ENGINEERING RESEARCH & DEVELOPMENT SERVICES

Creare®

PEOPLE & TECHNOLOGY
FALL 2012

ABOUT CREARE

Creare is an advanced engineering research and development firm working in a wide range of industries: aerospace, biomedical, cryogenics, and more. For more than 50 years Creare has served both industry and government on the frontiers of product and process technology. Our *People & Technology* newsletter provides just a sampling of 80+ active engineering projects.

Creare engineers work on challenging problems requiring multidisciplinary solutions for improved energy efficiency at a time of global need, increased national security, improved medical assessment and delivery systems, and much more.

Creare interns have the opportunity for direct project involvement, whether coding, analyzing data, or designing/building experimental test facilities. Engineering coursework becomes immediately relevant in our R&D environment.

Founded in 1961, we are a company of approximately 120 people, including 45+ advanced degree engineers. Find more *People & Technology* newsletters on our website.

Creare's location in Hanover, New Hampshire, offers the best of four-season living in a New England college town. The area offers exceptional opportunities for the outdoor enthusiast, excellence in medical centers and schools, and cultural amenities offered by Dartmouth College.

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Creare is an Equal Opportunity Employer F/M/D/V.

Cryogenic Machining Hits the Mark

In the last 20 years, there has been a renewed emphasis on Advanced Manufacturing in the United States. The ever-increasing need for systems that are more efficient, lighter, and lower cost has required the development and use of new materials such as ceramics, titanium, and composites. In most cases, the raw material can be made affordably; however, shaping that material with conventional processes into a useful component is too difficult and costly. To help solve these problems, Creare developed an innovative Indirect Cooling System (ICS) for cryogenic machining, using liquid nitrogen as a replacement for conventional fluid coolants (and at 1% or less of the current coolant volumes).

MAG's VMC 960 Machine Tool with a Fully Integrated ICS for Cryogenic Machining.

Creare initially demonstrated the technology by milling titanium aerospace components. (The Fall 2008 issue of Creare *People & Technology* featured an article on this work.) The critical breakthrough for this technology occurred when Creare engineers designed and implemented the routing of cryogen flow through the machine tool spindle, utilizing our extensive experience in cryogenics, vacuum-insulation techniques, precision fabrication, and system integration. The result was the development of highly integrated machining centers, reduced machining costs, increased processing speeds, and the elimination of costly and hazardous coolants. In addition, we developed design tools to accurately predict system performance for a wide range of tool geometries, machining conditions, and materials. A technology demonstration for the F-35 program evidenced significant productivity gains and cost reductions while maintaining and improving machined part quality. As a result, the prime contractor, Lockheed Martin Aeronautics Company, issued a press release endorsing the Creare technology for machining F-35 titanium components. The successful demonstration and endorsement were critical steps in the industrial acceptance of the technology and its transition to commercial markets.

Creare transitioned its technology via licensing to MAG Industrial Automation Systems (www.mag-ias.com), North America's largest machine tool and automation supplier. The technology was featured at key industry machine tool shows including the International Machine Tool Show (IMTS) in 2010, and the Interactive Manufacturing Experience (imX) in 2011. At the 2012 IMTS, MAG will feature a platform that focuses on the ability to retrofit the technology to existing machines. MAG will be delivering its first product, an AutoDrill with Cryogenic Machining technology, to Boeing's South Carolina facility in early 2013 for use in manufacturing its new 787 aircraft.

The goal of Creare's R&D is commercial application whenever possible. While the path is often long, creating a broad, positive impact is the goal. In some cases, as in the case of Cryogenic Machining, Creare's technology can change the landscape of an entire industry. Creare's work in this area is a prime example of how an innovative idea combined with technical expertise and entrepreneurial determination can result in success. Advanced Manufacturing at Creare has grown to encompass additional innovations including laser-assisted machining, real-time metrology of part geometry, adaptive control of tool path during machining, cryogenic-assisted grinding, laser-assisted consolidation and curing of thermosetting or thermoplastic composites, novel back surface reflectors for paper drying, and many others.

Dr. Jay C. Rozzi is a Principal Engineer and leads the Advanced Manufacturing business area. He received undergraduate, M.S., and Ph.D. degrees in Mechanical Engineering from Purdue University. While focusing on Advanced Manufacturing, he has also developed innovative technologies in areas related to two-phase flow, thermal systems, cryogenics, and biomedical systems.

