeline of some of the significant accomplishments and progress achieved by the NCEMT over the past 15 years. The retrospective presents a unique occasion to assess our achievements, understand how technology has transitioned within the Department of Defense (DoD), and contemplate the evolution of the NCEMT Program over the past decade and a half.

A significant change for the new year is my role as the Program Director for the NCEMT. I'm pleased to be leading an organization that is delivering revolutionary technologies to meet the demanding directives of the U.S. Navy and DoD—directives to protect the warfighter by manufacturing vessels and aircraft that are lighter, faster, stronger, and more effective.

This year, the NCEMT has a number of new projects that answer these mandates. A manufacturing concepts project is underway and several new projects have been developed in support of the future aircraft carrier CVN 21. Three projects have been developed with the goals of reducing weight and lowering the ship's center of gravity. On one project, high-strength and toughness steel (10Ni Steel) will be further developed, tested and evaluated for application on CVN 21. On a second project, application development is being performed to permit the use of stiff, lightweight metallic sandwich panels called LASCOR (LASer-welded corrugated-CORe) panels. On a third project, titanium components and manufacturing techniques will be developed, evaluated and demonstrated. Several projects also have been developed to implement welding enhancements. Manufacturing processes will be developed on one project to eliminate weld distortion of heavy plate erection units. Two other projects will address the availability of shielded-metal-arc-welded electrodes (MIL-10718-M) and low-fuming, flux-core welding electrodes for joining high-strength steels.

The NCEMT is also supporting DD(X)—the Multi-Mission Surface Combatant for the 21st Century. The NCEMT has partnered with the Navy Joining Center (NJC) to develop an automated thermal plate-forming system for the shipbuilding industry to ensure that complex curved steel plates are formed accurately and efficiently. On another project, the NCEMT has teamed with the NJC in the development of high-productivity welding technology for large thick-section, high-strength steel structures with enhanced survivability. Additional DD(X) projects are currently under consideration.

The Joint Unmanned Combat Air Systems (J-UCAS) Program is a joint Defense Advanced Research Projects Agency (DARPA)/Air Force/Navy effort to develop a weapon system that expands tactical mission operations. The goal of the J-UCAS weapon system is to exploit the design and operational flexibility of an uninhabited vehicle. To contribute to this new paradigm of weapon systems, the NCEMT is working with two prime weapons contractors to identify state-of-the-art metalworking technologies that will contribute to the operational performance while lowering the cost of this aircraft. Currently, the NCEMT is supporting both companies, through a Concept Exploration project, to identify the most promising metalworking technologies that meet these goals. Future anticipated projects include System Design and Manufacturing Development, Hybrid Machining, and Orbital Drilling.

In the coming year, I look forward to reporting on the progress of these projects; continuing our relationships with MANTECH, the Navy, and the defense community; and forging new relationships with program offices and prime contractors as we provide 21st Century metalworking solutions for ships that must go in harm's way.

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Concurrent Technologies Corporation (*CTC*) operates the National Center for Excellence in Metalworking Technology (NCEMT) for the U.S. Navy Manufacturing Technology (MANTECH) Program. The NCEMT serves as a national resource for developing and disseminating advanced technologies for metalworking products and processes. The NCEMT applies these technologies to solve productivity problems in support of the Navy and Department of Defense needs.

CTC is committed to assisting industry and government achieve world-class competitiveness. Through a unique concurrent engineering framework, *CTC* provides comprehensive solutions that improve our clients' product quality, productivity, and cost effectiveness. The professional staff of *CTC* has the requisite experience, knowledge, and resources to rapidly and effectively meet the diverse needs of our clients by transitioning appropriate science, technology, and management applications.

For further information about topics in this publication or about Concurrent Technologies Corporation, please contact Information Services at 717-796-2760.

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New Projects

Concept Exploration Project for Joint Unmanned Combat Air Systems (J-UCAS) Metalworking Technology Needs

Northrop Grumman's X-47A Pegasus, J-UCAS

ONR MANTECH has selected the Joint Unmanned Combat Air Systems (J-UCAS) (pictured) as a key naval system in early development on which MANTECH can have a significant impact. ONR has directed the NCEMT to perform a Metalworking Technology Concept Exploration Project to determine where MANTECH may best benefit the production needs of the J-UCAS program. Working with two J-UCAS industrial partners, Boeing and Northrop Grumman, the NCEMT will focus on identifying enabling metalworking technologies that are needed for its production.

Concept Exploration Project for CVN 21 Metalworking Technology Needs

U.S. Navy's CVN 21

ONR MANTECH has also selected the CVN 21 (pictured), the Navy's next generation of aircraft carriers, as a key naval system in early development on which MANTECH can have a significant impact. ONR has directed the NCEMT to perform a Concept Exploration Project to determine where MANTECH may best benefit the PEO Carriers in the CVN 21 Program. The NCEMT, along with Integrated Project Team members NGGN, NAVSEA, the CVN 21 Program Office, material suppliers, and others, will explore concepts on welding, forming, and straightening of HSLA-65 plates; implementation of aluminum structures; development of friction stir welding; evaluation of weight-efficient structural panels; and extension of net-shape technologies for component manufacture.

Automated Thermal Plate Forming

Northrup Grumman's DD(X)

The NCEMT has been selected by ONR MANTECH as a lead Center of Excellence to oversee the development of an automated thermal plate-forming (ATPF) system that will be a collaborative effort among the NCEMT, NJC, iMAST, NGSS-Ingalls, BIW, NSWC-CD, and the DD(X) Leadership Integrated Project Team to develop a prototype ATPF system that is capable of forming steel plates whose size, thickness, and grades are representative of the hull requirements for the DD(X) land attack destroyer (pictured). An ATPF system, capable of producing complex plate geometries within tight tolerances, will increase shipyard plate production rate (throughput), reduce rework caused by human error, decrease skilled labor costs, and provide plates that comply dimensionally to stringent hull signature requirements.

METALWORKING TECHNOLOGY *Update*

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What's New

Newest MANTECH Projects

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