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Hearing Above the Noise

The door closes, and a level of profound quiet envelops you. The audiologist takes great care to fit the headphones to first one ear and then the other to conduct your hearing test, assessing your ability to hear a range of frequencies, as well as performing other diagnostics to determine the source of your hearing problem. Unfortunately, this level of medical expertise and quality is not universally available.

In the human auditory system, sound is first funneled from the outer ear to the eardrum which transmits it to the middle ear, which in turn transmits that acoustic energy to the cochlea; the cochlea, an organ deep within the skull, transforms the acoustic information into neural impulses which the central auditory system processes and transmits to the brain for interpretation and action. Insults such as excessive noise and sudden blasts as well as certain diseases and drugs can impact any one of the vital links in this complex system. Creare is developing technologies to test human hearing in challenging environments, improving the sensitivity of the assessments and providing operational support for remote or rural applications.

One challenging and noisy environment is the International Space Station. Monitoring the auditory health of astronauts in space required innovative approaches to use the existing onboard computer and minimal hardware, yet provide accurate hearing tests. Under contract for NASA, Creare significantly advanced hardware and software development, but this project ended before Creare could test the prototype in space. However, as is often the case, one opportunity segues to the next and another challenging project was soon underway.

The National Institutes of Deafness and Communication Disorders engaged Creare and Dartmouth College to understand the effects of HIV/AIDS on patients' hearing. Are people with HIV/AIDS more likely to suffer from hearing loss? If so, is the hearing loss due to the disease, or is it due to drugs used to treat the disease? Or, is it due to co-morbidities associated with the disease (tuberculosis and infections)? And what part of the auditory system is affected? We proposed to use a modified version of the space station system to test a large number of HIV/AIDS subjects at the Dartmouth clinic in Dar-es-Salaam, Tanzania.

Creare's technology supports hearing tests in Tanzanian clinic.

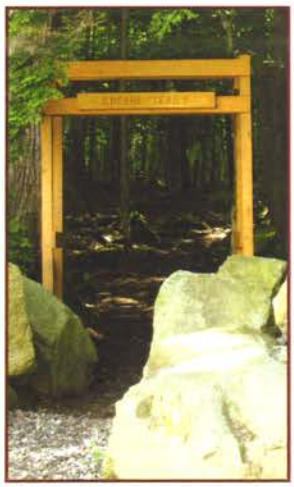
For this effort, Creare developed easy-to-use software to conduct and manage the hearing tests, specifically designed for nurses rather than trained audiologists (or astronauts), and integrated with educational materials. Based on a ruggedized laptop computer, our system is unusual in the full range of tests it performs: middle ear (tympanometry); inner ear (otoacoustic emissions); the central auditory system; as well as quality control measures to ensure data reliability. Creare engineers traveled to Tanzania to help deliver the testing hardware and get the initial group of nurses trained. The clinical work utilizing this technology will be completed in 2015.

Now, Creare continues to advance hearing science by improving testing sensitivity and relevance to specific applications; prototyping easy-to-use, high performance testing systems; and continuing to develop and support operational applications. Other applications for our technology include hearing screening at industrial sites, in neo-natal nurseries, and for military personnel in a great variety of environments. Ultimately, the goal is to make advanced auditory evaluation available in remote and noisy locations anywhere.

Odile Clavier received her B.S. from Florida Tech, and M.S. and Ph.D. degrees from Stanford University in Aeronautics and Astronautics. Since joining Creare in 2003, she has been leading research in diverse areas including hearing assessment and small satellite technology. She is broadly interested in dynamics, controls and precision engineering with an emphasis on biomedical and aerospace applications.

Creare Hiking Trails

As part of the company's 50th Anniversary Year, outdoor enthusiasts on Creare's staff developed hiking, mountain biking, snowshoe, and cross-country ski trails on the forested 30+ acres behind the facility. Using GPS and following natural features and some pre-existing trails, new trails were roughed out. Employee work parties did the hard work of tree cutting, stumping, rock removal and rearrangement, and bridging over wet areas to create an excellent lunchtime getaway, for use in any season. The entrance (shown below) directs visitors to the trail start, and trail markers ensure employees make it back in time for an afternoon project meeting. The bike shelter is close to the trail entrance for convenience, and facility showers make it possible to clean up as needed! A memorial bench and two picnic areas further down the trails offer an alternative for quiet reflection during the workday. Creativity is enhanced by a change of view; the Creare Trails offer opportunity for a problem-solving "aha" moment.



Creare

Wave Front Imaging

Many combustion systems involve a liquid jet of fuel emanating into a gaseous flow, followed by subsequent breakup and atomization. This mixing of fuel and oxidizer is critically important in modern propulsion devices (such as afterburners and rockets), and directly affects thrust, efficiency, stability and emissions. Despite its importance, the process of jet breakup and atomization is poorly understood, limiting design capabilities and hampering the development of the next generation of propulsion technology. Creare engineers and researchers from the Massachusetts Institute of Technology are developing a 3-D diagnostic imaging system that allows visualization of the dense core region of the jet. The dynamics occurring in this core region typically play a dominant role in determining the fuel distribution in the combustion zone. By simultaneously imaging the jet from multiple vantage points and applying emerging Wave Front Imaging (WFI) methods, 3-D structural information can be inferred from data collected in a single exposure. Additionally, the multiple viewpoints address the partial occlusions that defeat conventional imaging approaches. Initial results have shown excellent performance in representative test sprays. Current work is focused on developing robust research-grade tools that can be deployed in combustion research facilities and introducing the WFI diagnostic in other applications.

Compact Swaging Machine for Carriers

Life onboard an aircraft carrier is demanding and fraught with many dangers for sailors and aircrews, above and below the flight deck. Labor-intensive tasks, both challenging and tedious, must be accomplished with the utmost care to ensure that the carrier operates safely and stays mission-ready. An extremely critical task involves the maintenance of the arresting cables for aircraft landings which are comprised of the cross deck pendant (CDP) which stretches across the center of the aircraft deck and engages the aircraft tail hook, the purchase cables (PCs) and terminals on each side of the CDP, and the hydraulic engines located below the flight deck. The purchase cables are woven through the engines and together they provide the smooth braking force in the system needed to safely stop the aircraft. The PC terminals require regular replacement (about every 1500 arrestments) due to the repeated stress and strain of aircraft landings. Creare's project for the Navy is focused upon an improved method for replacing the purchase cable terminals.

The Navy currently uses speltering (a bonding process using molten zinc) on board its carriers for attaching the replacement terminals to the purchase cables. Speltering is a hazardous, difficult, and labor-intensive process. Several sailors will work as long as 12 hours to complete one terminal replacement. To revolutionize this task, Creare is developing a Compact Swaging Machine (CSM). The Creare machine uses a process comparable to the existing swaging process used at the land-based Navy facility to produce the cross deck pendant assembly, but without the use of large industrial-style hydraulic presses. Creare's CSM is much smaller and lighter to fit on board ship and enables one sailor to complete the terminal swaging process in less than an hour. Creare's CSM will improve overall operability of the aircraft carrier, reduce operational costs, and improve the quality of life for Navy personnel by allowing the Navy to entirely eliminate the speltering process.

Creare's Compact Swaging Machine offers an improved on-board process to attach replacement terminals to the purchase cables.

Creare technology will revolutionize maintenance of carrier arresting gear. CSM project team and prototype.

As this *People & Technology* newsletter goes to press, Creare is completing development and testing of the prototype compact swaging machine. We conducted accelerated lifetime testing of the machine as well as environmental, shock, and vibration tests. We worked closely with the Navy to qualify the new swaged PC terminal by conducting land arrestments with jet cars and F-18 aircraft. In addition we are performing laboratory tests to validate the life expectancy of the terminal and the purchase cable. We look forward to the first installation of our prototype machine on the USS Dwight D. Eisenhower in 2013 to conduct arrestment tests at sea. Following a successful conclusion to our testing program, the Navy's plan is to deploy the Creare CSM technology across the entire carrier fleet by 2016. In recognition of this advanced technology effort, Creare personnel and our Navy collaborators received the prestigious Innovation Award from NAVAIR.

Mike Barton received a Master's degree from Dartmouth College and a Bachelor's degree from the University of New Hampshire, both in Mechanical Engineering. Prior experience includes a four-year tool and die making apprenticeship, early employment at Creare as a Mechanical Technician and an Engineering Intern. Mr. Barton has over fifteen years of fabrication and design experience with expertise in cryogenics, vacuum systems, machining, welding, fabrication, and advanced manufacturing. He is the Systems Engineer and Deputy Program Manager on this Navy project.

Inside Perspective

My graduate school research focused on combustion in scramjet engines, a type of air-breathing engine in which the combustion takes place at supersonic speeds. These engines have the potential to greatly increase the speed of aircraft and decrease the cost of space launch. Stabilizing the flame is one of the primary technical challenges in scramjets. For my research, I built a laboratory scramjet combustor and investigated the fundamental flame stabilization mechanism and structure under the extreme conditions encountered in these engines.

As graduation neared, I considered what career path would be right for me. I had a strong desire to be involved with an entire technology development cycle, from initial conception to the testing of prototypes. While I enjoyed my hypersonic propulsion work, I worried about the potential narrowness in this niche field, as well as the long development time and large project scale typically associated with this work. I was interested in other fields such as energy conversion and diverse combustion applications. However, I did not want to leave hypersonics behind entirely or take a big step back technically.

My job search led me to Creare where I am continuing to work in my areas of technical expertise while also learning new skills in areas of interest. The projects are fast paced, and my individual contributions are clear and important. I am impressed by the knowledge and helpful nature of my work colleagues.

Since joining Creare in late 2009, I have worked on a wide variety of projects involving gas turbine augmentors, hypersonic flow control, small burners for power generation and cooking, novel machining technologies, and modeling of parachutists in free fall. My first project at Creare involved developing a novel fuel system for augmentors to improve flame stability. During this project, we used a unique passive optical combustion sensor for analysis of the laboratory flames. Due to the success of this sensor technology, we are now developing a version of the sensor which can make measurements in augmented jet engines on military aircraft. Seeing the potential of this technology for scramjets, I wrote a proposal to use these sensors as part of an active scramjet engine controller. The proposal was recently awarded, and we will initially test the sensors in the scramjet combustor I built in graduate school! I find it very rewarding to combine my academic background with the skills I am learning on the job. Creare is proving to be a great environment for me to grow as an engineer and project manager.

In addition to the work offered at Creare, I was also attracted to the Upper Valley by the abundant opportunities for outdoor recreation in the area. I enjoy hiking and mountain biking on the many area trails, including those just outside Creare's back door. I am also fond of the lunchtime football and volleyball games which are played weekly on Creare's front lawn. In the winter I also enjoy snowboarding and cross-country skiing at the many area resorts and in the backcountry. Just as my work assignments are diverse, it seems there is a new personal adventure to pursue in every season.

Dr. Danny Micka received his B.S. from Georgia Tech and his M.S. and Ph.D. in Aerospace Engineering from the University of Michigan. His thesis research focused on the flame stabilization and structure in a dual-mode scramjet combustor. At Creare, Dr. Micka is working on combustion projects involving gas turbine augmentors, remote power generation, and military field kitchens. He is also involved with hypersonic flow control, flight dynamics modeling, and advanced machining technologies.

Danny Micka spring snowboarding at Tuckerman's Ravine.

Creare Heads to Mars

In late 2011, an Atlas V rocket lifted off from Cape Canaveral carrying the Mars Science Laboratory rover "Curiosity," marking the beginning of a trip that will last until early August 2012, when the rover touches down in the Gale crater on Mars to begin exploration. For Creare the lift-off marked the end of more than five years of NASA-funded research to design, build, test, and qualify two vacuum pumps that are key components in the most complex instrument ever used on Mars. This instrument will be able to detect minute traces of water, carbohydrates, and other materials confirming that life exists or once existed on the red planet. Even as the Curiosity rover represents the culmination of NASA's Mars program to date, there are already new missions that need Creare's vacuum pumps for further exploration of Mars and other planets in our solar system. Creare is currently funded to build pumps for the European Space Agency ExoMars rover, and we are developing pump technology for use on the planet Venus and Titan, a moon of Saturn. Long-term we hope these robots will enable astronaut exploration on Mars and beyond.